2008-2009 Program Work Plan

September 2008

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EXECUTIVE SUMMARY

The Aurora Program is a consortium of public agencies focused on collaborative research, evaluation, and deployment of advanced technologies for detailed road weather monitoring and forecasting. Members of Aurora seek to implement advanced road weather information systems (RWIS) that fully integrate state-of-the-art roadway and weather forecasting technologies with coordinated, multi-agency weather monitoring infrastructures. Aurora's projects are designed to improve the efficiency of highway maintenance operations and distribute effective real-time information to travelers. These initiatives are expected to result in technological advancement and improvement of existing RWIS, significantly reducing the adverse impacts of inclement weather on mobility. The seventeen (17) active members of the program for 2008-2009 are:

- Alaska Department of Transportation and Public Facilities
- Illinois Department of Transportation
- Indiana Department of Transportation
- Iowa Department of Transportation
- Michigan Department of Transportation
- Minnesota Department of Transportation
- Nevada Department of Transportation
- New York State Department of Transportation
- North Dakota Department of Transportation
- Ohio Department of Transportation
- Ontario Ministry of Transportation
- Pennsylvania Department of Transportation
- Québec Ministry of Transportation
- Swedish Road Administration
- Utah Department of Transportation
- Virginia Department of Transportation
- Wisconsin Department of Transportation

Aurora works closely with the Federal Highway Administration, having been approved for federal-aid research and development funds without state matching using 100 percent SP&R funding. Aurora also has a strong relationship with the American Association of State Highway and Transportation Officials (AASHTO) and its Snow and Ice Pooled Fund Cooperative Program (SICOP). In addition, Aurora coordinates with the American Meteorological Society (AMS) and the Intelligent Transportation Society of America (ITSA).

Furthermore, Aurora works closely with research organizations already teamed with member agencies, including the University of Gothenburg in Sweden, the University of Waterloo in Ontario, the University of North Dakota, the University of Minnesota, the University of Wisconsin, Ohio University, Iowa State University, Virginia Polytechnic Institute and State University, Purdue University, Pennsylvania State University, the Massachusetts Institute of Technology, the Swedish Meteorological and Hydrological Institute, the National Center for Atmospheric Research, and the National Oceanic and Atmospheric Administration (NOAA) Forecast Systems Laboratory.

The Aurora Program has also established and continued an outreach initiative with private RWIS concerns through the Friends of Aurora (FOA) program. Aurora will continue to pursue this cooperative relationship in hopes of establishing a continuing dialogue between the public and private road weather communities. The next FOA event will be scheduled in early 2009.

This document provides the program's vision, mission, goals, and objectives; as well as details of the current members of the program and additional organizations that play a role in the program's activities. The program organization and structure are included, as are several key technical areas of interest identified by members. Also included is information detailing how interested organizations can participate in the program. Member agencies undertake various outreach activities in order to heighten the profile of Aurora, including presentation of papers, participation in specialized interest groups, and the Aurora Program Internet web site. These activities are outlined in this document as well.

Since the inception of the Aurora Program, approximately fifty technical projects have been funded. To date, approximately thirty of these efforts have been completed, while several others are very near completion. Details of the newly selected projects for 2008-2009, as well as the previous projects completed or underway, are provided in this document. Also included are overviews of the project work scopes, project participants, and the status of ongoing projects. Lastly, details of the program budget are included, encompassing details of program income, allocation of pooled funds, and other expenditures. The following section contains an overview of key achievements during the previous program year.

The Year in Review – Aurora Program Achievements in 2007-2008

Established in 1996, the Aurora Program recently completed its twelfth full program year.

Program-Level Activities:

The following items summarize the program's key achievements during this past year.

- The Aurora Program was re-affirmed as a regional pooled-fund study program for 100 percent SP&R funds.
- Aurora Project 2003-02, which involved an off-the-shelf component RWIS developed in Québec, was completed.
- Aurora Project 2003-05, which investigated the variability of snow cover along a highway maintenance route, was completed.
- Aurora Project 2005-05, which investigated the use of RWIS to trigger spring load restrictions in Ontario, was completed.
- Several Aurora research initiatives, including Project 2005-03 - Mobile Weather and Road Condition Reporting and Project 2006-04 - Evaluation of the Vaisala Spectro Pavement Sensor, are very near completion and scheduled to be approved during the upcoming program year.

As a result of its activities and research, numerous documents have been created within the program. The following documents are available through the Aurora management consultant:

- Aurora Program 2007-2008 Work Plan
- Aurora Program Work Plans for all previous program years since 1996
- Aurora Organizational Charter and Operating Rules
- Memorandum of Understanding with ENTERPRISE Pooled Fund
- Review of the Institutional Issues Relating to RWIS
- RWIS Protocol NTCIP White Paper
- Decision Support System for Winter Maintenance: Feasibility Demonstration
- Decision Support System for Winter Maintenance: The DART Database
- Feasibility Study on Adaptation of the Local Climatological Model in Southern Ontario
- Identification and Documentation of Weather and Road Condition Dissemination Devices and Data Formats
- Standardized Testing Methodologies for Pavement Sensors
- Road Weather Roadshow
- Synthesis of Road Weather Forecasting
- Signal and Image Processing for Road Condition Classification
- Interjursdictional Traveler Information Exchange
- Test Methods for Evaluating Field Performance of RWIS Sensors
- RWIS Data Integration Guidelines
- Laboratory and Field Studies of Pavement Temperature Sensors
- Intelligent Image-Based Winter Road Condition Sensor – Phase II Report
- Evaluation of the Hotplate Snow Gauge
- Whether Weather matters to Traffic Demand, Traffic Safety, and Traffic Flow
- Variation of Snow Cover and Extrapolation of RWIS Data Along a Highway Maintenance Route
- Using RWIS to Control Load Restrictions on Gravel and Surface-Treated Highways
- Off-the-Shelf Component RWIS

The Aurora Program Executive Board meets via telephone conference call or on-site meeting. The following board conference calls and on-site meetings were held over the 2007-2008 program year:

- October 18, 2007 (conference call)
- December 4-5, 2007 (on-site meeting in Indianapolis, Indiana, USA)
- January 31, 2008 (conference call)
- March 6, 2008 (conference call)
- May 6-7, 2008 (on-site meeting in Reno, Nevada, USA)
- June 26, 2008 (conference call)
- August 21, 2008 (conference call)
- September 24-25, 2008 (on-site meeting in Toronto, Ontario, Canada)

In addition, the program chair, vice-chair, and administrator continue to meet as needed via conference call with the management consultant to discuss various program administrative issues and research progress.

The Aurora Program exchanges information between members and with the outside world in several ways; including workshops, seminars, publications, and presentations. Aurora was represented at several events during the past year, including the annual meetings of the Transportation Research Board and the American Meteorological Society. In addition, several papers and presentations were presented by Aurora participants at various events in the past program year.

Project-Level Activities:

At the time of producing the 2008-2009 plan, several previously funded projects remained ongoing, including those funded under Aurora's 2007-2008 Work Plan. To date, twenty-eight (28) projects have been completed. These completed projects are described below and on the following pages.

- **RWIS Institutional Issues (Project 1997-01) –** This project documented various institutional issues encountered by several agencies in the process of planning and deploying road weather information systems or programs, as well as measures taken to overcome these issues. All Aurora members were involved in this project, addressing issues such as public-private partnerships, barriers to implementation, and strategies for deployment. The project was considered an outreach activity, the product of which was a compendium of findings and lessons learned relating to the institutional issues involved in the development and implementation of RWIS.

- **RWIS Communications Standards (Project 1997-02) –** This effort provided support to the ongoing standards development process for RWIS communications and protocols. Aurora members played a supporting role, providing strategic input and technical expertise in many RWIS areas. As a part of these activities, Aurora prepared an RWIS protocol white paper submitted to the National Transportation Communications for ITS Protocol (NTCIP) Working Group. Aurora worked with numerous other groups; including the FHWA, the American Association of State Highway and Transportation Officials (AASHTO), and NTCIP; as a part of this initiative.

- **Expert System for Maintenance Decision Support (Project 1997-03)** – This effort, led by the Ontario Ministry of Transportation with assistance from Swedish Road Administration and the Meteorological Service of Canada, was undertaken to promote the development of decision support tools that help winter maintenance personnel take appropriate preventative measures needed in different weather conditions. The result of this project produced details of both Sweden's and FHWA's approaches to classifying environmental conditions for material application and a report describing Ontario's De-icing Anti-icing Response Treatment (DART) database.

- **Adaptation of the Local Climatological Model (Project 1997-04) –** This effort involved a feasibility study of which factors need to be modified, and how these modifications should be performed, in order to implement the Local Climatological Model (LCM) in the province of Ontario, Canada. The LCM was developed for Swedish conditions and requirements. Therefore, modifications were required in the LCM before installation in a new geographic area. The final report for this project includes a detailed inventory of geographic and meteorological conditions for adaptation in the Ontario region, an assessment of LCM transferability, a description of LCM data requirements, and an outline implementation plan for LCM at the site in Ontario.

- **Standardized Weather and Road Condition Information (Project 1997-05) –** This project sought to identify means to make road and weather information more usable and consistent. The project consisted of two parts. Part 1 identified past, current, or planned implementations of information provision services or systems that supply road and weather information to general end users. Part 2 was intended to facilitate development of guidelines for presentation techniques to suit the needs of the general road users for different types of information provided over a variety of media. Under Part 2, Aurora and ENTERPRISE began a joint project in to develop uniform messages for road weather information presentation. The results of this joint effort did not produce definitive guidelines. Therefore, as a follow-up, human factors work will need to be done before icons and color codes can be posted on a website. In addition, Aurora is investigating further opportunities to leverage this work under the *Clarus* Initiative

- **Standardized Testing Methodologies for Pavement Sensors (Project 1998-02) –** This project was undertaken to establish and evaluate standard procedures for testing RWIS sensors, related software, and models. This research attempted to discern the state of the practice around the world, and the report for this project indicates that a number of nations and organizations are developing standards for testing and calibrating road weather sensors. A strategy to promote the development of national and international standards and procedures was funded as an extension of this project.

- **Compilation of RWIS Specifications (Project 1999-01) –** The first objective of this project was to collect specifications for the construction of, maintenance of, and/or forecasts at RWIS stations from member agencies and to develop a database of these specifications. The second objective was to survey the agencies that had provided specifications to better document and understand the issues associated with administering the various contracts.

- **Road Weather Roadshow (Project 1999-02) –** This project involved development of an outreach presentation that captured the advances and improvements in road weather forecasting and nowcasting. As the National Weather Service (NWS) modernization moved into full implementation, some recognized the potential impact this could have on daily operations, but many others were not convinced. Therefore, there was a need to show the rest of the transportation community the difference between the old and new through simple presentation material. The primary audiences for this presentation were state and local DOT staff and managers.

- **Synthesis of Road Weather Forecasting (Project 2000-02) –** This project involved determining the arrangements that exist in other countries between local and national government surface transportation agencies and their national weather forecasting agency. A questionnaire was sent to DOT personnel in nine countries requesting information collected by the road agencies and the information supplied and protocol used by the forecasting service. Responses to the survey from these 9 countries form the basis for the final report.

- **Computer-Based Training Development (Project 2000-04)** – The objective of this effort was to develop a comprehensive, interactive training program for winter operations that would include segments on RWIS, anti-icing, de-icing chemicals, and other related aspects of winter operations. This objective was accomplished through coordination between Aurora and the American Association of State Highway and Transportation Officials (AASHTO). Aurora's role in this effort was to develop an RFP and assist AASHTO in the contractor selection process. The development itself is now complete.

- **Road Weather Training for Improved Winter Response (Project 2000-07)** – Under this project, the Quebec Ministry of Transportation provided to Aurora members a training program it developed to improve winter response capabilities of operators and managers and to enhance skills and knowledge base for using data received from remote weather stations. In addition, the possibility of combining this effort with the Computer-Based Training program developed by AASHTO was pursued. Although Quebec's training materials were not combined with the CBT, metric standards were incorporated into a CBT version. Quebec also provided nine training modules for distribution and use by the Aurora member agencies.

- **Intelligent Image-Based Winter Road Condition Sensor – Phase I (Project 2000-08)** – This project focused on building a field prototype of a video-based road condition sensor and extending its function such that both the current condition and trend could be measured with high accuracy. The limitations of the system were also investigated under this research. Sweden has been very pleased with the results of this effort. The system performed very well, matching picture to condition approximately 98% of the time.

- **Interjurisdictional Traveler Information Exchange (Project 2001-01) –** This project focused on the ability to share weather data jurisdiction to jurisdiction (province or state) and to make weather information more available to travelers. The final report provides a survey of road weather information systems in North American jurisdictions, a review of three systems that includes the system architecture of each, and an evaluation of the financial and economic feasibility of those systems.

- **Guidelines for Testing, Installation, Maintenance, and Calibration of Pavement Sensors (Project 2001-02)** – The overall goal of this effort was to promote the development of national and/or international standards for testing and calibrating road weather surface sensors. This was undertaken in two parts. In Part 1, actions were taken to promote the idea of national/international standards and procedures for testing and calibration of road surface condition sensors. Part 2 set aside funds to contribute to a coordinated effort to develop testing and calibration standards and procedures.

- **RWIS Data Integration and Sharing Guidelines (Project 2001-03)** – This project was undertaken in order to provide agencies with a guide to fully utilize their own weather data and that of other agencies. This effort involved identifying the level of integration of data from different devices or from different jurisdictions, identifying best practices in integrating RWIS from multiple agencies and the barriers to that integration, and developing a conceptual design for information exchange among various states and different types of RWIS devices.

- **Pavement Temperature Sensor Accuracy (Project 2001-04) –** This project sought to determine the accuracy and variation in readings of various in-pavement and mobile pavement temperature sensors, by first developing a method to determine the "true" pavement temperature for comparison purposes. Past studies compared accuracy of various devices, but none of them have included a method of determining true readings. The final report for this project includes descriptions of how well various sensors performed under various conditions.

- **Intelligent Image-Based Winter Road Condition Sensor – Phase II (Project 2002-01) –** This project was undertaken to further previous research conducted under the Phase I project. Phase I showed that combining image and other RWIS data resulted in reliably determining road conditions. Since the first phase did not cover trials with illuminated roads at night, this second phase focused on classification of nighttime pictures. Results of this second phase have provided valuable insight into how to design a final version of the sensor system. The initial phase concluded that it was important to move the image-processing prototype to Dalarna University's RWIS test site. In both of the first two phases, analysis of the images was conducted at Dalarna University, rather than in the field. The third phase involves continuing research and movement of the test site to a new location to acquire more data and test the portability of the prototype.

- **RWIS Equipment Monitoring System – Phase I (Project 2002-02)** – The objective of this project was to provide Aurora member agencies with an automated means of problem identification and reporting for their RWIS equipment. Functionality of an existing Minnesota Department of Transportation system was used as a base to design the desired system. The end result of this project was a web-based solution that each member state could choose to host or have someone host for a fee.

- **Improved Frost Forecast Model – Phase I (Project 2003-01) –** This project looked to determine under what condition frost on bridge decks creates slippery conditions and then to develop a forecast model that can predict when this may occur at a site or across a region. Work under Phase I is now complete. Remaining work will be completed under the second phase, Project 2004-05. A final report on the entire effort will be available upon completion of the second phase.

- **Off-the-Shelf Component RWIS (Project 2003-02) –** This project was championed by the Québec Ministry of Transportation. The objective of this research was to build an RWIS station with an open architecture in order to utilize various sensors from different manufacturers. The final report for this project details how the Québec research was done and the results of the open architecture system developed.

- **Investigation of the Variability of Snow Cover Conditions (Project 2003-05) –** The objective of this project was to develop an understanding of the variability of snow cover along a highway maintenance route at the scale of RWIS station intervals; including its relation to surrounding terrain, to maintenance operations, and to winter storm conditions. The final report for this effort details the results of the work performed by the Ontario Ministry of Transportation.

- **Hot Plate Snow Gauge Demonstration (Project 2004-01)** – This project involved testing the utility of a new real-time snow gauge for use in winter road maintenance and possible addition to automated weather stations in the future. The project also tested the utility of the Weather Support for Deicing Decision Making (WSDDM) aircraft deicing/anti-icing nowcast system for winter road maintenance operations. The final report details the performance of this sensor.

- **Laser Road Surface Sensor (Project 2004-02)** – This project involved the purchase, installation, and evaluation of a laser road surface sensor (LRSS) to determine if it could be used to detect frost and how it could be used in winter maintenance operations. The research approach was to install an LRSS to sense the surface condition of a functional roadway in a location that also has other sensors to help evaluate the LRSS data. Sensor data was supplemented by visual observations at times. Research results are documented in the final report.

- **Support of the MDSS Pooled Fund Study (Project 2004-03)** – This project provided funding to develop and test the MDSS as an operational tool in the states involved in the pooled-fund study. Funding was provided to the South Dakota DOT, the pooled-fund's lead state.

- **Improved Frost Forecast Model – Phase II (Project 2004-05) –** A continuation of earlier research, this project completed analysis and publication of results on bridge frost observations and modeling for previous frost seasons, developed an interface to pass weather forecast information to BridgeT and frost accumulation algorithm, managed the forecast model and data flow over the upper Midwest for the 2003-2004 frost season, developed a graphical web-based display of 24-hour forecast of and produced maps of frost hazard potential. A final report details results of this research.

- **Integration of Road Weather Information with Traffic Data (Project 2005-04)** – This effort involved integrating road weather data with traffic flow data to quantify the impacts of weather on capacity and flow along urban freeways. The most important conclusion from this project and findings of other transportation weather researchers is that weather conditions do have an important impact on traffic safety, demand, and flow. The final report also concluded that much more research is needed to measure, understand, and develop management strategies to mitigate the impacts of weather on traffic safety, traffic demand, and traffic flow. Another important conclusion of this work is that if RWIS environmental sensors are going to be of significant value to traffic managers, then they must more reliably collect different data elements.

