

Michigan DOT's Direct Liquid Application (DLA) Pilot

2025 Michigan Winter Operations Conference

October 21st, 2025

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MDOT Maintenance Section Engineer

[Act 51 of 1951 Use of Agricultural Additives Pilot Program](#)

Michigan Public Act 310 of 2020 (PA 310)

- Study liquid only plow routes...aka *Direct Liquid application (DLA)*
- Examine results from expanded use of Agricultural Byproducts (ABP) (inc liquid sugar beet by products)
- Pilot in at least three (3) test locations
 - Collaborate with at least one (1) local road agency
- Review Environmental and Fiscal Impacts
- MDOT to provide report by June 2025



Historical Liquid Use



Salt Bounce and Scatter Studies

Maintenance Advisory

MA 2013-01
August 27, 2013

From Mark Geib, Engineer of Operations Field Services Division

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this advisory should
be directed to:

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Best Practices for Applying Deicing Materials

Due to increasing costs and growing environmental concerns regarding the use of deicing materials for winter maintenance operations, it is critical we do everything possible to reduce the use of these materials, while still providing adequate levels of service. A major component of reducing the amount of deicing material required is conducting operations in ways that limit the amount of material that bounces and scatters off the roadway during application. The 2012 MDOT Salt Bounce and Scatter Study concluded that using pre-wet salt and applying deicing materials at slower speeds significantly increases the amount of material that stays on the roadway. Incorporating these practices into MDOT's winter operations program will ensure that as much deicing material as possible remains on the roadway and within the target area (4' on either side of the centerline), where it is most effective.

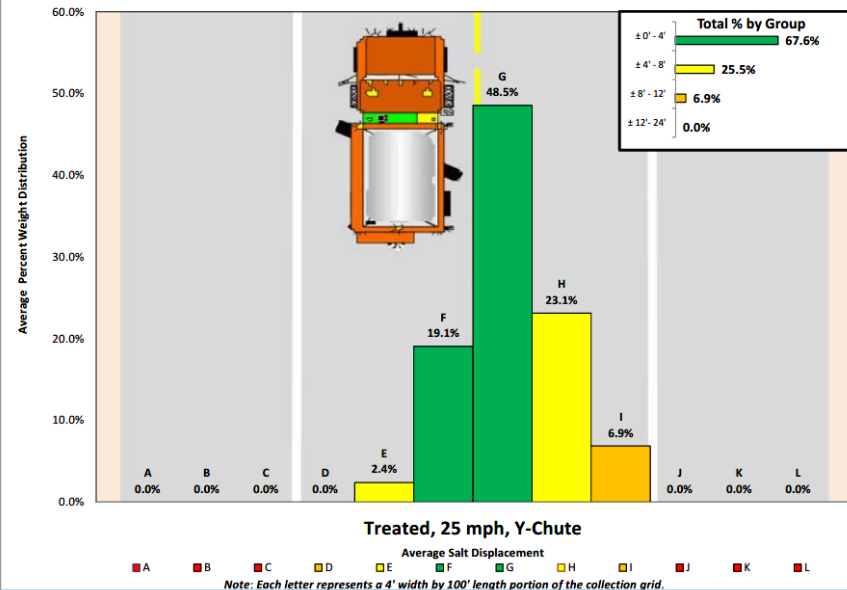
In order to keep the most deicing material on the roadway during the application process, the following guidelines should be followed (for all MDOT maintenance facilities beginning with the 2013/2014 season):

1. The truck's speed should operate be applying deicing material. Every effort should be made to operate as slow a speed as possible while applying deicing material. Justified exceptions to this practice may include:
 - Peak hours on high-speed roads
 - Trucks equipped with technology that allows for zero-velocity spreaders, slurry generators, etc. Results from the 2013 MDOT Salt Bounce and Scatter Study show that these advanced systems should not be used at speeds greater than 15 mph
 - Other circumstances approved by the

2. All salt applied to a roadway should be pre-wet with a liquid chloride product. Rates of pre-wetting should be between 7 to 10 gallons per ton of untreated salt (salt slurry will require more, per manufacturer's recommendations). Salt can be treated at the stockpile, by the truckload, or at the point of application on the truck.



Bounce and Scatter Collection Graphs



Wisconsin DOT Trip (Feb 2020)



Liquid Use Resources

- Materials: Liquid Materials - Clear Roads (clearroads.org)

Implementation of Liquid-Only Plow Routes (Full Video)



Pavement Temperature	Trend	Road Surface Condition	Liquid (gal/ln-mi)	Field Data Details		
			NaCl and CaCl ₂ 90/10 Blend	Storms	Locations	Agencies
20-25°F	Remaining in range	Light snow cover	20-45	4	3	Farmington Hills (MI), Minnesota (MN), and Shawano (WI)
15-20°F	Remaining in range	Light snow cover	40-60	4	3	Farmington Hills (MI), Outagamie (WI), and Shawano (WI)

Clear Roads Application Rate Guidance for Direct Liquid Application and Anti-Icing

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National Electric Ve...
NEVI (DB) - Home
Field Services - Ho...
Maintenance Servic...
Maintenance Servic...
Human Resources -...

CLEAR ROADS

research for winter highway maintenance

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Materials: Liquid Materials

Liquid materials are used for both anti-icing and deicing applications. Liquids have many benefits: They begin to work immediately, effectively stay on the road surface longer than dry materials, and they save money. After a snow or ice storm, Clear Roads helps to help with the implementation of liquid-only plow routes.

In-progress Clear Roads Research

None at this time.

