

INSTITUTIONAL IMPROVEMENTS

This chapter describes institutional issues that hinder improved use of RWIS, their causes, and recommended solutions.

The key pieces to improving the use of Road Weather Information Systems by Caltrans are related to institutional improvements. Through the collection of data during this project, participants (TAC members, survey responders, participants in the District visits) have highlighted areas where the use of RWIS can be improved. Institutional issues can also be identified in successes in the use of RWIS at each District and in other states.

The areas of improvement in moving toward a better-quality RWIS linked across the state are interrelated. Issues preventing Caltrans from reaching this goal fall into the categories of cost and quality, system utilization, isolated systems, varied users, and liability. FIGURE 7-1 shows some of the causes of these issues on the right side of the diagram. Since nearly every one of these relates to other areas, there will be some overlap in the discussion. In many cases, the solution to an issue creates its own problems. The following sections discuss the issues, the causes identified as most directly related, and some recommended solutions.

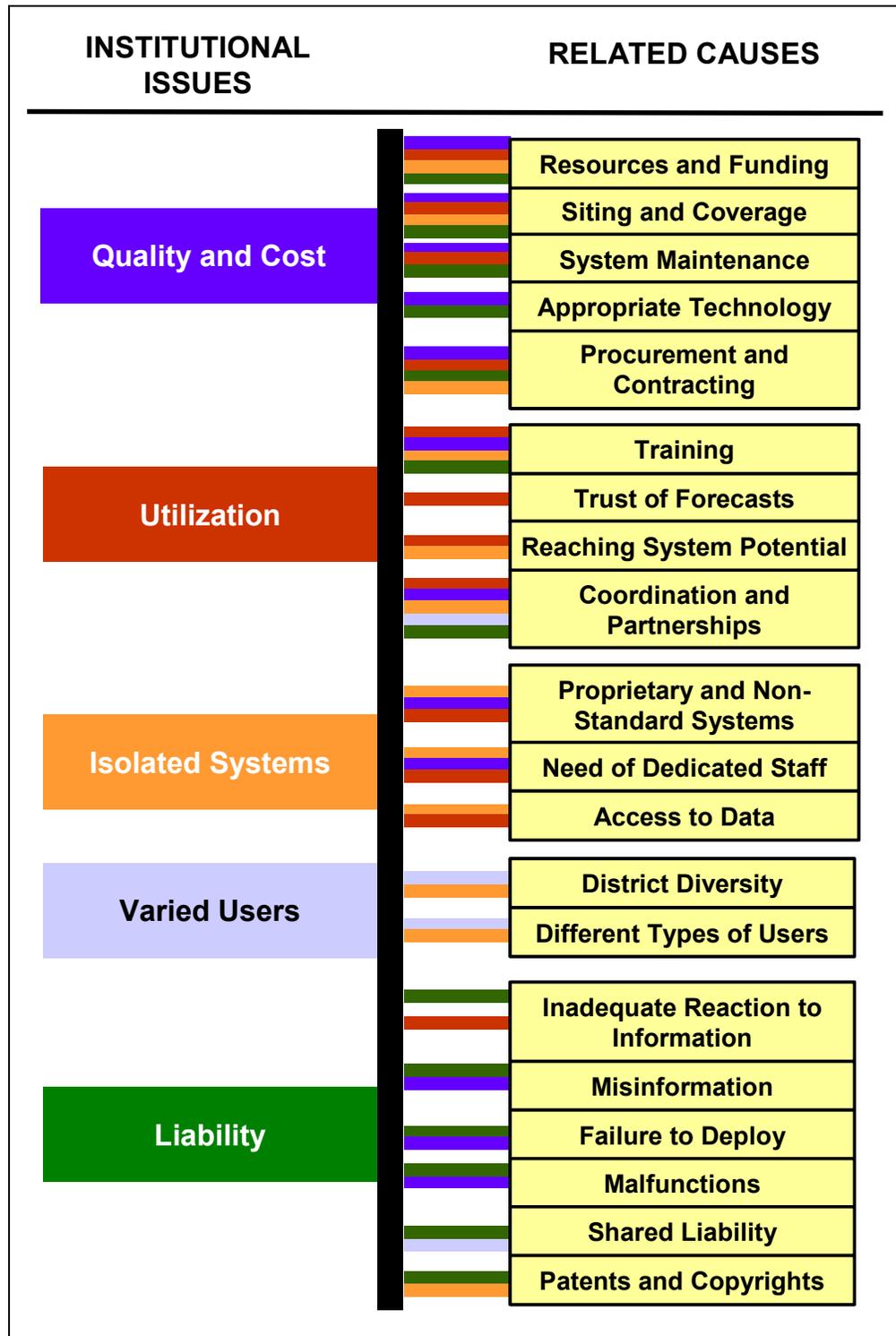


FIGURE 7-1 Issues and causes are interrelated.

