

CONCLUSIONS AND RECOMMENDATIONS

Key points from the project research and recommendations for improving use of RWIS.

Conclusions

This study assessed the use of Road Weather Information Systems by Caltrans, with intent to improve operational efficiency and effectiveness of RWIS technologies within the state of California. Findings and recommendations of the project include the following areas:

- State of the Practice – Use of RWIS by other states
- Current Use of RWIS by California
- Caltrans Goals for RWIS
- ITS Standards for RWIS Technologies
- Institutional Improvements

Many states outside of California have had roadside RWIS stations in operation since the late 1980's. Federal earmarks funded the majority of the original stations, which were used primarily to improve safety on hazardous roadways. Continued funding and research have spurred many technological and operational advancements in RWIS. These changes have had a direct effect on the states' RWIS approach, and have provided many lessons learned.

Following the current state of the practice, most states deploy RWIS with three primary objectives: to detect current weather conditions at a specific location, to monitor changing conditions to provide lead time to decision makers, and/or to forecast weather conditions in advance. In all cases, RWIS are being utilized more as an operational tool, rather than simply as a weather station.

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The state of the practice involves support from all user levels within an agency in the deployment, education, and maintenance process.

Of individual states with RWIS technologies in place, the most successful are those that have embraced a statewide vision yet maintained a cooperative autonomy by involving all levels of personnel, management through maintenance, as well as specific regional needs. Maintenance personnel, the most common end-user, are often more willing to embrace RWIS if given a vested interest in the technologies and application. Thus, the state of the practice involves support from all user levels within an agency in the deployment, education, and maintenance process.

It is imperative to have a comprehensive plan that can be used as a guide for future goals, data collected, and how systems will relate to other operations that are in place.

States that have realized the importance of staff involvement and education are at the forefront of RWIS use. These states recognize that RWIS technologies are a tool which must be implemented and extensively integrated into operations and management. Consequently, as a tool it requires that users have proper technical training, skills, and in some cases additional developed tools and procedures to take advantage of the full potential of RWIS. An overall lesson learned is that it is imperative to have a comprehensive plan that can be used as a guide for future goals, data collected, and how systems will relate to other operations that are in place (e.g. snowplowing operations).

By contrast, more than one-third, or 36%, of Caltrans District staff surveyed rarely or never use RWIS and approximately 29% felt they were not encouraged to use it. One reason this may occur is that 87% of the respondents have received less than eight hours of training (69% saw this amount of training as inadequate). Caltrans management at the District level and at headquarters recognizes the need to incorporate training. However, as Caltrans is aware, there are many institutional (and achievable) changes that must come about to initiate a transformation.

The following are additional findings from the survey of Caltrans RWIS users that may help guide future development and improvements within the state (p. 4-4):

- 67% feel that RWIS would work better if there were more sites
- 41% think that RWIS would work better if the sites were better located
- 47% believe that RWIS would work better if the sites were maintained better
- 50% of the respondents feel RWIS would be more useful if more people knew how to use it
- 58% feel they are encouraged to use RWIS
- 64% agree that RWIS is used in their district for winter road maintenance
- 40% agree that RWIS is used in their district for traffic operations
- 56% of the respondents feel that RWIS is accurate
- 65% of the respondents feel that the RWIS information is current

In general, this study suggests a correlation between the amount of resources allocated to a state's RWIS program, and their state of the practice. The states that have invested significant time (assigning dedicated staff, training personnel, integrating with operations) and capital have systems that are better organized and effective. They know exactly what they want to accomplish with their program, and where they will want to make developments in the future. These states represent the state of the art for the practice of RWIS applications.

Caltrans first began implementing RWIS in 1992. To date, almost all Districts have implemented RWIS technologies. Between the 12 Districts, there are varying degrees of acceptance and trust in system performance and utility.

California as a state is geographically diverse. Differences in climate, population density, and topography affect the use of RWIS and priority of application. Coupled with differing objectives and expertise in autonomous Districts, RWIS by Districts varies in application and degree of use.

The intended use of an RWIS station (e.g., detection, monitoring, forecasts) and corresponding road/weather information play an integral role in the selection of an installation site (ideally, they should be placed to satisfy more than one intended use). Qualified Caltrans staff may best determine the selection with review from a professional meteorologist.

