**Weather and Traffic Innovations for Municipal RWIS/ITS Programs**

**2017 Purdue Road School**

# 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!
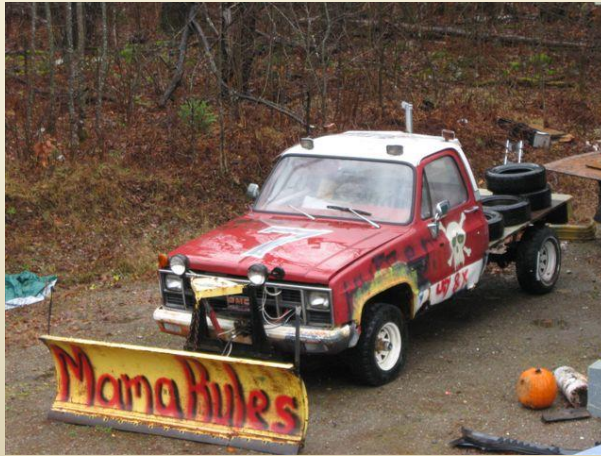
# City of WDM Efforts

- 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?



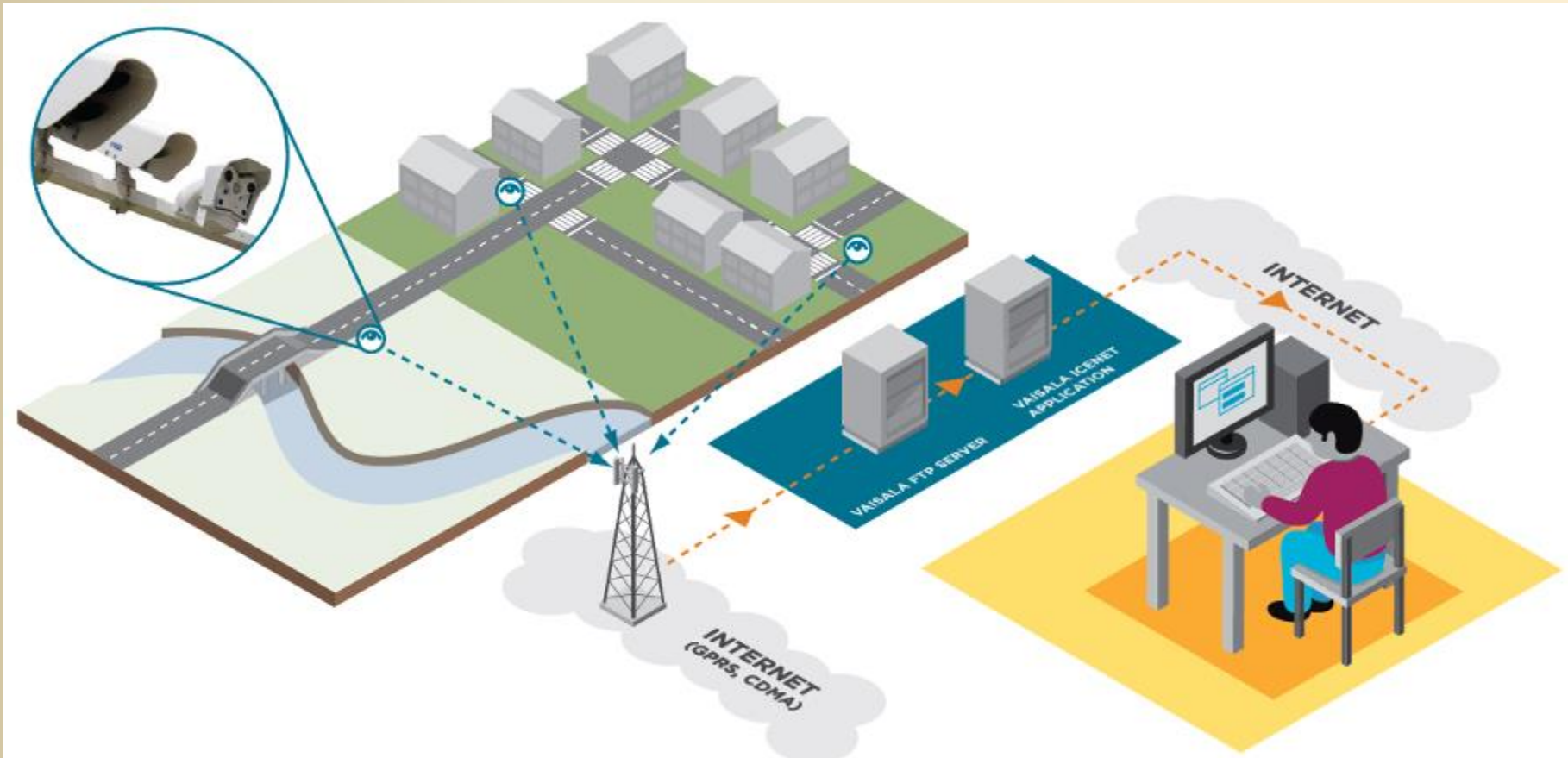Use existing infrastructure for RWIS deployments
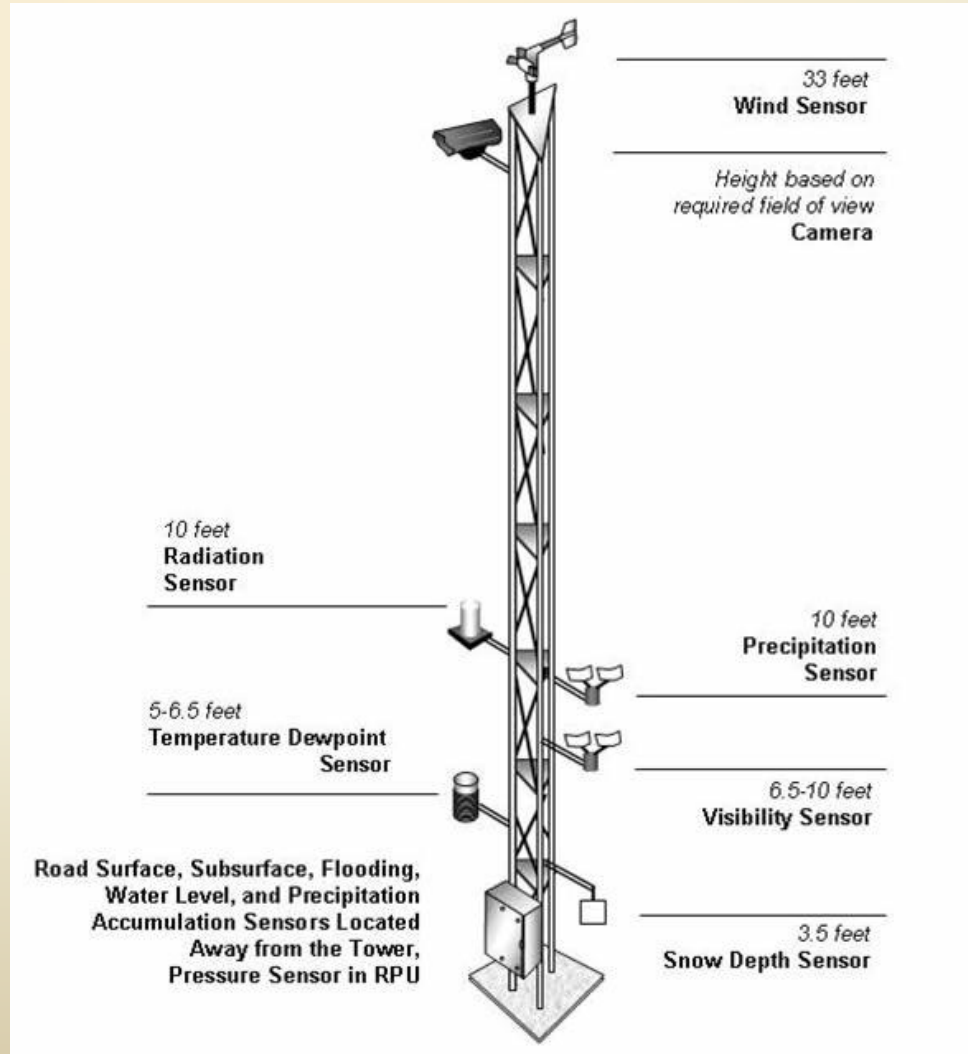
# Municipal Alternatives - RWIS

