Maintenance Decision Support System
MDSS Concept

Generate a graphical tool that rapidly depicts in a simple format the state-of-the-art in road-weather condition prediction, especially as it relates to common maintenance activities. Coupled with the displayed road condition is a state-of-practice recommendation for maintenance, including expected outcomes for acceptance or user-selected alternative courses of action.
Decisions Supported by MDSS (1)

2.1 become aware of weather threat
2.2 monitor weather threat
2.3 identify weather threat occurrence

2.4 assess sufficiency of equip. & consumables
2.6 check readiness of equip. & consumables

2.10 assign minimum staff to monitor and manage
2.13 disseminate important weather info to field staff
2.14 forward-place equipment and stocks
2.16 alert supervisory staff to monitor/prepare
2.18 alert crews
Decisions Supported by MDSS (2)

2.21 select treatment expendables
2.5 replenish consumable stocks
2.7 mix expendables

2.11 select event-treatment strategy
2.17 confirm strategy-plan in place

2.12 assign crews to shifts, schedules
2.22 dress and load equipment
2.19 split crew shifts
2.25 dispatch crews to treat (anti-ice)
Decisions Supported by MDSS (3)

2.24 dispatch crews to wait at routes
2.27 dispatch crews to treat (plow/spread)
2.28 dispatch crews to treat (plow cake, de-ice)
2.30 dispatch crews to treat (ice-spot treat)
2.42 re-evaluate storm intensity and duration
2.44 determine the LOS goal is reached
2.39 close roads
2.40 monitor crew working time and conditions
Decisions Supported by MDSS (4)

2.29 dispatch crews to treat (bulk removal)
2.31 dispatch crews to treat (drifting)
2.47 dispatch crews to clean up

2.43 identify threat end
2.48 open roads
Road Condition

Function of Boundary Conditions which are:

- the air/weather column above the road surface
- the pavement/soil column below the road surface
- materials mechanically & naturally placed on the road
- traffic

MDSS Addressed Properties are:

- road temperature
- contaminates (snow, slush, frost)
- chemicals and sand
Station 10

Temperature (°C)

Fractional DOY

Road temp snow
Road temp no snow
Air temp

Rain
Snow
Chemical Concentration/Dilution

![Graph showing temperature in °F and °C vs. solution concentration (% by weight) for different chemicals: MgCl₂, NaCl, CaCl₂, CMA, and KAc.](image)
Chemical Concentration/Dilution

- Fully Saturated Solution
- Pavement Temperature

- Chemical Concentration/Dilution

- Rain
- Snow

- One time 400 lb/lane mi
- 100 lb/lane mi @ 3 hrs
- 250 lb/lane mi @ 6 hrs
- 400 lb/lane mi and 100 @ 3hrs
Contaminate Build-Up Over Course of Storm
Station #10

Snow/slush depth no treatment (in)
Mobility Index over Course of Storm
Station #20

Road Friction without treatment
Road-Weather Conditions Binned to Correspond with:

**Similar Mobility Indices**

**Snow Falling**

<table>
<thead>
<tr>
<th>Road</th>
<th>Air Temp</th>
<th>Light</th>
<th>Moderate</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;40</td>
<td>warm</td>
<td>0.5</td>
<td>0.45</td>
<td>0.4</td>
</tr>
<tr>
<td>39-33</td>
<td>warm</td>
<td>0.35</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>32-29</td>
<td>warm</td>
<td>0.25</td>
<td>0.35</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>cold</td>
<td>0.35</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>&lt;29</td>
<td>warm</td>
<td>0.35</td>
<td>0.35</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>cold</td>
<td>0.60</td>
<td>0.55</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Effect of Traffic: Moderate to heavy traffic will drop $\mu$ for $Tr <40$; will minimally impact $Tr >40$
Road-Weather Conditions Binned to Correspond with:

**Standard Treatment Prescriptions (Rules of Practice)**

<table>
<thead>
<tr>
<th>PAVEMENT TEMPERATURE RANGE, AND TREND</th>
<th>INITIAL OPERATION</th>
<th>SUBSEQUENT OPERATIONS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Above 0°C (32°F), dry or rising</strong></td>
<td>Dry, wet, slush, or light snow cover</td>
<td>None, see comments</td>
<td>None, see comments</td>
</tr>
<tr>
<td><strong>0° to 0°C (32°F), wet or slush</strong></td>
<td>Apply liquid or prewetted solid chemical</td>
<td>28 (100)</td>
<td>28 (100)</td>
</tr>
<tr>
<td><strong>-5° to -7°C (20 to 2°F), wet or slush</strong></td>
<td>Apply liquid or solid chemical</td>
<td>55 (200)</td>
<td>55 (200)</td>
</tr>
<tr>
<td><strong>-10° to -15°C (15 to 5°F), dry or falling</strong></td>
<td>Dry or light snow cover</td>
<td>Plow as needed</td>
<td>Plow as needed</td>
</tr>
</tbody>
</table>

**Chemical Applications:** (1) Time initial and subsequent chemical applications to prevent deteriorating conditions or development of packed and bonded snow. (2) Apply chemical ahead of traffic rush periods occurring during storm.

