WINTER MAINTENANCE AT A GLANCE 2020-2021

Innovation, Partnership Drive Salt Use to a 30-Year Low

Introduction

Snow and ice control is a critical element of operations on our state highway system. To meet level of service goals in this area, Wisconsin DOT contracts with the state's 72 county highway departments for winter maintenance on these highways, which is a unique and mutually beneficial partnership. WisDOT receives the services of a skilled, experienced workforce, and supports the counties through training, research initiatives, and testing of products, equipment and methods.

This summary document highlights key aspects of the 2020-2021 winter, including weather, materials and equipment use, performance, and costs. The complete Annual Winter Maintenance Report, which provides further detail on these areas and others, is available at: http://wisconsindot.gov/Pages/doing-bus/local-gov/hwy-mnt/winter-maintenance/default.aspx.

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Winter by the Numbers

In 2020-2021, Wisconsin experienced a less costly and less severe winter than the previous year. Compared to last year's winter costs of $84,639,241 this winter's costs totaled $74,101,934, a decrease of 12.4 percent. The state experienced an average of 25 winter storms this winter, resulting in an average of 51.8 total inches of snowfall. This average represents a 28 percent decrease from last year's statewide average of 71.9 inches of snow. Salt use was also 23.8 percent lower than 2019-2020, at 324,265 tons.

The great news from this past winter was that it was our lowest salt use in terms of Tons/Lane mile since the 1988/1989 winter, with a statewide average of 9.2 tons/lane mile.

Table 1 below summarizes key facts and statistics from this winter in several core areas. The 2020-2021 Annual Winter Maintenance Report provides more detail on all topics in this table.

Table 1. Statewide Summary: This Winter by the Numbers

	Measure	Previous Winter	2020-2021
Infrastructure	Lane miles	34,859 miles	35,177 miles
	Patrol sections[4]	756.0	754.0
	Average patrol section length[4]	46.5 lane miles	46.7 lane miles
Weather	Average statewide Winter Severity Index	94.3	64.1
	Number of storms, statewide average and range across counties	Average: 31 Range:16 to 51	Average: 25 Range: 14-19
	Snowfall, statewide average and range across counties	Average: 71.9 Range: 27.3 to 193.5	Average: 51.8 Range: 29.7-124.4
Materials[1]	Salt used	425,558 tons 12.2 tons/lane mile	324,265 tons 9.2 tons per lane mile
	Average cost of salt	$77.10 per ton	$80.09 per ton
	Total liquids used (prewet, anti-icing, direct liquid application)	11,398,968 gal.	11,548,222 gal.
	Sand used	8,208 cubic yd.	14,393 cubic yd.
Costs and Performance	Total winter costs[2]	$84,639,241	$74,101,934
	Total winter costs per lane mile	$2,428	$2,107
	Average crew reaction time from start of storm	2.83 hours	2.77 hours
	Percentage of roads to bare/wet pavement (Within WisDOT target times)	72%	67%
	Road Weather Information System (RWIS) stations	70	70
	Underbody plows	803	803
	Counties that used anti-icing agents during the winter season	65 of 72 (90%)	68 of 72 (94%)
Labor and Services	Regular county winter labor hours[3]	141,804 hrs.	112,788 hrs.
	Overtime county winter labor hours	121,982 hrs.	112,903 hrs.
	Public service announcements aired	None	None

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.

A Mild Winter Season

Our weather for the winter of 2020-2021 was relatively mild across the state up until February when winter started to show up with some larger snowstorms, accompanied by brutally cold temperatures for most of the month. Winter seemed to break across most of the state in March as normally is expected, especially in the southern parts.

