The Economics of Best Practice Implementation

Can a dollar saved equal a pound saved?

Laura Fay
Montana State University
Western Transportation Institute
Selling Environmental Stewardship

• Upgrading to newer technology
• Tight budgets = finding cost savings
  – Often costs savings = material savings
*We often sell best practices because they are cost savings measures, with the side benefit of reduced environmental impacts.
Winter Maintenance 101

Environment:
- Humidity
- Rate & Type of Precipitation
- Water Content of Snow
- Air Temperature
- Solar Radiation
- Wind Speed & Direction

Pavement:
- Temperature
- Type
- Texture
- Condition
Winter Maintenance Products, Application Rates, & Working Temps

- **Sand** – 100 to 1000 lbs/l·m (32°F and colder)
- **Salt/sand** – 400 to 1000 lbs/l·m (32 to 0°F)
- **NaCl** (32 to 15°F)
  - Solid – 100 to 800 lbs/l·m
  - Liquid – 10 to 40 gal/l·m
  - Pre-wet – 8 to 20 gal/l·m
- **MgCl₂** (32 to -5°F) and **CaCl₂** (32 to -15°F)
  - Solid – 100 to 500 lbs/l·m
  - Liquid – 10 to 40 gal/l·m
  - Pre-wet – 8 to 20 gal/l·m
- **Ag-based by products** – typically an additive
- **Corrosion inhibitors** – typically an additive
# Treatment recommendations

## Salt Application Rate Guidelines

### Prewetted salt @ 12’ side lane (assume 2-hr route)
<table>
<thead>
<tr>
<th>Surface Temperature</th>
<th>(Fahrenheit)</th>
<th>32-30</th>
<th>29-27</th>
<th>26-24</th>
<th>23-21</th>
<th>20-18</th>
<th>17-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Frost, Mist, Light Snow</td>
<td>50</td>
<td>75</td>
<td>95</td>
<td>120</td>
<td>140</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>Drizzle, Medium Snow ½” per hour</td>
<td>75</td>
<td>100</td>
<td>120</td>
<td>145</td>
<td>165</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Light Rain, Heavy Snow 1” per hour</td>
<td><strong>100</strong></td>
<td>140</td>
<td><strong>182</strong></td>
<td>250</td>
<td><strong>300</strong></td>
<td>350</td>
<td></td>
</tr>
</tbody>
</table>

### Prewetted salt @ 12’ wide lane (assume 3-hr route)

<table>
<thead>
<tr>
<th>Surface Temperature</th>
<th>(Fahrenheit)</th>
<th>32-30</th>
<th>29-27</th>
<th>26-24</th>
<th>23-21</th>
<th>20-18</th>
<th>17-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Frost, Mist, Light Snow</td>
<td>75</td>
<td>115</td>
<td>145</td>
<td>180</td>
<td>210</td>
<td>255</td>
<td></td>
</tr>
<tr>
<td>Drizzle, Medium Snow ½” per hour</td>
<td>115</td>
<td>150</td>
<td>180</td>
<td>220</td>
<td>250</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Light Rain, Heavy Snow 1” per hour</td>
<td>150</td>
<td>210</td>
<td><strong>275</strong></td>
<td>375</td>
<td>450</td>
<td>525</td>
<td></td>
</tr>
</tbody>
</table>

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From DeVries & Nixon (2015)

This versus this!

This versus this!
Salt Smart Principles

• Deliver the right type & amount of materials in the right location at the right time.
  – Improves -> effectiveness & efficiency
  – Reduces -> material usage, costs, environmental footprint.

The Triple Bottom Line
For WM = Balancing LOS versus sustainability.
Let’s jump into some examples
Prewetting

• The application of liquids to solids

• Benefits
  – Eases product management and distribution
  – Accelerates break-up of snow/ice and enhances melting, by going into solution quicker.
  – Minimizes bounce and scatter (by 26%)
  – Improves longevity on the road = less frequent applications
Prewetting

• Michigan DOT Salt Bounce and Scatter Study
• Speed Matters
  – 25mph -> 35 mph -> 45 mph
  – At 25 mph there is double the amount of salt in the lane when compared to driving at 35 mph.
  – Increasing speed to 45 mph, still loose salt but not as much as the increase from 25 mph to 35 mph.