- **Using RWIS to Trigger Spring Load Restrictions (Project 2005-05)** – This project investigated the use of RWIS to trigger spring load restrictions in Ontario. Results of the research can be found in the final report.

- **Road Weather Information Outreach / National Conference (Project 2006-07)** – The purpose of this project was to conduct a national winter maintenance meeting for Aurora, Clear Roads, and the FHWA to share research results, solicit research needs, and get updates from each snow-belt state. As a result, the National Winter Maintenance Peer Exchange was held on August 28-29, 2007 in Columbus, Ohio.

In addition, the twenty-two (22) ongoing projects funded and underway through Aurora's earlier research programs are as follows:

- **Benchmarking the Performance of RWIS Forecasts (Project 2000-01) –** Under this project, a report is being developed that will review the state-of-the-art within the meteorological community in regards to measuring the performance of weather forecasting information, review the current status of RWIS verification efforts by public agencies, establish procedures and parameters that can be used to measure forecast accuracy in any country, and benchmark the accuracy of forecasts provided to member agencies.

- **RWIS Leverage Opportunities (Project 2000-05)** – This project serves as a reserve fund for future RWIS initiatives. Projects continue to be sought that, while not currently involving program member agencies, compliment overall program objectives. Program members monitor these projects in order to identify for funding any particular projects that match Aurora Program priorities.

- **Intelligent Image-Based Winter Road Condition Sensor – Phase III (Project 2003-04) –** This project involves a third phase of the intelligent image-based winter sensor project. The first two phases of this project have shown to be very promising and this third phase involves continuing research and movement of the test site to a new location to acquire more data and test the portability of the prototype to new locations without re-calibration.

- **Winter Weather Severity Index Enhancements (Project 2004-04)** – This project will determine the weather events that affect winter operational performance, then it will develop a software application that can automatically extract NWS data and calculate differences in weather across a region.

- **Development of an RWIS Quality Assurance Monitoring System (Project 2005-01)** – This project will develop a quality assurance monitoring system that is modular to allow installation with different host organizations and platforms, expandable for incorporating additional quality assurance modules, and accessible via the web. The system will also hold a historical database of quality assurance reports for future reference.

- **RWIS Telecommunications Issues and Options (Project 2005-02)** – This project will investigate options to get the data from the RWIS sites to a central location in a significantly less expensive manner.

- **Mobile Weather and Road Condition Reporting (Project 2005-03)** – This project will develop a condition reporting system that collects data electronically via mobile sources.

- **New Road Surface Condition Sensor (Project 2005-06)** – This project is evaluating a prototype of a new inexpensive sensor to be used in combination with RWIS. To date, the draft report has been completed and is being revised based on project team review.

- **Support of the *Clarus* Initiative (Project 2006-01)** – The purpose of this project is to influence the *Clarus* Initiative, which is a federal project that establishes a vision for the leveraging of local and regional weather observations, and to assist with its early implementation.

- **Pilot Test of ESS Sensor Testing Guidelines (Project 2006-02)** – The research objectives of this project are to gain real world experience with the implementation of an ESS sensor testing program, to develop a standardized kit for testing ESS sensors, and to develop software/forms that can be used to record test data.

- **Update of SHRP H-350 and H-351 (Project 2006-03)** – The objective of this project is to review SHRP reports H-350 and H-351 to determine which portions of the original report would benefit from a fifteen year update and complete a thorough benefit/cost analysis of RWIS technology.

- **Evaluation of Vaisala Spectro Pavement Sensor (Project 2006-04)** – The objective of this project is to study the accuracy and usefulness of the new Vaisala Spectro sensor under real-world highway conditions.

- **Technology Transfer (T^2) of Alternative Inexpensive RWIS (Project 2006-05)** – The purpose of this project is to research, through a proof of concept test, the ability to integrate pavement thermistors to existing atmospheric weather stations and document the application of this new RWIS concept for pavement management and to develop urban sighting guidelines for the addition of pavement sensors to existing infrastructure.

- **Low Cost Mobile RWIS (Project 2006-08)** – The objective of this research project is to build a low cost mobile RWIS station with open architecture to mix different sensors of different manufacturers.

- **RWIS Equipment Monitoring System – Phase II (Project 2007-01)** – The objective of this project is to expand the RWIS Equipment Monitoring System.

- **Cold Weather Testing of the Halliday Road Grip Unit (Project 2007-02)** – The objective of this project is to provide for more extensive testing of the RGT unit.

- **Incorporation of MDSS into Winter Weather Forecasting (Project 2007-03)** – The objective of this project is to research, through a concept evaluation, the ability of the Pooled Fund MDSS to integrate weather forecast information from a separate forecast provider, and to provide guidance to states and forecast companies on the requirements of this type of MDSS procurement.

- **Development and Demonstration of a Freezing Drizzle Algorithm for Roadway ESS (Project 2007-04)** – The objective of this project is to demonstrate the accuracy and utility of a freezing drizzle algorithm that can be implemented on roadway ESSs.

- **Multiple-Use ITS Data Collection Sites (Project 2007-05)** – The objective of this project is to integrate, through a proof-of-concept, non-obtrusive traffic data collection technology at Road Weather Information System (RWIS) sites in an arctic environment.

- **Development of a National Road Weather Testing Facility (Project 2008-01)** – The purpose of this project is to fund Aurora to market the idea of a national testing facility to various audiences and sources of support

- **Evaluation of Utah DOT Weather Operations Program (Project 2008-02)** – The purpose of this project is to evaluate the benefit-cost ratio of the weather operations program on winter maintenance, quantify the benefits and costs of the RWIS elements of the UDOT program, quantify the benefits of the weather operations program to other UDOT users, and quantify the indirect benefits, including delay reduction and improved safety, of the weather operations program.

- **Next Generation RWIS for Canada (Project 2008-03)** – The objective of this project is to evaluate environmental, safety an cost benefits of a new generation of RWIS products and services that can be implemented to improve road maintenance in Ontario.

Looking Ahead – Aurora Program for 2008-2009

The new projects selected for funding during 2008-2009 are as follows:

- **Evaluation and Inter-comparison of the Lufft R2S Microwave Precipitation Sensor (Project 2009-01)**
- **Road Weather Information Outreach / Second Peer Exchange (Project 2009-02)**
- **Knowledge Base for RWIS Programs and Environmental Data Loggers (Project 2009-03)**
- **Road Weather Education Enhancements and Dissemination (Project 2009-04)**
- **Further Development of Pavement Precipitation Accumulation Estimation System (Project 2009-05)**
- **Salinity Sensor Improvements and Development (Project 2009-06)**
- **Review of Friction Detection Technologies (Project 2009-07)**

Further Information

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1. INTRODUCTION

The Aurora Program is a collaborative research, development, deployment, and advocacy venture in the area of road weather information systems (RWIS). Aurora was established by a group of agencies through the mechanism of a US Department of Transportation State Planning and Research (SP&R) pooled fund program. The Aurora Program is an initiative currently lead by the Iowa Department of Transportation, in cooperation with other state, federal, and international agencies that share a common vision of future road weather information systems. The inaugural Aurora meeting was held on February 22-23, 1996, in Minneapolis, Minnesota.

1.1 Vision

The common vision of the Aurora Program participants is to deploy advanced road weather information systems (RWIS) that fully integrate state-of-the-art roadway and weather forecasting technologies with coordinated, multi-agency weather monitoring infrastructures and with the National Intelligent Transportation Systems (ITS) Architecture. Aurora should provide the basis for fruitful public-private partnerships of mutual benefit to industry and government, which will help save lives, preserve property, protect the environment, enhance homeland security, and significantly reduce the adverse impacts of inclement weather on mobility.

1.2 Mission

The mission of the Aurora Program is to support cooperative research, evaluation, and deployment of advanced technologies that advance road weather monitoring and forecasting and to serve as an international advocate for expanded uses of these technologies.

1.3 Goals and Objectives

The goals of Aurora members define areas of potential benefit that the group is pursuing. Aurora's specific objectives address activities or areas of work that support realization of their goals. Aurora's general goals and subsequent objectives are:

- **To improve dissemination of road weather information to transportation providers and end users, ultimately enhancing safety by reducing potential weather-related incidents and reducing congestion and delays in both urban and rural areas.**

    - to enhance and support the individual road and weather system deployment plans of Aurora Program participants.
    - to support the development and deployment of promising advanced technologies for use in road weather monitoring, forecasting, information exchange, and dissemination.
    - to contribute to activities which aim to integrate RWIS into the intelligent transportation systems (ITS) infrastructure
    - to actively support the Federal Highway Administration's *Clarus* Initiative.

- **To improve the efficiency of maintenance operations.**

  - to jointly pursue emerging road and weather project opportunities in areas of interest to the group's members.
  - to identify common development and evaluation needs within the group and to coordinate resulting technical activities.
  - to advocate implementation of its research findings into the day-to-day practices of road maintenance agencies by establishing and/or supporting RWIS-related standards.

- **To aid in the development of RWIS programs that seamlessly integrate maintenance operations and dissemination of road weather information.**

  - to provide a mechanism to facilitate further regional and international project cooperation and technical information interchange so as to benefit all surface transportation modes.
  - to actively support the activities of the Federal Highway Administration's Maintenance Decision Support System (MDSS) and Maintenance Decision Observational Support System (MDOSS) efforts.

- **To develop initiatives which assist public agencies in deploying RWIS technologies.**

  - to facilitate the formation of public-private partnerships addressing appropriate program activities.

- **To encourage greater cooperation and information exchange between transportation agencies and the meteorological community.**

  - to coordinate with other agencies and groups conducting road and weather information work, such as the Weather Team of the Federal Highway Administration (FHWA), the Office of the Federal Coordinator for Meteorology (OFCM), the National Weather Service (NWS), American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), the Weather Information Applications Special Interest Group (WIASIG) of the Intelligent Transportation Society of America (ITS America), the World Road Association (PIARC), the American Meteorological Society (AMS) Standing Committee on Surface Transportation, and others.

- **To support development of alternative uses of RWIS technologies.**

  - to provide test beds in a variety of environments and locations for the evaluation of emerging road weather information system technologies and standards.

1.4 Program Partners

Aurora member agencies for the upcoming year are as follows:

- Alaska Department of Transportation and Public Facilities
- Illinois Department of Transportation
- Indiana Department of Transportation
- Iowa Department of Transportation
- Michigan Department of Transportation
- Minnesota Department of Transportation
- Nevada Department of Transportation
- New York State Department of Transportation
- North Dakota Department of Transportation
- Ohio Department of Transportation
- Ontario Ministry of Transportation
- Pennsylvania Department of Transportation
- Québec Ministry of Transportation
- Swedish Road Administration
- Utah Department of Transportation
- Virginia Department of Transportation
- Wisconsin Department of Transportation

Michigan and Nevada are the most recent additions to Aurora, becoming the newest member agencies within the past year. Aurora is also working with several research organizations already teamed with member agencies. These associated organizations currently include:

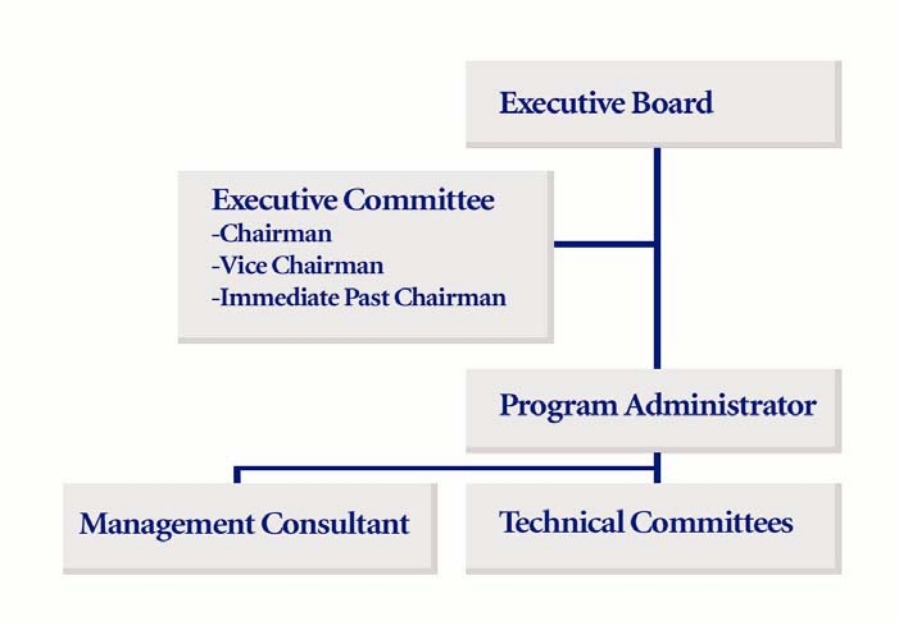
- Iowa State University
- Massachusetts Institute of Technology (MIT)
- Meteorological Service of Canada (MSC)
- National Center for Atmospheric Research (NCAR) Research Applications Laboratory
- National Oceanic and Atmospheric Administration (NOAA) Forecast Systems Laboratory
- Ohio University
- Pennsylvania State University
- Purdue University
- Swedish Meteorological and Hydrological Institute (SMHI)
- University of Gothenburg, Sweden
- University of Waterloo, Ontario
- University of Minnesota
- University of North Dakota (UND)
- University of Wisconsin
- Virginia Polytechnic Institute and State University

The Federal Highway Administration (FHWA) serves as a monitoring body, providing strategic and technical input to the program. Both national and regional FHWA personnel participate in the Aurora Program.

2. PROGRAM ORGANIZATION

Aurora's organizational structure was established to maximize its ability to meet its objectives, while effectively managing a group comprised of numerous agencies. Figure 1 below shows the organizational structure of the Aurora Program.

Figure 1 – Aurora Program Organizational Structure



2.1 Executive Board

The Executive Board consists of one voting representative from each active member agency. All of Aurora's operating authority is derived from the Executive Board. The Executive Board is responsible for overall policy direction and budget approval, as well as for organizing itself, establishing operating rules, and conducting other business. Board members may propose voting membership for two federal agencies that could participate in Aurora: FHWA and NOAA. Following established precedents, however, FHWA would not vote on matters involving the expenditure of any federal funds over which it has approval authority, such as SP&R funds.

2.2 Program Chair, Vice Chair, and Program Administrator

The Program Chair serves as head of the Executive Board. The duties of the Chair include developing meeting agendas, chairing meetings, and representing the Aurora Program in discussions with other organizations.

In 1998, the Aurora Board voted to create the position of Vice Chair, who supports the Chair in the activities noted above and acts as a representative of the Chair and the program as required. Additionally, an amendment to the program charter was proposed and approved, such that the program Chair and Vice Chair will each serve a one-year term, at the end of which the Vice Chair shall succeed the Chair and a new Vice Chair shall be elected. In addition, the outgoing Chair shall become a voting member of the administrative group for one year.

The Program Administrator operates under the delegated authority of the Executive Board and is responsible for the day-to-day management of Aurora. The Administrator is an employee from the lead administrative state that controls expenditures from the program's pooled funds. The Program Administrator is responsible for contracts administration, quality control and evaluation, recommendations on contract preparation, change order requests, authorizing payments, and informing the Executive Board of all contract progress. Finally, the Program Administrator is responsible for administering the Aurora management budget and approving travel authorizations.

During the upcoming 2008-2008 (FY 2009) program year, the Chair of the Executive Board will be Ralph Patterson of the Utah DOT. The Vice Chair will be Bill Hoffman of the Nevada DOT, and the Ex-Officio Past Chair will be Max Perchanok of the Ontario MOT. The Aurora Program Administrator is Dennis Burkheimer of the Iowa DOT.

2.3 Technical Committees

Aurora technical committees study those areas of interest identified by the Executive Board. Committee activities include problem definition, analysis of alternative approaches, development of requests for proposals, project selection recommendations, project oversight, and future program planning. Voting authority on the technical committees is limited to Executive Board member agencies. This authority may be given to an agency's board member or a designated representative.

To date, the Executive Board has established three technical committees. These committees are the Membership Outreach Committee, the Web Site Review Committee, and the Communications Committee. The Membership Outreach Committee is responsible for keeping up on potential new membership opportunities by assisting the management consultant in the development of outreach materials and to be the key point of contact for potential new members. The Web Site Review Committee is responsible for monitoring web site items and reviewing potential new changes to the site, including proposed links to RWIS-related Internet sites. The Communications Committee is responsible for developing and implementing the program's communications plan, which involves dissemination of research findings, RWIS advocacy, and other communications-related activities.

2.4 Management Consultant

The Executive Board may appoint a management consultant to support program administration and address technical issues that arise from time to time. The management consultant's role will be to provide both general and specific support to the Chair, Vice Chair, and Program Administrator and program participants on an ongoing basis. These duties range from preparing meeting agendas and minutes to coordinating and performing technical studies, evaluations, and related activities. For the FY 2009 program year, the program's management consultant will be the Center for Transportation Research and Education (CTRE) at Iowa State University. Chris Albrecht will serve as the Program Manager in the coming year.

3. PROJECT IDENTIFICATION AND MANAGEMENT

3.1 Project Development

Aurora defines and develops technical projects using several complementary approaches:

1. *Review of member agency plans*. On an ongoing basis, the management consultant may review the related activities, interests, and road and weather system deployment plans of the Aurora Program members. This activity identifies common themes among program participants, which can be used as guidelines in preparing project outlines.

2. *Proposals by Aurora members*. Aurora participants, both member agencies and associates, may propose projects developed in discussion with colleagues in the participating agencies. Although such projects may initially reflect the specific interests of the proposing organization, projects with broad appeal are most likely to be supported by other Aurora Board members. To facilitate this, a series of mutually identified areas of interest have been developed by the Aurora members (see Section 3.2). Support is available to all participating agencies, via the management consultant, during project development and refinement processes. In addition, Aurora reviews results of the National Winter Maintenance Peer Exchange for possible research initiatives.

3. *FHWA and NOAA*. Aurora may also offer its services to FHWA and NOAA for the coordination of appropriate road and weather developments that address national and international interests. These activities could include projects that might otherwise be funded by these other agencies internally, but which are likely to benefit from joint development within Aurora.