Completed Clear Roads Research

- Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-Icing
- Training Video for the Implementation of Liquid-Only Plow Routes
- Understanding the Effectiveness of Non-Chloride Liquid Agricultural By-Products and Solid Complex Chloride/Mineral Products Used in Snow and Ice Control Operations
- Establishing Effective Salt and Anti-icing Application Rates
- Identifying the Parameters for Effective Implementation of Liquid-Only Plow Routes

BACK TO TOPICS

Specifications and Guidance

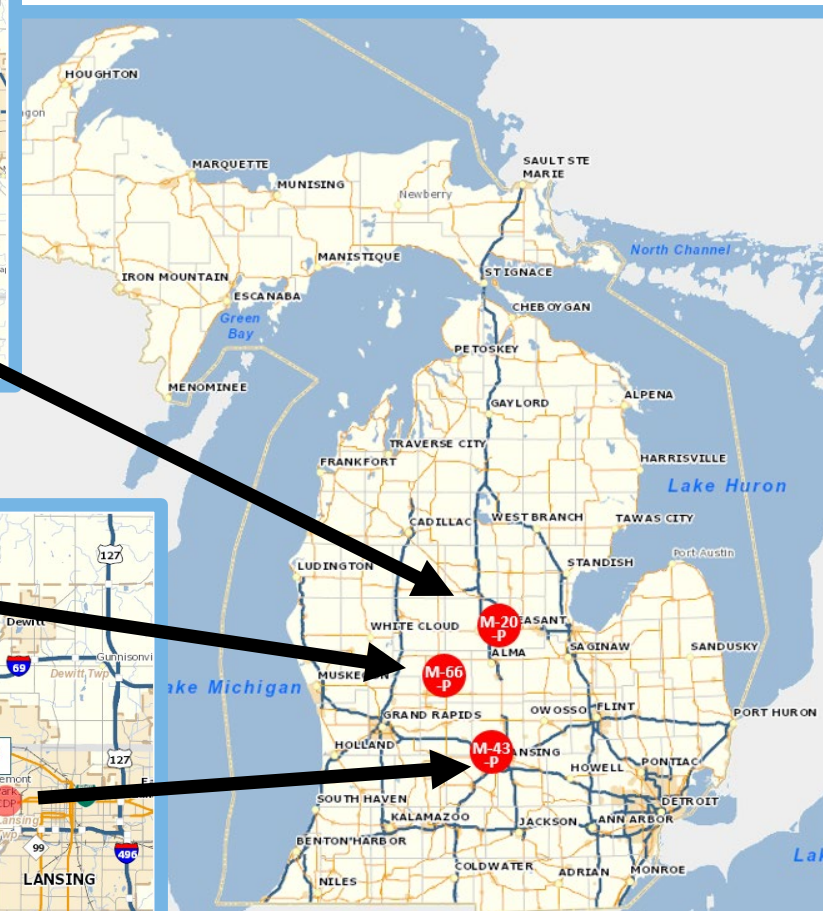
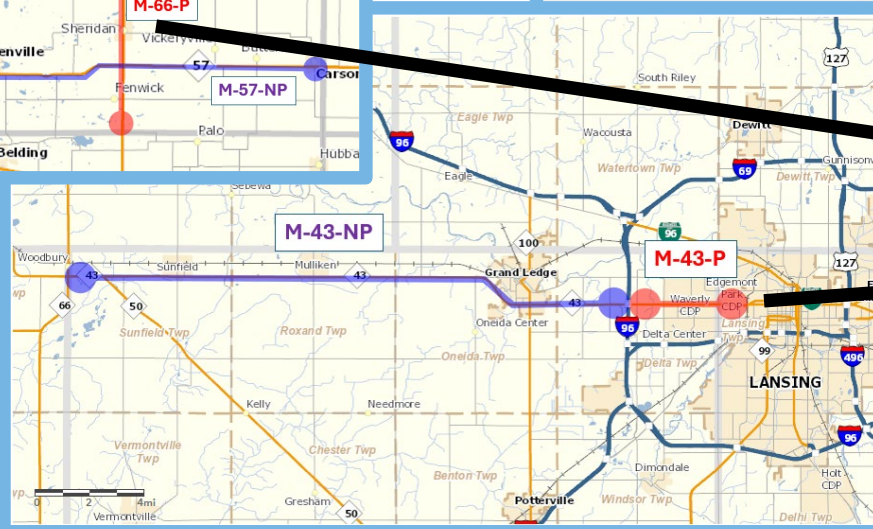
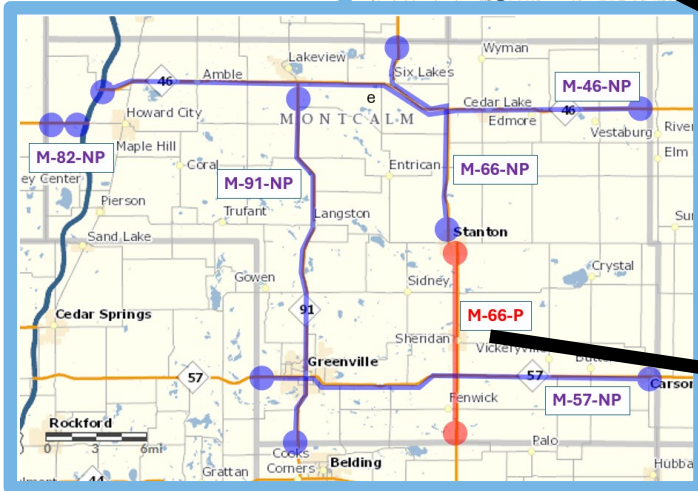
- Clear Roads Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-Icing
- Clear Roads Liquid Roadway Treatments Technical Reference Guide
- Clear Roads Liquid Roadway Treatments Start-Up Reference Guide
- Clear Roads Material Application Methodologies Guidebook

MDOT Tasks/Objectives for Pilot

- Pilot on three snow routes (1 local agency maintained)
- Equip Routes with Liquid Tank Trucks
- Procure Liquid Chlorides with Agricultural Byproducts (ABP) for Testing
- Ensure adequate liquid storage at each facility for their route
- Study *Direct Liquid application (DLA)*
 - *Liquid Mostly Routes (at times solids may be applied)*
- Review Environmental and Fiscal Impacts
- Record information over Five Winter seasons for final report to legislature by June 2025
- SAFETY is TOP PRIORITY! Strive for liquid routes to meet (or exceed) LOS from nearby rock salt routes)

