Development of a Road Weather Information System (RWIS) Network for Alberta's National Highway System

Draft Report

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ABSTRACT

Developing an RWIS Network for Alberta's National Highway System

In support of Transport Canada's call for Intelligent Transportation Systems (ITS) proposals under the Strategic Highway Infrastructure Program, Alberta Transportation identified the need to develop an ITS blueprint for Advanced Traveller Information and Traffic Management Systems along Highway 2 between Edmonton and Calgary. A major component of this blueprint study was to design a network of Road Weather Information Systems (RWIS) for Alberta's National Highway System in order to increase safety through enhanced winter maintenance practices and traveller information.

The RWIS consultant used an innovative methodology that combined the road maintainers' knowledge, meteorological information, other relevant environmental and geographical data, traffic and safety data, and multi-jurisdictional station data into a Geographic Information System (GIS) model.

The first step in the Network Design identified important stakeholders within and outside of Alberta Transportation who will be affected or who can make a contribution to this RWIS network. Once user needs were identified, training sessions were held to assist many of the primary road maintenance users who had minimal exposure to RWIS and ITS. AT and contractor representatives then developed a list of candidate RWIS sites covering the NHS. The suitability of these candidate sites was evaluated from a macro perspective using the GIS model to ensure they were representative of the local regions.. The final phase of design involved data collection, micro-surveys for each individual site, and subsequent analysis of the site data and other relevant information. This ensured that equipment and sensors were placed to communicate data that was truly representative of conditions at the site.
Developing this GIS decision support model required a balanced view of road conditions. This meant including problematic " Hot spot" sites as well as a selection of "Trigger" sites that represented the conditions of a larger area. The model identified contiguous segments with similar maintenance requirements by associating them with the features that affect the degree of road maintenance required (e.g. topography, vegetation, meteorology, traffic volumes, proximity to water).

The proposed RWIS architecture was developed in accordance with the ITS Architecture for Canada to facilitate data exchange with legacy systems and other ITS systems. The RWIS network may be able to feed relevant information to potential ATIS (Advanced Traveler Information System) and ATMS (Advanced Traffic Management System) for Highway 2. This will benefit the drivers with road and weather information in real time. The Alberta RWIS network model will serveas a blueprint for future network expansion should Alberta Transportation choose to expand the network to other parts of the province.

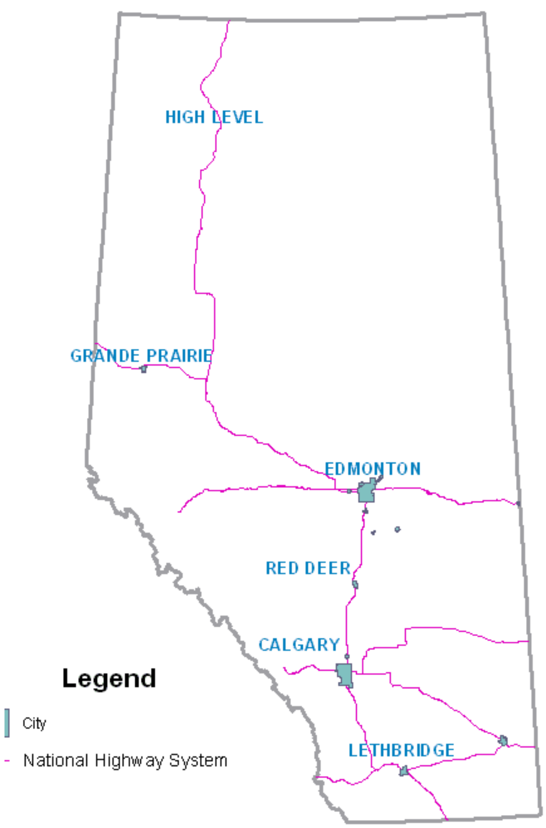
1.0 BACKGROUND

Transport Canada's Strategic Highway Infrastructure Program (SHIP) ITS Initiative identified the need to develop blueprints for an Advanced Traveler Information System and a Traffic Management System for Highway 2 between Edmonton and Calgary. Based on this initiative and the special needs of Hwy 2, Alberta Transportation secured funding for this project. The project also identified the opportunity of using Road Weather Information Systems (RWIS) technologies to enhance winter maintenance operations and provide input to the province's National Highway System (NHS) and the traveller information system.

A working committee consisting of representatives from each province and territory drafted a "Road Weather System for Canada" (RWSC) proposal for review by Transport Canada and Environment Canada. The main points of this proposal were:

- Build a national network of RWIS stations in a coordinated, consistent manner
- Federal and provincial governments to cost-share on capital and installation costs

From discussions held between all the provinces' representatives at the working group sessions, a station distribution formula was agreed to based on each province's winter severity, density of the network, and budget availability from Transport Canada. For Alberta, the maximum number of stations proposed was 70. They are to be strategically placed on the designated 3400 kms in the National Highway System (NHS) to become part of a national network. Completion of a strategic plan for their RWIS network positioned Alberta Transportation (AT) to advance final designs and deploy the network as soon as funding became available. The systematic approach to site selection and network design ensures that maximum benefit to Alberta's maintenance operators, meteorologists and stakeholders is realized from the infrastructure investment made by the project sponsors.



The proposed RWIS architecture for the Alberta RWIS NHS Network has been developed in accordance with the ITS Architecture for Canada to facilitate data exchange with existing and other proposed ITS systems. The RWIS network may be able to feed relevant information to potential ATIS (Advanced Traveller Information System) and ATMS (Advanced Traffic Management System) for Highway 2 benefiting drivers with real-time road and weather information.