- 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

The Hoosier Co. Inc. – 5421 W. 86th Street, Indianapolis, IN 46268
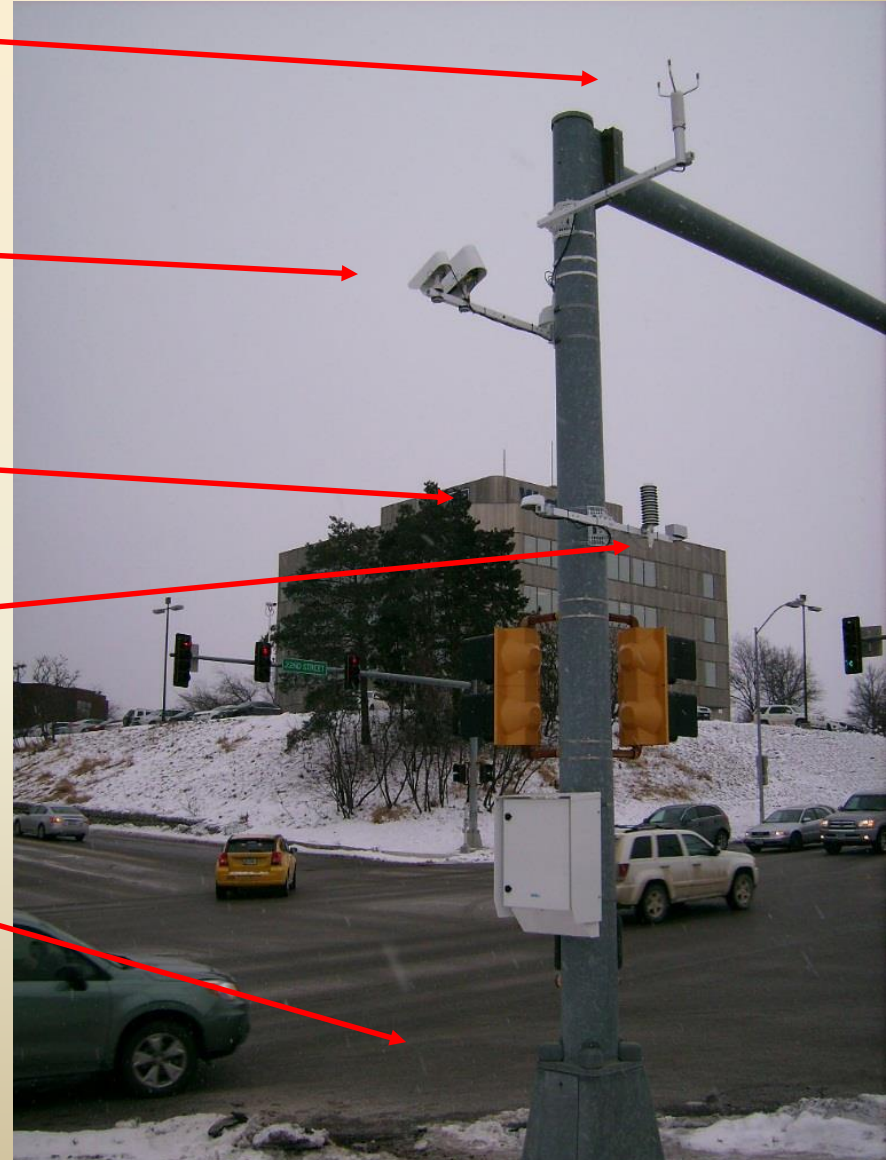
# City of WDM
# RWIS Site