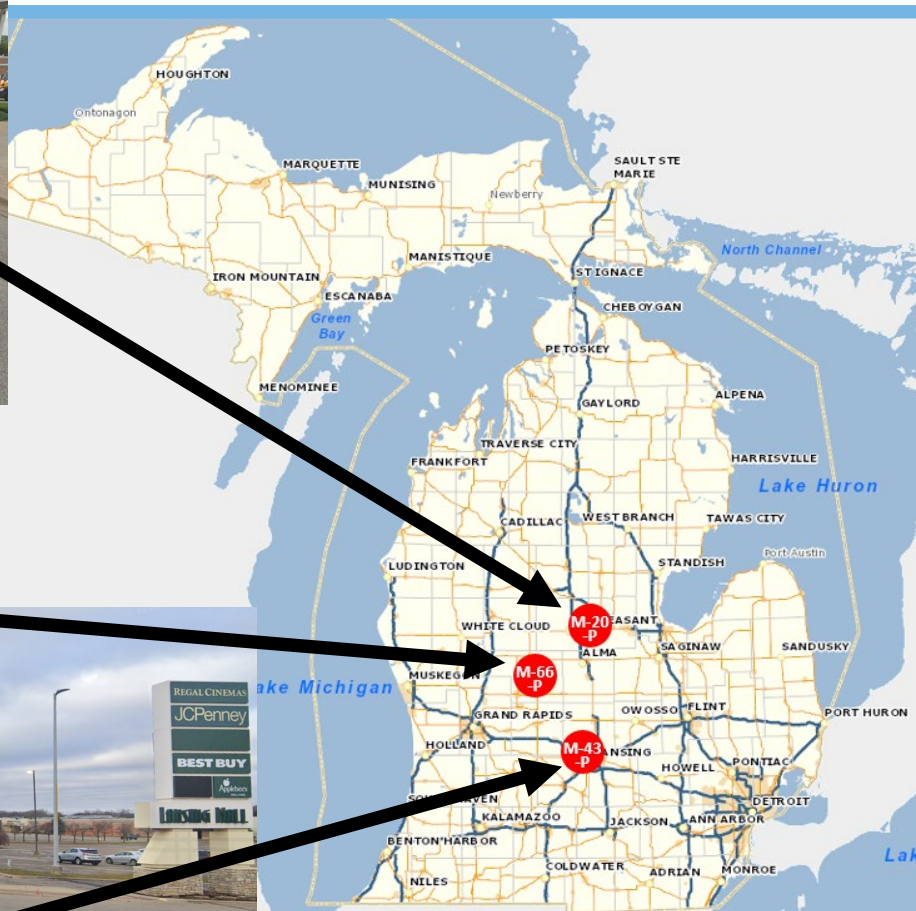
Pilot Routes

Route	Limits	Lane-Miles	Maintenance Provider
M-66	Ionia County line to City of Stanton	24	Montcalm County Road Commission
M-20	Summerton to Midland County line	30	MDOT Mt. Pleasant Garage
M-43	Canal to Rosemary	22	MDOT Grand Ledge Garage



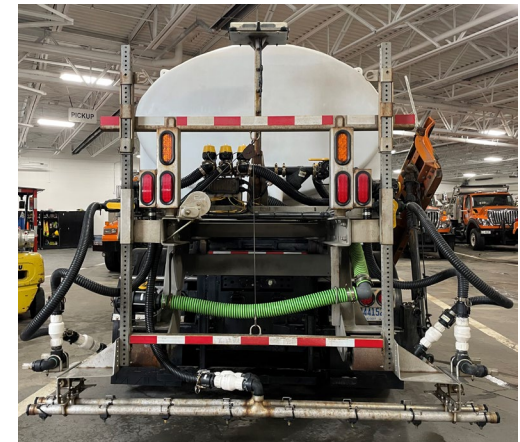
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Route	Limits	Lane-Miles	Maintenance Provider
M-66	Ionia County line to City of Stanton	24	Montcalm County Road Commission
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Equipment

<u>Route</u>	<u>Limits</u>	<u>Lane-Miles</u>	<u>Maintenance Provider</u>
M-66	Ionia County line to City of Stanton	24	Montcalm County Road Commission
M-20	Summerton to Midland County line	30	MDOT Mt. Pleasant Garage
M-43	Canal to Rosemary	22	MDOT Grand Ledge Garage



Liquid Materials

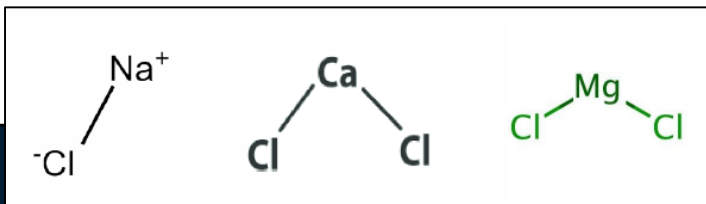
Considerations:

- Chloride Liquids (In solution) melt snow and ice
- Ag Byproducts (ABPs) help chlorides work at lower temperatures (*ABPs need a Chloride*)

Liquids Used: (1,131,000 total gallons of liquid applied over 5 seasons)

(FY25: 290K gal: FY24: 200K gal FY23: 290K gal; FY22: 282K gal FY21: 69K gal)

- Natural Occurring Calcium Chloride Mineral Well Brine (MWB)...No ABP



Liquid Materials

- Montcalm CRC (M-66) able to procure their own liquids
- MDOT set up contracts for its garages
- MWB least expensive (\$0.23), MWB+Corn ABP (\$0.55), Beet and Sugar Cane liquids (Over \$1.00)
- Garages tried blending or just MWB to reduce costs.

