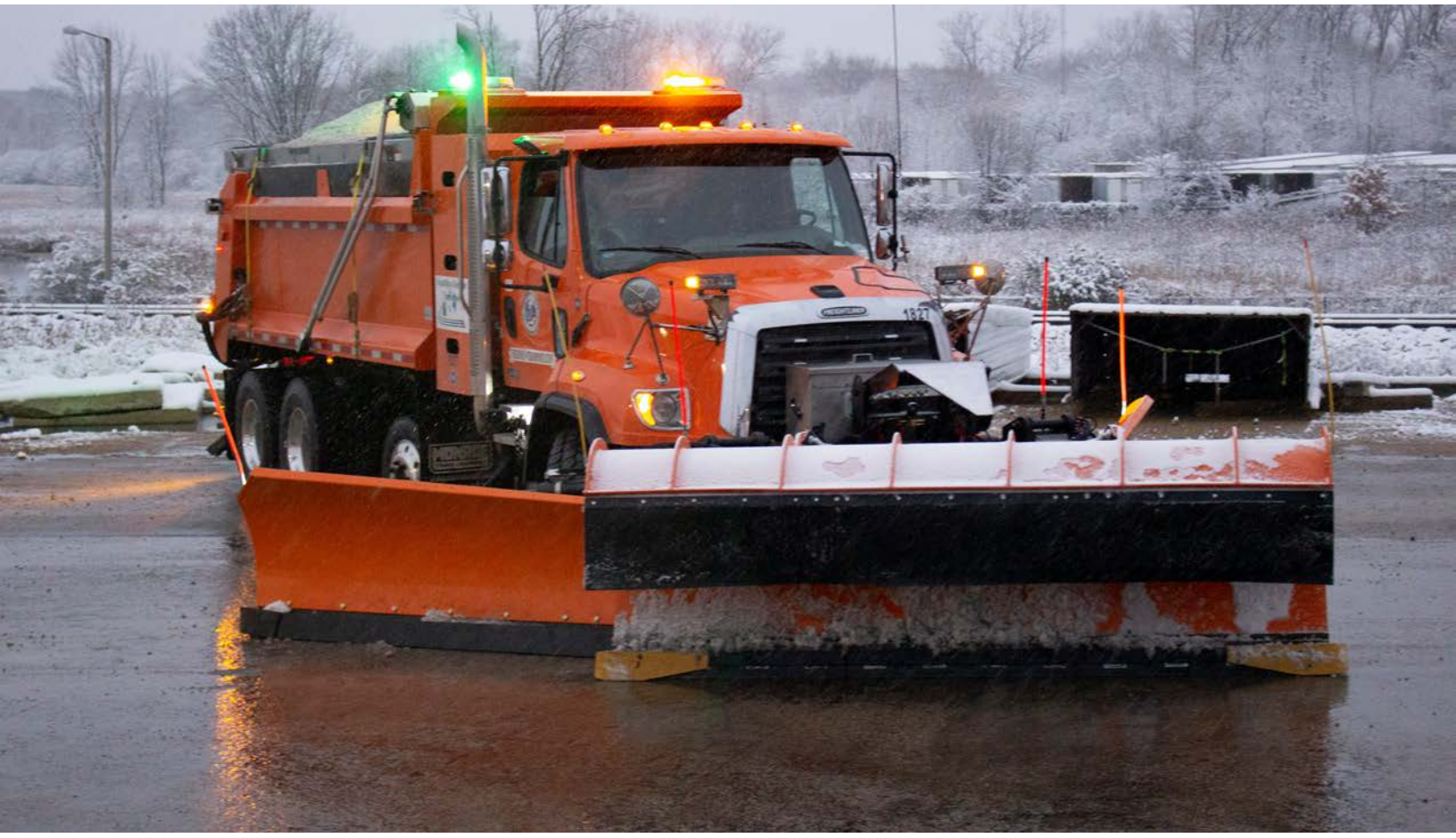
ANNUAL WINTER MAINTENANCE REPORT 2022/2023

Balancing Act: Maintaining Salt Reduction Effort During Harshest Winter in a Decade



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

NOVEMBER 2023

Acknowledgments

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

- Rebecca Szymkowski, Bureau of Highway Maintenance
- Cody Churchill, Bureau of Highway Maintenance
- Mike Adams, Bureau of Highway Maintenance
- Emil Juni, Bureau of Highway Maintenance
- Donald Lyden, Bureau of Transportation Safety

A great deal of effort went into preparing this report. The group wishes to thank our county partners in their ongoing efforts to make Wisconsin's winter maintenance as safe and efficient as possible. The individuals above would like to thank you for taking the time to review this report. If you have additional questions or require additional information, please contact Cody Churchill at the Bureau of Highway Maintenance (BHM), cody.churchill@dot.wi.gov.

Cover Photo Credit: Wisconsin DOT

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Glossary

AVL - GPS: Automated Vehicle Location - Global Positioning System

BHM: Bureau of Highway Maintenance

BMP: Best Management Practice

BTO: Bureau of Traffic Operations

DLA: Direct Liquid Application

FHWA: Federal Highway Administration

GUI: Graphical User Interface

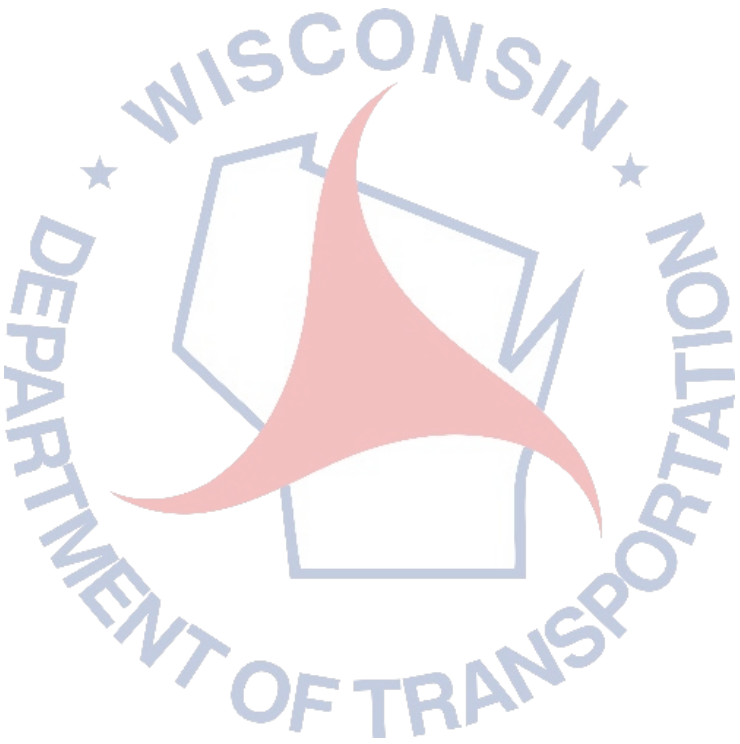
MDSS: Maintenance Decision Support System

NWS: National Weather Service

RWIS: Roadway Weather Information System

STOC: State Traffic Operations Center

WISDOT: State of Wisconsin Department of Transportation


WISCONSIN
DEPARTMENT OF TRANSPORTATION

1 Summary

Table 1.1. Statewide Summary: This Winter Versus Last Winter, by the Numbers

		2021-2022 Winter	2022-2023 Winter
Infrastructure	Lane miles	**34,736**	**34,723**
	Patrol sections[4]	**754**	**754**
	Average patrol section length[4]	**46.1 lane miles**	**46.1**
Weather	Average statewide Winter Severity Index (100=normal)	**97.1**	**116.2**
	Number of storms, statewide average and range across counties	**Average: 34 Range:10-77**	**Average: 38 Range:14-69**
	Snowfall (in), statewide average and range across counties	**Average: 64.6 Range: 24.6 - 225.1**	**Average: 100.6 Range: 39.9 - 281.2**
Materials[1]	Salt used	**387,600 tons 11.2 tons per lane mile**	**483,874 tons 13.9 tons per lane mile**
	Average cost of salt	**$81.80 per ton**	**$83.31 per ton**
	Total liquids used (prewet, anti-icing, direct liquid application)	**14.394.545 gal.**	**20,153,562 gal.**
	Sand used	**12,625 cubic yd.**	**10,849 cubic yd.**
Costs, Equipment and Performance	Total winter costs[2]	**$85,354,493**	**$118,759,205**
	Total winter costs per lane mile	**$2,457**	**$3,420**
	Average crew reaction time from start of storm	**2.56 hours**	**2.56 hours**
	Percentage of roads to bare/wet pavement (Within WisDOT target times)	**72%**	**73%**
	Road Weather Information System (RWIS) stations	**75**	**75**
	Underbody plows	**803**	**850**
	Counties that used anti-icing agents during the winter season	**66 out of 72 (92%)**	**66 out of 72 (92%)**
Labor and Services	Regular county winter labor hours[3]	**131,702 hrs.**	**184,644 hrs.**
	Overtime county winter labor hours	**108,230 hrs.**	**154,418 hrs.**

1. All material usage quantities are from the county storm reports except for salt. Salt quantities are from WisDOT's Salt Inventory Reporting System.
2. Costs refer to final costs billed to WisDOT for all winter activities, including activities such as installing snow fences and thawing culverts.
3. Labor hours come from county storm reports, and reflect salting, sanding, plowing and anti-icing efforts.
4. Patrol sections and average length include hybrid sections in some counties which may include a portion of county highway.

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 Maintenance 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. The report has also been shared with the WisDOT Secretary's Office, the state legislature, national organizations such as Clear Roads, and the general public.

REPORT STRUCTURE AND DATA SOURCES

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

- Section 2: Weather
- Section 3: Winter Operations
- Section 4: Performance
- Section 5: Looking Ahead

Each section has several subsections; refer to the Table of Contents for more detail. To improve readability, the 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 , D, E and F), which reflect the difference in the level of service provided on roads in these counties and facilitate comparisons within these groups. See Table 1.3 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 regions in different parts of the state.

This report presents data from several sources:

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

The final billed amounts are considered the most accurate source of cost and materials data, and are presented wherever possible.

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 Maintenance, in partnership with the five WisDOT regional offices, is responsible for the maintenance of the state trunk and Interstate highway system. This system includes 34,723 lane miles of highway and ~4,600 bridges.

WisDOT contracts with the state's 72 county highway departments to provide snow and ice control on all state- and U.S.-owned highways in Wisconsin, including the Interstate system. This partnership was set up more than 100 years ago and is unique in the nation.

This relationship benefits both WisDOT and the county highway departments. WisDOT receives the services of a skilled, experienced work force at fair labor rates, and the counties are able to purchase more pieces and types of equipment than they could otherwise afford. This equipment is then available for use on both county and state roads, an arrangement that allows WisDOT and the counties to avoid duplicating equipment and facilities. This arrangement also allows for increased efficiencies in work crews, thus reducing labor costs to taxpayers.

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

Wisconsin DOT policy in the "Highway Maintenance Manual" specifies two types of snow removal strategies in an effort to be cost-effective while recognizing the public need for clear roads during hours when most travel is done. High-volume highways with the most traffic typically receive 24-hour coverage, while on lower-volume highways, 18-hour coverage is sufficient. On 18-hour routes, the service hours can be adjusted based on the timing or severity of the storms; passing lanes, if present, may require less attention than the driving lanes and ramps.

Table 1.2 shows these categories and what percent of the highways fall into each group.

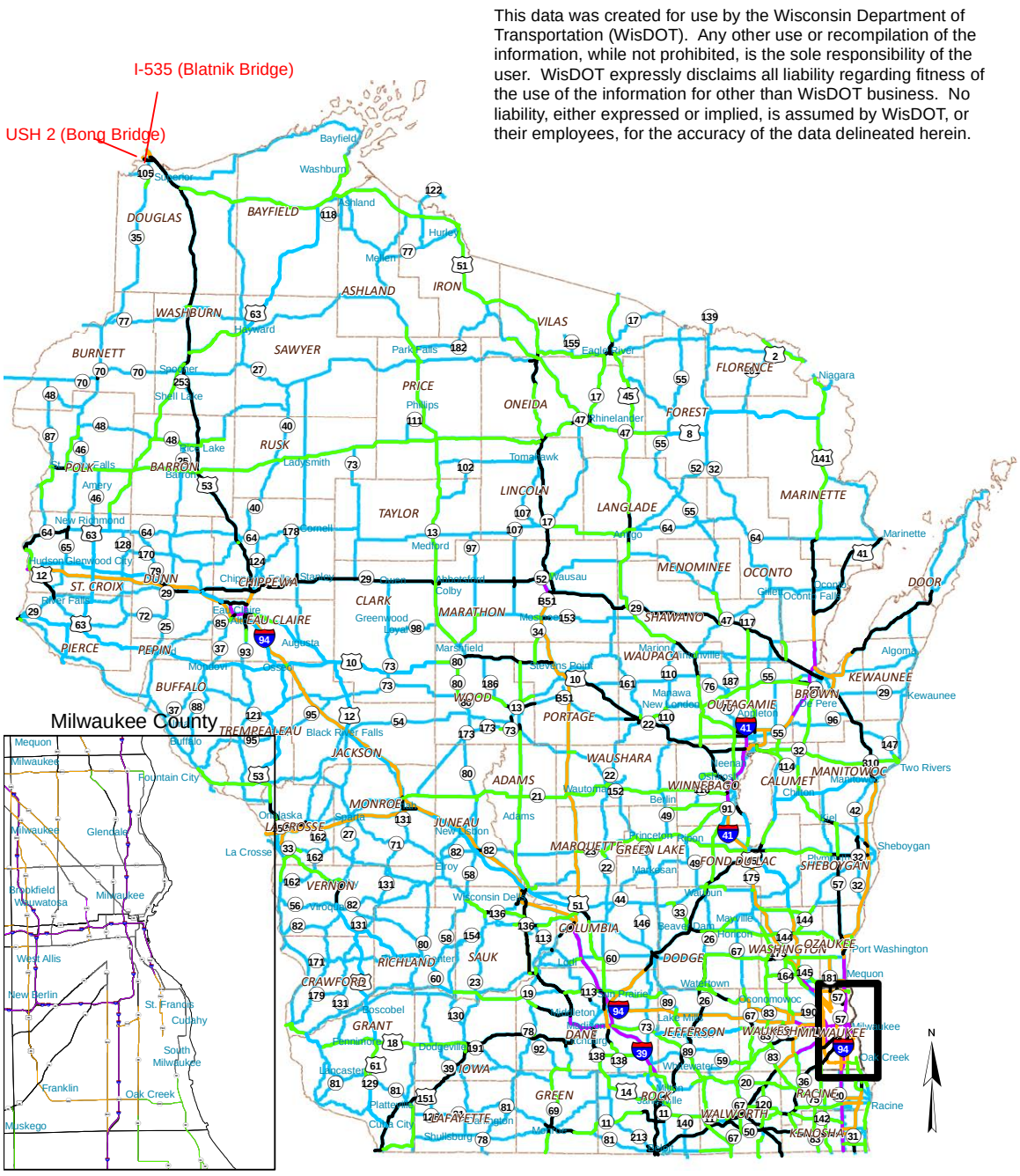
To fairly compare counties with similar levels of service, WisDOT assigns the 72 counties into six winter service groups – A, B, C, D, E, and F with winter service group A being the most urban and complex counties and F the most rural. Table 1.3 shows which counties are assigned to each group. These are the original assignments from when this method for comparison was developed about 20 years ago. Today's definition of the group might not fit all the counties assigned to

Table 1.2. Lane Miles Per Category

Category	Definition	Lane miles	% of total
1	Major urban freeways and highways with six lanes and greater	3,616	10%
2	High volume four-lane highways (Average Daily Traffic ≥ 25,000)	3,229	9%
3	All other four-lane highways (ADT < 25,000)	8,025	23%
4	High volume two-lane highways (ADT ≥ 5,000)	4,055	12%
5	All other two-lane highways (ADT < 5,000)	15,798	45%
Total		34,723	-

Figure 1.1. WisDOT Snow Plowing and Ice Control Categories During A Storm

Online at: https://wisconsindot.gov/Pages/doing-bus/local-gov/hwy-mnt/winter-maintenance/default.aspx



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Snow Plowing and Ice Control Categories During a Storm

Category

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

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

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

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

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

***ADT = Average Daily Traffic**

Table 1.3. County Winter Service Groups

Winter Service Group	County Names	Number of Counties	% of Counties
A	Dane, Milwaukee,Waukesha	3	4%
B	Brown, Chippewa, Columbia, Dodge, Eau Claire, Fond du Lac, Grant, Jefferson, Kenosha, Marathon, Monroe, Outagamie, Portage, Racine, Rock, Sauk, St. Croix, Walworth, Washington, Waupaca, Winnebago	21	29%
C	Barron, Clark, Crawford, Douglas, Dunn, Iowa, Jackson, Juneau, La Crosse, Lincoln, Manitowoc, Oconto, Pierce, Shawano, Sheboygan, Vernon, Wood	17	24%
D	Bayfield, Buffalo, Door, Green, Lafayette, Marinette, Marquette, Oneida, Ozaukee, Polk, Richland, Trempealeau, Washburn, Waushara	14	19%
E	Ashland, Burnett, Calumet, Forest, Green Lake, Iron, Langlade, Pepin, Price, Rusk, Sawyer, Taylor, Vilas	13	18%
F	Adams, Florence, Kewaunee, Menominee	4	6%

that group, but for now the counties are still assigned to the Winter Service Group in this table. Be sure to look at Chapter 4B if you are interested in a county by county comparison of plow routes in this table and winter patrol sections – a plow route is the same as a winter patrol section.

THIS WINTER IN WISCONSIN

Table 1.4 on the following pages summarizes key data from this winter for all 72 counties, including total salt use and cost data. This table facilitates comparisons in these core areas across regions and counties, and serves as a quick reference for commonly used data. The table uses a similar format to the Storm Report Summary (Table A-1 of the Appendix), but the cost data in Table 1.4 are actual billed costs as submitted to WisDOT by the counties, rather than estimates from the storm reports.

COUNTY-BY-COUNTY
QUICK REFERENCE WINTER SUMMARY TABLE
FOR SECTION 1: INTRODUCTION

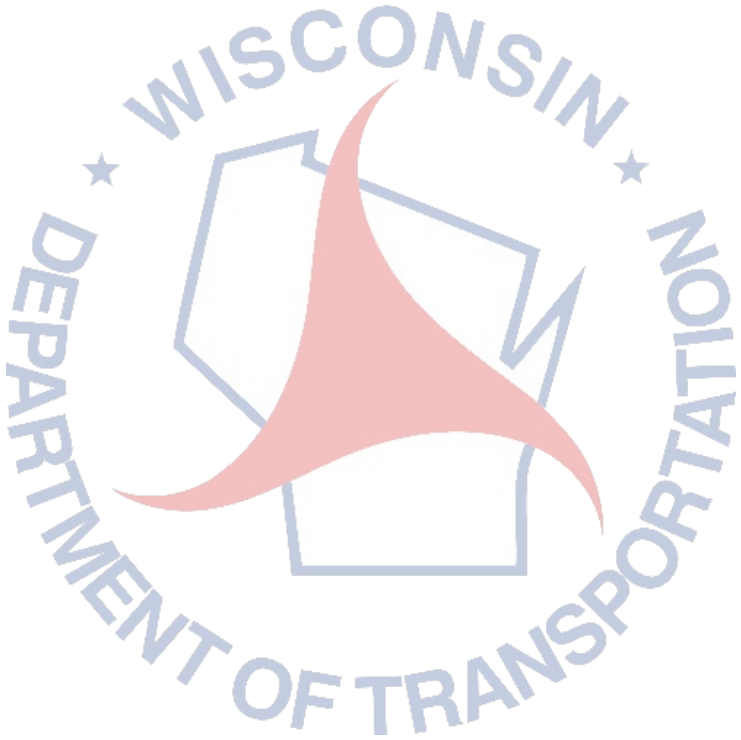
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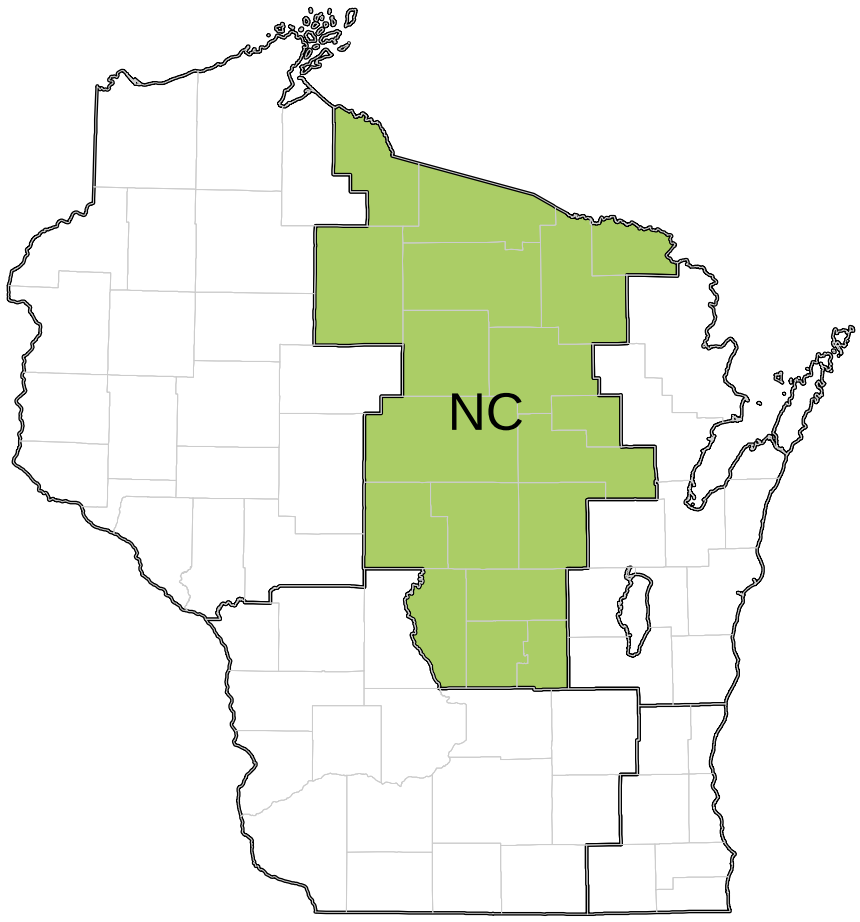
Table 1.4. Winter in Wisconsin, 2022-2023												
County	Lane miles	MDSS Severity Index	Snowfall (inches)	Total salt used (tons)	Salt used (tons) per lane mile	Salt used per lane mile per Severity Index	Total salt costs	Total salt costs per lane mile	Total winter costs	Total winter costs per lane mile	Total winter costs per lane mile per Severity Index
North Central Region											
Adams	202.76	98.6	71.8	2,258	11.14	0.11	$ 225,484	$1,112	$ 526,623	$ 2,597	$ 26.33
Florence	137.43	161.5	137.6	3,055	22.23	0.14	$ 275,347	$2,004	$ 558,113	$ 4,061	$ 25.15
Forest	314.15	166.4	130.2	6,569	20.91	0.13	$ 583,918	$1,859	$ 1,225,201	$ 3,900	$ 23.44
Green Lake	154.23	91.1	71.9	905	5.87	0.06	$ 85,613	$555	$ 278,647	$ 1,807	$ 19.83
Iron	240.51	242.7	281.2	4,778	19.87	0.08	$ 473,261	$1,968	$ 1,221,887	$ 5,080	$ 20.93
Langlade	300.53	137.6	134.6	4,003	13.32	0.10	$ 362,392	$1,206	$ 909,811	$ 3,027	$ 22.01
Lincoln	399.09	145.9	155.8	5,032	12.61	0.09	$ 475,675	$1,192	$ 1,288,448	$ 3,228	$ 22.13
Marathon	903.02	128.6	108.5	10,639	11.78	0.09	$ 979,958	$1,085	$ 3,077,089	$ 3,408	$ 26.49
Marquette	245.99	96.7	78.2	1,169	4.75	0.05	$ 108,530	$441	$ 604,013	$ 2,455	$ 25.40
Menominee	90.66	113.4	84.7	1,817	20.04	0.18	$ 159,496	$1,759	$ 302,218	$ 3,334	$ 29.40
Oneida	394.97	174.7	135.2	4,444	11.25	0.06	$ 405,782	$1,027	$ 1,550,546	$ 3,926	$ 22.47
Portage	559.84	108.9	73.4	3,806	6.80	0.06	$ 326,136	$583	$ 1,650,203	$ 2,948	$ 27.08
Price	318.47	176.5	179.4	5,293	16.62	0.09	$ 502,782	$1,579	$ 1,333,376	$ 4,187	$ 23.73
Shawano	533.57	112.2	130.1	6,712	12.58	0.11	$ 525,147	$984	$ 1,923,766	$ 3,605	$ 32.14
Vilas	307.61	203.1	190.4	6,182	20.10	0.10	$ 618,385	$2,010	$ 1,587,752	$ 5,162	$ 25.42
Waupaca	557.05	98.6	86.3	5,785	10.39	0.11	$ 451,461	$810	$ 1,523,241	$ 2,734	$ 27.72
Waushara	342.05	99.8	86.7	1,804	5.27	0.05	$ 173,040	$506	$ 576,971	$ 1,687	$ 16.91
Wood	448.55	107.2	87.8	5,708	12.73	0.12	$ 522,282	$1,164	$ 1,305,887	$ 2,911	$ 27.17
Region total	**6,450.48**			**79,959**			**$ 7,254,690**		**$ 21,443,793**		
Region average	**358.36**	**136.9**	**123.5**	**4,442**	**12.40**	**0.09**	**$ 403,038**	**$1,125**	**$ 1,191,322**	**$ 3,324**	**$ 24.29**

Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data is taken from WisDOT's Salt Inventory Reporting System.



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Northeast Region											
Brown	866.87	99.0	86.1	14,766	17.03	0.17	$ 978,248	$1,128	$ 3,289,965	$ 3,795	$ 38.33
Calumet	219.61	97.7	91.0	2,091	9.52	0.10	$ 170,730	$777	$ 578,659	$ 2,635	$ 26.98
Door	274.02	85.5	80.5	3,078	11.23	0.13	$ 256,736	$937	$ 809,767	$ 2,955	$ 34.55
Fond du Lac	626.81	98.8	68.7	6,631	10.58	0.11	$ 531,342	$848	$ 1,776,547	$ 2,834	$ 28.68
Kewaunee	125.73	80.5	107.5	1,150	9.15	0.11	$ 96,359	$766	$ 291,615	$ 2,319	$ 28.82
Manitowoc	424.86	84.6	50.3	6,511	15.33	0.18	$ 499,133	$1,175	$ 1,312,744	$ 3,090	$ 36.53
Marinette	414.01	110.6	112.0	7,736	18.69	0.17	$ 547,709	$1,323	$ 1,326,031	$ 3,203	$ 28.96
Oconto	482.03	107.7	93.5	4,592	9.53	0.09	$ 333,241	$691	$ 1,222,221	$ 2,536	$ 23.54
Outagamie	577.92	101.0	91.0	7,279	12.60	0.12	$ 536,608	$929	$ 2,069,439	$ 3,581	$ 35.45
Sheboygan	532.95	79.8	82.1	6,757	12.68	0.16	$ 592,792	$1,112	$ 1,904,754	$ 3,574	$ 44.80
Winnebago	686.74	97.7	85.3	5,440	7.92	0.08	$ 417,846	$608	$ 1,910,612	$ 2,782	$ 28.48
Region total	**5,231.55**			**66,031**			**$ 4,960,744**		**$ 16,492,352**		
Region average	**475.60**	**94.8**	**86.2**	**6,003**	**12.62**	**0.13**	**$ 450,977**	**$948**	**$ 1,499,305**	**$ 3,152**	**$ 33.25**

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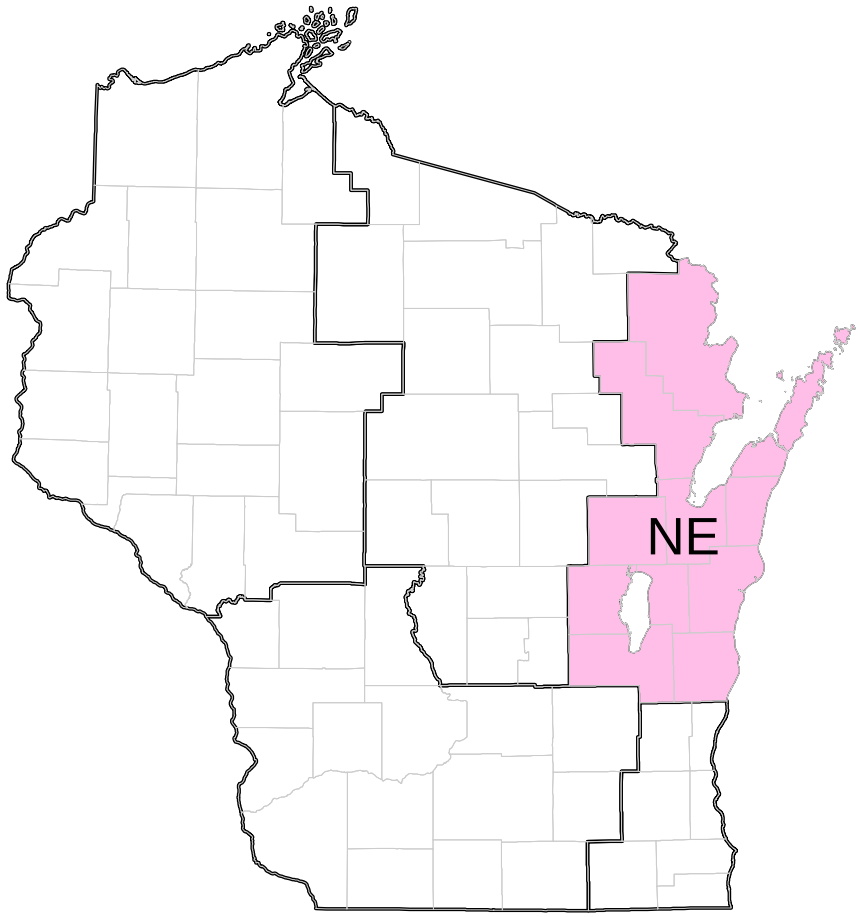

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Northwest Region											
Ashland	255.69	209.5	205.8	4,032	15.77	0.08	$ 376,347	$1,472	$ 1,116,601	$ 4,367	$ 20.84
Barron	434.95	165.5	116.6	6,176	14.20	0.09	$ 512,670	$1,179	$ 1,845,858	$ 4,244	$ 25.64
Bayfield	346.03	189.7	228.4	5,544	16.02	0.08	$ 458,433	$1,325	$ 1,548,193	$ 4,474	$ 23.58
Buffalo	311.69	116.5	98.5	3,129	10.04	0.09	$ 279,169	$896	$ 714,975	$ 2,294	$ 19.69
Burnett	235.35	154.6	119.7	2,733	11.61	0.08	$ 240,367	$1,021	$ 715,167	$ 3,039	$ 19.65
Chippewa	651.76	129.3	99.6	9,461	14.52	0.11	$ 865,965	$1,329	$ 2,683,694	$ 4,118	$ 31.85
Clark	401.29	139.0	120.1	5,827	14.52	0.10	$ 604,668	$1,507	$ 1,382,251	$ 3,445	$ 24.79
Douglas	465.51	179.0	184.4	8,898	19.11	0.11	$ 660,410	$1,419	$ 2,434,708	$ 5,230	$ 29.22
Dunn	519.12	135.1	85.1	12,563	24.20	0.18	$ 1,110,569	$2,139	$ 2,397,537	$ 4,618	$ 34.18
Eau Claire	529.80	124.6	88.8	10,326	19.49	0.16	$ 981,073	$1,852	$ 2,468,589	$ 4,659	$ 37.40
Jackson	518.28	108.3	106.5	8,503	16.41	0.15	$ 782,276	$1,509	$ 1,730,565	$ 3,339	$ 30.84
Pepin	109.41	126.2	86.6	874	7.99	0.06	$ 80,242	$733	$ 347,466	$ 3,176	$ 25.17
Pierce	368.74	136.3	85.8	5,610	15.21	0.11	$ 485,546	$1,317	$ 1,262,533	$ 3,424	$ 25.12
Polk	374.63	162.0	136.0	7,544	20.14	0.12	$ 630,905	$1,684	$ 1,507,230	$ 4,023	$ 24.84
Rusk	213.24	150.2	116.9	2,625	12.31	0.08	$ 243,495	$1,142	$ 591,885	$ 2,776	$ 18.47
Saint Croix	653.34	149.8	114.8	12,890	19.73	0.13	$ 1,072,190	$1,641	$ 3,112,001	$ 4,763	$ 31.80
Sawyer	357.24	178.2	137.5	4,260	11.92	0.07	$ 367,425	$1,029	$ 932,737	$ 2,611	$ 14.65
Taylor	232.32	150.6	119.3	2,808	12.09	0.08	$ 294,475	$1,268	$ 794,571	$ 3,420	$ 22.71
Trempeleau	420.19	110.5	85.0	9,249	22.01	0.20	$ 831,393	$1,979	$ 1,739,304	$ 4,139	$ 37.47
Washburn	388.27	169.2	149.6	6,635	17.09	0.10	$ 554,487	$1,428	$ 1,496,065	$ 3,853	$ 22.78
Region total	**7,786.85**			**129,687**			**$ 11,432,105**		**$ 30,821,929**		
Region average	**389.34**	**149.2**	**124.3**	**6,484**	**15.72**	**0.11**	**$ 571,605**	**$1,468**	**$ 1,541,096**	**$ 3,958**	**$ 26.53**

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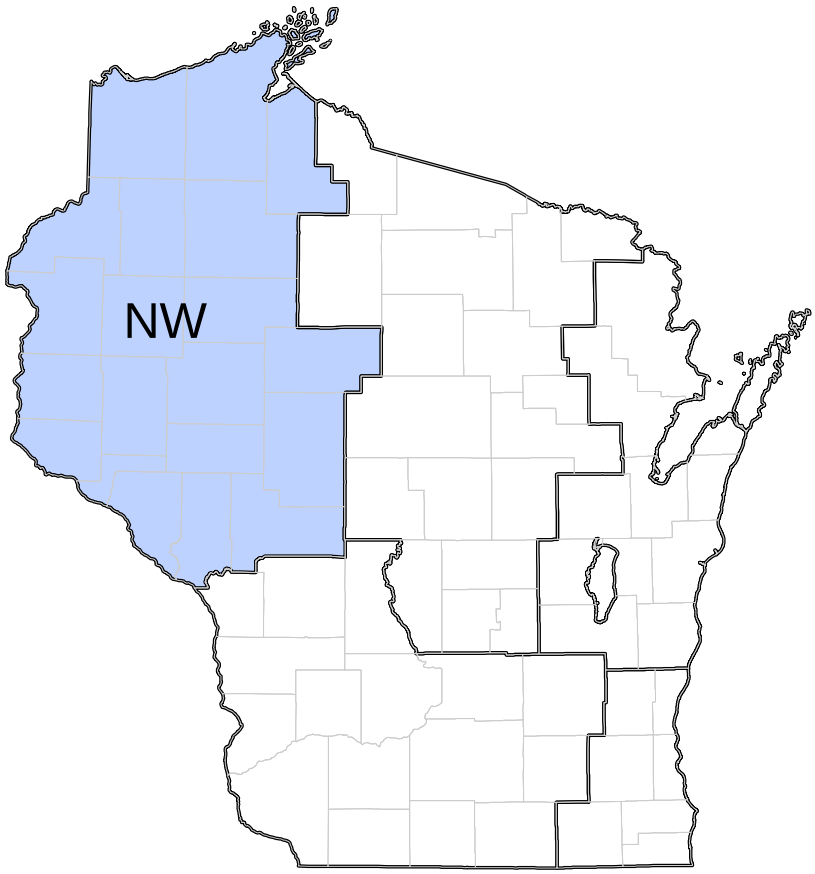

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Southeast Region												
	Kenosha	674.12	58.5	39.9	6,396	9.49	0.16	$ 469,786	$697	$ 1,540,543	$ 2,285	$ 39.05
	Milwaukee	1,567.44	66.8	51.7	21,694	13.84	0.21	$ 1,516,411	$967	$ 6,636,137	$ 4,234	$ 63.39
	Ozaukee	300.72	71.8	69.4	3,349	11.14	0.16	$ 234,731	$781	$ 867,116	$ 2,883	$ 40.14
	Racine	765.35	65.2	59.1	11,973	15.64	0.24	$ 922,879	$1,206	$ 2,115,252	$ 2,764	$ 42.38
	Walworth	696.59	71.9	88.3	8,269	11.87	0.17	$ 600,743	$862	$ 2,052,598	$ 2,947	$ 40.99
	Washington	591.14	93.0	85.5	6,873	11.63	0.12	$ 549,084	$929	$ 1,876,514	$ 3,174	$ 34.12
	Waukesha	1,044.48	84.6	67.1	16,764	16.05	0.19	$ 1,195,776	$1,145	$ 3,532,510	$ 3,382	$ 39.97
Region total		**5,639.84**			**75,318**			**$ 5,489,410**		**$ 18,620,670**		
Region average		**805.69**	**73.1**	**65.9**	**10,760**	**13.35**	**0.18**	**$ 784,201**	**$973**	**$ 2,660,096**	**$ 3,302**	**$ 45.15**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data is taken from WisDOT's Salt Inventory Reporting System.												

