Agenda

• What is RWIS? What options are available?
• Innovation/Improvement in Winter Operations & Maintenance
• Key RWIS sensing parameters
• Data accessibility and utilization
• City of West Des Moines program summary
• Critical operational success factors
• Verification/Results
Weather Impact on Transportation

- **Safety**
  - 1.57± million weather-related crashes/year
    - 7,400 fatalities; 690,000 injuries
    - 24% of all crashes occurred on slick pavement or under adverse weather

- **Mobility**
  - Cost of congestion is $9.45 billion/year for the 85 major urban areas (weather causes ~25% of non-recurrent delay on highways)
    - 554 million vehicle-hours of delay per year from snow, ice, and fog

- **Productivity (economic)**
  - Weather related delay adds $3.4 billion to freight costs annually

- **Environment**
  - Chemicals affect watersheds
  - Air quality
  - Infrastructure
To Do Your Job Well You Must Know About...

- Staffing levels
- Equipment and material availability
- Staff and equipment effectiveness
- Outside influences (traffic/congestion)
- Weather and road conditions
Forward Thinkers!
City of WDM Efforts

• Technology Driven
• Engage Staff
• Challenges/Opportunities
• Not Afraid to Fail
Technology Tools

- Equipment
- RWIS/Pavement Sensors
- Traffic Network Cameras
- Deicer Blending System
- Automated Vehicle Location (AVL)
Remote weather Information Systems

Not just for State DOT’s anymore!
How to maximize your budget with RWIS deployments?

Use existing infrastructure for RWIS deployments
Municipal Alternatives - RWIS

• Lease/Data Only vs. Purchase
• Developed Contract
• Maintenance and Communications Included
• Data Shared with Weather Service
• Data Shared with Municipal stakeholders as needed
RWIS System Overview
Typical RWIS Site

- Wind Sensor: 33 feet
- Camera: Height based on required field of view
- Radiation Sensor: 10 feet
- Precipitation Sensor: 10 feet
- Temperature Dewpoint Sensor: 5.5 feet
- Visibility Sensor: 6.5-10 feet
- Snow Depth Sensor: 3.5 feet

Road Surface, Subsurface, Flooding, Water Level, and Precipitation Accumulation Sensors Located Away from the Tower, Pressure Sensor in RPU
City of WDM
RWIS Site

- Wind Speed/Wind Direction
- Non-invasive condition and temperature sensor
- Relative Humidity/Dew point and Precipitation Sensor
- RPU with cell modem communications
- Sub-Surface Temperature Sensor
NON INTRUSIVE PAVEMENT TEMPERATURE SENSOR – FIXED MOUNT (NIRS)
NIRS31 (non-invasive sensor)

Measured parameters:

- Surface conditions: Dry, Damp, Wet, Snow, Ice
- Waterfilm height, Snow height
- Ice percentage in water
- Freezing point, Surface temperature
- Friction coefficient

6 – 15 m

5 – 45°
Installation is Quick, Easy & Cost effective

- Existing structures such as Poles, Lamp columns and Overhead Structures can be used
- The remote installation means that there is no requirement to slot-cut the surface or close the road, so safer to install than embedded sensors
- Can be installed at anytime of the year, even if road surface is wet, icy or snow covered
- Technology advancements offer sustainable roadside ITS systems.
• No need to replace sensor when pavement is resurfaced

• Sensors are not prone to damage from snow chains, unlike traditional embedded sensors

• Less data downtime when sensors eventually require replacement

• Bridge decks do not have to be cut, therefore reducing the potential of premature wear on infrastructures.
North Dakota, MODOT
Salinity and Chemical vs. Friction

- Traditional roadway tools focus and rely on Salinity and Chemical detection.

- Traditional tools are chemical dependent.

- Traditional tools are intrusive based technology and have a high life cycle cost structure.

- New Technology offers lower life cycle cost structures, enhanced data sets with an innovative and simplistic maintenance philosophy shift.
Multiple chemical options with varied Freeze points

How much Chemical do you need?

300 lb. per lane mile?