3.2 Project Areas of Interest

A series of broad project areas was identified when Aurora was first established. A brief description of specific activities to be conducted accompanies each area. Since the original formulation of these areas of interest in 1996, they have been adapted and reviewed annually to reflect the most recent developments in the road weather world, as well as the interests of the program and its members.

- **Decision Support Systems** – The primary users of RWIS information are highway maintenance staff and the traveling public, many of whom have little or no knowledge of meteorology and how to interpret weather information to make effective decisions. Within this area, Aurora members seek to design and implement decision support systems which transform weather and road condition data into an easily understandable format, such as color-coded graphical displays, to allow for informed decision making capabilities. Specific activities in this area include:
  - development of appropriate modeling and graphics software
  - analysis of human factors for the purposes of determining readily acceptable information presentation formats
  - evaluation of benefits of the system on improved decision making processes
  - deployment and integration of system with traveler information efforts
  - final deployment of integrated RWIS and meso-scale networks into decision support systems and other applications

- **Weather Modeling and Analysis** – This area involves determining the scope for further enhancement of road and weather modeling to cover road sections of as little as 5 or 10 meters. Inputs to these models would include information from stationary and mobile sensors and current state-of-the-art meso-scale modeling techniques. This area also seeks to apply techniques developed at the Meteorological Service of Canada, University of North Dakota, NOAA/GSD, NWS, NCAR, and other agencies to support detailed weather situation assessment and short-term forecasts on particular highway links. Specific activities expected to be conducted in this area include:
  - instrumentation of maintenance vehicles to acquire pavement and ambient air temperatures, dew point, relative humidity, wind direction and speed, atmospheric pressure, and any other appropriate data types
  - evaluation of improved road condition information for maintenance activities and traveler safety
  - deployment of micro-scale models for integration with RWIS networks
  - initial integration of meso-scale models and RWIS networks
  - quality control of RWIS data using meso model outputs
  - evaluation of mutual benefits arising from systems integration

- **Standards and Architecture** – This interest area involves complementing current activities being undertaken by member agencies in the development and promotion of standardized RWIS system specifications, protocols, and architectures. Common design structures will reduce or eliminate proprietary systems, thus allowing for increased competition, reduced system cost, and improved data transferability between state agencies. Specific architecture components that may be addressed include open communication standards and open hardware platform (Universal Roadside Platform). As a number of government supported bodies – including the American Association of State Highway and Transportation Officials (AASHTO), the National Transportation Communications for ITS Protocol (NTCIP) group, traffic management data dictionary (TMDD), and ENTERPRISE – are currently working in this area, the Aurora Program is working to support and provide guidance to those bodies during the standards development process.

- **Equipment Evaluations** – Due to the highly dynamic nature of RWIS innovations and technology improvements, it is necessary to examine and evaluate the ability of new components to improve the information being collected and reported from field stations. This area of interest seeks to use Aurora as an information exchange forum for program members to provide results and insight into newly developed RWIS technologies. Individual agencies may be provided with support to review specific RWIS components on behalf of all program members based upon their expertise and experience with particular vendors, for example.

- **Information Dissemination Technologies** – A primary component of RWIS is the provision of weather and road condition information to the general public to allow for informed travel decisions. This activity involves investigating current Intelligent Transportation System (ITS) traveler information efforts underway and identifying those that may be most appropriate for RWIS dissemination to both the public and maintenance agencies.

- **Road Condition Monitoring –** This area of interest involves investigating technologies for the purposes of improved roadway monitoring. Data obtained from these sources may be utilized to improve the accuracy of road condition models as well as for information dissemination purposes. Among the various technologies to be investigated will be:
  - video monitoring of roadways – numerous transportation agencies currently have closed circuit television (CCTV) cameras deployed for traffic surveillance. The potential exists to utilize these systems to monitor roadway conditions via the development of simple pixel image algorithms
  - monitoring of winter friction – friction between a tire and pavement varies in a predictable manner with snow cover area in the tire footprint. Continuous measurement of friction along a roadway therefore provides a rapid means of monitoring snow cover conditions at and between RWIS stations. Activities are underway to use this information to improve planning and monitoring of winter maintenance operations.
  - remote monitoring of roadway conditions with new technologies – several efforts are underway to utilize alternative technologies, such as laser and infrared technology, to monitor roadway conditions.

- **Other –** This area of interest involves additional efforts that are important to the road weather industry, including collaborative efforts with other research groups and outreach activities.

3.3 Project Selection

New Aurora projects are considered on an annual basis. However, if a member agency or associate identifies a project that offers significant immediate benefits or takes advantage of short-term opportunities, they may suggest this to the Executive Board for early consideration. The Board can then choose to accept such projects for fast-tracked initiation, reject them, or delay a decision until the start of the normal work plan development process. The normal annual project selection process is as follows:

1. Proposed project outlines are submitted to the Program Administrator and the Management Consultant. The consultant distributes these outlines to members for their review.

2. A meeting or conference call is then convened during which projects are discussed and short-listed, if necessary. Telephone, teleconference, e-mail, or facsimile polling is also used as appropriate. Members vote to select those projects that will be undertaken by Aurora during the upcoming program year. These projects form the basis of the annual work plan.

3. The projects are then elaborated into more detailed work scopes. In some cases, RFP's and other contract documents are developed and mailed to prospective bidders. In other cases, program member agencies or their associates may carry out projects.

4. Since Aurora's legal authority to solicit proposals and award contracts lies with the lead administrative state, the lead state's procurement process takes precedence over Aurora's Charter and Operating Rules when soliciting for and awarding contracts. The Federal Highway Administration (FHWA) approves state DOT procurement procedures.

3.4 Project Teams

A project team comprised of representatives of the participating agencies is established for each approved project. The management consultant provides technical support to the project teams on an as-needed basis.

4. AURORA MEMBERSHIP AND PARTICIPATION

There are many ways for organizations, both public and private, to become involved in the Aurora Program. In addition to the participation options outlined below, it is envisioned that some specific program activities will benefit from public-public or public-private partnerships. In these cases, program participants will explore opportunities for public or private sector agencies to become contributing partners in a particular project. More detailed information on participation in Aurora is contained in the public agency or private sector participation guidelines documents. Contact details for all current Aurora member agency representatives are provided in Section 4.3.

4.1 Public Agency Participation Guidelines

As an **Aurora Member**, a public sector organization is entitled to all the benefits of participation in the program. Members may propose and vote on proposed projects for program funding. A complete description of membership rights and benefits are contained within the Aurora Organizational Charter and Operating Rules, found in Appendix A. As an FHWA pooled-fund study program, the overall success of the Aurora Program is directly linked to active support and guidance provided by its members. Aurora Program membership is available for an annual fee of $25,000.

The Aurora Associate Membership option is designed for research, non-profit public entities such as universities or other research institutions. To become an **Aurora Associate Member**, an organization must be nominated by an active Aurora member. Aurora Associates may attend all Aurora meetings and receive all documents and materials developed through the Aurora Program on request. An Associate Member may also propose projects for program funding.

The **Aurora Visitor** option allows public organizations the opportunity to gain first-hand understanding of the Aurora Program through attendance at one general meeting. It is intended that the visitor option will enable agencies to become familiar with the program prior to becoming a full member.

4.2 Private Sector Participation Guidelines

The **Friends of Aurora (FOA)** program enables private sector firms or individuals to receive information produced within the program, as well as invitations to events held in conjunction with general meetings. Participation in Friends of Aurora requires no fees. Friends of Aurora meetings will be held as deemed necessary by the board.

These meetings involve inviting selected private sector representatives to an informational meeting and discussion concerning RWIS technology and research. The Friends of Aurora program will be used as a mechanism to maintain an ongoing dialogue with the private sector community. The next FOA event will be held in early 2009.

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5. OUTREACH ACTIVITIES

The Aurora Program differs from ITS America and the American Meteorological Society (AMS) in that it is a funded program of research, development, and deployment rather than a professional group with liaison and monitoring functions. Aurora maintains active links with appropriate technical committees, such as the AMS Standing Committee on ITS and Surface Transportation and the Weather Information and Applications Special Interest Group (WIASIG) of ITS America. In addition, Aurora has established links with the maintenance community, including organizations such as the American Association of State Highway and Transportation Officials (AASHTO) and its Snow and Ice Cooperative Program (SICOP), the Strategic Highway Research Program (SHRP), the National Cooperative Highway Research Program (NCHRP), and the Transportation Research Board (TRB).

Aurora activities also tend to differ from those of organizations involved in standards development – such as the ENTERPRISE (Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency) pooled fund program, the American Association of State Highway and Transportation Officials (AASHTO), the Society of Automotive Engineers (SAE), and the International Organization for Standardization (ISO). However, Aurora supports these entities by providing technical input to standards development or by testing proposed standards prior to finalization, where applicable. In addition, Aurora has established a memorandum of understanding with the ENTERPRISE pooled fund program intended to develop a formal relationship to leverage their resources on projects where cooperation would result in mutual benefit. Aurora has also established a memorandum of understanding with the Clear Roads pooled fund program.

Aurora exchanges information between members and with the outside world in several ways, including workshops, seminars, publications, and presentations. These activities are used to share the findings of Aurora-sponsored research and to promote related activities. Economies of scale are realized as individuals from member agencies represent Aurora. Aurora was represented at several events during the past year, including:

- National Rural Intelligent Transportation System 2007 Conference in Traverse City, Michigan (October 2007)
- Transportation Research Board 87th Annual Meeting in Washington, D.C. (January 2008)
- 88th Annual Meeting of the American Meteorological Society in New Orleans, Louisiana (January 2008)
- Transportation Research Board 4th National Conference on Surface Transportation Weather in Indianapolis, Indiana (June 2008)
- 7th International Symposium on Snow Removal and Ice Control Technology in Indianapolis, Indiana (June 2008)
- AASHTO 2008 Joint Meeting of the Subcommittee on Maintenance, Standing Committee on Environment, and Subcommittee on Asset Management in Monterey, California (July 2008)
- *Clarus* Initiative Coordinating Committee in Reno, Nevada (August 2008)
- 2008 Mid-Continent Transportation Research Symposium in Madison, Wisconsin (August 2008)
- National Rural Intelligent Transportation System (NRITS) 2008 Conference in Anchorage, Alaska (September 2008)

Over the years, use of the Aurora web site has continued to be invaluable in facilitating both internal and external information flow. The web site, found at www.aurora-program.org, contains:

- background information about RWIS, the program, and its members
- details of options for becoming involved in the program
- links to other resources such as member websites and other weather-related sites
- an area where visitors can post comments and send email to member agencies
- a password-protected area where members can access meeting minutes and other information
- documents downloadable to the public
- information on completed projects
- updates on recent activities of the ongoing projects, including monthly project status reports
- an online newsletter updated three times per year

6. COMPLETED AURORA PROJECTS

Since the inception of the Aurora Program in 1996, Twenty-eight (28) research projects have been completed. This section contains descriptions of these completed projects.

6.1 RWIS Institutional Issues (Project 1997-01)

Under this project, institutional issues encountered by agencies in the process of planning and deploying road weather information systems (RWIS) or programs were documented, as were the measures taken to overcome these issues. All Aurora Program member agencies were involved in this project, addressing issues such as public-private partnerships, barriers to implementation, and strategies for deployment.

The project was seen as an outreach activity, the product of which is a compendium of findings and lessons learned relating to the institutional issues involved in the development and implementation of RWIS. These findings and lessons are published in the final report for this effort. This final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.2 RWIS Communications Standards (Project 1997-02)

Under this effort, support was provided to the ongoing standards development process for RWIS communications and protocols. Aurora members served in a support role, providing strategic input and technical expertise in many RWIS areas. Consensus was reached within the group on particular issues, and then input was provided at the appropriate standards development forum. Participants then reported back to Aurora, ensuring partners were kept up to date.

In addition, Aurora members prepared an RWIS protocol white paper submitted to the National Transportation Communications for ITS Protocol (NTCIP) Working Group. Throughout the effort, Aurora worked with numerous other groups; including the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and NTCIP.

6.3 Expert System for Maintenance Decision Support (Project 1997-03)

This project was undertaken to promote the development of decision support tools to help winter maintenance personnel take appropriate preventative measures needed in different weather conditions. The three specific objectives of this research effort were to report on existing work in developing decision support tools to select chemical applications appropriate for winter weather conditions, to describe in detail those which are at or near an operational state, and to assess the feasibility of implementation as part of a road weather information system. This project was led by the Ontario Ministry of Transportation with assistance from the Swedish Road Administration and Canadian Meteorological Service. The review and assessment focused on an expert system developed in Sweden in the early 1990's, the FHWA Manual of Practice for anti-icing published in 1996, and the De-Icing Anti-Icing Response Treatment (DART) system developed in Ontario in 1999.

The first two project objectives were completed in 2000. The subsequent report includes details of both Sweden's and FHWA's approaches to classifying environmental conditions for material application and recommends integration of Ontario's DART program with their RWIS. A demonstration copy of DART was provided to Aurora, and a database of experimental measurements on the effectiveness of alternative treatments that could be used to support future winter maintenance decision support systems was also developed. Though Ontario Ministry of Transportation ultimately decided not to integrate DART with their RWIS, the DART database continued to accumulate records. To complete the effort, a report describing the database was produced. The final report covering the entire project can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.4 Adaptation of the Local Climatological Model (Project 1997-04)

The effort involved a feasibility study to determine which factors need to be modified, and how these modifications should be performed, in order to implement the Local Climatological Model (LCM) in the Province of Ontario, Canada. The LCM was developed for Swedish conditions and requirements. Therefore modifications were required in before installation in a new geographic area.

The final report for this project includes a detailed inventory of geographic and meteorological conditions for LCM adaptation in the Ontario region, an assessment of LCM transferability, a description of LCM data requirements, and an outline implementation plan for LCM at the Canadian feasibility site, including additional instrumentation/data collection required. This final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.5 Standardized Weather and Road Condition Information (Project 1997-05)

This project sought to identify means to make road and weather information more usable and consistent. The project consisted of two parts. Part 1 identified past, current, or planned implementations of information provision services or systems that supply road and weather information to general end users. The final report for Part 1 can be accessed on the Aurora Program web site, found at www.aurora-program.org.

Part 2 was intended to facilitate development of guidelines for presentation techniques to suit the needs of the general road users for different types of information provided over a variety of media. Under Part 2, Aurora and ENTERPRISE began a joint project in to develop uniform messages for road weather information presentation. The results of this joint effort did not produce definitive guidelines. The results of this joint effort did not produce definitive guidelines. Therefore, as a follow-up, human factors work will need to be done before icons and color codes can be posted on a website.

6.6 Standardized Testing Methodologies for Pavement Sensors (Project 1998-02)

The objective of this project was to establish and evaluate standard procedures for testing RWIS sensors, related software, and models. The research attempted to discern the state of the practice around the world. The subsequent report, published in December 1999, indicates that a number of nations and organizations were developing standards for testing and calibrating road weather sensors. As of the report date, only the Ministère de l'Equipment des Transports et du Logement (METL) of France had adopted and implemented standards. This report can be accessed on the Aurora Program web site at www.aurora-program.org.

Later correspondence on the SICOP Snow-Ice Listserve supported the findings of the study and indicates interest in developing standards. It also indicates how complicated this issue is. This research also found that while Aurora's size and resources are such that it cannot fund an independent effort to develop test and calibration standards, Aurora can act as a catalyst to move this process forward. Therefore, a strategy to promote the development of national and international standards and procedures was funded as a continuation of this project.

6.7 Compilation of RWIS Specifications (Project 1999-01)

The first objective of this project was to collect member specifications for the construction of, maintenance of, and/or forecasts at RWIS stations and develop a database of these specifications to be published on the Aurora Program Internet web site. The second objective was to survey the agencies that had provided specifications to better document and understand the issues associated with administering the various contracts.

Both the specifications and surveys of agencies administering them were completed. The final matrix containing maintenance, construction, forecast, and other specifications, as well as user surveys, can be accessed on the Aurora Program web site at www.aurora-program.org.

6.8 Road Weather Roadshow (Project 1999-02)

The objective of this project was to develop an outreach presentation that captured the advances and improvements in road weather forecasting and nowcasting. This area is drastically changing as the National Weather Service modernization moved into full implementation. While some recognized the potential impact this could have on daily operations, many others were not convinced.

Therefore, there was a need to show the rest of the transportation community the difference between the old and new through simple presentation material.

The presentation produced through this project addresses this need, with its primary audience being state and local DOT staff and managers. The final presentation of this effort, in PowerPoint format, can be accessed on the Aurora Program web site at www.aurora-program.org.

6.9 Synthesis of Road Weather Forecasting (Project 2000-02)

The objective of this project was to determine the arrangements that exists in other countries between local and national government surface transportation agencies and their national weather forecasting agency. A questionnaire was sent to DOT personnel in nine countries. The questionnaire requested information collected by the road agencies and the information supplied and protocol used by the forecasting service.

Responses to the survey from these countries form the basis for the final report, which is posted on the Aurora web site at www.aurora-program.org.

6.10 Computer-Based Training Development (Project 2000-04)

The objective of this effort was to develop a comprehensive, interactive training program for winter operations that would include segments on RWIS, anti-icing, de-icing chemicals, and other related aspects of winter operations. This objective was accomplished through coordination between Aurora and the American Association of State Highway and Transportation Officials (AASHTO). Aurora's role in this effort was to develop an RFP and assist AASHTO in the contractor selection process. This was accomplished in early 2001. Since that time, 34 state DOT's, APWA, NACE, three Canadian provinces, one Canadian city, and the Ontario Good Roads Association have participated in the development of the training.

The program was completed and distributed on May 1, 2003. As the CBT was utilized in states and provinces, many suggestions were submitted to make improvements. Also, as new snow and ice control research was completed, the CBT was recognized as an effective way to provide the technology transfer to get that research implemented in field operations. Version 2 of the AI/RWIS CBT was, therefore, prepared and distributed on July 9, 2007. The CBT has received awards in both national and international training methods competitions.