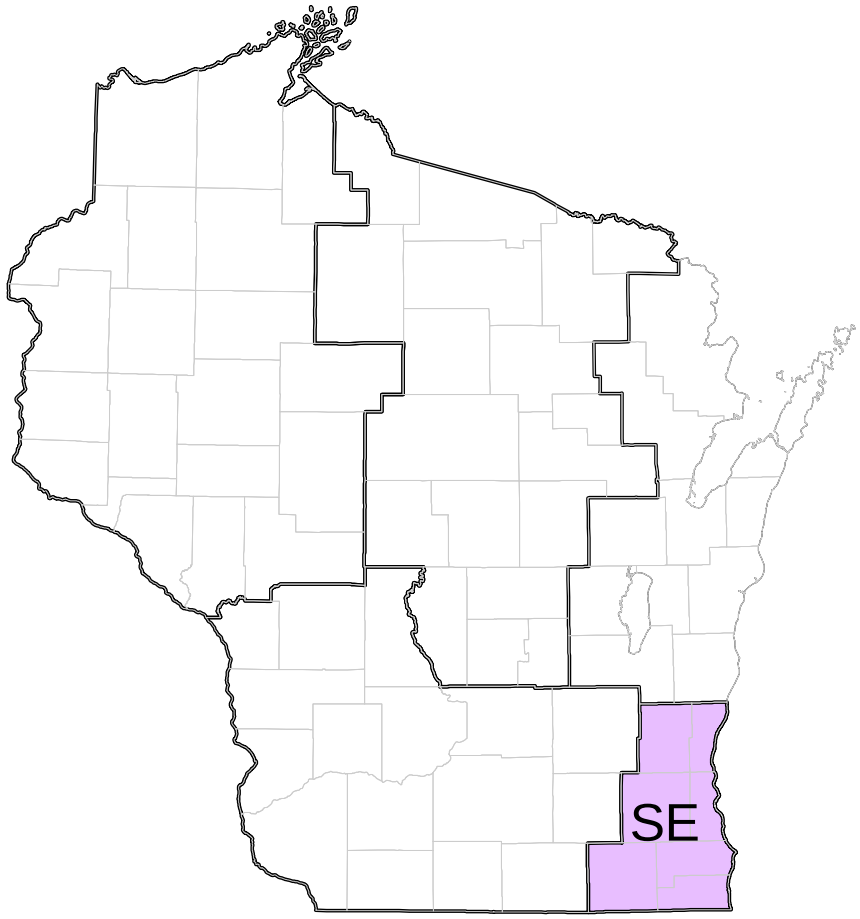
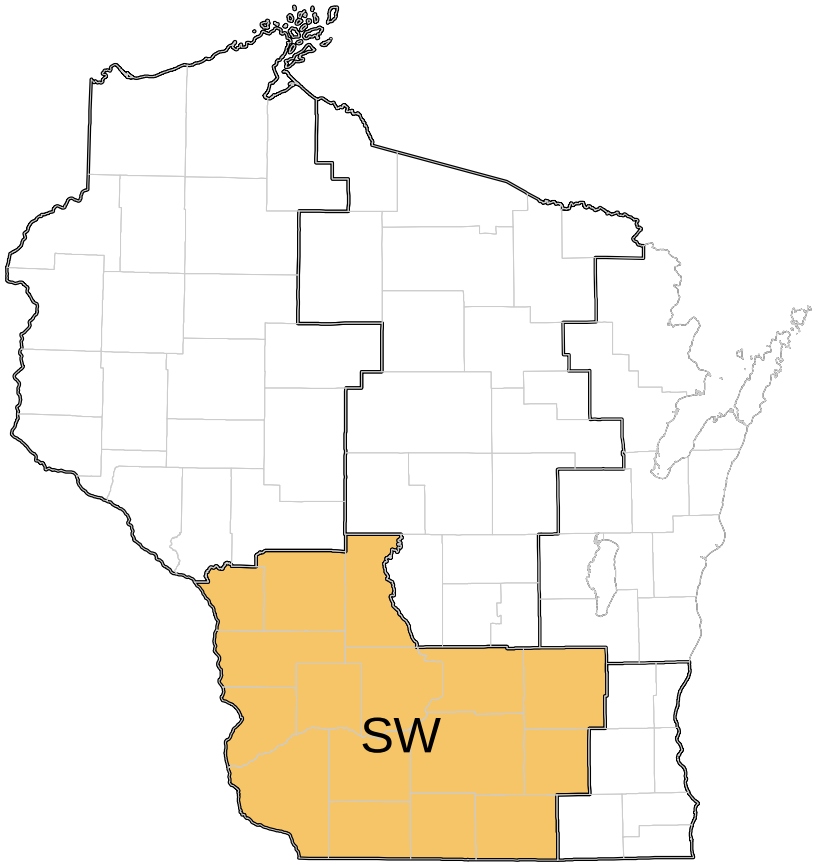
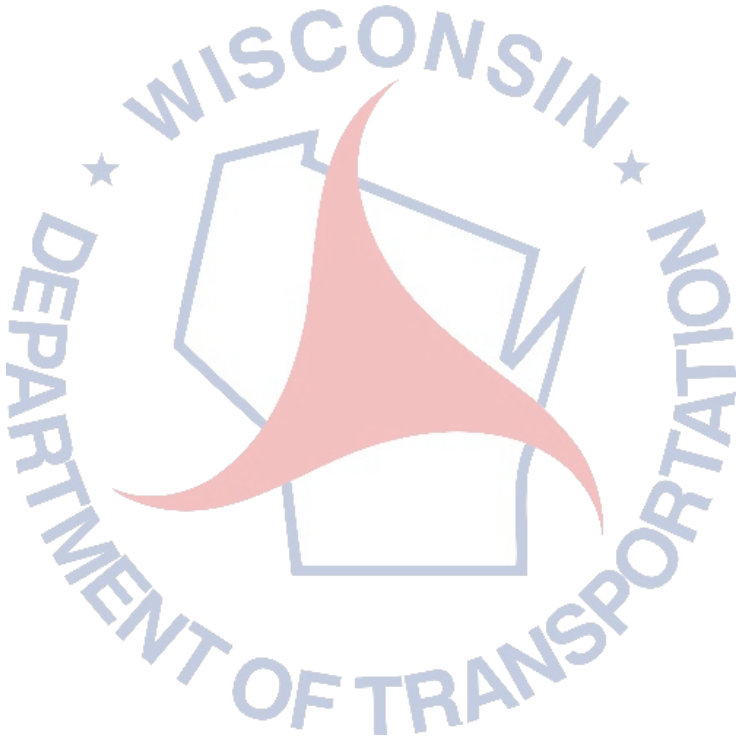


Table 1.4. Winter in Wisconsin, 2022-2023											
County	Lane miles	MDSS Severity Index	Snowfall (inches)	Total salt used (tons)	Salt used (tons) per lane mile	Salt used per lane mile per Severity Index	Total salt costs	Total salt costs per lane mile	Total winter costs	Total winter costs per lane mile	Total winter costs per lane mile per Severity Index
Southwest Region											
Columbia	802.42	95.6	64.2	16,425	20.47	0.21	$ 1,541,651	$1,921	$ 3,223,555	$ 4,017	$ 42.03
Crawford	398.16	80.8	53.7	3,205	8.05	0.10	$ 281,207	$706	$ 728,278	$ 1,829	$ 22.64
Dane	1,663.43	79.1	81.5	33,417	20.09	0.25	$ 2,756,903	$1,657	$ 8,405,018	$ 5,053	$ 63.92
Dodge	667.93	89.4	87.2	11,263	16.86	0.19	$ 855,875	$1,281	$ 2,256,413	$ 3,378	$ 37.79
Grant	642.71	78.6	76.8	7,715	12.00	0.15	$ 635,485	$989	$ 1,736,911	$ 2,702	$ 34.38
Green	313.01	71.5	61.4	2,248	7.18	0.10	$ 222,057	$709	$ 775,355	$ 2,477	$ 34.64
Iowa	457.02	82.3	71.8	4,494	9.83	0.12	$ 382,754	$837	$ 1,318,092	$ 2,884	$ 35.03
Jefferson	552.95	78.7	86.0	2,277	4.12	0.05	$ 187,124	$338	$ 1,122,300	$ 2,030	$ 25.80
Juneau	501.12	91.8	69.2	6,043	12.06	0.13	$ 567,800	$1,133	$ 1,472,149	$ 2,938	$ 32.00
LaCrosse	490.01	91.8	60.2	4,719	9.63	0.10	$ 378,369	$772	$ 1,385,774	$ 2,828	$ 30.80
Lafayette	292.64	75.2	82.9	2,712	9.27	0.12	$ 231,252	$790	$ 883,670	$ 3,020	$ 40.16
Monroe	671.54	107.4	69.0	9,638	14.35	0.13	$ 860,095	$1,281	$ 1,691,379	$ 2,519	$ 23.45
Richland	321.58	83.9	48.0	2,597	8.08	0.10	$ 240,300	$747	$ 623,173	$ 1,938	$ 23.09
Rock	775.29	70.8	52.8	12,177	15.71	0.22	$ 993,034	$1,281	$ 2,465,318	$ 3,180	$ 44.89
Sauk	595.90	92.3	78.6	8,581	14.40	0.16	$ 836,390	$1,404	$ 2,070,420	$ 3,474	$ 37.63
Vernon	468.58	96.7	84.7	5,368	11.46	0.12	$ 450,107	$961	$ 1,222,657	$ 2,609	$ 27.00
Region total	**9,614.29**			**132,879**			**$ 11,420,404**		**$ 31,380,462**		
Region average	**600.89**	**85.4**	**70.5**	**8,305**	**13.82**	**0.16**	**$ 713,775**	**$1,188**	**$ 1,961,279**	**$ 3,264**	**$ 38.23**
Statewide total	**34,723.01**			**483,874**			**$ 40,557,352**		**$ 118,759,205**		
Statewide average		**116.2**	**100.6**		**13.9**			**$1,168**		**$ 3,420**	**$ 29.43**
Sources: Cost data are final billed costs as billed to WisDOT by the counties. Salt data is taken from WisDOT's Salt Inventory Reporting System.											




WISCONSIN
DEPARTMENT OF TRANSPORTATION

2 Winter Weather

In this section...

Every winter is different. The number and type of storms, the range of temperatures, the amount of snow – these factors, along with many others, combine to create varying challenges for Wisconsin's county highway departments each year.

This section describes the weather Wisconsin experienced during the 2022-2023 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, 2022-2023

	Statewide average	Range across counties
Total snowfall[1]	100.6 inches	40 - 281 inches
Winter Severity Index[2]	116.2	58.5 - 242.7
Winter storms	38	14 - 69
Frost events	3.7	0 - 29
Freezing rain events	6.9	0 - 17

1. All data in this table is from Winter Storm Reports, 2022-2023.
2. Winter Severity Index is calculated from the Maintenance Decision Support System (MDSS) tool.

Tracking the Winter

Each week during winter, representatives from the 72 county highway departments complete winter storm reports. These reports give WisDOT the tools to manage statewide materials use and maintenance expenses as the winter progresses. *See page 65 for more information.*

Photo Credit: Pixabay- Creative Commons License

WINTER WEATHER CHALLENGES

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

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

Counties in the northern half of the state tend to face colder temperatures and heavier snowfall than those in the southern half. Wisconsin's average annual snowfall ranges from about 40 inches in the south to as much as 200+ inches along the shores of Lake Superior. In 2022-2023 snowfall ranged from 40 inches in the south to 281 inches in the north. The statewide average annual snowfall is 55.6 inches (30-year normal as recorded by the Wisconsin State Climatology Office).

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

THIS WINTER'S WEATHER

The 2022-2023 winter was tiered through the state similar to a typical Wisconsin winter, with higher severity in the North and lower severity in the south. However, winter hit extremely hard in the Northwest region with snowfall and severities well above average. This coupled with the somewhat average winter in the Southern part of the state led to the overall statewide winter severity average being the highest in a decade.

During the 2022-2023 winter season, county highway departments responded to:

- A statewide average of 38 winter snow events per county, 4 more than the previous winter. The high was 69 events in Vilas County and the low was 14 events in La Crosse County.
- A statewide average of 4 frost events.
- A statewide average of 7 freezing rain/sleet events.

Figure 2.1. Statewide Snowfall, 2022-2023

From Winter Storm Reports

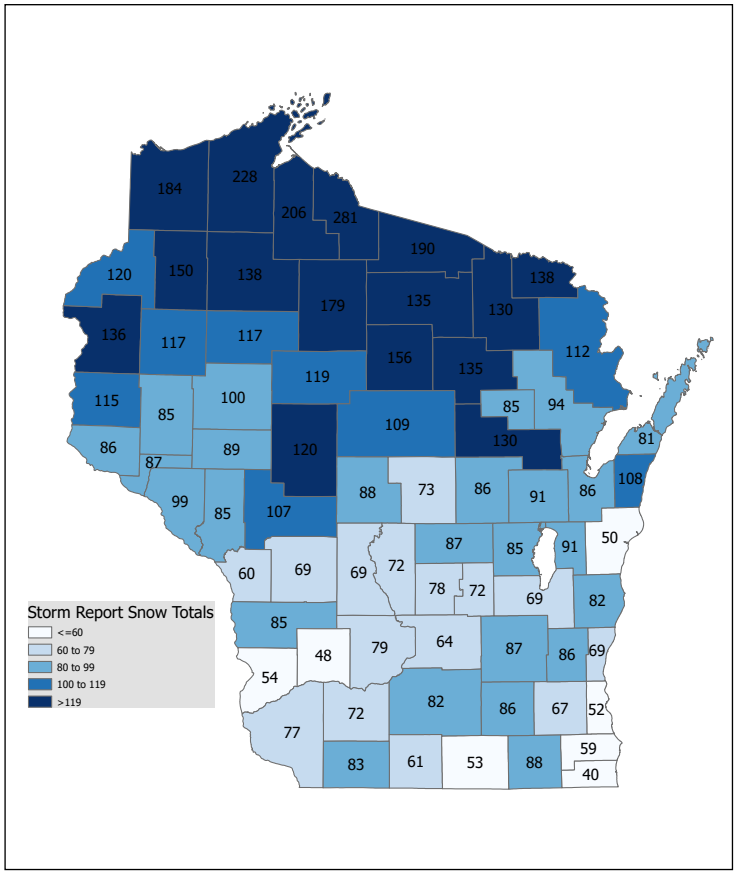


Figure 2.1 shows the total snowfall received in Wisconsin this winter based on storm report data. Snowfall varied significantly across the state; the highest snowfall recorded was in Iron County, at 281 inches; the lowest was in Kenosha County, at 40 inches. This winter's statewide average total snowfall was 100.6 inches, over 36 inches above last year.

WINTER SEVERITY INDEX

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

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

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

Since all of these factors can affect material 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 material use and costs over several seasons, and identify trends in winter weather that can be useful in planning material 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 used from one region or county to another within a single winter. This allows WisDOT to assess whether materials are being used consistently, whether counties have enough staff, and other factors that affect each region's response to winter.

The Maintenance Decision Support System (MDSS) is used to compute the Winter Severity Index. Results were originally scaled such that the 5-year average was 100 at the time the equation was entered (2014-2015 winter). The current 5-year winter severity average is 91.0. This winter:

- The statewide average Winter Severity Index for 2022-23 was 116.2, which is 28 percent more than the average of the previous five winters (91.0).

Figure 2.2. Winter Severity Index, 2022-2023

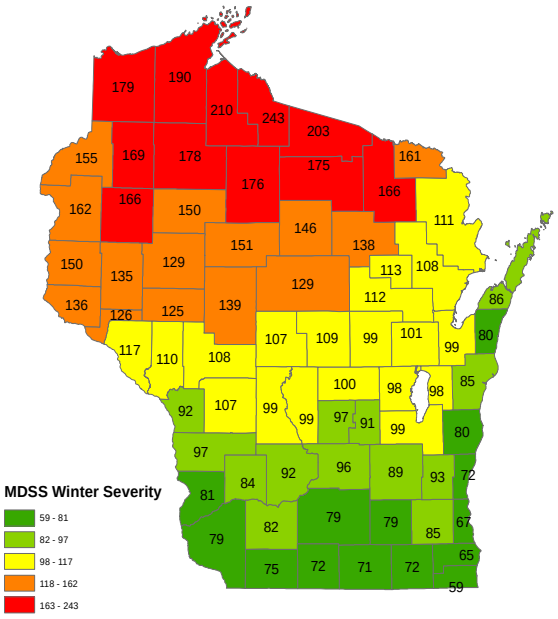
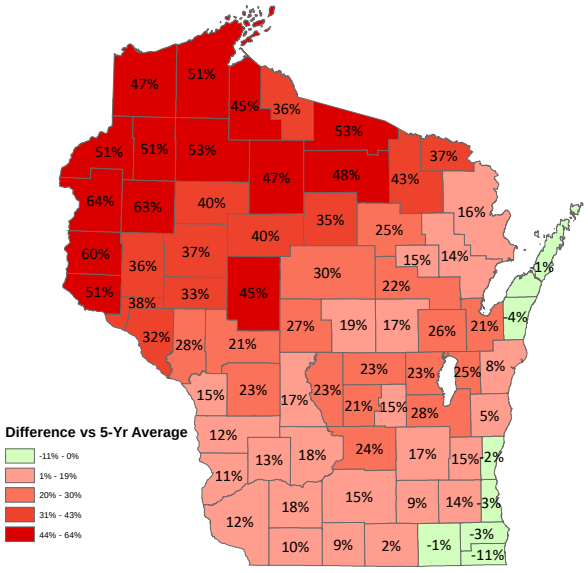


Figure 2.3. 2022-2023 Winter Severity Index vs. 5-Year Average (2017-2018 to 2021-2022)



- Iron and Ashland Counties had the highest severity indexes of 243 and 210 respectively.
- Kenosha and Racine Counties had the lowest severity indexes of 59 and 65 respectively.

All the Northern half of the state this winter was more severe than the 5-year average of 91, and only a small portion of the Southern part of the state along the Illinois border and Lake Michigan was lower than the average severity. 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.

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. This includes Figure 3.1, as well as Figure 3.2 (salt used per lane mile), Figure 4.1 (winter costs), and Figure 4.6 (winter crashes).

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

- A description of the formula used in the Maintenance Decision Support System to calculate out the winter severity index.
- A table showing Winter Severity Index values for each county for the previous 10 winter seasons.

On the following 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.

COUNTY-BY-COUNTY
TABLES FOR SECTION 2
WINTER WEATHER

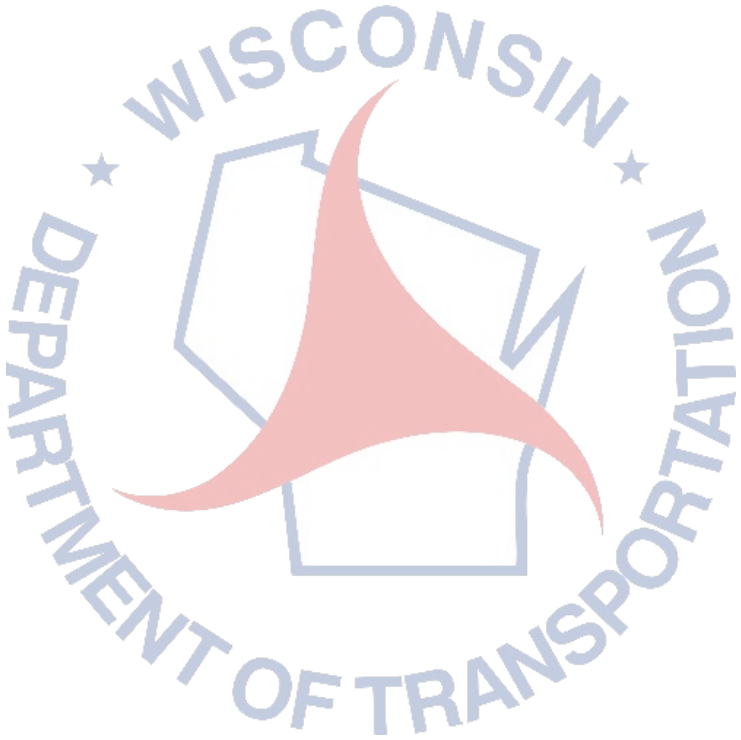

WISCONSIN
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Table 2.1

Storms and Incidents - End of Season

From Winter Storm Reports, 2022-2023

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NC	GREEN LAKE	71.9	154.23	876	5.68	30	16	11	7	6	8	3	1	3	0	0	2	1
	MARQUETTE	78.2	245.99	1406	5.72	33	23	10	1	1	14	4	3	7	4	0	2	6
	WAUSHARA	86.7	342.05	2233	6.53	31	17	10	5	4	13	5	5	4	0	0	4	0
	PORTAGE	73.4	559.84	3860	6.89	42	26	11	17	6	27	8	5	5	7	13	6	13
	ONEIDA	135.2	394.97	3370	8.53	51	22	28	14	13	17	7	0	5	7	2	6	9
	LANGLADE	134.6	300.53	2566	8.54	45	34	14	9	3	26	15	7	0	13	0	5	12
	WAUPACA	86.3	557.05	5110	9.17	30	22	7	6	4	19	6	4	5	8	3	8	1
	WOOD	87.8	448.55	4146	9.24	46	32	23	12	6	14	8	6	9	2	1	6	20
	LINCOLN	155.8	399.09	4426	11.09	53	32	15	9	11	23	6	6	0	11	5	14	12
	SHAWANO	130.1	533.57	6067	11.37	37	26	13	2	2	44	13	7	5	8	5	19	3
	MARATHON	108.5	903.02	10906	12.08	51	34	12	8	7	28	9	4	1	8	4	19	9
	ADAMS	71.8	202.76	2542	12.54	33	28	16	12	7	13	8	6	1	5	0	1	23
	PRICE	179.4	318.47	4335	13.61	66	50	32	13	25	16	10	1	4	5	1	1	5
	VILAS	190.4	307.61	4536	14.75	69	49	17	12	12	21	4	10	0	11	0	18	7
	FOREST	130.2	314.15	4736	15.08	60	49	8	9	7	13	6	4	1	1	0	7	3
	IRON	281.2	240.51	4439	18.46	56	31	21	6	9	25	8	1	0	10	0	18	1
	FLORENCE	137.6	137.43	2571	18.71	45	33	13	5	8	25	11	5	2	5	1	14	7
	MENOMINEE	84.7	90.66	1921	21.19	25	19	4	3	0	41	0	14	5	15	0	11	1
Region Average		123.5	358.36	3891	11.62	45	30	15	8	7	22	7	5	3	7	2	9	7

Final totals as of Monday, June 19, 2023

Table 2.1

Storms and Incidents - End of Season

From Winter Storm Reports, 2022-2023

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NE	CALUMET	91.0	219.61	1528	6.96	41	31	16	10	0	15	10	11	3	1	0	3	16
	KEWAUNEE	107.5	125.73	899	7.15	36	23	15	6	9	14	10	10	0	4	0	8	4
	SHEBOYGAN	82.1	532.95	4076	7.65	36	36	17	7	1	34	13	9	29	2	0	18	49
	OCONTO	93.5	482.03	4072	8.45	40	30	19	16	8	25	4	4	9	11	1	11	20
	OUTAGAMIE	91.0	577.92	5506	9.53	32	8	23	0	0	13	4	4	3	1	0	6	1
	DOOR	80.5	274.02	2619	9.56	38	17	25	7	5	17	8	8	8	6	0	7	13
	WINNEBAGO	85.3	686.74	6665	9.71	28	19	12	5	0	22	0	2	4	6	8	13	13
	FOND DU LAC	68.7	626.81	6661	10.63	28	16	14	5	0	18	5	2	3	5	2	3	11
	MARINETTE	112.0	414.01	5846	14.12	53	26	18	6	0	29	7	1	0	9	7	13	23
	MANITOWOC	50.3	424.86	6052	14.24	25	18	5	3	2	1	0	0	0	1	0	0	20
	BROWN	86.1	866.87	12717	14.67	37	20	12	5	6	5	4	3	1	0	1	2	42
Region Average		86.2	475.60	5149	10.24	36	22	16	6	3	18	6	5	5	4	2	8	19

Table 2.1

Storms and Incidents - End of Season

From Winter Storm Reports, 2022-2023

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
NW	PEPIN	86.6	109.41	982	8.98	29	19	21	7	13	16	9	9	2	6	3	5	9
	BUFFALO	98.5	311.69	3241	10.40	50	32	16	11	11	20	13	5	0	9	0	7	9
	TAYLOR	119.3	232.32	2496	10.74	42	27	11	7	7	26	12	10	6	18	6	10	3
	BURNETT	119.7	235.35	2564	10.89	41	26	11	11	15	6	5	3	0	1	0	4	11
	CHIPPEWA	99.6	651.76	8397	12.88	43	26	18	11	3	9	6	1	2	2	0	1	6
	SAWYER	137.5	357.24	4902	13.72	52	34	17	6	12	18	6	5	0	11	4	5	0
	RUSK	116.9	213.24	3046	14.28	32	22	7	7	5	24	10	6	0	5	9	11	1
	SAINT CROIX	114.8	653.34	9756	14.93	40	24	13	7	15	4	4	4	0	0	0	4	0
	JACKSON	106.5	518.28	7936	15.31	34	28	10	10	27	17	6	3	2	7	10	8	15
	BARRON	116.6	434.95	6723	15.46	46	27	16	13	22	39	14	9	4	23	8	23	1
	ASHLAND	205.8	255.69	3966	15.51	49	32	16	11	4	35	18	13	0	1	0	22	5
	CLARK	120.1	401.29	6242	15.55	38	9	21	5	6	15	4	5	4	6	7	6	3
	PIERCE	85.8	368.74	5842	15.84	38	31	3	5	0	6	2	3	0	2	1	1	1
	WASHBURN	149.6	388.27	6216	16.01	58	42	20	14	6	13	4	5	13	0	7	6	17
	EAU CLAIRE	88.8	529.80	9296	17.55	31	15	15	5	0	0	0	0	0	0	0	0	8
	DOUGLAS	184.4	465.51	8354	17.95	58	27	26	6	1	52	12	1	1	0	0	44	25
	BAYFIELD	228.4	346.03	6328	18.29	57	30	26	1	1	33	14	8	0	5	0	20	0
	TREMPEALEAU	85.0	420.19	7776	18.51	41	32	11	6	7	22	7	3	0	6	1	13	9
	DUNN	85.1	519.12	10411	20.06	33	12	12	8	1	24	8	7	4	6	6	12	0
	POLK	136.0	374.63	9297	24.82	39	22	10	6	1	28	7	2	4	6	0	13	3
Region Average		124.3	389.34	6189	15.38	43	26	15	8	8	20	8	5	2	6	3	11	6

Final totals as of Monday, June 19, 2023

Table 2.1

Storms and Incidents - End of Season

From Winter Storm Reports, 2022-2023

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
SE	KENOSHA	12.4	674.12	6010	8.92	19	12	8	2	2	0	0	0	0	0	0	0	2
	OZAUKEE	69.4	300.72	2736	9.10	25	26	8	7	8	3	0	1	11	2	1	1	13
	RACINE	59.1	765.35	7270	9.50	37	11	23	5	3	0	0	0	0	0	0	0	10
	WALWORTH	88.3	696.59	7129	10.23	34	20	13	6	5	24	11	14	14	3	3	5	16
	WASHINGTON	85.5	591.14	7590	12.84	39	31	24	12	4	20	5	4	14	2	5	6	25
	WAUKESHA	67.1	1,044.48	14697	14.07	22	14	7	2	8	0	0	0	0	0	0	0	8
	MILWAUKEE	51.7	1,567.44	25966	16.57	21	9	10	2	4	2	0	0	2	1	2	0	1
Region Average		61.9	805.69	10200	11.60	28	18	13	5	5	7	2	3	6	1	2	2	11

Table 2.1

Storms and Incidents - End of Season

From Winter Storm Reports, 2022-2023

Region	County	Snow Depth	Lane Miles	Salt Used	Tons /LM	Number of Storms	Types of Storms				Number of Incidents	Types of Incidents						Anti-Icing applic.
							Wet Snow	Dry Snow	Freezing Rain	Sleet		Drifting	Blowing Snow	Frost	Ice	Bridge Decks	Clean Up	
SW	JEFFERSON	86.0	552.95	2004	3.62	37	21	16	7	7	12	6	0	8	1	1	5	8
	LA CROSSE	38.0	490.01	2541	5.19	14	10	4	2	5	12	10	8	7	5	1	4	7
	GREEN	61.4	313.01	1818	5.81	29	16	12	5	5	17	4	4	4	0	1	6	8
	RICHLAND	48.0	321.58	2301	7.16	18	21	3	4	3	39	7	7	3	15	9	27	10
	CRAWFORD	53.7	398.16	2953	7.42	29	20	9	11	8	35	16	16	8	16	4	11	7
	LAFAYETTE	82.9	292.64	2520	8.61	44	20	18	3	8	15	3	9	3	0	0	6	4
	ROCK	52.8	775.29	7330	9.45	25	17	7	2	1	7	4	3	2	0	1	1	5
	IOWA	71.8	457.02	4347	9.51	35	19	11	7	6	15	2	3	5	8	3	1	9
	JUNEAU	51.1	501.12	5350	10.68	31	15	11	4	1	28	4	1	0	8	6	11	15
	VERNON	84.7	468.58	5222	11.14	40	10	18	11	5	0	0	0	8	0	0	0	18
	GRANT	76.8	642.71	8628	13.42	22	12	6	3	1	31	4	11	1	3	1	10	2
	MONROE	69.0	671.54	9834	14.64	33	26	6	6	2	21	8	1	0	9	4	5	12
	SAUK	78.6	595.90	9112	15.29	37	23	5	7	7	18	5	4	2	6	4	8	18
	DODGE	87.2	667.93	10703	16.02	28	22	5	1	6	15	2	2	6	9	1	2	16
	COLUMBIA	64.2	802.42	13182	16.43	20	10	5	1	12	20	17	18	4	2	8	18	21
	DANE	81.5	1,663.43	28326	17.03	36	25	16	9	2	0	0	0	7	0	0	0	14
Region Average		68.0	600.89	7261	10.71	30	18	10	5	5	18	6	5	4	5	3	7	11

Final totals as of Monday, June 19, 2023

Table 2.1
Storms and Incidents - End of Season

From Winter Storm Reports, 2022-2023

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		--	482	6084	12.25	37.8	23.8	13.7	6.9	6.0	18.3	6.5	4.9	3.7	5.1	2.4	8.2	10.0

3 Winter Operations

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 skills and experience to combine these pieces in the most efficient way possible for each storm.

This section describes the counties' response to the 2022-2023 winter season, including material use, best practices in equipment and technology, and training efforts. Most counties have added prewetting and anti-icing to their arsenal of best practices—strategies that help them use materials efficiently, save money and minimize environmental impacts. There are also counties that have been using direct liquid applications (DLA) for deicing during a winter event, in which salt brine is used in place of prewetted rock salt after plowing.

Statewide Materials Use, 2022-2023

Total salt used[1]	483,874 tons
Total salt used per lane mile	13.9 tons
Total cost of salt used[2]	$40,557,352
Average cost per ton of salt	$83.31
Total abrasives used	10,849 cubic yards
Total brine and blends used	20,153,652 gal.

There's More on the Web!

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

See https://wisconsindot.gov/Pages/doing-bus/local-gov/hwy-mnt/winter-maintenance/default.aspx

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.

Photo Credit: Pixabay-Creative Commons License

3A. MATERIALS

Salt (Sodium Chloride) remains the primary material used in winter maintenance. The common practice of prewetting has improved the efficiency of materials use (by keeping more of the material on the road instead of scattering off the edges), and proactive anti-icing applications have reduced the amount of salt needed to keep roads clear. Direct Liquid Application is also becoming more common across the State as it saves taxpayer dollars and reduces harm to the groundwater and environment.

Salt

Salt is a critical part of a highway crew's response to winter storms in Wisconsin. 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.

Due to 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. Best practices to reduce salt use include Direct Liquid Application, prewetting, anti-icing, under body plows, etc.

Historically, counties have used disproportionately more salt during more severe winters. Between the winters of 2006 -07 and 2015-16, Winter Severity Index fluctuated greatly, as did salt usage. Between 2016-19 both Winter Severity Index and salt usage remained relatively stable. Figure 3.1 plots the average statewide salt use per lane mile versus the average statewide Winter Severity Index. Looking back over the past 20 plus years of data, this year's salt use and severity index was similar to multiple years in the past. . This winter's statewide Winter Severity Index of 116.2 was 19.6 percent higher than the previous year, while salt use increased 24.8 percent from the previous year, at 483,874 tons. See Table 1.4 for county-by- county salt use data for this winter. It is important to note as well that this was the highest Winter Severity Index in 10 years but is only the 4th highest salt usage year during the same time frame.

Wisconsin counties applied a statewide average of 13.9 tons of salt per lane mile on state highways, an increase of 24.1 percent compared with the 2021-2022 winter. (See Figure 3.10 for a county-by-county comparison.) When compared with nearby states, which differ by winter severity and level of service standards, Wisconsin salt use is becoming more comparable in the past few years due to better management practices of salt.

Figure 3.2 shows salt use per lane mile in each county, overlaid with severity index to allow a further "apples to apples" comparison of salt use in each county. The counties in Winter Service Groups A and B have more urban highways and tend to use more salt per lane mile for a given level of severity. See Figure 3.11 for a statewide map of tons of salt used per lane-mile.

For more detail on salt use in previous years, see Table A-6, "History of Salt Use on State Trunk Highways," in the Appendix.