Wind Speed/Wind Direction

Non-invasive condition
and temperature sensor

Relative Humidity/Dew point
and Precipitation Sensor

RPU with cell modem
communications
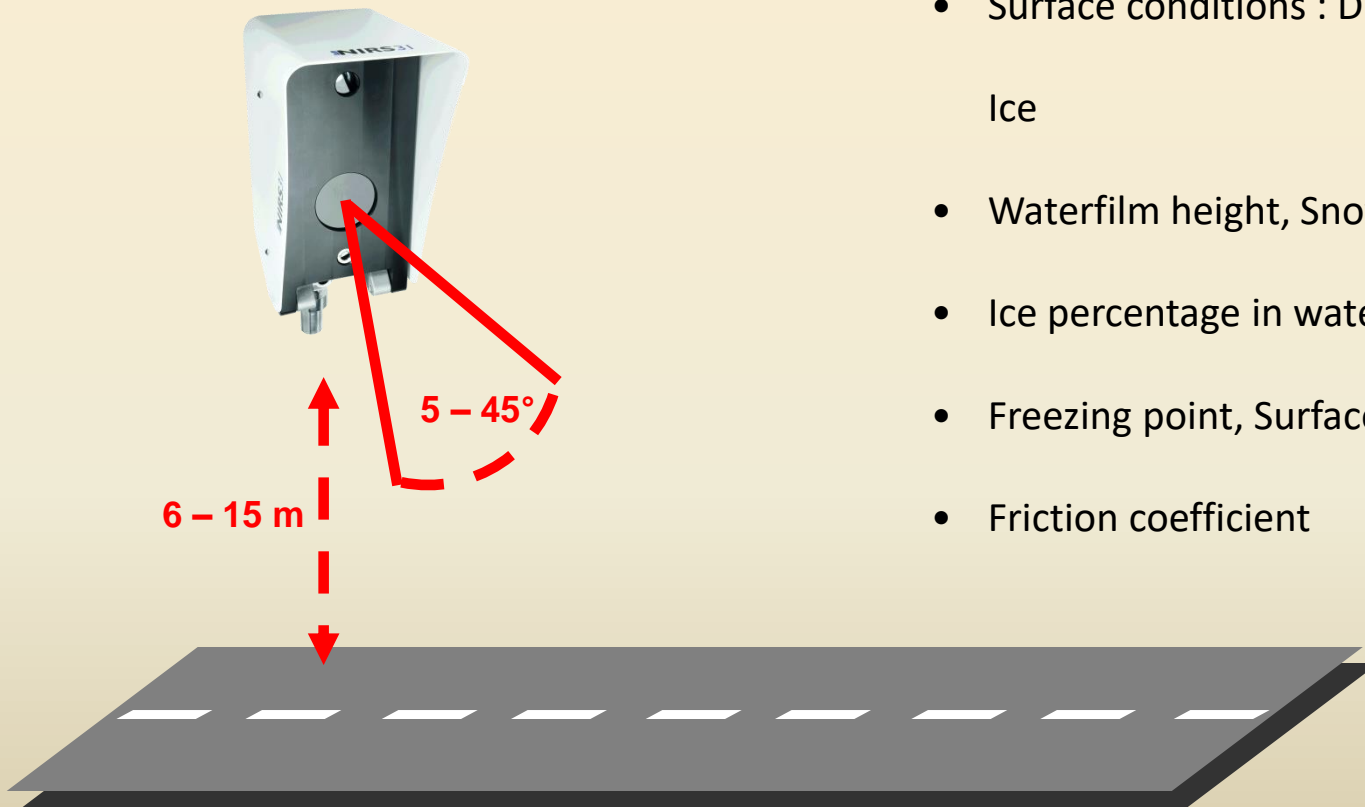
Sub-Surface Temperature
Sensor