6.11 Road Weather Training for Improved Winter Response (Project 2000-07)

Under this project, the Quebec Ministry of Transportation provided to Aurora members a training program it developed to improve winter response capabilities of operators and managers and to enhance skills and knowledge base for using climatological data received from remote weather stations. In addition, the possibility of combining this effort with the Computer-Based Training program developed by AASHTO was pursued.

Although Quebec's training materials were not combined with the CBT, metric standards were incorporated into a CBT version. Quebec also provided nine training modules for distribution and use by the Aurora members.

6.12 Intelligent Image-Based Winter Road Condition Sensor – Phase I (Project 2000-08)

The objective of this research project was to build a field prototype of a video-based road condition sensor and to extend its function such that both the current condition and trend could be measured with high accuracy. The limitations of the system were also investigated as part of this effort.

The project was led by the Swedish Road Administration and involved the development of software and integration of algorithms to create an interface to allow cameras to function as pavement condition sensors. Phase I showed that the use of only image data was not sufficient to determine road conditions, but combining image and other RWIS data in the prototype system resulted in reliable results, matching picture to condition approximately 98% of the time. The final report for this project can be accessed on the Aurora Program web site, found at www.aurora-program.org.

A second phase of this project (see project 2002-01) involved further development of the prototype. In both of the first two phases, analysis of the images was conducted at Dalarna University, rather than in the field. This project also includes a third phase (see Project 2003-04). The third phase involved continuing research and movement of the test site to a new location to acquire more research data and test the portability of the prototype to new locations without re-calibration.

6.13 Interjurisdictional Traveler Information Exchange (Project 2001-01)

This project focused on the ability to share weather data jurisdiction to jurisdiction (province or state) and to make weather information more available to travelers. The final report for the project provides a survey of Road Weather Information systems in North American jurisdictions, a review of three systems including the system architecture, and an evaluation of the financial and economic feasibility of those systems. This final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.14 Guidelines for Testing, Installation, Maintenance, and Calibration of Pavement Sensors (Project 2001-02)

The overall goal of this research was to promote the development of national and/or international standards for testing and calibrating road weather surface sensors. This project, led by the Virginia DOT, was undertaken in two parts. In Part 1, actions were taken to promote the idea of national/international standards and procedures for testing and calibration of road surface condition sensors. Part 2 set aside funds to contribute to a coordinated effort to develop testing and calibration standards and procedures. Part 2 was funded through the National Cooperative Highway Research Program (NCHRP) in 2003.

The final report for this project, NCHRP 6-15 - Testing and Calibration Methods for RWIS Sensors, can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.15 RWIS Data Integration and Sharing Guidelines (Project 2001-03)

The objective of this project was to provide agencies with a guide to fully utilize their own weather data and that of other agencies. The project, which was a collaborative effort between Aurora and ENTERPRISE, was conducted in two parts. The first part involved a survey of state DOT's on their current RWIS practices and their thoughts on the benefits of and barriers to RWIS integration and data sharing. A second survey was developed for vendors of RWIS components, as it was felt that vendors might have a different take on how integration and data sharing should take place, and also to gain further understanding into how ESS play a role in designing an integrated system.

The second part of this project utilized past research into RWIS practices and successfully integrated

systems, along with the survey results, to present a discussion of the various issues involved in the deployment of a data integration project. This second part also introduced a conceptual design for RWIS integration that includes functional requirements for the various elements of an integrated RWIS.

A final report combines the two parts to present a comprehensive view of the state-of-practice for the deployment and integration of RWIS, and how an integrated system, capable of sharing information with other agencies, may be successfully established. The final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.16 Pavement Temperature Sensor Accuracy (Project 2001-04)

This project sought to determine the accuracy and variation in readings of various pavement temperature sensors, both in-pavement and mobile, by first developing a method to determine the "true" pavement temperature for comparison purposes. Previous to this effort, there had been studies comparing accuracy of various devices, but none of them have included a method of determining true readings.

The final report for this project includes descriptions of how well various sensors performed under various conditions. The final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.17 Intelligent Image-Based Winter Road Condition Sensor – Phase II (Project 2002-01)

The objective of this effort was to further previous research conducted under the Phase I project. Phase I showed that combining image and other RWIS data resulted in reliably determining road conditions. Since the first phase did not cover trials with illuminated roads at night, this second phase focused on classification of night time pictures.

Results of the second phase also provided insight into how to design a final version of the sensor system. Specifically, the research has shown that there are two parameters that could have an effect in this evaluation compared to earlier tests in this matter. These parameters are different types of cameras and differences in day and night time images. The research has also shown that two neural networks are likely needed, one for daytime images and one for nighttime images. The final report for Phase II can be accessed on the Aurora Program web site, found at www.aurora-program.org.

Also, as noted under the Phase I summary, the initial phase also concluded that it was important to move the image-processing prototype to Dalarna University's RWIS test site. In both of the first two phases, analysis of the images was conducted at Dalarna University, rather than in the field. The third phase (see Project 2003-04) involves continuing research and movement of the test site to a new location to acquire more research data and test the portability of the prototype to new locations without re-calibration.

6.18 RWIS Equipment Monitoring System – Phase I (Project 2002-02)

The objective of this project was to provide Aurora member agencies with an automated means of problem identification and reporting for their RWIS equipment. Functionality of an existing Minnesota Department of Transportation system was used as a base to design the desired system.

The end result of this project was a web-based solution that each member state could choose to host themselves or have someone host for a fee.

6.19 Improved Frost Forecast Model – Phase I (Project 2003-01)

The objective of this effort was to determine under what atmospheric conditions frost is most likely to form on bridge decks and create slippery conditions, then develop a forecast model that can predict when this may occur (at a site or across a region) and can be used by forecasters to more accurately predict frost. The project was led by the Iowa Department of Transportation and Iowa State University.

The resulting model for predicting frost was made available to private forecasters and researchers are working with National Weather Service labs to include frost in MDSS. Frost forecasts for Iowa were also made available on the Iowa Mesonet website, with further data analysis continued under a second phase of this effort (see Project 2004-05).

6.20 Off-the-Shelf Component RWIS (Project 2003-02)

This project was championed by the Québec Ministry of Transportation. The objective of this research was to build an RWIS station with an open architecture in order to utilize various sensors from different manufacturers.

The final report for this project details how the Québec research was done and the results of the open architecture system developed. The final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.21 Investigation of the Variability of Snow Cover Conditions (Project 2003-05)

The objective of this project was to develop an understanding of the variability of snow cover along a highway maintenance route at the scale of RWIS station intervals; including its relation to surrounding terrain, to maintenance operations, and to winter storm conditions.

The final report for this effort details the results of the work performed by the Ontario Ministry of Transportation. The final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.22 Hot Plate Snow Gauge Demonstration (Project 2004-01)

This project was undertaken to test the utility of a new real-time snow gauge for use in winter road maintenance and possible addition to automated weather stations in the future. The project also tested the utility of the Weather Support for Deicing Decision Making (WSDDM) aircraft deicing/anti-icing nowcast system for winter road maintenance operations.

The final report details the performance of this sensor from the demonstration. The final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.23 Laser Road Surface Sensor (Project 2004-02)

Led by the Iowa Department of Transportation, this project involved the purchase, installation, and evaluation of a Goodrich Laser Road Surface Sensor (LRSS) to determine if it could be used to detect frost and how it could be used in winter maintenance operations. The research approach was to install an LRSS to sense the surface condition of a functional roadway in a location that also has other sensors to help evaluate the LRSS data. Sensor data was also supplemented by visual observations at times.

Research results are documented in the final report. The final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.24 Support of the MDSS Pooled Fund Study (Project 2004-03)

The objective of this project was to provide funding to develop and test the Maintenance Decision Support System (MDSS) as an operational tool in the states involved in the pooled-fund study. Since the FHWA's intent with MDSS was only to establish proof of concept and map the architecture for a system, the job of taking this prototype to an operational level will fall on state DOT's and/or the private sector. Recognizing both the importance and difficulties involved in a project of this nature, the states of Indiana, Iowa, Minnesota, North Dakota and South Dakota formed a pooled-fund study to develop and test an operational MDSS in their states.

Aurora funding was provided to the South Dakota DOT, the pooled-fund's lead state. The MDSS test continues. A link to information on the MDSS effort can be found on the Aurora Program web site, found at www.aurora-program.org.

6.25 Improved Frost Forecast Model – Phase II (Project 2004-05)

A continuation of earlier research, this project involved completion of analysis and publication of results on bridge frost observations and modeling for previous frost seasons, development of an interface to pass weather forecast information to BridgeT and a frost accumulation algorithm, management of the forecast model and data flow over the upper Midwest for the 2003-2004 frost season, development of a graphical web-based display of 24-hour forecast of frost hazard potential, and production of maps of frost hazard potential.

A final report details results of this research. The final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.26 Integration of Road Weather Information with Traffic Data (Project 2005-04)

This project involved integrating road weather data with traffic flow data to quantify the impacts of weather on capacity and flow along urban freeways. The most important conclusion from this project and the findings of other transportation weather researchers is that weather conditions do have an important impact on traffic safety, traffic demand, and traffic flow.

The final report also concluded that much more research is needed to measure, understand, and develop management strategies to mitigate the impacts of weather on traffic safety, traffic demand, and traffic flow. Another important conclusion of this work is that if RWIS environmental sensors are going to be of significant value to traffic managers, then they must more reliably collect different data elements. The final report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.27 Using RWIS to Trigger Spring Load Restrictions (Project 2005-05)

This project investigated the use of RWIS to trigger spring load restrictions in Ontario. Results of the research can be found in the final report. This report can be accessed on the Aurora Program web site, found at www.aurora-program.org.

6.28 Road Weather Information Outreach / National Conference (Project 2006-07)

The project involved funding and conducting a national winter maintenance meeting for Aurora, Clear Roads, and the FHWA to share research results, solicit research needs, and get updates from each snow-belt state. The resulting National Winter Maintenance Peer Exchange was held on August 28-29, 2007 in Columbus, Ohio.

7. ONGOING AURORA PROJECTS

This section provides overviews of the research projects funded prior to FY 2009 that are still underway at the time this work plan was produced.

7.1 Benchmarking the Performance of RWIS Forecasts (Project 2000-01)

Project Champion: Ontario Ministry of Transportation

Project Area: Standards and Architecture

Background: Road weather information systems (RWIS) provide real-time measurements and forecasts of weather and pavement surface conditions at sensor sites on a highway network. The information is used by road maintenance agencies to plan and schedule snow and ice control operations. The type of weather systems contributing to winter hazards, the methods and timing of measurements and forecasts, and spacing of sites along a highway network all contribute to the success of forecasts and to the way they can be used in maintenance operations. There is no standard or benchmark for the accuracy of RWIS forecast information, and this adds to the uncertainty inherent in planning winter maintenance. Benchmarking the accuracy of RWIS forecasts among agencies using different approaches to forecast generation and between areas of different meteorological influences will assist in effective planning of highway maintenance and in guiding future improvements to RWIS.

Purpose/Objectives: This project will produce statistical analyses of new or previously analyzed data to verify and provide benchmarks for the accuracy of RWIS forecasts. The report will estimate the reliability of forecasts for defined road-weather parameters in each study area and will discuss similarities and difference in the benchmarks among study sites. The benchmarks will be presented in a manner that guides agencies in making operational decisions appropriate to forecast accuracy.

Strategy/Approach: The study includes the following milestones:

- Literature review and contact with Aurora members and RWIS service providers to identify potential study sites, sources and content of verification data.
- Selection of case study sites (a minimum of five will be selected) based on the following criteria:
  a. availability and reliability of verification data from past years
  b. geographical dispersal across North America and Sweden
  c. winter season meteorological influences
  d. approaches to RWIS forecast and network configuration and
  e. forecast parameters common to all cases.
- Specification of forecast parameters and methods of analysis
- Acquisition, quality control and analysis of data
- Reporting

Deliverables: The project will deliver a report that contains summaries of statistical data and an analysis that compares the accuracy of forecasts obtained on different time bases using different forecast methods, different verification parameters, and different verification sources. It will provide an assessment of the accuracy of forecasts that should be expected under operational conditions, and a standard against which forecast products can be compared.

Estimated Project Completion Date: June 2009

Duration: Tasks 1 and 2: 8 months, Task 3: 18-24 months

Total Project Cost:
- Tasks 1 and 2 – $30,000
- Tasks 3 through 5 – $34,000 (in-kind contribution from Ontario)

Authorized Aurora Funding:
- Tasks 1 and 2 – $25,000 in-kind (FY 2000 in-kind contribution from Ontario)
- Task 3 – $25,000 in-kind (FY 2001 in-kind contribution from Ontario)

Project Participants:
- Ontario Ministry of Transportation (champion)
- Wisconsin Department of Transportation
- Pennsylvania Department of Transportation
- Meteorological Service of Canada
- University of North Dakota

Status:
- This effort is approximately 40% complete.
- An interim report on Tasks 1 and 2 was presented in August 2000. An expanded report on Tasks 1 and 2 is to be included in the Task 3 work.
- Following renewed interest in this topic recognized at the spring 2005 Aurora Program board meeting, this project became a higher priority for Ontario MOT.
- MTO surveyed data sources in December of 2006 using internal resources.
- An RFP has been developed based on the existing statement of work and will be advertised.

7.2 RWIS Leverage Opportunities (Project 2000-05)

Project Champion: Iowa Department of Transportation

Background: Aurora voted to maintain a small amount of funds to be leveraged against other agencies' ongoing projects should the need arise.

Purpose/Objectives: This initiative is an opportunity area rather than a project. Program members will monitor the progress and direction of several key RWIS research programs, including, for example, the AASHTO Snow and Ice Cooperative Program (SICOP). The aim is to consider funding any activities identified as priorities within these other programs that are also of interest to Aurora participants, and that cannot be solely funded by either program in the immediate future. Alternatively, this "reserve funding" could be utilized by the Aurora Program to fund any general project opportunity that arises during the course of the program year.

Strategy/Approach: Follow the progress of SICOP and other RWIS-related interests and be ready to fund a small project that is not selected and that ranks high on the Aurora Program selection criteria of program balance, leverage opportunities, and "early winners".

Deliverables: This would be dependent on the project that would be funded by Aurora.

Authorized Aurora Funding:

- $20,000 (FY 2000 funds)
- $25,000 (FY 2001 funds)
- $10,000 (FY 2000 funds from discontinued Project 2000-06)
- $20,000 (FY 2001 funds from discontinued Project 2001-05)

Project Participants: Leverage opportunities would not necessarily require Aurora member participation.

Aurora Funding Distributed: $34,000 for the FY 2004 program and $10,000 for Project 2006-04 (which leaves $31,000 in available funds for future leveraging opportunities)

Available Aurora Funding: $31,000

7.3 Intelligent Image-Based Winter Road Condition Sensor - Phase III (Project 2003-04)

Project Champion: Swedish Road Administration

Project Area: Road Condition Monitoring

Background: Research at Dalarna University has shown that winter road condition can be classified with better than 90% accuracy using video images of the road. Knowledge of the current surface conditions is important both to maintenance staff and road-users. There are no image-based sensors available for this purpose today, ready to be implemented into RWIS. Phase I of this effort addressed this issue. This phase is complete. Results when using only image data were not sufficient. Combining image and other RWIS data has resulted in reliable results. It was thus imperative to move the image-processing prototype to the University's RWIS test site or update one of SNRA own sites for Phase II trials with illuminated road at night-time.

Purpose/Objective: This third phase involves continuing research and movement of the test site to a new location to acquire more research data and test the portability of the prototype to new locations without re-calibration.

Strategy/Approach: This project will involve a third phase of the intelligent image-based winter sensor project. The first two phases of this project have shown to be very promising. The third phase would involve continuing research and movement of the test site to a new location to acquire more research data.

Deliverables/Products: The project will deliver a report that contains summaries of statistical data.

Estimated Project Completion Date: December 2008

Authorized Aurora Funding:
- $25,000 in-kind (FY 2003 in-kind contribution from Sweden)
- $25,000 in-kind (FY 2004 in-kind contribution from Sweden)
- $25,000 in-kind (FY 2006 in-kind contribution from Sweden)

Project Participants:
- Swedish Road Administration (champion)
- Ontario Ministry of Transportation
- Virginia Department of Transportation

Status:
- This effort is approximately 95% complete.
- The critical second camera test site to verify that the neural network is operational in any location was tested, and the result was unexpected. The accuracy on road classification from the field image classification system was unacceptable.
- A final report is being prepared.

7.4 Winter Weather Severity Index Enhancements (Project 2004-04)

Project Champion: Iowa Department of Transportation

Project Area: Decision Support Systems

Background: Measuring the performance of winter maintenance operations is becoming a standard practice among many agencies. Weather is one of the key factors to be considered when attempting to measure performance levels, yet most states either do not use a weather index or use the one developed by SHRP several years ago. To get an accurate assessment of performance, weather differences in the area need to be accounted for, and an automated method should be developed to allow users the ability to pull NWS data from statewide or regional collection sites and determine weather differences in the area.

Purpose/Objective: To determine the weather events that affect winter operational performance, then develop a software application that can automatically extract NWS data and calculate differences in weather across a region.

Deliverables/Products: Research to determine which weather factors have a correlation with winter operation cost/performance and then development of a software package to extract NWS data and calculate differences in weather based on the user's zip code.

Estimated Project Completion Date: December 2008

Total Project Cost: $100,000

Authorized Aurora Funding: $50,000 (FY 2004 funds)

Project Participants:
- Iowa Department of Transportation (champion)
- Indiana Department of Transportation
- Wisconsin Department of Transportation
- Minnesota Department of Transportation

Status:
- This project is approximately 60% complete.
- CTRE completed the literature review.
- Based on the results of the literature search, the draft RFP was developed and advertised.
- A vendor was selected and is working to complete this research.

