Evaluation of ODOT Roadway/Weather Sensor Systems for Snow and Ice Removal Operations
PART I: RWIS

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**Problem**

Road Weather Information Systems (RWIS) are used by winter maintenance managers to monitor road weather condition data not available through conventional weather sources, particularly pavement temperature and status (wet or dry). They are an integral component of anti-icing practice. RWIS have been used in ODOT Districts 2, 6, and 12 for several years with enough success that the department wanted to expand the network statewide.

**Objectives**

The objective was to determine what the right RWIS system for the whole state of Ohio would be. This included determining the number, spacing, and siting of stations to cover the state, which manufacturers to purchase the RWIS stations from and how to make all the components work together, which components of RWIS are relevant and useful for Ohio, the current best practices of RWIS use in other states, and how to gain the most benefit from the systems after installation.

**Description**

The study consisted of an extensive literature review, several field trips, a survey of RWIS administrators and users nationwide, a product review based on manufacturers’ documentation, and a cost of ownership analysis.

The literature review included over 250 documents, including journal articles, conference papers, technical reports, manuals, handbooks, and brochures on the topics of RWIS and anti-icing.

Field trips were made to Districts 2, 6, and 12, the city of Cincinnati, the states of Pennsylvania, Michigan, Kentucky, Nevada, and Utah. The cantons of Luzern, Berne, and Ticino in Switzerland were also visited. Additionally two Eastern Winter Road Maintenance Symposia were attended.

The survey consisted of two extensive questionnaires, one for RIWS administrators, who set up and maintain the network, and another for RWIS users, who use the RWIS information to decide winter weather call outs. Additionally, both groups completed pairwise constant sum comparison matrices in order to rank RWIS measurements in order of usefulness. About ten users and ten administrators responded.

The product review considered pavement sensors, air weather sensors, remote processing units (RPUs), forecasting, auxiliary services such as training, and maintenance.

The cost of ownership over a thirty year period was determined using the latest pricing information from vendors, including estimates for ODOT labor for ongoing maintenance and replacement of sensors at regular intervals (3, 6, or 10 years) due to resurfacing.

Factors used to determine optimal RWIS station deployment included distance between existing RWIS stations in Ohio and surrounding states, declared snow days, and annual snowfall amounts in Ohio.

**Conclusions & Recommendations**

The literature review showed an overwhelming consensus in favor of RWIS implementation and use, but only if its use is thoroughly integrated into the agency’s anti-icing practices, where winter maintenance crews work proactively ahead of a storm where possible. This means spreading salt brine an hour or two before a winter storm moves in to prevent ice from bonding to the pavement, which makes snow easier to plow, if indeed snow accumulates at all.

Though cost-benefit figures are vague and difficult to compare, there is a consensus that RWIS and anti-icing practices pay for themselves several times over in terms of reduced material use and labor. This is before accounting for the benefit of decreased accidents and delays due to winter conditions.

The sensor measures considered most important by users and administrators are precipitation type, surface temperature, surface status, precipitation rate, and visibility.

The cost comparison showed that most of the costs of an RWIS system come after the initial implementation – the major component of that being the replacement of pavement sensors with periodic resurfacing. Active pavement sensor systems, which use twice as many pavement sensors, are considerably more expensive than passive sensor systems.

At a minimum, in addition to the RWIS stations already deployed in the Toledo, Columbus, and Cleveland areas, placement of 14 RWIS stations around the state should be sufficient to meet basic statewide weather prediction and monitoring needs. It may be advantageous for ODOT to deploy more RWIS stations to achieve a denser coverage encompassing all 88 counties in the state. Certain trouble spots, such as bridges, may warrant additional RWIS stations on a case-by-case basis, a concern not addressed in this report. At a minimum, each district should have at least one RWIS station, or two in northern districts. This compares well with the 18 stations required following SSI guidelines.

It is additionally recommended that the five RWIS stations maintained by the city of Cincinnati and also those that may be installed on the Ohio Turnpike be incorporated into Ohio’s RWIS network. Exact sites should be chosen by district managers or personnel in consultation with meteorology and RWIS experts, subject to approval higher up, to give the district personnel that will use the information an additional incentive to use the RWIS. Installations should be at locations with typical rather than extreme conditions.
Each RWIS station should have four pavement sensors to maximize the statistical reliability of sensor readings. There should also be a subsurface temperature sensor 3 inches below the surface. Each station should include a present weather sensor (such as WIVIS), and traffic speed and volume measuring capabilities.

Information from the RWIS and forecast sources should be compiled on a central database and accessible to winter maintenance personnel. Much of this information should also be made public through websites, variable message signs, and on video screens at rest areas.

In conjunction with an expanded RWIS network, it is also recommended that ODOT also vigorously extend its existing pro-active anti-icing program. This program would include expanded data collection and record keeping efforts.

Implementation Potential

These conclusions and recommendations can be implemented immediately in drawing up specifications for a request for proposals to expand Ohio’s RWIS network. Properly expanding the RWIS network will require extensive annual training. This expansion will also involve the implementation of appropriate winter operations performance measures and the full adoption of anti-icing practices and equipment throughout the state.