Fig 1.0 Alberta National Highway System

Abbreviations and Definitions

AT	Alberta Transportation
ATIS	Advanced Transportation Information System
ATMS	Advanced Traffic Management System
CPU	Central Processing Unit
EC	Environment Canada
FAST	Fixed Automated Spray Technology
GIS	Geographic Information System
ITS	Intelligent Transportation System
MCI	Maintenance Contract Inspectors
MSC	Meteorological Services of Canada.
NHS	National Highway System
NTCIP	National Transportation Communication for ITS Protocol.
RPU	Remote Processing Unit
RWIS	Road Weather Information System
RWSC	Road Weather System for Canada
SHIP	Strategic Highway Infrastructure Program
VAM	Value Added Meteorologist

2.0 METHODOLOGY

RWIS sites were selected based on road maintainers' knowledge of the region, meteorological patterns, traffic and safety data, other relevant environmental and geographical data, and other available multi-jurisdictional data. An innovative approach combined this information into an RWIS Network Site Selection GIS (Geographic Information System) model of the provincial network. This model could be expanded to provide pavement condition information for the entire network, other ITS applications, or part of a customized Maintenance Decision Support System.

The first step in the Network Design process was to identify important stakeholders within and outside of Alberta Transportation or those who could contribute to this RWIS network. Once user needs were identified, training sessions were held to assist many of the primary road maintenance users who had minimal exposure to RWIS and ITS. AT and contractor representatives then developed a list of candidate RWIS sites covering the NHS. The suitability of these candidate sites was evaluated from a macro perspective using the GIS model to ensure they were representative of local regions. The final phase, data gathering, included on-site, micro-surveys of the candidate station sites and analysis of the site information. This ensured that equipment and sensors were placed to communicate data that was truly representative of conditions at the site.

A key criterion in developing this GIS decision support model was to ensure a balanced view of road conditions. This meant including problematic "Hot spot" sites as well as a number of "Trigger" sites that were representative of the conditions for a larger area. The model identified contiguous segments having similar maintenance requirements by associating them with features that can affect the degree of road maintenance required (e.g. topography, vegetation, meteorology, traffic volumes, proximity to water, etc.).

The Alberta RWIS network model will serve as a blueprint for future expansion of the network should Alberta Transportation choose to include other parts of the province.

2.1 Training

Training was the first step in achieving buy-in from all the stakeholders. Up until 6 or 7 years ago, maintenance operators did not widely perceive a need for technology to perform winter maintenance activities. The situation changed with increased pressure to reduce costs, maintain safe roads, enhance mobility and minimize the impacts of their activities on the environment.

Pivotal to a new approach was the employment of technology that could enable decision support systems. One of the primary obstacles to widespread deployment of technology solutions was the difference in understanding of the objectives, technology, and potential benefits of the technology by managers and practitioners of maintenance operations. Knowledge of RWIS capabilities and its potential role was even more limited at the operator level – often the end users of the technology.

Experience has shown that it takes up to three years for the technology to become fully integrated into a maintenance operator's business process. The buy-in process can be started earlier, by initiating the training concurrently with the development of the decision support system and allowing practitioners to participate in the design, resulting in faster integration into maintenance operations.

2.1.1 Study Objectives

The province of Alberta had previously developed a high level vision for implementation of ITS in the province. The purpose of this study was to develop the vision into a functional level plan for some areas along the Highway 2 corridor and detailed design some specific ITS components including RWIS.

Alberta Transportation's objectives of the RWIS component of the project included:

- Enhancement of traffic safety and operations of Hwy 2 between Edmonton and Calgary including Deerfoot Trail in Calgary and Anthony Henday Drive in Edmonton
- Enhance winter maintenance performance on the National Highway System
- Provide a detailed plan for RWIS deployment including detailed equipment specifications for road and atmospheric sensors and the linkage to the proposed ITS systems.

2.1.2 RWIS role in Winter Maintenance (See Figure 2.1)

The primary user of RWIS information is the maintenance operator. RWIS information helps meet objectives relating to:

- Safety
- Environmental protection
- Fiscal responsibility
- Mobility and maintenance efficiency to achieve approved winter maintenance level of service
- Monitoring and validation of maintenance activities.

Environment Canada and Alberta Transportation have become increasingly concerned with the amount of road salt being used in winter road maintenance operations due to the cost and the negative impact on the environment. A stakeholder "needs assessment" revealed that more accurate road and weather condition information can assist maintenance operators to:

- Remotely monitor atmospheric and pavement conditions across the province
- Facilitate forecasting of pavement conditions
- Document the application and effectiveness of deicing chemicals
- Enable a more efficient, proactive approach to winter maintenance.

"Salt Management" refers to the control of winter maintenance application of deicing chemicals and abrasives and related activities. The RWIS network blueprint provides recommendations and an action plan that addresses salt management and documentation of winter maintenance activities required.

Existing condition Information gathered by the maintenance operator's RWIS system information can be made available to other ITS subsystems including ATMS and ATIS. This enables system operators to manage traffic on the province's highway network and the travellers to make informed pre-trip and en route decisions.