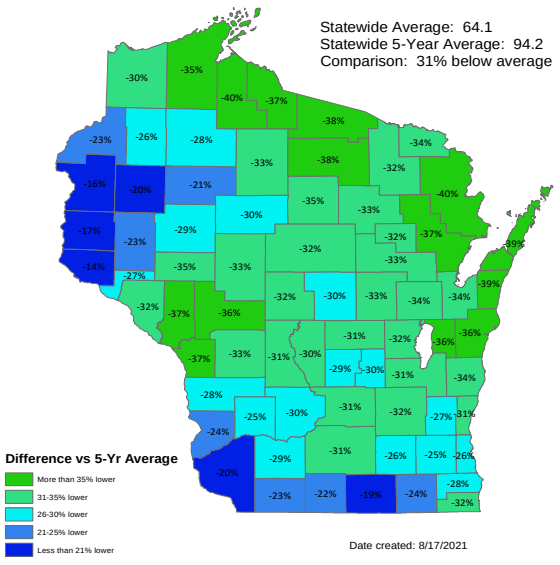
Even with the challenges COVID brought to everything over this past winter, the partnership between the counties and WisDOT maintained the expected level of service for winter maintenance without any issues.

During the 2020-2021 winter season, county highway departments responded to:

- A statewide average of 25 winter events per county, 6 less than the previous winter. The high was 49 events in Bayfield County and the low was 14 events in La Crosse County.
- A statewide average of 5 frost events.
- A statewide average of 8 freezing rain/sleet events.

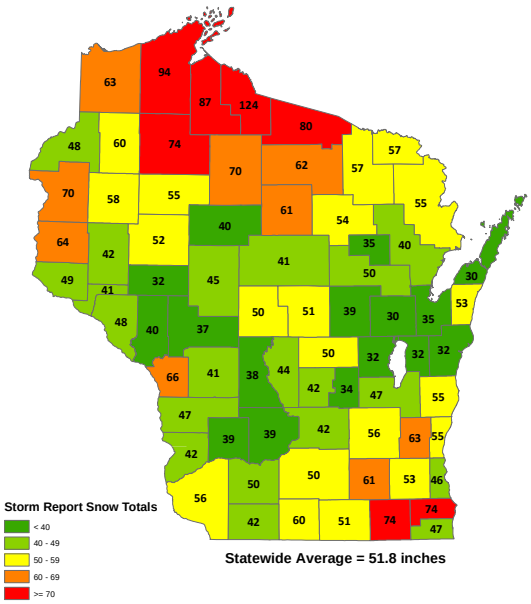
Figure 2 shows the total snowfall received in Wisconsin this winter based on storm report data. Snowfall varied significantly across the state; the highest snowfall recorded was in Iron County, at 124 inches; the lowest was in Door County, at 30 inches. This winter's statewide average total snowfall was 51.8 inches.

Figure 1. 2020-2021 Winter Severity Index vs. 5-Year Average



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

Figure 2. Statewide Snowfall, 2020-2021



Note: Snowfall totals are based on winter storm reports data.

Salt and Anti-icing Work Together

Salt use was 23.8 percent lower than the previous year, at 324,265 tons. Figure 3 shows county 2020-2021 salt usage per lane mile versus 5-year averages. Figure 4 shows statewide historical salt usage per lane mile overlaid with average severity index. WisDOT encourages counties to use salt efficiently by making use of best practices such as anti-icing and prewetting. Use of anti-icing materials was down 4 percent over last year, with counties using 3,642,986 gallons of anti-icing liquid. 68 counties made at least one anti-icing application. Use of prewetting materials was similar to last year with counties using 4,773,553 gallons.

Direct Liquid Application (DLA) is a relatively new best practice in Wisconsin. During the winter of 2020-2021, 30 counties used this technique, up from 17 counties in the previous year. Liquids applied directly to the pavement for deicing replace rock salt as the primary storm management tool. This reduces the amount of salt applied and has been found to be more effective than solid salt. WisDOT hopes to expand use of DLA in the future.

In contrast, WisDOT actively discourages counties from using sand on the state trunk highway system. Sand is not effective at high traffic speeds, negatively impacts the environment, and ultimately decreases the level of service provided. Counties used 14,393 cubic yards of sand on state highways this year, a 2 percent decrease from the average of the five previous winters (14,689 cubic yards).