<u>5-year Liquid Pilot Application</u>	<u>Total Gallons</u>	<u>Liquid Ln-Mi</u>	<u>Avg Rate (Gal/Ln-Mi)</u>	<u>MWB</u>	<u>MWB +Corn ABP *</u>	<u>CaCL2 +Beet ABP **</u>	<u>MWB +Beet ABP ***</u>	<u>CaCL2 +Sugar Cane ABP ****</u>	<u>Rock Salt (ton)</u>
Total	1,132,147	20,112	56	698,236	315,157	9,964	98,457	10,013	808
Montcalm CRC (M-66)	429,215	8,182	52	325,537	93,714	9,964	0	0	20
Mount Pleasant Garage (M-20)	465,221	8,700	53	245,238	173,210	0	46,763	0	135
Grand Ledge Garage (M-43)	237,711	3,230	74	127,461	48,233	0	51,694	10,013	653

- *10% Corn, **15% Beet, ***5% Beet, ****5-20% SC

Facility Storage

- 40,000 – 50,000 gal storage required at each facility for their pilot route (filled as needed throughout a season).
- Montcalm had sufficient tank storage
- MDOT garages had some existing tank storage, but relied on rental tanks each season to ensure sufficient product on hand.



Data Reporting

<u>Garage:</u>		<u>DATE:</u>		2/22/2023
Mt. Pleasant		<u>TIME IN: (AM/PM)</u>		6:00 AM
<u>Truck #:</u>	04-4125	<u>TIME OUT: (AM/PM)</u>		2:00 PM
<u>ROUTE:</u>	M-20	<u>LANE MILES:</u>		30
<u>EMPLOYEE NAME:</u>		(Omitted)		
<u>AIR TEMP @ START:</u>		27	<u>AIR TEMP @ END:</u>	
ROAD TEMP @ START:		18	ROAD TEMP @ END:	
			20	
<u>TYPE OF PRECIPITATION OR INCIDENT: (CIRCLE ONE)</u>				
DRY	RAIN	FREEZING RAIN	SLEET	SNOW
<u>SNOW DEPTH:</u>		1-2"	<u>HARD PACK:</u>	
<u>DRIVING SURFACE CONDITION: (CIRCLE ONE)</u>				
WET	DRY	ICE	DRIFTING SNOW	SLIPPERY IN SPOTS
<u>LIQUID NAME:</u>		LIQ1: DIMP	LIQ2: Brine	LIQ3:
<u>LIQUID BLEND %:</u>		25%	75%	
<u>DE-ICE or ANTI-ICE (circle one)</u>			<u>TANK REFILL TIME (NA or total minutes)</u>	
<u>APPLICATION RATE PER MILE:</u>		<u>APPLICATION #1:</u>		60
		<u>APPLICATION #2:</u>		80
		<u>APPLICATION #3:</u>		
<u>TOTAL GALLONS APPLIED:</u>		2500		
<u>APPLICATION SPEED:</u>				
<u>Solid USED (tons)</u>		<u>SALT</u>	<u>GRIT</u>	
<u>NOTES:</u>		Treated slow and fast lane before the storm hoping snow would not stick to roadway. When the storm hit used 500 gal. Treated Leaton Rd. stop light and Michigan lefts.		

- Operator Log
- Summary Tacking Sheets
- Season End Reports and Observations
- Season Cost Reports for pilot route and local non-pilot routes

Feb 2022: Montcalm

Anti-Ice 2-8-22



Salt Route 2-3-22 9am 17 degrees



Liquid Route 2-3-22 9am 17 degrees



2-12-25: Mt Pleasant



Liquid Truck
Start of Event

Truck Tank
Fill-Up

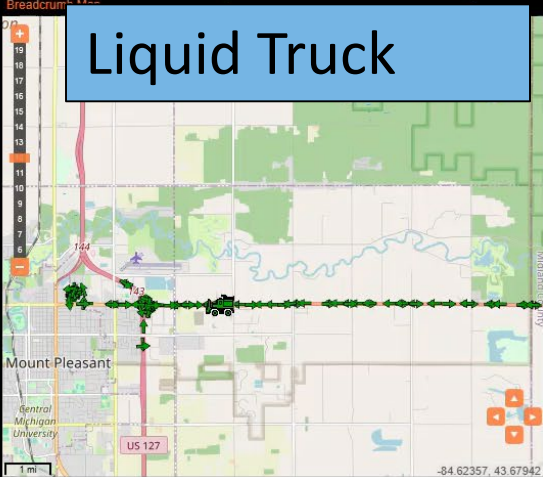


2-12-25: Mt Pleasant

04-4125

AVL History

Liquid Truck



AVL List:

Breadcrumb Date Range

Start: 2/12/2025 13:00

End: 2/12/2025 17:33

Find All Vehicles with Breadcrumbs

Status Field Selector

Air Temperature

Relative Humidity

Surface Temperature

RPM

Oil Pressure

Coolant Temperature

First Breadcrumb of selected vehicle(s)-2/12/2025, 1:00:14 PM

Last Breadcrumb of selected vehicle(s)-2/12/2025, 5:32:13 PM

Primary Vehicle

☒	Mt. Pleasant:04-4125	135 of 333	29.2 mph	90°
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Actual Solid Rate: 0 lb/mi

Selected Liquid Material: unknown

Liquid Rate: Unknown

Current Solid Material: DSALT

Current Liquid Material: unknown

Air Temperature: -97.96°F

Surface Temperature: -97.96°F

Additional Vehicles (select max of 6)