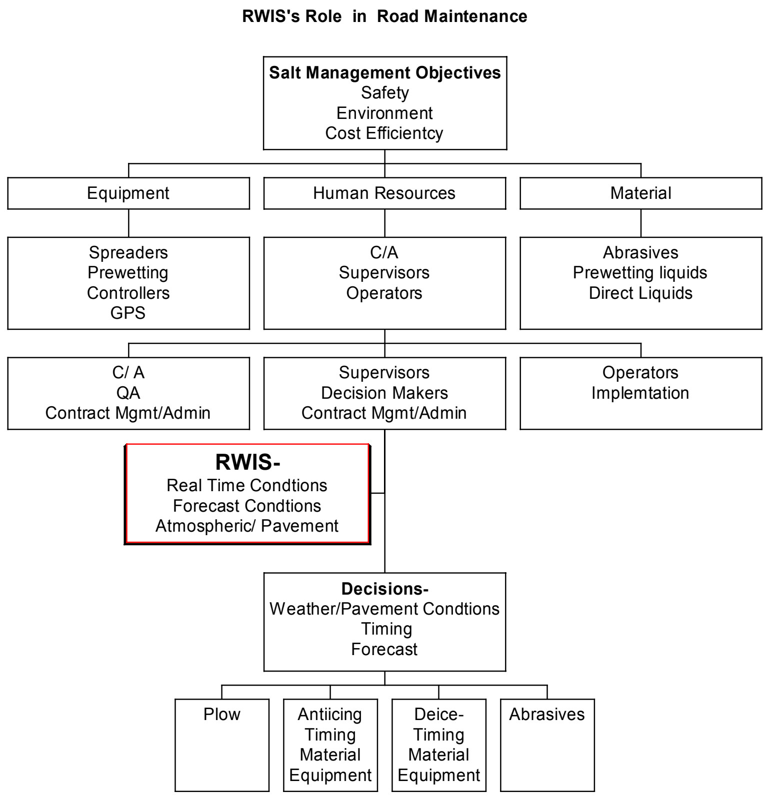


Figure 2.1: RWIS Role in Road Maintenance

2.1.3 RWIS Technology Description – Basic Site

RWIS data is collected from hardware at the site. The pavement sensors measure surface temperature, subsurface temperature, freezing point of liquid on the road surface, chemical concentrations of liquid (deicing chemical) on the road surface, moisture thickness, and pavement condition (i.e. ice covered). Passive sensors determine the freeze point by measuring the conductance of the moisture on the surface and correlating it to the conductance of various concentrations of a known chemical solution. They work well if only one type of deicing chemical is present.

Atmospheric sensors measure air temperature, wind speed, wind direction, precipitation, relative humidity, and barometric pressure.

This information is important to road maintenance and the value added meteorologist (VAM) forecaster.

"Basic" roadside equipment at a typical RWIS site consists of:

- Passive pavement sensor
- Air temperature sensor
- Relative humidity sensor
- Precipitation sensor which indicates if precipitation is occurring and what type (considered advanced in RWSC proposal)
- Wind speed and direction sensor
- A remote processing unit used to collect and store the data
- Modem to send information to a server
- 10.0m fold over tower for mounting sensors to achieve desirable exposures.

2.1.4 Advanced RWIS options

Depending on the nature of the problem and the information required from a site, additional equipment might be added to a "Basic" RWIS site including:

- Active pavement sensors. Active sensors determine the freeze point by cooling the sensor and freezing a sample of the moisture. They function regardless of the chemicals present in the deicing solution. This function is significant when anti-icing or pre-wetting techniques are employed.
- FAST (Fixed Automated Spray Technology) system. This is an automated detection and anti-icing system.
- Video camera to provide digital images visually validate the information provided by sensors.
- Visibility sensor to detect fog, blowing snow and other restrictions on visibility.
- Traffic Counters to measure traffic volumes.
- Advanced Environmental Sensors to provide additional atmospheric information including rain gauge, snow depth, stream/water level, and solar radiation.

2.1.5 Site Location Problem Outline

Alberta is a geographically diverse province. Topography, climate, water resources, traffic volumes, and weather and road conditions can vary significantly across the province, region and even districts. Weather conditions are currently forecasted by Environment Canada under contract.

Alberta Transportation administers contracts for road maintenance. The contractors' foremen and AT maintenance contract inspectors (MCI) obtain forecasts from Environment Canada, compare it to other publicly available sources and, based on their experience and observations of the road system in the field, extrapolate a start time for a weather event. Once there is sufficient accumulation of precipitation for rock-salt or sand-salt to adhere on the road surface, contractors begin their maintenance operations based on what they feel is the best approach. Most municipalities in Alberta operate in this conventional, reactive mode.

Alberta Transportation and their road maintenance contractors are aware of the concepts of proactive winter maintenance. "Anti-icing" is the timely application of suitable deicing chemicals and abrasives to prevent ice and snow from bonding to the pavement. This is ideally performed before the start of precipitation. Significantly less effort and less chemical is required to prevent bonding rather than melting through accumulated hard pack and ice to break the bond.

If road salt or abrasives are applied before there is an accumulation of ice or snow, the product will simply bounce off the road during application or be blown away by passing vehicles. While this problem has resulted in the development of a range of products and techniques, all of them have limitations that are primarily dependent on pavement temperature versus air temperatures. Most anti-icing practices are based on the application of a liquid to the salt, sand or even directly onto the road. Without expertise and the knowledge of what road temperatures will be in the future, what may have been appropriate during the initial application may have disastrous consequences as pavement conditions change.

2.2 Needs analysis

All system requirements should support end user needs. An overview of RWIS and its potential role was provided to maintenance operations and other potentially benefiting groups. The needs identified by these key stakeholders were translated into site locations, market packages, and sub-user packages. Based on feedback from AT, a potential list of targeted stakeholders was developed. Structured surveys were prepared and interviews conducted with each of these groups. A synopsis of collected comments is provided in Appendix C.

The results of this needs assessment activity highlights following observations as they relate to RWIS and were reflected in ITS system requirements.

- The primary needs of the majority of ITS users are concentrated in the areas of road conditions and traffic information, incident management, and road weather information systems.
- Data collection, data management, and inter-agency coordination are key aspects that support the primary needs. The sharing of information electronically and coordination among agencies is a particularly strong theme in the needs identified.
- Road weather information system applications should be viewed from the broader need for an inter-provincial and international network.
- There is an overall desire for integrated, efficient, and effective ITS applications based on proven and compatible technologies.

3.0 RWIS SITE SELECTION MODEL DEVELOPMENT

The ability to forecast pavement conditions is a prerequisite to implementation of a cost effective, environmentally responsible, anti-icing approach to winter road safety and maintenance activities. Maintenance operators must manage resources based on regional conditions as well as specific conditions at problem locations. Over time, experienced operators and decision makers have been able to build knowledge-based models based on cues from available information sources. Pavement conditions inside and outside of their region, however, vary with numerous geographical, operational, and metrological factors. Through experience gained over years of patrolling the network, they know how pavement conditions change across it.

Therefore, to initiate the site selection process, maintenance contract inspectors (MCIs) were requested to propose two candidate RWIS sites approximately every 50 kilometers along the highway network. The first was a location which they felt was representative of the conditions of a larger geographical area and the second representative of a problem location.

3.1 Location Types – Trigger and Hot Spot

The 50 km spacing was selected to coincide with the National RWSC proposal (3400 km / 50km between sites = 68 Sites ~70 site allocation).