Figure 3.1. Salt Use per Lane Mile and Average Severity Index From Salt Inventory Reporting System, 1992–2023

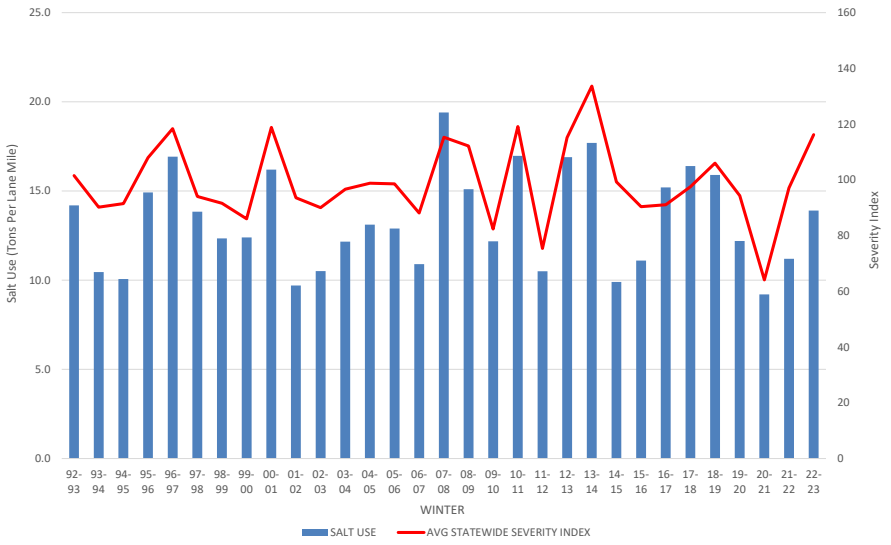
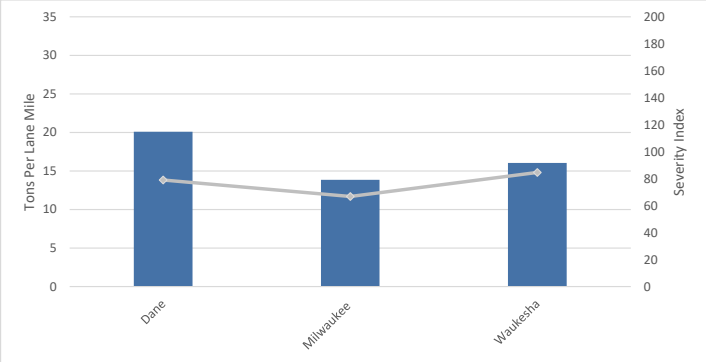


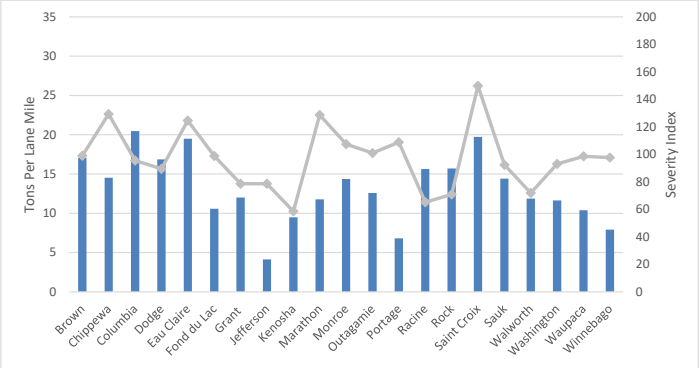
Figure 3.2. Salt Used per Lane Mile and Severity Index

From Salt Inventory Reporting System, 2022-2023

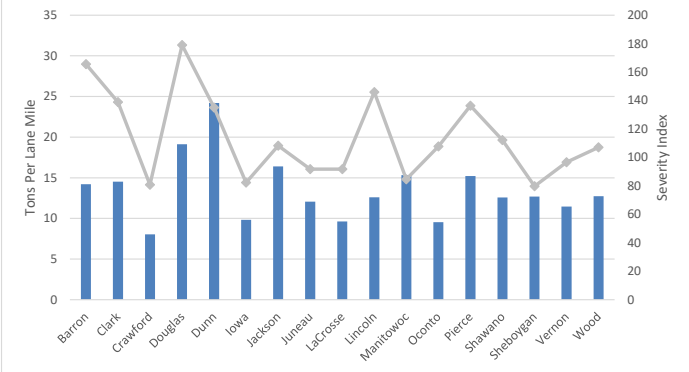
Salt Used per Lane Mile and Severity Index (Group A)



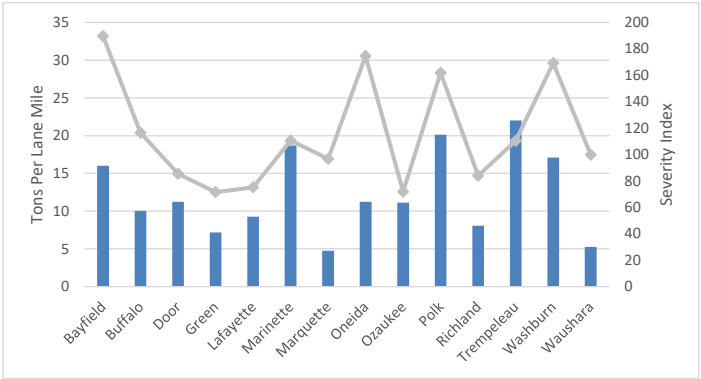
Salt Used per Lane Mile and Severity Index (Group B)



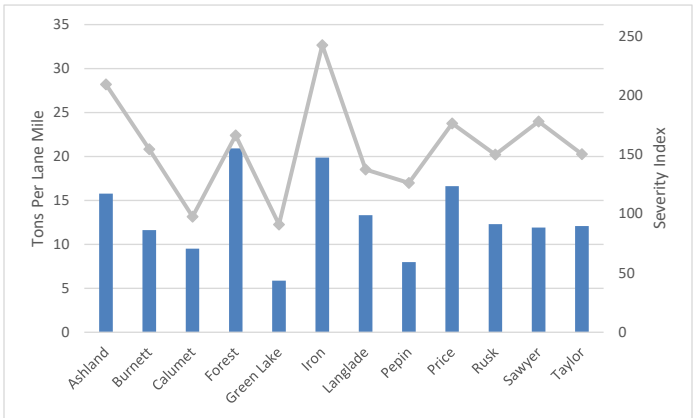
Salt Used per Lane Mile and Severity Index (Group C)



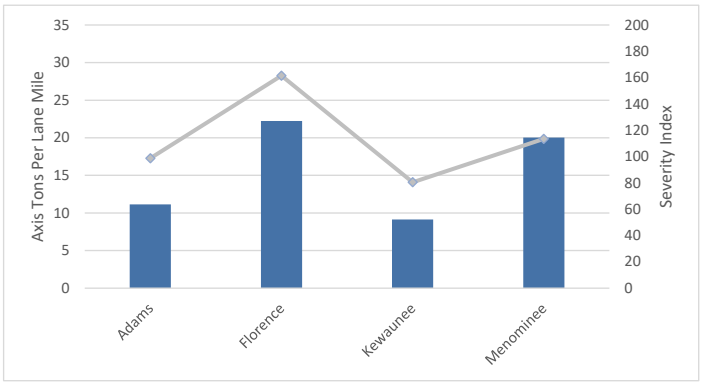
Salt Used per Lane Mile and Severity Index (Group D)



Salt Used per Lane Mile and Severity Index (Group E)



Salt Used per Lane Mile and Severity Index (Group F)

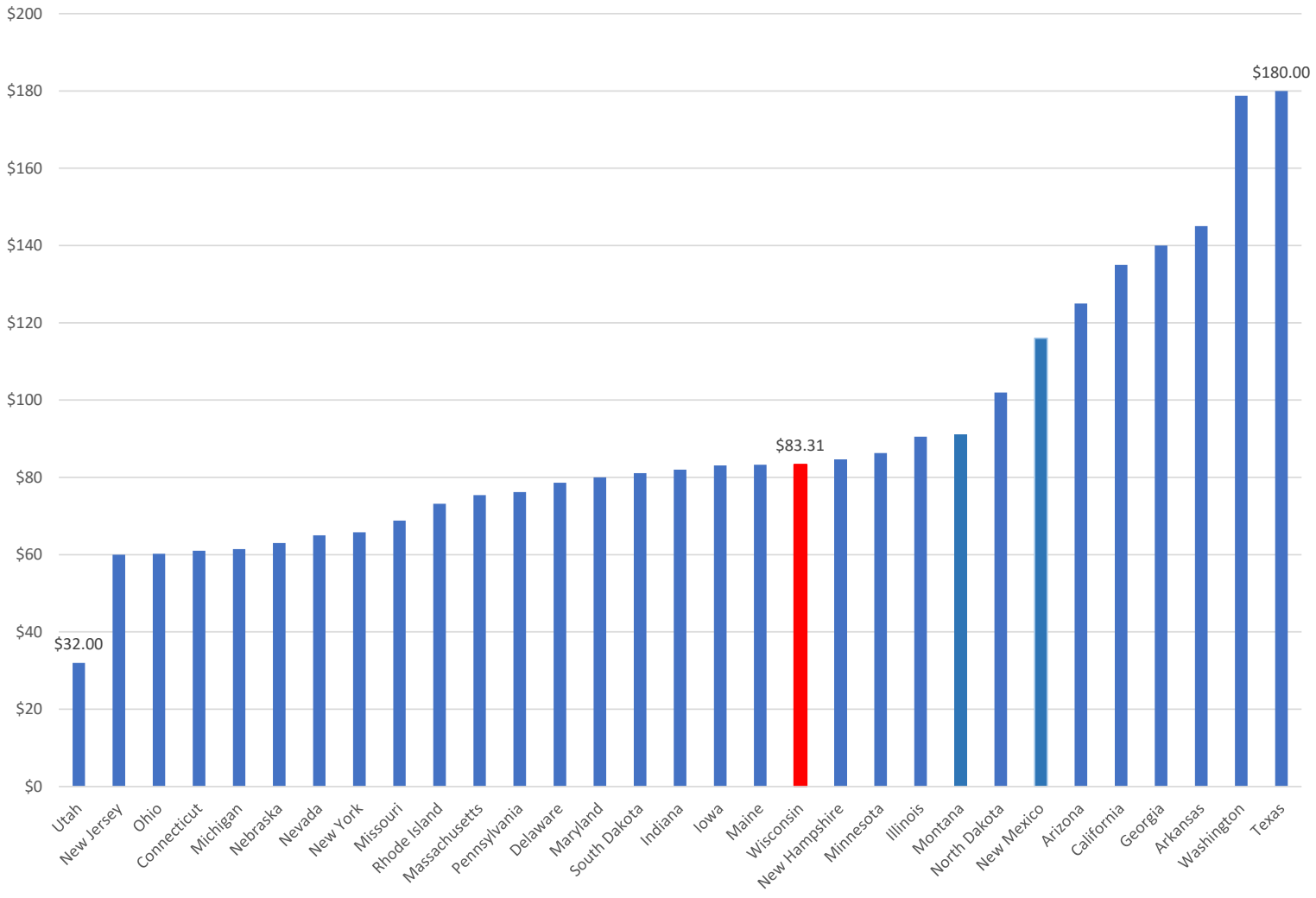


Salt used (tons) per lane mile — Severity Index

Figure 3.3. Salt Prices Across the United States 2021-2022

Source: Clear Roads

Note: Updated data for 2022-2023 has not yet been released



Cost of Salt

This winter, WisDOT spent $40,557,352 on salt statewide, purchasing salt at an average of $83.31 per ton. This is an increase of 1.9 percent from last year. Over the past few years, the gap between $/ton has closed with the other similar snowy states, according to data compiled by Clear Roads. See Figure 3.3. Note this is 2021-2022 data as the 2022-2023 data has not been released yet.

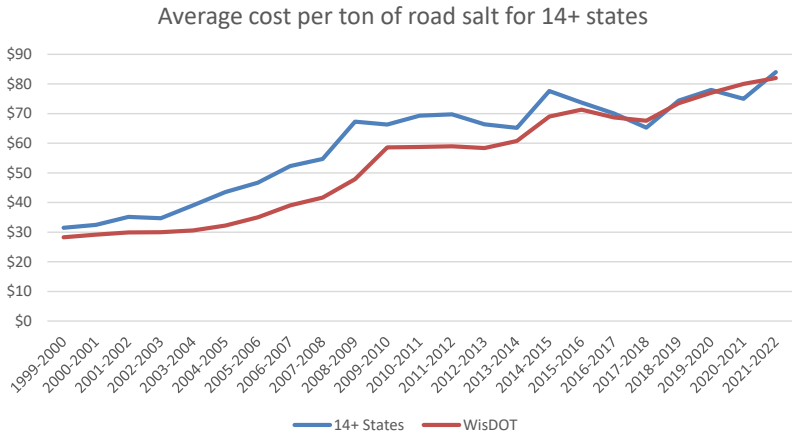
The department speculates that the flexibility of its contracting method might account for similar prices to its peers, despite having to import all salt into the state. Wisconsin's contracts include a 100 percent provision, which means that the department guarantees that it will purchase 100 percent of the contracted amount of salt. Some other states' contracts include an 80/120 provision that requires the salt vendor to keep 120 percent of the contracted salt amount on reserve, and commits the state to purchasing only 80 percent of the contracted amount. This 40 percent spread could translate to higher costs for states under an 80/120 contract.

For more on costs, see Section 4.

Figure 3.4. Salt Prices Over Time (through 2021-2022)

Source: Historical data supplied by Clear Roads. From 1999 to present, the number of states reporting data has increased from 14 to 36 states.

Note: Updated data for 2022-2023 has not yet been released



States Included in Figure 3.4: Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Texas, Utah, Vermont, Washington, West Virginia, and Wyoming

A Note About Materials Data

This winter marks the 14th year that all salt data in this report comes from WisDOT's Salt Inventory Reporting System (SIRS). In previous years, some tables used preliminary salt use data collected in the weekly winter storm reports. Sand use data continues to come from the storm reports, as does the anti-icing, prewetting, and direct liquid application data. These materials use estimates are included in this report because they provide a level of detail and correlation with storm events that is not available from SIRS or from final financial data. The source of each table's data is indicated below the table title.

Abrasives

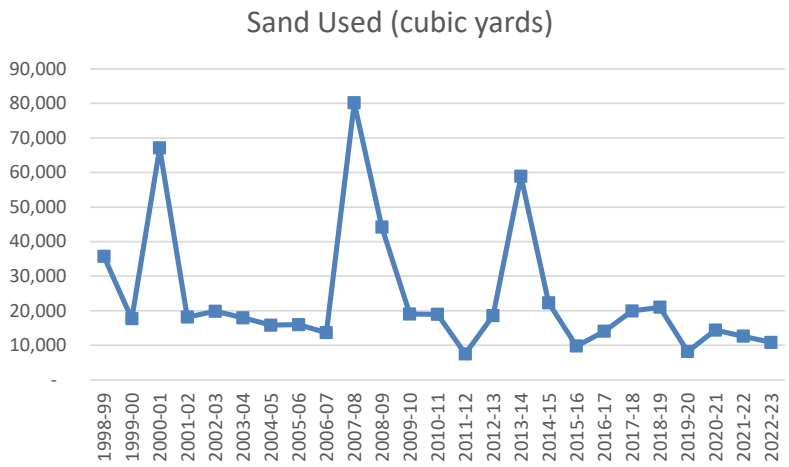
County highway departments sometimes use sand and other abrasives to improve vehicles' traction on icy or snowy roads or when temperatures are too low for salt to be effective. Abrasives are somewhat effective in low-speed trouble spots and intersections. Abrasives should be prewetted with a liquid agent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

A total of 10,849 cubic yards of sand was used by 50 counties on state highways this winter, a 29 percent decrease from the average of the five previous winters (15,240 cubic yards).

In 2008, the Bureau of Highway Maintenance commissioned a synthesis report, "Limitations of the Use of Abrasives in Winter Maintenance Operations" to substantiate WisDOT's guidance to Wisconsin counties on reducing sand use. The report cites factors recommending against the use of sand that have been supported by research, and offers the following general conclusions:

- Sand used in a salt-abrasive mixture has not been shown to reduce accidents.
- Salt is more cost-effective than sand in winter maintenance operations.
- A salt-sand mixture requires approximately three times more material applied to the road to achieve the same effectiveness as pre-wetted salt and results in plows making more frequent return trips to the sand pile to fill up.

Figure 3.5. Statewide Sand Use From Storm Reports Data, 1998-2023



The 2008 synthesis report is available on-line at: https://clearroads.org/project/limitations-of-the-use-of-abrasives-in-winter-maintenance-operations/

Figure 3.5 compares this winter's statewide sand use with previous years. The spikes in the figure are due to salt shortages during those years.

Prewetting

Prewetting salt and sand with liquid deicing agents before or during their application to the pavement has several advantages. When used with dry rock 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 dry 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 one or more deicing agents so that different agents can be used as conditions warrant. For example, salt brine can be reasonably used at pavement temperatures down to about 15°F, whereas agents such as magnesium chloride and calcium chloride are effective at lower pavement temperatures, to about 0°F. See Table 3.1 for details on statewide prewetting agent use.

Salt brine is a relatively inexpensive choice for prewetting. Salt brine use has increased significantly since counties first tested it over 20 years ago; all 72 counties used salt brine for prewetting this winter (see Table A-5 of the Appendix for details). Counties used 6,879,995 gallons of salt brine and salt brine blends for prewetting this winter, a 37% increase to the year prior. While most counties in the state are applying brine as a prewetting agent on a regular basis, there are also some counties that have started to apply brine directly to the road during winter storm events known as direct liquid application (DLA). The 2022-2023 winter was the fourth-year tracking usage of direct liquid application, in which 29 counties used DLA during the winter for a total of 8,704,840 gallons a 45 percent increase from last year.

In addition to salt brine, some counties used calcium chloride, magnesium chloride, or agricultural-based products for prewetting this year. See Table 3.1 and Table A-5 in the Appendix for details. Organic blends seem to be preferred over the straight chemical products because they adhere to the pavement longer. The addition of the organics helps reduce corrosion of equipment. 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.

BEST PRACTICES: On-Board Prewetting

WisDOT encourages counties to prewet salt before applying it to the roadway. Agencies across the country and worldwide consider prewetting a best practice, and some require that all material be prewetted before it is placed. Studies have shown that prewetting significantly improves the amount of material that stays on the road. On-Board prewetting is preferred because it is the simplest way to ensure that salt is being uniformly prewetted.

Some counties choose to prewet their salt directly in the pile. The benefit to this approach is that less equipment is required on salt trucks.

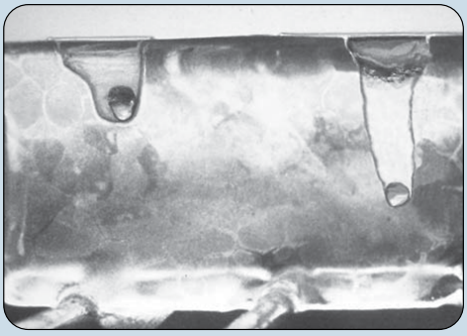
Wisconsin Transportation Bulletin No. 22 (December 2005) notes that as much as 26 percent more salt stays on the roadway when prewetted versus dry salt is used. Pre-wetting salt has been used since the late 1960s. In addition to reduced loss of salt from bounce and scatter, advantages of pre-wetting salt include:

1) Quicker melting.

2) Better salt penetration into ice and snow pack.

3) Salt melts at lower temperature if wetted with other deicing chemicals (generally limited to pavement temperatures above 20°F).

For more information on prewetting, see Chapter 6, Section 20 of the State Highway Maintenance Manual.



Faster melting action is the main benefit of pre-wetting salt. After 20 minutes the difference is significant. This photo shows two salt particles penetrating ice. The one on the right was pre-wetted.

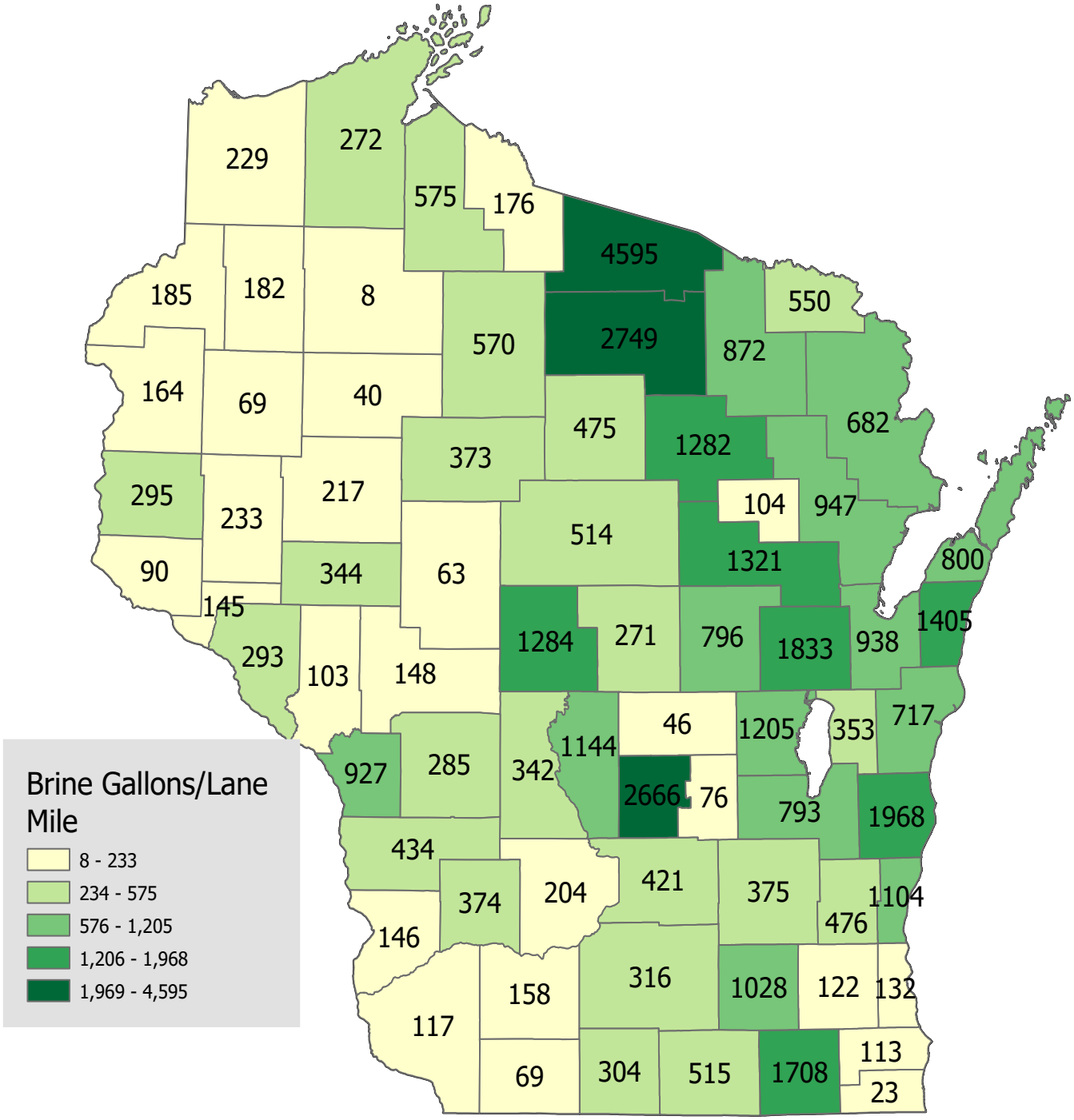
Some counties are still using pretreated salt, in which a liquid prewetting agent is spray-applied to the salt supply before the salt is placed in storage. According to the Minnesota Snow and Ice Control Field Handbook for Snowplow Operators (published by the Minnesota Local Road Research Board), when treating a stockpile of salt, a liquid deicing chemical should be applied at a rate of 8 to 10 gallons/ton. Since liquid prewetting increases the leach risk of the stockpile, salt should be stored on an impervious pad.

While prewetting salt is a best practice in Wisconsin, prewetting abrasives is far less common but still considered a best practice. 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. The Minnesota Snow and Ice Control Field Handbook for Snowplow Operators recommends prewetting sand at a rate of 4 gallons of salt brine/ton of sand.

Table 3.1. Statewide Brine Agent Usage

Agent	***Prewet Gallons Used***	*# counties using PreWet*	***Anti-Icing Gallons Used***	*# counties using Anti-Icing*	***Direct Liquid Gallons used***	*# counties using Direct Liquid*
Salt (NaCl) Brine	6,460,017	72	4,478,669	66	8,578,518	29
Calcium Chloride						
$CaCl_2$ - Liquid	109,055	13	1,185	3	54,468	6
Magnesium Chloride						
$MgCl_2$ - Liquid	14,732	4	5,288	2	1,260	1
Proprietary Mixtures						
FreezeGuard	46,764	10	-	-	53,914	1
GeoMelt	-	-	4,310	1	-	0
IceBite 55	-	-	-	-	-	0
Beet 55	89,763	4	55,676	4	-	0
AMP	5,022	1	7,857	1	0	-
BeetHeet	154,642	12	15,742	7	16,680	2
Total Liquid Used	**6,879,995**		**4,568,727**		**8,704,840**	
Total (Anti-Icing, Prewet, DLA):	***20,153,562***					

Figure 3.6. Total Gallons of Brine Per Lane-Mile



Statewide Average = 414 Gal/Ln-Mi

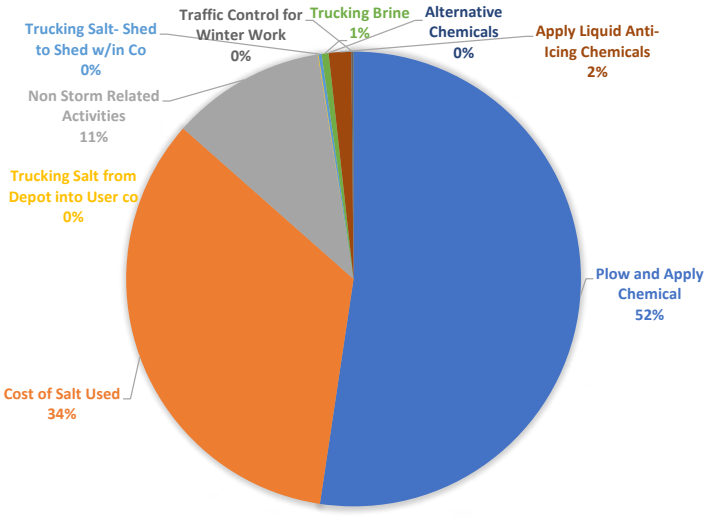
Map created: July 2023

Anti-icing

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

This winter, counties used 4,568,727 gallons of anti-icing liquid, a 36% increase from the year prior (see Table A-3 in the Appendix for details). Currently, 66 of 72 counties (92 percent) are performing anti-icing operations and made at least one anti-icing application (counties may choose not to anti-ice if weather conditions do not warrant it). See Table A-4 in the Appendix for county-by-county data on salt brine use.

Figure 3.7. Winter Costs by Activity Code, 2022-2023



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

WisDOT encourages counties to explore stocking one or more agent for prewetting, anti-icing and direct liquid application so that a choice of agents is available for use according to pavement temperature and weather conditions. Table 3.1 shows the agents used for anti-icing in Wisconsin this winter.

BEST PRACTICES: Anti-icing (see Figure 3.7)

Anti-icing is a best practice not only nationwide, but across the globe. Anti-icing is the process of applying brine to the dry pavement- in the right conditions- prior to a winter storm. Agencies are finding that this technique, once reserved for bridge decks and trouble spots, yields excellent results on highways as well. More agencies are turning to anti-icing to help them use labor and materials efficiently, and to reduce overall salt usage.

This winter, Wisconsin counties used 4,568,727 gallons of anti- icing liquid—an increase of 36% from 2021-22. Yet at 1.6 percent of total winter expenditures, anti- icing continues to represent a small fraction of winter costs which is why anti-icing is a highly recommended practice when appropriate. For more information on anti-icing, see Chapter 6, Section 15 of the State Highway Maintenance Manual.

Direct Liquid Application

The use of Direct Liquid Application (DLA) is relatively new in Wisconsin. Liquid brine, a simple mixture of salt and water, is applied directly to the pavement for deicing to replace rock salt as the primary storm management tool. This not only reduces the amount of salt applied but has been found to be more effective than solid salt.

In an effort to support the implementation of this practice in Wisconsin, WisDOT funded the purchase of high-capacity brine makers (HCBM) for the counties, starting from the 2018-2019 winter season. Every year since then, WisDOT continued funding the purchase of HCBMs in more counties. As of the end of June 2023, WisDOT has funded a total of 48 HCBMs. We look to keep continuing this effort as twelve additional counties are seeking to get funding for HCBMs in Fiscal Year 2024 (see Figure 3.8).

Counties receiving funding to purchase an HCBM have outfitted some or most of their trucks with tanks capable of holding enough liquid to treat specific routes, along with high- pressure spray nozzles. This type of nozzle has proven more effective at penetrating the snowpack and reaching the road surface. Multiple counties have brought DLA to the interstate and 4-lane highways and find it to be more valuable to apply brine at higher speeds which were more equivalent to traffic speeds during winter operations to eliminate the bounce and scatter effect. Figure 3.9 shows the counties that used DLA at some point this past winter and how many gallons they used.

WisDOT has sponsored multiple research studies to learn more about DLA and its best practices and benefits. WisDOT contracted with UW TOPS Lab to conduct a two-phase analysis of DLA technique in collaboration with the counties. The final report of phase 2 of this project was completed at the end of 2021, which builds on data collected from the counties in the 2020-21 winter season. This project analyzed the cost-benefits of DLA, and measured the salt use reduction, the difference in achieving time to bare/wet, and friction rating of pavement when using liquids compared to granular salt. More than 10 counties supplied data to UW TOPS Lab for this project.

Some of the highlights from this project are:

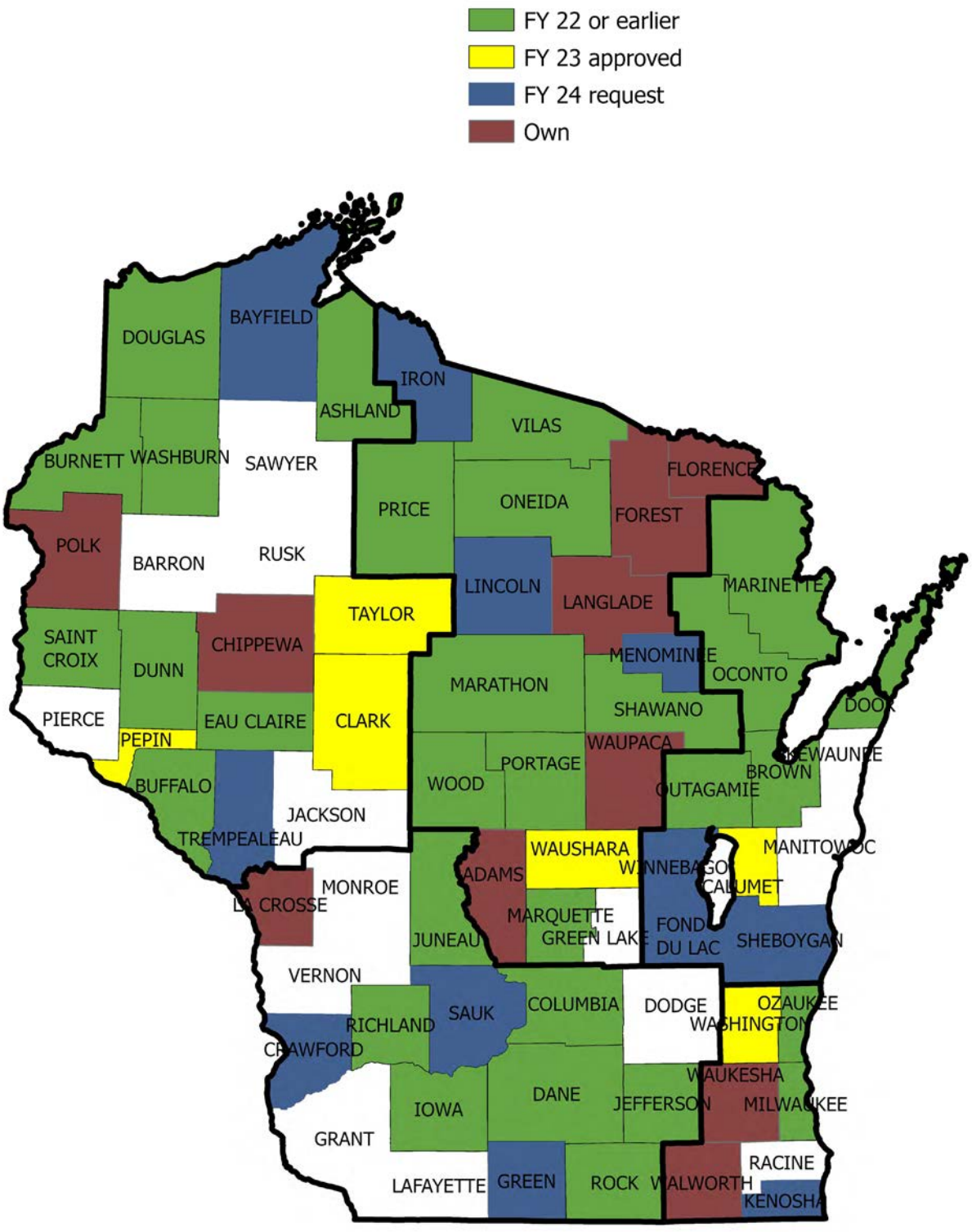
- Benefits of DLA far outweigh the infrastructure costs to move to a more liquid application model for winter highway maintenance events. Looking at only materials (salt) savings, over the winter 2020-21 period, DLA method saves WisDOT $5.95 per lane mile. With over 35 thousand miles in the state highway system and an average of 35 events each year, this is a significant saving.
- Comparing the use of DLA vs. granular salt, the counties participated in the study are shown as successfully reduced overall salt use by 23%, with data showing that during certain storms, salt use was reduced by well over 50%.
- Analysis of friction rating and time to bare/wet pavement comparing DLA use vs. granular salt showed that condition rating of pavement surface was on average of 15% better with DLA, and time to bare/wet pavement was reached 11.9% quicker.

WisDOT also championed a research study focusing on DLA through Clear Roads, a national research consortium focused on rigorous testing of winter maintenance materials, equipment, and methods for use by highway maintenance crews. This study is also done by UW TOPS Lab and completed in December 2021. It focuses on expanding the application rate guidance for liquid application. The result of this study is a comprehensive guidance on best practices of application rates of DLA, more specifically for lower temperatures of application rates of DLA, more specifically for lower temperatures.

BEST PRACTICES: Direct Liquid Application (see Figure 3.9)

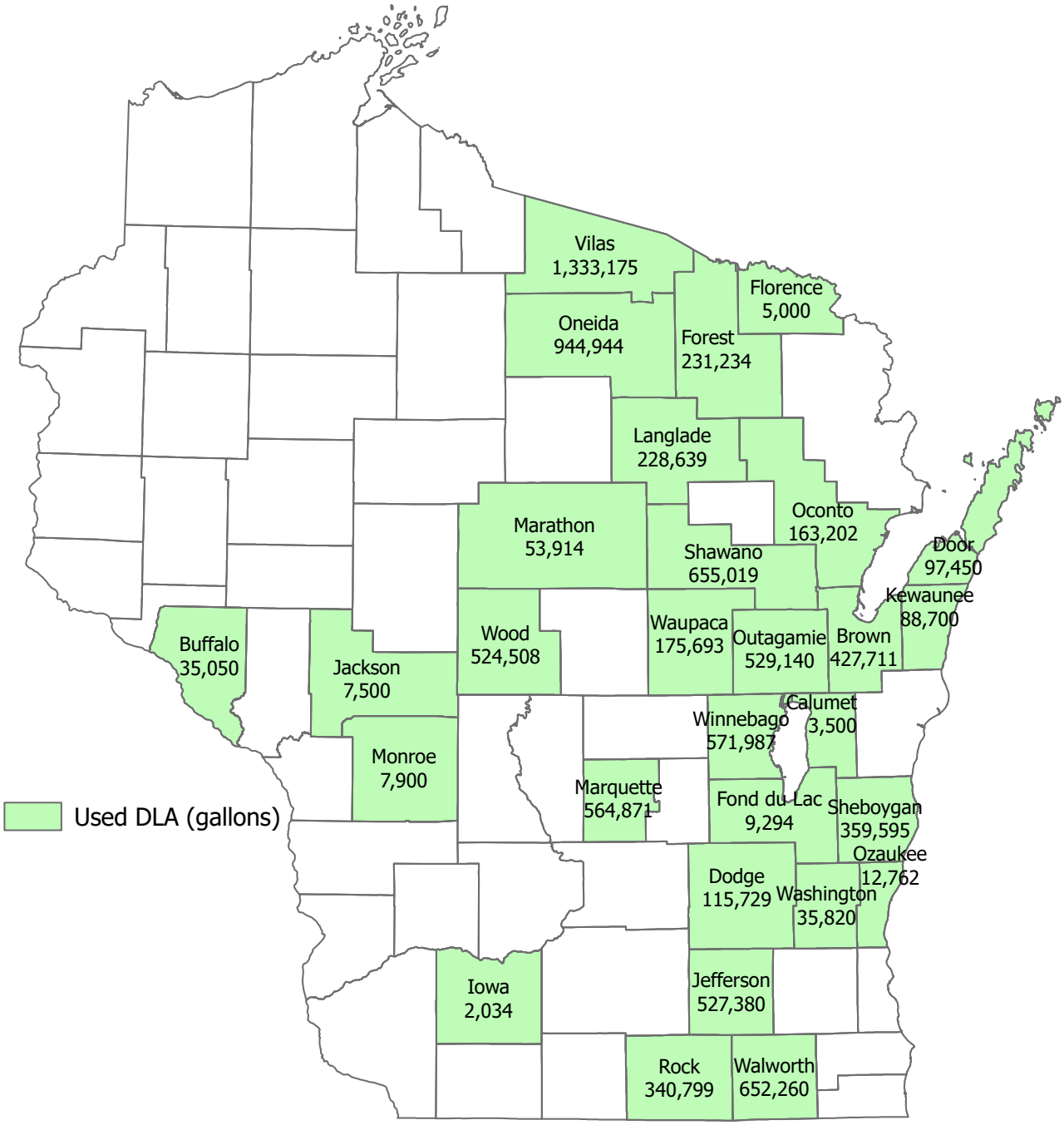
Direct Liquid Application is gaining traction in Wisconsin. Salt brine (possibly combined with other agents) is applied directly do the roadway during winter events to break the bond between snow and the pavement. High-capacity brine-makers are used to mix brines of various recipes. Specially equipped plow trucks with large tanks are used to apply the brine instead of rock salt. This results in faster time to bare/wet pavement and greatly reduced amounts of salt used.

Figure 3.8. State Funded High Capacity Brinemakers



Map created: June 2023

Figure 3.9. Counties Using Direct Liquid Application



Map created: June 2023

3B. EQUIPMENT AND TECHNOLOGY

As winter maintenance technology and practices evolve, the counties are continually expanding their arsenal of snow and ice control strategies. Winter Maintenance Research is one venue that helps crews continue to stay up to date on the latest tools and practices. There are several research initiatives that WisDOT is part of including Clear Roads and Aurora. In recent years, Road Weather Information Systems (RWIS) have become an effective tool for anticipating winter weather. These systems are automatic weather stations and measure real-time conditions. The Maintenance Decision Support System (MDSS) is another key system WisDOT has implemented. MDSS assists in assessing conditions and recommends appropriate treatments for routes. Equipment calibration is another strategy which not only ensures materials are applied to the roadway consistently, but also reduces product waste and costs.