Caltrans survey responders expressed that site selection should be based on intended use of new systems, according to the following considerations:

- Roads prone to snow and ice with the highest volumes of traffic are the most important locations to place RWIS sites
- Of secondary importance are mountain passes and other roads with severe snow and ice weather

Roads prone to intense rain and flooding problems ranked as the least important locations for RWIS sites

Given the diverse application and degree of use of RWIS statewide, District priorities for goals at the state level were remarkably consistent. The following are a few goals that stood out as high priority:

- Implement a standard RWIS communications protocol
- Make RWIS easy to read and interpret
- Develop statewide guidelines for RWIS, but do not institute statewide requirements beyond interoperability

Through this project, the Technical Advisory Committee has agreed upon a vision for Caltrans RWIS, which parallels the strategic direction of the state of the practice. Caltrans statewide vision includes the following components:

Create and maintain a statewide linked road weather information system for road maintenance, traffic operations, and traveler information utilizing the best practices from around the world.

- Procure flexible, cost effective road weather information systems that meet the needs for the designed use and consider the needs of partners
- Work with vendors and partners to provide quality, cost effective forecasting services
- Create the best possible return on investment through
 - ▀ Proper system maintenance and training
 - ▀ Knowledge and data sharing between districts and with partners

There is a national movement to widely accept and embrace standards in the transportation industry. The National Transportation Communication for ITS Protocol specifies standards to achieve and enhance the interchangeability and interoperability of RWIS devices. These standards assure that expansions and system upgrades are easier to implement and more cost-effective. Consequently, compliant systems add worth to the RWIS.

Complying with NTCIP standards may have benefits including:

- Decreased early obsolescence of hardware and software
- Increased choice of vendors
- Increased interagency coordination through easy sharing of information
- Use of one communication network for all purposes
- Device and software portability

Meteorological standards assure that weather data disseminated between diverse federal, state, and commercial entities is consistent and meteorologically sound (accurate). These standards relate to data structure, sampling and proper exposure of sensors. There are benefits associated with deploying RWIS stations and sensors that adhere with established meteorological standards. These include:

- Increased ability to obtain meteorologically accurate data
- Obtaining data that has high value and usability to multiple users
- Increased potential for data dissemination and exchange with other agencies
- Sensor installation built on proven methods

There are many industry and institutional barriers hindering Caltrans movement towards a statewide linked RWIS; however Caltrans has substantial control over many of these factors. Overcoming the barriers depends largely on Caltrans’ initiative and efforts to actively change.

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The research group identified institutional improvements as the key pieces to improving use of RWIS by Caltrans. Issues currently preventing Caltrans from reaching its full potential were grouped into causes under the categories of cost and quality, system utilization, isolated systems, varied users, and liability. (Many causes were found in fact to be interrelated.) Recommendations for improvement to these issues are given below.

Recommendations

Throughout this project, participants (TAC members, survey responders, participants in the District visits, and users in other states) have highlighted some recommendations where Caltrans can improve its RWIS. Given the vision for RWIS in Caltrans and inputs from project participants, the researchers identified key recommendations for improvement and asked the technical advisory committee to prioritize these recommendations. These are listed in TABLE 8-1 with an indication of the cost to implement the recommendation.

TABLE 8-1 TAC Recommendations for Institutional Improvements

Category	Recommendations	Priority	Cost
General	Continue pursuing Road Weather Information Systems and weather-related features for managing Caltrans roadways	4	Medium
	Assess sensor capabilities to address trade offs of cost, accuracy, and reliability; develop performance specifications for sensors	4	Medium
	Conduct benefit-cost analysis of RWIS development	4	Medium
	Update headquarters electrical maintenance inventory with RWIS stations	4	Medium
	Identify deployment locations based on safety and relevant other criteria	5	Medium
Maintenance decision support	Identify Caltrans representative to participate and track national Maintenance Decision Support System efforts	3	Low