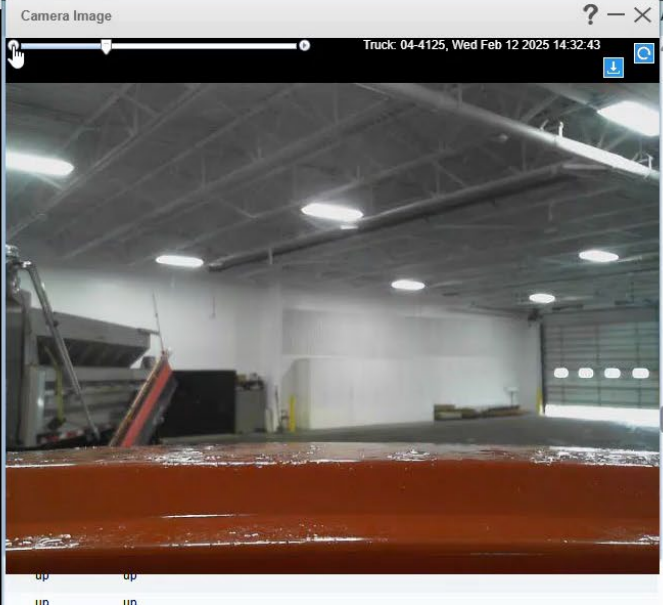
☐	Marshall:04-4220	n/a	0 mph	0°
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Stop Playback

Wed Feb 12 2025 14:46:14 GMT-0500 (Eastern Standard Time)

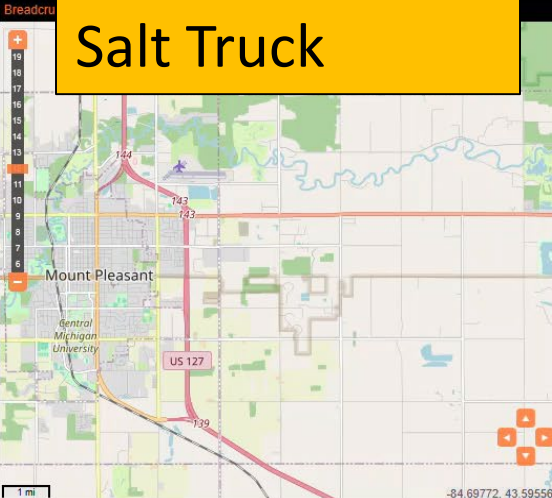
Camera Image

Truck: 04-4125, Wed Feb 12 2025 14:32:43



Breadcrumb

Salt Truck



Breadcrumb Date Range

Start: 2/12/2025 14:30

End: 2/12/2025 17:45

Find All Vehicles with Breadcrumbs

Status Field Selector

Air Temperature

Relative Humidity

Surface Temperature

RPM

Oil Pressure

Coolant Temperature

First Breadcrumb of selected vehicle(s)-2/12/2025, 2:33:30 PM

Last Breadcrumb of selected vehicle(s)-2/12/2025, 5:44:35 PM

Primary Vehicle

☒	Mt. Pleasant:04-4182	0 of 386	0 mph	0°
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Selected Solid Material: unknown

Actual Solid Rate: 0 lb/mi

Current Solid Material: DSALT

Air Temperature: 36.14°F

Surface Temperature: 36.14°F

Additional Vehicles (select max of 6)

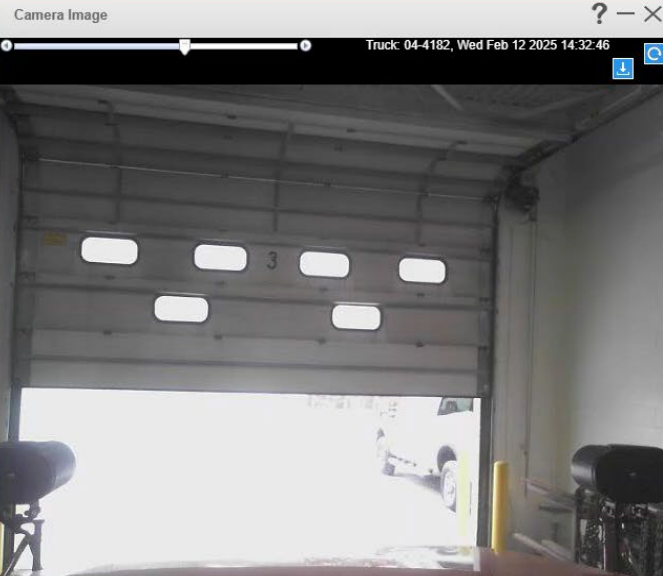
☐	Marshall:04-4220	n/a	0 mph	0°
☐	Plainwell:04-4156	n/a	0 mph	0°
☐	Saginaw Westside:04-4106	n/a	0 mph	0°

Start Playback

Wed Feb 12 2025 14:31:30 GMT-0500 (Eastern Standard Time)