From prior experience, when requested to identify locations for remote RWIS stations, maintenance personnel typically select problem sites. Using only this rationale for selection would have resulted in 70 well-instrumented problematic locations but limited value for making proactive decisions regarding when and how the fleet of maintenance vehicles should be mobilized. Maintenance costs could increase without the corresponding benefit to the network as a whole.

During interviews with maintenance personnel, it was determined that experienced operators could predict the onset of adverse conditions at problem locations given accurate weather and pavement conditions for the zone around the problem sites. By observing trends for the relevant atmospheric and pavement conditions for their zone and having the benefit of similar information from a network of RWIS sites in adjacent jurisdictions, maintenance operators are expected to have a better sense of the existing and forecasted conditions for their specific zone of interest – including the entire network and most problem locations. In most instances when discussing the prospect of only one site within their 50 km zone, patrol supervisors preferred to select a representative *"Trigger" site.*

As noted previously, the province has diverse maintenance requirements and is subject to widespread variations of weather, traffic volumes and topography. With only 70 site locations from which to extrapolate conditions, there remains potential winter maintenance risk on 3400 kms of roadways. Much of the roadway is typical and some problem locations can be predicted. However, some locations exist where Hot Spots are difficult to predict based on conditions in the region, and still others exist that are so problematic and the cost of incidents so high, that prediction and detection of icing and de-icing response must be instantaneous to prevent serious consequences.

As such, it was necessary to analyze the highway network to identify:

- Sections which might be represented by the approximately 120 RWIS candidate problem (Hot Spot and Trigger) sites.
- Problems and information noted or requested for the specific region.
- Type of equipment and options required to address the information need.
- *"Hot spots" are point-specific locations and usually are not representative of a region*. As such, Hot Spot locations must be highlighted such that their environmental data recognized by those not intimately familiar with them and interpreted accordingly. These sites are of limited value for use by others in forecasting and extrapolating pavement and environmental conditions.

A "Macro RWIS Selection Model" using GIS software was developed to validate the candidate sites and to identify the zone/regions that each RWIS site represented.

3.1.1 Macro RWIS Selection Model

The macro review criteria included parameters important for locating the sites from a "high level" perspective so that they would be representative of a larger geographic area. Data supplied by Alberta Transportation and generated by the study was imported into the model and matched against the candidate sites. The model addressed relevant features including natural environment (e.g. regional meteorology, topography, vegetation, water resources) and operational (e.g. highway network sections, bridge locations, collision statistics, traffic volumes, candidate sites, other environmental stations).

Zones with similar properties were identified around each of the Trigger type (typical) candidate RWIS sites.

3.1.2 Micro Scale Criteria

At this point, sufficient information within the model was available to assess the regional zone of influence from a macro perspective. However, once the candidate site locations were input into the

Macro RWIS Selection Model and the regions of influence zone defined, the site selection process required more input to determine which sites could be short listed to pare the total to 70 sites.

Another task was to confirm equipment placement proposed by field staff to ensure that Trigger sites would portray representative conditions reflective of the larger region and that Hot Spot sites would expose the specific conditions that made it a Hot Spot.

To gather the appropriate field information, AT Field staff and interested AT maintenance contractors were provided with general RWIS site selection and survey training. They were provided with a structured site survey form to be completed at the site. This form included pertinent information describing a site's general location, layout and the intended use. . The field staff also completed an evaluation of site suitability and described potential problems, information descriptions, and relevant existing pavement surface condition information. The micro scale review criteria encompassed features specific to the site which may have precluded the location from being representative of the larger zone. Trigger sites emphasized ease of servicing with power and communications whereas problematic locations were more focused on detecting the actual problem and the relevant physical conditions that cause the problem. These site descriptions, surveys, photos, video, maps, and site sketches and characteristics were used to evaluate the sites.

Some of the main micro characteristics reviewed were:

- Physical geography
- Soil type
- Sky view
- Obstructions
- Vegetation
- Topography
- Proximity to water courses/structures
- Utilities
- Road conditions
- Road rehabilitation schedule
- Road right-of-way boundaries
- Security for the field equipment

Field staff also identified specific information still required to confirm pavement conditions for the site and on the Trigger sites - the zone represented by the RWIS site.

On the basis of the information provided, the modeling was completed, the short-listed sites chosen, and the redistributed zone of influence for the trigger RWIS sites mapped.

3.1.3 Other Environmental Monitoring Sites

One of the objectives in developing the Alberta Transportation RWIS system was to cooperate with other adjacent agencies that already had strategically located RWIS or environmental station sites. By exchanging information, Alberta Transportation could achieve the most complete network of RWIS information for the lowest cost.

To this end, the authors and Alberta Transportation Staff initiated discussions with the City of Calgary, the City of Edmonton, Alberta Agriculture and Alberta Environment for a cooperative exchange of information.

The City of Calgary began installing their network in 1988 and as of 2002 had seven sites located across the city; four of which are located on the Deerfoot Trail. Sites are spaced approximately 30 kilometers apart in rural areas and are more densely spaced in urban areas.

4.0 FAST - FIXED AUTOMATED (or ANTI-ICING) SPRAY TECHNOLOGY

FAST is the combined use of Road Weather Information System (RWIS) and spray de-icing systems. It has been available in Europe for 20 years but has only recently made its way to North America for roadway applications.

Based on collision statistics, research, and the experience of other agencies, potential problems exist at a number of structures on the study corridor during winter storm events. By implementing a program of remote sensing of ice and frost using RWIS and automated application of liquid de-icing/ chemicals, anti-icing of the surface immediately before freezing at critical locations may significantly improve de-icing response times. Significantly less de-icing chemical is required to maintain the same level of service. The reduced volume of de-icing chemical justifies the economic use of less corrosive and more environment friendly inert de-icing chemicals that are otherwise cost prohibitive. In cases where steel or concrete structures are involved, FAST significantly improves the cost benefit ratio of implementation.