Category	Recommendations	Priority	Cost
Traveler information	Include RWIS information and road conditions in Caltrans-designed traveler information sources - Web page - Phone systems including 511 - California Highway Incident Network	4	Medium
	Conduct detailed requirements and design to provide information in a manner most useful to the traveling public	4	Medium
	Include the ability to incorporate forecasted conditions into traveler information systems	3	Medium
Traffic management systems	Include RWIS in requirements for upgrades to ATMS	4	Medium
	Include ability to incorporate site-specific forecasts	3	Medium
	Include user-settable operational alarms	4	Medium
Statewide coordination and assistance	Establish a statewide RWIS coordinator	4	Medium
	Encourage each district to utilize existing headquarters staff and experts in other districts	4	Low
	Hold an RWIS user group meeting every other year - Include training - Invite partners	4	Medium
	Require roadside equipment to be NTCIP compliant; require software to be compliant with National ITS Architecture and regional architectures	4	Medium
	Validate NTCIP compliance through independent contractor	4	Low
	Require that data from RWIS and forecasts be owned by Caltrans and can be housed on Caltrans servers	5	Low
Product selection	Procure equipment through competitive bid process or request for proposal process	4	Low
	Establish one statewide contract for each chosen vendor	3	Low
Partnerships	Provide Caltrans RWIS data to Mesowest	3	Low
	Develop relationship with the local National Weather Service and other identified potential partners	4	Low
	Initiate an effort to form or join a California meteorological consortium	4	Low

Category	Recommendations	Priority	Cost
	Identify potential partners from which to collect meteorological data and exchange information	4	Low
Access to data from field	Interested districts should pursue products that provide access to data via pager, Internet, or mobile phone	4	Medium
	Create opportunities to develop and deploy “push” technology (e.g., email alerts) to assisted partner organizations	4	Medium

Priority ranked from 5 (very important) to 1 (not important)

Furthermore, based on suggestions and recommendations expressed in district visits, surveys, phone interviews, and literature review, the research group highlighted some additional recommendations and suggestions to improve the effectiveness of RWIS by Caltrans. The intent of these additional recommendations is to supplement those developed by the TAC and so they are not ranked. Recommendations are as follows:

Quality and Cost

- Strive to achieve quality along with cost. Do not simply select a contract based on the lowest bid. Foremost consider required functionality and reliability for the intended use and then balance with cost.
- Be informed of RWIS maintenance requirements.
 - Consider developing a maintenance plan or program, which includes a statewide vision that blends with each individual Districts needs.
 - Recognize an agency’s preventive and recurring maintenance needs for those with RWIS in place, or those acquiring RWIS.
 - Determine most cost-effective method for maintenance services: in-house or vendor-provided
 - Develop state level financial support for RWIS maintenance; pursue a Budget Change Proposal
- Identify meteorological data, siting and sensor requirements at the District level. Review potential sites with a professional meteorologist and the National Weather Service to better determine specific sensor needs and placement.
- Identify appropriate RWIS technology through careful definition of the intended use of the system. Coordinate with qualified internal staff, external vender-independent professionals, and meteorologists

regarding placement, needed hardware, and functionality of the system.

- Consider University-based resources, a cost-effective source for research and evaluation.
- Create a state level RWIS specialist to champion coordination and provide staff support. Consider incorporating into the BCP a request for funding for staff dedicated to RWIS.
- Conduct and utilize cost benefit studies:
 - ▀ Consider conducting a cost benefits study on the use of RWIS in different Districts in California to determine return on investment
 - ▀ Use cost benefit studies to determine equipment needs, such as for selecting number and type of sensors needed
- Conduct a thorough vendor selection and contract process:
 - ▀ Look at all potential providers for each service
 - ▀ Investigate an open bid/Request for Proposal process
 - ▀ Consider teaming on contracts with other Districts to negotiate bulk discounts
 - ▀ Do not automatically accept a vendor's standard contract
 - ▀ Write performance criteria for vendor tasks, e.g. forecast accuracy, service response times, etc.

Utilization

- Know (determine ahead of time) what RWIS goals the District desires. Develop a plan as to how RWIS will be used and where sites will be located in the future.
- Expand training opportunities to build expertise:
 - ▀ Develop and initiate a semi-annual statewide RWIS user's conference including a train the trainer workshop. The conference would allow Districts to share lessons learned and review advances within and outside of Caltrans. The training workshop would focus on a continuing education approach to train District educators on RWIS technologies, operation, maintenance, and available value added services.
 - ▀ Conduct in-District hands-on training each fall for all involved staff levels. Training should provide skills to allow fully integrated RWIS technologies and corresponding road/weather information into the snow and ice control decision process and traffic operations.
 - ▀ Develop a technical session at existing statewide and District meetings to train maintenance staff.