# Prewetting

- Treated (prewet) salt scatters less than untreated salt!

<table>
<thead>
<tr>
<th>Total Percent Retained ± 8' (Green + Yellow)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>95.3%</td>
<td>Treated, 25 mph, Conveyor</td>
</tr>
<tr>
<td>93.1%</td>
<td>Treated, 25 mph, Y-Chute</td>
</tr>
<tr>
<td>87.2%</td>
<td>Untreated, 25 mph, Conveyor</td>
</tr>
<tr>
<td>78.3%</td>
<td>Untreated, 25 mph, Y-Chute</td>
</tr>
<tr>
<td>74.4%</td>
<td>Treated, 35, Conveyor</td>
</tr>
<tr>
<td>58.2%</td>
<td>Treated, 35 mph, Y-Chute</td>
</tr>
<tr>
<td>57.3%</td>
<td>Treated, 45, Conveyor</td>
</tr>
<tr>
<td>54.3%</td>
<td>Untreated, 35 mph, Y-Chute</td>
</tr>
<tr>
<td>53.0%</td>
<td>Untreated, 35 mph, Conveyor</td>
</tr>
<tr>
<td>44.4%</td>
<td>Untreated, 45 mph, Y-Chute</td>
</tr>
<tr>
<td>43.5%</td>
<td>Untreated, 45 mph, Y-Chute</td>
</tr>
<tr>
<td>35.7%</td>
<td>Treated, 45 mph, Y-Chute*</td>
</tr>
</tbody>
</table>
Prewetting

The Economics

• For Michigan DOT this means at $60 a ton of salt and a total road budget of $3.5M (2012 US dollars)
  – 25 mph treated – only lose $355,080
  – 25 mph untreated - $689,040
  – 35 mph treated - $1,247,400
  – 35 mph untreated - $1,878,360
  – 45 mph treated – $1,762,200
Michigan DOT takeaways

• Slow down (25 mph)
• Try pre-wetting
Slurry Spreaders

- High volume liquid anti-icer to dry salt (30%:70%) ~ 60-90 gal/ton
- 200 lb/l-m = ~ 9 gal
- Oatmeal consistency, salt grains fully saturated
- Material and cost savings (Maine DOT 2005)
  - Goes into action quicker, acts immediately, lasts longer on road, out-perform traditional pre-wetting methods, minimizes bounce and scatter.
- Maine DOT – saved 30% on salt (APWA 2006)
- New Jersey DOT – put 55 – 75% less on the road (APWA 2006)
**Prewetting Case Study**

<table>
<thead>
<tr>
<th>Consideration #1 - Ability to perform DLA with a spreader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Application DLA with slurry spreaders</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Lane Miles</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1 gallon of brine</td>
</tr>
<tr>
<td>40 gallons per MI</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td>Granular Application</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>250 lbs. per MI</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>SAVINGS per event:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>SALT Saved:</td>
</tr>
<tr>
<td>Dollars Saved:</td>
</tr>
</tbody>
</table>

(data from Marc Valenti – Lexington, MA)
# Prewetting Case Study

Consideration #2 - Reduction of salt consumption

<table>
<thead>
<tr>
<th>300 lbs/mi.</th>
<th>Slurry Spreader setting</th>
<th>225 lbs of salt</th>
<th>70% Granular</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 lbs</td>
<td>30% Liquid</td>
<td>17.1 lbs of salt**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>242.1 lbs per MI</td>
<td></td>
</tr>
<tr>
<td>FOR 300 LBS PER MILE, YOU ARE ONLY DISPENSING 242 LBS PER MILE!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>**Salt brine solution is 10 lbs. per gallon. 1 Gallon of Brine has 2.28 lbs of salt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57.9 LBS per lane mile savings of SALT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(data from Marc Valenti – Lexington, MA)
# Prewetting Case Study