300 lb. per lane mile with 0.05 inch water on the surface = 7.17% saturated solution

300 lb. per lane mile with 0.10 inch water on the surface = 3.62% saturated solution

Remember though 0.05 and 0.10 inches of water are only 0.5 and 1.0 inches of snow respectively.
When using Freeze Point, the decision point is many times not as simple as it could be.

Surface Temp 29°F (-1.6° C)  
Fp 28°F (-2.2° C)  
Chemically wet / wet & treated

Surface Temp 29°F (-1.6° C)  
Fp 30°F (-1.1° C)  
Chemically wet / wet & treated

Surface Temp 29°F (-1.6° C)  
Fp 32°F (0° C)  
Ice Warning

When this change will occur is not easy to tell.
Friction and chemical concentration

- Ice layer showing small amount of ICE – Friction 0.6
- As ice increases in density...Friction will fall – Friction<0.6
- Note this is independent of chemical
- Real measure of what is important to the driver

- There are multiple tools!

INDOT examples:

- INDOT has FP2000 and IRS31 roadway sensors to measure chemical concentrations
- IRS31 and NIRS31 roadway sensors also measure Friction
- INDOT has Mobile MARWIS Systems that report Roadway Friction
What do the grip/friction numbers mean?

- This is the point that traffic mobility is affected
- Above 0.6 usually wet (or dry) surface
- General ranges of grip
  - 0.60-.82 wet
  - 0.50-.60 slush or ice forming
  - 0.40-.50 snow pack or icy
  - Below .40 cars may start sliding off
  - .30 and lower multiple slide offs possible; mobility greatly affected

Goal: Monitor progress and quality of treatment through friction observations as events unfold
Data

- Grip (Pavement Friction)
- Pavement Temperature
- Relative Humidity
- Dew Point
- Air Temperature
- Roadway Imagery (Photos)

❖ (Real-time) Data Accessibility for all users with alerting functionality via iRWIS RoadDSS/Navigator (cloud based GUI) and iPad Tablet App.
How friction information can be used to maintain roads

- **Level of Service** - Operators receive real time friction data and use this to adjust their treatment of the road
- **Storm Management** - Friction data are collated to a central location and used to deploy assets to locations where friction levels are unacceptable
- **Application of materials** - real time friction values are used to adjust the application of materials directly from the truck
- **Operator Safety** - Real time friction values provide in-cab warnings to alert operators to presence of black ice
- **Early warning for Ice formation** - Patrol vehicles use friction to locate ice formation and call out trucks for de-icing
- **Litigation** - Archived friction values provide significant benefit when agencies are sued for accidents
- **Quality control** - Friction is used as an independent quality check of roadway conditions. Especially helpful when maintenance services are contracted out.
- **ITS Applications** - Friction values used to inform and advise the traveling public of road conditions with VMS signs or traffic signal control
- **Friction on chemically treated roadways** - In some circumstances liquid chemicals can give rise to slick surface conditions. Using friction devices would allow for improved guidelines for liquid chemical usage
- **FAST trigger** - As an efficient trigger for Fixed Automated Spray Technologies
Performance monitoring and reporting throughout whole chain of events

- Forecast accuracy
  - Complete “like for like” verification based upon difference between forecast grip and observed grip
  - Feedback will help to continuously improve forecast accuracy

- Contractor performance
  - Archive will show whether contractor operated as planned
  - Performance can be monitored by observed Grip levels
  - Targets can be based upon minimum expected level of Grip on any route
  - Performance based contracts can be easily measured
  - Data collected by weather stations and from data input into system

- Resource reporting
  - As all aspects of the winter program are recorded in one application resource management reports can be easily created
  - Winter index reports can be generated to assess spending levels
Mobile Road Weather Station (MARWIS)

- Installed on Supervisor/Patrol vehicles
- Measurements
  - Grip (Slipperiness)
  - Road state (Dry, Moist, Wet, Snow, Ice)
  - Layer thicknesses
  - Surface Temperature
  - Dew Point Temperature
  - Air temperature
  - Humidity
- In-vehicle system operation/calibration via smartphone or iPad
- Verification and Route based measurement inputs for operational decision making
Fixed and Mobile Temperature/Friction sensors
Benefits of Mobile Weather Observations