7.5 Development of an RWIS Quality Assurance Monitoring System (Project 2005-01)

Project Champion: Alaska Department of Transportation and Public Facilities

Project Area: Standards and Architecture

Background: Knowledge of RWIS data quality is essential to fully utilize the data being collected. Optimally, the monitoring of data flow and quality should be accomplished in near real time to avoid proliferation of errors, especially into derived products, and to minimize the lag between outages and maintenance scheduling. In addition, the knowledge of RWIS data quality can assist in maintenance verification and be used during research or other data studies. Knowing the extent and complexity of RWIS siting requires that a quality assurance monitoring system should have the following characteristics:

- Modular, allowing for easy installation with different host organizations and platforms
- Expandable, different quality assurance algorithms can be developed and added at any time
- Accessible, a user friendly interface to view the quality information obtained from RWIS data
- Historical, continually builds a database of quality assurance results for future reference

Purpose/Objective: To develop an RWIS Data Quality Assurance Monitoring System that employs the above characteristics. Its complexity is easily recognized and the development will proceed in three levels. Figure 1 illustrates the proposed RWIS Data Quality Assurance Monitoring System and three sub systems. This development will take place on the open source operating system LINUX and will utilize the PERL programming language as well as the open source database MySQL. This will permit the system to be easily adaptable on other platforms.

Strategy/Approach: This project will develop an RWIS Data Quality Assurance Monitoring System that employs the above characteristics. Its complexity is easily recognized and the development will proceed in three levels. This development will take place on the open source operating system LINUX and will utilize the PERL programming language as well as the open source database MySQL. This will permit the system to be easily adaptable on other platforms.

Deliverables/Products: Three distinct sub-systems:

- RWIS Data Collection/Ingest System – develop avenues to ingest RWIS data at the highest time frequency available (i.e. 5 minute data, 15 minute data, etc)
- RWIS Automated Quality Assurance Processing System both an operational and developmental version – modular system that will allow Quality Assurance checks to be executed as data is collected and ingested. Examples:
- RWIS Quality Assurance Dissemination

Estimated Project Completion Date: December 2008

Total Project Cost: $100,000

Authorized Aurora Funding:

- $50,000 (FY 2005 funds)
- $50,000 (FY 2006 funds)

Project Participants:

- Alaska Department of Transportation and Public Facilities (champion)
- Michigan Department of Transportation
- Minnesota Department of Transportation
- Wisconsin Department of Transportation
- Utah Department of Transportation
- Iowa Department of Transportation
- Swedish Road Administration

Status:

- This effort is approximately 5% complete.
- The contracting mechanism has been resolved. The project will use a request for proposals through Iowa DOT.
- The *Clarus* System quality checking feedback to the three proof of concept states was made available at the *Clarus* Initiative Coordinating Committee.
- The Aurora project team will review the output and then detail a scope of work for incorporation into the RFP.

7.6 RWIS Telecommunications Issues and Options (Project 2005-02)

Project Champion: Illinois Department of Transportation

Project Area: Equipment Evaluations

Background: With the RWIS networks in many states increasing in size, and given shrinking budgets, agencies are looking at ways to reduce costs. Services or non-project expenses are being squeezed to the point where reduced or eliminated services are being considered. One major area of concern involves how much agencies spend on their RWIS telecommunications services. For example, existing dial-up phone lines work, but the cost is often prohibitive, while less expensive options may not be well-tested or reliable.

Purpose/Objective: To investigate the various options for getting RWIS and other data back and forth between remote sites and a central location, while looking for efficiencies of existing and new technologies that reduce costs, ultimately recommending specific technologies and/or methods to reduce telecommunications costs. The ultimate benefits of this research include cost savings and performance enhancements as states look to expand the data and services from upgraded RWIS sites.

Strategy/Approach: This effort will be undertaken in three parts.

- Task 1: The first task will involve a review of literature and of potential or existing data transmission methodologies being used or considered by various public agencies in communicating with their RWIS sites. The results of this task will be summarized into a literature/state-of-the-practice/technology review.
- Task 2: Next, the results of the literature search and review of technologies will be further evaluated and compiled into a collection of best practices and potential applications. The research will consider benefit-cost issues as well as qualitative determination of alternatives to consider the intangible issues of the various options, such as installation, maintenance, or license issues with third party agreements. A survey of end users may also be done as an additional task. The task deliverable will be a compilation of best practices from existing users as to what works, with possible feedback from a survey of end users.
- Task 3: Finally, a list of recommendations for states to potentially study and choose as a proposal to their management will be created.

Deliverables/Products: The project deliverables will be:

- Results from a literature search
- A compilation of best practices from existing users as to what works and end user feedback (survey of end users)
- A list of recommendations for states to potentially study and choose as a proposal to their management.

Estimated Project Completion Date: December 2008

Total Project Cost: $15,000

Authorized Aurora Funding: $15,000 (FY 2005 funds)

Project Participants:

- Illinois Department of Transportation (champion)
- Minnesota Department of Transportation
- Alaska Department of Transportation and Public Facilities

Status:

- This effort is approximately 75% complete.
- Curt Pape has provided a database of communications options to CTRE.
- Work is underway at CTRE, with a final report being reviewed by the project team.
- Further research and deeper analysis may be suggested to the board.

7.7 Mobile Weather and Road Condition Reporting (Project 2005-03)

Project Champion: Indiana Department of Transportation

Project Area: Equipment Evaluations

Background: Winter road conditions are rarely recorded and/or evaluated. If road conditions are recorded, the operator of the snow and ice removal (S&I) truck records road condition data on a "taper log", which is a paper form for recording road condition and activities. This form is submitted at the end of a shift. Road condition data could be used during the weather event to guide snow and ice removal efforts, provide road conditions to the general public and after the event to evaluate performance. It is extremely important for managers to know the road and weather conditions. A system that improves the recording of road conditions and provides appropriate weather data could significantly improve operational decision making and provide the traveling public with current road condition information.

Purpose/Objective: The objective is to develop a Road and Weather Condition Reporting System that collects data electronically at the S&I truck and transfers it to managers that are supervising the efforts. In addition the data would be provided to the Maintenance Decision Support System (MDSS) and to a road condition report for the general public. The challenge is to develop a system that simplifies the recording and data transfer. And on the operational end display the data in an efficient manner so that it is useful for the managers and the traveling public.

Strategy/Approach: The following activities will be performed to meet the above objectives.

- Develop a user interface for the S&I truck operator that simplifies the recording of road conditions and is compatible with existing and planned INDOT networks. One option that will be tried is to use either a tablet or PDA device that has a map interface for recording road conditions. The researchers would like to develop a menu that contains the possible types of road conditions and the driver selects the appropriate one and highlights the road on a map.
- Other information will be collected automatically through sensors installed on the truck. Information on pavement friction, road temperature, air temperature, and solar radiation can be collected, stored and transferred electronically.
- There are different data transfer options. These include cellular transfer, satellite communications, and developing a network of hot spots or data collection areas through the use of 802.11 technologies. The last one is the preferred option that will be used on this project. The reason for using is that it potentially provides an interface that makes it ubiquitous to the driver for transferring collected data. Setting up a system of hot spots has interest from INDOT and potentially could be used by other operations, traffic and construction. On this project the active syncing, security, and data transfer processes will be tested. Data transmissions will be compatible with existing INDOT Division of Systems Technology wireless data communication plans. Appropriate data will be provided to create/update road conditions reporting for various needs.

Estimated Project Completion Date: December 2008

Deliverables/Products:

- A driver user interface for recording and collecting road condition data.
- A process or procedure for automating the transmission of this data through the use of 802.11 technologies.
- A management tool that turns the recorded data into useful information for making operational decisions and to inform the traveling public of road conditions.
- Develop an interface into the Maintenance Decision Support System for this data.

Total Project Cost: $75,000

Authorized Aurora Funding:

- $50,000 (FY 2005 funds)
- $25,000 (FY 2006 funds)

Project Participants:

- Indiana Department of Transportation (champion)
- Iowa Department of Transportation
- North Dakota Department of Transportation
- Purdue University

Status:

- This effort is approximately 95% complete.
- This project is being done in conjunction with an AVL research project being performed by Purdue University through the Joint Transportation Research Program.
- The existing AVL project provided good technical support and head start for the Aurora project with the report generation functions being developed.
- During the summer of 2006, a hotspot data transfer option was tested.
- For winter 2006/2007 the system was tested at three locations on 10 vehicles.
- The system utilizes a statewide wireless network used by the State Police; and it records road and weather conditions, road temperatures, and plow position, then updates ARCIMS maps with the information every three minutes.
- A procedure has also been developed to transfer the data into MDSS.

7.8 New Road Surface Condition Sensor (Project 2005-06)

Project Champion: Swedish Road Administration

Project Areas: Road Condition Monitoring / Equipment Evaluations

Background: It has even since the start of RWIS been a need for a sensor that can give accurate information about surface conditions. The knowledge if the road is wet or dry gives a supervisor a good chance to avoid problems in the future.

Purpose/Objective: The project aims to evaluate a prototype of a new ordinary and cheap road condition sensor to be use in combination with RWIS.

Deliverables/Products: The road condition sensor will give the end-user information if the surface is dry or wet, and also information about the heat balance as well as surface temperature and ground temperature 3 inches below surface.

Estimated Project Completion Date: December 2008

Total Project Cost: $40,000

Authorized Aurora Funding: $25,000 in-kind (FY 2005 in-kind contribution from SRA)

Project Participants:
- Swedish Road Administration (champion)
- Ontario Ministry of Transportation

Status:
- This effort is approximately 95% complete.
- An evaluation of the results was presented to the Aurora board.
- The final report is being revised.

7.9 Support of the *Clarus* Initiative (Project 2006-01)

Project Champion: Iowa Department of Transportation

Project Area: Standards and Architecture

Background: The *Clarus* Initiative is a Federal project that establishes a vision for the leveraging of local and regional road, rail and marine weather observations. This will be accomplished through the design, demonstration and deployment of a national surface transportation weather data collection and management system that complements the existing National Weather Observation System. The *Clarus* System design effort involves the following activities.

- Development of High Level System Requirements, such as detailed user interaction with the system for road weather information needs,
- Development of Detailed System Requirements, such as communications protocols, programming interfaces, format translators, and data storage capabilities,
- Architecture Analysis and a Design Gap Analysis to develop a high level design by examining alternative architectures and exposing potential limitations in Environmental Sensor Station (ESS) deployment, design, or observational capability
- System design documents to define the hardware configuration and develop system software specifications

Purpose/Objective: To influence the *Clarus* initiative and assist with its early implementation through funding costs 1) for member participation in the *Clarus* project when the *Clarus* Initiative does not cover costs 2) associated with drafting and submitting a proposal to be the test location for the multi-state regional demonstration.

Strategy/Approach: Once the system design is complete in the spring of 2006, it will be necessary to implement, integrate, and test the *Clarus* System in a Multi-state Regional Demonstration. This limited demonstration will be conducted at a selected location so that system components, core functions, and information management processes may be tested and improved. Aurora supports this initiative. Active participation in the design and demonstration phases will allow Aurora members to influence the final product, gain knowledge of the details involved with implementation, and help promote this needed system.

Deliverables/Products: The project deliverables will be:

- Added participation in *Clarus* Initiative
- Funding for Aurora membership travel expenses to *Clarus* events
- Source of funding to develop a proposal for Aurora to serve as multi-state regional demonstration project
- Capture of the multi-state regional demonstration project

Estimated Project Completion Date: June 2009

Total Project Cost: $50,000

Authorized Aurora Funding: $50,000 (FY 2006 funds)

Project Participants:

- Iowa Department of Transportation (champion)
- Virginia Department of Transportation
- Alaska Department of Transportation and Public Facilities
- Indiana Department of Transportation
- Illinois Department of Transportation
- Wisconsin Department of Transportation
- Ohio Department of Transportation
- National Center for Atmospheric Research

Status:

- This effort is approximately 55% complete.
- Detailed System requirements have been developed and reviewed by a task force that included Dan Roosevelt and Curt Pape.
- Proof-of-Concept test involved Aurora members UT, AK and MN.
- The multi-state regional demonstration project was advertised in late 2006. The Aurora application was accepted, and work is underway. Iowa, Illinois, Indiana, and Ohio are Aurora members on this team.

7.10 Pilot Test of ESS Sensor Testing Guidelines (Project 2006-02)

Project Champion: Utah Department of Transportation

Project Area: Standards and Architecture

Background: NCHRP 6-15, Testing and Calibration Methods for RWIS Sensors, was completed in 2005. The product was a manual, *Guidelines for Testing ESS Sensor*. Aurora supported this project and several members served on the project steering committee. Aurora should support adoption and implementation of these guidelines as a national standard. This project proposes Aurora pilot test the guidelines in up to three member states and publish the results and findings. This project will cover costs for the following activities:

- Create and acquire six kits for testing ESS surface and atmospheric sensors for use by the states.
- Acquire field data acquisition equipment (e.g., hand held computer) for pilot states
- Consultant costs to
  - Develop training material on the guidelines
  - Present training once in each state,
  - Document the results of the pilot states' experience with use of the guidelines,
  - Develop software/forms that can be used to record test data.

Purpose/Objective: The research objectives are:

- To gain real-world experience with implementation of an ESS sensor testing program
- To develop a standardized kit for testing ESS sensors
- To develop data collection software

Strategy/Approach: This proposal anticipates engaging a consultant to accomplish these activities. Participating state costs, other than those for the test kits and data acquisition equipment will be borne by the states.

Deliverables/Products: The project deliverables will be:

- Report documenting the implementation and results of the pilot test
- Standardized kit for testing ESS surface and atmospheric sensors
- Software program for data recordation

Estimated Project Completion Date: December 2009

Total Project Cost: $70,000

Authorized Aurora Funding:

- $10,000 (FY 2006 funds)
- $25,000 (FY 2001 funds unexpended from Project 2001-02)
- $35,000 (FY 2002 funds unexpended from Project 2001-02)

Project Participants:

- Utah Department of Transportation (champion)
- Minnesota Department of Transportation
- Alaska Department of Transportation and Public Facilities
- Virginia Department of Transportation
- Michigan Department of Transportation
- Iowa Department of Transportation
- National Center for Atmospheric Research

Status:

- This effort is approximately 5% complete.
- The draft final report and draft field test procedures have been reviewed by the advisory panel and the testing guidelines should be released shortly.
- The plan outlined under Strategy/Approach will be revised.

7.11 Update of SHRP H-350 and H-351 (Project 2006-03)

Project Champion: Iowa Department of Transportation

Project Area: Information Outreach

Background: In the early 1990's Strategic Highway Research Program (SHRP) projects H-350 and H-351 investigated the use of RWIS for winter maintenance operations in the United States. Questionnaires and interviews were conducted in several states to determine the current status of RWIS technology. Field testing was also conducted as part of this project to help determine placement and function of systems. Over the past fifteen years, the network of RWIS sites has grown in the United States and information from these sites is currently being used by more than winter maintenance personnel to combat winter weather. A cost/benefit analysis of RWIS technology for winter maintenance operations was delivered with the original report but was based on limited deployment of systems in the U.S. With more systems in the U.S. and more experience with RWIS technologies an update to the cost/benefit analysis seems appropriate.

Purpose/Objective: The objective is to review H-350 and H-351 to determine which portions of the original report would benefit from a fifteen year update and complete a thorough benefit/cost analysis of RWIS technology.

Deliverables/Products: The project deliverables will be:
- Synthesis of best practices for RWIS installation and use based on questionnaires and interviews
- Updated cost/benefit analysis for winter maintenance operations
- Recommendations of alternatives uses for RWIS information

Estimated Project Completion Date: December 2008

Total Project Cost: $150,000

Authorized Aurora Funding:
- $50,000 (FY 2006 funds)
- $100,000 (FY 2007 funds)

Project Participants:
- Iowa Department of Transportation (champion)
- Utah Department of Transportation
- New York Department of Transportation

Status:
- This effort is approximately 70% complete.
- WTI drafted a survey to learn more about weather usage in winter maintenance as background for the cost benefit study.
- The research is expected to go into late 2008.

7.12 Evaluation of Vaisala Spectro Pavement Sensor (Project 2006-04)

Project Champion: Wisconsin Department of Transportation

Project Area: Equipment Evaluations

Purpose/Objective: The objective is to study the accuracy and usefulness of the new Vaisala Spectro pavement temperature and condition sensor.

Strategy/Approach: The project will be completed as follows:
- Task 1: Prepare sensor test plan. It will be based upon the previous test of the Goodrich unit as well as previous pavement sensor tests.
- Task 2: Work with Vaisala to select a location for testing.
- Task 3: Procure the sensor and install it.
- Task 4: Perform evaluation in a roadway environment, gather data.
- Task 5: Prepare final report.

Deliverables/Products: The research result will be a final report outlining how well the Vaisala Spectro sensor performed under real-world highway conditions.

Estimated Project Completion Date: December 2008

Total Project Cost: $70,000

Authorized Aurora Funding:
- $50,000 (FY 2006 funds)
- $10,000 (transferred from Project 2000-05)
- $10,000 (FY 2008 funds)
- $25,000 in-kind (FY 2005 in-kind contribution from Ontario MOT)

Project Participants:
- Wisconsin Department of Transportation (champion)
- Iowa Department of Transportation
- Minnesota Department of Transportation
- Ohio Department of Transportation
- Swedish Road Administration
- Utah Department of Transportation
- Ontario Ministry of Transportation
- University of North Dakota
- National Center for Atmospheric Research

Status:
- This effort is approximately 95% complete.
- Final reports from both the Ontario and North Dakota tests have been drafted and are under review.