- ▶ Encourage employee attendance at national conferences and workshops regarding RWIS technologies operation and service.
- Involve road maintenance and traffic operations personnel at all levels of the implementation/deployment process to instill a feeling of ownership. Involve them in site/data selection, station maintenance and service, and evaluations/change decisions.
- Promote data ownership, sharing and use of advanced tools:
 - ▶ A District should require full ownership of its RWIS data with the freedom to disseminate as it pleases.
 - ▶ Be informed of the FHWA Maintenance Decision Support System. While the initial product of this effort may not be directly useable by Caltrans, headquarters and maintenance should track this endeavor, participate in steering the product and look for opportunities to use this and other next generation RWIS tools.

Isolated Systems

- Consider using existing or developing statewide communication systems for the dissemination of RWIS data.
- Make an effort to realize the potential of developing inter/intra-District consistent systems as well as consistency with external partnering agencies.
- Promote compliancy with national standards:
 - ▶ New stations should be addressable via an IP address to ensure access through a network as identified in the TMS Standardization Plan.
 - ▶ Push towards NTCIP compliant systems to help avoid early obsolescence of software and hardware, provide choice of vendor, enable interagency coordination, facilitate use of single communications network for all purposes, and ensure access to federal funding.
 - ▶ Follow meteorological weather standards when developing partnerships
- Work with Information Services to revisit their blanket policy of no vendor access within the firewall in the Caltrans Intranet. Information Services should explore innovative technologies to allow limited, secure Intranet access by vendors.

Varied Users

- Develop regional standards for defining road weather incidents for the traveler, e.g., The Central Valley should have a consistent definition of heavy fog; the Sierra Nevada should have consistent snow-related

regulations and warnings. When information goes to the traveler via the Internet, Caltrans should provide access to explanations of differing regional criteria for warnings to minimize risk of claims.

- Form ongoing relationships with partners, users and other states to access their expertise:
 - ▀ Look to partners to develop a network of stations and add worth to system. Potential partners include the National Weather Service, Bureau of Land Management, Department of Forestry, as well as representatives of the meteorological, emergency response and transportation communities.
 - ▀ Form a statewide user group. The user group could be an inter-District group of people interested in advancing RWIS and utility. The group could facilitate technology transfer, share goals, objectives and needs, reach agreements for coordination, identify issues and establish mechanisms to address them, assess agency participation with the larger meteorological community and possible corresponding weather support, and establish a between meeting support network for RWIS.
 - ▀ Investigate and consider involvement in consortiums such as Aurora. Members are state agencies that have a long history with RWIS, and can provide good information.
- Weigh the pro's and con's of state information custody versus vendor custody/management. Putting appropriate RWIS data in the public domain can facilitate the widest distribution and use.
- Post weather-related traveler information on the web page in the most user-friendly manner possible. Review Washington State DOT rWeather web site (<http://www.wsdot.wa.gov/rweather/>) as a potential model.

Liability

- Include appropriate written disclaimers, limitations on liability, indemnity provisions, and warnings when posting data. If possible, the receiving parties should be required to formally agree to such terms before receiving the data.
- RWIS technologies should be thoroughly tested, and once deployed, they should be subject to appropriate monitoring and control. Generally, RWIS devices should not be deployed as substitutes for traditional safety measures.
- Be informed of claims arising from partnerships. An agency should incorporate indemnification provisions and insurance requirements into all agreements.

- Be aware of proprietary liabilities. Accordingly, agencies should sign license agreements to avoid claims of misappropriation and liability for patent and copyright infringement.
- Weigh your options for deployment. When assessing potential liabilities, it should be remembered that the deployment of RWIS may increase safety and reduce the occurrence of accidents and fatalities, which may help agencies avoid certain liabilities. These potential benefits should be weighed against the risk of liabilities.
- Caltrans should seek legal advice from a licensed California attorney with expertise in the field, prior to the deployment of cutting-edge RWIS projects.