The Ministry of Transportation Ontario (has completed a review of a FAST system, which they installed at the Highway 416/401 northbound, high-speed, freeway-to-freeway interchange ramp. , MTO has deemed the FAST system a resounding success. The results from the first three winters of operation revealed that there had been an impressive 100 percent reduction in the number of accidents – from fourteen in 1999/2000 to zero for 2000/2001, 2001/2002 and 2002/2003.

4.1 FAST Warrants

From the analysis of stakeholder needs, concerns were often expressed by stakeholders regarding maintenance problems at structures in close proximity to watercourses. Employing the RWIS Network Selection GIS Model, the team identified and subsequently reviewed a number of identified problem structures along Highway 2. These locations were reviewed to establish the relative priority for increased winter maintenance attention.

These structures include:

- Bow River Bridge
- Bow "Bottom" Bridge
- Calf Robe Bridge
- Red Deer River Crossing
- Blind Man River Crossing
- Battle River Crossing
- Anthony Henday Drive (AHD) North Saskatchewan Crossing
- AHD and Calgary Trail.

Existing problem locations are easy to identify and to prioritize based on collision statistics. Identification of problem locations on new facilities must be assessed on the basis of the projected warrants. A model was developed to project the warrants and assess the relative priority for installation.

4.2 FAST Warrant Factors

Structures have statistically been more susceptible to dangerous winter conditions than other roadway elements. They are subject to a greater frequency of collisions primarily because conditions differ from the adjacent road. This phenomenon may be exacerbated by proximity to open water and features that keep water open all year round. Motorists often encounter these structures while driving in accordance to the predominant roadway conditions rather than with due regard for the specific bridge conditions that are often unexpectedly worse.

The severity and frequency of the collisions increases depending on the following factors:

- Traffic volumes
- Speed
- Horizontal alignment
- Proximity to open water
- Profile grade of the approach and structure
- Length of structure.

Based on the FAST warrant review, the structures were ranked in terms of their priority for installation of FAST. Two structures, one on Anthony Henday drive in Edmonton and one on Calf Robe Bridge in Calgary, have been identified in the short term plans for deployment on a demonstration basis.

5.0 RWIS IMPLEMENTATION PLAN

The implementation plan addresses the deployment of the Alberta Transportation RWIS network and will discuss:

- Selected sites and deployment phasing
- Architecture/user interface
- Implementation process
- Roles and responsibilities
- Post deployment system operation
- Contracting

5.1 Selected Sites

Figure 5.1 identifies the selected RWIS sites, the zone of influence, and the corresponding type of site (Trigger or Hot Spot).

5.2 Deployment Phasing

Given the timeline for supply and installation of the equipment, the available funding, and the capacity to provide technical support to AT and contractor staff, a three year deployment plan was selected. The implementation priority of these 70 sites was based on an assessment of the need for RWIS and maximizing the benefit.

Based on the study objectives, several methodologies and rationale were reviewed to determine the desired plan of action for rolling out of the RWIS network. Though discussions with AT staff, the preferred option for 2003/2004 deployments was to involve RWIS installations along the CANAMEX North South Trade Corridor from the southern Alberta border to Grande Prairie.

“Advanced” pavement sensors are considered to be state-of-the-art with respect to pavement condition detection. Freeze point of deicing chemical mixtures is measured rather than extrapolated from calibrated deicing chemical algorithms as is the case from passive sensors. The concept of advanced pavement sensors will be evaluated as a demonstration and potentially their use extended in subsequent phases. With the interest in salt management, most maintenance operators (including the province of Alberta) are moving towards the pre wetting and anti-icing approach, which involves chemical mixtures rather than use of one single pure deicing chemical.

Since passive sensors use a conductance measurement to extrapolate, there is some question as to how accurately they report the freeze point of mixtures and as such identify the need to re-apply chemical. Active sensors in theory, and in practice, have been proven to accurately predict and report freeze point and are imperative for FAST systems. They are, however, some shortcomings with active sensors. Since they are thermally active (able to change sensor surface temperature), active sensors still must be used in conjunction with passive sensors to accurately report pavement temperature and conditions. Active sensors also require additional power and there are only a limited number of vendors with active sensors. There is some question as to the life expectancy of the sensors and the operating range. However, where freeze point is important and a mixture of deicing chemicals is present, active sensors or some other system of measuring freezer point type is imperative. This opinion is supported by the move from RWIS vendors to develop active sensor technology. As such, further testing is proposed and "Advanced" pavement sensors are suggested at locations where pre-wetting is employed. The suggested distribution is 25% of sites in rural areas to have advanced pavement sensors and 50% of urban or high volume areas to have advanced pavement sensors.

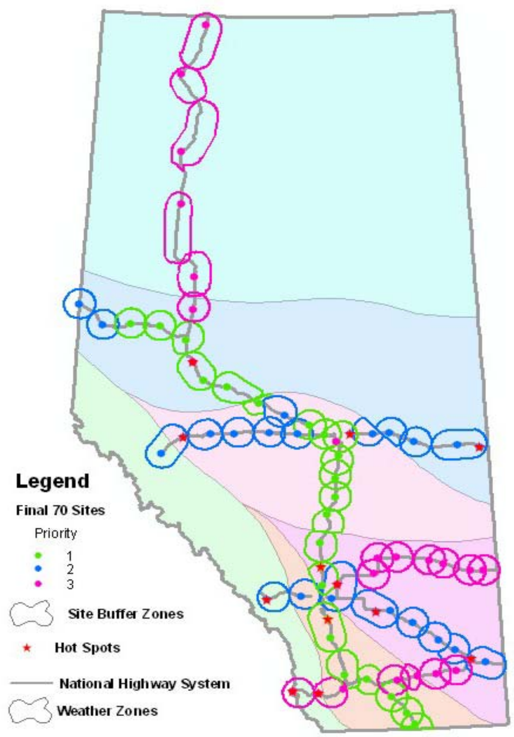


Figure 5.1: The preferred phasing

5.2.1 Year One (2003/2004) Deployment - CANAMEX North South Trade Corridor (22 Sites)

The CANAMEX North South Trade Corridor links was selected since:

- It is an important international trade corridor linking Canada to the US and Mexico.
- The balance of the ATMS/ATIS study focuses on Hwy 2 between Edmonton and Calgary including Deerfoot trail and Anthony Henday Drive.
- Hwy 2 constitutes a significant portion and the highest volume portion of the corridor.
- A large variety of traffic travel sections of the route including commercial, commuters, tourists, business and pleasure, and long-haul / short-haul trips.
- The entire route will benefit from RWIS information

- Covers a range of contract management areas and provides exposure to a range of contractors and maintenance contract inspectors.
- Covers a range of topography and 4 of 6 micro-climate zones
- Covers some of the routes with the highest historical salt application rates in the province.
- Range of pre-wetting practices.