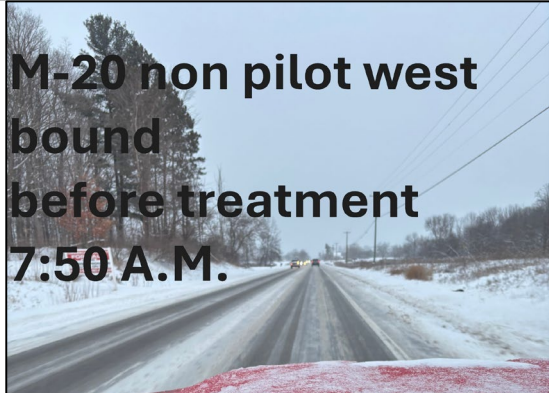
Camera Image

Truck: 04-4182, Wed Feb 12 2025 14:32:46

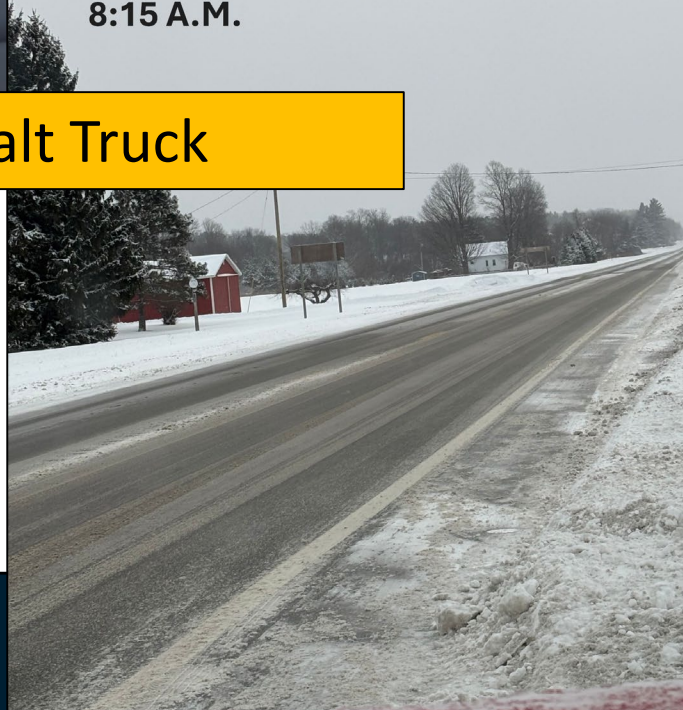


2-13-25: Mt Pleasant

**M-20 non pilot west
bound
before treatment
7:50 A.M.**



**M-20 Non Pilot Route East bound
40 min. after treatment
300 Lbs per 2 lane miles
8:15 A.M.**

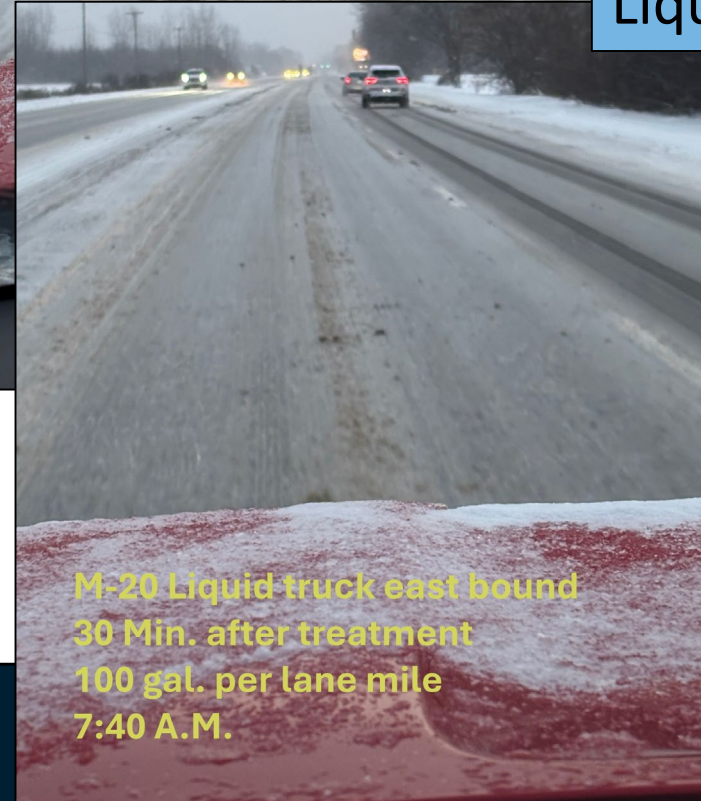


Salt Truck

**Liquid pilot West bound
before treatment
7:20 A.M.**



Liquid Truck



**M-20 Liquid truck east bound
30 Min. after treatment
100 gal. per lane mile
7:40 A.M.**

2-12-25: Grand Ledge

04-4174

AVL List

AVL History

Breadcrumb Map

Liquid Truck

Breadcrumb Date Range

Start: 2/12/2025 14:15

End: 2/12/2025 17:15

Find All Vehicles with Breadcrumbs

Status Field Selector

- Current Solid Material
- Current Liquid Material
- Air Temperature
- RPM
- Oil Pressure
- Coolant Temperature

First Breadcrumb of selected vehicle(s)-2/12/2025, 2:25:09 PM

Last Breadcrumb of selected vehicle(s)-2/12/2025, 5:14:33 PM

Primary Vehicle

Grand Ledge:04-4174	176 of 236	0 mph	1.3°
Selected Solid Material	unknown		
Actual Solid Rate	0 lb/mi		
Selected Liquid Material	unknown		
Liquid Rate	Unknown		
Current Solid Material	DSALT		
Current Liquid Material	CACL2		
Air Temperature	25.16°F		
Surface Temperature	29.12°F		

Camera Image

Truck: 04-4174, Wed Feb 12 2025 15:13:08

FILTERS

04-1611

AVL List

AVL History

Breadcrumb Map

Salt Truck

Breadcrumb Date Range

Start: 2/12/2025 14:30

End: 2/12/2025 17:23

Find All Vehicles with Breadcrumbs

Status Field Selector

- Left Plow
- Right Plow
- Pavement
- Target Liquid Rate
- RPM
- Oil Pressure
- Coolant Temperature

First Breadcrumb of selected vehicle(s)-2/12/2025, 2:30:06 PM

Last Breadcrumb of selected vehicle(s)-2/12/2025, 5:22:48 PM

Primary Vehicle

Grand Ledge:04-1611	136 of 236	34.8 mph	89.6°
Selected Solid Material	unknown		
Target Solid Rate	200 lb/mi		
Actual Solid Rate	71 lb/mi		
Current Solid Material	DSALT		
Air Temperature	Unknown		
Surface Temperature	Unknown		

Additional Vehicles (select max of 6)

Marshall:04-4220	n/a	0 mph	0°
Plainwell:04-4156	n/a	0 mph	0°

Stop Playback Wed Feb 12 2025 16:10:06 GMT-0500 (Eastern Standard Time)

Camera Image

Truck: 04-1611, Wed Feb 12 2025 15:14:31

up down up 0 lb/mi DSALT 25.2°F

down down up 344 lb/mi DSALT 25.2°F

up up up

2-18-22: Grand Ledge



Cost Comparisons

Table 5.3. Costs for 2022 Season

Route	Brine Pilot Cost (\$/lane-mile)	Non-Pilot Cost (\$/lane-mile)	Comparative Cost of Pilot to Non-Pilot (%)
Montcalm	959	2,412	60% lower
Mt. Pleasant	5,128	2,459	109% higher
Grand Ledge	2,896	1,382	110% higher