Quality and Cost

Implementing RWIS requires that State DOTs incur a large capital investment and dedicate significant resources toward procurement, forecasts services, maintenance, effective coordination and data dissemination. Opinions are mixed on whether the financial investment in RWIS is valid. If the systems don't function properly or accurately, the venture is viewed as poor. Alternately, if the systems function properly, are well maintained, and provide useful information, the full potential in RWIS technologies is generally realized and the investment is regarded as worthwhile.

As with any agency, Caltrans strives to minimize the cost of the system it provides without sacrificing the quality of service. The return on investment can be maximized through conformance with established standards, contract improvements, equipment selection, and site selection.

Quality addresses the functional efficiency of RWIS technologies and contracted services. Many of the issues affecting quality are similar to those affecting cost, including forecasts, ongoing maintenance and consistency in system.

In general, Caltrans should consider quality above cost. That is, selection of contracts should not be based solely on the lowest bid; instead, required functionality and reliability should be given greater priority. On the other hand, cost should not be excessive and stay within budget: new and advanced system features should only be added to the extent that they serve specific needs. Cost and quality decisions should be determined by all participating parties in order to best address statewide and District level goals.

Selection of contracts should not be based solely on the lowest bid; instead, required functionality and reliability should be given greater priority.

Some of the causes of quality and cost issues are discussed in more detail in the following sections.

Resources and Funding

Many recommendations from this report will require dedicated resources or increased funding. One example is proper system maintenance. Caltrans electrical maintenance staff have never had dedicated resources for the maintenance of RWIS. As a result, the Districts are left with limited options. Stations can be maintained through service contracts with the vendors or field maintenance can be conducted by unfunded, and often under trained, Caltrans staff.

Other recommendations from this report that will require funding include dedicated staff, system training, implementing standards-compliant systems, and improving partnerships. For example, if Caltrans decides to develop an RWIS network with statewide coverage, it would need to dedicate funding for design and

implementation. Limited resources and funding is one factor contributing to all of the remaining institutional issues identified in this chapter: utilization, isolated systems, varied users, and liability. For example, inadequate funding can expose Caltrans to liability through a perceived failure to deploy systems where an incident occurs.

To increase funding, Caltrans should pursue and advocate for a Budget Change Proposal for RWIS. The first step will be to incorporate a statewide inventory of RWIS into the maintenance inventory. Caltrans should also incorporate into the BCP a request for funding for staff dedicated to RWIS.

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A cost/benefit analysis is vital to the success of a BCP. Literature and research on this topic is limited and what is available is more applicable in traditional snow and ice areas where RWIS is primarily used for anti-icing [12]. Caltrans should review existing information and consider conducting a cost benefits study specific to the use of RWIS in California. Recommendations:

- Pursue a BCP that includes dedicated funding for maintenance and RWIS staff
- Conduct a cost/benefit analysis of RWIS use in California

Siting and Coverage

If meteorological standards are not met, the quality of the data will suffer.

When used for forecasting purposes, stations should have sensors that meet meteorological standards. If meteorological standards are not met, the quality of the data will suffer. When atmospheric data is collected at a non-representative location, such as a location surrounded by trees, a bulls-eye effect can take place on the monitoring of the area sensors. For example, the prevailing winds could be at twenty miles per hour, but in the RWIS location they could register at 5 miles per hour. When this data is graphed and forecasts are made off this data, the meteorologist sees maps with prevailing conditions across the area and a bulls-eye image at the non-representative location.

While quality of data is important, cost considerations also suggest that the level of data collected not exceed actual needs. In other words, if the National Weather Service is not going to use certain data for their forecasts, why pay to collect it? Data needs should be carefully considered during the siting process. Sites that are intended to provide data that will be shared should be full RWIS stations that meet NWS standards. Sites that are only providing spot location data to the district may not need to meet NWS standards.

Careful placement of Environmental Sensor Stations (ESS) will also help increase quality and control costs. Caltrans should make use of siting considerations developed by federal agencies, described more thoroughly in Chapter 6.

Once the decision is made to develop a fully compliant RWIS station, Caltrans should make full use of partner and consultant expertise in order to maximize its return on this significant investment. Meteorologists and the National Weather Service can be useful at nearly every step of the development process. Meteorologists should be asked to review station design and prospective sites, and in some cases, provide a field review. During the Plans, Specifications and Estimate (PS&E) process, the NWS can provide assistance such as design recommendations and siting guidelines. In fact, the NWS often welcomes participating in this process if they are going to be receiving the data. Designers statewide should be encouraged to work with their local NWS, and include NWS review as a standard step in the development and siting process.