<table>
<thead>
<tr>
<th>Consideration #3 - Return on Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$48,000 for a six wheel unit</td>
</tr>
<tr>
<td>Cost of Salt per Ton: $ 59.90</td>
</tr>
<tr>
<td>Savings per Application: 5790 lbs per LANE mile</td>
</tr>
<tr>
<td>Savings per Application: 2.895 tons per LANE mile</td>
</tr>
<tr>
<td>$ 173.41</td>
</tr>
<tr>
<td>Return on Investment: 277</td>
</tr>
<tr>
<td>Assume that you apply at least twice per event</td>
</tr>
<tr>
<td>Rate of Return on 2 Applications per event on 25 events per season: 6 YEARS</td>
</tr>
</tbody>
</table>

(data from Marc Valenti – Lexington, MA)
Marc’s parting thoughts:

1. It seems like a major capital expense to invest in a product/equipment, but based on the calculations, the ROI (return on investment) is 6 years over what they may have been spending with conservative numbers.

2. If they are applying more than 300 per mile; the ROI is less.
Anti-icing in Parking Lots

**Case Study:**
1.5” snow
15 degree GT
2 miles apart

<table>
<thead>
<tr>
<th></th>
<th>Retail Store 1</th>
<th>Retail Store 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• 250,000 sqft</td>
<td>• 243,200 sqft</td>
</tr>
<tr>
<td></td>
<td>• Pretreated with 28 gallons</td>
<td>No pretreat</td>
</tr>
<tr>
<td></td>
<td>• Post treated with 500lbs</td>
<td>Post treated 1.5 tons</td>
</tr>
</tbody>
</table>

That is $\frac{1}{4}$ of the amount used at Store 2!

(Data from Eric Hartmann)
Anti-icing in Parking Lots

Case Study:
1.5” snow
15 degree GT
2 miles apart

Retail Store 1 COST:
Salt - $17.5
Liquid - $7
Labor - $54
L/E/M = $78.50

Retail Store 2 COST:
Salt - $52.50
Liquid - $0
Labor - $72
L/E/M = $124.5

$124.50
-$78.50
$46.00

(Data from Eric Hartmann)
Anti-icing in Parking Lots

• Benefits noted by Eric Hartmann:
  – Applied liquid before snow plows arrived
  – Safer conditions at the start of the snow event
  – Save time plowing and less cleanup
  – Decreased the amount of chlorides applied = less in the environment = cost savings!
* 37% Cheaper!
Equipment Calibration

• Is a must
• Why:
  – to realize savings gained from investment in new technology
  – To know what you are putting out there
• Train how to calibrate & keep records
• When to calibrate:
  – When first acquired, points throughout a season, whenever a new material is used, after repairs, if there appears to be discrepancy in material usage
Equipment Calibration Case Study

$avings of $75,000 from calibrating in the first year.

1. Ask the driver where they set the knob (500-1200lbs/l-m)

2. Recommend an application rate (e.g., 250 lbs/l-m), test use once calibrated.

Changing the culture of the operators.

(from Mark DeVries)
The power of knowledge

- Using information to make informed decisions.

Benefits of measuring your data

- Improve your work
  - Make data-informed decisions

- Multiply Impact
  - Understand your community’s demographics, identify high need areas

- Accountability
  - Demonstrate your impact to members, donors, customers, board and prospects

- Better forecasts
  - Predict and analyze impacts of programming and fundraising

- Know what’s effective
  - Understand what is working and what isn’t working

The Salt Dashboard

Iowa DOT, Tina Greenfield

- An automated, web-based tool to help evaluate the amount of salt used on roadways during snow and/or ice events.
Salt dashboard

• Allocates salt to garages based:
  – Guidelines for salt application rates
  – Weather-related information (precipitation type, roadway temperatures, duration of a winter weather event)
  – Garage responsibility information (lane miles, level-of-service expectations)
• Creates a salt budget for each garage
• Targets are compared to actual salt use (as % of target used)
• Since started in 2012 salt use has been consistently below the 100% targeted amount.
Level of Service (LOS) - The type of metric used to determine how a road is maintained using winter maintenance practices.