Wisconsin counties applied a statewide average of 9.2 tons of salt per lane mile, a decrease of 24.6 percent compared with the 2019-2020 winter.

Figure 3. 2020-2021 Salt Use per Lane Mile vs. 5-Year Average

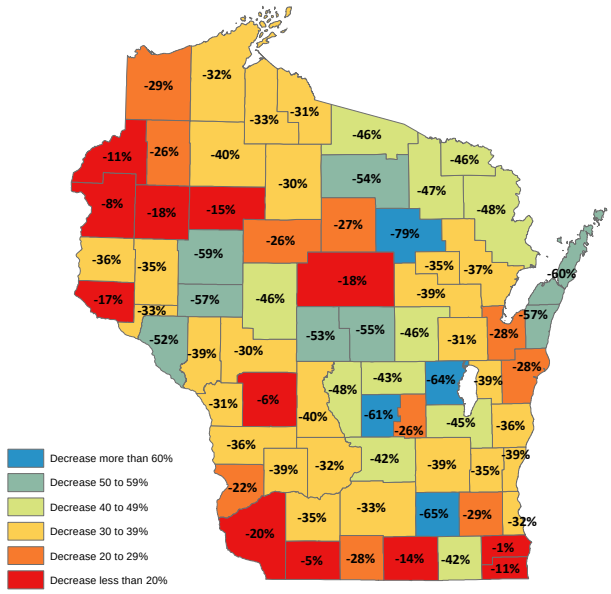
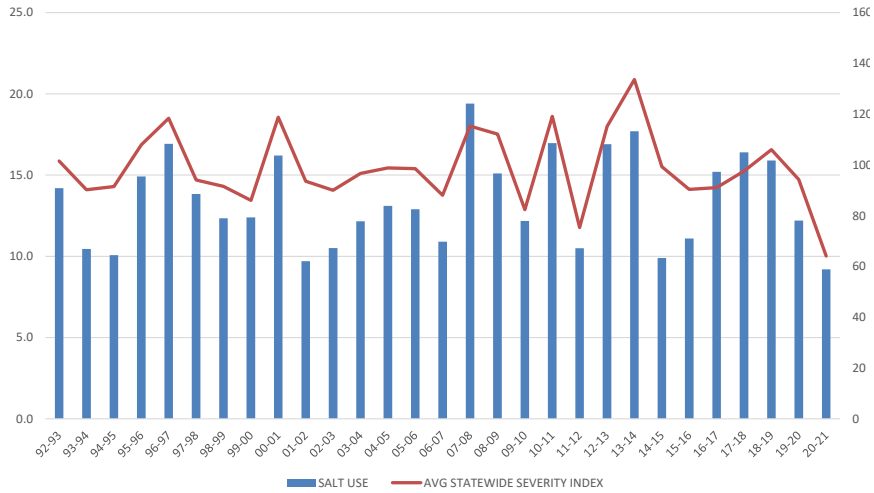


Figure 4. Salt Use per Lane Mile and Average Severity Index

From Salt Inventory Reporting System, 1992–2021



Lower Salt, Labor, and Equipment Costs

The total cost of statewide winter operations this winter was $74.1 million, making it 12.5 percent less costly than 2019-2020. The winter was less severe in 2020-2021, which likely accounts for the decrease in cost. Figure 5 also demonstrates a decrease in winter costs from the average of the previous five years for a majority of the counties. This winter's statewide average cost per lane mile of $2,107 was 13 percent lower than last year's cost of $2,428 per lane mile.

In 2020-2021 WisDOT spent $25.7 million on salt, $23.0 million on equipment-related expenses, $20.9 million on labor, and $2.6 million on materials other than salt, such as sand and additives used in brine. Similar to previous winters, anti-icing activities only made up about 2 percent of total expenditures.