The first year (2003/2004) deployment involves installation RWIS sites along the CANAMEX North South Trade Corridor from the southern Alberta border to Grand Prairie.

Year One Scope

- 22 of 27 sites along the CANAMEX North South Trade Corridor
- 4 sites along Hwy 43 deferred due to twinning of these control sections
- 1 site on Anthony Henday Drive deferred until completion of AHD construction (projected for 2005)
- AT central server installation at a location in the City of Edmonton.
- Data collection in year one by Environment Canada using the AT RWIS server.
- User interface provided by Environment Canada based on data from the Contractor supplied AT central RWIS server

Timing

- Completion by March 31st, 2004

Equipment

- 14 "Basic" Sites
- 8 Basic (Passive) plus Advanced pavement sensors at demonstration sites (allocation based on a density of 50% urban/high volume and 25% rural)
- 2 Video camera sites

Estimated Cost

$2,100,000 (Two million one hundred thousand dollars)

5.2.2 Year Two (2004/2005) Deployment – Hwy 1 and Hwy 16 East West Corridors (25 sites)

Year Two deployment will complete the balance of the sites in the CANAMEX North South Trade Corridor along the Highway 43 corridor with installations on Hwy 1, 3 and 9 leading to Saskatchewan. The balance of the Year Two deployment will be phased-in based with pre-wetting implementation. RWIS can assist the road maintenance decision makers with remote sensing of conditions, but this is not the primary benefit. RWIS benefits will come from the ability to predict conditions which allow maintenance procedures to be adapted on an ongoing basis to suit the forecasted conditions. This will assist road maintainers to the greatest extent when implementing anti-icing procedures such as prewetting. The combined use of RWIS and prewetting has been widely reported to achieve the objectives of safer roads with less environmental damage at the lowest possible cost. If pre-wetting is not available, then the benefits of RWIS and return on investment will be marginal.

As such, the Year Two implementation priorities were set to maximize return with respect to safety (i.e. collisions) by ensuring that RWIS and pre-wetting can be used in tandem. The use of pre-wetting and other anti-icing techniques are primarily geared to moderate (by Canadian standards) winter weather conditions. The benefits of RWIS will be most evident in climates with frequent oscillations around the freezing point. As such, the second phase will focus on the south in the more moderate climate zones.

Year Two deployments will complete 3 out of the 4 sites in the CANAMEX North South Trade Corridor along the Hwy 43 corridor (deferred from Year One); as well as installations on Hwy 1 and Hwy 16 linking Alberta to Saskatchewan and British Columbia. The balance of the Year Two deployment will be phased based on the existing pre-wetting implementation by AT.

Year Two Scope
- 25 sites along the two major East West corridors (Hwy 1 & 16)
- Including 3 of the 4 along Hwy 43 deferred from 2003/2004
- Existing AT central server in Edmonton from Year One deployment
- Primary data collection in Year 2 by Environment Canada or private sub-contractor using the AT central server.
-

Timing
- Completion by March 31st, 2005

Equipment -
- 17 "Basic" Sites
- 8 Basic (Passive) plus Active pavement sensor sites
- 1 Video Camera site

Estimated Cost
$2,200,000 (Two million two hundred thousand dollars)

5.2.3 Year Three (2005/2006) Deployment - Northern /South Eastern Alberta (23 sites)

Year Three deployments will complete the installation of all 70 sites on Alberta's National Highway System. The remaining two sites deferred from Year One will also be included: one on Hwy 43 and one on Anthony Henday Drive scheduled for completion in 2005. The balance of the Year Three deployments will also be phased in based on pre-wetting implementation.

Year Three Scope
- 23 sites completing deployment on the NHS including the remaining 2 sites deferred from year one.
- Server installation in Grande Prairie
- Hwy 3,9 and 35
- Primary data collection in year 3 by Environment Canada or private sub-contractor using the AT server.

Timing
- Completion by March 31st, 2006

Equipment
- 17 "Basic" Sites
- 6 Basic (Passive) plus Active Pavement sensor sites
- 1 Video Camera site

Estimated Cost
$2,050,000 (Two million fifty thousand dollars)

6.0 ARCHITECTURE

RWIS has been identified as an element in the Canadian ITS Architecture.
Of the 35 user services, there are three directly supported by RWIS

- Environmental conditions management (includes directly RWIS equipment)
- Operations and maintenance
- Weather and environmental data management

Traffic management for use by maintenance operators gathers roadway, weather, environmental data and relevant road maintenance information from roadside sensor systems.
Based on the pavement and atmospheric conditions observed and forecasted, a range of maintenance processes and equipment can be employed. A preferred method of operation is to employ forecasts of road and atmospheric conditions prepared for a specific user and for the specific location of the equipment. Although mobile equipment may be used to monitor and document existing conditions, only a complete suite of atmospheric, pavement and subsurface conditions can facilitate a pavement condition forecast.

Once site-specific, pavement condition forecasting services become available, maintenance operators can develop a systematic approach to maintenance management. A customized maintenance management system can be developed to address the metrological, geographic, operational, equipment capacity, and material capability specific to the jurisdiction of the site or region.