Table 5.5. Costs for 2023 Season

Route	Brine Pilot Cost (\$/lane-mile)	Non-Pilot Cost (\$/lane-mile)	Comparative Cost of Pilot to Non-Pilot (%)
Montcalm	3,359	2,734	23% higher
Mt. Pleasant	2,688	1,399	92% higher
Grand Ledge	2,634	2,371	11% higher

Table 5.7. Costs for 2024 Season

Route	Brine Pilot Cost (\$/lane-mile)	Non-Pilot Cost (\$/lane-mile)	Comparative Cost of Pilot to Non-Pilot (%)
Montcalm	1,812	2,574	30% lower
Mt. Pleasant	1,792	506	254% higher
Grand Ledge	2349	1295	81% higher

Table 5.9. Costs for 2025 Season

Route	Brine Pilot Cost (\$/lane-mile)	Non-Pilot Cost (\$/lane-mile)	Comparative Cost of Pilot to Non-Pilot (%)
Montcalm	\$2,236	\$3,316	33% lower
Mt. Pleasant	\$2,220	\$1,457	52% higher
Grand Ledge	\$3,190	\$1,204	165% higher

- DLA Route Lane Mile Costs Vs Salt Routes.
- Costs include Labor, Equipment and Materials
- Liquid Material Costs costs (ABPs Expensive)
- More Liquids may have been applied to ensure

Environmental Analysis

- Approximate gallons CaCl₂ as equivalent Tons of NaCl

- 2.7 lb. of CaCl₂ per 1 gallon of 26% CaCl₂ solution
- Pure rock salt (100% NaCl)
- 110.98 lb. of CaCl₂ contains 70.91 lb. of elemental chloride
- 58.44 lb. of NaCl contain 35.45 lb. of elemental chloride

$$1,000 \text{ gal. CaCl}_2 \text{ soln.} \times \frac{2.7 \text{ lb. CaCl}_2}{1 \text{ gal. CaCl}_2 \text{ soln.}} \times \frac{70.91 \text{ lb. Cl}}{110.98 \text{ lb. CaCl}_2} \times \frac{58.44 \text{ lb. Cl}}{35.45 \text{ lb. NaCl}} \times \frac{1 \text{ ton}}{2000 \text{ lb.}} = 1.42 \text{ tons solid NaCl}$$

- 1000 Gal CaCl₂ liquid ≈ 1.42 tons of NaCl Rock Salt

Table 5.11. Chemicals Applied in 2023 Season — Pilot versus Non-Pilot Routes

Location	Route	Route Lane Miles	Actual Liquid CaCl ₂ (gallons)	Liquid CaCl ₂ as equivalent rock salt (tons)	Actual rock salt applied (tons)	Total chloride impact (equivalent + actual, tons)	Chloride impact per lane mile (tons per mile)	Comparative impact of pilot to non-pilot
Montcalm	M-66-P	24	121,051	172	20	192	8.0	4% lower
Montcalm	(5) M-Routes	214.3			1781	1781	8.3	
Mt. Pleasant	M-20-P	30	109,500	156	22	178	5.9	21% higher
Mt. Pleasant	(2) M-Routes	90			441	441	4.9	
Grand Ledge	M-43-P	22	59,472	85	190	275	12.5	18% lower
Grand Ledge	M-43-NP	57			869	869	15.2	

Environmental Analysis

$$1,000 \text{ gal. CaCl}_2 \text{ soln.} \times \frac{2.7 \text{ lb. CaCl}_2}{1 \text{ gal. CaCl}_2 \text{ soln.}} \times \frac{70.91 \text{ lb. Cl}}{110.98 \text{ lb. CaCl}_2} \times \frac{58.44 \text{ lb. Cl}}{35.45 \text{ lb. NaCl}} \times \frac{1 \text{ ton}}{2000 \text{ lb.}} = 1.42 \text{ tons solid NaCl}$$

Table 5.12. Chemicals Applied in 2024 Season — Pilot versus Non-Pilot Routes

Location	Route	Route Lane Miles	Actual Liquid CaCl ₂ (gallons)	Liquid CaCl ₂ as equivalent rock salt (tons)	Actual rock salt applied (tons)	Total chloride impact (equivalent + actual, tons)	Chloride impact per lane mile (tons per mile)	Comparative impact of pilot to non-pilot
Montcalm	M-66-P	24	68,600	98	0	98	4.1	6% lower
Montcalm	(5) M-Routes	214.3			930	930	4.3	
Mt. Pleasant	M-20-P	30	93,100	132	54	186	6.2	4% higher
Mt. Pleasant	(2) M-Routes	90			539	539	6.0	
Grand Ledge	M-43-P	22	38,117	54	81	135	6.1	12% lower
Grand Ledge	M-43-NP	57			396	396	6.9	

Table 5.13. Chemicals Applied in 2025 Season — Pilot versus Non-Pilot Routes

Location	Route	Route Lane Miles	Actual Liquid CaCl ₂ (gallons)	Liquid CaCl ₂ as equivalent rock salt (tons)	Actual rock salt applied (tons)	Total chloride impact (equivalent + actual, tons)	Chloride impact per lane mile (tons per mile)	Comparative impact of pilot to non-pilot
Montcalm	M-66-P	24	89,778	128	3	131	5.4	21% lower
Montcalm	(5) M-Routes	214.3			1,481	1,481	6.9	
Mt. Pleasant	M-20-P	30	111,050	158	48	206	6.9	30% lower
Mt. Pleasant	(2) M-Routes	90			878	878	9.8	
Grand Ledge	M-43-P	22	88,772	126	73	199	9.1	49% lower
Grand Ledge	M-43-NP	57			1,009	1,009	17.7	