Another tool a few counties have started using is tow plows, which are typically used on multi-lane highways or on roads with wider shoulders. A tow plow is just as it sounds, it is a plow that is towed by the snow plow which allows one driver to plow two lanes of highway and apply chemicals as well. This increases efficiency as one driver can plow two lanes in one pass with the truck and tow plow.

Winter Maintenance Research

WisDOT joins other state DOTs in funding research projects of common interest. The three pooled fund groups where WisDOT participates are Clear Roads, Aurora, and Maintenance Decision Support System (MDSS). The projects from these entities allow WisDOT to combine funds with other states to provide more effective research for the dollar.

CLEAR ROADS. Clear Roads research is grouped into six areas: methods, equipment, materials, training, technology, and safety. Launched in 2004 by Wisconsin and a few other states, Clear Roads now has 39 member states, led by the Minnesota DOT. They have completed 86 research projects conducted by universities and consultants and 15 projects are currently in progress.

See the Clear Roads website for a complete list of projects: : https://clearroads.org/all-research-and-synthesis-projects/

Examples of recently completed research include:

- Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-Icing
- Measuring the Efficiencies of Town Plows and Wing Plows
- Implementation of Liquid-only plow routes
- Review and Summary of Pre-wet Methods and Procedures

AURORA. Aurora is an international pooled fund partnership of public agencies that work together to perform joint research on road weather information systems (RWIS). Its membership includes 19 state DOTs and FHWA. WisDOT attended two in-person meetings and participated in monthly virtual meetings. WisDOT is a member of several project technical panels:

- Evaluation of Spring Load Restriction Removal Protocols
- Optimal RWIS Sensor Density and Location – Phase 4
- Automated Extraction of Weather Variables from Imagery

For a full list of Aurora projects, please go to https://aurora-program.org/.

Road Weather Information Systems (RWIS)

A roadside weather station.

WisDOT has had a Road Weather Information System (RWIS) 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:

- 75 weather and pavement condition sensors along state highways.
- Detailed weather forecasts via the Maintenance Decision Support System (MDSS).
- A winter storm warning service for WisDOT and county highway departments.
- Over 1,000 mobile infrared pavement temperature sensors on patrol trucks around the state.

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

The health of the system has improved significantly in the past year. Funding limitations had prevented needed upgrades to the RWIS infrastructure prior to FY 23. In FY 23, the following improvements were accomplished:

- Replacement of processors at 50 sites
- Installation of cellular communications at these same sites
- Replacement of 17 obsolete towers
- Replacement of inoperative atmospheric sensors

On the docket for FY 24 are the following tasks:

- Replacement of inoperative pavement sensors (many with non-invasive technology)
- Installation of solar power at two sites
- Installation of cameras at all sites not near an existing ITS freeway camera

BEST PRACTICES: Underbody Plow

WisDOT encourages counties to use underbody plows when possible. If the plow blade is positioned in this way, it will apply downward pressure and can remove more snow pack and ice than a front-mounted plow. The underbody plow is most effective when removing hard packed snow and ice. In light and fluffy snow conditions, snow will compact a under truck with an underbody blade. Unevenness in pavement can also cause operating issues for this type of blade.

Photo credit: fancy-cats-are-happy-cats (https://commons.wikimedia.org/wiki/File:DesCoPlow.tif)

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

- Management of the MDSS, as well as attending three meetings of the MDSS Pooled Fund Technical Panel.
- Assisting with WisDOT's AVL-GPS.
- Coordinating with DTN on forecast services.
- Responding to comments from counties using any weather technology
- Providing MDSS and RWIS training for regional operations staff, the TMC, and county highway departments.
- Overseeing maintenance and repair of the department's RWIS equipment.
- Representing WisDOT on the Aurora Program board and the MDSS Technical Panel.

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 such as Pathfinder with the National Weather Service.
- Participating in national RWIS initiatives, such as EDC-5.
- Providing RWIS presentations to WisDOT groups and agencies both inside and 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 and researching a potential new winter severity index based on MDSS data.
- Establishing a plan for replacement of aging infrastructure, such as roadside towers and communications.
- RWIS program management (budgeting, billing, planning, etc.).
- Developing enhanced methods of data display using GIS technology.

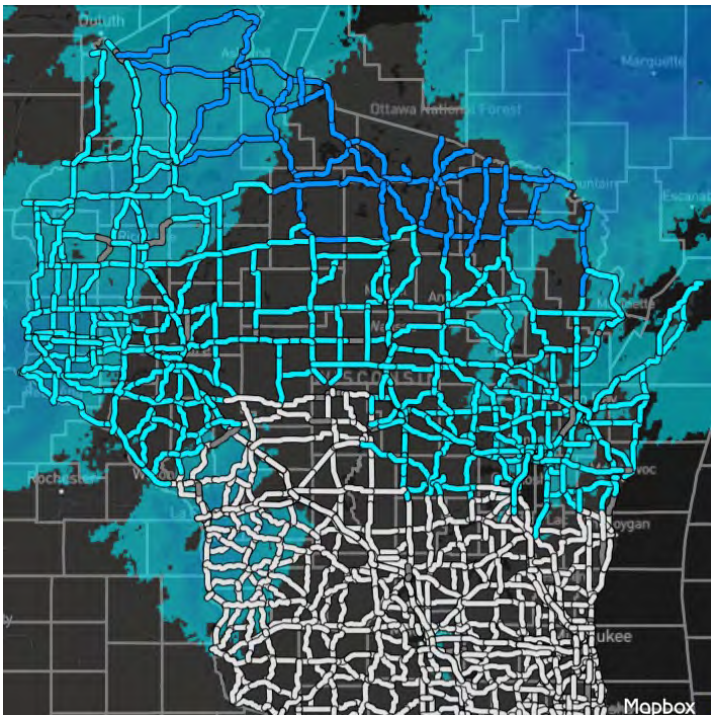
BEST PRACTICES: Ground speed controllers

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. See Chapter 6, Section 20 in the Winter Maintenance Manual for more information.

Photo credit: apwa.net

Maintenance Decision Support System (MDSS)



BACKGROUND. Project management of MDSS activities continued to be a major focus for WisDOT.

CONFIGURATION. BHM continued to update routes as required when the counties made changes at their level. One significant addition to this process is the inclusion of BTO in the process, as they are now using road conditions pulled from MDSS to populate 511. They must be notified anytime there is any change in route configuration.

MANAGEMENT TOOLS. BHM continues to attempt to use the comparison of actual versus recommended salt use. It still doesn't seem to be providing useful output, and it is believed that the lane-mile calculations in the system are causing the problem. This will be examined in the next route configuration update.

TRAINING. WisDOT and DTN conducted in-person training for the first time since 2019. Attendance was very sparse. This led to WisDOT putting training on the agenda at the June 2023 MDSS Technical Panel meeting. This will likely be a major focus for the group in the coming year.

MONITORING. WisDOT received reports on usage on a monthly basis, and then an annual one at the end of the winter season. We plan to analyze this data to guide development of a training agenda in the fall.

PAVEMENT BUCKLING. BHM used previously-developed maps in MDSS to monitor conditions during the pavement buckle season. BHM records pavement information out of WebMDSS at the time of the event.

511 Road Conditions. Using MDSS, every state highway is now mapped for road conditions. BHM facilitated this transition and worked with the 511 contractor to solve a few minor issues. Public feedback was generally positive, though a major issue arose in late December when a strong cold front impacted the state. Snow was falling, but because pavement temperatures were so cold, the MDSS model kept removing the blowing snow from the roads. This led to dry pavement conditions being indicated during what were at times blizzard conditions. Mn/DOT experienced the same issue. As a result, DTN tweaked the model to more accurately portray the conditions. There were several other times during the winter that TMC operators were forced to override the model output because of inaccuracies. It remains a work in progress.

COORDINATION. WisDOT attended one in-person and two virtual (one due to a blizzard at the meeting location causing the in-person meeting to be switched to virtual) MDSS Pooled Fund Study Technical Panel meetings. We interacted with other pooled fund members to elicit ideas that would help WisDOT. We provided presentations on WisDOT's experience in implementing MDSS and its work with the management tools and GIS route configuration. BHM worked with DTN on a continuing basis to resolve any issues that arose and to better understand the workings of the system. As mentioned above, WisDOT requested that training be included on the latest agenda, then actually led the session discussing it.

WisDOT made several suggestions to the Pooled Fund Technical Panel for projects to be funded in the FY 2023 work plan, then coordinated WisDOT's response to project voting. We pushed for a method to use MDSS to calculate actual route cycle times, as well as a management-level exportable dashboard showing treatment recommendations across a large area.

Equipment Calibration

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

CALIBRATION SCALES. Proper calibration has been and always will be an important part of winter maintenance. If the calibration is off by even 10 percent, thousands of dollars' worth of salt can be wasted in one winter season.

The winter readiness program also ensures that all truck spreaders are calibrated ahead of each winter season by the counties.

Here is additional information on calibration in a completed Clear Roads study: https://clearroads.org/project/17-s1/

Product and Equipment Innovations

Winter maintenance is a continuously evolving field—new technology and innovations are developed each year and best practices are being disseminated to staff as efficiently as possible. Many useful research projects have been developed by Clear Roads and funded by DOTs in the Clear Roads program across the US (including Wisconsin). Here is a list of the few recent ones that can be found on the Clear Roads website:

- Measuring the Efficiencies of Tow Plows and Wing Plows
- Standard Specifications for Plow Blades with Carbide Inserts
- Inventory and Use of Salt Spreading Systems
- Alternative Methods for Deicing
- Effective Snow and Ice Personnel and Equipment Management for Storm Activation
- Training Video for the Implementation of Liquid-Only Plow Routes

3C. LABOR

Over 1,500 employees of Wisconsin's county highway departments are licensed to operate a snowplow, and over 1,000 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 contracts, which also define when overtime hours can be charged. This winter, counties spent over $28.8 million on labor, for an average of $830 per lane mile. Per-lane-mile labor expenditures increased 29 percent compared with last year's winter. An average of 24 percent of counties' winter maintenance costs were spent on labor, with a high of 32 percent in the Southeast Region, where hourly labor rates tend to be higher. Labor hours were up 40 percent for regular hours and up 42 percent for overtime hours compared with last winter. See Table 4.10 for county-by-county labor expenditures and Table 3.4 for county-by-county estimated labor hours and costs from the winter storm reports.

Photo Credit: Pixabay Commons License

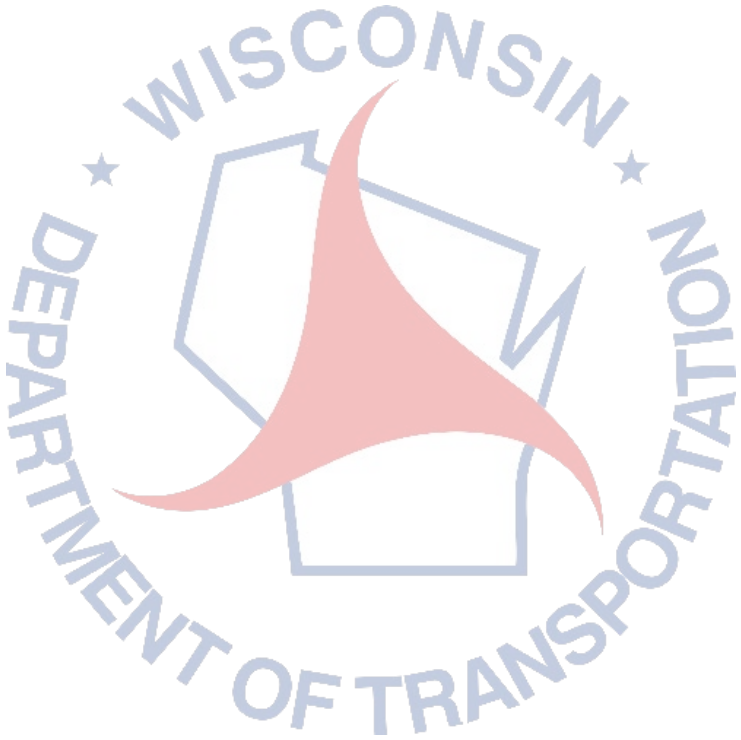
Winter Operations Training

Before each winter season, BHM provides and supports a variety of training efforts for WisDOT regional staff and county highway departments. Recent efforts over the last few years have included:

- MDSS/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.
- Regional Operations/County Fall Training Sessions. These sessions are held in all regions in preparation for the upcoming winter season and WisDOT provides support and participated in some of these training sessions.
- Clear Roads. Clear Roads continues to create many training documents for a wide variety of winter activities, and they can be seen at: https://clearroads.org/all-research-and-synthesis-projects/
- Winter Tech Talk. Organized a Winter Tech Talk in October 2022 which was a large scale one-day in-person event held at Chippewa Valley Technical College in Eau Claire. The event was for winter maintenance operators from the counties to meet, learn, discuss, and share information regarding winter maintenance practices, more specifically related to improvement in liquid use, including direct liquid application.
- Plow Driver Training. The Bureau of Highway Maintenance prepared and gave plow driver training to three counties prior to the 22/23 winter season. These sessions demonstrated the benefits of using more liquids and having a better salt management program.
- Brine Technical Advisory Committee: BHM brings together counties and other interested parties in the use of liquids for deicing during winter events. Which includes presentations on where the state currently stands with liquid use as well as brainstorming ideas while everyone is together on what works and what hasn't worked the best for each county.

We hope to provide additional training/education opportunities over the upcoming year to continue with the progress that has been made over the past years.

COUNTY-BY-COUNTY TABLES AND FIGURES FOR SECTION 3: SNOW AND ICE CONTROL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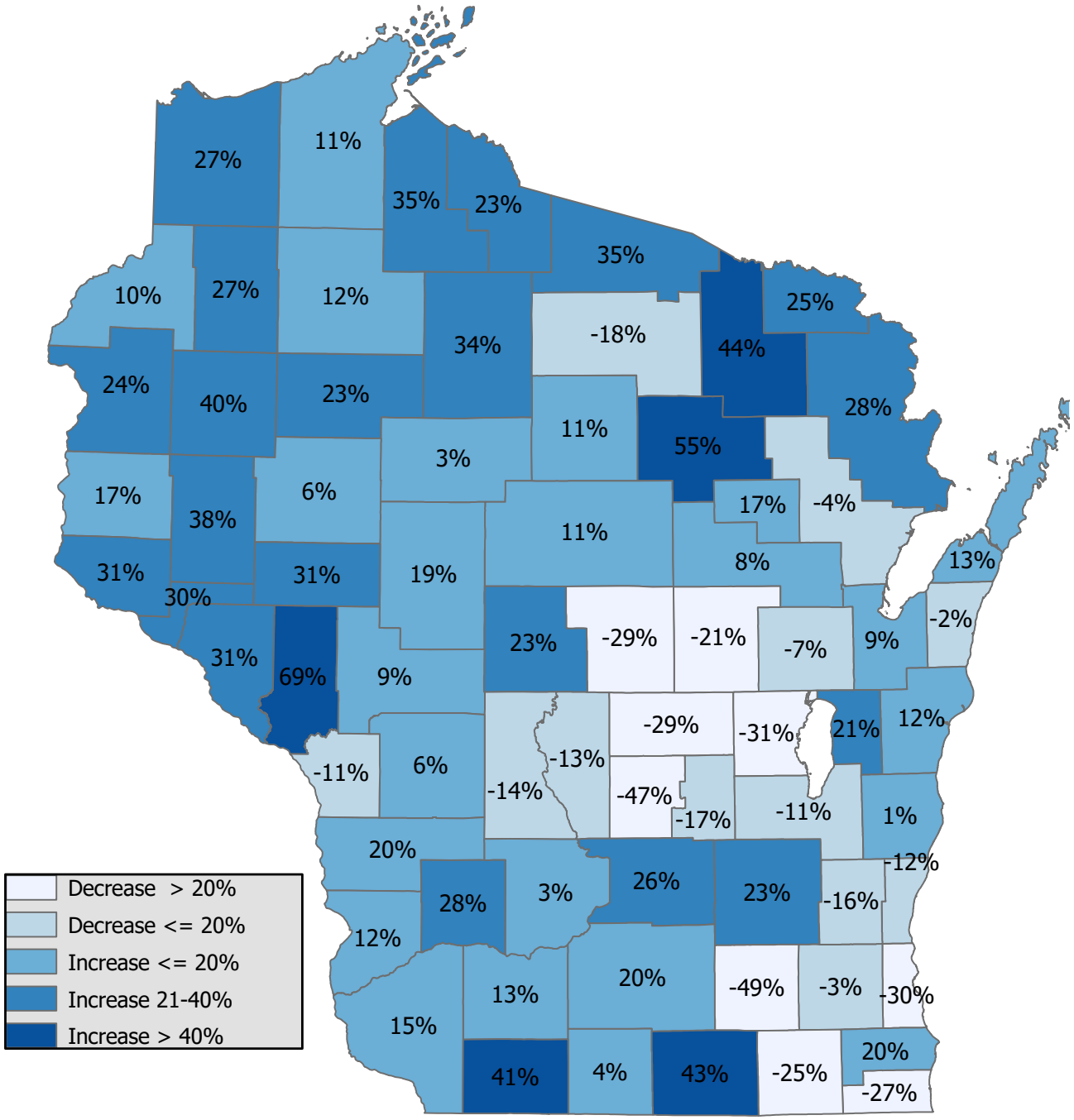
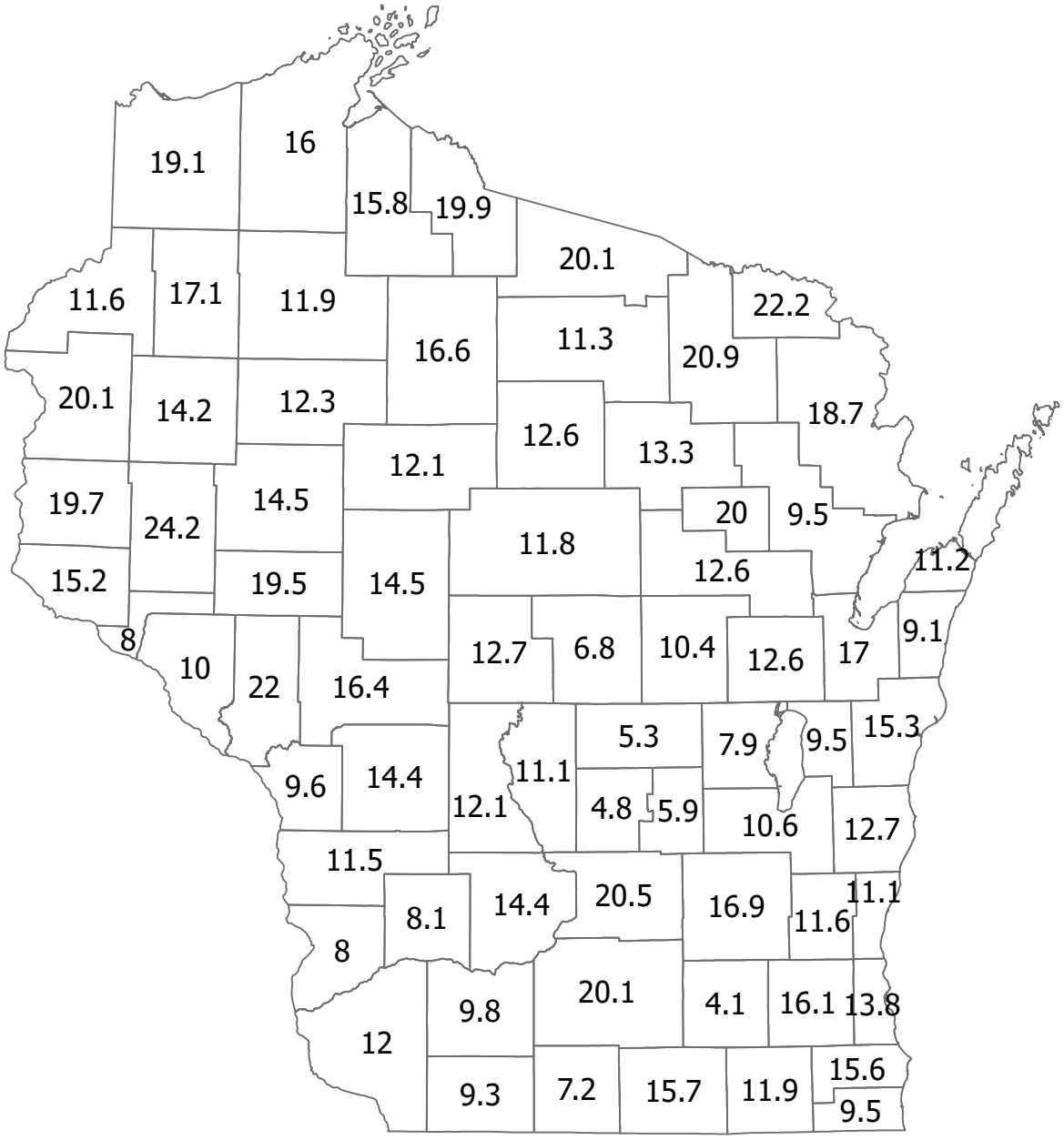
DEPARTMENT OF TRANSPORTATION

Figure 3.10 2022-2023 Salt Use per Lane Mile vs. 5-Year Average



Map created: July 2023

Figure 3.11 Tons of Salt/Lane-Mile 2022-2023



Map created: July 2023

Table 3.2. Labor Hours/Lane Miles/Severity Index Ranking (Group A)

From Winter Storm Reports, 2022-2023

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
MILWAUKEE	SE	1567.44	73.99	13.84	$976	9608	9188	18796	48.9%	11.99	0.16
WAUKESHA	SE	1044.48	66.67	16.05	$464	4473	3429	7902	43.4%	7.57	0.11
DANE	SW	1663.43	112.25	20.09	$1,040	6530	14347	20877	68.7%	12.55	0.11
Group A Avg		1,425.12	84.30	16.66	$827	6870	8988	15858	53.7%	10.70	0.13

Final totals as of Tuesday, June 27, 2023

Table 3.2. Labor Hours/Lane Miles/Severity Index Ranking (Group B)

From Winter Storm Reports, 2022-2023

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
KENOSHA	SE	674.12	47.84	9.49	$445	2227	2305	4532	50.9%	6.72	0.14
EAU CLAIRE	NW	529.80	98.92	19.49	$745	4944	2374	7318	32.4%	13.81	0.14
OUTAGAMIE	NE	577.92	87.40	12.60	$622	3954	2504	6458	38.8%	11.17	0.13
BROWN	NE	866.87	98.70	17.03	$666	3251	6578	9829	66.9%	11.34	0.11
WINNEBAGO	NE	686.74	89.09	7.92	$542	3452	3163	6615	47.8%	9.63	0.11
DODGE	SW	667.93	93.72	16.86	$638	2542	4126	6668	61.9%	9.98	0.11
SAUK	SW	595.90	120.87	14.40	$631	3799	3420	7219	47.4%	12.11	0.10
FOND DU LAC	NE	626.81	98.72	10.58	$621	2610	3445	6055	56.9%	9.66	0.10
ROCK	SW	775.29	65.39	15.71	$501	1728	3170	4898	64.7%	6.32	0.10
CHIPPEWA	NW	651.76	125.53	14.52	$673	3535	4187	7722	54.2%	11.85	0.09
COLUMBIA	SW	802.42	90.14	20.47	$456	3545	2905	6450	45.0%	8.04	0.09
SAINT CROIX	NW	653.34	118.95	19.73	$576	2749	4036	6785	59.5%	10.39	0.09
PORTAGE	NC	559.84	137.90	6.80	$562	5215	1479	6694	22.1%	11.96	0.09
JEFFERSON	SW	552.95	106.71	4.12	$591	1810	3223	5033	64.0%	9.10	0.09
WASHINGTON	SE	591.14	119.39	11.63	$565	2758	3137	5895	53.2%	9.97	0.08
MONROE	SW	671.54	106.89	14.35	$473	2727	3181	5908	53.8%	8.80	0.08
MARATHON	NC	903.02	138.51	11.78	$587	5229	4828	10057	48.0%	11.14	0.08
GRANT	SW	642.71	90.63	12.00	$383	1839	2805	4644	60.4%	7.23	0.08

Table 3.2. Labor Hours/Lane Miles/Severity Index Ranking (Group B)

From Winter Storm Reports, 2022-2023

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
WALWORTH	SE	696.59	118.49	11.87	$546	3099	2798	5897	47.4%	8.47	0.07
WAUPACA	NC	557.05	101.74	10.39	$372	2393	1527	3920	39.0%	7.04	0.07
RACINE	SE	765.35	88.25	15.64	$397	2337	2063	4400	46.9%	5.75	0.07
Group B Avg		669.00	102.08	13.21	$552	3131	3203	6333	50.5%	9.55	0.10

Table 3.2. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2022-2023

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
MANITOWOC	NE	424.86	72.58	15.33	$427	2257	1663	3920	42.4%	9.23	0.13
LA CROSSE	SW	490.01	53.48	9.63	$383	1334	1729	3063	56.4%	6.25	0.12
BARRON	NW	434.95	155.82	14.20	$783	4828	1946	6774	28.7%	15.57	0.10
DUNN	NW	519.12	120.40	24.20	$654	2819	2875	5694	50.5%	10.97	0.09
DOUGLAS	NW	465.51	171.04	19.11	$671	6140	794	6934	11.5%	14.90	0.09
SHAWANO	NC	533.57	130.89	12.58	$626	4301	1704	6005	28.4%	11.25	0.09
PIERCE	NW	368.74	121.25	15.21	$561	2238	1556	3794	41.0%	10.29	0.08
IOWA	SW	457.02	110.15	9.83	$526	2114	2115	4229	50.0%	9.25	0.08
JUNEAU	SW	501.12	95.16	12.06	$470	2099	1881	3980	47.3%	7.94	0.08
SHEBOYGAN	NE	532.95	115.21	12.68	$534	2360	2228	4588	48.6%	8.61	0.07
CLARK	NW	401.29	111.78	14.52	$426	1609	1673	3282	51.0%	8.18	0.07
LINCOLN	NC	399.09	164.15	12.61	$575	3593	1185	4778	24.8%	11.97	0.07
JACKSON	NW	518.28	127.26	16.41	$444	2492	2186	4678	46.7%	9.03	0.07
VERNON	SW	468.58	118.31	11.46	$402	2033	1725	3758	45.9%	8.02	0.07
WOOD	NC	448.55	132.81	12.73	$423	2065	1544	3609	42.8%	8.05	0.06
OCONTO	NE	482.03	148.65	9.53	$480	2538	1618	4156	38.9%	8.62	0.06
CRAWFORD	SW	398.16	118.47	8.05	$312	1469	941	2410	39.0%	6.05	0.05

Table 3.2. Labor Hours/Lane Miles/Severity Index Ranking (Group C)

From Winter Storm Reports, 2022-2023

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
Group C Avg		461.40	121.61	13.54	$512	2723	1727	4450	40.8%	9.66	0.08

Final totals as of Tuesday, June 27, 2023

Table 3.2. Labor Hours/Lane Miles/Severity Index Ranking (Group D)

From Winter Storm Reports, 2022-2023

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
RICHLAND	SW	321.58	70.26	8.08	$316	1167	939	2106	44.6%	6.55	0.09
GREEN	SW	313.01	92.54	7.18	$451	1197	1446	2643	54.7%	8.44	0.09
TREMPEALEAU	NW	420.19	115.78	22.01	$595	2491	1943	4434	43.8%	10.55	0.09
POLK	NW	374.63	150.70	20.14	$704	3047	1878	4925	38.1%	13.15	0.09
OZAUKEE	SE	300.72	77.54	11.14	$392	1099	920	2019	45.6%	6.71	0.09
ONEIDA	NC	394.97	172.46	11.25	$676	4308	1376	5684	24.2%	14.39	0.08
MARQUETTE	NC	245.99	91.00	4.75	$376	979	718	1697	42.3%	6.90	0.08
BAYFIELD	NW	346.03	189.13	16.02	$727	3350	1470	4820	30.5%	13.93	0.07
LAFAYETTE	SW	292.64	111.89	9.27	$416	1176	1207	2383	50.7%	8.14	0.07
WASHBURN	NW	388.27	171.28	17.09	$650	2613	2127	4740	44.9%	12.21	0.07
DOOR	NE	274.02	109.01	11.23	$504	804	1256	2060	61.0%	7.52	0.07
MARINETTE	NE	414.01	143.22	18.69	$510	2142	1521	3663	41.5%	8.85	0.06
WAUSHARA	NC	342.05	103.70	5.27	$310	1348	754	2102	35.9%	6.15	0.06
BUFFALO	NW	311.69	152.52	10.04	$425	1715	984	2699	36.5%	8.66	0.06
Group D Avg		338.56	125.07	12.30	$504	1960	1324	3284	42.4%	9.44	0.08

Table 3.2. Labor Hours/Lane Miles/Severity Index Ranking (Group E)

From Winter Storm Reports, 2022-2023

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	109.41	104.88	7.99	$708	806	676	1482	45.6%	13.55	0.13
RUSK	NW	213.24	123.49	12.31	$558	1433	773	2206	35.0%	10.35	0.08
CALUMET	NE	219.61	126.95	9.52	$499	1289	847	2136	39.7%	9.73	0.08
VILAS	NC	307.61	192.03	20.10	$542	4080	39	4119	0.9%	13.39	0.07
IRON	NC	240.51	208.32	19.87	$653	1984	1220	3204	38.1%	13.32	0.06
FOREST	NC	314.15	160.18	20.91	$457	2055	1079	3134	34.4%	9.98	0.06
ASHLAND	NW	255.69	203.14	15.77	$632	2099	1072	3171	33.8%	12.40	0.06
TAYLOR	NW	232.32	135.29	12.09	$426	1017	895	1912	46.8%	8.23	0.06
BURNETT	NW	235.35	125.89	11.61	$360	1041	701	1742	40.2%	7.40	0.06
GREEN LAKE	NC	154.23	86.98	5.87	$276	465	320	785	40.8%	5.09	0.06
LANGLADE	NC	300.53	151.84	13.32	$411	1693	909	2602	34.9%	8.66	0.06
PRICE	NC	318.47	187.30	16.62	$487	1848	1499	3347	44.8%	10.51	0.06
SAWYER	NW	357.24	155.56	11.92	$413	1661	1231	2892	42.6%	8.10	0.05
Group E Avg		250.64	150.91	13.68	$494	1652	866	2518	36.7%	10.05	0.07

Final totals as of Tuesday, June 27, 2023

Table 3.2. Labor Hours/Lane Miles/Severity Index Ranking (Group F)

From Winter Storm Reports, 2022-2023

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
MENOMINEE	NC	90.66	107.27	20.04	$379	622	157	779	20.2%	8.59	0.08
FLORENCE	NC	137.43	134.74	22.23	$365	922	369	1291	28.6%	9.39	0.07
ADAMS	NC	202.76	113.92	11.14	$318	1050	281	1331	21.1%	6.56	0.06
KEWAUNEE	NE	125.73	116.08	9.15	$319	500	229	729	31.4%	5.80	0.05
Group F Avg		139.14	118.00	15.64	$345	774	259	1033	25.3%	7.59	0.06

4 Winter Performance

In this section...

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

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

Performance and Costs, 2022-2023

Total lane miles	34,723
Total patrol sections	754
Average lane miles per patrol section	46.1
Roads to bare/wet pavement within WisDOT targets[1]	73%
Total tons of salt/lane-mile	13.9
Total gallons of brine and blends/lane-mile	580
Average crew reaction time from start of storm	2.56 hours
Total winter costs[2]	$ 118,759,205
Total winter costs per lane mile	$ 3,420
Total winter crashes[3]	7,755
Total winter crashes per 100 million VMT	25

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.

Photo Credit: Citypages.com (Google - Creative Commons License)

An Economical Choice

Proactive anti-icing operations are about three times less costly than treating frost once it has formed. Anti-icing costs made up only 1.6 percent of total winter maintenance costs this year. ***See page 40 for more information on anti-icing costs.***

4A. WINTER PERFORMANCE MEASURES

Performance 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 include:

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

Table 4.1 gives the statewide average values for these measures for the last five winters. More detail on these measures is provided later in this section.

WisDOT has gathered several years of baseline data, this data can be used to make a year-to-year comparison in these areas.

Table 4.1. Statewide Winter Performance Measures for Winter

	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Percentage of roads to bare/wet pavement (Within WisDOT target times)	69%	72%	68%	72%	73%
Cost per lane mile	$3,212	$2,428	$2,107	$2,457	$3,420
Winter Severity Index	105.7	94.3	64.1	97.1	116.2
Cost per lane mile per Winter Severity Index point	$30.39	$25.28	$31.09	$25.30	$29.43
Winter weather crashes	30 per 100 million VMT	21 per 100 million VMT	23 per 100 million VMT	19 per 100 million VMT	25 per 100 million VMT

4B. 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. With the implementation of MDSS, this process has become more automated. Patrol superintendents receive treatment recommendations based on the characteristics of the route, such as traffic volume and pavement type, residual de-icers, actions already performed and forecasted weather.

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 mid season if necessary. 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.
- Mobility, Accountability, Preservation, Safety, and Service (MAPSS) measures: https://wisconsindot.gov/pages/about-wisdot/performance/mapss/default.aspx
- DTSD Performance Measures.

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://transportal.cee.wisc.edu/storm-report/ 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.

BEST PRACTICES: Automatic Vehicle Location (AVL-GPS)

AVL-GPS is used to determine the location of a vehicle and allows management to monitor the location of an entire fleet. This system can assist in the management of labor, equipment and materials. WisDOT primarily uses data from AVL-GPS to improve MDSS recommendations.

Additionally, AVL can record and transmit operational data from snowplows. Data such as application rates, pavement temperatures, and the position of blades and plows can all be captured. This data can be stored and used for reporting and analysis at a later date.

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 754 winter patrol sections, an average of 10.5 sections per county. 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 their section.

Table 4.2. Average Patrol Section Lengths by Winter Service Group

Winter Service Group	Average Patrol Section Length (lane miles)	Min Lane Miles per Section	Max Lane Miles per Section
A	46.0	40.2	50.4
B	47.3	36.1	58.9
C	45.9	31.1	57.7
D	47.9	30.4	62.4
E	47.9	36.5	59.5
F	43.4	40.6	45.8
Statewide Average	46.1	30.4	62.4

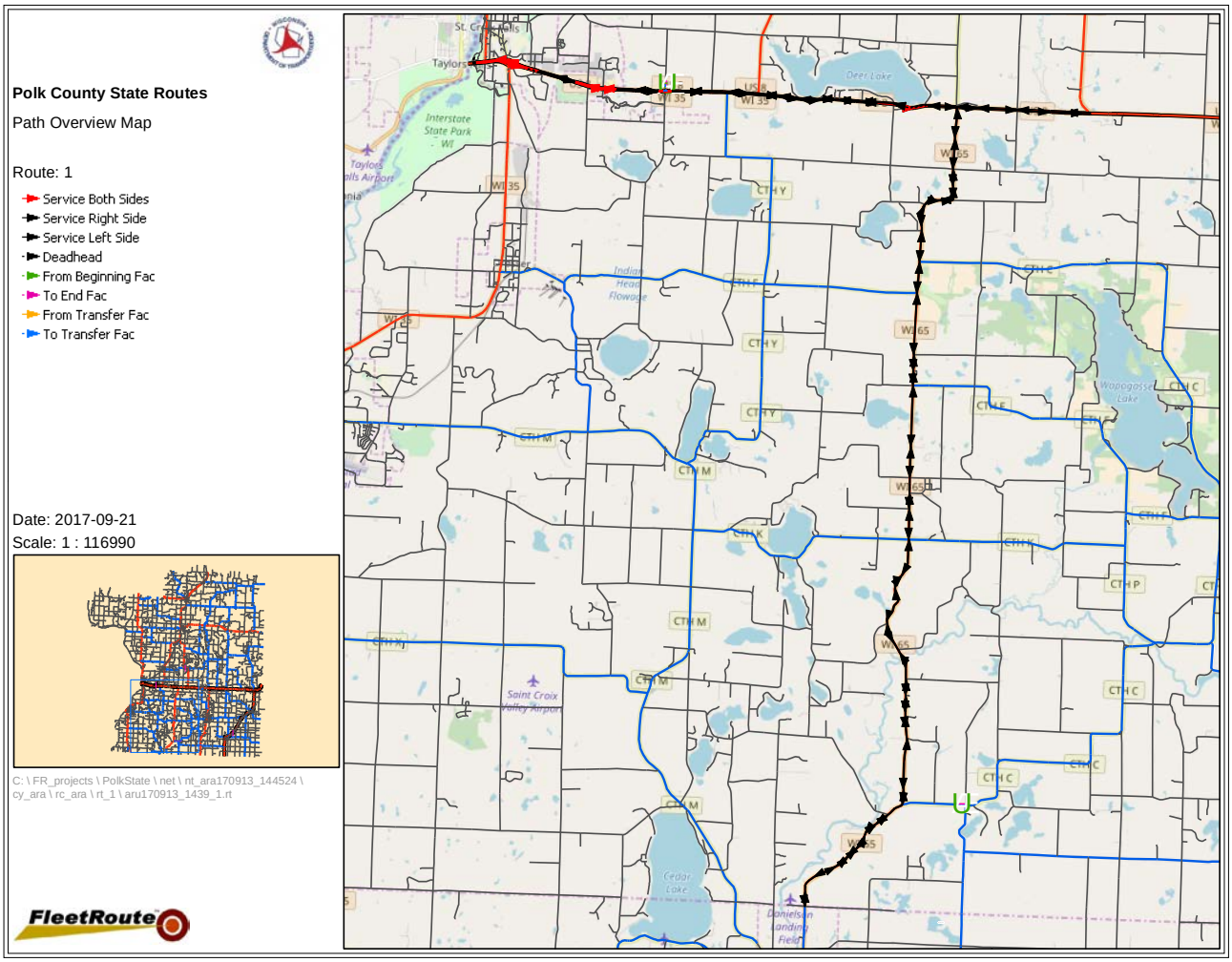
Table 4.2 shows the average patrol section length for the counties in each Winter Service Group. For county-by-county patrol section data, see Table 4.8.