Data is collected, validated, and placed in a structured database. Information is then available to be retrieved by a user. The system can deliver the information in a form suitable for their purpose. These users may include:

- Maintenance operators
- Travelers
- Meteorological services (Environment Canada).
- Environmental analyst

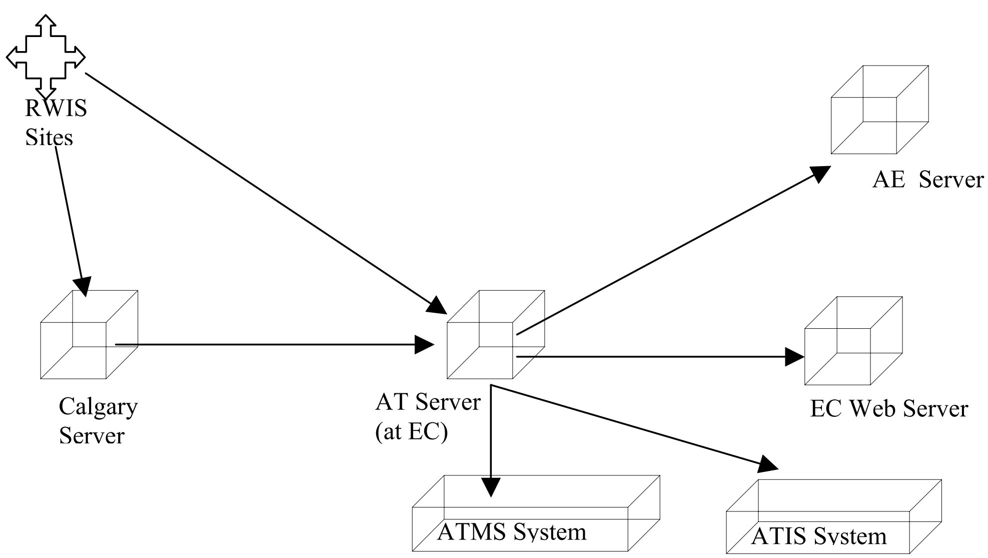


Figure 6.0: RWIS Architecture (Year One Configuration Shown)

Alternatively software programs can be developed to look for specific data, events or sequences of events and generate a message or execute a task. As an example, if a data string is not acceptable an appropriate message could be emailed to a system administrator.

6.1 Central Server

Pavement and atmospheric sensors at the remote RWIS site measure conditions in terms of low voltage analogue, digital, and pulse signals. The RPU (Remote Processing Unit) at each RWIS site measures the signals at regular intervals, translates them into numeric values, and logs the data in a proprietary database against time and sensor type. The processor has the capability to store a limited volume of data at the site before it must overwrite the memory. Thus, a central data server collects this information from the site on a regular basis. The "age" (degree to which the site information is real time) is determined by the frequency of the site RPU being polled by the central server. The central data server polls all sites in a cycle and stores the raw numeric data in a central database.

In order for the data server to poll the RPU site, it must understand the data structure and language that the RPU is using to store and transmit the data. This data structure/language is referred to as the data and communications protocol.

Development of a universally acceptable communications protocol and data structure has been a tremendous challenge for agencies that employ RWIS technology on a large-scale basis. Without a common communications protocol and data structure, agencies must deal with one vendor potentially limiting their choice to that vendor's hardware and software. As technology advances, the original vendor's equipment may not be priced competitively or may not be able to function with additional complementary sensors.

ITS Canada (Intelligent Transportation Systems) Canada has been working towards development of a universally accepted standard and architecture which will allow interoperability between a range of vendors' equipment and related systems. The currently suggested standard is NTCIP–ESS. Manufactures of RWIS equipment have slowly been moving towards this standard and a number are currently compliant. However, not all vendors are there yet. Environment Canada have been playing a pivotal role since 1996 in collection of environmental and RWIS data from a range of vendors and incorporating the information into their Mesoscale Meteorological Model as well as their Pavement Condition Forecast Model. They have successfully worked with numerous vendors and are able to present the results of existing conditions, historical conditions, and forecast conditions using an internet browser rather than the expensive, proprietary interfaces sold by each equipment vendor to serve only their line of RWIS equipment.

6.2 Information Dissemination- User Interface

Environment Canada currently provides data collection, server administration, web-enabled user interface, and pavement condition forecasting services for the City of Calgary, and for many of the provinces (including the existing provincial network in Ontario). Their system automatically polls data from RWIS sites, stores the data, and provides the information on a password protected client customized internet web page. Users have ready access to sites from multiple vendors on the same web site with the same, standardized view. By using the Environment Canada server, Alberta Transportation would not need to purchase a server or software. However Environment Canada typically provides only limited data archive services and charge for long-term data storage and management. Environment Canada has been advising their clients that Treasury Board has given notice that their services should be migrated to the private sector in the next few years including local forecasting services. If Environment Canada were to divest of this role, it would leave Alberta Transportation in a precarious position with a substantial investment having been made in roadside equipment, but no way to collect the data, archive it, display it, or manage it.

An alternative method of information dissemination is to use a vendor's server and software which would collect the data from an Alberta Transportation owned server and be accessed through the vendor's web site. Although a limited number of vendors claim to have NTCIP compliant software which works with their NTCIP-ESS roadside hardware, compliance is difficult to test – especially for interfacing with other vendor's NTCIP-ESS compliant equipment as some data fields are allowed to be vendor specific.