Environmental Analysis

Chloride Impact Trends 2023-2025

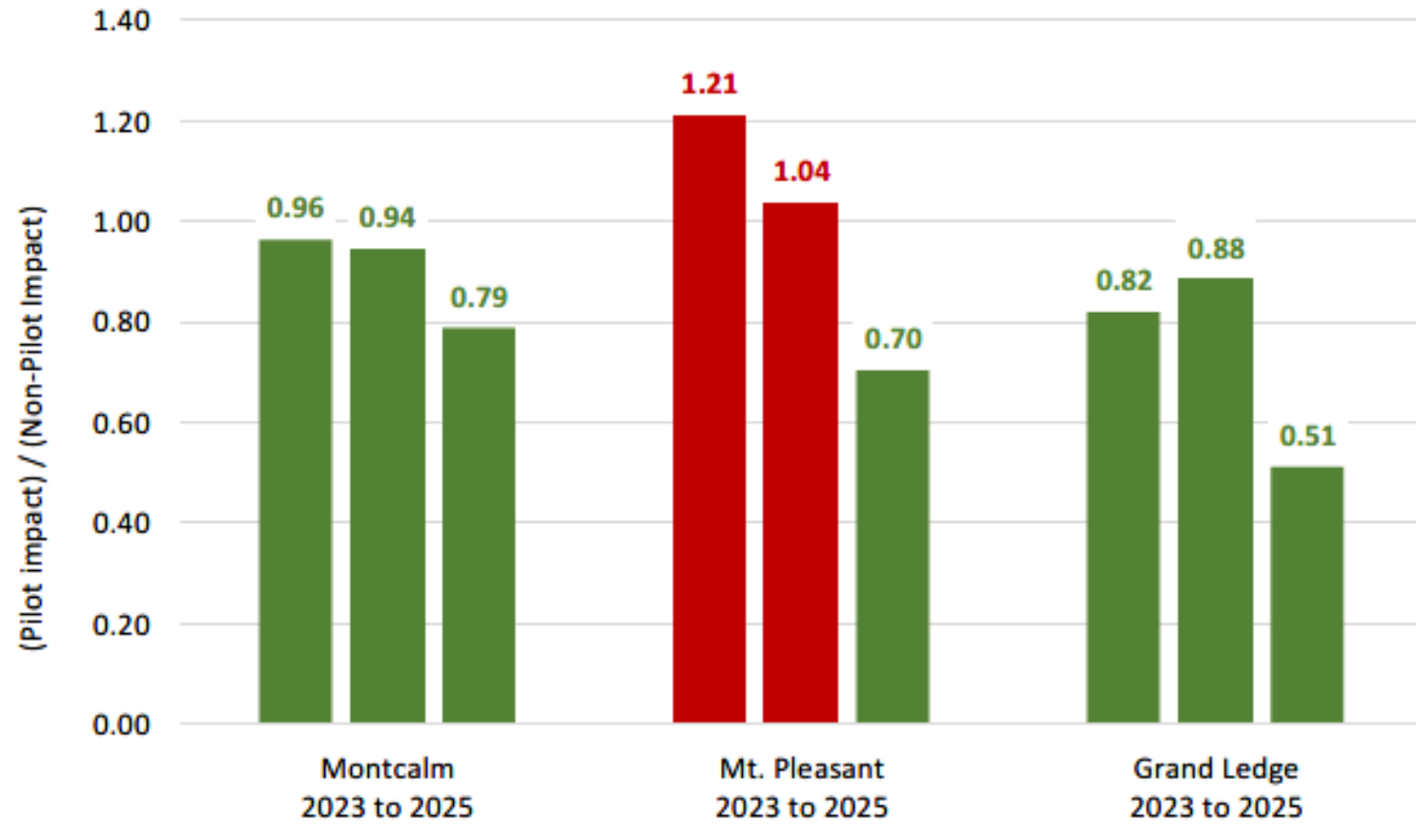


Figure 5.4. Comparison of Chloride Impact of Pilot Routes to Non-Pilot Routes by Location and Year

DLA Pilot Takeaways

- LOS can be met with DLA (*liquid mostly*)
- Liquids work fast, but not as long as salt
- ABP liquids best for anti-ice and colder temps
- ABP liquids more expensive than Salt
- Success with just MWB (no ABP)
- Success with blending MWB with ABP liquid
- Significant investment would be required to convert garage facilities and equipment to liquid mostly
- Environmental impacts of DLA were similar to Rock Salt routes
- Two pilot garages plan to continue liquid applications at their facility.



Thanks!!

Thanks

- Montcalm County Road Commission, MDOT Cadillac TSC, MDOT Grand Region.
- MDOT Mount Pleasant Garage, MDOT Mount Pleasant TSC, MDOT Bay Region.
- MDOT Grand Ledge Garage, MDOT Lansing TSC, MDOT University Region.



Final Report

Act 51 of 1951 Use of Agricultural Additives Pilot Program



Act 51 of 1951 Use of Agricultural



State of Michigan (.gov)

<https://www.michigan.gov> > Legislative-Reports PDF

Act 51 of 1951 Use of Agricultural Additives Pilot Program

Jun 30, 2025 – Substances made from **agricultural** byproducts. (ABPs) can be added to the salt chemicals to increase the salt's effectiveness in certain weather.

FY 2025 Appropriation Report

Public Act 51 of 1951

MCL 247.661a, Section 11a

(as amended by Public Act 310 of 2020)

247.661a Use of agricultural additives pilot program; report to legislature.

Sec. 11a.

(1) As provided in this section, the department must implement a pilot program on the use of agricultural additives to control ice on public roads, highways, and bridges in this state and to review the potential efficacy and environmental impacts of agricultural additives, while maintaining the safety and mobility of the motoring public.

(2) At a minimum, the pilot program described in subsection (1) must be designed to study liquid-only plow routes and must do all of the following:

(a) Identify and utilize methods for the use of agricultural additives, including, but not limited to, liquid sugar beet by-products, that promote surface adhering and reduce the freezing point of applied substances.

(b) Examine results from expanded use of agricultural additives, including, but not limited to, potential environmental and fiscal impacts.

(c) Develop best practices and technical guidelines for the use of agricultural additives, and for the expansion of the use of agricultural additives in the pilot program.