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In summary, siting and coverage costs can be controlled through:

- Quantity of sites – use full RWIS where pavement temperatures are required. Look to partners including the National Weather Service, Bureau of Land Management, and Department of Forestry for a network of stations.
- Consulting a meteorologist to better determine specific sensor needs and placement.
- Weighing the benefit of accuracy versus coverage. Is it more advantageous to go with a larger number of less expensive sensor to provide coverage to a greater area or less coverage with more expensive sensors for greater accuracy.

Maintenance

As with most advanced technologies, RWIS systems require routine maintenance to sustain accurate and effective operation. After the initial capital investment, additional costs such as maintenance may be neglected in the operation budget. However, it must be recognized that RWIS is a tool that must be properly maintained and effectively managed and used in order to realize a return on the capital investment. In order to provide proper maintenance:

- Maintenance services must be considered as part of the contract if services are to be external to Caltrans.
- A maintenance plan should be developed, which if possible should include a statewide vision that blends with each individual Districts needs.
- Proper education should be provided to maintenance staff.

Caltrans equipment inventory defines the equipment for which dedicated funding is allocated for maintenance. As stated in an earlier section, routine maintenance of RWIS is currently not funded within Caltrans. Consequently, RWIS needs to

be added to the equipment inventory list, and funding should be pursued through a Budget Change Proposal.

Routine maintenance of RWIS is necessary to assure long-term system accuracy, worth and user trust in RWIS technologies.

Routine maintenance of RWIS is necessary to assure long-term system accuracy, worth and user trust in RWIS technologies. Caltrans Districts using or acquiring RWIS should establish a maintenance program which outlines preventive and recurring needs. Frequency of maintenance should be based on field experience, national standards and the manufacturers' recommendations.

Preventative maintenance is considered by many to be a luxury item and therefore, there is no consensus on the frequency of system maintenance. One example of a proactive preventative program comes from the Oregon DOT ITS Maintenance Plan, which recommends maintenance as below [13].

- **Sensors:** Visual inspection; cleaning and calibration. Every 12 months
- **Local cable and wiring:** Visual inspection. Every 12 months
- **RPU:** Re-boot and visual inspection. Every 2 months
- **Modems / Routers:** Visual inspection; check connections. Every 12 months
- **Software (User Interface & Database):** Install upgrades as available
- **Surge Protection / Power:** Visual inspection and testing. Every 6 months
- **Servers (Regional / Statewide):** Database and server management activities. Every week

Appropriate Technologies

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Caltrans should not dedicate resources to equipment or systems that have capabilities far beyond their intended use. For example, less expensive sensors are less precise but may allow for a greater coverage because more sensors may be purchased for a given budget.

Fog detection sensors provide a specific example. Members of the Technical Advisory Committee expressed concern that the sensors currently in place exceed what is necessary for the application. Because visibility is outside of the core package of information that the National Weather Service and other meteorologists need for their forecasts, this is a case where the most affordable sensors should be used. Therefore it is recommended that Caltrans completes the following before purchasing an RWIS:

- Define intended use of RWIS systems to determine proper technology to carry out the job
- Consult a meteorologist to better determine specific sensor needs and placement.
- Conduct a study to identify costs and needed accuracy of sensors for the different uses of RWIS (fog and low visibility detection, automatic bridge deicing, anti-icing practices, traveler information). Balance specific needs at site against needs for forecasting and partners.

Procurement and Contracting

Procurement methods play a pivotal role in minimizing costs. Caltrans needs to define the procurement contract specifications and also require the vendor to stick to them. We found that currently many Districts allow the vendor to make system design and equipment decisions. By being specific in procurement contracts through requiring compliant specifications, desired services (e.g., maintenance, forecasts, etc) and RWIS equipment Caltrans will be buying only what is needed for their intended use. For this to work properly Caltrans must be educated and informed of exactly what they need. This requires defining the intended use of the system and coordination with the qualified internal staff or external vendor-independent consultant regarding placement, needed hardware and functionality of the system.

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Costs can also be addressed through the method of procuring services. Other states have realized significant savings by going to an open bid process. If the Districts were to procure services together instead of separately, they may be able to realize a bulk savings. Recommendations:

- Push towards NTCIP compliant systems to help avoid early obsolescence of software/hardware, provide choice of vendor, enable interagency coordination and facilitated use of a single communication network for all purposes.
- Specifications should be vendor neutral. Don't rely on specifications provided by vendor.
- Explore potential cost benefits of open bid contracting and joint purchases with other districts.