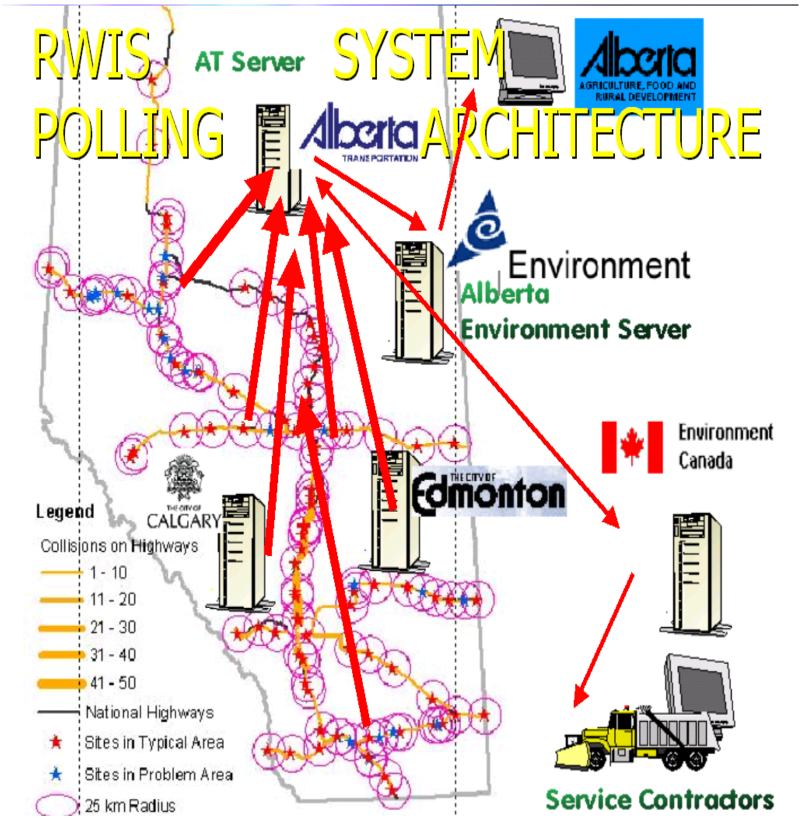


Figure 6.2: User Based RWIS Architecture

It has been suggested that, in the medium term, AT begin developing their own NTCIP compliant server, user interface and data management server to maintain their independence.
With this approach, information for each site can be gathered and displayed as required. AT would have control of the server making it easier to service and upgrade when required. The main negative is the cost associated with the server, software installation, setup and operation (24/7). Also, the information from other (i.e. City of Calgary and Edmonton) sites would not be readily available on the same web site if AT was to own their server.

The Figure 6.2 schematically represents the broader system network, which encompasses data from other VAM service providers. Data from surrounding areas is collected by Environment Canada and are accessible to all authorized municipal and contractor users. This is important for determining incoming weather patterns. As discussed earlier, the benefit of access to a larger network of RWIS sites is that more accurate forecasting of storms can be achieved in real time by watching it progress across the network.

6.3 Implementation Process

From experience, successful Implementation of RWIS and integration of the information into the maintenance operators' business process must follow defined steps and involve a range of activities performed by numerous parties by, or on behalf of, the system owner. Figure 6.3 portrays the activities and potential distribution of roles and relationships. From the designs prepared for the 70 RWIS sites, the next steps in the implementation process will be:

- Detailed engineering designs
- Develop specifications and contract documents
- Tender process
- Construction contract administration and review during construction
- Post construction services
- Post implementation services

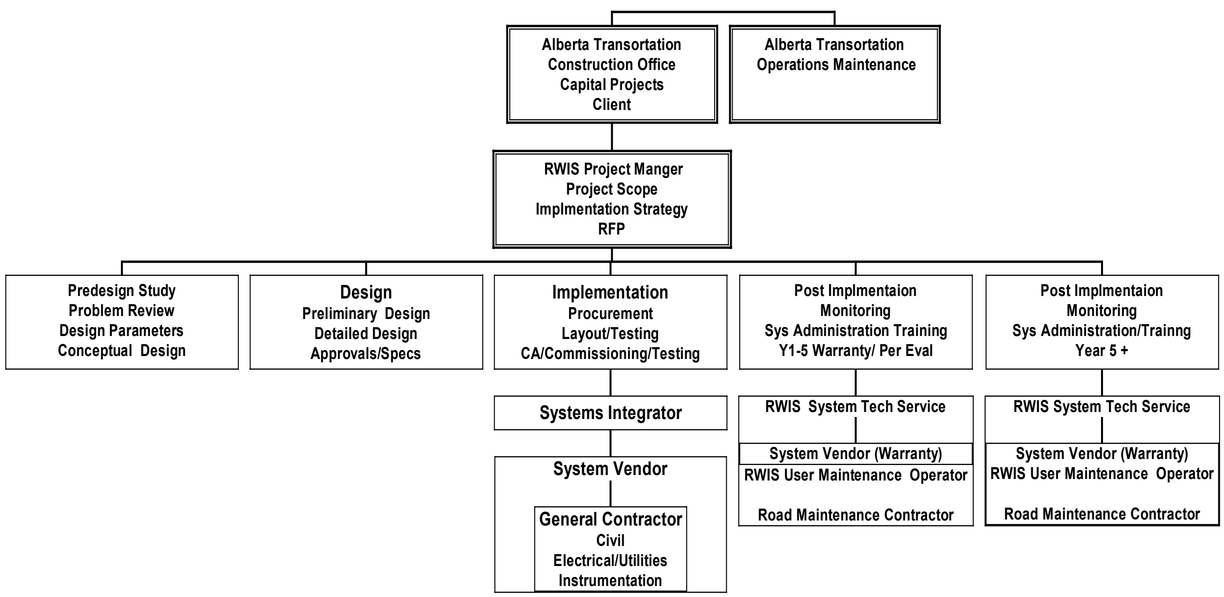


Figure 6.3: RWIS Deployment and Operational Activities

6.3.1 Roles and Responsibilities

Based on experience in other jurisdictions, all of the steps in Figure 6.3 should be performed for successful deployment and operation of an RWIS network. The "packaging" or task allocation can be modified. For example, the responsibility for providing detailed design, circulations, coordination of utility supply, project management and monitoring during the warranty period could be performed by the owner or be contracted out. Whatever the allocation of tasks, there must be a QA/QC process and someone acting on behalf of the owner. Alberta Transportation has elected to complete the deployment as a three year design-build proposal with a five year warranty period and retain a contract administrator to work on their behalf.

7.0 CONCLUSION

The RWIS network proposed is a state-of-the-art augmentation for the national RWIS network to be implemented across Canada.

On implementation, the Alberta RWIS network will be available to support the proposed Advanced Traveller Information System and Advanced Traffic Management System; enable efficient detection and clean-up of snow and ice
on the roads by the province's maintenance operators and also act as an early warning system for the drivers of the road.

The 70 RWIS sites, to be implemented in three yearly phases, are designed to maximize the return of Alberta Transportation's investment and ensure safer provincial highways during winter and adverse winter weather conditions.