7.13 Technology Transfer (T^2) of Alternative Inexpensive RWIS (Project 2006-05)

Project Champion: Alaska Department of Transportation and Public Facilities

Project Area: Equipment Evaluations

Background: Aurora seeks to find inexpensive alternatives to current RWIS technology. RWIS technology has traditionally focused on installing new systems expanding a grid of points used by maintenance staff and weather forecasters. These new systems are expensive and many states have reduced the number of new systems installed in the last several years due to budget concerns. For this reason there has been increased interest in finding inexpensive alternatives. Large networks of independent surface weather observation systems; both public and private, already exist that are essentially RWIS stations without pavement temperature or related data. These atmospheric weather stations are in both urban and rural areas. Many of these systems are hardwired into the internet allowing for timely delivery of data, reporting data as often as every few seconds. Use of these existing stations reduces the need to create and support sophisticated RWIS communication networks. Basic RWIS networks may cause time lags between the observation time and observation availability decreasing the value of the reported data. An inexpensive RWIS alternative that also leverages this faster data exchange has many advantages.

The high cost of system installation and maintenance prevent many potential candidates in the road maintenance community from using RWIS data. These potential candidates include city and county facilities. We believe it is important to introduce new technologies and concepts to this group and expand the use of RWIS at the city and county level. Reducing the cost of basic RWIS data can increase use of RWIS technologies at these levels and will result in reducing the overall road maintenance costs for the secondary roadway system while improving interoperability between states and the city and county RWIS community.

Purpose/Objective: To research, through a proof of concept test, the ability to integrate pavement thermistors to existing atmospheric weather stations and document the application of this new RWIS concept for pavement management and to develop urban sighting guidelines for the addition of pavement sensors to existing infrastructure.

Deliverables/Products: The project deliverables will be:

- Research documentation on the feasibility of using low cost RWIS solutions based on leveraging existing surface weather infrastructure.
- Sighting guidelines for installation of thermistor to existing infrastructure.
- Research on use of RWIS data at the city and county level with low cost RWIS alternative.
- Research on improved interoperability between various state, city and county RWIS groups.

Estimated Project Completion Date: June 2009

Total Project Cost: $50,000

Authorized Aurora Funding: $50,000 (FY 2006 funds)

Project Participants:

- Alaska Department of Transportation and Public Facilities (champion)
- Iowa Department of Transportation
- New York State Department of Transportation
- Michigan Department of Transportation

Status:

- This effort is approximately 5% complete.
- This project will take approximately 2 years to complete.
- The project will use approximately two dozen pavement thermistors (YSI -081-55033-NA-PF-480ST), an interface board, and signal processing hardware from project 2001-04.
- A Concept of Operations, which will be used for putting together an RFP, will be developed.

7.14 Low Cost Mobile RWIS (Project 2006-08)

Project Champion: Québec Ministry of Transportation

Project Area: Equipment Evaluations

Purpose/Objective: The objective of this project is to build a low cost mobile RWIS station with open architecture to mix different sensors of different manufacturers. The researchers plan to use an embedded Linux computer, 4x40 LCD display, USB GPS WAAS, and 1-wire sensors (pressure, air temperature, humidity, temperature of pavement).

Strategy/Approach: The project will develop a low cost open architecture mobile RWIS station with open software on Linux embedded computer.

Deliverables/Products: Result will be an open low cost RWIS mobile station.

Estimated Project Completion Date: December 2008

Total Project Cost: $50,000

Authorized Aurora Funding: $50,000 in-kind (FY 2006 and FY 2007 in-kind contribution from Québec MOT)

Project Participants:
- Québec Ministry of Transportation (champion)
- Minnesota Department of Transportation
- Virginia Department of Transportation
- Indiana Department of Transportation
- Iowa Department of Transportation

Status:
- This effort is approximately 65% complete.
- Equipment was purchased, and researchers worked on the software architecture in 2006.
- Researchers have begun to develop software for the daemon of data acquisition:

7.15 RWIS Equipment Monitoring System – Phase II (Project 2007-01)

Project Champion: Alaska Department of Transportation and Public Facilities

Project Area: Information Dissemination Technologies

Background: Project 2002-02 – RWIS Equipment Monitoring System, provided Aurora member agencies with an automated means of RWIS equipment problem identification and reporting. The project has been completed and the software application is ready to deployment at member agencies. Member agencies may choose to install the application or have a vendor host the application. Minnesota and Alaska DOT have deployed the system, with Meridian Environmental hosting the web application for their respective agencies. As these two agencies and others join, there may be functionality software changes that these agencies desire. The system provides the capability to change the site status and export metadata and site status files. Existing reports show site status changes by date/time. Additional reports for in-commission rates by site, area, date/time, and sensors would be very useful for managing the RWIS network. The system is designed to accept automated sensor updates from other sources such as the *Clarus* System or Project 2005-01 – Development of a RWIS Quality Assurance Monitoring System. Member agencies may be interested in doing so when the two capabilities come online. There potentially could be integration issues that need to be addressed before this capability could be fully realized.

Purpose/Objective: This project proposes four enhancements to the RWIS Equipment Monitoring System. First, expand the existing RWIS Equipment Monitoring System to include in-commission rate reports. The reports would include the percent of time the site was fully operational or degraded by no data received, incomplete data, or incorrect/suspicious data. The Aurora member agency would run the reports periodically to analyze the site in-commission rates, identify problem areas, and propose improvements to the RWIS network. Second, implement the specific changes to the RWIS Data and Reporting System proposed by the Aurora member states. Third, evaluate how site performance by sensor can be added to the application. Ideally the manager would want the capability to determine the rates for specific sensors, but this could potentially require extensive software changes. This capability will be evaluated as part of the project. Fourth, complete an implementation plan and deployment (assuming sufficient funding) for ingesting *Clarus* System output or the RWIS Quality Checking module (Aurora Project 2005-01- Development of an RWIS Quality Assurance Monitoring System) when these applications come online. Member agencies would have a choice of which system to use for data ingest.

Strategy/Approach: The project would follow an abbreviated Intelligent Transportation System (ITS) system engineering analysis (SEA) for each of the objectives:

- Modify the existing RWIS Data and Reporting System software for the first research objective's expanded export file capabilities and Aurora member validated enhancements.
- Complete an implementation plan and deployment (assuming sufficient funding) for the ingest of data reports following deployment of the *Clarus* System or the RWIS Equipment Monitoring System.
- Analyze the possibility of adding sensors to the RWIS site in-commission rate reports.

Deliverables/Products: There will be four deliverables:

- Implement the specific changes to the RWIS *Data and Reporting System* proposed by the Aurora member states.
- Create a suite of automated reports to be run periodically that shows the percent of time the site was fully operational or degraded by no data received, incomplete data, or incorrect/suspicious data. There would be reports by individual site and system wide (much like the existing reports for metadata and site history). The user could specify which report to turn and the period of record (year, month, or specified date range).
- Develop an implementation plan for importing the RWIS performance statistics from the *Clarus* System or the *RWIS Quality Assurance Monitoring System*. The integration would include both options. If funding allows, the data import process will also be deployed.
- Complete a Concept of Operations and high level design to expand the RWIS Equipment Monitoring System software to include reports for specific RWIS sensors.

Estimated Project Completion Date: December 2008

Total Project Cost: $25,000

Authorized Aurora Funding: $25,000 (FY 2007 funds)

Project Participants:

- Alaska Department of Transportation and Public Facilities (champion)
- Minnesota Department of Transportation
- Iowa DOT Department of Transportation
- Utah Department of Transportation
- New York State Department of Transportation

Status:

- This effort is approximately 5% complete.
- The proposal will incorporate the *Clarus* System quality checking output for objective #4.
- A detailed analysis of the *Clarus* System quality checking output has been completed.
- A draft scope of work will be completed soon.

7.16 Cold Weather Testing of the Halliday Road Grip Unit (Project 2007-02)

Project Champion: Ohio Department of Transportation

Project Areas: Equipment Evaluations / Decision Support Systems

Background: For the past several years, the Ohio Department of Transportation (ODOT) has been testing prototype road grip measuring devices, manufactured by Halliday Technologies, Inc., designed to be mounted on either the underside of a snowplow truck or as a separate unit attached to the tow hitch of a conventional vehicle. Initial results of the tests, conducted both in real-time on various state highway routes and offline at ODOT's Transportation Research Center, have been quite encouraging, though there have been insufficient days with significant winter conditions to allow for intensive testing. In cooperation with the University of North Dakota (UND)'s efforts to evaluate the Vaisala spectral sensors at their field research facility as part of Aurora project 2006-04, ODOT has loaned UND one of their Halliday tow hitch road grip test units as a cross-validation tool. This partnership, however, can also allow UND and ODOT to conduct more extensive testing of the Halliday unit's performance under cold weather/winter conditions, given the much greater likelihood of such conditions at UND's RWRF along Interstate 29 in eastern North Dakota.

Purpose/Objective: The proposed project provides for more extensive testing of the unit, as well as allows for more extensive cross-validation and data analysis than possible with the limited funding for such work under Project 2006-04.

Strategy/Approach: We propose that the project will involve three components:

- In-depth experimental testing and cross-comparison (with the Vaisala and Aurora/IDOT LRSS spectral sensors) at the UND RWRF, where controlled experiments changing the road condition will be conducted during the 2006-07 winter season. Measurements with the Halliday unit will be taken under the scope of these experiments for comparison with measurements from the remote sensors and with previous ODOT tests. An evaluation of the sensitivity of each device to changing conditions should be possible.
- As part of other UND research activities involving surveys of roadway conditions (pavement condition and roadway visibility) along selected MDSS test routes (US Highway 2 and I-29), the pickup with the Halliday unit will be utilized for some of these surveys during the 2006-07 winter season, taking road grip measurements in real-time as an analog to ODOT's previous real-time tests. In tandem with real-time video as well as audio commentary and the air and road temperature measurements systems that are included on the ODOT pickup, this will allow for a more comprehensive picture of the roadway environment and provide a robust context for evaluation of Halliday performance in the more extreme North Dakota winter environment.
- Testing of other tires for use with the Halliday unit. Virtually all ODOT testing with the Halliday unit thus far has utilized a single brand/type of tire, commonly utilized on ODOT fleet vehicles. Communication with Halliday Technologies has indicated that testing of the unit with other tires is desirable and would be a valuable complement to the body of testing either previously completed or proposed herein, to determine the dependency of the unit performance (and thus the cross-validation with the other sensors) on specific tire characteristics. We propose to consult with Halliday Technologies to determine at least one additional tire to use for testing during the 2006-07 winter seasons within the experimental framework discussed above.

Deliverables/Products: Deliverables for this project will include:

- A report including a detailed evaluation of the performance of the Halliday road grip unit pursuant to the objectives 1–3 above, including any recommendations related to dependency of the results on the specific tire characteristics.
- Copies of journal articles, conference preprints, etc. arising from the project, including those related to the cross-validation activities related to Aurora project 2006-04 (i.e., the Vaisala and LRSS remote sensing units) and case study reports, articles, etc. related to an integrated analysis of roadway conditions during the real-time testing conducted under objective 2 above.

Estimated Project Completion Date: December 2008

Total Project Cost: $40,000

Authorized Aurora Funding: $40,000 (FY 2007 funds)

Project Participants:

- Ohio Department of Transportation (champion)
- North Dakota Department of Transportation
- Virginia Department of Transportation
- Ontario Ministry of Transportation
- Iowa Department of Transportation
- University of North Dakota

Status:

- This effort is approximately 85% complete.
- A final report is being drafted.

7.17 Incorporation of MDSS into Winter Weather Forecasting (Project 2007-03)

Project Champion: Iowa Department of Transportation

Project Area: Decision Support Systems

Background: The Pooled Fund MDSS project is nearing maturity. One of the expected capabilities of this new MDSS is that it should be able to incorporate forecasts from any source, provided it is supplied in the correct format and frequency. This capability may be very beneficial to states who are interested in receiving MDSS information, but who prefer to receive weather forecasts from a weather provider who does not provide its own MDSS service. The Federal Prototype MDSS was designed to be a tool that could be incorporated into a private-sector weather forecast provider's system, so that the forecast provider could offer MDSS products to its customers. The spirit of the Prototype MDSS project was to create modules that can be incorporated without requiring extensive development by the forecast provider. These two MDSS programs may open new opportunities for states who are interested in MDSS products. Furthermore, these programs can benefit companies who wish to keep contracting with agencies who want MDSS products without investing a lot of resources to create their own MDSS. Unfortunately, there is little guidance for either state or private contractors on the costs, benefits, possible problems, and effort involved to pursue these options. Agencies and companies may be reluctant to pursue MDSS capabilities if the process has not yet been proven. The process, necessary resources and expertise, and forecast requirements for input into the two MDSS programs should be documented. This can be accomplished by contracting a non-MDSS weather company to provide working forecasts into the Pooled Fund MDSS, and install, incorporate, and provide forecasts through the Prototype MDSS. These forecasts should be provided as if they were operational forecasts to a DOT.

Purpose/Objective: To research, through a concept evaluation, the ability of the Pooled Fund MDSS to integrate weather forecast information from a separate forecast provider, and to provide guidance to states and forecast companies on the requirements of this type of MDSS procurement. This study will also provide guidance to private forecasting companies regarding the feasibility of implementing the Prototype MDSS and some of the problems and benefits to expect. Furthermore, this documentation can be used by the MDSS developers to improve the MDSS modules, its ease-of-implementation, or determine appropriate levels of implementation support and guidance.

Deliverables/Products: The project deliverables will be:

- Research documentation on the feasibility of using separate forecast information into the Pooled Fund MDSS
- Guidelines for procuring the necessary services and agreements among the State, forecast provider, and the MDSS provider
- Report on the historical use of the Prototype MDSS – research whether any private forecast companies have successfully incorporated the Prototype MDSS, and document reasons for why some companies chose to not try it or discontinued implementation.
- Compilation of Prototype MDSS implementation requirements
- Description and results of test implementation

Estimated Project Completion Date: December 2008

Total Project Cost: $30,000 (reduction in project cost from $80,000 to $30,000, as requested by the project team, was approved at the September 2008 board meeting)

Authorized Aurora Funding:

- $50,000 (FY 2007 funds)
- $30,000 (FY 2007 funds)
- - $50,000 (reduction in funding, as requested by the project team, was approved at the September 2008 board meeting)

Project Participants:

- Iowa Department of Transportation (champion)
- Utah Department of Transportation
- Indiana Department of Transportation
- Ontario Ministry of Transportation
- National Center for Atmospheric Research
- University of North Dakota

Status:

- This effort is approximately 15% complete.
- After discussing procedures and responsibilities with NCAR and Utah another change of plan was suggested to have both NCAR and a private computer/software engineering company deploy the MDSS at Utah.
- A scope of work and budget was submitted by NCAR and preparations for contracting were begun by Iowa.
- Recommended budget increase of $30,000 was approved in August 2007.
- Iowa DOT and NCAR have not come to an agreement on contracting.
- A recommended budget decrease of $50,000 was approved in September 2008.

7.18 Development and Demonstration of a Freezing Drizzle Algorithm for Roadway ESS (Project 2007-04)

Project Champion: Ontario Ministry of Transportation

Project Area: Decision Support Systems

Background: Freezing drizzle results in dangerous driving conditions and is poorly observed by radar and surface observations systems. The National Weather Service (NWS) Automated Surface Observing Systems (ASOS) and the Federal Aviation Administration (FAA) Automated Weather Observing Systems (AWOS) report freezing rain, but not freezing drizzle. Roadway environmental sensing systems (ESS) (e.g., Weather Information Systems - RWIS) are not capable of reporting freezing drizzle unless expensive optical devices are implemented. Testing of some of the most modern optical devices indicate that the probability of detection of drizzle is only near 70%. In addition, the optical devices estimate freezing precipitation intensity based on optical properties and not liquid equivalent or ice accretion rate. FAA development of aircraft anti-icing and deicing technologies has led to the development of a freezing drizzle algorithm that utilizes air temperature data and the raw vibration frequency of a Rosemount freezing rain sensor (Rosemount Aerospace Corporation's Model 872C2). The algorithm, initially developed by Al Ramsay of Science Applications Corporation (Ramsay, 1999) and refined by the National Center for Atmospheric Research (NCAR), has been successfully demonstrated at Denver International Airport. The presentation of freezing drizzle alerts to the airlines has already resulted in the successful avoidance of engine damage due to the ingestion of ice (Rasmussen, 2005).

Purpose/Objective: The primary goal of the project is to demonstrate the accuracy and utility of a freezing drizzle algorithm that can be implemented on roadway ESSs.

Strategy/Approach: The freezing drizzle algorithm developed for the FAA will be refined to utilize data from standard roadway ESSs and from the Rosemount ice detection sensor. Vibration frequency data from the Rosemount sensor will be integrated with 1 to 5 minute air temperature data from the standard roadway ESS. Output from the algorithm will include freezing drizzle occurrence, freezing drizzle intensity, and freezing rain intensity. The intensity values are based on accretion rate, which is more accurate than estimating the values based on optical properties. A test site collocated with an ESS will be instrumented and configured to run the algorithm over a winter season. Output will be provided to researchers and participating DOT personnel in real-time for evaluation.

Deliverables/Products: The expected outcome of this research is a product that accurately detects freezing drizzle and rain intensities that can be implemented on ESSs utilizing standard air temperature data from the ESS, plus an ice accretion sensor.

Estimated Project Completion Date: December 2008

Total Project Cost: $85,000

Authorized Aurora Funding:

- $15,000 (FY 2007 funds)
- $70,000 (FY 2008 funds)

Project Participants:

- Ontario Ministry of Transportation (champion)
- Minnesota Department of Transportation
- Wisconsin Department of Transportation
- National Center for Atmospheric Research
- University of North Dakota

Status:

- This effort is approximately 30% complete.
- The equipment has been purchased and installed.
- Mn/DOT and UND are working out logistics for transport and installation.

7.19 Multiple-Use ITS Data Collection Sites (Project 2007-05)

Project Champion: Alaska Department of Transportation and Public Facilities

Project Area: Road Condition Monitoring

Background: There are a number of highway factors that contribute to trip safety safety: road surface condition, weather, sub-surface temperatures, traffic volume and speed, vehicle classification and weight. State DOTs use a variety of sensors to measure these parameters. Choice of sensor station location depends on how representative the site data is, how the site fits into the agencies traffic data plan, ease and safety on sensor installation, site environment, and availability of power and communication. Deploying sensors for multiple intelligent transportation system (ITS) application at a single site in a cold weather climate can maximize available funding, and reduce maintenance risks.