Utilization

Based on the survey results and interviews, there is a diversity in feelings about how useful RWIS is. While the overall impression is positive, some of the less enthusiastic responses can explain under use of the system. Some comments questioning the usefulness of RWIS are to be expected; for example, in the urban coastal Districts, the traffic operators are concentrated on incident management,

and they have limited time to check the road weather information on a separate computer or application from their primary traffic management system.

If users do not trust the RWIS data, if they don't know how to interpret the information, or if they do not feel comfortable with a computer application, they will tend to turn to other tools for monitoring weather conditions.

Maintenance supervisors fighting a storm lack the time to check multiple sources of weather information. If they do not trust the RWIS data, if they don't know how to interpret the information, or if they do not feel comfortable with a computer application, they will tend to turn to other tools for monitoring weather conditions.

Caltrans has a significant investment in RWIS and plans to increase it; thus they should strive for the maximum use of the system, both within Caltrans and with partners. Members of the meteorological community, the emergency response community, and the transportation community have shown interest in Caltrans data, and partnerships in California and in other states have resulted in better uses of the system. The following issues can assist in identifying ways to increase usage.

Training

As it stands, some Caltrans Districts contract out RWIS maintenance to outside vendors, partially because these Districts are not effectively trained (and funded) to completely maintain the systems in-house. To make the move to an in-house maintenance program Caltrans should establish RWIS maintenance workshops. The focus of the workshops should be to establish a maintenance program, which includes preventative and recurring maintenance requirements.

Many RWIS functions and systems are underutilized. Operational training has been provided by the vendors, yet 87% of the survey respondents felt the training they received was not adequate. Better and more frequent operations training should be provided for RWIS to reach its full potential.

Each District should assign an RWIS educator for the District that will attend state train-the-trainer workshops and then develop workshops to train District staff.

As highlighted in Chapter 3, each District operates their RWIS differently compared to other Districts. This complicates developing a statewide maintenance workshop and users' conferences that meet the broad needs of all Districts. Also, the number of users statewide makes it difficult to provide the quality hands-on training that is required, and to fund participation of all users at a statewide level. Each District should assign an RWIS educator for the District that will attend state train-the-trainer workshops and then develop workshops to train District staff. Training at the District should occur annually, and after any system improvements are in place and functioning properly. The best time for training is in the fall, when the users would almost immediately be able to use their new knowledge. For Districts with minimal RWIS users, they should consider joint training with neighboring Districts. Training should not just include users of RWIS but also maintenance staff.

Recommendations:

- Develop and initiate a semi-annual statewide RWIS user's conference including a train the trainer workshop. The conference would allow RWIS champions from throughout the state to share success stories and to talk about national and international successes. 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
- Develop technical session at regularly scheduled statewide and District meetings to train maintenance staff
- When feasible, Caltrans should encourage employee attendance to national conferences and workshops regarding RWIS technologies operation and service.

Trust of Forecasts

Many project participants felt that the localized forecasts at trouble spots provided the greatest potential benefit of RWIS. For maintenance crews, the forecasts provide specific lead-time information to supplement the area forecasts and their instinct. Maintenance supervisors use the forecasts for proper scheduling of crews and to monitor trouble spots remotely instead of sending crews to wait for potential problems. Traffic operators can use the forecasts for staff scheduling and for warning motorists of possible hazards. Yet if forecasts are not accurate or too expensive, staff loses trust in them and the information is not used.

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The users' opinions about forecasting services varied according to their experiences with accuracy and costs. Overall, those that believed that the forecasting services were generally accurate and cost effective usually had positive experiences with forecast providers and more active participation than those who did not. Furthermore, one of the satisfied Districts has obtained service from an independent forecast provider instead of going with the forecasting service from the RWIS equipment provider.

Recommendations:

- Forecast providers do not need to be the same as the system vendor, and many private meteorology companies have experience providing these types of forecasts to Departments of Transportation. Districts (or the state) should look at all potential providers when procuring forecasting services. This set of recommendations will be easier to follow if every Caltrans district has full ownership of its RWIS data and is free to share it with partners.

- Districts and the users of the forecasts should provide feedback to the contracted meteorologist. In general, the meteorologist wants to hear about forecasts that were both good and bad. Users who have actively taken this approach have seen their forecasts improve.
- Forecasting quality is directly related to the quality of the measurements provided to the forecaster. Station siting criteria and partnerships will help accomplish this.

Reaching System Potential

For traffic operations, inclusion of RWIS information and District-customized decision support capabilities into an upgrade of the Caltrans ATMS will improve weather data utilization and eliminate “swivel chair integration”.