Route Optimization

After a discussion about Winter Patrol Sections, it is appropriate to mention the newest trend across the country, Route Optimization. Route Optimization is just what it implies – optimizing a route traveled by taking less left turns or U-turns and equalizing the length of time between routes. Winter road maintenance route optimization highway segments are designed for plow speeds of 25-32.5 mph and a maximum rate of 300 lbs. of salt/lane-mile over the course of 2.5-3 hours. The 2.5-3 hours optimal plow route time is used because that is typically how long salt or salt brine will remain on the road before it becomes too diluted to be effective. Route optimization is used by major private sector companies including FedEx and UPS, and is considered a best practice for efficiency. In recent years, the public sector has seen success with the process too.

To date, 44 Wisconsin counties have volunteered to collaborate with WisDOT to determine the value of using GIS technology to optimize snow plow routes. Of the 44 Wisconsin counties involved, Dane, Jefferson and Waukesha have implemented Route Optimization and have seen a return on the investment. Return on investment will be unique to each county. WisDOT expects to experience significant savings related to operations, salt use, fuel consumption and increases in safety as more counties implement route optimization. Cost savings during winter months means more funding is available for maintenance work during summer months, which Wisconsin residents view as a high priority. Preliminary numbers from route optimization show:

- When routes are absorbed into larger routes through optimization, it creates savings of roughly $85,000 annually per route.
- There is still more work that could be done; based on 2.5 hour route cycle times, the existing 754 patrol sections throughout the state could be reduced to 639 routes.



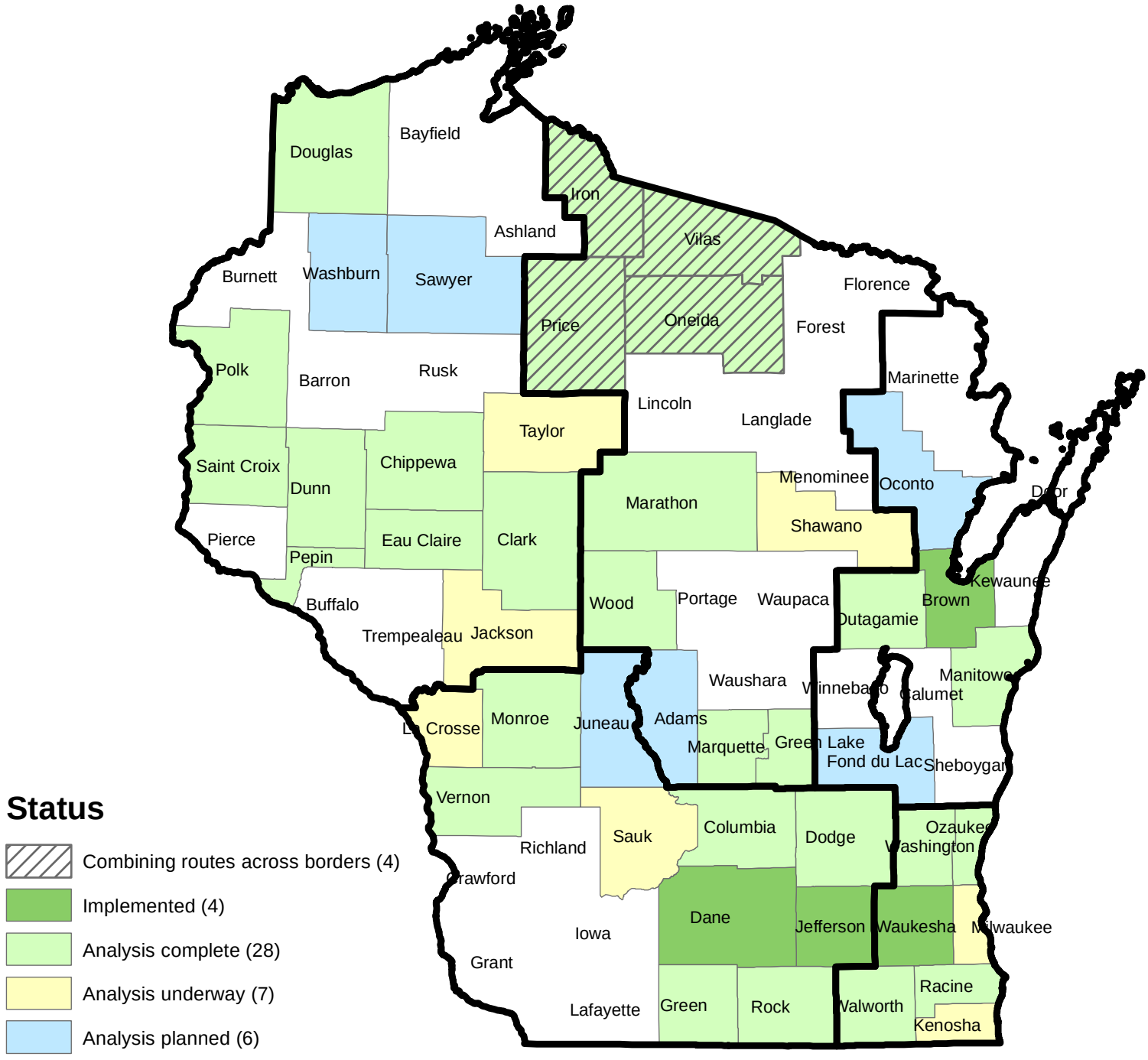
Route Optimization mapping completed for Polk County.

Figure 4.1 shows the counties that have committed to invest in route optimization.

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. However, WisDOT guidelines dictate that lower-volume highways receive 18-hour winter maintenance coverage rather than 24-hour coverage, so slower average reaction times are expected on 18-hour roads.

Figure 4.1. Counties Using Route Optimization



Map updated: July 2022

Table 4.3. Maintenance Crew Reaction Time

From winter storm reports, 2012/2013–2022/2023

	10-Year Average reaction time (hours)										10-year Average	Average reaction time (hours)	Percent change
Winter Service Group	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2012-2013 to 2021-2022	*2022-2023*	*2022-2023 vs. 10-year avg.*
A	0.63	2.31	0.32	1.21	0.37	0.52	0.48	1.01	0.23	1.15	**0.82**	***0.10***	***-88%***
B	1.27	4.48	1.67	2.4	1.07	1.34	1.16	1.26	1.30	1.13	**1.71**	***1.15***	***-33%***
C	2.38	4.99	2.57	3.19	2.22	2.61	2.16	2.24	2.66	2.29	**2.73**	***2.40***	***-12%***
D	3.77	6.23	2.86	3.91	2.06	2.7	2.61	2.90	3.02	2.53	**3.26**	***2.37***	***-27%***
E	2.99	9.36	3.77	6.72	3.94	5.04	4.4	4.29	4.39	3.98	**4.89**	***4.73***	***-3%***
F	3.79	14.81	4.78	8.62	3.64	5.13	3.91	5.27	5.04	4.3	**5.93**	***4.58***	***-23%***
Statewide average (unweighted)	2.42	7.03	2.66	4.34	2.22	2.89	2.45	2.83	2.77	2.56	**3.22**	***2.56***	***-20%***

Maintenance Crew Reaction Time

Being proactive in getting on the road—even before the start of a storm—can result in bare/wet pavement being achieved faster and with less effort. Knowing this, county highway departments are becoming more proactive in their response to winter storms. Plows and salt spreader trucks are often on the road before a storm starts or shortly afterward. Sometimes counties wait until the sun comes out so their salting and plowing are more effective, which can increase average reaction times.

Bare/wet condition is when the lanes of travel are wet and snow is no longer visible in the lane. Some winter levels of service are not expected to achieve a bare/wet condition as quickly as others.

Using data from the weekly winter storm reports, Table 4.3 shows the average reaction time to storm events in each Winter Service Group. This winter the average reaction time of 2.56 hours was 21 percent faster than the latest 10-year average. 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.

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 would receive more materials, labor and equipment—and would show a quicker recovery to bare/wet pavement—than a rural, two-lane highway. For more information on these categories, see page 8.

Table 4.4. Percentage to Bare/Wet Pavement

	Percent of Time the Highway Category Target Time to Bare/Wet Pavement was Met (Target Times: 4 hours for 24-Hour Roads; 6 hours for 18 Hour Roads)										
Highway Category	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
24-Hour Roads	75%	66%	75%	78%	79%	73%	73%	78%	74%	79%	82%
18-Hour Roads	70%	59%	67%	71%	70%	60%	65%	67%	62%	66%	66%
Target	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%

"Time to bare/wet pavement" is measured from the reported end time of a storm. Table 4.4 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 2022-23 percentage of roadways cleared to bare/wet pavement increased slightly from the previous year.

4D. COSTS

The total billed cost of statewide winter operations this winter was $118.8 million, making it 39 percent more costly than 2021-22. A number of factors drive the cost of winter maintenance, including both the nature and severity of the winter (i.e. how much work has to be performed), as well as the unit costs of the component elements of winter maintenance (i.e. cost per lane mile for salt, labor and equipment).

Winter maintenance costs per lane mile increased in 2022-23 by about 39 percent from 2021-22. See Figure 4.4 for a statewide map of winter cost per lane-mile. Figure 4.2 shows the statewide average winter cost per lane mile and Winter Severity Index since the 1998-99 winter. The average Winter Severity Index was more in all regions compared with the previous winter.

Table 4.5 shows total winter maintenance costs statewide and for each region per lane mile, as well as relative to the region's average Winter Severity Index. The level of service provided in each county affects the total costs, and the mix of counties in a region affects the overall comparative costs.

Figure 4.3 shows in 2022-23 that all Regions experienced higher costs compared to 2021-2022. The same is true while looking at comparison to the 5-year average that all regions experienced higher costs.

Table 4.5. Total Winter Costs Relative to Winter Severity, 2022-2023

Region	Average Winter Severity Index	Actual cost per lane mile	Relative cost per severity index point
SW	85.4	$3,264	$38.22
SE	73.1	$3,302	$45.17
NE	94.8	$3,152	$33.25
NC	136.9	$3,324	$24.28
NW	149.2	$3,958	$26.53
Statewide	116.2	$3,420	$29.43

Figure 4.2. Statewide Average Winter Costs per Lane Mile and Winter Severity Index, 1999-00 thru 2022-2023

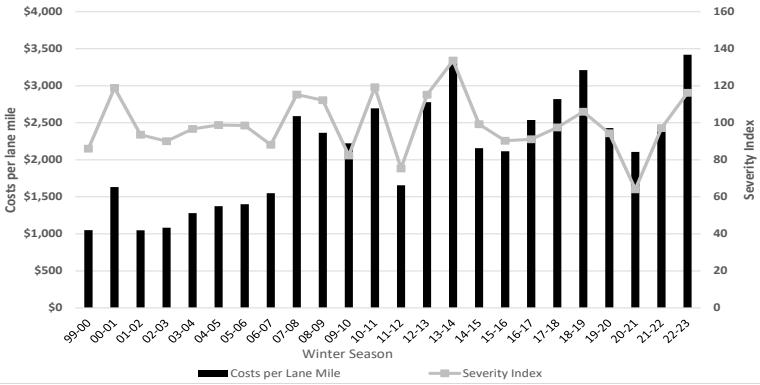


Figure 4.3. Total Winter Maintenance Cost by Region, 2021-22 vs. 2020-21 vs. Previous 5-Year Average

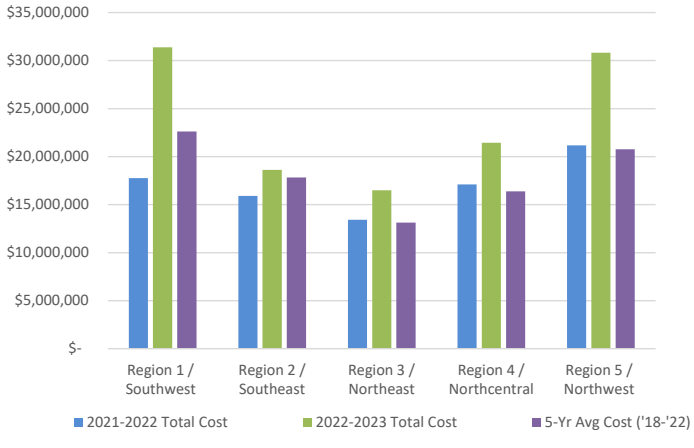
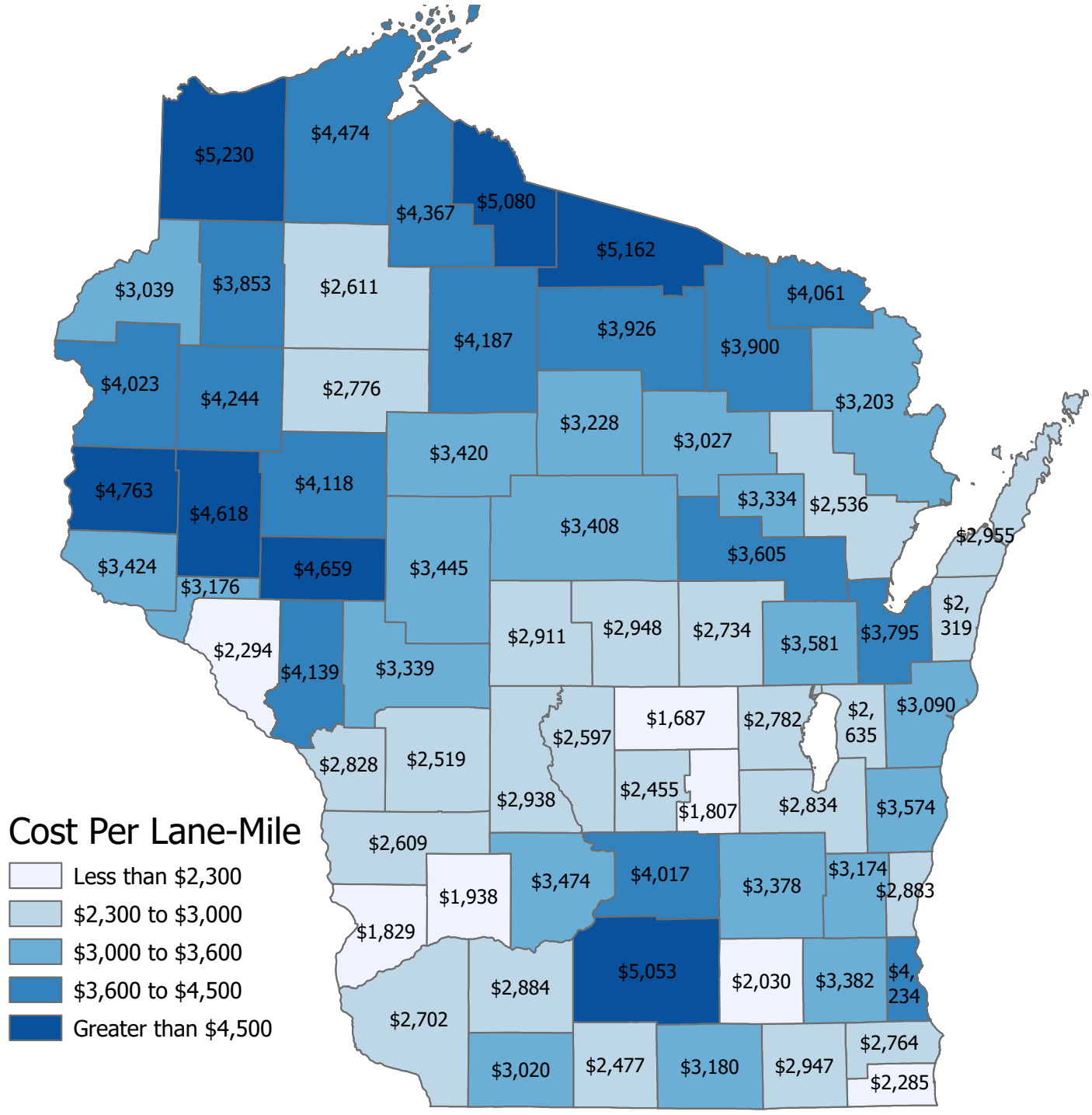


Figure 4.4 Winter Cost/Lane-Mile 2022-2023



Map created: July 2023

There are five major cost categories in the Department's winter maintenance billing system. These include: cost of salt used, labor costs, cost of other materials furnished by the county, and administration costs. Figure 4.5 below shows the breakdown of the $118.8 million in 2022-23 statewide winter maintenance costs by these billing categories.

Figure 4.5. Statewide Winter Costs by Category

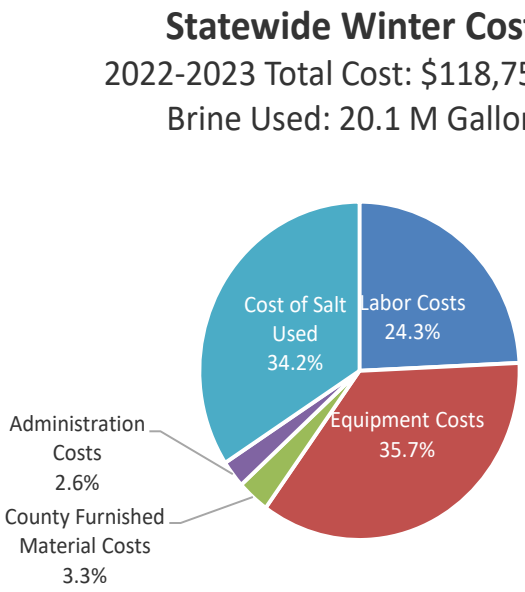


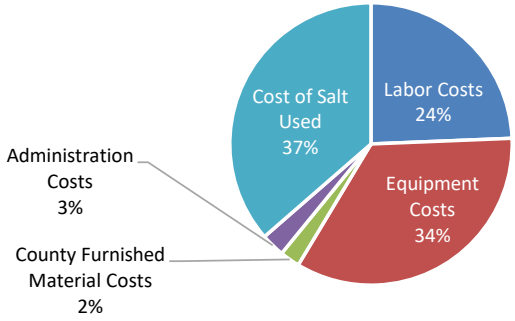
Figure 4.6 shows the breakdown of costs by billing category for each of the five regions. More specific, detailed cost figures by region and for the state as a whole are shown in Table 4.6.

In the five individual winter maintenance expenditure categories for 2022-23 statewide, the following trends were noted:

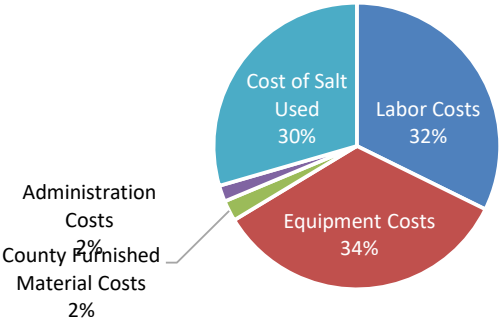
- Salt expenditures were $40.6 million - a 28 percent increase compared to the previous winter. The Southwest region saw a 70 percent increase from the previous winter, the Southeast region had a 1 percent decrease, the Northcentral region had a 12 percent increase from last winter, the Northeast region had a 2 percent increase from last winter, the Northwest region had a 38 percent increase from last winter.
- Equipment expenditures were $42.4 million, an increase of 60 percent compared to the previous winter.
- Labor expenditures were $28.8 million, an increase of 29 percent from the previous winter.
- County Furnished Material Costs were $3.9 million, an increase of 39 percent compared with the previous winter.

Figure 4.6. Regional Winter Costs by Category, 2021-2022

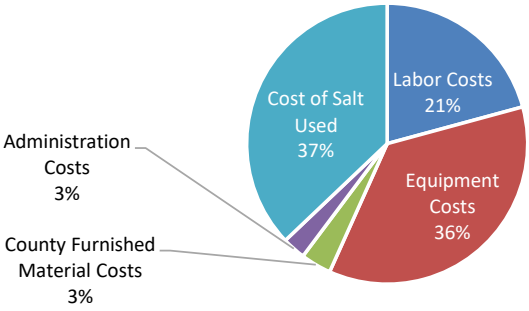
Southwest Region Winter Costs
2022-2023 Total Cost: $31,380,462
Brine Used: 3.7 M Gallons



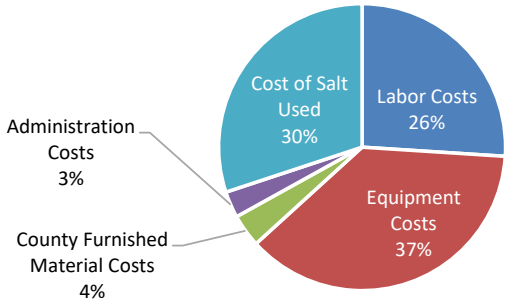
Southeast Region Winter Costs
2022-2023 Total Cost: $18,620,670
Brine Used: 2.2 M Gallons



Northwest Region Winter Costs
2021-2022 Total Cost: $30,821,929
Brine Used: 1.6 M Gallons



Northeast Region Winter Costs
2022-2023 Total Cost: $16,492,352
Brine Used: 5.8 M Gallons



Northcentral Region Winter Costs
2021-2022 Total Cost: $21,443,793
Brine Used: 6.9 M Gallons

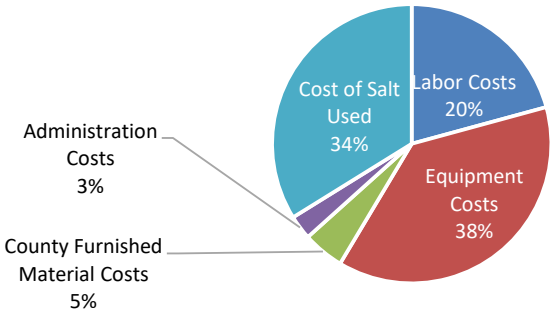


Table 4.6

Winter 2022-23 Expenses for County Services

Region	Labor Costs	Equipment Costs	County Furnished Material Costs	Administration Costs	Cost of Salt Used	Total Costs for Winter	Five Year Average Cost for Winter ('18-'22 avg)	% Total Costs over Five Year Average
Southwest	$7,643,434	$10,751,765	$715,840	$849,020	$11,420,404	$31,380,462	$22,613,600	39%
Southeast	$6,011,803	$6,342,441	$436,855	$340,161	$5,489,410	$18,620,670	$17,830,300	4%
Northeast	$4,291,510	$6,139,487	$610,967	$489,645	$4,960,744	$16,492,352	$13,130,800	26%
North Central	$4,453,464	$8,107,478	$1,025,106	$603,054	$7,254,690	$21,443,793	$16,372,900	31%
Northwest	$6,405,083	$11,076,163	$1,084,212	$824,366	$11,432,105	$30,821,929	$20,773,900	48%
Totals	**$28,805,294**	**$42,417,334**	**$3,872,979**	**$3,106,246**	**$40,557,352**	**$118,759,205**	**$90,721,500**	**31%**

Figure 4.7. Costs per Lane Mile by Category

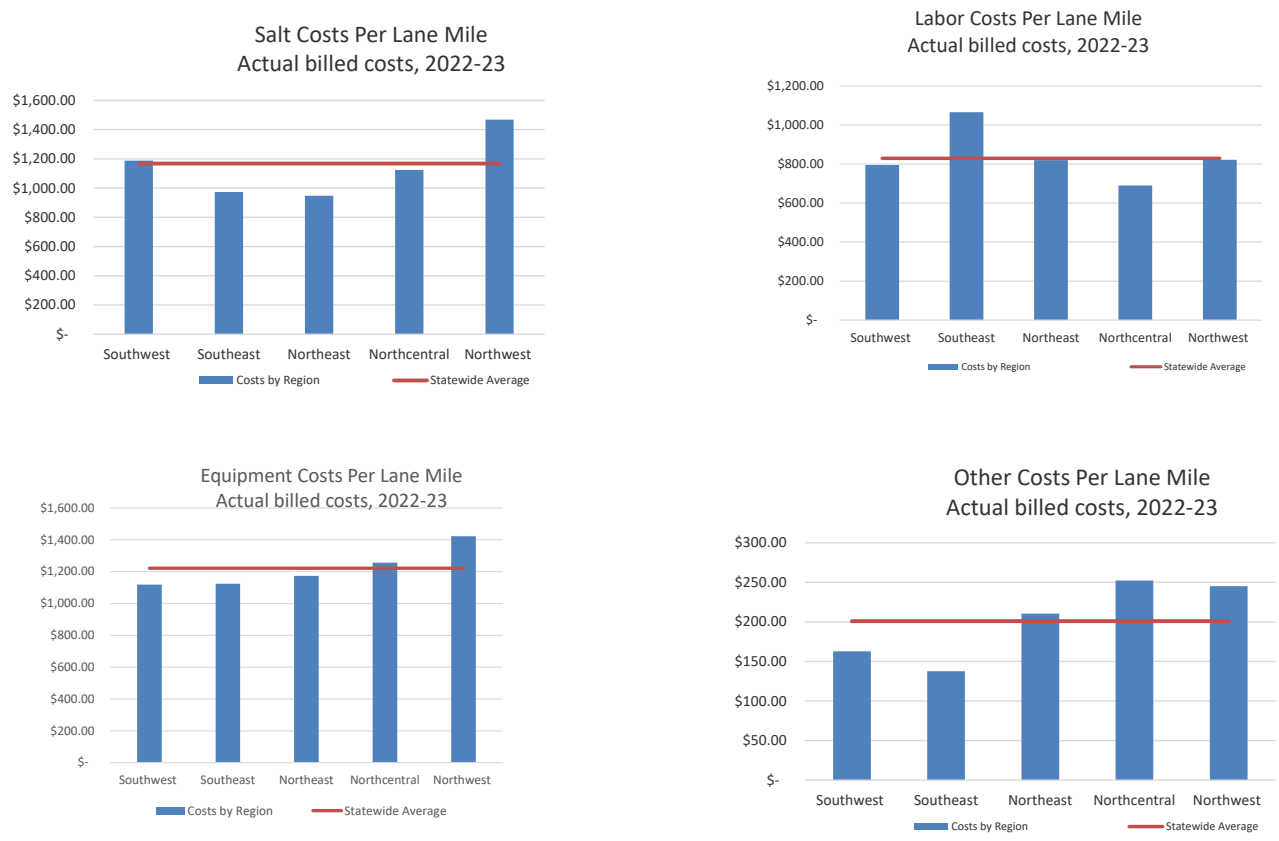


Figure 4.7 shows the total cost per lane mile for winter maintenance in each region, along with the region's Winter Severity Index. The level of service provided in each county affects total costs, as do the factors listed below. For these reasons, the Southeast Region historically experiences significantly higher costs relative to winter severity than the other regions.

Components of Winter Costs

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

- Labor costs are based on rates set in each county's union contracts. Hourly rates tend to be higher in more urban counties. Timing of storms can increase labor costs if more overtime hours are required.
- Equipment costs are determined by the state Machinery Management Committee, which assigns an hourly rate to each piece of equipment that includes depreciation from the purchase price, maintenance costs, and fuel costs. Rising fuel costs have contributed to increased equipment costs, as have some counties' purchase of larger, more expensive vehicles. These larger vehicles are often more useful for year-round maintenance tasks and are also more efficient in the winter, as they can accommodate larger plows and carry more salt.
- Salt costs are affected by salt prices per ton, which vary because of transportation costs. For example, salt entering the state at the Port of Milwaukee doesn't have to travel as far to reach counties in the Southeast region as it does to reach counties in the center of the state.

- Costs for materials other than salt, such as sand, are also affected by transportation costs. In addition, some counties use more expensive deicing agents that are more effective at lower temperatures (see Table 3.1 for details on deicing agent costs).
- Administrative costs are calculated at 4.39 percent of each county's combined labor, equipment and materials costs, and cover the overhead costs for office activities.

The breakdown of expenditures by category varies among regions because of the factors described above. For example, the Southeast Region spends more on labor because hourly labor rates tend to be higher in those counties, while equipment expenditures make up a smaller percentage of that region's total expenditures. Figure 4.6 shows the distribution of costs by category for each region.

County-by-county cost data is available in Table 4.10.

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 Cost per Lane Mile per Severity Index Ranking) are included in this report because they provide county-by-county breakdowns of cost data not available elsewhere. Many of the tables in the Appendix also include cost data from the storm reports. The source of each table's data is indicated below the table title.

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

4E. TRAVEL AND CRASHES

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

In the winter of 2022-2023, there were 7,755 reported winter weather crashes (those that occurred on pavements covered with snow, slush or ice), a 38 percent decrease over the previous winter. The statewide average crash rate (number of crashes per 100 million vehicle miles traveled) increased from 19 to 25, a 32 percent increase over the previous winter.

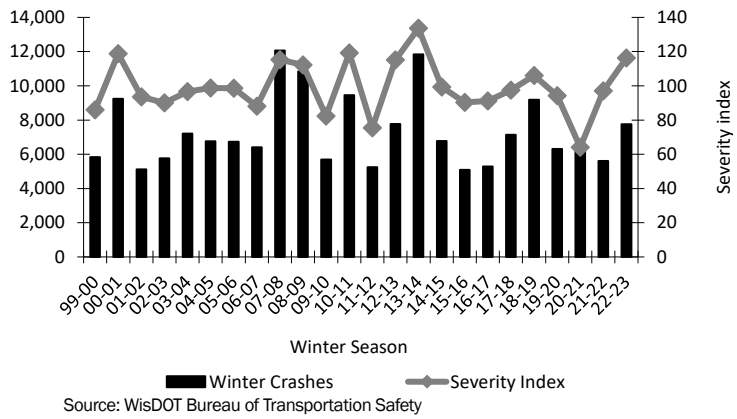
Crash rates tend to increase in more severe winters. Figure 4.8 shows the trends in total crashes statewide over the last 20 years overlaid with the Winter Severity Index. This past winter followed that trended as had a very severe winter with an increase in crashes as well.

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

Crashes and Vehicle Miles Traveled

More urban areas such as the Southeast Region often have fewer winter weather crashes per 100 million vehicle miles traveled. This is partly due to the fact that a single crash in a county with low VMT has a bigger impact on the overall crash rate. Urban regions have more highways with 24 hour coverage. As you can see from table 4.4 these highways are at clear pavement sooner due to continuous coverage

Figure 4.8. Winter Crashes and Winter Severity Index



Source: WisDOT Bureau of Transportation Safety

This year, all regions saw an increase in crash rates, other than North Central region which had a 3 percent decrease, with a crash rate at 28 crashes per 100 million. The Southeast region saw the greatest percentage increase in crash rates (a 62 percent increase), with this year's crash rate at 25 crashes per 100 million VMT (see Table 4.7). Table 4.12 gives the estimated number of vehicle miles traveled in each county this winter (November 2022 to April 2023), and the number of crashes that occurred in each county.

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 non-divided. Figure 4.9 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 shows the breakdown of crashes in each county according to highway type.

Photo Credit: Pixabay Commons License

Table 4.7. Crashes and Vehicle Miles of Travel by Region

Region	Winter Severity Index (2022-23)	VMT (100 million) (Nov 2022 - April 2023)	Snow/Slush/Ice Crashes (Nov 2022 - April 2023)	Crashes per 100M VMT (2021–2022)	Crashes per 100M VMT (2022–2023)
NC	136.9	37.9	1,056	29	28
NW	149.2	50.9	1,425	24	28
NE	94.8	56.1	1,332	22	24
SE	73.1	85.3	1,830	13	21
SW	85.4	77.5	2,112	17	27
Statewide	116.2	307.8	7,755	19	25

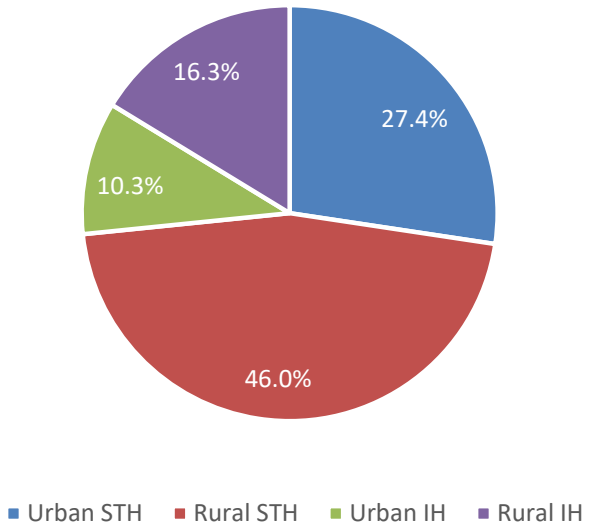
How VMT Is Calculated

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

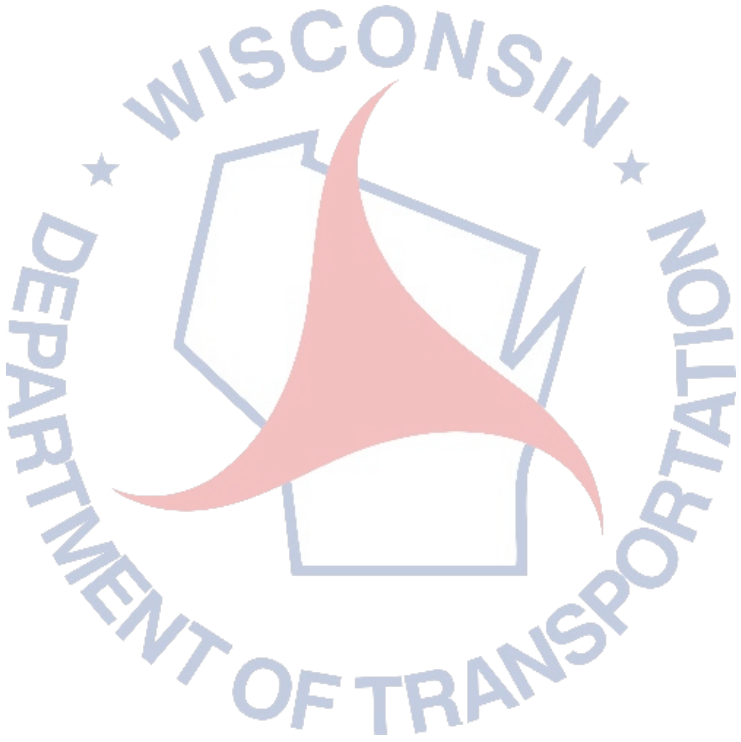
estimates are made for the counties not counted. In addition, forecasters factor in gallons of gas sold, fuel tax collected, and average vehicle miles per gallon.

Total winter VMT for all counties is shown in Table 4.12. This winter, total VMT ranged from a low of 14.8 million in Menominee County to a high of 3.2 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.