Purpose/Objective: To integrate, through a proof-of-concept, non-obtrusive traffic data collection technology at Road Weather Information System (RWIS) sites in an arctic environment.

Strategy/Approach: Non-obtrusive traffic data collection equipment will be installed at three RWIS sites that represent a wide diversity of arctic climates. The RWIS sites will be near existing automatic traffic recorders (ATRs) for test equipment and ATR data comparison. The equipment shall operate for one complete winter. Ideally, the equipment shall be from several vendors. An independent contractor shall oversee the sensor installation, integration, field testing, and performance review. Sensor manufactures may take part in the sensor installation and commissioning. The project will document the sensor performance, site integration and maintenance issues, and suitability of arctic environment deployment.

Deliverables/Products: A field test report that will document:

- Installation and commissioning of non-obtrusive traffic data collection equipment
- Integration issues involved in installation, calibration, maintenance, operation, and polling
- Wintertime performance
- Evaluation of the traffic data with the respective ATR
- Siting, installation, calibration, and operation guidelines based on the field tests

Estimated Project Completion Date: December 2008

Total Project Cost: $35,000

Authorized Aurora Funding: $35,000 (FY 2007 funds) – Alaska DOT&PF personnel costs will be covered by the department's annual work program. Sensor integration technical support for integration with the existing RWIS remote processing unit (RPU) and the polling server may be required from the RWIS vendor. Alaska DOT&PF will fund this integration from the State Transportation Improvement Program.

Project Participants:

- Alaska Department of Transportation and Public Facilities (champion)
- Iowa Department of Transportation
- New York State Department of Transportation
- Utah Department of Transportation
- Minnesota Department of Transportation

Status:

- This effort is approximately 5% complete.
- Selected the three regional RWIS sites in Fairbanks, Anchorage, and Juneau. The Fairbanks site was upgraded from a pavement sensor only site to a full RWIS site.
- A draft scope of work is being developed.

7.20 Development of a National Road Weather Testing Facility (Project 2008-01)

Project Champion: Iowa Department of Transportation

Project Area: Equipment Evaluations

Background: In recent years, there has been discussion concerning establishment of a national center for testing winter maintenance and road weather monitoring equipment.

Purpose/Objective: The purpose of this project is to fund Aurora to market the idea of a national testing facility to various audiences and sources of support.

Strategy/Approach: Aurora will market the idea of a national testing facility to various audiences and sources of support.

Estimated Project Completion Date: December 2009

Total Project Cost: $40,000

Authorized Aurora Funding:
- $1,000 (FY 2008 funds)
- $10,000 (FY 2009 funds)

Project Participants:
- Iowa DOT Department of Transportation
- Alaska Department of Transportation and Public Facilities (champion)
- Ontario Ministry of Transportation

Status:
- This effort is approximately 15% complete.
- This project was first mentioned at the National Winter Maintenance Peer Exchange in Ohio in August 2007. Other winter maintenance testing needs were also brought up in the Peer Exchange round-table discussions. These needs were assigned to AASHTO/SICOP at the December 2007 meeting.
- Clear Roads, AASHTO, SICOP, PNS, and Aurora discussed possible cooperation and coordination on a "national facility" projects. This group decided cooperation was beneficial and began working on a draft document describing the facility.
- The idea of a single facility morphed into the idea of a consortium or board of experts which can help requestors of research find appropriate facilities.

7.21 Evaluation of Utah DOT's Weather Operations/RWIS Program (Project 2008-02)

Project Champion: Utah Department of Transportation

Background: UDOT's Weather Operations and RWIS Program is unique nationally because of its reliance on in-house, customized meteorological forecasting services. Its services are used throughout the department to assist in activities such as winter maintenance, construction scheduling, and TOC operations. An independent, limited-scale evaluation completed recently showed a very favorable benefit-cost ratio of the program's forecasting services for winter maintenance operations (specifically examining labor and materials costs). In order to optimize the program's usefulness and services, it is necessary to expand the scope of this evaluation to include the full range of benefits that may be provided by the service, as well as the full range of associated costs. This will ensure that UDOT's investment in weather information services is appropriate to the needs of UDOT as well as other key stakeholders.

Purpose/Objective:
1. Evaluate the benefit-cost ratio of the weather operations program on winter maintenance, including the costs of labor, materials and equipment.
2. Quantify the benefits and costs of the RWIS elements of the UDOT program.
3. Quantify the benefits of the weather operations program to other UDOT users.
4. Quantify the indirect benefits of the weather operations program.

Strategy/Approach:
1. Literature review
2. Inventory
3. Surveys and interviews of key stakeholders
4. Data collection and analysis
5. Modeling
6. Benefit-cost analysis

Estimated Project Completion Date: December 2008

Authorized Aurora Funding: $25,000 (FY 2008 funds)

Project Participants:
- Utah Department of Transportation (champion)
- Wisconsin Department of Transportation
- Iowa Department of Transportation

Status:
- This effort is approximately 15% complete.
- Ralph Patterson has solicited information from team members.
- A contract with WTI is being prepared.

7.22 Next Generation RWIS for Canada (Project 2008-03)

Project Champion: Ontario Ministry of Transportation

Background: The services and products of Ontario's RWIS are essentially unchanged since the system began operations in 200, including point information on current and forecast atmospheric and pavement conditions during winter. Advances have been made in other countries to:

- Spatially interpolate or predict parameter values between observing points
- Add decision support tools that incorporate predicted outcomes of winter maintenance interventions in addition to the forecast weather inputs,
- Link contract payments with road conditions observed by RWIS. These advances may lead to reduced use of road salt, improved road safety, and reduced costs of administering maintenance contracts.

Purpose/Objective: The objective of this project is to evaluate environmental, safety an cost benefits of a new generation of RWIS products and services that can be implemented to improve road maintenance in Ontario.

Research Approach: The approach is to review RWIS/MDSS developments in the United States and Europe, to integrate selected features to one forecast area in Ontario's existing system, to evaluate their benefits over the existing system, and to recommend an implementation program for beneficial components. The project will have 3 main tasks:
1) technology review
2) implementation and demonstration
3) evaluation and report.

Deliverables/Products: The project will have two deliverables, a written report and an operating demonstration system

Total Project Cost: $75,000

Authorized Aurora Funding: $75,000 (Ontario's in-kind contributions for FY 2008, FY 2009, and FY 2010)

Project Participants:

- Ontario Ministry of Transportation (champion)
- Utah Department of Transportation
- Minnesota Department of Transportation
- National Center for Atmospheric Research

Status:

- This effort is approximately 5% complete.
- Preliminary discussions have been held with RWIS service providers in Ontario
- MTO resources have been planned, and a technical review is underway.

8. 2008-2009 AURORA PROJECTS

The Aurora Program selected and developed additional projects to be launched during the upcoming program year. As in past years, several selection criteria were utilized to guide this process, as follows:

1. **Program Balance.** This criterion is applied to project concepts that will "round out" the Aurora Program as a whole, taking into account the projects that are already ongoing. The use of this criterion enables the selection of projects that complement existing Aurora initiatives.

2. **RWIS Trends**. This criterion is applied to project concepts that reflect any current "hot topics" in the RWIS arena, to ensure that the Aurora Program is seen to be at the forefront of RWIS. The use of this criterion enables the selection of projects that are particularly timely and relevant to the RWIS industry.

3. **Leverage Opportunities.** This criterion is applied to project concepts that can "piggyback" onto other initiatives, involving collaboration with individual states or other programs, and providing added value to both initiatives. This criterion could also apply to a project that is a continuation of a successfully completed Aurora project, in which the leveraging would occur on Aurora's previous investment. The use of this criterion enables the selection of projects that optimize the return on the resources invested, and whose results are transferable.

4. **Early Winners.** This criterion is applied to project concepts that will produce near-term results. The use of this criterion enables the selection of projects whose findings can be used to demonstrate the success of the Aurora Program.

5. **Program Recognition.** This criterion is applied to project concepts that will contribute particularly to the visibility and profile of the Aurora Program. The use of this criterion enables the selection of projects that will generate interest in the program and contribute to the program's reputation.

6. **Return on Investment.** This criterion is applied to project concepts that will offer a particularly strong return on the investment made by participants. The use of this criterion enables the selection of projects that optimize the resources of the program.

7. **Feasibility of Implementation.** This criterion is applied to project concepts whose findings or outputs are deemed to be the most easily implemented in the real world environment. The use of this criterion enables the selection of projects that are most likely to lead to some form of RWIS deployment.

Seven (7) new projects have recently been selected for funding in FY 2009. The descriptions of these projects are listed on the following pages.

8.1 Evaluation and Inter-comparison of the Lufft R2S Microwave Precipitation Sensor (Project 2009-01)

Project Champion: Utah Department of Transportation

Project Area: Equipment Evaluations

Background: It is becoming increasingly recognized that precipitation observation/measurement technologies, while improved from that a decade ago, still allow for considerable errors in reporting. As a result, work has continued by several instrument developers on new technologies for observing precipitation. One of the newer sensors is a small, low-cost microwave Doppler radar technology developed by Lufft, called the R2S. The R2S radar directly measures speed of falling precipitation particles, and provides a derived estimate of drop size. Precipitation quantity and intensity is calculated from the correlation between drop size and speed. The type of precipitation (rain/snow) is detected from the difference in drop speed. The digital outputs of the sensor include precipitation quantity/intensity (rain rate) and precipitation type. Such a sensor, while a significant investment compared to some other RWIS sensors, has the potential to be a very cost-effective solution compared to other types of radar technologies.

Purpose/Objective: The purpose of this project is to fund Aurora to market the idea of a national testing facility to perform an evaluation (including cross-comparison with other pre-existing precipitation sensors) of the R2S's capabilities and utilities over a full annual cycle (thus providing information on its utility to distinguish between very light drizzle and fog/mist droplets, as well as various frozen precipitation types).

Strategy/Approach: The two focus areas for the project are to evaluate the utility of the R2S sensors for both cold- and warm-season precipitation observation and to provide a recommendation on the cost-effectiveness of the R2S sensor for RWIS applications.

Estimated Project Completion Date: June 2010

Total Project Cost: $55,000

Authorized Aurora Funding: $55,000 (FY 2009 funds)

Project Participants:
- Utah Department of Transportation (champion)
- Minnesota Department of Transportation
- Alaska Department of Transportation and Public Facilities
- Illinois Department of Transportation
- New York State Department of Transportation
- University of North Dakota

Status: This project will begin in FY 2009.

8.2 Road Weather Information Outreach / Second Peer Exchange (Project 2009-02)

Project Champion: Iowa Department of Transportation

Background: Aurora has been actively researching a number of surface transportation weather projects while Clear Roads is researching materials, equipment and practices related to winter maintenance operations. Unfortunately the information/results sometimes do not reach end users in all states or at different agency levels. The winter maintenance community needs to be more aware of the research conducted by Aurora and Clear Roads and other research organizations and take a more active role in requesting research to meet winter operational needs.

Purpose/Objective: The purpose of this funding is to conduct a National winter maintenance meeting for Aurora, Clear Roads, SICOP, PNS and the FHWA to share research results from the Peer Exchange held in 2007, get updates from each snow-belt state and discuss other issues related to winter snow removal operations. Each state would send two representatives to the meeting that are most actively involved with the areas covered by Aurora, Clear Roads, PNS, SICOP and FHWA efforts.

Strategy/Approach: This effort will involve a national, multi-day meeting to cover a wide variety of topics related to winter maintenance operations. Updates on research completed by the various winter research groups and a summary of the meeting.

Estimated Project Completion Date: December 2009

Total Project Cost: $90,000

Authorized Aurora Funding: $30,000 (FY 2009 funds)

Project Participants:
- Iowa Department of Transportation (champion)
- Wisconsin Department of Transportation
- Nevada Department of Transportation
- North Dakota Department of Transportation
- Illinois Department of Transportation
- Clear Roads
- PNS
- SICOP
- FHWA

Status: This project will begin in FY 2009.

8.3 Knowledge Base for RWIS Programs and Environmental Data Loggers (Project 2009-03)

Project Champion: Alaska Department of Transportation and Public Facilities

Purpose/Objective: The objective of this project is to develop a web-enabled knowledge base (wiki-like) that allows sharing and retrieval of road weather information, with specific emphasis on data loggers. The application will have a search capability, various levels of administrative update control, be easy to update, and include capabilities for adding/replacing material. The knowledge base might have links to web-based information, stand alone articles, user manuals, and frequently asked questions. The data logger knowledge base may contain:

- commonly user sensor configurations, setup, and operation
- Site setup and environmental considerations
- Data logger programs
- Troubleshooting information
- Best practices

Research Approach: The project will draw on the data logger experience of Au member states and the data logger community.

Total Project Cost: $20,000

Authorized Aurora Funding: $20,000 (FY 2009 funds)

Project Participants:

- Alaska Department of Transportation and Public Facilities (champion)
- Utah Department of Transportation
- Minnesota Department of Transportation
- University of North Dakota

Status: This project will begin in FY 2009.

8.4 Road Weather Education Enhancements and Dissemination (Project 2009-04)

Project Champion: Michigan Department of Transportation

Background: This project idea is the result of priorities from the 2007 National Winter Maintenance Peer Exchange. Weather and RWIS Education received several votes during prioritization, including the areas of forecasting utilization and decision making.

Purpose/Objective: The objective of this project is to develop methods and/or materials to disseminate existing road weather and RWIS educational materials.

Deliverables/Products: The project will produce training/educational materials, such as brochures describing existing materials

Total Project Cost: $20,000

Authorized Aurora Funding: $20,000 (FY 2009 funds)

Estimated Project Completion Date: December 2010

Project Participants:

- Michigan Department of Transportation (champion)
- Ontario Ministry of Transportation
- Utah Department of Transportation
- Iowa State University
- University of North Dakota

Status: This project will begin in FY 2009.

8.5 Further Development of Pavement Precipitation Accumulation Estimation System (Project 2009-05)

Project Champion: Utah Department of Transportation

Project Area: Decision Support Systems

Background: Wintertime precipitation has serious impacts on surface vehicular transportation. Despite this, identifying wintertime precipitation occurrence and accumulation is very difficult. In discussions with state DOT personnel several years ago, the determination of wintertime precipitation occurrence and accumulation was identified as one of the top wintertime maintenance problems. The primary reason why wintertime precipitation occurrence and accumulation are so difficult to determine is that for wintertime precipitation, each observation platform (surface, radar, satellite, etc.) has significant limitations. For surface observations, the principal limitation is scarcity; for radar, the principal limitation is that radar beams "overshoot" precipitation altogether. For satellite data, the principal limitations are precipitation algorithm inaccuracies and the lack of testing of satellite algorithms for such purposes. To address these inadequacies, a prototype Pavement Precipitation Accumulation Estimation System (PPAES) was developed under separate funding during 2005-2007 at UND. PPAES utilizes multiple observation platforms and three dimensional analyses to provide a more accurate picture of precipitation occurrence and accumulation than possible by the other means discussed above. PPAES currently utilizes radar, satellite, and surface observations to estimate precipitation occurrence and precipitation rates. Analyses are used to determine precipitation type. Given the current *Clarus* effort directed towards enhancing the utility of RWIS, this is an opportune time to significantly improve PPAES such that it might be eventually incorporated within a decision support system such as MDSS/MODSS. The aim of this project, then, is to enhance the capabilities of PPAES to allow such incorporation.

Purpose/Objective: The two primary objectives of this project are the utilization of RWIS data within PPAES and the blending of PPAES products produced using different observation platforms.

Deliverables/Products: The project deliverables are:

- PPAES codes (available to be implemented by member states if desired)
- Preliminary and Final Project Reports
- Potential delivery of code to PFS MDSS infrastructure, pending results of validation activities (i.e., is it an improvement over what PFS MDSS already uses?)

Estimated Project Completion Date: June 2010

Total Project Cost: $83,000

Authorized Aurora Funding: $83,000 (FY 2009 funds)

Project Participants:

- Utah Department of Transportation (champion)
- Alaska Department of Transportation and Public Facilities
- Illinois Department of Transportation
- Nevada Department of Transportation
- University of North Dakota

Status: This project will begin in FY 2009.

8.6 Salinity Sensor Improvements and Development (Project 2009-06)

Project Champion: Iowa Department of Transportation

Project Area: Equipment Evaluation

Background: This project idea is the result of priorities from the 2007 National Winter Maintenance Peer Exchange. The final report from this event identified the desire for development of an on-vehicle salinity sensor and improvements in in-pavement chemical sensing capabilities.

Purpose/Objective: The objective of this project is to survey state transportation agencies to gauge interest in purchasing and utilizing on-vehicle chemical sensors, and if so, how many and at what price. Clear Roads would be a likely partner on such an effort.

Research Approach: *The approach will be to:*

- determine the need,
- develop the specification,
- and select a developer/vendor to produce sensors that would not be copyrighted.

Deliverables/Products: Salinity sensors for use by road agencies.

Total Project Cost: $50,000

Authorized Aurora Funding: $50,000 (FY 2009 funds)

Project Participants:

- Iowa Department of Transportation (champion)
- Ontario Ministry of Transportation
- Illinois Department of Transportation
- North Dakota Department of Transportation
- University of North Dakota

Status: This project will begin in FY 2009.

8.7 Review of Friction Detection Technologies (Project 2009-07)

Project Champion: Ontario Ministry of Transportation

Project Area: Equipment Evaluation

Background: This project idea is the result of priorities from the 2007 National Winter Maintenance Peer Exchange. The final report from this event identified the desire for evaluating friction devices, especially low-cost options and possible uses of ABS data.

Purpose/Objective: The objective of this project is to review the state-of-the-art in friction detection.

Research Approach: The approach will be to perform a review of friction detection technologies.

Deliverables/Products: A state-of-the-art review of friction detection technologies.