A system that is operated at its full potential will be more widely used and will help limit liability. Caltrans Districts can help RWIS reach its potential by acting on recommendations related to the other causes identified in this chapter. An improved RWIS application design can also contribute to improving the effectiveness of the system. The use of decision support systems (DSS) customized to the needs of the District user can help the road and weather data be used more effectively. A decision support system is a computer program application that analyzes data and presents it so that users can make decisions more easily. For traffic operations, inclusion of RWIS information and District-customized decision support capabilities into an upgrade of the Caltrans ATMS will improve weather data utilization and eliminate “swivel chair integration”. For maintenance, FHWA has been working with the national meteorology labs in design of a maintenance decision support system (MDSS) prototype. While the final product of this effort may not be directly useable by Caltrans, headquarters maintenance should track this effort and look for opportunities to use this next generation of RWIS products by adjusting the software to fit Caltrans’ needs. Recommendation:

- Explore the use of computer applications such as DSS that allow data to be used more effectively

Coordination and Partnerships

District 2 has found great feedback from the emergency response community after it posted its RWIS data online.

RWIS coordination between Districts is limited, primarily due to funding and autonomy issues. Furthermore, to date Caltrans has established only a few partnerships with external agencies. By sharing data with partners, Caltrans can greatly increase the benefits in its system, as has been done in Washington (see Chapter 2). Some districts have already realized benefits. For example, District 2 has found great feedback from the emergency response community after it posted its RWIS data online. Other districts have begun to identify and pursue partnership opportunities.

However, some obstacles to partnerships are related to proprietary and non-standard systems, as described in the next section. A first step towards better

coordination would be a shared vision on RWIS architecture between Districts. This can lead to compliancy in data format, packaging and distribution and easier access by partners and by VAMS. Recommendation:

- Caltrans should package weather data so that the format agrees with established meteorological standards. (See Chapter 6 for more detail.)

Isolated Systems

In an effort to facilitate coordination, some Caltrans districts have chosen their vendor because nearby districts have the same vendor, making it easier to share information. However, there are other options for moving away from isolated RWIS systems.

Proprietary and Non-Standard Systems

Compliant systems add worth to RWIS, since existing system upgrades and new expansions may be less costly and troublesome as a result. Consistent systems facilitate data exchange between collaborating agencies and agency interoperability. Thus, Caltrans should push towards developing consistent systems on a statewide framework. Recommendations include:

- A CPU-to-CPU standard communication protocol and standard data format should be established and used by Caltrans.
- State highway agencies should consider using existing or developing statewide communication systems for the dissemination of RWIS data.

The benefits of system consistency must be coordinated with the benefits of moving toward an open bid process. Using RFP's will help in controlling costs but it may threaten the consistency of the systems. Many of the Districts selected the vendor for RWIS because the neighboring District was using the same vendor. This eases sharing data, and it also eases difficulty of maintenance. Under this scenario, Districts can learn from each other about problems with the specifics of the system and how they were overcome, yet it can prevent the Districts from procuring the best possible system. If Caltrans succeeds in moving away from sole source for RWIS, this consistency formerly provided by a common vendor can partially be replaced through standards, contracting, partnerships, and statewide cooperation.

This consistency issue also applies to communication barrier conflicts between existing systems and planned new systems. Common situations include choosing to install a new roadside station simply because it will communicate with an existing station that is not compliant, or software barriers that restrict replacing a

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defective non-compliant sensor with a compliant one or one from a different vendor.

Purchasing agents must be given clear direction on an agency's integration goals.

Currently, it is left to the purchasing agency to decide whether to stay with an existing vendor or move towards compliant systems. Purchasing agents must be given clear direction on an agency's integration goals. It may be helpful to realize, however, that even integrating non-consistent systems with a District's existing RWIS architecture will ultimately lead to a more universally consistent system within an agency and with external partners.

A fundamental proprietary issue that must be considered in the integration process is data ownership. Each district has its own agreement with the vendor. However, in general, Caltrans owns the raw data that comes from the sensors, and the vendor owns the conversion formulas and applications that process the data. In the end, Caltrans owns the processed information in the database, but may not be able to access, interpret, or manipulate data at all steps of the process. This issue will have to be addressed before information can be fully shared with other agencies.