- Complements traditional fixed RWIS weather data
  - Fills in the gaps between the fixed stations
  - Identification of problematic sites
  - Data whenever and wherever you need it
- Tool for forecast verification
- Integrates into existing AVL systems, hydraulic control systems or telematics
- Indicates real-time condition of the road
- Tool for Key Performance Indicator monitoring
  - More consistent evaluation of the road state
  - No need to stop for collecting samples
  - No need to do braking for getting the results
  - Measurements can be done when driving in normal traffic flow
- Improves decision making through better information
Mobile RWIS Unit

- MARWIS – iPad - App
- Real time connection via bluetooth
Mapping of the Roadway Grip, Surface Temperature, and Surface Status
INDOT MARWIS Program

- Tool for public safety as well as DOT winter maintenance decision support/MDSS program
- Can be a great Social media tool to reach large segments of the population.
Freezing rain forecasted tonight. Crews are treating, but temps will be above freezing so minimal impact is expected indot.carsprogram.org
Storm Performance Index – WDM Next Steps

• What is it?
  – A numerical value – estimates winter maintenance performance
    • Data comes from RWIS sites
      – Algorithm uses Grip, Wind Speed, Surface Temperature, Water/Ice/Snow thickness
    • Lower numbers indicate better performance

  – A storm severity index is also calculated using empirical data
    • Severity = Wind + Snow + (300/Temperature)
    • Larger values indicate worse storms
RWIS Data and a tailored pavement forecast with consultation is the Key!

They have one job – watch the weather
Don’t Forget Training!

- Annual In-House Training
- IDEAS Program
- SPOT/Roadeo Training
- Regional Training Events
- APWA Certificate Program
Training
On-going, Routine Education Program

• Annual RWIS User Training promotes and supports utilization of RWIS as an Weather Responsive Traffic management tool.
  • How do I use all these tools together?

• Adoption of a regular training program ensures the RWIS, (Weather Data) is being used in harmony with processes to make effective and efficient decisions.

• Routine, Regional Training Workshops are a good catalyst for sustainable educational programs for any agency.

• Promotion of cross functional “best practices” between agency departments
City of WDM Approach

- Provide the Tools
- Train/Educate
- Verify
- Retrain if necessary
- Continue to Verify
Salt Usage vs. Accumulation

- 2005-2006: 25.5 tons
- 2006-2007: 35.9 tons
- 2007-2008: 50.25 tons
- 2008-2009: 40.35 tons
- 2009-2010: 66.25 tons
- 2010-2011: 36.96 tons
- 2011-2012: 21.5 tons
- 2012-2013: 43 tons
- 2013-2014: 45 tons

Accumulation in Inches:
- 2005-2006: 25.5 inches
- 2006-2007: 35.9 inches
- 2007-2008: 50.25 inches
- 2008-2009: 40.35 inches
- 2009-2010: 66.25 inches
- 2010-2011: 36.96 inches
- 2011-2012: 21.5 inches
- 2012-2013: 43 inches
- 2013-2014: 45 inches

Legend:
- Blue bar: Tons of Salt
- Blue line: Accumulation

Note: The chart compares the usage of salt with the accumulation of snow.
Salt Usage vs Roadway Growth

- **Tons per Event**
- **Lane Miles**

Data points for each year:

- **2005-2006**
- **2006-2007**
- **2007-2008**
- **2008-2009**
- **2009-2010**
- **2010-2011**
- **2011-2012**
- **2012-2013**
- **2013-2014**

Legend:

- Blue: Tons per event
- Red: Lane Miles
Complete Weather Decision Support Solution

**Building Blocks of Effective RWIS/ITS Solution Include**

- Strategically Located RWIS/ITS infrastructure in the Field

- Flexible, Accessible, Graphical User Interface that has aligned Maintenance and Specific ITS functionality and goals

- Knowledge to the Users through consultation and a routine and consistent training regiment.
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