# 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

5 – 45°

6 – 15 m

# 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.
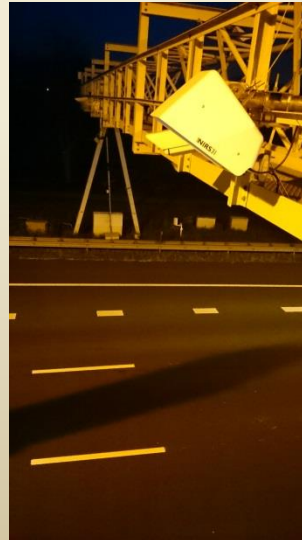
# North Dakota, MODOT
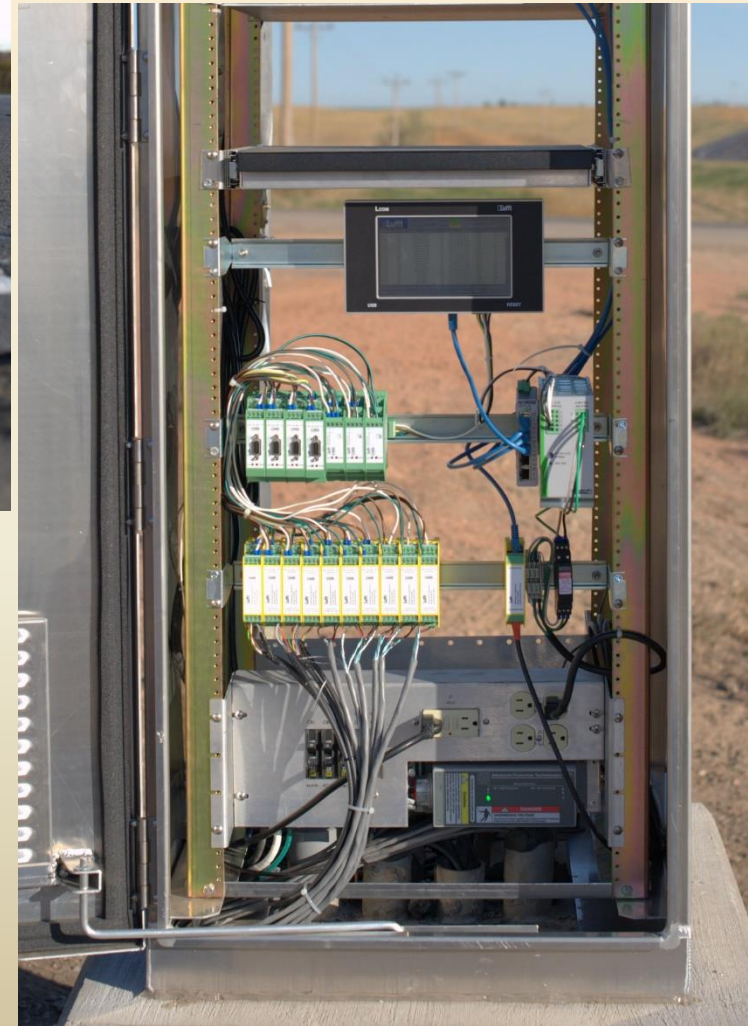
# Salinity and Chemical vs. Friction

- 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
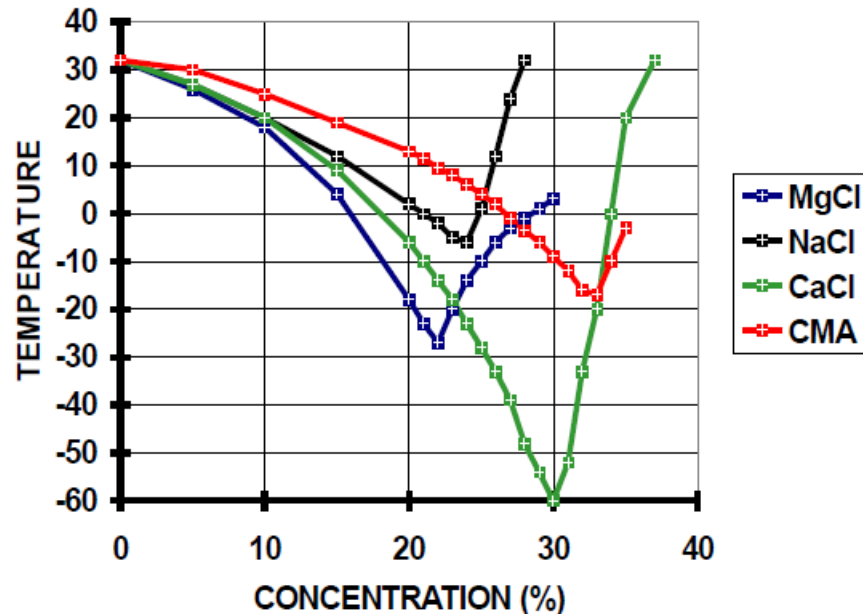


How much Chemical do you need?

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.