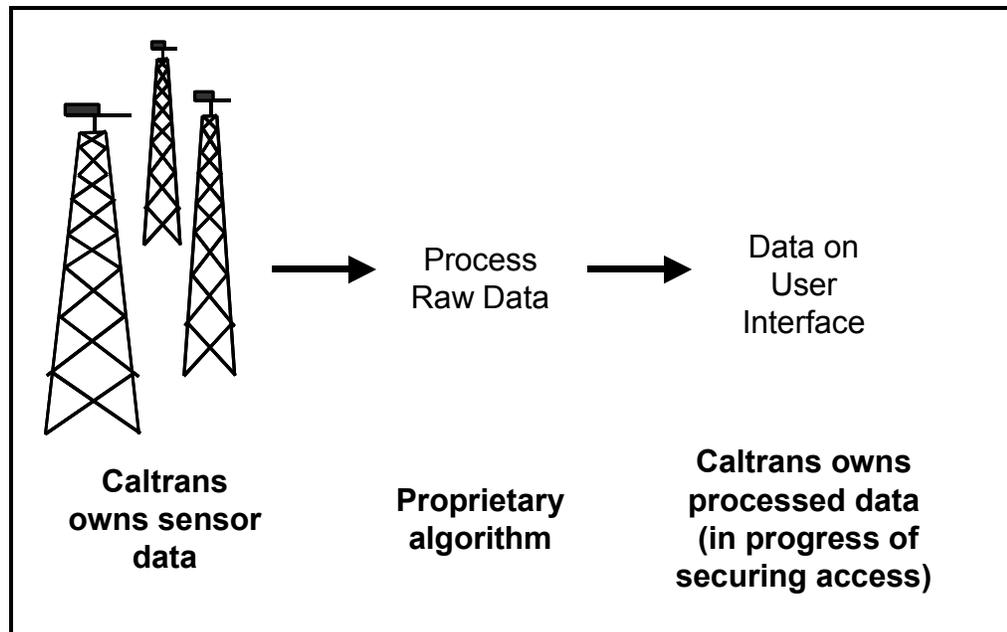


FIGURE 7-2 Caltrans owns data but vendor owns processing algorithm.

Recommendations

- Caltrans should explore the potential of inter/intra-District consistent systems as well as consistency with external partnering agencies.
- Educate purchasing individuals of the broad choice of RWIS vendors available.

- 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, and facilitate use of single communications network for all purposes.

Need of Dedicated Staff

The most successful RWIS programs in other states have at least one dedicated staff person at the state level. In California, no one's time is fully dedicated to RWIS. For example, District Electrical Engineers who facilitate the design of the systems have more experience with loop detectors, traffic signals, and ramp metering than with RWIS. Some staff in Districts and headquarters have gained good expertise and serve as advocates for the improvements in use and design of RWIS, yet these people also have other responsibilities. They don't have the time to track and participate in what is happening on the national level and to provide assistance to others in the state with less experience. Recommendation:

- Caltrans should dedicate someone at the state level for RWIS coordination who will champion implementation of recommendations from this report and support staff in Districts with their issues.

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Access to data

Sharing data with partners and server maintenance by vendors require that Caltrans allow at least some access to weather information. Caltrans has encountered problems in this area due to system security and related policies. Historically, vendors had been able to provide service, upgrades, and maintenance to the RWIS server because the system was been outside of the core Caltrans operations and its firewall. This has become an issue because the RWIS server has been moved inside the Caltrans network; thus there now is supposed to be a firewall between the server and the vendor. Caltrans Information Technology does not allow non-Caltrans computers past that firewall (See FIGURE 7-3).

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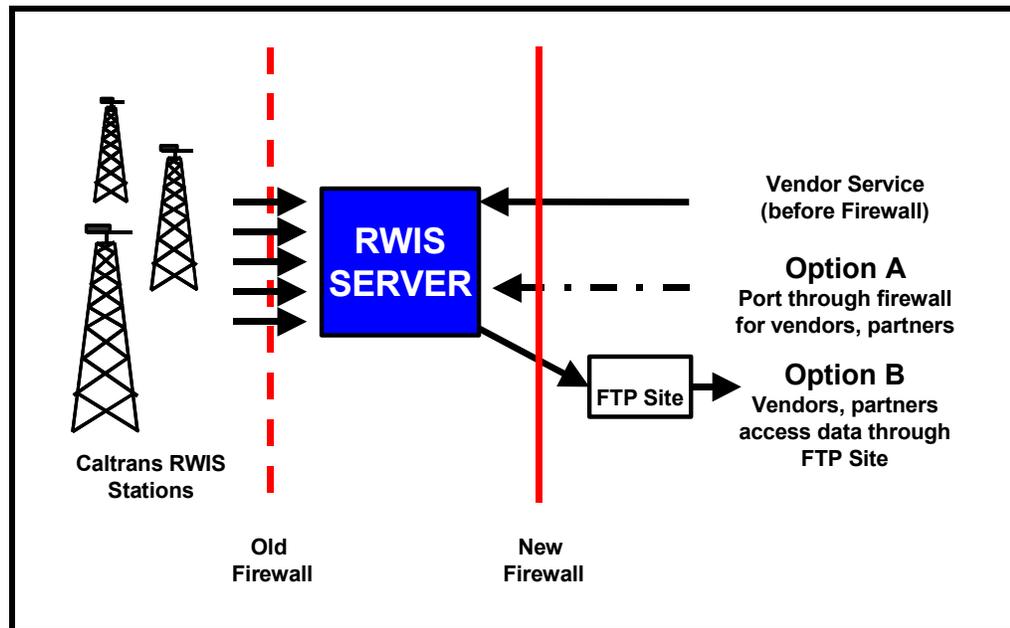


FIGURE 7-3 Access to data is limited by security issues.