Figure 4.9. Winter Crashes by Highway Type, Bureau of Transportation Safety Data 2022-2023



COUNTY-BY-COUNTY TABLES AND FIGURE FOR SECTION 4: PERFORMANCE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DEPARTMENT OF TRANSPORTATION

Table 4.8. Winter Maintenance Sections

NC Region

County	Lane Miles	Winter Patrol Sections 2023	Lane Miles per Patrol Section	Winter Service Group
Adams	202.76	5	40.6	F
Florence	137.43	3	45.8	F
Forest	314.15	6	52.4	E
Green Lake	154.23	3	51.4	E
Iron	240.51	6	40.1	E
Langlade	300.53	6	50.1	E
Lincoln	399.09	10	39.9	C
Marathon	903.02	20	45.2	B
Marquette	245.99	5	49.2	D
Menominee	90.66	2	45.3	F
Oneida	394.97	10	39.5	D
Portage	559.84	15	37.3	B
Price	318.47	6	53.1	E
Shawano	533.57	14	38.1	C
Vilas	307.61	7	43.9	E
Waupaca	557.05	12	46.4	B
Waushara	342.05	6	57.0	D
Wood	448.55	10	44.9	C
Region Average			**45.6**	

NW Region

County	Lane Miles	Winter Patrol Sections 2023	Lane Miles per Patrol Section	Winter Service Group
Ashland	255.69	5	51.1	E
Barron	434.95	14	31.1	C
Bayfield	346.03	6	57.7	D
Buffalo	311.69	7	44.5	D
Burnett	235.35	5	47.1	E
Chippewa	651.76	16	40.7	B
Clark	401.29	10	40.1	C
Douglas	465.51	9	51.7	C
Dunn	519.12	9	57.7	C
Eau Claire	529.80	9	58.9	B
Jackson	518.28	9	57.6	C
Pepin	109.41	3	36.5	E
Pierce	368.74	7	52.7	C
Polk	374.63	6	62.4	D
Rusk	213.24	5	42.6	E
Saint Croix	653.34	12	54.4	B
Sawyer	357.24	6	59.5	E
Taylor	232.32	4	58.1	E
Trempeleau	420.19	11	38.2	D
Washburn	388.27	7	55.5	D
Region Average			**49.9**	

NE Region

County	Lane Miles	Winter Patrol Sections 2023	Lane Miles per Patrol Section	Winter Service Group
Brown	866.87	20	43.3	B
Calumet	219.61	6	36.6	E
Door	274.02	9	30.4	D
Fond du Lac	626.81	15	41.8	B
Kewaunee	125.73	3	41.9	F
Manitowoc	424.86	11	38.6	C
Marinette	414.01	9	46.0	D
Oconto	482.03	10	48.2	C
Outagamie	577.92	16	36.1	B
Sheboygan	532.95	10	53.3	C
Winnebago	686.74	18	38.2	B
Region Average			**41.3**	

SW Region

County	Lane Miles	Winter Patrol Sections 2023	Lane Miles per Patrol Section	Winter Service Group
Columbia	802.42	16	50.2	B
Crawford	398.16	8	49.8	C
Dane	1663.43	33	50.4	A
Dodge	667.93	17	39.3	B
Grant	642.71	11	58.4	B
Green	313.01	7	44.7	D
Iowa	457.02	10	45.7	C
Jefferson	552.95	10	55.3	B
Juneau	501.12	10	50.1	C
LaCrosse	490.01	13	37.7	C
Lafayette	292.64	6	48.8	D
Monroe	671.54	13	51.7	B
Richland	321.58	7	45.9	D
Rock	775.29	14	55.4	B
Sauk	595.90	12	49.7	B
Vernon	468.58	11	42.6	C
Region Average			**48.5**	

SE Region

County	Lane Miles	Winter Patrol Sections 2023	Lane Miles per Patrol Section	Winter Service Group
Kenosha	674.12	17	39.7	B
Milwaukee	1567.44	33	47.5	A
Ozaukee	300.72	6	50.1	D
Racine	765.35	13	58.9	B
Walworth	696.59	14	49.8	B
Washington	591.14	14	42.2	B
Waukesha	1044.48	26	40.2	A
Region Average			**46.9**	

	Lane Miles	Winter Patrol Sections 2023	Lane Miles per Patrol Section
Statewide Totals	34,723.0	754.0	46.1
Statewide Averages	482.3	10.5	46.1
Group A Averages	1,425.1	30.7	46.0
Group B Averages	669.0	14.5	47.3
Group C Averages	461.4	10.3	45.9
Group D Averages	338.6	7.3	47.9
Group E Averages	250.6	5.2	47.9
Group F Averages	139.1	3.3	43.4

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

From Winter Storm Reports, 2022-2023

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several 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)						
DANE	SW	0.12	0.05	0.17	0.00	0.10	112.25	2.13
WAUKESHA	SE	0.36	0.11	0.00	-0.19	0.20	66.67	1.97
MILWAUKEE	SE	0.00	0.00	0.00	0.00	0.00	73.99	1.66
Group A Averages		0.16	0.05	0.06	-0.06	0.10	84.30	1.92

Final totals as of Monday, July 10, 2023 **Page 1 of 1**

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

From Winter Storm Reports, 2022-2023

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

County	Region	Precipitation Type (Average Time in Hours)					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
EAU CLAIRE	NW	1.23	2.23	4.50		1.79	98.92	6.36
SAUK	SW	0.90	1.30	1.75	1.21	1.36	120.87	4.77
SAINT CROIX	NW	0.69	1.04	1.16	1.57	1.10	118.95	4.52
OUTAGAMIE	NE	2.52	2.63	2.25		2.52	87.40	4.49
CHIPPEWA	NW	0.26	0.89	1.00	0.50	0.66	125.53	4.31
DODGE	SW	0.20	1.68	1.63	4.58	1.41	93.72	3.87
COLUMBIA	SW	0.00	0.00	0.00	0.00	0.00	90.14	3.70
WASHINGTON	SE	1.08	0.82	0.94	0.75	0.94	119.39	3.62
FOND DU LAC	NE	0.86	0.45	1.87		0.80	98.72	3.48
PORTAGE	NC	3.27	3.00	1.83	2.90	2.67	137.90	3.40
MONROE	SW	0.92	0.93	2.08	0.75	1.14	106.89	3.40
WAUPACA	NC	2.79	1.52	1.17	1.13	1.77	101.74	3.13
WALWORTH	SE	0.77	1.25	1.75	1.80	0.91	118.49	2.97
BROWN	NE	-0.38	-0.82	-0.20	-0.42	-0.50	98.70	2.96
GRANT	SW	0.00	0.00	0.20	0.00	0.05	90.63	2.86
ROCK	SW	0.86	1.19	0.00	-0.50	1.00	65.39	2.79
JEFFERSON	SW	1.00	0.63	0.23	0.00	0.74	106.71	2.69
MARATHON	NC	2.63	3.03	1.93	2.07	2.84	138.51	2.64
RACINE	SE	0.89	1.00	2.50	1.33	1.12	88.25	2.53
WINNEBAGO	NE	0.91	1.70	1.63		1.38	89.09	2.50
KENOSHA	SE	0.50	0.54	0.00	0.00	0.45	47.84	2.32
Group B Averages		1.04	1.19	1.34	1.04	1.15	102.08	3.49

Final totals as of Monday, July 10, 2023 **Page 1 of 1**

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

From Winter Storm Reports, 2022-2023

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

County	Region	Precipitation Type (Average Time in Hours)					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
DUNN	NW	0.21	0.83	0.44	0.00	0.55	120.40	6.76
BARRON	NW	3.31	2.94	3.19	3.70	3.50	155.82	6.62
PIERCE	NW	0.33	2.11	1.00		1.80	121.25	6.58
DOUGLAS	NW	2.15	3.35	2.63	2.00	2.69	171.04	6.49
CLARK	NW	4.02	6.39	3.37	3.58	4.42	111.78	6.10
LINCOLN	NC	7.40	5.14	5.16	6.91	5.72	164.15	6.07
MANITOWOC	NE	0.30	1.47	0.40	0.00	1.14	72.58	5.39
SHEBOYGAN	NE	-0.64	0.45	0.62	0.00	0.15	115.21	4.97
JACKSON	NW	0.56	0.11	0.34	0.36	0.40	127.26	4.80
WOOD	NC	3.79	3.07	1.77	2.92	3.24	132.81	4.63
SHAWANO	NC	1.65	1.86	1.80	0.75	1.84	130.89	4.36
JUNEAU	SW	1.32	1.33	0.75	6.00	1.40	95.16	4.20
IOWA	SW	1.95	2.34	1.67	0.92	1.94	110.15	4.12
VERNON	SW	-0.03	0.00	0.14	1.80	0.26	118.31	4.10
OCONTO	NE	3.37	4.71	4.14	4.93	3.87	148.65	3.68
LA CROSSE	SW	2.38	1.22	2.40	2.30	1.82	53.48	3.52
CRAWFORD	SW	7.50	6.87	2.07	1.93	5.98	118.47	3.39
Group C Averages		2.33	2.60	1.88	2.38	2.40	121.61	5.05

Final totals as of Monday, July 10, 2023 **Page 1 of 1**

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

From Winter Storm Reports, 2022-2023

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

County	Region	Precipitation Type (Average Time in Hours)					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
BAYFIELD	NW	3.69	4.12	2.75	0.00	3.85	189.13	8.58
POLK	NW	5.20	1.20	1.50	-4.50	2.09	150.70	8.47
TREMPEALEAU	NW	0.45	0.62	0.30	1.00	0.56	115.78	7.48
WASHBURN	NW	6.32	5.59	6.75	2.63	5.77	171.28	7.41
DOOR	NE	2.79	3.13	2.62	2.60	2.79	109.01	7.20
ONEIDA	NC	5.91	5.11	5.18	5.00	5.49	172.46	6.35
OZAUKEE	SE	1.79	2.17	1.44	1.50	2.06	77.54	6.04
LAFAYETTE	SW	0.81	0.95	0.75	1.25	0.97	111.89	5.96
MARINETTE	NE	0.00	-0.02	0.00		-0.01	143.22	5.93
BUFFALO	NW	0.00	-0.03	0.00	0.00	-0.02	152.52	5.82
GREEN	SW	4.00	3.36	2.44	1.00	3.69	92.54	5.43
MARQUETTE	NC	2.11	1.13	4.17	12.00	1.38	91.00	5.26
RICHLAND	SW	3.17	2.80	3.00	0.25	2.86	70.26	4.68
WAUSHARA	NC	3.00	1.76	1.17	0.25	1.76	103.70	3.45
Group D Averages		2.80	2.28	2.29	1.77	2.37	125.07	6.29

Final totals as of Monday, July 10, 2023 **Page 1 of 1**

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

From Winter Storm Reports, 2022-2023

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

County	Region	Precipitation Type (Average Time in Hours)					Severity Index	Cost per LM per Severity Index
		Dry Snow	Wet Snow	Freezing Rain	Sleet	All Precip. Types		
PEPIN	NW	6.00	4.72	5.50	6.00	5.60	104.88	19.79
IRON	NC	7.21	4.45	2.04	2.50	5.26	208.32	14.21
ASHLAND	NW	3.97	5.07	4.85	1.83	5.26	203.14	11.86
VILAS	NC	5.79	5.02	3.48	4.04	4.74	192.03	11.06
RUSK	NW	2.07	4.60	4.17	4.40	4.03	123.49	10.92
TAYLOR	NW	6.82	5.34	4.77	4.50	5.37	135.29	9.77
FOREST	NC	9.63	5.67	3.75	4.21	5.82	160.18	9.31
PRICE	NC	2.89	3.07	3.00	3.08	2.97	187.30	9.04
CALUMET	NE	4.32	4.12	3.00		4.07	126.95	8.38
BURNETT	NW	5.68	5.87	7.05	4.10	5.74	125.89	7.91
GREEN LAKE	NC	1.95	2.73	1.92	2.67	2.28	86.98	7.37
LANGLADE	NC	5.73	3.75	4.31	1.75	4.38	151.84	7.35
SAWYER	NW	6.12	5.81	5.81	5.58	5.90	155.56	5.31
Group E Averages		5.25	4.63	4.13	3.72	4.73	150.91	10.17

Final totals as of Monday, July 10, 2023 **Page 1 of 1**

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

From Winter Storm Reports, 2022-2023

Note: 1) A negative number indicates that the crews were on the road when the storm started. 2) A discrepancy is inherent in these calculation because an individual storm may have several 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)						
MENOMINEE	NC	2.12	4.84	6.83		4.12	107.27	29.72
FLORENCE	NC	5.46	4.02	1.50	3.42	4.24	134.74	21.96
KEWAUNEE	NE	5.39	4.95	4.05	4.44	5.04	116.08	12.76
ADAMS	NC	4.85	6.07	5.19	4.20	4.92	113.92	10.20
Group F Averages		4.46	4.97	4.39	4.02	4.58	118.00	18.66

Final totals as of Monday, July 10, 2023 **Page 1 of 1**

Table 4.10. Winter Maintenance Costs per Lane Mile

County #		Total Labor	Labor $'s per Lane Mile	Total Equipment	Equip $'s per Lane Mile	Total Materials	Materials $'s Lane Mile	Total Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2023 Winter Costs	2023 LOS Lane Miles	Winter Costs Per Lane Mile
	Southwest Region												
11	**Columbia**	$615,542	$767	$921,947	$1,149	$72,937	$91	$71,477	$1,541,651	16,425	$3,223,555	802.42	$4,017
12	**Crawford**	$165,529	$416	$249,777	$627	$12,726	$32	$19,038	$281,207	3,205	$728,278	398.16	$1,829
13	**Dane**	$2,444,564	$1,470	$2,815,690	$1,693	$147,541	$89	$240,320	$2,756,903	33,417	$8,405,018	1,663.43	$5,053
14	**Dodge**	$469,941	$704	$781,964	$1,171	$89,129	$133	$59,504	$855,875	11,263	$2,256,413	667.93	$3,378
22	**Grant**	$429,304	$668	$580,464	$903	$44,755	$70	$46,904	$635,485	7,715	$1,736,911	642.71	$2,702
23	**Green**	$225,874	$722	$285,721	$913	$18,164	$58	$23,539	$222,057	2,248	$775,355	313.01	$2,477
25	**Iowa**	$392,651	$859	$481,951	$1,055	$20,964	$46	$39,772	$382,754	4,494	$1,318,092	457.02	$2,884
28	**Jefferson**	$335,847	$607	$533,034	$964	$26,579	$48	$39,716	$187,124	2,277	$1,122,300	552.95	$2,030
29	**Juneau**	$305,898	$610	$518,882	$1,035	$41,103	$82	$38,467	$567,800	6,043	$1,472,149	501.12	$2,938
32	**La Crosse**	$361,639	$738	$585,649	$1,195	$17,226	$35	$42,891	$378,369	4,719	$1,385,774	490.01	$2,828
33	**Lafayette**	$187,735	$642	$288,565	$986	$148,367	$507	$27,752	$231,252	2,712	$883,670	292.64	$3,020
41	**Monroe**	$356,539	$531	$439,058	$654	$315	$0	$35,371	$860,095	9,638	$1,691,379	671.54	$2,519
52	**Richland**	$125,462	$390	$239,540	$745	$1,554	$5	$16,317	$240,300	2,597	$623,173	321.58	$1,938
53	**Rock**	$514,053	$663	$863,762	$1,114	$31,919	$41	$62,550	$993,034	12,177	$2,465,318	775.29	$3,180
56	**Sauk**	$465,837	$782	$692,677	$1,162	$22,986	$39	$52,530	$836,390	8,581	$2,070,420	595.90	$3,474
62	**Vernon**	$247,020	$527	$473,084	$1,010	$19,575	$42	$32,871	$450,107	5,368	$1,222,657	468.58	$2,609
	SWR Totals	**$7,643,434**	**$795**	**$10,751,765**	**$1,118**	**$715,840**	**$74**	**$849,020**	**$11,420,404**	**132,879**	**$31,380,462**	**9,614.29**	**$3,264**

Table 4.10. Winter Maintenance Costs per Lane Mile

County #		Total Labor	Labor $'s per Lane Mile	Total Equipment	Equip $'s per Lane Mile	Total Materials	Materials $'s Lane Mile	Total Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2023 Winter Costs	2023 LOS Lane Miles	Winter Costs Per Lane Mile
	Southeast Region												
30	**Kenosha**	$416,945	$619	$587,869	$872	$20,571	$31	$45,372	$469,786	6,396	$1,540,543	674.12	$2,285
40	**Milwaukee**	$2,980,372	$1,901	$2,110,228	$1,346	$29,126	$19	$0	$1,516,411	21,694	$6,636,137	1,567.44	$4,234
45	**Ozaukee**	$278,858	$927	$281,913	$937	$44,813	$149	$26,800	$234,731	3,349	$867,116	300.72	$2,883
51	**Racine**	$524,656	$686	$603,375	$788	$13,727	$18	$50,615	$922,879	11,973	$2,115,252	765.35	$2,764
64	**Walworth**	$434,309	$623	$709,601	$1,019	$246,230	$353	$61,716	$600,743	8,269	$2,052,598	696.59	$2,947
66	**Washington**	$472,942	$800	$760,940	$1,287	$37,108	$63	$56,440	$549,084	6,873	$1,876,514	591.14	$3,174
67	**Waukesha**	$903,721	$865	$1,288,515	$1,234	$45,280	$43	$99,218	$1,195,776	16,764	$3,532,510	1,044.48	$3,382
	SER Totals	**$6,011,803**	**$1,066**	**$6,342,441**	**$1,125**	**$436,855**	**$77**	**$340,161**	**$5,489,410**	**75,318**	**$18,620,670**	**5,639.84**	**$3,302**

County #		Total Labor	Labor $'s per Lane Mile	Total Equipment	Equip $'s per Lane Mile	Total Materials	Materials $'s Lane Mile	Total Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2023 Winter Costs	2023 LOS Lane Miles	Winter Costs Per Lane Mile
	Northeast Region												
5	**Brown**	$707,736	$816	$1,461,121	$1,686	$44,849	$52	$98,012	$978,248	14,766	$3,289,965	866.87	$3,795
8	**Calumet**	$161,414	$735	$215,512	$981	$13,669	$62	$17,333	$170,730	2,091	$578,659	219.61	$2,635
15	**Door**	$218,541	$798	$264,936	$967	$46,017	$168	$23,537	$256,736	3,078	$809,767	274.02	$2,955
20	**Fond du Lac**	$499,779	$797	$627,744	$1,001	$64,736	$103	$52,945	$531,342	6,631	$1,776,547	626.81	$2,834
31	**Kewaunee**	$75,594	$601	$101,916	$811	$9,446	$75	$8,301	$96,359	1,150	$291,615	125.73	$2,319
36	**Manitowoc**	$342,757	$807	$409,596	$964	$26,693	$63	$34,564	$499,133	6,511	$1,312,744	424.86	$3,090
38	**Marinette**	$285,857	$690	$456,676	$1,103	$2,793	$7	$32,996	$547,709	7,736	$1,326,031	414.01	$3,203
42	**Oconto**	$359,929	$747	$468,529	$972	$22,781	$47	$37,740	$333,241	4,592	$1,222,221	482.03	$2,536
44	**Outagamie**	$650,625	$1,126	$727,093	$1,258	$89,955	$156	$65,158	$536,608	7,279	$2,069,439	577.92	$3,581
59	**Sheboygan**	$510,642	$958	$568,523	$1,067	$177,075	$332	$55,722	$592,792	6,757	$1,904,754	532.95	$3,574
70	**Winnebago**	$478,635	$697	$837,841	$1,220	$112,953	$164	$63,336	$417,846	5,440	$1,910,612	686.74	$2,782
	NER Totals	**$4,291,510**	**$820**	**$6,139,487**	**$1,174**	**$610,967**	**$117**	**$489,645**	**$4,960,744**	**66,031**	**$16,492,352**	**5,231.55**	**$3,152**

Table 4.10. Winter Maintenance Costs per Lane Mile

County #		Total Labor	Labor $'s per Lane Mile	Total Equipment	Equip $'s per Lane Mile	Total Materials	Materials $'s Lane Mile	Total Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2023 Winter Costs	2023 LOS Lane Miles	Winter Costs Per Lane Mile
	North Central Region												
1	Adams	$86,666	$427	$179,536	$885	$22,121	$109	$12,816	$225,484	2,258	$526,623	202.76	$2,597
19	Florence	$81,826	$595	$180,890	$1,316	$8,059	$59	$11,992	$275,347	3,055	$558,113	137.43	$4,061
21	Forest	$168,710	$537	$426,141	$1,356	$19,230	$61	$27,201	$583,918	6,569	$1,225,201	314.15	$3,900
24	Green Lake	$83,288	$540	$98,794	$641	$2,731	$18	$8,221	$85,613	905	$278,647	154.23	$1,807
26	Iron	$254,713	$1,059	$452,235	$1,880	$9,881	$41	$31,796	$473,261	4,778	$1,221,887	240.51	$5,080
34	Langlade	$183,539	$611	$304,762	$1,014	$35,887	$119	$23,232	$362,392	4,003	$909,811	300.53	$3,027
35	Lincoln	$307,210	$770	$464,279	$1,163	$6,788	$17	$34,496	$475,675	5,032	$1,288,448	399.09	$3,228
37	Marathon	$659,593	$730	$1,190,300	$1,318	$158,036	$175	$89,202	$979,958	10,639	$3,077,089	903.02	$3,408
39	Marquette	$119,962	$488	$242,465	$986	$111,973	$455	$21,083	$108,530	1,169	$604,013	245.99	$2,455
73	Menominee	$29,718	$328	$97,772	$1,078	$9,175	$101	$6,057	$159,496	1,817	$302,218	90.66	$3,334
43	Oneida	$356,796	$903	$647,044	$1,638	$92,307	$234	$48,618	$405,782	4,444	$1,550,546	394.97	$3,926
49	Portage	$487,700	$871	$712,683	$1,273	$67,348	$120	$56,335	$326,136	3,806	$1,650,203	559.84	$2,948
50	Price	$254,801	$800	$466,010	$1,463	$74,465	$234	$35,318	$502,782	5,293	$1,333,376	318.47	$4,187
58	Shawano	$442,204	$829	$788,994	$1,479	$108,058	$203	$59,364	$525,147	6,712	$1,923,766	533.57	$3,605
63	Vilas	$197,147	$641	$588,172	$1,912	$142,855	$464	$41,193	$618,385	6,182	$1,587,752	307.61	$5,162
68	Waupaca	$342,370	$615	$577,777	$1,037	$106,051	$190	$45,582	$451,461	5,785	$1,523,241	557.05	$2,734
69	Waushara	$159,354	$466	$222,065	$649	$5,321	$16	$17,193	$173,040	1,804	$576,971	342.05	$1,687
71	Wood	$237,867	$530	$467,560	$1,042	$44,822	$100	$33,355	$522,282	5,708	$1,305,887	448.55	$2,911
	NCR Totals	**$4,453,464**	**$690**	**$8,107,478**	**$1,257**	**$1,025,106**	**$159**	**$603,054**	**$7,254,690**	**79,959**	**$21,443,793**	**6,450.48**	**$3,324**

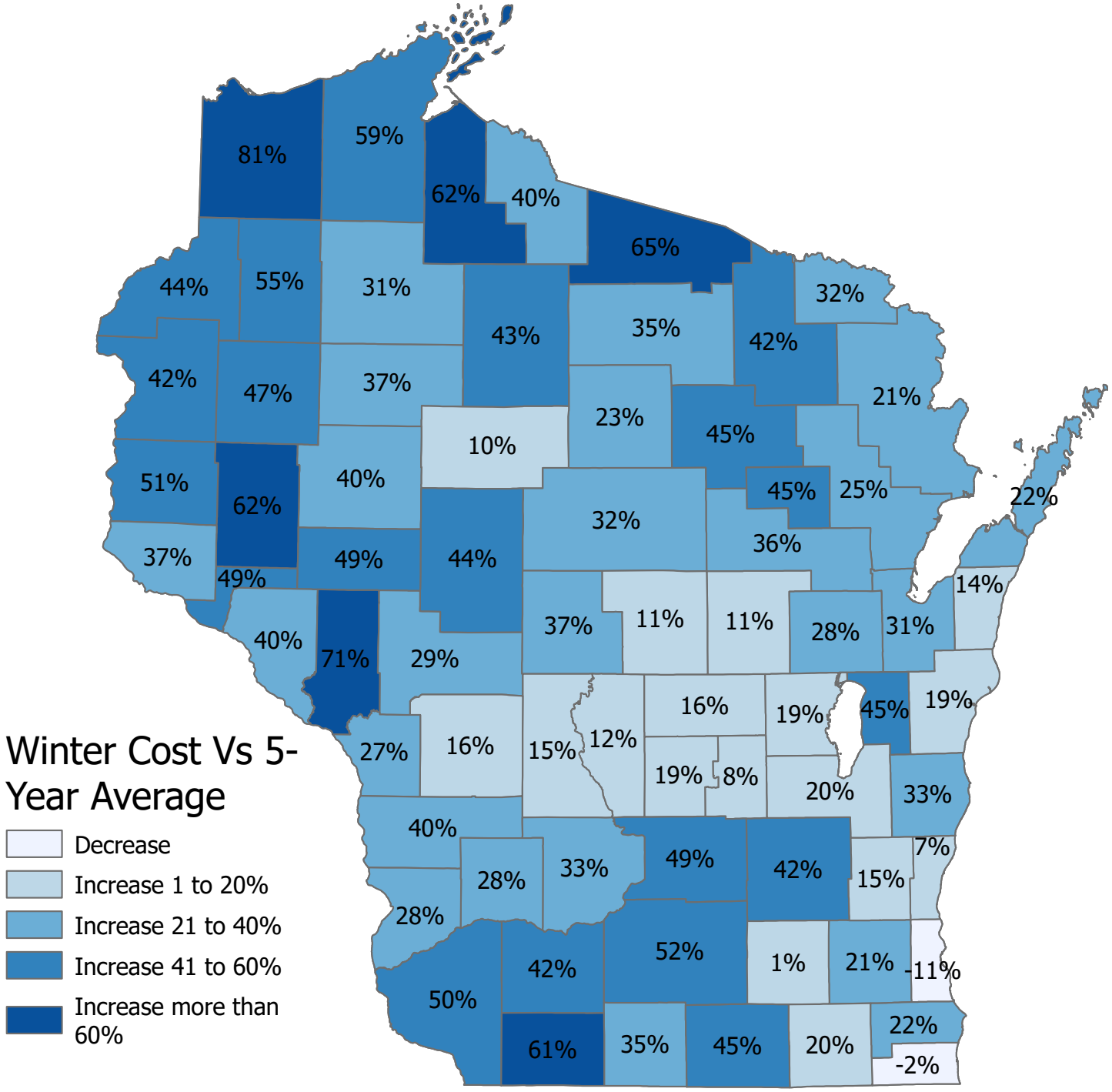
Table 4.10. Winter Maintenance Costs per Lane Mile

County #		Total Labor	Labor $'s per Lane Mile	Total Equipment	Equip $'s per Lane Mile	Total Materials	Materials $'s Lane Mile	Total Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2023 Winter Costs	2023 LOS Lane Miles	Winter Costs Per Lane Mile
	Northwest Region												
2	**Ashland**	$177,871	$696	$468,132	$1,831	$62,814	$246	$31,438	$376,347	4,032	$1,116,601	255.69	$4,367
3	**Barron**	$517,500	$1,190	$721,744	$1,659	$37,298	$86	$56,646	$512,670	6,176	$1,845,858	434.95	$4,244
4	**Bayfield**	$329,619	$953	$667,201	$1,928	$46,690	$135	$46,251	$458,433	5,544	$1,548,193	346.03	$4,474
6	**Buffalo**	$151,914	$487	$264,489	$849	$856	$3	$18,547	$279,169	3,129	$714,975	311.69	$2,294
7	**Burnett**	$148,699	$632	$254,365	$1,081	$51,593	$219	$20,143	$240,367	2,733	$715,167	235.35	$3,039
9	**Chippewa**	$675,876	$1,037	$1,013,893	$1,556	$50,639	$78	$77,321	$865,965	9,461	$2,683,694	651.76	$4,118
10	**Clark**	$280,012	$698	$462,337	$1,152	$2,136	$5	$33,097	$604,668	5,827	$1,382,251	401.29	$3,445
16	**Douglas**	$369,679	$794	$832,900	$1,789	$496,513	$1,067	$75,206	$660,410	8,898	$2,434,708	465.51	$5,230
17	**Dunn**	$469,685	$905	$747,815	$1,441	$14,675	$28	$54,792	$1,110,569	12,563	$2,397,537	519.12	$4,618
18	**Eau Claire**	$474,242	$895	$919,877	$1,736	$30,105	$57	$63,291	$981,073	10,326	$2,468,589	529.80	$4,659
27	**Jackson**	$281,020	$542	$600,507	$1,159	$26,391	$51	$40,371	$782,276	8,503	$1,730,565	518.28	$3,339
46	**Pepin**	$121,426	$1,110	$132,673	$1,213	$1,752	$16	$11,372	$80,242	874	$347,466	109.41	$3,176
47	**Pierce**	$267,883	$726	$469,086	$1,272	$6,950	$19	$33,069	$485,546	5,610	$1,262,533	368.74	$3,424
48	**Polk**	$278,958	$745	$534,239	$1,426	$25,869	$69	$37,259	$630,905	7,544	$1,507,230	374.63	$4,023
54	**Rusk**	$122,677	$575	$192,870	$904	$18,041	$85	$14,802	$243,495	2,625	$591,885	213.24	$2,776
55	**Saint Croix**	$736,792	$1,128	$1,076,783	$1,648	$139,394	$213	$86,842	$1,072,190	12,890	$3,112,001	653.34	$4,763
57	**Sawyer**	$188,027	$526	$347,147	$972	$6,102	$17	$24,035	$367,425	4,260	$932,737	357.24	$2,611
60	**Taylor**	$179,608	$773	$294,315	$1,267	$4,912	$21	$21,261	$294,475	2,808	$794,571	232.32	$3,420
61	**Trempealeau**	$332,724	$792	$527,206	$1,255	$9,373	$22	$38,608	$831,393	9,249	$1,739,304	420.19	$4,139
65	**Washburn**	$300,869	$775	$548,584	$1,413	$52,110	$134	$40,015	$554,487	6,635	$1,496,065	388.27	$3,853
	NWR Totals	**$6,405,083**	**$823**	**$11,076,163**	**$1,422**	**$1,084,212**	**$139**	**$824,366**	**$11,432,105**	**129,687**	**$30,821,929**	**7,786.85**	**$3,958**

Table 4.10. Winter Maintenance Costs per Lane Mile

	Total Labor	Labor $'s per Lane Mile	Total Equipment	Equip $'s per Lane Mile	Total Materials	Materials $'s Lane Mile	Total Admin	Cost of Salt Used	Tons of Salt Used	Total FY 2023 Winter Costs	2023 LOS Lane Miles	Winter Costs Per Lane Mile
STATEWIDE SUMMARY												
SW Region	$7,643,434	$795	$10,751,765	$1,118	$715,840	$74	$849,020	$11,420,404	132,879	$31,380,462	9,614.29	$3,264
SE Region	$6,011,803	$1,066	$6,342,441	$1,125	$436,855	$77	$340,161	$5,489,410	75,318	$18,620,670	5,639.84	$3,302
NE Region	$4,291,510	$820	$6,139,487	$1,174	$610,967	$117	$489,645	$4,960,744	66,031	$16,492,352	5,231.55	$3,152
NC Region	$4,453,464	$690	$8,107,478	$1,257	$1,025,106	$159	$603,054	$7,254,690	79,959	$21,443,793	6,450.48	$3,324
NW Region	$6,405,083	$823	$11,076,163	$1,422	$1,084,212	$139	$824,366	$11,432,105	129,687	$30,821,929	7,786.85	$3,958
Statewide Totals	$28,805,294	$830	$42,417,334	$1,222	$3,872,979	$112	$3,106,246	$40,557,352	483,874	$118,759,205	34,723.01	$3,420

Figure 4.10. 2022-2023 Winter Costs vs. 5-Year Average



Map created: August 2023

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

From Winter Storm Reports, 2022-2023

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
DANE	SW	1,663.43	112.25	81.5	33417	20.09	0.18	$5,830,000	$3,546	2.13
WAUKESHA	SE	1,044.48	66.67	67.1	16764	16.05	0.24	$2,132,000	$2,053	1.97
MILWAUKEE	SE	1,567.44	73.99	51.7	21694	13.84	0.19	$4,055,000	$2,605	1.66
Group A Averages		1,425.12	84.30	66.8	23958	16.66	0.20	$4,005,667	$2,735	1.92

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

From Winter Storm Reports, 2022-2023

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
EAU CLAIRE	NW	529.80	98.92	88.8	10326	19.49	0.20	$1,769,000	$3,369	6.36
SAUK	SW	595.90	120.87	78.6	8581	14.40	0.12	$1,694,000	$2,844	4.77
SAINT CROIX	NW	653.34	118.95	114.8	12890	19.73	0.17	$1,907,000	$2,953	4.52
OUTAGAMIE	NE	577.92	87.40	91.0	7279	12.60	0.14	$1,342,000	$2,597	4.49
CHIPPEWA	NW	651.76	125.53	99.6	9461	14.52	0.12	$1,817,000	$2,811	4.31
DODGE	SW	667.93	93.72	87.2	11263	16.86	0.18	$1,711,000	$2,586	3.87
COLUMBIA	SW	802.42	90.14	64.2	16425	20.47	0.23	$2,349,000	$2,972	3.70
WASHINGTON	SE	591.14	119.39	85.5	6873	11.63	0.10	$1,244,000	$2,141	3.62
FOND DU LAC	NE	626.81	98.72	68.7	6631	10.58	0.11	$1,316,000	$2,179	3.48
PORTAGE	NC	559.84	137.90	73.4	3806	6.80	0.05	$1,058,000	$1,906	3.40
MONROE	SW	671.54	106.89	69.0	9638	14.35	0.13	$1,530,000	$2,283	3.40
WAUPACA	NC	557.05	101.74	86.3	5785	10.39	0.10	$930,000	$1,742	3.13
WALWORTH	SE	696.59	118.49	88.3	8269	11.87	0.10	$1,402,000	$2,069	2.97
BROWN	NE	866.87	98.70	86.1	14766	17.03	0.17	$2,192,000	$2,566	2.96
GRANT	SW	642.71	90.63	76.8	7715	12.00	0.13	$1,172,000	$1,838	2.86
ROCK	SW	775.29	65.39	52.8	12177	15.71	0.24	$1,670,000	$2,164	2.79
JEFFERSON	SW	552.95	106.71	86.0	2277	4.12	0.04	$822,000	$1,489	2.69
MARATHON	NC	903.02	138.51	108.5	10639	11.78	0.09	$2,121,000	$2,384	2.64

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

From Winter Storm Reports, 2022-2023

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
RACINE	SE	765.35	88.25	59.1	11973	15.64	0.18	$1,474,000	$1,937	2.53
WINNEBAGO	NE	686.74	89.09	85.3	5440	7.92	0.09	$1,177,000	$1,718	2.50
KENOSHA	SE	674.12	47.84	12.4	6396	9.49	0.20	$1,052,000	$1,561	2.32
Group B Averages		669.00	102.08	79.2	8981	13.21	0.14	$1,511,857	$2,291	3.49

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

From Winter Storm Reports, 2022-2023

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
DUNN	NW	519.12	120.40	85.1	12563	24.20	0.20	$1,805,000	$3,508	6.76
BARRON	NW	434.95	155.82	116.6	6176	14.20	0.09	$1,248,000	$2,880	6.62
PIERCE	NW	368.74	121.25	85.8	5610	15.21	0.13	$890,000	$2,426	6.58
DOUGLAS	NW	465.51	171.04	184.4	8898	19.11	0.11	$1,398,000	$3,023	6.49
CLARK	NW	401.29	111.78	120.1	5827	14.52	0.13	$978,000	$2,446	6.10
LINCOLN	NC	399.09	164.15	155.8	5032	12.61	0.08	$954,000	$2,421	6.07
MANITOWOC	NE	424.86	72.58	50.3	6511	15.33	0.21	$966,000	$2,288	5.39
SHEBOYGAN	NE	532.95	115.21	82.1	6757	12.68	0.11	$1,305,000	$2,651	4.97
JACKSON	NW	518.28	127.26	106.5	8503	16.41	0.13	$1,291,000	$2,490	4.80
WOOD	NC	448.55	132.81	87.8	5708	12.73	0.10	$929,000	$2,079	4.63
SHAWANO	NC	533.57	130.89	130.1	6712	12.58	0.10	$1,238,000	$2,327	4.36
JUNEAU	SW	501.12	95.16	51.1	6043	12.06	0.13	$1,052,000	$2,107	4.20
IOWA	SW	457.02	110.15	71.8	4494	9.83	0.09	$854,000	$1,882	4.12
VERNON	SW	468.58	118.31	84.7	5368	11.46	0.10	$881,000	$1,920	4.10
OCONTO	NE	482.03	148.65	93.5	4592	9.53	0.06	$838,000	$1,775	3.68
LA CROSSE	SW	490.01	53.48	38.0	4719	9.63	0.18	$804,000	$1,727	3.52
CRAWFORD	SW	398.16	118.47	53.7	3205	8.05	0.07	$533,000	$1,348	3.39

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

From Winter Storm Reports, 2022-2023

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 C Averages		461.40	121.61	94.0	6278	13.54	0.12	$1,056,706	$2,312	5.05