# Freeze Point – Decision Point

- 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
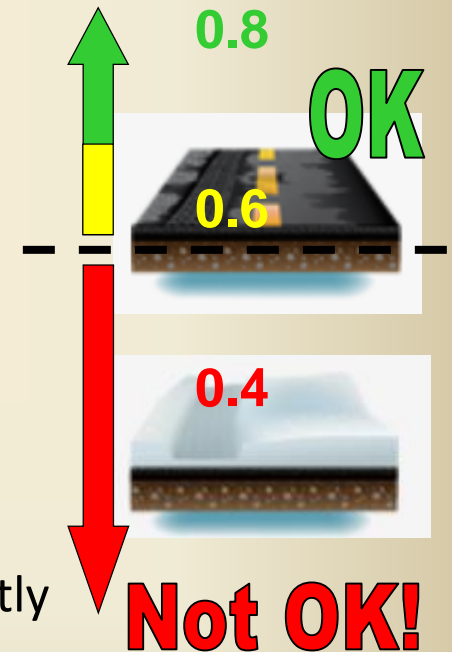
Friction

0.8

0.6

0.4

0.1

# 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
  - .60-.82 wet
  - .50-.60 slush or ice forming
  - .40-.50 snow pack or icy
  - Below .40 cars may start sliding off
  - .30 and lower multiple slide offs possible; mobility greatly affected

**0.8**

**OK**

**0.6**

**0.4**

**Not OK!**

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

# Data

- <span style="color:red">Grip (Pavement Friction)</span>
- 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)
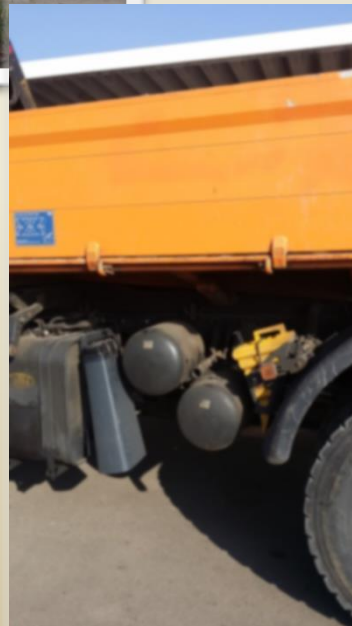




- Installed on Supervisor/Patrol vehicles
- Measurements
  - Grip (Slipperiness)
  - Road state (Dry, Moist, Wet, Snow, Ice)
  - Layer thicknesses
  - Surface Temperature
  - Dew Point Temperature
  - Air temperature
  - Humidity
- In-vehicle system operation/calibration via smartphone or iPad
- Verification 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 whereever 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

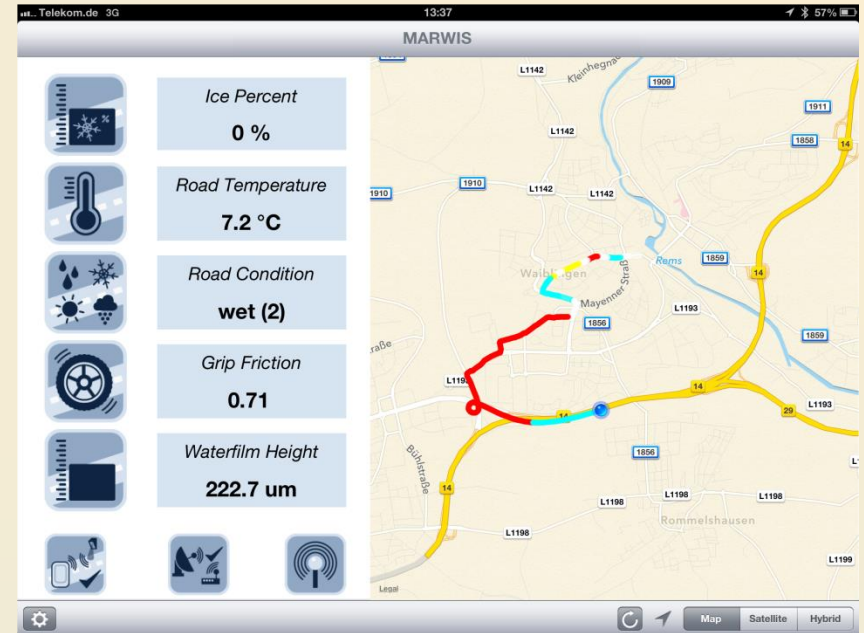- Improves decision making through better information

# 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.

# 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

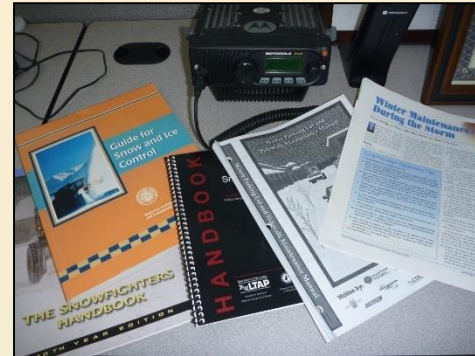# RWIS Data and a tailored pavement forecast with consultation is the Key!