Other organizations have addressed this issue by setting up a special port on the firewall that provides limited access to identified vendors and partners. Services related to decision support capabilities, where there could be a graphical display with RWIS data, satellite images, and Infrared images, are not possible without addressing this issue. Traveler information uses of data are also limited.

Recommendations:

- Caltrans should 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.
- RWIS sensor data should be considered to be in the public domain in order to facilitate their widest distribution and use.

Varied Users

Institutionally, one of the most difficult things for RWIS will be to implement changes for better data sharing, quality, and costs while respecting the differences in users of RWIS.

District Diversity

Each of the twelve Caltrans Districts operates independently and have historically been leery of requirements from headquarters. As mentioned in almost every District visited, the Districts know their needs and restrictions better than

headquarters. Differences in climate, population density, and topography affect the priority uses of RWIS. Staff expertise with RWIS also varies greatly by district.

The priorities for RWIS differ drastically between Districts. For example, in District 2 RWIS is used primarily for winter road maintenance. In District 3, the first priority is to provide information to the public. By contrast, District 6 believes that the RWIS data should be provided to partners for them to package for best use by the public. Their philosophy is that partners who are weather experts are better suited to provide current conditions and forecasts to the public than Caltrans (However, the headquarter maintenance TAC member believes that the forecasts that Caltrans receives from private vendors are capable of out performing the National Weather Service, providing forecasts by as much as six to eight hours earlier.)

Differences in climate, population density, and topography affect the priority uses of RWIS

The same type of weather conditions can impact the Districts differently because of the experience of the drivers. When snow hits the Grapevine in District 7 or the Tehachapi pass in District 11, it has a greater impact than the same storm hitting I-80 on Donner Pass in District 3 because southern Californians are generally less experienced at driving in the snow. Also, snow often attracts people to the area, adding to the traffic problems. Because of these differences, road maintenance and traffic operations in these southern California Districts deal with conditions differently and may have differing needs of RWIS.

Finally, the individual District policies have led to different definitions for warnings related to heavy fog, heavy rain, chain requirements, and other weather-related conditions. Drivers across the state expect consistency when they move between districts and encounter warnings, yet drivers' experience with these weather-related issues also differs by district. Drivers on the Grapevine in Los Angeles County react differently to the same amount of snow on the road compared to drivers on Donner Pass over the snow-covered Sierra Nevada on I-80. As Caltrans integrates data across the state, Caltrans should examine these differences and standardize definitions within geographic regions. 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 will need to provide access to explanations of differing criteria for warnings. Recommendation:

District policies have led to different definitions for warnings related to heavy fog, heavy rain, chain requirements, and other weather-related conditions.

- Regionally adopt standard definitions for weather terminology used in traveler warnings.

Types of Users

In many districts, traveler information is in many cases a secondary user, but this application is on the rise.

Any institutional improvements need to respect the three primary uses of RWIS by Caltrans: maintenance, traffic operations, and traveler information. For road maintenance crews and related dispatch, RWIS helps with scheduling crews for winter maintenance, deciding when and where to apply anti-icing, de-icing and abrasives for winter conditions, and monitoring worker safety. Traffic operations staff have different needs than maintenance, as they monitor the meteorological data provided by RWIS primarily to post messages and monitor conditions. In many districts, traveler information is in many cases a secondary user, but this application is on the rise.

At the same time that this project has been taking place, Caltrans has been working towards developing their 511 system. The first 511 system in California has been a transformation of the TravInfo 1-800 phone number in the Bay Area, which gives information about incidents on roadways and transit options. For the rural areas of California, weather information may serve a more significant role and Caltrans is still deciding how to incorporate this information. A recent national Gallup poll conducted on behalf of the national 511 coalition found that those polled felt road and weather conditions were the most important information to include in a traveler information system.

To reconcile these different needs, each District should define its primary purpose for RWIS and make investments and siting accordingly.