As is to be expected, winter costs per lane mile tend to decrease as the statewide average winter severity decreases. Annual increases in labor rates and salt pricing also affect overall winter maintenance cost, even in less severe winters. This winter was less severe than last year and costs were slightly lower this year. Total salt expenditures decreased by 22 percent compared to the prior year. The cost for materials other than salt increased by 13 percent. Labor costs decreased 1 percent and equipment costs decreased by 13 percent. Salt continues to be the largest expenditure, accounting for 35 percent of all costs (see Figure 6).

Salt prices in Wisconsin increased 3.9 percent from last year, from $77.10 to $80.09 per ton. Despite this increase, WisDOT still pays less per ton of salt than a number of other snowy states across the country. Figure 7 shows historical salt prices for Wisconsin and for 14+ states nationwide.

Figure 5. 2020-2021 Winter Costs vs. 5-Year Average

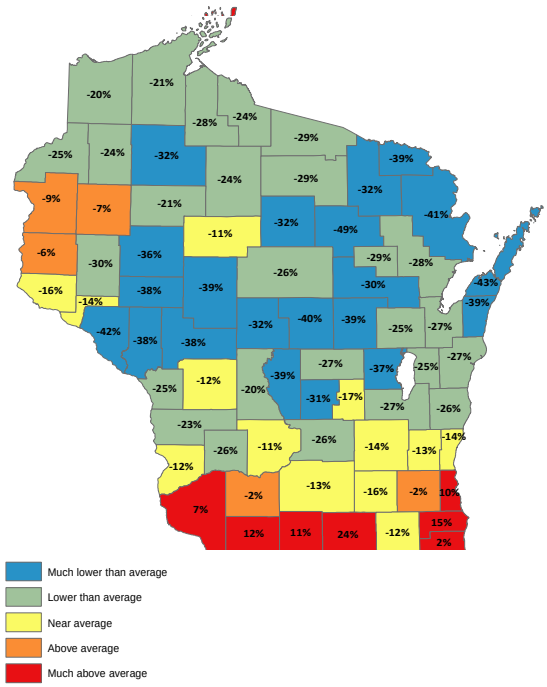


Figure 6. Expenditures by Category, 2020-2021

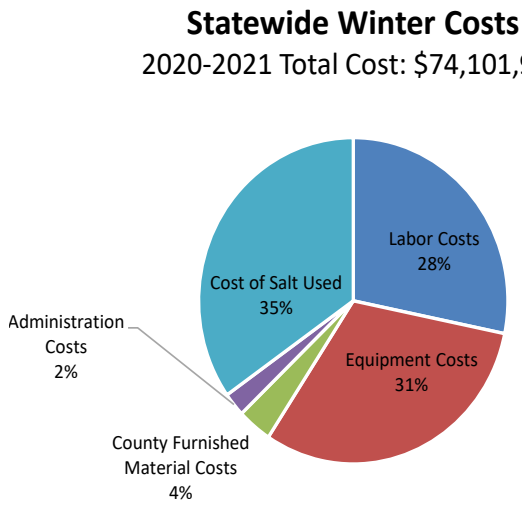
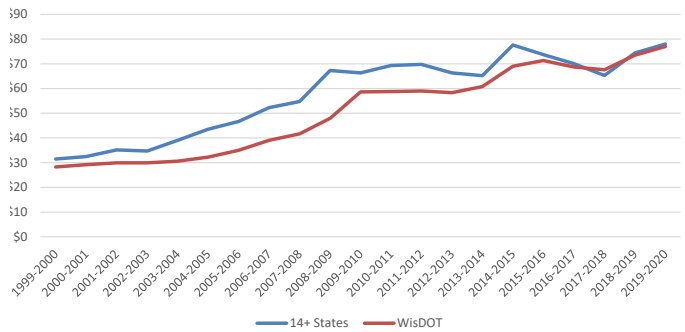


Figure 7. Salt Prices Over Time (through 2019-2020)

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 2020-2021 has not yet been released.