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.

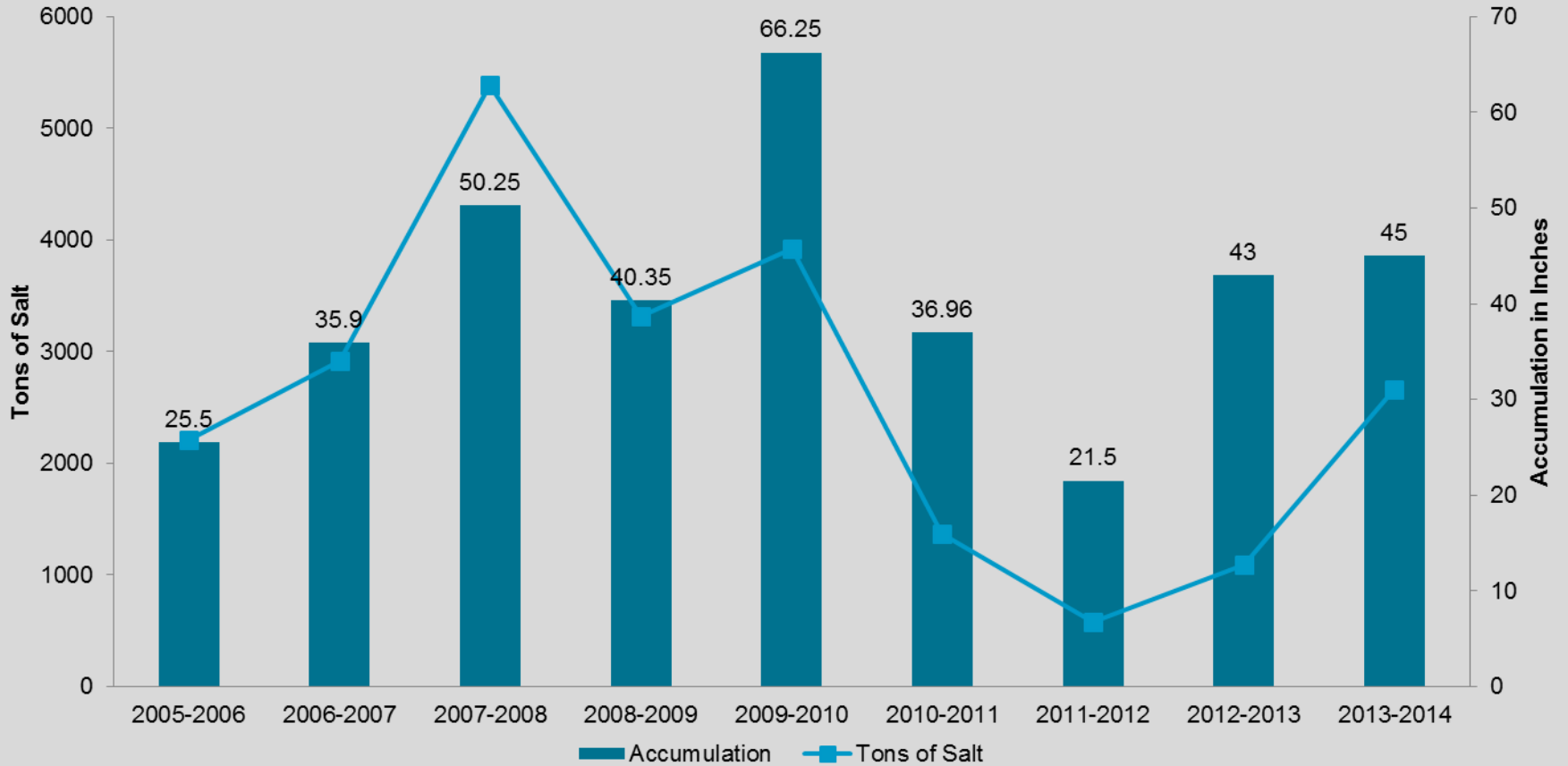• Promotion of cross functional "best practices" between agency departments
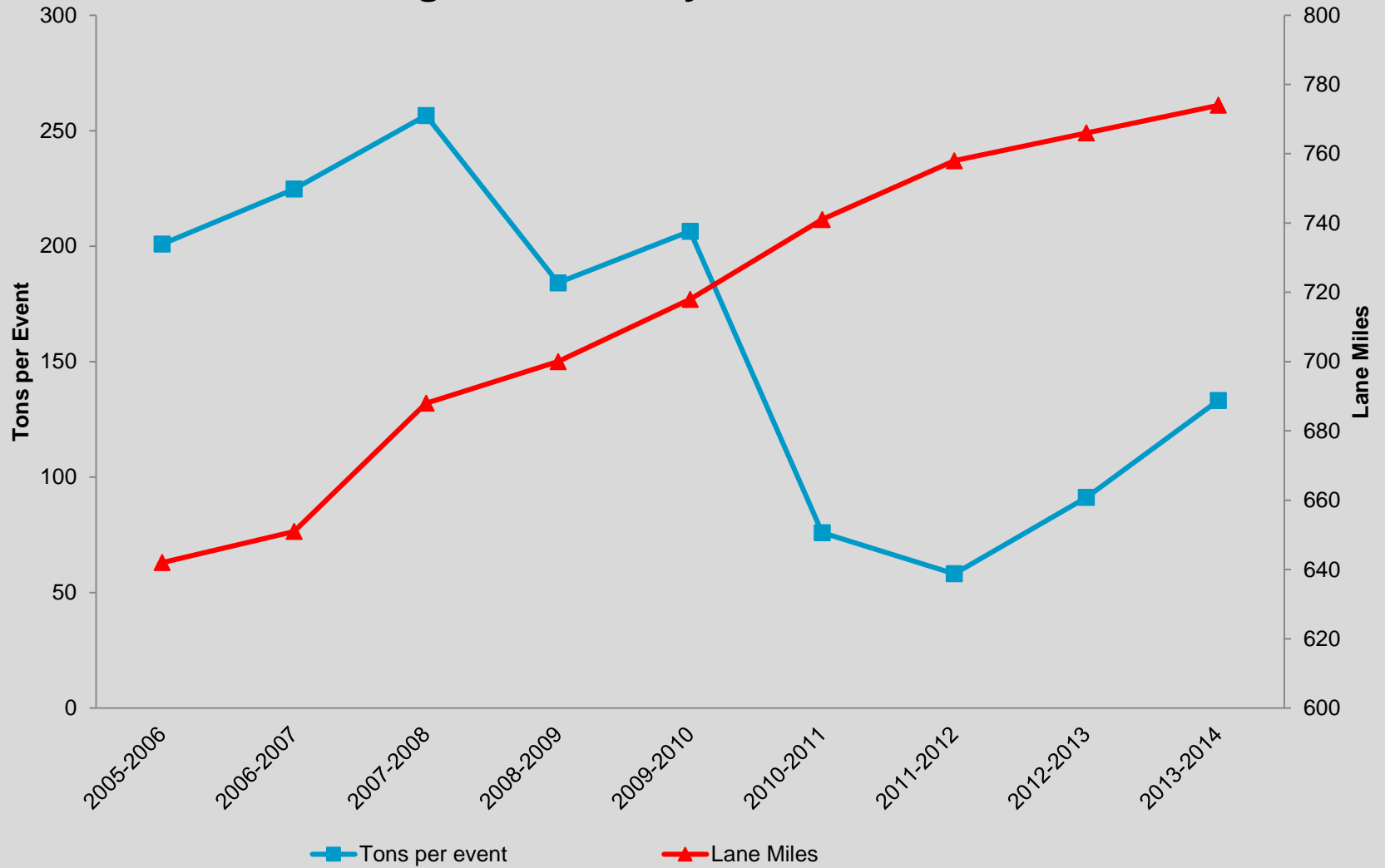
# City of WDM Approach

- Provide the Tools
- Train/Educate
- Verify
- Retrain if necessary
- Continue to Verify

# 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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