To reconcile these different needs, each District should define its primary purpose for RWIS and make investments and siting accordingly. For example, RWIS for traffic operations in District 6 (Fresno) is designed for Tulle fog, a condition that occurs during a window of time in spring and fall. Siting criteria and equipment criteria differ for this purpose than for black ice, for example. Maintenance in District 6 wants sites in icing trouble spots. Vendors and meteorological partners want a station at particular sites to improve forecasts. The District needs to site based on these issues.

Traveler information phone numbers, web sites, Changeable Message Signs, and Highway Advisory Radio all have the potential to improve travelers' access to information related to road and weather conditions and forecasts. Before implementation, however, reliability and liability issues will have to be considered. In addition, Caltrans must decide whether travelers' services such as forecasts fall within its overall mission.

Liability

The deployment of RWIS raises many liability considerations, some of which are briefly discussed below. This discussion is not intended to provide an agency with formal legal advice or even an exhaustive list of issues. Rather, this discussion highlights some general liability considerations that might be worthy of further

analysis. It should also be noted that no opinion is expressed as to the probability of success of such claims. This section is intended to make transportation officials aware of potential liability issues in advance of RWIS deployment, and to encourage them to seek legal counsel if they need further information or guidance.

Inadequate Reaction to Information

It may be useful to distinguish between situations where data collected through RWIS is used internally by a transportation agency, as opposed to situations where RWIS data is transmitted to other parties or the general public. However, even where RWIS data is collected solely for a transportation agency's internal use, potential liability issues remain. RWIS projects will tend to increase the quantity and quality of real time roadway information that a transportation agency possesses. Accordingly, it may be easier for claimants to prove:

1. that the agency had knowledge of dangerous conditions
2. that the agency had increased duties to undertake corrective measures
3. that an agency's response to certain roadway hazards was unreasonable under the circumstances.

On the other hand, data collected through RWIS might help an agency defend against certain claims; for example, to the extent that it *refutes* plaintiffs' allegations concerning roadway conditions.

Misinformation

The possibility of liability claims expands when information collected by RWIS is shared with the general public. The transmission of hazard warnings based on RWIS data is a good example. Traditionally, transportation agencies have been faced with liability claims relating to the location and readability of warnings. With the advent of RWIS, a transportation agency may also be faced with increased scrutiny of the accuracy, adequacy and timing of those warnings because the agency has enhanced real time RWIS data. Liability claims may also arise out of the failure to display a hazard warning, particularly where hazard warnings were previously displayed under similar circumstances.

In the event that a transportation agency more broadly disseminates RWIS data to other parties or the general public (e.g., via the internet, fax or telephone), an agency may face a claim that the data is incomplete, inaccurate, untimely or otherwise misleading. In order to minimize the risk of such claims, appropriate written disclaimers, limitations on liability, indemnity provisions and warnings

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should be provided with such data. If possible, the receiving parties should be required to formally agree to such terms before receiving the data.

Failure to deploy RWIS

Liability claims may also arise out of the failure to deploy RWIS. For example, an injured motorist might allege that a transportation agency was negligent in not installing a hazard warning system near the site of an accident, particularly if the agency had previously installed such systems in comparable locations. Similar claims might surface from other possible deployments of RWIS (e.g., de-icing), which if deployed, might have prevented an accident.

Malfunctions

Liability claims may also be asserted if RWIS devices malfunction (whether caused by technological failure or misoperation), or if such devices fail to produce adequate or reliable results. Under such circumstances, motorists might bring suits claiming their injuries were caused by these failures. In order to reduce the risk of such claims, an agency should not rely too heavily on new or unproven technologies. RWIS technologies should be thoroughly tested, and once deployed, they should be subject to appropriate monitoring and control. As a general rule, RWIS devices should not be deployed as substitutes for traditional safety measures.

RWIS technologies should be thoroughly tested, and once deployed, they should be subject to appropriate monitoring and control.

Shared liability

The deployment of RWIS will likely involve multiple parties, including equipment suppliers, maintenance contractors, and other service providers. While a transportation agency may seek to delegate various duties and responsibilities to such parties in connection with RWIS projects, the agency may remain directly liable to motorists who are injured on roads which are under their jurisdiction -- even if such injuries arise out of the other parties' failure to properly perform their delegated duties and responsibilities. The burden of such liabilities should be fairly and legally allocated among the parties. The agency should incorporate indemnification provisions and insurance requirements into all agreements with these parties.

Patents and copyrights

RWIS projects will likely incorporate valuable proprietary technologies that may be protected under intellectual property laws. Accordingly, agencies should obtain necessary licensures to avoid claims of misappropriation and liability for patent and copyright infringement.

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. Recommendation:

- Caltrans seek legal advice from a licensed California attorney with expertise in the field, prior to the deployment of RWIS projects.

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