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

From Winter Storm Reports, 2022-2023

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
BAYFIELD	NW	346.03	189.13	228.4	5544	16.02	0.08	$1,014,000	$2,970	8.58
POLK	NW	374.63	150.70	136.0	7544	20.14	0.13	$1,180,000	$3,172	8.47
TREMPEALEAU	NW	420.19	115.78	85.0	9249	22.01	0.19	$1,318,000	$3,141	7.48
WASHBURN	NW	388.27	171.28	149.6	6635	17.09	0.10	$1,111,000	$2,878	7.41
DOOR	NE	274.02	109.01	80.5	3078	11.23	0.10	$535,000	$1,974	7.20
ONEIDA	NC	394.97	172.46	135.2	4444	11.25	0.07	$983,000	$2,507	6.35
OZAUKEE	SE	300.72	77.54	69.4	3349	11.14	0.14	$513,000	$1,815	6.04
LAFAYETTE	SW	292.64	111.89	82.9	2712	9.27	0.08	$508,000	$1,744	5.96
MARINETTE	NE	414.01	143.22	112.0	7736	18.69	0.13	$1,013,000	$2,453	5.93
BUFFALO	NW	311.69	152.52	98.5	3129	10.04	0.07	$562,000	$1,816	5.82
GREEN	SW	313.01	92.54	61.4	2248	7.18	0.08	$526,000	$1,699	5.43
MARQUETTE	NC	245.99	91.00	78.2	1168	4.75	0.05	$313,000	$1,294	5.26
RICHLAND	SW	321.58	70.26	48.0	2597	8.08	0.11	$475,000	$1,504	4.68
WAUSHARA	NC	342.05	103.70	86.7	1804	5.27	0.05	$402,000	$1,181	3.45
Group D Averages		338.56	125.07	103.7	4374	12.30	0.10	$746,643	$2,153	6.29

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

From Winter Storm Reports, 2022-2023

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
PEPIN	NW	109.41	104.88	86.6	874	7.99	0.08	$236,000	$2,165	19.79
IRON	NC	240.51	208.32	281.2	4778	19.87	0.10	$815,000	$3,417	14.21
ASHLAND	NW	255.69	203.14	205.8	4032	15.77	0.08	$758,000	$3,034	11.86
VILAS	NC	307.61	192.03	190.4	6182	20.10	0.10	$1,046,000	$3,404	11.06
RUSK	NW	213.24	123.49	116.9	2625	12.31	0.10	$495,000	$2,328	10.92
TAYLOR	NW	232.32	135.29	119.3	2808	12.09	0.09	$514,000	$2,269	9.77
FOREST	NC	314.15	160.18	130.2	6569	20.91	0.13	$913,000	$2,924	9.31
PRICE	NC	318.47	187.30	179.4	5293	16.62	0.09	$899,000	$2,879	9.04
CALUMET	NE	219.61	126.95	91.0	2091	9.52	0.08	$402,000	$1,840	8.38
BURNETT	NW	235.35	125.89	119.7	2733	11.61	0.09	$433,000	$1,861	7.91
GREEN LAKE	NC	154.23	86.98	71.9	905	5.87	0.07	$174,000	$1,136	7.37
LANGLADE	NC	300.53	151.84	134.6	4003	13.32	0.09	$657,000	$2,208	7.35
SAWYER	NW	357.24	155.56	137.5	4260	11.92	0.08	$678,000	$1,897	5.31
Group E Averages		250.64	150.91	143.4	3627	13.68	0.09	$616,923	$2,412	10.17

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

From Winter Storm Reports, 2022-2023

County	Region	Lane Miles	Severity Index	Snow Depth (in)	Salt (ton)	Salt per LM	Salt per LM per Severity Index	Total Cost	Total $/LM	Cost per LM per Severity Index
MENOMINEE	NC	90.66	107.27	84.7	1817	20.04	0.19	$243,000	$2,695	29.72
FLORENCE	NC	137.43	134.74	137.6	3055	22.23	0.16	$411,000	$3,018	21.96
KEWAUNEE	NE	125.73	116.08	107.5	1150	9.15	0.08	$194,000	$1,605	12.76
ADAMS	NC	202.76	113.92	71.8	2258	11.14	0.10	$404,000	$2,068	10.20
Group F Averages		139.14	118.00	100.4	2070	15.64	0.13	$313,000	$2,346	18.66

Table 4.12. Winter Crashes per 100 Million Vehicle Miles of Travel

Bureau of transportation Safety data, Nov. 1, 2022 - April 30, 2023 State, U.S. and Interstate Highways only

WisDOT REGION / COUNTY	2022-23 WINTER VEHICLE MILES OF TRAVEL (VMT)	2022-23 WINTER CRASHES	CRASH RATE PER 100M VMT
NORTH CENTRAL			
ADAMS	108,000,000	14	13
FLORENCE	42,800,000	6	14
FOREST	71,600,000	19	27
GREEN LAKE	102,600,000	8	8
IRON	51,200,000	20	39
LANGLADE	104,300,000	28	27
LINCOLN	275,300,000	71	26
MARATHON	826,500,000	310	38
MARQUETTE	141,200,000	39	28
MENOMINEE	14,800,000	4	27
ONEIDA	247,900,000	85	34
PORTAGE	448,500,000	110	25
PRICE	90,700,000	23	25
SHAWANO	312,200,000	59	19
VILAS	156,700,000	55	35
WAUPACA	293,700,000	98	33
WAUSHARA	176,900,000	47	27
WOOD	325,700,000	60	18
Region Total	**3,790,600,000**	**1,056**	**28**
NORTHEAST			
BROWN	1,167,900,000	224	19
CALUMET	209,200,000	52	25
DOOR	245,000,000	29	12
FOND DU LAC	588,700,000	112	19
KEWAUNEE	101,500,000	16	16
MANITOWOC	389,900,000	89	23
MARINETTE	451,700,000	49	11
OCONTO	313,000,000	59	19
OUTAGAMIE	771,400,000	198	26
SHEBOYGAN	493,500,000	134	27
WINNEBAGO	879,600,000	370	42
Region Total	**5,611,400,000**	**1,332**	**24**

Table 4.12. Winter Crashes per 100 Million Vehicle Miles of Travel

Bureau of transportation Safety data, Nov. 1, 2022 - April 30, 2023 State, U.S. and Interstate Highways only

WisDOT REGION / COUNTY	2022-23 WINTER VEHICLE MILES OF TRAVEL (VMT)	2022-23 WINTER CRASHES	CRASH RATE PER 100M VMT
NORTHWEST			
ASHLAND	109,100,000	25	23
BARRON	333,500,000	78	23
BAYFIELD	189,800,000	26	14
BUFFALO	121,500,000	20	16
BURNETT	131,200,000	15	11
CHIPPEWA	494,400,000	151	31
CLARK	260,800,000	57	22
DOUGLAS	290,800,000	108	37
DUNN	366,500,000	131	36
EAU CLAIRE	534,900,000	220	41
JACKSON	341,700,000	86	25
PEPIN	46,900,000	13	28
PIERCE	181,100,000	51	28
POLK	259,500,000	53	20
RUSK	123,300,000	22	18
ST.CROIX	630,300,000	225	36
SAWYER	152,200,000	32	21
TAYLOR	116,700,000	32	27
TREMPEALEAU	238,200,000	52	22
WASHBURN	175,700,000	28	16
Region Total	**5,098,100,000**	**1,425**	**28**
SOUTHEAST			
KENOSHA	784,600,000	142	18
MILWAUKEE	3,166,800,000	677	21
OZAUKEE	486,200,000	92	19
RACINE	803,100,000	212	26
WALWORTH	590,000,000	176	30
WASHINGTON	732,400,000	234	32
WAUKESHA	1,970,700,000	297	15
Region Total	**8,533,800,000**	**1,830**	**21**

Table 4.12. Winter Crashes per 100 Million Vehicle Miles of Travel

Bureau of transportation Safety data, Nov. 1, 2022 - April 30, 2023 State, U.S. and Interstate Highways only

WisDOT REGION / COUNTY	2022-23 WINTER VEHICLE MILES OF TRAVEL (VMT)	2022-23 WINTER CRASHES	CRASH RATE PER 100M VMT
SOUTHWEST			
COLUMBIA	507,700,000	201	40
CRAWFORD	135,900,000	22	16
DANE	2,411,200,000	517	21
DODGE	501,800,000	115	23
GRANT	302,100,000	73	24
GREEN	178,100,000	31	17
IOWA	199,700,000	66	33
JEFFERSON	495,900,000	160	32
JUNEAU	364,900,000	79	22
LA CROSSE	536,200,000	204	38
LAFAYETTE	141,300,000	23	16
MONROE	423,100,000	150	35
RICHLAND	129,400,000	21	16
ROCK	798,300,000	278	35
SAUK	432,600,000	140	32
VERNON	192,700,000	32	17
Region Total	**7,750,900,000**	**2,112**	**27**
STATEWIDE TOTAL	**30,784,800,000**	**7,755**	**25**

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

Bureau of transportation Safety data, Nov. 1, 2022 - April 30, 2023 State, U.S. 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	14	0	14	0	0	0	0	0	14	0	0
FLORENCE	6	0	6	0	0	0	0	0	6	0	0
FOREST	19	0	19	0	0	0	0	0	19	0	0
GREEN LAKE	8	2	6	0	0	2	0	0	6	0	0
IRON	20	0	20	0	0	0	0	0	16	2	2
LANGLADE	28	15	13	0	0	12	1	2	13	0	0
LINCOLN	71	10	61	0	0	9	1	0	22	39	0
MARATHON	310	108	157	5	40	42	64	2	50	104	3
MARQUETTE	39	0	15	0	24	0	0	0	14	0	1
MENOMINEE	4	0	4	0	0	0	0	0	4	0	0
ONEIDA	85	0	85	0	0	0	0	0	78	4	3
PORTAGE	110	18	53	17	22	6	10	2	23	30	0
PRICE	23	0	23	0	0	0	0	0	23	0	0
SHAWANO	59	4	55	0	0	4	0	0	19	34	2
VILAS	55	0	55	0	0	0	0	0	49	4	2
WAUPACA	98	0	98	0	0	0	0	0	36	62	0
WAUSHARA	47	0	31	0	16	0	0	0	30	1	0
WOOD	60	33	27	0	0	14	18	1	17	10	0
TOTAL	1,056	190	742	22	102	89	94	7	439	290	13

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	224	133	26	43	22	45	83	5	15	11	0
CALUMET	52	19	33	0	0	9	9	1	30	2	1
DOOR	29	4	25	0	0	2	2	0	14	9	2
FOND DU LAC	112	32	68	3	9	16	16	0	26	40	2
KEWAUNEE	16	0	16	0	0	0	0	0	16	0	0
MANITOWOC	89	24	34	0	31	11	13	0	26	8	0
MARINETTE	49	10	39	0	0	7	3	0	28	11	0
OCONTO	59	0	59	0	0	0	0	0	19	40	0
OUTAGAMIE	198	75	89	8	26	37	37	1	43	44	2
SHEBOYGAN	134	29	60	1	44	16	11	2	32	26	2
WINNEBAGO	370	125	105	98	42	50	70	5	40	63	2
TOTAL	1,332	451	554	153	174	193	244	14	289	254	11

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

Bureau of transportation Safety data, Nov. 1, 2022 - April 30, 2023 State, U.S. and Interstate Highways only

NW 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
ASHLAND	25	12	13	0	0	8	3	1	13	0	0
BARRON	78	2	76	0	0	0	2	0	43	32	1
BAYFIELD	26	0	26	0	0	0	0	0	23	1	2
BUFFALO	20	0	20	0	0	0	0	0	18	0	2
BURNETT	15	0	15	0	0	0	0	0	14	0	1
CHIPPEWA	151	19	132	0	0	7	12	0	33	97	2
CLARK	57	0	57	0	0	0	0	0	27	29	1
DOUGLAS	108	67	39	2	0	30	29	8	22	16	1
DUNN	131	26	44	14	47	17	9	0	40	4	0
EAU CLAIRE	220	92	50	11	67	23	67	2	33	17	0
JACKSON	86	0	20	0	66	0	0	0	19	0	1
PEPIN	13	0	13	0	0	0	0	0	13	0	0
PIERCE	51	3	48	0	0	3	0	0	47	1	0
POLK	53	0	53	0	0	0	0	0	49	4	0
RUSK	22	0	22	0	0	0	0	0	19	0	3
ST. CROIX	225	8	122	18	77	4	4	0	77	43	2
SAWYER	32	0	32	0	0	0	0	0	27	3	2
TAYLOR	32	0	32	0	0	0	0	0	32	0	0
TREMPEALEAU	52	0	48	0	4	0	0	0	47	0	1
WASHBURN	28	0	28	0	0	0	0	0	9	17	2
TOTAL	1,425	229	890	45	261	92	126	11	605	264	21

SE 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
KENOSHA	142	57	40	31	14	28	26	3	14	26	0
MILWAUKEE	677	395	0	282	0	131	245	19	0	0	0
OZAUKEE	92	20	18	23	31	10	10	0	8	10	0
RACINE	212	122	53	7	30	43	74	5	33	19	1
WALWORTH	176	24	121	4	27	13	11	0	63	56	2
WASHINGTON	234	87	120	5	22	35	50	2	42	77	1
WAUKESHA	297	86	64	102	45	14	71	1	28	36	0
TOTAL	1,830	791	416	454	169	274	487	30	188	224	4

SW 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
COLUMBIA	201	19	80	6	96	15	3	1	72	6	2
CRAWFORD	22	3	19	0	0	3	0	0	15	3	1
DANE	517	206	157	60	94	36	165	5	71	81	5
DODGE	115	12	100	0	3	10	2	0	50	47	3
GRANT	73	1	72	0	0	1	0	0	58	14	0
GREEN	31	5	26	0	0	1	4	0	24	2	0
IOWA	66	0	66	0	0	0	0	0	26	40	0
JEFFERSON	160	21	58	0	81	17	3	1	32	25	1
JUNEAU	79	0	30	1	48	0	0	0	28	0	2
LA CROSSE	204	119	51	16	18	53	65	1	27	24	0
LAFAYETTE	23	0	23	0	0	0	0	0	17	6	0
MONROE	150	16	38	2	94	7	9	0	36	1	1
RICHLAND	21	0	21	0	0	0	0	0	18	3	0
ROCK	278	50	93	42	93	23	25	2	73	18	2
SAUK	140	10	100	0	30	9	1	0	63	36	1
VERNON	32	0	32	0	0	0	0	0	28	3	1
TOTAL	2,112	462	966	127	557	175	277	10	638	309	19

STH = State highw ays or non-interstate US highw ays
IH = Interstate highw ays Non-div = Non-divided
Rural = An unincorporated area or an incorporated area w ith a population under 5,000
Urban = An incorporated area w ith a population of 5,000 or more.

*2023 figures are preliminary at this time.
**Does not include deer or other animal crashes

5 Looking Ahead

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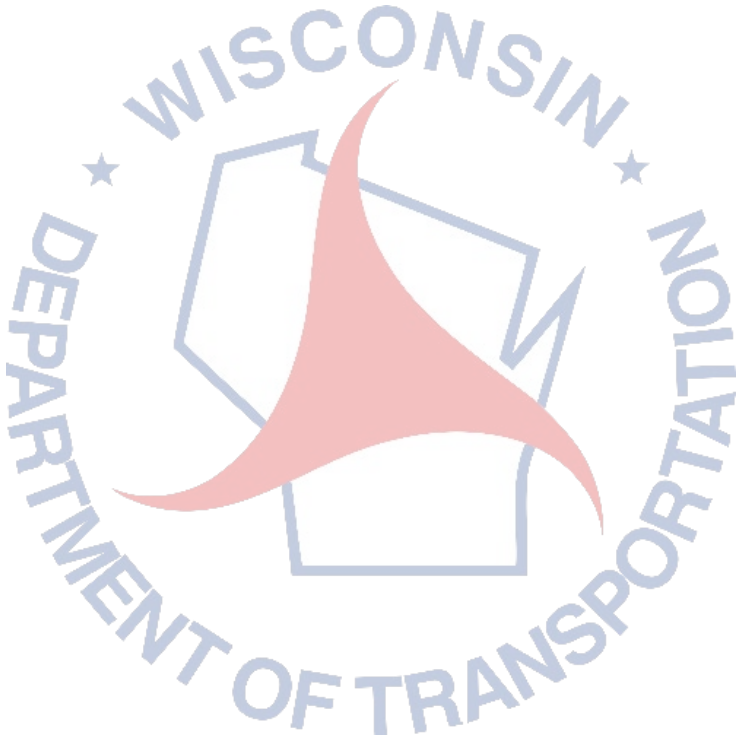
The Wisconsin Department of Transportation (WisDOT) Bureau of Highway Maintenance continues to look for efficiencies that reduce winter maintenance costs. For example, using brine during winter storm events helps reduce salt use and can result in a significant reduction in cost of materials. Additionally, reducing salt use can lessen negative impacts to roadside vegetation and the state's water resources.

WisDOT will continue to work together with the counties to move towards the use of more liquids in place of rock salt. WisDOT has looked back at the five-year averages of salt use and of winter severity in each county. In the 2022-2023 winter season, 62 out of 72 counties improved their salt use based on those calculations. It was also estimated that the state as a whole saved $11.1 million due to the use of liquids that improve the efficiency of rock salt use. This estimate also shows that saved 131,000 tons of salt that wasn't spread so didn't end up going out into the environment.

WisDOT will also continue with a Brine Technical Advisory Committee, which brings WisDOT staff and county staff together to discuss brine liquid use and learn from successes and failures. Due in part to this education effort, brine use increased from 2.2 million gallons of brine 10 years ago to nearly 20.2 million gallons this past winter, a new statewide record.

A study focusing on liquid application was completed last year by the University of Wisconsin Madison Traffic Operations and Safety (TOPS) Laboratory in collaboration with several Wisconsin counties. The result from this study showed the benefits, in cost and materials, of using a mostly liquid model for fighting winter storms. TOPS Lab is also currently in the early phase of another winter maintenance study funded through the Clear Roads group that will show further insight into the benefits of using brine. This study focuses on the various performance measures of liquid operations in comparison to rock salt, including friction and speed recovery. The result of this study will give a thorough understanding of how direct liquid application benefits road users, and hopefully will be a turning point in changing how liquid application is perceived by the traveling public.

The Maintenance Decision Support System (MDSS) continues to be refined, including the option of having treatment recommendations sent directly to plow drivers. WisDOT will continue to work with MDSS to come up with better and more precise application recommendations for specific weather conditions and direct liquid application rates. Through the Wisconsin County Highway Association, winter maintenance training at all levels will be implemented using materials and methods created by Clear Roads and other expert sources. The data from MDSS has also been integrated this past year into the Wisconsin 511 system to show road conditions across all the state highway network and will continue to be improved upon. These many efforts are aimed at providing users of Wisconsin's highways the safest possible experience despite harsh winter weather while also safeguarding the state's natural environment.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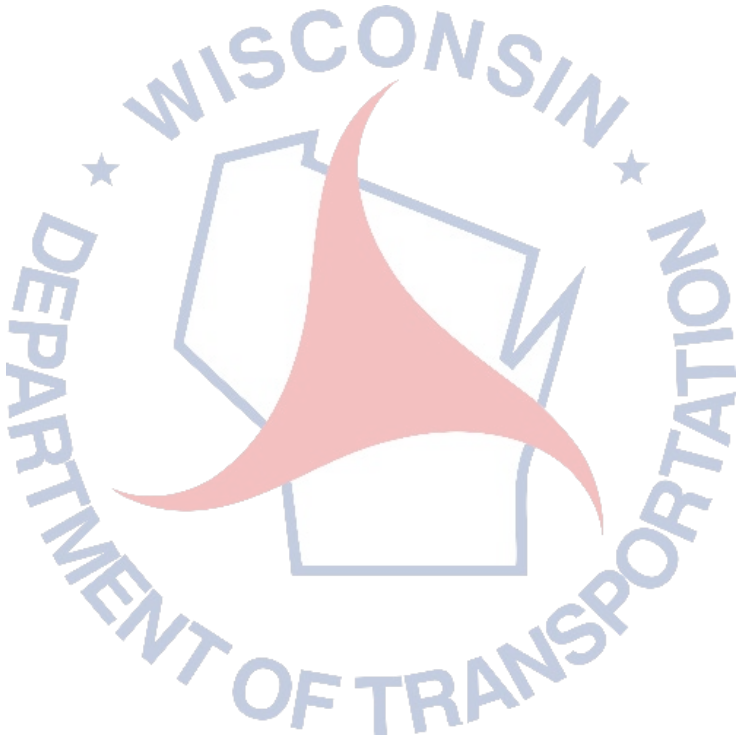
Appendix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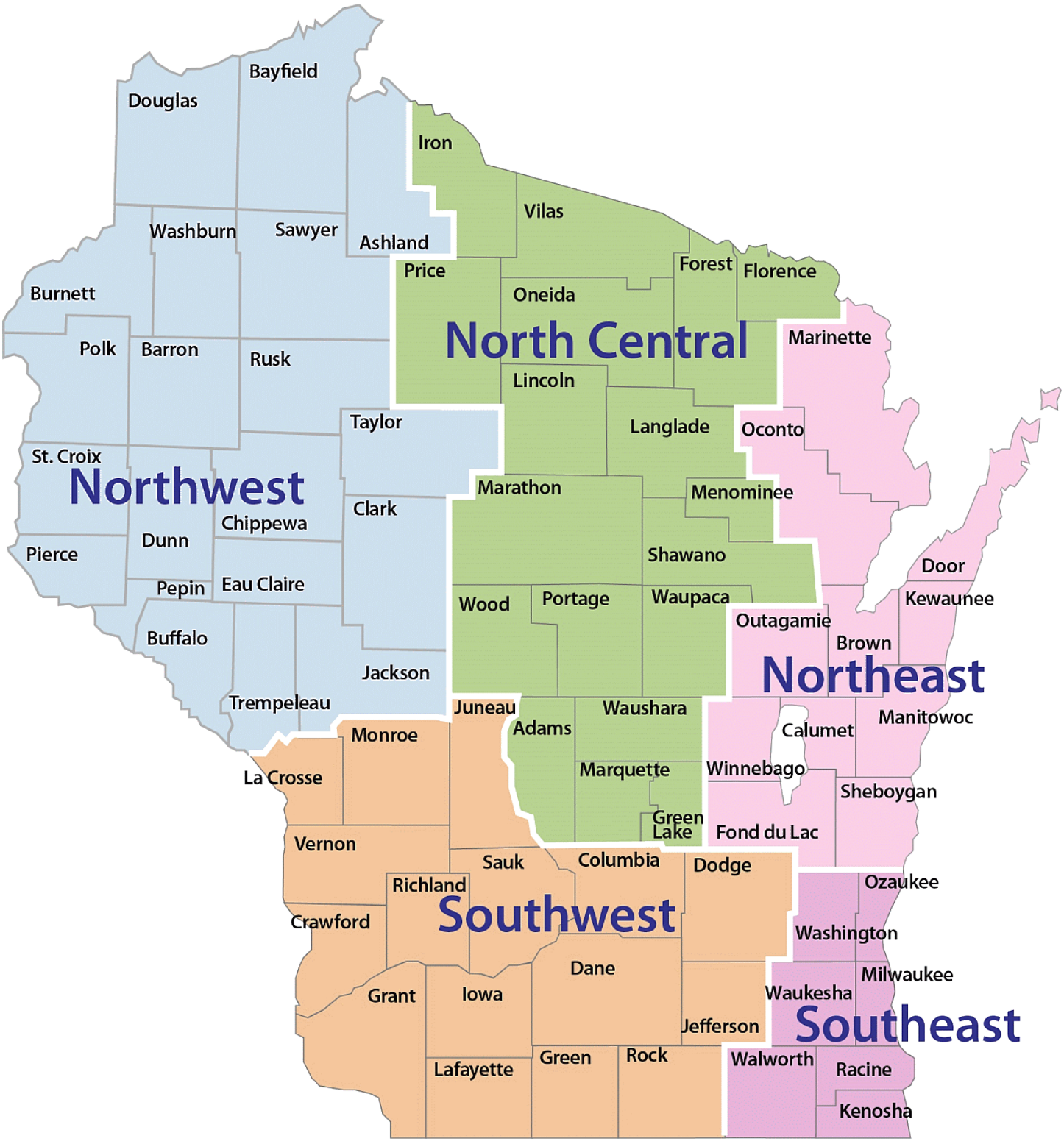
Wisconsin Department of Transportation
Region Map
October 2023



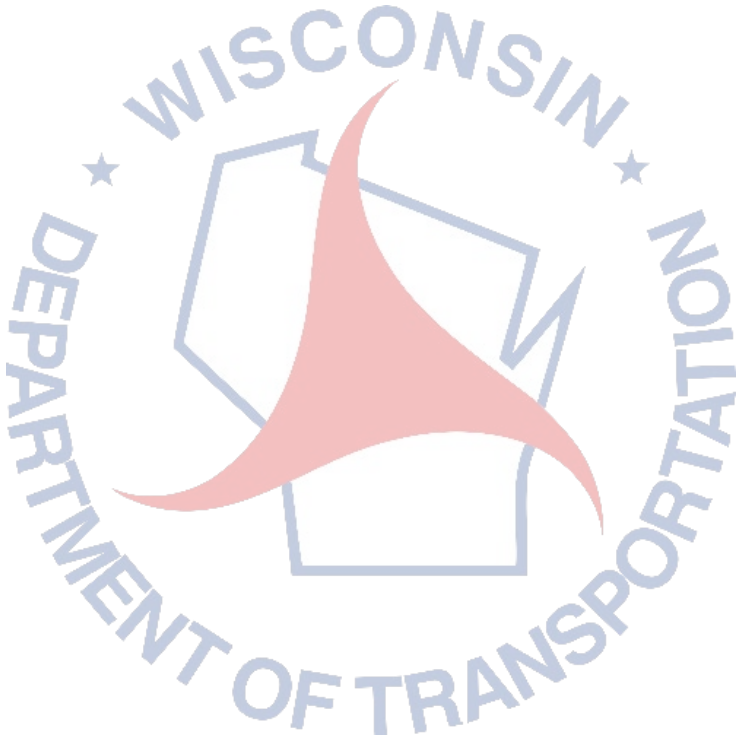

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Table A-1. Storm Report Summary, 2022-2023

Storm Report Summary - End of Season

From Winter Storm Reports, 2022-2023

General Notes: 1) Costs shown in table are estimated and do not include the Administrative Costs; 2) Material Costs includes Brine, Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on an estimated $90 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds plus "early fill" plus "seasonal fill" plus "vendor reserve" available. 6) Some Material Costs are estimated. 7) Severity Indices in this table are not the official MDSS severity index used by WisDOT in other reports. 8) This report is sorted by TOTAL Cost per Lane Mile.

Region / NC / County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season: Anti-Icing	Events this Season: Storms	Events this Season: Incident	Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile: Mat'l	Equip	Labor	Total	Estimated Total Cost to Date	Salt per LM per Severity Index
VILAS	307.61	192.03	190.4	7	69	21	29	8,800	6,182	2,618	20.1	0	0	1186	4080.0	39.0	$2,088	$1,156	$542	$3,786	$1,164,478	0.10
IRON	240.51	208.32	281.2	1	56	25	12	7,400	4,778	2,622	19.9	0	0	141	1984.0	1220.0	$2,001	$1,106	$653	$3,760	$904,140	0.10
FLORENCE	137.43	134.74	137.6	7	45	25	7	3,478	3,055	423	22.2	0	0	26	922.0	369.0	$2,083	$812	$365	$3,259	$447,906	0.16
FOREST	314.15	160.18	130.2	3	60	13	13	7,593	6,569	1,024	20.9	0	0	0	2055.0	1079.0	$1,892	$844	$457	$3,193	$1,000,944	0.13
PRICE	318.47	187.30	179.4	5	66	16	30	5,683	5,293	390	16.6	0	0	0	1848.0	1499.0	$1,657	$945	$487	$3,088	$999,713	0.09
MENOMINEE	90.66	107.27	84.7	1	25	41	3	2,283	1,817	466	20.0	0	0	189	622.0	157.0	$1,797	$754	$379	$2,931	$265,636	0.19
ONEIDA	394.97	172.46	135.2	9	51	17	27	10,298	4,444	5,854	11.3	0	0	793	4308.0	1376.0	$1,103	$1,060	$676	$2,838	$1,122,938	0.07
SHAWANO	533.57	130.89	130.1	3	37	44	7	10,307	6,712	3,595	12.6	0	0	10	4301.0	1704.0	$998	$1,044	$626	$2,669	$1,424,110	0.10
LINCOLN	399.09	164.15	155.8	12	53	23	25	6,741	5,032	1,709	12.6	0	0	728	3593.0	1185.0	$1,281	$801	$575	$2,658	$1,060,742	0.08
MARATHON	903.02	138.51	108.5	9	51	28	15	14,749	10,639	4,110	11.8	0	0	344	5229.0	4828.0	$1,152	$894	$587	$2,633	$2,390,399	0.09
LANGLADE	300.53	151.84	134.6	12	45	26	14	6,441	4,003	2,438	13.3	0	0	27	1693.0	909.0	$1,285	$734	$411	$2,430	$730,309	0.09
WOOD	448.55	132.81	87.8	20	46	14	22	7,819	5,708	2,111	12.7	0	0	102	2065.0	1544.0	$1,184	$697	$423	$2,304	$1,033,547	0.10
PORTAGE	559.84	137.90	73.4	13	42	27	22	8,875	3,806	5,069	6.8	0	0	98	5215.0	1479.0	$625	$1,054	$562	$2,241	$1,254,756	0.05
ADAMS	202.76	113.92	71.8	23	33	13	13	4,538	2,258	2,280	11.1	0	0	45	1050.0	281.0	$1,274	$603	$318	$2,195	$445,080	0.10
WAUPACA	557.05	101.74	86.3	1	30	19	9	11,256	5,785	5,471	10.4	0	0	0	2393.0	1527.0	$883	$623	$372	$1,877	$1,045,628	0.10
MARQUETTE	245.99	91.00	78.2	6	33	14	3	5,030	1,168	3,862	4.7	0	0	0	979.0	718.0	$496	$597	$376	$1,470	$361,662	0.05
WAUSHARA	342.05	103.70	86.7	0	31	13	9	4,420	1,804	2,616	5.3	0	0	0	1348.0	754.0	$513	$526	$310	$1,349	$461,554	0.05
GREEN LAKE	154.23	86.98	71.9	1	30	8	12	2,283	905	1,378	5.9	0	0	0	465.0	320.0	$566	$430	$276	$1,272	$196,211	0.07
Region Total		--	--	--	--	--	--	127,994	79,958	48,036	--	0	0	3689	--	--	--	--	--	--	$16,309,753	
Region Average		139.76	123.5	7.4	44.6	21.5	15.1	7,111	4,442	2,669	13.2	0	0	205	2452.8	1166.0	$1,271	$816	$466	$2,553	$906,097	0.09

Final totals as of Tuesday, June 6, 2023

Table A-1. Storm Report Summary, 2022-2023

Storm Report Summary - End of Season

From Winter Storm Reports, 2022-2023

General Notes: 1) Costs shown in table are estimated and do not include the Administrative Costs; 2) Material Costs includes Brine, Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on an estimated $90 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds plus "early fill" plus "seasonal fill" plus "vendor reserve" available. 6) Some Material Costs are estimated. 7) Severity Indices in this table are not the official MDSS severity index used by WisDOT in other reports. 8) This report is sorted by TOTAL Cost per Lane Mile.

Region NE County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date	Salt per LM per Severity Index
				Anti-Icing	Storms	Inci-dent											Mat'l	Equip	Labor	Total		
BROWN	866.87	98.70	86.1	42	37	5	10	19,818	14,766	5,052	17.0	0	0	34	3251.0	6578.0	$1,194	$1,002	$666	$2,862	$2,481,339	0.17
SHEBOYGAN	532.95	115.21	82.1	49	36	34	8	12,058	6,757	5,301	12.7	0	0	18	2360.0	2228.0	$1,408	$760	$534	$2,702	$1,440,167	0.11
MARINETTE	414.01	143.22	112.0	23	53	29	10	9,620	7,736	1,884	18.7	0	0	3	2142.0	1521.0	$1,425	$767	$510	$2,702	$1,118,633	0.13
OUTAGAMIE	577.92	87.40	91.0	1	32	13	4	11,674	7,279	4,395	12.6	0	0	4	3954.0	2504.0	$1,204	$745	$622	$2,570	$1,485,441	0.14
MANITOWOC	424.86	72.58	50.3	20	25	1	5	8,275	6,511	1,764	15.3	0	0	0	2257.0	1663.0	$1,282	$848	$427	$2,557	$1,086,320	0.21
FOND DU LAC	626.81	98.72	68.7	11	28	18	5	10,640	6,631	4,009	10.6	0	0	9	2610.0	3445.0	$966	$769	$621	$2,356	$1,476,823	0.11
DOOR	274.02	109.01	80.5	13	38	17	8	5,032	3,078	1,954	11.2	0	0	51	804.0	1256.0	$1,005	$667	$504	$2,176	$596,315	0.10
CALUMET	219.61	126.95	91.0	16	41	15	11	2,735	2,091	644	9.5	0	0	0	1289.0	847.0	$828	$756	$499	$2,083	$457,433	0.08
OCONTO	482.03	148.65	93.5	20	40	25	19	8,081	4,592	3,489	9.5	0	0	2	2538.0	1618.0	$783	$713	$480	$1,976	$952,620	0.06
WINNEBAGO	686.74	89.09	85.3	13	28	22	5	11,559	5,440	6,119	7.9	0	12	16	3452.0	3163.0	$665	$760	$542	$1,967	$1,350,983	0.09
KEWAUNEE	125.73	116.08	107.5	4	36	14	12	1,920	1,150	770	9.1	0	0	59	500.0	229.0	$876	$521	$319	$1,716	$215,799	0.08
Region Total		--	--	--	--	--	--	101,412	66,031	35,381	--	0	12	196	--	--	--	--	--	--	$12,661,875	
Region Average		109.60	86.2	19.3	35.8	17.5	8.8	9,219	6,003	3,216	12.2	0	1	18	2287.0	2277.5	$1,058	$755	$520	$2,334	$1,151,080	0.12

Table A-1. Storm Report Summary, 2022-2023

Storm Report Summary - End of Season

From Winter Storm Reports, 2022-2023

General Notes: 1) Costs shown in table are estimated and do not include the Administrative Costs; 2) Material Costs includes Brine, Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on an estimated $90 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds plus "early fill" plus "seasonal fill" plus "vendor reserve" available. 6) Some Material Costs are estimated. 7) Severity Indices in this table are not the official MDSS severity index used by WisDOT in other reports. 8) This report is sorted by TOTAL Cost per Lane Mile.