**Plowing:** If needed, plow before chemical applications so that excess snow, slush, or ice is removed and pavement is wet, slushy, or lightly snow covered when treated.
### Maine DOT Application Rate Matrix
*(Rules of Practice)*

<table>
<thead>
<tr>
<th>Current Pavement Temperature (F)</th>
<th>Anticipated Pavement Temperature Change</th>
<th>Precipitation Type* / Severity</th>
<th>Salt Application Rate ** (lbs per two-lane mile)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 32</td>
<td>Higher</td>
<td>R, SL, WS / Light</td>
<td>100 to 200</td>
<td>Use Pre-Wet System</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>R, SL, WS / Mod. - Heavy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 to 32</td>
<td>Higher</td>
<td>FR, SL, DS, WS / Light</td>
<td>200 to 300</td>
<td>Pre-Wet: 6 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Higher</td>
<td>FR, SL, DS, WS / Mod. – Heavy</td>
<td>200 to 300</td>
<td>Pre-Wet: 6 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>FR, SL, DS, WS / Light</td>
<td>200 to 400</td>
<td>Pre-Wet: 6 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>FR, SL, DS, WS / Mod. - Heavy</td>
<td>200 to 400</td>
<td></td>
</tr>
<tr>
<td>20 to 25</td>
<td>Higher</td>
<td>SL, DS, WS / Light</td>
<td>300 to 500</td>
<td>Pre-Wet: 8 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Higher</td>
<td>SL, DS, WS / Mod. – Heavy</td>
<td>300 to 500</td>
<td>Pre-Wet: 8 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>SL, DS, WS / Light</td>
<td>400 to 600</td>
<td>Pre-Wet: 8 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>SL, DS, WS / Mod. - Heavy</td>
<td>400 to 600</td>
<td></td>
</tr>
<tr>
<td>15 to 20</td>
<td>Higher</td>
<td>SL, DS / Light</td>
<td>500 to 700</td>
<td>Pre-Wet: 10 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Higher</td>
<td>SL, DS / Mod. – Heavy</td>
<td>500 to 700</td>
<td>Pre-Wet: 10 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>SL, DS / Light</td>
<td>700 to 800</td>
<td>Pre-Wet: 10 Gallons/Ton</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>SL, DS / Mod. - Heavy</td>
<td>700 to 800</td>
<td></td>
</tr>
<tr>
<td>15 or Below</td>
<td></td>
<td>No Salt. Apply Sand and Plow as Needed.</td>
<td>Monitor Pavement Temp. Switch to Salt if Rising Above 15F</td>
<td></td>
</tr>
</tbody>
</table>

*  R=Rain, FR=Freezing Rain, SL=Sleet, WS=Wet Snow, DS=Dry Snow

**  Initial application. Plow and re-apply salt at half-rate if surface becomes mealy or slushy, or full rate if glazed or packed.

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If snow is blowing off roadway and no hard-pack exists, do not apply chemicals or abrasives.

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Maine DOT Application Rate Matrix (Rules of Practice)
RWFS Weather & Environment

ROAD MODULES Calculate Road Condition

DECISION SUPPORT Determine Maintenance (recommended)

DOT INTERFACE Collect Maintenance (actual)

GUI Display Forecasts

Spatial & Temporal
Two-Day Decision Support Prediction

**Recommended Treatments**

Prediction Point #3

- **Precipitation Rate (SWE) (in/hr)**
- **Time (hrs)**

- **Midnight Tuesday**
- **Midnight Wednesday**
- **Midnight Thursday**

- **Chemical Application**
- **Plowing Effort**
- **Combined Action**

- **Mixed**
- **Rain**
- **Snow**

Combined Action
**What do I do?**

**When do I do it and how often?**

**What resources are required?**

**What if I do/don’t follow guidance?**

**What is the likely decision outcome?**

<table>
<thead>
<tr>
<th>Call @</th>
<th>Route</th>
<th>Segment</th>
<th>Driver</th>
<th>Truck ID</th>
<th>Dress &amp; Load</th>
<th>Treat. Start Time</th>
<th>Treat. Rate/TLM</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 pm Monday</td>
<td>A</td>
<td>2,3,4</td>
<td>Sam Salter</td>
<td>Mack X</td>
<td>midnight Mon/Tue NaCl, pw-8g. CaCl</td>
<td>3:15 am Tuesday</td>
<td>400 lbs</td>
</tr>
<tr>
<td>Notes:</td>
<td>Drive reverse route</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 9:00 pm Monday | C   | 8,9,10 | Polly Plowgirl | Mack Z   | 1:00 am Tuesday Sand (ballast) | 3:15 am Tuesday | Plow only |

| 9:00 pm Monday | B   | 6,7 | Gary Grippy | Mack Y Ford | 1:30 am Tuesday Sand; Seg. 7 NaCl; Seg. 6 | 3:30 am Tuesday | 1200 lbs |
| Notes: | | | | | | | 400 lbs |
What A Plan!