Coordinating Counties' Response

This winter WisDOT continued its emphasis on close communication between the counties and WisDOT regional staff. Before each event, regional staff worked with the counties to coordinate available materials, staffing and equipment, and regional staff assisted the counties in managing shifts for long events.

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. Winter storm reports are also used to compile data used in the annual report and other statewide performance measures.

Response Time

The counties continue to work on becoming more proactive in responding to winter storm events. Average response time this winter was 2 hours and 46 minutes. This is 4 minutes faster than 2019-2020. See Table 2 for reaction time by Winter Service Group. Winter Service Groups reflect the difference in the level of service provided on roads in these counties.

"Time to bare/wet pavement" is measured from a storm's reported end time until bare/wet is declared on the roadways. Heavily traveled urban highways tend to be returned to a bare/wet condition sooner than rural roads. WisDOT expects 24-hour roads to be clear within four hours of the end of the storm and 18-hour roads to be clear within six hours. This year, on average statewide, 67 percent of roads were to bare/wet pavement within the targeted time frame (see Table 3 on page 7).

Table 2. Maintenance Crew Reaction Time

	Avg. Reaction Time (hours)		10-year Average	Percent change
Winter Service Group	2019-2020	2020-2021	2010-2011 to 2019-2020	2019-2020 vs. 10-year avg.
A	1.01	0.23	0.75	-69%
B	1.26	1.30	1.74	-25%
C	2.24	2.66	2.74	-3%
D	2.90	3.02	3.28	-8%
E	4.29	4.39	4.72	-7%
F	5.27	5.04	5.90	-15%
Statewide average (unweighted)	2.83	2.77	3.17	-12%

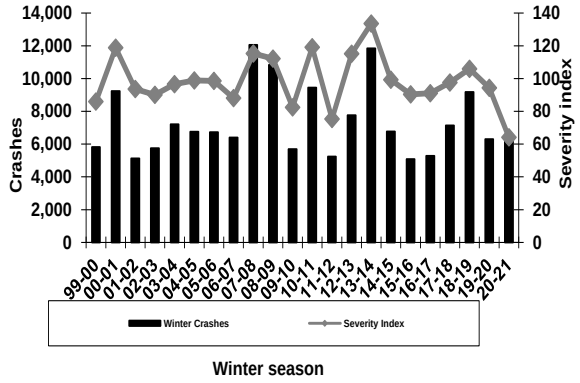
Analyzing Travel and Crashes

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 crashes. This year, there were 6,403 winter weather crashes (those that occurred on pavements covered with snow, slush or ice).

The statewide average crash rate (number of crashes per 100 million vehicle miles traveled) increased from 21 to 23, a 10 percent increase over the previous winter. Last year, 6,303 winter crashes were reported.

Crash rates tend to correlate with winter severity. This past winter broke that trend, but due to the unique situations caused by the COVID pandemic, there are a lot of variables that could have attributed to this. For example, as traffic volumes were down the more severe crashes could have went up because traffic speeds were increased. Figure 8 shows the trends in total crashes statewide over the last 20 years overlaid with the Winter Severity Index.

Figure 8. Crashes and Winter Severity Index



Using 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. As indicated in Table 3, this winter was more costly than the previous three winters when adjusted for winter severity. This winter, the success rate of getting to bare/wet pavement within 4 or 6 hours of the end of a storm decreased from last year and the total number of winter weather crashes increased.