Region NW County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date	Salt per LM per Severity Index
				Anti-Icing	Storms	Incident											Mat'l	Equip	Labor	Total		
DUNN	519.12	120.40	85.1	0	33	24	8	15,098	12,563	2,535	24.2	0	0	135	2819.0	2875.0	$2,172	$932	$654	$3,758	$1,966,208	0.20
EAU CLAIRE	529.8	98.92	88.8	8	31	0	8	12,443	10,326	2,117	19.5	0	0	475	4944.0	2374.0	$1,919	$1,012	$745	$3,676	$1,947,538	0.20
POLK	374.63	150.70	136.0	3	39	28	9	8,237	7,544	693	20.1	0	0	336	3047.0	1878.0	$1,716	$1,094	$704	$3,514	$1,316,309	0.13
TREMPEALEAU	420.19	115.78	85.0	9	41	22	10	10,008	9,249	759	22.0	0	0	157	2491.0	1943.0	$1,998	$818	$595	$3,410	$1,432,899	0.19
BAYFIELD	346.03	189.13	228.4	0	57	33	10	7,085	5,544	1,541	16.0	0	0	122	3350.0	1470.0	$1,369	$1,249	$727	$3,345	$1,157,624	0.08
DOUGLAS	465.51	171.04	184.4	25	58	52	16	10,530	8,898	1,632	19.1	0	0	17	6140.0	794.0	$1,443	$1,226	$671	$3,339	$1,588,296	0.11
BARRON	434.95	155.82	116.6	1	46	39	26	5,998	6,176	-178	14.2	0	0	715	4828.0	1946.0	$1,206	$1,320	$783	$3,309	$1,439,236	0.09
ASHLAND	255.69	203.14	205.8	5	49	35	34	4,107	4,032	75	15.8	0	0	23	2099.0	1072.0	$1,543	$1,086	$632	$3,260	$850,872	0.08
WASHBURN	388.27	171.28	149.6	17	58	13	21	7,610	6,635	975	17.1	0	0	346	2613.0	2127.0	$1,459	$1,076	$650	$3,185	$1,250,173	0.10
SAINT CROIX	653.34	118.95	114.8	0	40	4	19	16,906	12,890	4,016	19.7	0	0	267	2749.0	4036.0	$1,689	$897	$576	$3,161	$2,102,499	0.17
CHIPPEWA	651.76	125.53	99.6	6	43	9	13	15,835	9,461	6,374	14.5	0	0	305	3535.0	4187.0	$1,358	$1,067	$673	$3,098	$2,048,813	0.12
JACKSON	518.28	127.26	106.5	15	34	17	32	12,230	8,503	3,727	16.4	0	0	26	2492.0	2186.0	$1,527	$778	$444	$2,749	$1,424,984	0.13
CLARK	401.29	111.78	120.1	3	38	15	15	7,113	5,827	1,286	14.5	0	0	0	1609.0	1673.0	$1,516	$742	$426	$2,685	$1,077,499	0.13
PIERCE	368.74	121.25	85.8	1	38	6	14	6,417	5,610	807	15.2	0	0	59	2238.0	1556.0	$1,332	$780	$561	$2,673	$985,599	0.13
RUSK	213.24	123.49	116.9	1	32	24	19	3,004	2,625	379	12.3	0	7	83	1433.0	773.0	$1,152	$889	$558	$2,599	$558,510	0.10
PEPIN	109.41	104.88	86.6	9	29	16	13	1,319	874	445	8.0	0	0	39	806.0	676.0	$759	$1,036	$708	$2,503	$273,811	0.08
TAYLOR	232.32	135.29	119.3	3	42	26	15	4,372	2,808	1,564	12.1	0	0	0	1017.0	895.0	$1,323	$697	$426	$2,447	$568,382	0.09
SAWYER	357.24	155.56	137.5	0	52	18	21	6,100	4,260	1,840	11.9	0	0	19	1661.0	1231.0	$1,029	$671	$413	$2,113	$757,637	0.08
BURNETT	235.35	125.89	119.7	11	41	6	25	4,119	2,733	1,386	11.6	0	0	56	1041.0	701.0	$1,049	$627	$360	$2,036	$482,287	0.09
BUFFALO	311.69	152.52	98.5	9	50	20	20	3,582	3,129	453	10.0	0	0	59	1715.0	984.0	$925	$680	$425	$2,030	$632,576	0.07
Region Total		--	--	--	--	--	--	162,113	129,687	32,426	--	0	7	3239	--	--	--	--	--	--	$23,861,752	
Region Average		138.93	124.3	6.3	42.6	20.4	17.4	8,106	6,484	1,621	15.7	0	0	162	2631.4	1768.9	$1,424	$934	$587	$2,945	$1,193,088	0.12

Final totals as of Tuesday, June 6, 2023

Table A-1. Storm Report Summary, 2022-2023

Storm Report Summary - End of Season

From Winter Storm Reports, 2022-2023

General Notes: 1) Costs shown in table are estimated and do not include the Administrative Costs; 2) Material Costs includes Brine, Salt, Sand, and other Deicing and Anti-icing Agents; 3) Equipment Costs are based on an estimated $90 per hour per unit; 4) Labor Costs are based on each County's average labor rate; 5) Total Salt Available = salt in sheds plus "early fill" plus "seasonal fill" plus "vendor reserve" available. 6) Some Material Costs are estimated. 7) Severity Indices in this table are not the official MDSS severity index used by WisDOT in other reports. 8) This report is sorted by TOTAL Cost per Lane Mile.

Region / SE / County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season: Anti-Icing	Events this Season: Storms	Events this Season: Incident	Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile: Mat'l	Equip	Labor	Total	Estimated Total Cost to Date	Salt per LM per Severity Index
MILWAUKEE	1567.44	73.99	51.7	1	21	2	4	54,359	21,694	32,665	13.8	0	0	0	9608.0	9188.0	$991	$931	$976	$2,898	$4,541,833	0.19
WASHINGTON	591.14	119.39	85.5	25	39	20	14	16,148	6,873	9,275	11.6	0	0	0	2758.0	3137.0	$992	$821	$565	$2,378	$1,405,449	0.10
WAUKESHA	1044.48	66.67	67.1	8	22	0	10	41,000	16,764	24,236	16.1	0	0	0	4473.0	3429.0	$1,171	$611	$464	$2,245	$2,344,935	0.24
WALWORTH	696.59	118.49	88.3	16	34	24	8	19,196	8,269	10,927	11.9	0	0	0	3099.0	2798.0	$1,019	$670	$546	$2,236	$1,557,291	0.10
RACINE	765.35	88.25	59.1	10	37	0	6	18,377	11,973	6,404	15.6	0	0	0	2337.0	2063.0	$1,227	$452	$397	$2,076	$1,589,169	0.18
OZAUKEE	300.72	77.54	69.4	13	25	3	12	9,500	3,349	6,151	11.1	0	0	0	1099.0	920.0	$940	$560	$392	$1,892	$568,917	0.14
KENOSHA	674.12	47.84	12.4	2	19	0	2	14,176	6,396	7,780	9.5	0	0	0	2227.0	2305.0	$714	$603	$445	$1,762	$1,187,893	0.20
Region Total		--	--	--	--	--	--	172,756	75,318	97,438	--	0	0	0	--	--	--	--	--	--	$13,195,486	
Region Average		84.59	61.9	10.7	28.1	7.0	8.0	24,679	10,760	13,920	12.8	0	0	0	3657.3	3405.7	$1,008	$664	$541	$2,212	$1,885,069	0.16

Table A-1. Storm Report Summary, 2022-2023

Storm Report Summary - End of Season

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Region SW County	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season: Anti-Icing	Storms	Incident	Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile: Mat'l	Equip	Labor	Total	Estimated Total Cost to Date	Salt per LM per Severity Index
DANE	1663.43	112.25	81.5	14	36	0	11	53,600	33,417	20,183	20.1	0	0	249	6530.0	14347.0	$1,707	$1,137	$1,040	$3,883	$6,459,917	0.18
COLUMBIA	802.42	90.14	64.2	21	20	20	11	26,217	16,425	9,792	20.5	0	0	405	3545.0	2905.0	$1,989	$724	$456	$3,169	$2,543,038	0.23
SAUK	595.9	120.87	78.6	18	37	18	8	16,314	8,581	7,733	14.4	0	0	125	3799.0	3420.0	$1,408	$921	$631	$2,960	$1,876,789	0.12
DODGE	667.93	93.72	87.2	16	28	15	4	20,272	11,263	9,009	16.9	0	0	0	2542.0	4126.0	$1,309	$899	$638	$2,846	$1,911,597	0.18
MONROE	671.54	106.89	69.0	12	33	21	7	14,938	9,638	5,300	14.4	0	0	0	2727.0	3181.0	$1,323	$725	$473	$2,521	$1,692,682	0.13
ROCK	775.29	65.39	52.8	5	25	7	2	15,300	12,177	3,123	15.7	0	0	18	1728.0	3170.0	$1,292	$541	$501	$2,334	$1,809,736	0.24
JUNEAU	501.12	95.16	51.1	15	31	28	4	10,860	6,043	4,817	12.1	0	0	0	2099.0	1881.0	$1,180	$631	$470	$2,282	$1,157,295	0.13
IOWA	457.02	110.15	71.8	9	35	15	9	7,885	4,494	3,391	9.8	0	0	6	2114.0	2115.0	$861	$721	$526	$2,108	$963,410	0.09
VERNON	468.58	118.31	84.7	18	40	0	11	7,436	5,368	2,068	11.5	0	0	0	2033.0	1725.0	$1,025	$671	$402	$2,098	$985,955	0.10
GRANT	642.71	90.63	76.8	2	22	31	5	10,237	7,715	2,522	12.0	0	0	699	1839.0	2805.0	$1,017	$634	$383	$2,034	$1,307,497	0.13
LAFAYETTE	292.64	111.89	82.9	4	44	15	4	3,325	2,712	613	9.3	0	0	1893	1176.0	1207.0	$865	$682	$416	$1,964	$574,606	0.08
GREEN	313.01	92.54	61.4	8	29	17	10	3,569	2,248	1,321	7.2	0	0	56	1197.0	1446.0	$757	$711	$451	$1,918	$600,334	0.08
LA CROSSE	490.01	53.48	38.0	7	14	12	7	10,276	4,719	5,557	9.6	0	0	0	1334.0	1729.0	$911	$520	$383	$1,814	$888,724	0.18
JEFFERSON	552.95	106.71	86.0	8	37	12	12	16,427	2,277	14,150	4.1	0	0	8	1810.0	3223.0	$350	$819	$591	$1,759	$972,866	0.04
RICHLAND	321.58	70.26	48.0	10	18	39	7	3,653	2,597	1,056	8.1	0	0	132	1167.0	939.0	$807	$533	$316	$1,656	$532,674	0.11
CRAWFORD	398.16	118.47	53.7	7	29	35	13	5,184	3,205	1,979	8.0	0	0	134	1469.0	941.0	$732	$442	$312	$1,486	$591,506	0.07
Region Total		--	--	--	--	--	--	225,493	132,879	92,614	--	0	0	3725	--	--	--	--	--	--	$24,868,627	
Region Average		97.30	68.0	10.9	29.9	17.8	7.8	14,093	8,305	5,788	12.1	0	0	233	2319.3	3072.5	$1,096	$707	$499	$2,302	$1,554,289	0.13

Final totals as of Tuesday, June 6, 2023

Table A-1. Storm Report Summary, 2022-2023

Storm Report Summary - End of Season

From Winter Storm Reports, 2022-2023

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	Lane Miles	Severity Index	Snow Amount (inches)	Events this Season			Freez. Rain Events	Total Salt Avail. (tons)	Total Salt Used (tons)	Total Salt Remain. (tons)	Salt Used per LM (tons)	Total Thaw-Rox (tons)	Total Clear-Lane (tons)	Total Sand Used (CY)	Total Reg. Hours	Total OT Hours	Estimated Cost Per Lane Mile				Estimated Total Cost to Date	Salt per LM per Severity Index
				Anti-Icing	Storms	Inci-dent											Mat'l	Equip	Labor	Total		
Statewide Total	--	--	--	--	--	--	--	789,768	483,873	305,895	--	0	19	10849.0	--	--	--	--	--	--	$90,897,494	--
Statewide Average	120.12	99.7	10.0	37.8	18.3	12.5	10,969	6,720	4,249	13.5	0.0	0.3	150.7	2564.5	2144.7	$1,216	$800	$523	$2,539	$1,262,465	0.12	

Table A-2. Anti-Icing Usage (Gallons)

From Winter Storm Reports, 2022-2023

Region	County	# Applications	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
NC	ADAMS	23	0	116,064	0	0	0	0	0	0
	FLORENCE	7	0	43,700	0	0	0	0	0	0
	FOREST	3	0	16,067	0	0	0	0	0	0
	GREEN LAKE	1	0	4,200	0	0	0	0	0	0
	IRON	1	0	600	0	0	0	0	0	0
	LANGLADE	12	0	111,051	0	0	0	0	0	0
	LINCOLN	12	0	108,600	0	0	0	0	0	0
	MARATHON	9	0	168,523	0	0	0	0	7,857	0
	MARQUETTE	6	0	52,775	0	0	0	0	0	0
	MENOMINEE	0	0	0	0	0	0	0	0	0
	ONEIDA	9	0	98,173	0	0	0	0	0	2,357
	PORTAGE	13	0	91,553	0	0	0	0	0	0
	PRICE	5	0	49,139	0	0	0	0	0	0
	SHAWANO	3	0	29,096	0	0	0	0	0	0
	VILAS	7	0	73,470	0	0	0	0	0	0
	WAUPACA	1	0	500	0	0	0	0	0	0
	WAUSHARA	0	0	0	0	0	0	0	0	0
	WOOD	20	0	30,363	0	0	0	0	0	0
	Region Totals	**132**	**0**	**993,874**	**0**	**0**	**0**	**0**	**7,857**	**2,357**

Region	County	# Applications	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
NE	BROWN	42	0	158,568	0	0	4,310	220	0	0
	CALUMET	16	0	61,400	0	0	0	0	0	0
	DOOR	13	0	85,200	0	0	0	0	0	0
	FOND DU LAC	11	0	155,646	0	0	0	0	0	0
	KEWAUNEE	4	0	36,000	0	0	0	0	0	0
	MANITOWOC	20	0	263,000	0	0	0	0	0	0
	MARINETTE	23	0	261,400	0	0	0	0	0	0
	OCONTO	20	0	174,343	0	0	0	0	0	0
	OUTAGAMIE	1	0	1,200	0	0	0	0	0	0
	SHEBOYGAN	49	0	329,657	0	0	0	0	0	0
	WINNEBAGO	13	0	235,285	0	0	0	0	0	0
	Region Totals	**212**	**0**	**1,761,699**	**0**	**0**	**4,310**	**220**	**0**	**0**

Table A-2. Anti-Icing Usage (Gallons)

From Winter Storm Reports, 2022-2023

Region	County	# Applications	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
NW	ASHLAND	5	0	3,941	288	0	0	916	0	0
	BARRON	1	0	800	0	0	0	0	0	0
	BAYFIELD	0	0	0	0	0	0	0	0	0
	BUFFALO	9	0	30,033	0	0	0	0	0	0
	BURNETT	11	0	8,157	0	0	0	0	0	257
	CHIPPEWA	6	0	9,090	0	0	0	0	0	1,660
	CLARK	3	0	3,110	0	0	0	0	0	0
	DOUGLAS	25	0	11,227	0	0	0	0	0	7,168
	DUNN	0	0	0	0	0	0	0	0	0
	EAU CLAIRE	8	0	71,000	0	0	0	0	0	0
	JACKSON	15	0	60,500	5,000	0	0	0	0	0
	PEPIN	9	0	9,955	0	0	0	0	0	0
	PIERCE	1	0	1,350	0	0	0	0	0	0
	POLK	3	0	270	0	0	0	0	0	0
	RUSK	1	0	225	0	0	0	0	0	225
	ST. CROIX	0	0	0	0	0	0	0	0	0
	SAWYER	0	0	0	0	0	0	0	0	0
	TAYLOR	3	0	2,185	0	0	0	0	0	0
	TREMPEALEAU	9	0	31,500	0	0	0	0	0	0
	WASHBURN	17	0	15,150	0	0	0	0	0	2,815
	Region Totals	**126**	**0**	**258,493**	**5,288**	**0**	**0**	**916**	**0**	**12,125**

Region	County	# Applications	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
SE	KENOSHA	2	375	0	0	0	0	0	0	0
	MILWAUKEE	1	0	10,740	0	0	0	0	0	0
	OZAUKEE	13	0	99,113	0	0	0	0	0	0
	RACINE	10	0	24,700	0	0	0	0	0	0
	WALWORTH	16	210	228,672	0	0	0	0	0	0
	WASHINGTON	25	600	97,575	0	0	0	0	0	0
	WAUKESHA	8	0	34,280	0	0	0	0	0	0
	Region Totals	**75**	**1,185**	**495,080**	**0**	**0**	**0**	**0**	**0**	**0**

Table A-2. Anti-Icing Usage (Gallons)

From Winter Storm Reports, 2022-2023

Region	County	# Applications	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
SW	COLUMBIA	21	0	102,600	0	0	0	0	0	0
	CRAWFORD	7	0	32,400	0	0	0	0	0	0
	DANE	14	0	63,297	0	0	0	0	0	0
	DODGE	16	0	19,912	0	0	0	0	0	1,260
	GRANT	2	0	10,300	0	0	0	0	0	0
	GREEN	8	0	57,520	0	0	0	0	0	0
	IOWA	9	0	27,666	0	0	0	0	0	0
	JEFFERSON	8	0	31,918	0	0	0	0	0	0
	JUNEAU	15	0	131,123	0	0	0	12,501	0	0
	LA CROSSE	7	0	172,062	0	0	0	0	0	0
	LAFAYETTE	4	0	4,500	0	0	0	0	0	0
	MONROE	12	0	163,430	0	0	0	0	0	0
	RICHLAND	10	0	65,050	0	0	0	0	0	0
	ROCK	5	0	9,204	0	0	0	0	0	0
	SAUK	18	0	3,117	0	0	0	42,039	0	0
	VERNON	18	0	75,424	0	0	0	0	0	0
	Region Totals	**174**	**0**	**969,523**	**0**	**0**	**0**	**54,540**	**0**	**1,260**

Region	# Applications	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
NC	132	0	993,874	0	0	0	0	7,857	2,357
NE	212	0	1,761,699	0	0	4,310	220	0	0
NW	126	0	258,493	5,288	0	0	916	0	12,125
SE	75	1,185	495,080	0	0	0	0	0	0
SW	174	0	969,523	0	0	0	54,540	0	1,260
Statewide Totals	**719**	**1,185**	**4,478,669**	**5,288**	**0**	**4,310**	**55,676**	**7,857**	**15,742**

Total Anti-Icing Liquid Used	**4,568,727**

Table A-3. Actual Anti-Icing Costs, 2022-2023

	Cost to Apply Liquid Anti-Icing Chemicals	Total Winter Maintenance Costs	Anti-Icing as a % of Total Winter Costs
Northwest Region			
Ashland	$4,593	$1,116,601	0.41%
Barron	$0	$1,845,858	0.00%
Bayfield	$863	$1,548,193	0.06%
Buffalo	$8,859	$714,975	1.24%
Burnett	$18,442	$715,167	2.58%
Chippewa	$20,249	$2,683,694	0.75%
Clark	$7,298	$1,382,251	0.53%
Douglas	$17,325	$2,434,708	0.71%
Dunn	$0	$2,397,537	0.00%
Eau Claire	$17,787	$2,468,589	0.72%
Jackson	$11,627	$1,730,565	0.67%
Pepin	$5,178	$347,466	1.49%
Pierce	$4,246	$1,262,533	0.34%
Polk	$486	$1,507,230	0.03%
Rusk	$5,178	$591,885	0.87%
Saint Croix	$13,857	$3,112,001	0.45%
Sawyer	$0	$932,737	0.00%
Taylor	$3,004	$794,571	0.38%
Trempealeau	$36,798	$1,739,304	2.12%
Washburn	$27,424	$1,496,065	1.83%
Region Totals	**$203,214**	**$30,821,929**	**0.66%**

Table A-3. Actual Anti-Icing Costs, 2022-2023

	Cost to Apply Liquid Anti-Icing Chemicals	Total Winter Maintenance Costs	Anti-Icing as a % of Total Winter Costs
North Central Region			
Adams	$26,570	$526,623	5.05%
Florence	$12,861	$558,113	2.30%
Forest	$4,887	$1,225,201	0.40%
Green Lake	$812	$278,647	0.29%
Iron	$161	$1,221,887	0.01%
Langlade	$31,034	$909,811	3.41%
Lincoln	$9,850	$1,288,448	0.76%
Marathon	$108,691	$3,077,089	3.53%
Marquette	$24,003	$604,013	3.97%
Menominee	$0	$302,218	0.00%
Oneida	$47,199	$1,550,546	3.04%
Portage	$53,600	$1,650,203	3.25%
Price	$23,154	$1,333,376	1.74%
Shawano	$12,322	$1,923,766	0.64%
Vilas	$15,663	$1,587,752	0.99%
Waupaca	$1,994	$1,523,241	0.13%
Waushara	$304	$576,971	0.05%
Wood	$25,343	$1,305,887	1.94%
Region Totals	**$398,446**	**$21,443,793**	**1.86%**

Table A-3. Actual Anti-Icing Costs, 2022-2023

	Cost to Apply Liquid Anti-Icing Chemicals	Total Winter Maintenance Costs	Anti-Icing as a % of Total Winter Costs
Northeast Region			
Brown	$72,430	$3,289,965	2.20%
Calumet	$14,385	$578,659	2.49%
Door	$20,846	$809,767	2.57%
Fond du Lac	$45,758	$1,776,547	2.58%
Kewanee	$9,158	$291,615	3.14%
Manitowoc	$37,415	$1,312,744	2.85%
Marinette	$29,612	$1,326,031	2.23%
Oconto	$39,521	$1,222,221	3.23%
Outagamie	$0	$2,069,439	0.00%
Sheboygan	$165,130	$1,904,754	8.67%
Winnebago	$95,101	$1,910,612	4.98%
Region Totals	**$529,356**	**$16,492,352**	**3.21%**
Southeast Region			
Kenosha	$6,626	$1,540,543	0.43%
Milwaukee	$10,646	$6,636,137	0.16%
Ozaukee	$35,049	$867,116	4.04%
Racine	$29,033	$2,115,252	1.37%
Walworth	$100,143	$2,052,598	4.88%
Washington	$40,359	$1,876,514	2.15%
Waukesha	$35,767	$3,532,510	1.01%
Region Totals	**$257,622**	**$18,620,670**	**1.38%**

Table A-3. Actual Anti-Icing Costs, 2022-2023

	Cost to Apply Liquid Anti-Icing Chemicals	Total Winter Maintenance Costs	Anti-Icing as a % of Total Winter Costs
Southwest Region			
Columbia	$45,246	$3,223,555	1.40%
Crawford	$22,094	$728,278	3.03%
Dane	$45,688	$8,405,018	0.54%
Dodge	$95,470	$2,256,413	4.23%
Grant	$4,002	$1,736,911	0.23%
Green	$27,960	$775,355	3.61%
Iowa	$10,420	$1,318,092	0.79%
Jefferson	$17,814	$1,122,300	1.59%
Juneau	$43,554	$1,472,149	2.96%
La Crosse	$74,076	$1,385,774	5.35%
Lafayette	$3,722	$883,670	0.42%
Monroe	$29,468	$1,691,379	1.74%
Richland	$18,590	$623,173	2.98%
Rock	$11,349	$2,465,318	0.46%
Sauk	$33,215	$2,070,420	1.60%
Vernon	$20,265	$1,222,657	1.66%
Region Totals	**$502,933**	**$31,380,462**	**1.60%**

Table A-3. Actual Anti-Icing Costs, 2022-2023

	Cost to Apply Liquid Anti-Icing Chemicals	Total Winter Maintenance Costs	Anti-Icing as a % of Total Winter Costs
STATEWIDE SUMMARY			
SW Region	**$502,933**	**$31,380,462**	1.60%
SE Region	**$257,622**	**$18,620,670**	1.38%
NE Region	**$529,356**	**$16,492,352**	3.21%
NC Region	**$398,446**	**$21,443,793**	1.86%
NW Region	**$203,214**	**$30,821,929**	0.66%
Statewide Totals	**$1,891,572**	**$118,759,205**	**1.59%**

Table A-4. Salt Brine Used

From Winter Storm Reports, 2022-2023

Region	County	PreWetting (Gal)	Anti-Icing (Gal)	Direct Liquid (Gal)	Total (Gal)
North Central	ADAMS	115,840	116,064	0	231,904
	FLORENCE	26,908	43,700	5,000	75,608
	FOREST	26,553	16,067	231,234	273,854
	GREEN LAKE	7,470	4,200	0	11,670
	IRON	41,685	600	0	42,285
	LANGLADE	45,667	111,051	228,639	385,357
	LINCOLN	81,046	108,600	0	189,646
	MARATHON	233,478	176,380	53,914	463,772
	MARQUETTE	38,046	52,775	564,871	655,692
	MENOMINEE	9,400	0	0	9,400
	ONEIDA	40,380	100,530	944,944	1,085,854
	PORTAGE	60,385	91,553	0	151,938
	PRICE	132,468	49,139	0	181,607
	SHAWANO	20,655	29,096	655,019	704,770
	VILAS	6,700	73,470	1,333,175	1,413,345
	WAUPACA	267,483	500	175,693	443,676
	WAUSHARA	15,564	0	0	15,564
	WOOD	21,279	30,363	524,508	576,150
	Region Totals	**1,191,007**	**1,004,088**	**4,716,997**	**6,912,092**

Region	County	PreWetting (Gal)	Anti-Icing (Gal)	Direct Liquid (Gal)	Total (Gal)
Northeast	BROWN	222,371	163,098	427,711	813,180
	CALUMET	12,700	61,400	3,500	77,600
	DOOR	36,533	85,200	97,450	219,183
	FOND DU LAC	331,863	155,646	9,294	496,803
	KEWAUNEE	51,980	36,000	88,700	176,680
	MANITOWOC	41,822	263,000	0	304,822
	MARINETTE	20,810	261,400	0	282,210
	OCONTO	118,993	174,343	163,202	456,538
	OUTAGAMIE	529,140	1,200	529,140	1,059,480
	SHEBOYGAN	359,595	329,657	359,595	1,048,847
	WINNEBAGO	20,367	235,285	571,987	827,639
	Region Totals	**1,746,174**	**1,766,229**	**2,250,579**	**5,762,982**

Table A-4. Salt Brine Used

From Winter Storm Reports, 2022-2023

Region	County	PreWetting (Gal)	Anti-Icing (Gal)	Direct Liquid (Gal)	Total (Gal)
Northwest	ASHLAND	141,990	5,145	0	147,135
	BARRON	29,152	800	0	29,952
	BAYFIELD	94,050	0	0	94,050
	BUFFALO	26,166	30,033	35,050	91,249
	BURNETT	35,050	8,414	0	43,464
	CHIPPEWA	130,827	10,750	0	141,577
	CLARK	22,216	3,110	0	25,326
	DOUGLAS	88,247	18,395	0	106,642
	DUNN	120,731	0	0	120,731
	EAU CLAIRE	111,177	71,000	0	182,177
	JACKSON	3,919	65,500	7,500	76,919
	PEPIN	5,908	9,955	0	15,863
	PIERCE	31,823	1,350	0	33,173
	POLK	61,017	270	0	61,287
	RUSK	8,131	450	0	8,581
	SAINT CROIX	192,604	0	0	192,604
	SAWYER	2,785	0	0	2,785
	TAYLOR	84,428	2,185	0	86,613
	TREMPEALEAU	11,761	31,500	0	43,261
	WASHBURN	52,847	17,965	0	70,812
	Region Totals	**1,254,829**	**276,822**	**42,550**	**1,574,201**

Region	County	PreWetting (Gal)	Anti-Icing (Gal)	Direct Liquid (Gal)	Total (Gal)
Southeast	KENOSHA	15,144	375	0	15,519
	MILWAUKEE	195,513	10,740	0	206,253
	OZAUKEE	220,258	99,113	12,762	332,133
	RACINE	62,137	24,700	0	86,837
	WALWORTH	308,949	228,882	652,260	1,190,091
	WASHINGTON	147,398	98,175	35,820	281,393
	WAUKESHA	93,015	34,280	0	127,295
	Region Totals	**1,042,414**	**496,265**	**700,842**	**2,239,521**

Table A-4. Salt Brine Used

From Winter Storm Reports, 2022-2023

Region	County	PreWetting (Gal)	Anti-Icing (Gal)	Direct Liquid (Gal)	Total (Gal)
Southwest	COLUMBIA	234,828	102,600	0	337,428
	CRAWFORD	25,848	32,400	0	58,248
	DANE	462,204	63,297	0	525,501
	DODGE	113,814	21,172	115,729	250,715
	GRANT	64,961	10,300	0	75,261
	GREEN	37,625	57,520	0	95,145
	IOWA	42,382	27,666	2,034	72,082
	JEFFERSON	9,053	31,918	527,380	568,351
	JUNEAU	27,925	143,624	0	171,549
	LA CROSSE	281,988	172,062	0	454,050
	LAFAYETTE	15,592	4,500	0	20,092
	MONROE	20,376	163,430	7,900	191,706
	RICHLAND	55,210	65,050	0	120,260
	ROCK	49,397	9,204	340,799	399,400
	SAUK	76,613	45,156	0	121,769
	VERNON	127,755	75,424	30	203,209
	Region Totals	**1,645,571**	**1,025,323**	**993,872**	**3,664,766**
	Totals	**6,879,995**	**4,568,727**	**8,704,840**	**20,153,562**

Table A-5. Pre-Wet Usage (Gallons)

From Winter Storm Reports, 2022-2023

Region	County	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
NC	ADAMS	680	99,722	0	15,438	0	0	0	0
	FLORENCE	0	26,908	0	0	0	0	0	0
	FOREST	0	26,553	0	0	0	0	0	0
	GREEN LAKE	0	7,470	0	0	0	0	0	0
	IRON	0	41,685	0	0	0	0	0	0
	LANGLADE	0	45,667	0	0	0	0	0	0
	LINCOLN	0	80,676	0	370	0	0	0	0
	MARATHON	0	210,106	0	18,350	0	0	5,022	0
	MARQUETTE	0	38,046	0	0	0	0	0	0
	MENOMINEE	0	9,400	0	0	0	0	0	0
	ONEIDA	0	40,280	0	0	0	0	0	100
	PORTAGE	0	60,385	0	0	0	0	0	0
	PRICE	0	116,183	0	0	0	0	0	16,285
	SHAWANO	0	20,655	0	0	0	0	0	0
	VILAS	0	6,700	0	0	0	0	0	0
	WAUPACA	380	267,103	0	0	0	0	0	0
	WAUSHARA	0	15,564	0	0	0	0	0	0
	WOOD	0	21,279	0	0	0	0	0	0
	Region Totals	**1,060**	**1,134,382**	**0**	**34,158**	**0**	**0**	**5,022**	**16,385**

Region	County	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
NE	BROWN	70	218,812	0	3,489	0	0	0	0
	CALUMET	0	12,700	0	0	0	0	0	0
	DOOR	0	36,533	0	0	0	0	0	0
	FOND DU LAC	1,273	330,590	0	0	0	0	0	0
	KEWAUNEE	0	51,980	0	0	0	0	0	0
	MANITOWOC	0	39,427	0	2,395	0	0	0	0
	MARINETTE	0	19,900	0	910	0	0	0	0
	OCONTO	0	118,993	0	0	0	0	0	0
	OUTAGAMIE	0	529,140	0	0	0	0	0	0
	SHEBOYGAN	0	359,595	0	0	0	0	0	0
	WINNEBAGO	0	20,367	0	0	0	0	0	0
	Region Totals	**1,343**	**1,738,037**	**0**	**6,794**	**0**	**0**	**0**	**0**

Table A-5. Pre-Wet Usage (Gallons)

From Winter Storm Reports, 2022-2023

Region	County	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
NW	ASHLAND	0	115,527	10,073	0	0	16,380	0	0
	BARRON	0	29,152	0	0	0	0	0	0
	BAYFIELD	0	94,050	0	0	0	0	0	0
	BUFFALO	0	26,166	0	0	0	0	0	0
	BURNETT	0	32,247	0	0	0	0	0	2,803
	CHIPPEWA	50	98,787	0	3,907	0	0	0	28,083
	CLARK	0	22,216	0	0	0	0	0	0
	DOUGLAS	0	61,592	0	77	0	1,179	0	25,399
	DUNN	0	105,596	0	0	0	0	0	15,135
	EAU CLAIRE	5,645	105,532	0	0	0	0	0	0
	JACKSON	0	0	3,919	0	0	0	0	0
	PEPIN	0	5,868	40	0	0	0	0	0
	PIERCE	0	31,823	0	0	0	0	0	0
	POLK	0	57,074	0	0	0	0	0	3,943
	RUSK	0	8,141	0	0	0	0	0	0
	ST. CROIX	8,457	146,735	0	0	0	0	0	37,412
	SAWYER	0	0	0	0	0	0	0	2,785
	TAYLOR	0	84,428	0	0	0	0	0	0
	TREMPEALEAU	0	11,061	700	0	0	0	0	0
	WASHBURN	0	42,275	0	0	0	0	0	10,572
	Region Totals	**14,152**	**1,078,270**	**14,732**	**3,984**	**0**	**17,559**	**0**	**126,132**

Region	County	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
SE	KENOSHA	15,144	0	0	0	0	0	0	0
	MILWAUKEE	8,881	186,632	0	0	0	0	0	0
	OZAUKEE	0	220,258	0	0	0	0	0	0
	RACINE	5,777	56,360	0	0	0	0	0	0
	WALWORTH	47,361	261,588	0	0	0	0	0	0
	WASHINGTON	0	147,398	0	0	0	0	0	0
	WAUKESHA	12,907	80,108	0	0	0	0	0	0
	Region Totals	**90,070**	**952,344**	**0**	**0**	**0**	**0**	**0**	**0**

Table A-5. Pre-Wet Usage (Gallons)

From Winter Storm Reports, 2022-2023

Region	County	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
SW	COLUMBIA	0	234,828	0	0	0	0	0	0
	CRAWFORD	0	25,848	0	0	0	0	0	0
	DANE	2,310	459,894	0	0	0	0	0	0
	DODGE	0	103,102	0	1,358	0	0	0	9,354
	GRANT	0	64,961	0	0	0	0	0	0
	GREEN	0	37,155	0	470	0	0	0	0
	IOWA	0	42,382	0	0	0	0	0	0
	JEFFERSON	0	9,053	0	0	0	0	0	0
	JUNEAU	0	26,591	0	0	0	1,334	0	0
	LA CROSSE	0	281,988	0	0	0	0	0	0
	LAFAYETTE	0	15,592	0	0	0	0	0	0
	MONROE	800	19,576	0	0	0	0	0	0
	RICHLAND	0	55,210	0	0	0	0	0	0
	ROCK	0	49,397	0	0	0	0	0	0
	SAUK	0	5,743	0	0	0	70,870	0	0
	VERNON	0	125,040	0	0	0	0	0	2,715
	Region Totals	**3,110**	**1,556,360**	**0**	**1,828**	**0**	**72,204**	**0**	**12,069**

Region	$CaCl_2$	Salt Brine	$MgCl_2$	FreezeGard	GeoMelt	Beet 55	AMP	Beet Heet
NC	1,060	1,134,382	0	34,158	0	0	5,022	16,385
NE	1,343	1,738,037	0	6,794	0	0	0	0
NW	14,152	1,078,270	14,732	3,984	0	17,559	0	126,132
SE	90,070	952,344	0	0	0	0	0	0
SW	3,110	1,556,360	0	1,828	0	72,204	0	12,069
Statewide Totals	**109,735**	**6,459,393**	**14,732**	**46,764**	**0**	**89,763**	**5,022**	**154,586**

6,879,995

Table A-6. History of Salt Use on State Trunk Highways

From Salt Inventory Reporting System

Winter	Tons of Salt	Lane Miles	Tons/Lane Mile	Million Vehicle Miles Traveled STH System (Winter)
1959/60	93,673	19,521	4.8	8,828
1960/61	54,805	19,948	2.7	9,254
1961/62	109,412	19,966	5.5	9,558
1962/63	77,719	19,756	3.9	9,782
1963/64	82,033	19,717	4.2	10,064
1964/65	149,329	19,911	7.5	10,566
1965/66	111,634	19,505	5.7	11,122
1966/67	181,230	20,137	8.0	11,933
1967/68	137,729	22,395	6.2	12,140
1968/69	193,004	22,675	8.5	12,870
1969/70	199,353	22,831	8.7	13,853
1970/71	273,010	23,120	11.8	15,133
1971/72	223,249	25,543	8.7	14,325
1972/73	256,571	25,673	10.0	15,301
1973/74	218,189	N/A	N/A	16,198
1974/75	237,916	N/A	N/A	15,807
1975/76	257,154	N/A	N/A	16,198
1976/77	188,011	N/A	N/A	18,556
1977/78	210,054	N/A	N/A	19,621
1978/79	235,193	N/A	N/A	21,053
1979/80	220,180	N/A	N/A	20,403
1980/81	151,021	N/A	N/A	19,360
1981/82	192,740	N/A	N/A	20,210
1982/83	234,529	27,407	8.6	20,056
1983/84	224,368	27,416	8.2	20,873
1984/85	217,136	27,598	7.9	21,214
1985/86	304,296	27,632	11.0	22,110
1986/87	196,035	27,613	7.1	23,176
1987/88	224,573	27,743	8.1	24,346
1988/89	230,403	27,872	8.3	24,550
1989/90	297,004	28,024	10.6	25,370
1990/91	364,174	28,006	13.0	26,247
1991/92	337,079*	28,104	12.0*	27,391
1992/93	416,594*	28,182	14.8*	28,252
1993/94	314,489*	28,221	11.1*	28,859
1994/95	295,479*	28,312	10.4*	29,210
1995/96	440,488*	28,374	15.5	30,077
1996/97	509,147*	28,545	17.8*	31,122
1997/98	413,824*	29,619	14.0*	32,083
1998/99	371,602	30,119	12.4	33,236
1999/00	346,963*	30,340	11.4*	33,825
2000/01	521,056	30,553	17.1	34,657
2001/02	308,954	30,909	10.0	34,076
2002/03	328,922	30,975	10.6	35,088
2003/04	390,664	31,429	12.4	35,662
2004/05	407,924	31,810	12.8	36,013
2005/06	410,570	33,022	12.4	35,642
2006/07	405,793	33,221	12.2	27,911
2007/08	644,484	33,297	19.4	27,931
2008/09	569,985	33,531	17.0	26,888
2009/10	408,523	33,532	12.2	26,109
2010/11	573,253	33,776	17.0	26,998
2011/12	355,519	33,944	10.5	25,669
2012/13	621,207	34,192	18.2	26,512
2013/14	669,807	34,339	19.5	26,774
2014/15	388,797	34,435	11.3	28,218
2016/17	526,198	34,621	15.2	29,350
2017/18	567,600	34,678	16.4	30,095
2018/19	553,443	34,774	15.9	30,022
2019/20	425,558	34,859	12.2	30,525
2020/21	324,265	35,177	9.2	27,764
2021/22	387,600	34,736	11.2	28,773
2022/23	483,874	34,723	13.9	30,785

* Quantities adjusted