• Commonly used LOS in winter maintenance operations:
  – When snow and ice control begins,
  – Cycle-time to complete one pass on a route,
  – Pavement condition achieved (e.g., bare pavement, clear wheel paths, etc.)
  – A road condition achieved within a specified time after the storm ends.
  – A specified travel speed is achieved,
  – Measured friction values are within an acceptable range.
Level of Service

• There is no universally accepted or established standard for winter maintenance LOS; but there are suggested guidelines.

• *Bare pavement, and bare pavement in the center of the roadway only are* the most commonly used LOS metrics for highways, primary and secondary arterials roads, based on survey responses.
Economics of LOS

• Minnesota DOT
  – Looking into “customer driven benchmarks” using focus groups and phone surveys
  – Found that customers were as comfortable with bare lanes as they were with bare wheel paths
    • Were able to change LOS benchmark to bare wheel paths
    • Easier to achieve to bare wheel paths than bare lane (less time, less money, less deicer!)

• Idaho Transportation Dept.
  – Focus groups and surveys were used to assess the driving publics satisfaction with LOS
  – Overall, satisfied therefore no changes to LOS were recommend.
    • Bare pavement within 4 hrs after end of storm
    • Work on educating the public on impacts of all winter maintenance products.
Wildlife habitat, control erosion, improve water quality, reduce spring-time flooding, sequester carbon.

- Reduce blowing and drifting snow
- Low cost snow storage
- Increased safety
- Reduce need for snow & ice control product
- 25 year lifespan at $1.40 per ft²
Snow Fencing – Iowa DOT

• Standing Corn Snow Fences
  – Leaving 8-12 rows of standing corn after harvest.
  – Landowner is paid for the corn, then harvest these rows in spring.

https://iowadot.gov/maintenance/pdf/snowfencebooklet.pdf
Creating a Culture of Change

• Road User Expectations
• Implementing existing knowledge
• Project champions
• Training
• Culture change, operational change
  – Long term system wide approaches
  – Using each success is a stepping stone
The Clear Roads research program brings together transportation professionals and researchers from around the country to drive innovation in the field of winter maintenance. By evaluating materials, equipment and methods in real-world conditions, the program identifies the most effective techniques and technologies to save agencies money, improve safety and increase efficiency.
Completed Research

14-01: Synthesis on GPS/AVL Equipment Used for Winter Maintenance (September 2016)
13-02: Understanding the Effectiveness of Non-Chloride Liquid Agricultural By-Products and Solid Complex Chloride/Mineral Products Used in Snow and Ice Control Operations (May 2016)
14-06: Use Of Equipment Lighting During Snowplow Operations (September 2015)
13-03: Cost-Benefit of Various Winter Maintenance Strategies (September 2015)
14-08: Weather Severity Mapping Enhancement (March 2015)
14-05: Snow Removal Performance Metrics (May 2017)
12-02: Establishing Effective Salt and Anti-icing Application Rates (February 2015)
Resources/References

- Salt Bounce and Scatter Study, Michigan DOT (2012)
  http://clearroads.org/project/14-10/
- Manual of Environmental Best Practices for Snow and Ice Control
- Strategies to Mitigate the Impacts of Chloride Roadway Deicers on the Natural Environment
  http://www.trb.org/Publications/Blurbs/169520.aspx
- Evaluation of the Schmidt-STRATOS Spreader, Maine DOT (2005)
- Highway User Expectations for ITD Winter Maintenance (2014)
It is never just one thing, it is always a combination of many!

-Mark DeVries
2019 Low Volume Road Conference

• Meet, share, and learn from your counterparts in foreign countries, across our country, and from federal and state land agencies on all things low volume roads (construction, maintenance, stabilization, safety, dust control, you name it, we’ll have it!)

• Kalispell, Montana

• September 15-18

• Papers/abstracts due November 30, 2018

http://www.ucprc.ucdavis.edu/LVR2019/