Table 3. Statewide Winter Performance Measures for Winter

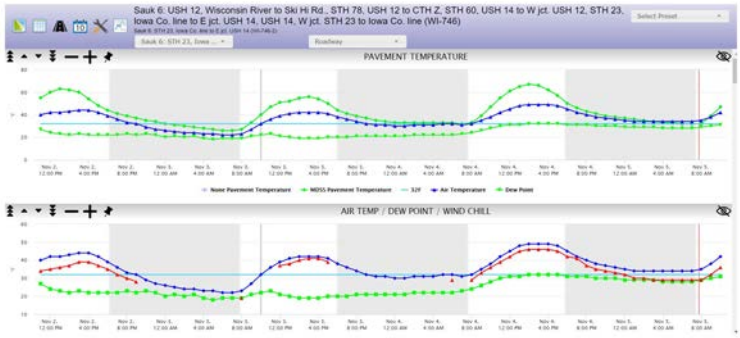
	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Percentage of roads to bare/wet pavement (Within WisDOT target times)	70%	66%	69%	72%	67%
Cost per lane mile	$2,537	$2,821	$3,212	$2,428	$2,107
Winter Severity Index	91.14	97.53	105.7	94.3	64.1
Cost per lane mile per Winter Severity Index point	$27.85	$28.93	$30.39	$25.28	$31.09
Winter weather crashes	18 per 100 million VMT	24 per 100 million VMT	30 per 100 million VMT	21 per 100 million VMT	23 per 100 million VMT

MDSS and AVL-GPS Initiative

MDSS (Maintenance Decision Support System) is a major project undertaken by WisDOT that began in 2009. Highlights from 2020-2021 include:

CONFIGURATION. In 2019-20, WisDOT upgraded all tracking routes to forecast routes. This continued in 2021 with the following:

- The effort to convert all routes to a GIS format is nearly complete. The WisDOT BHM entered them route-by-route and made sure the metadata was correct for each one. They developed methods to merge the data with WisDOT traffic and pavement databases. The file has been sent to DTN, with planned implementation prior to the coming winter. This shapefile can have a multitude of uses for the entire winter maintenance community.



When integrated with AVL/GPS (Automated Vehicle Location-Global Positioning System) equipment, the MDSS system can show past applications and future treatments as well as actual precipitation amounts and predicted snowfall, with probabilities.

MONITORING. Monitoring system use has become nearly impossible. A new system put in place by DTN cannot handle Wisconsin's configuration. The new system is able to monitor most states' use because all users have state e-mail addresses, but it is unable to handle Wisconsin's since each county has a different domain name. DTN continues to study this issue.

COORDINATION. WisDOT attended two virtual MDSS Pooled Fund Study Technical Panel meetings. We interacted with other pooled fund members to elicit ideas that would help WisDOT. We provided two presentations on WisDOT's experience implementing MDSS and its work with the management tools and GIS route configuration. BHM worked with DTN to resolve any issues that arose and to better understand the workings of the system.

Looking Ahead

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 2020-2021 winter season, 46 out of 72 counties improved their salt use based on those calculations. It was also estimated that the state as a whole saved $3.2 million due to the use of liquids that improve the efficiency of rock salt use.

WisDOT will also continue with a Brine Technical Advisory Committee, which bring WisDOT staff and county staff together to discuss brine liquid use and learn from successes and failures. Due in part to this education effort, liquid brine use went from 2.5 million gallons of brine just a few years ago to nearly 11.6 million gallons this past winter.

This past winter WisDOT contracted with the University of Wisconsin Madison Traffic Operations and Safety (TOPS) Laboratory to study the use of brine liquid vs. rock salt. Items being studied include cost comparisons, effectiveness in getting to bare/wet pavement, and friction coefficients during and after a storm. UW TOPS lab is working with 10+ counties that are high brine users to gather this data. The report from UW TOPS lab should be completed by early 2022. In addition, the UW TOPS Lab also has a contract with the Clear Roads Technical Advisory Committee led by WisDOT to look at nationwide analysis of brine application rates and recipes for all winter weather conditions. This will allow for synergy between WisDOT's efforts and those occurring at a national level.

WisDOT will continue to explore other methods of reducing rock salt usage on the state highway system. Through our county partnerships we will continue to implement route optimization, which has proven to enhance efficiency. 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.

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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