Total Project Cost: $35,000

Authorized Aurora Funding: $35,000 (FY 2009 funds)

Project Participants:

- Ontario Ministry of Transportation (champion)
- Michigan Department of Transportation (champion)
- Nevada Department of Transportation
- New York State Department of Transportation
- Iowa State University
- University of North Dakota
- NCAR

Status: This project will begin in FY 2009.

9. AURORA PROGRAM BUDGET

9.1 Background

Table 1 contains the proposed budget for the Aurora Program's 2008-2009 program year. This table illustrates the funding for each newly approved project described in Section 8, in addition to costs related to travel and program administration. The costs for ongoing projects are not included here for clarity, as these are fully funded through previous program year's income. While the funding estimates are as accurate as possible at the time of preparing the work plan, they will be revised as each project progresses. Therefore, the estimates presented in this section are intended to give an indication of each project's anticipated costs, rather than the final cost.

The Aurora Executive Board reviews its budget plans at each of the on-site meetings. This review ensures that projected income is on target. Any required mid-term corrections to project funding plans are also made at these meetings. It is envisioned that the current momentum of the program will ensure that project and other activities will be able to be funded as projected. Aurora is continuing its aggressive membership drive, and so it is anticipated that, at some point during the new program year, additional agencies may become members, thus increasing program income.

A five-step process is utilized to plan and track the Aurora Program budget. Using this process, the Program Administrator is able to maintain an updated budget and report to members at each board meeting. The remainder of this chapter describes the annual budget management process.

9.2 Aurora Program Income

Aurora Program income comprises agencies' membership contributions, and any additional income contributions for specific projects. In addition, funds carried over from the previous program year are also considered as income. Balances brought forward are extracted from the available funds described in the previous year's balance sheet.

Income directed for individual projects may comprise any additional contributions from a member agency that exceed the minimum membership contribution, or a grant from the Federal government. The minimum membership contribution is placed in a pooled fund to be allocated at the discretion of the Aurora. Where members' contributions are additional to the minimum membership contribution, members may select the Aurora project to receive the supplementary funding. These project-specific grants also contribute to Aurora's income. Although the income is presented for the 2008-2009 program year, it is important to note that income for multi-year projects will not all necessarily be received in FY 2009.

As a member of Aurora, U.S. member states have the option of contributing federally derived State Planning and Resources (SP&R) funds. This reflects Aurora's status as an FHWA-approved SP&R pooled-fund initiative. Most state DOT members from the United States use this approach. Other members have elected to make their contributions using non-SP&R funds or to contribute using funding sources appropriate to their individual involvement. To ensure appropriate use of program funds, SP&R and non-SP&R contributions are maintained in separate accounts.

9.3 Project Income

Aurora tracks income directed for individual projects. The four possible sources for individual project income are as follows:

1. Balances brought forward from previous years' allocations
2. Specified member agency contributions - in addition to membership contributions
3. Federal grants - directed towards specific projects
4. Allocation of pooled funds - approved by the Executive Board

The Aurora Program Administrator and management consultant use custom designed spreadsheets to track project income resulting from the first through the third sources above. Both the annual **planned** income committed and the **actual** income amounts received for each project are identified in this spreadsheet. Management of income received through the fourth source described above is described below.

9.4 Allocation of Pooled Funds

Once the Aurora income for FY 2009 is determined, pooled funds are allocated to individual projects. These allocations are based upon the planned projects' resource requirements and the current year activities as approved by the Aurora Executive Board.

9.5 Aurora Expenditures

Aurora Program expenditures include administrative costs, costs associated with Aurora meetings, and individual project costs. Administrative expenditures for Aurora include meeting and conference call costs, representation at conferences, management consultant support, and miscellaneous administrative costs.

Members meet several times each year to propose new projects for Aurora, vote on proposed projects, discuss the progress of present projects, and share progress and ideas. Travel expenses for member agencies are paid from pooled funds.

Once initiated, the expenditure for individual projects comes from the Aurora budget. Each project has a planned budget approved by the Executive Board. All costs incurred by a project are measured against this approved budget.

9.6 Balance Sheet

The funds available for any project can be ascertained by taking the difference between the allocated funding and the project expenditures to date. The expenditures include all costs relating to an individual project at the time of expenditure calculation. The allocated funding includes any project balance brought forward, if applicable, and any additional funding for the current year. The Aurora Program Administrator maintains balance sheets for each approved project, which are updated at least quarterly.

Table 1 – Aurora 2008-2009 (FY 2009) Program Budget
(September 29, 2008)

Income		**Expenditures**	
14 Member Payments	350,000	Administrative Contract	58,000
Ontario MOT In-kind	*25,000*	Travel	24,000
FY2008 Balance	42,000	Meetings	12,000
		Project Funding ↓	↓
		2008-01 National Test Facility	10,000
		2008-03 Next Canada RWIS (1)	*25,000*
		2009-01 Evaluate R2S Sensor	55,000
		2009-02 Peer Exchange in 2009	30,000
		2009-03 Knowledge Base	20,000
		2009-04 Road Weather Education	20,000
		2009-05 Precipitation Estimation	83,000
		2009-06 Salinity Sensors	50,000
		2009-07 Review of Friction	30,000
Total	**$417,000**	**Total**	**$417,000**

(1) Portion of this project approved as Ontario MOT in-kind contribution for FY 2009

At the August 2007 board meeting, the Aurora Program Executive Board voted to approve $75,000 of in-kind contributions from Ontario MOT for FY 2008 through FY 2010 for Project 2008-03. At the September 2008 meeting, the board approved the allocation of $10,000 of FY 2009 funds to Project 2008-01.

THE AURORA PROGRAM
ORGANIZATION CHARTER
Drafted: February 22, 1996
Updated: September 15, 1998
Updated: February 15, 2001
Updated: September 16, 2004

INTRODUCTION

The Aurora Program represents an international forum for collaborative research, development, and deployment ventures comprising the interest of governmental entities and industry groups. This forum will facilitate the sharing of technological and institutional experiences gained from road weather information system (RWIS) programs conceived and initiated by each participating entity. The cooperative and collaborative objectives of the Aurora Program provide for a more efficient use of resources than a series of independent initiatives. The synergistic effect of this forum is an accelerated implementation of RWIS programs.

In order to guide the deliberations of the forum participants, an agreement is required on the management structure and operating rules. An organizational charter provides a basis for this requirement.

GUIDING PRINCIPLES

A set of principles is intended to guide the Aurora Program and the creation of this charter.

These principles are simply stated as follows:

(1) the individual components of the program are locally organized and managed under the direction of a state-level program,

(2) individual states provide for the coordination with local level participants, both government and industry,

(3) each state-level organizational structure and program activity reflects individual priorities,

(4) comparison of state-level programs and interests will allow for the identification of joint program activities, and

(5) the Aurora Program management functions will require a minimum level of support.

From these principles an organizational structure, duties, and operating rules can be formulated.

1.0 EXECUTIVE BOARD

The purpose of the Executive Board (the "Board") is to develop the Pooled-Fund Study's budget, oversee the work program, and related matters of policy. The Board consists of a representative of each of the active member entities of the Aurora Program. Active membership is defined as a public entity contributing ***$25,000*** or more per year to the Program. In addition, on a case-by-case basis, the Executive Board may consider allowing an entity to become an active member through an in-kind contribution. Additional voting and non-voting members may be appointed to the Executive Board from international, national, or regional organizations, public or private, through a vote of approval by the existing Board members. The Executive Board is responsible for organizing itself, establishing operating rules and for conducting business with a quorum of members.

The Board shall be presided over and directed by the Program Chair, who shall be a representative of one of the voting member agencies. The Program Vice Chair, who shall also be a representative of one of the voting member agencies, shall be responsible for supporting the Chair in their role, and may temporarily assume the duties of the Chair when requested to do so by the Chair. The Chair and Vice Chair shall be elected by a vote of all Board members with voting privileges.

The Vice Chair shall succeed the Chair following the Chair's term of duty, and at this time a new Vice Chair shall be elected by the Board.

An Executive Committee will deal with administrative issues not requiring Board approval or when designated by the Board. The executive Committee will consist of the Chairman, Vice Chairman and the immediate past chairman.

1.1 Policies and Procedures

The Board will adopt such Program policies and procedures as deemed appropriate, including selection of the Chair and the Vice Chair.

1.2 Funding

Pooled funding will be derived from contributions received from participating entities. For U.S. states utilizing pooled SP&R funds, uniform treatment of funding is assured under existing FHWA mechanisms for such pooled funding projects.

1.3 Appointments

The Board is responsible for creating and terminating various committees or other organizational units as required to satisfy program requirements.

1.4 Budget and Work Program

The Board will approve a budget and a work program for the Pooled Study after consideration by the Program Administrator.

1.5 Active Membership

Active membership in Aurora is open to public organizations. Active membership of a private sector organization, or of a public organization seeking to join using non-SP&R funds, will require approval of the Executive Board.

For a designated member of the Board to continue active membership the participating entity must continue annual financial support of at least ***$25,000***. If an entity fails to meet its annual commitment, it may, at the discretion of the Board, be assigned non-voting member status until such time as its financial participation is continued.

On a case-by-case basis, the Board may consider allowing an organization to become a member of Aurora through an in-kind contribution. For continued active membership beyond the first year, this entity must contribute annual financial support of at least ***$25,000***. As with other agencies, if an entity fails to meet its annual commitment, it may, at the discretion of the Executive Board, be assigned non-voting member status until such time as its financial participation is continued.

1.6 Voting Rights

The representative of a public agency active Executive Board member is eligible to vote on all program issues. The representative of a private sector active Board member will have non-voting status. The voting members of the Aurora Board may choose to allow a private sector member to vote on an issue where it is determined that no potential for a conflict of interest exists. The public sector agencies of the Board may choose to go into executive session to prevent potential conflicts from occurring.

1.7 Approval of RFP's/Selection Processes

If external resources are required, committees of the Board will organize, review, and approve RFPs to assure their consistency with the work program and budget. Committees will recommend the selection of consultants, after consideration of a list of qualified consultants prepared by the Program Administrator. Committee consultant selection will assure consistent treatment of consultants and that the qualified list is consistent with the approved consultant selection process.

1.8 Review Products/Recommend Alternatives

Committees will be responsible for establishing a degree of expertise in their given areas of research. This expertise will facilitate in-depth analysis and detailed presentations before the Board. The Committees will review the products of their respective consultant teams and make recommendations to the Board.

1.9 Product Acceptance

The Board is responsible for acceptance of final products from consultant teams.

1.10 Coordination and Education

The Board is responsible for maintaining a high degree of coordination with impacted parties and for creating educational programs to increase awareness of the needs, benefits and impacts.

2.0 PROGRAM ADMINISTRATION

A single state approved by the Board will administer the Program's resources and will provide the Program Administrator ("Administrator").

2.1 General Support

The Administrator will be responsible for drafting RFPs, developing a proposal ranking and consultant selection process for the Board's approval, presentation of lists of consultants and RFP response materials to Committees of the Board.

2.2 Contract Administration

The Administrator is responsible for distributing RFPs, preparing contract documents and performing other functions related to contracts administration and management. The Administrator will assure that contracts, schedules, work plans, and project descriptions are followed. The Administrator will be responsible for quality control and evaluation, recommendations regarding preparation of contract documents, change order requests, and authorizing progress payments. The Administrator is responsible for providing contract progress reports to the Board.

2.3 Management Budget

The Administrator is responsible for administering a management budget, which may include travel and per diem payments for active participants or their designated representatives. Per diem and travel will be administered for each entity consistently with the policies of the Administrator and that entity’s prevailing per diem and travel policies.

2.4 Management Consultant

The Administrator may recommend to the Executive Board a Management Consultant to help coordinate technical studies and to prepare and administer various meeting agendas and related duties.

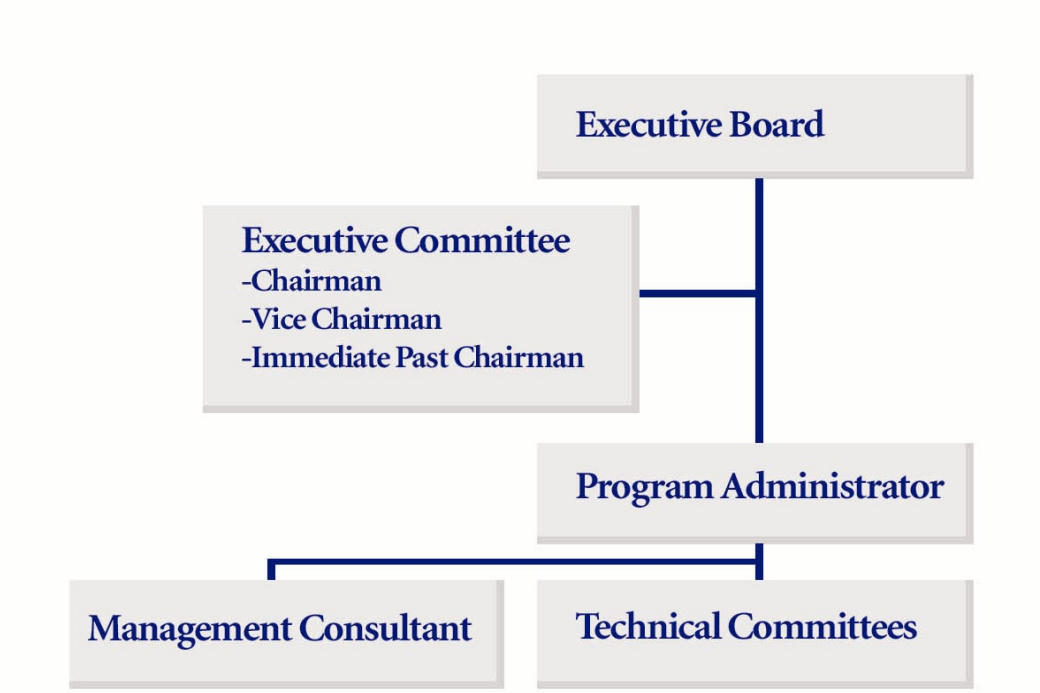
3.0 AMENDMENTS

This Charter may be amended by a 4/5 vote of the voting membership. If a quorum is not present the entire membership shall be polled.

4.0 ORGANIZATION CHART

The attached figure represents the Aurora Program organization presented herein.

Figure 1: Aurora Organizational Chart



THE AURORA PROGRAM
OPERATING RULES
Drafted: February 22, 1996
Updated: February 15, 2001
Updated: September 16, 2004
Updated: September 13, 2006

Quorum

A quorum of the Board, any committee or subcommittee shall consist of more than one-half of the voting membership. Voting members and non-voting members carrying written proxies in actual attendance at any meeting shall count toward a quorum.

Proxy Votes

All proxy votes shall be in writing and dated as to effective date and date of cancellation. Board members may identify in writing or via e-mail an individual to serve as proxy for a one-time event, or for all events at which the Board member is not present. The proxies may cover all issues subject to vote or may be limited to specific issues, as stated in writing. One-time proxy votes shall be delivered to the Executive Board or appropriate Committee Chair at the start of each meeting and recorded in the meeting minutes.

Voting Procedures

All votes may be cast by voice or by a show of hands. Any voting member may request a roll call vote.

For decision-making between meetings, voting by telephone, email, or facsimile polling may be undertaken when deemed suitable by the appropriate Board or Committee Chair. All voting members will be polled with a quorum required for approval.

Contracting Procedures

The Aurora Administrative State will administer all contracts unless the Board designates another agency to administer a specific contract. The Board may designate another agency as administrator by a majority vote of the voting membership. If a quorum is not present the entire membership will be polled. All contracts will follow the guidelines of the agency administering the contract.

Committee Size and Structure

A committee shall have a minimum of three voting members. There shall be no limit on non-voting members. Each Aurora member organization shall have no more than one voting representative on a committee. The Committee Chair shall be selected by the Executive Board, and shall be responsible for determining committee membership and reporting to the Board on committee activities.

Lists of Qualified Consultants

Mailing lists of qualified consultants shall be maintained by the Program Administrator and submitted to each committee for suggested additions or changes.

Aurora Newsletter

At the discretion of the Board, an Aurora newsletter or electronic newsletter will be developed with the objective of a wide yet targeted circulation. The Board will determine the appropriate body to be charged with preparing this newsletter.

Reports of Technical Consultants

Technical consultants will make presentations to committees of the Board and will be responsible for presenting committee approved final products to the Executive Board for acceptance.

Travel Support

The Board member or designated representative of each active member agency will be eligible for reimbursement of reasonable costs for travel, including registration fees, accommodation, and sustenance, to attend approved Aurora meetings. Travel costs of attendance at Aurora meetings by others may also be reimbursable in special cases approved in advance by the Aurora Program Administrator or the Executive Board.

Travel costs are to be kept to a minimum whenever possible. The Program Administrator and management consultant are charged with coordinating events requiring travel as appropriate to minimize travel costs.

If approved by the Executive Board, reasonable travel costs for attendance by Board members or designated representatives at other events germane to the Aurora program may be reimbursed. The procedure to obtain travel reimbursement in these cases is as follows:

- Those desiring to use Aurora funds to travel will submit an email request to the Aurora Chairman and the Program Administrator stating the 1) purpose of the trip, 2) start and end dates of the trip, and 3) estimated cost of the trip.
- Approval of the request will be based on 1) the person or purpose of the trip has been approved by the Aurora Board and 2) funding exists within the Aurora program to cover the anticipated travel costs.
- Approval by both the Chairman and the Program Administrator will be authorization for the person to travel and obtain reimbursement from Aurora
- The Chairman and Program Administrator are responsible for notifying the Management Consultant of action they take.
- Reimbursement will follow the same procedure and dollar limits currently used to reimburse qualifying members who attend Aurora meetings.

At the discretion of the Program Administrator, or if approved by the Board, reasonable travel costs for attendance of invited guests at Aurora meetings or other related events may be reimbursed.

Meetings and Registration Fees

From time to time, Aurora will hold general meetings open to members and nonmembers alike. The fee for attendance at these meetings will be $350 per person unless lowered or waived by the Executive Board or the Program Administrator. Fees may be lowered or waived differently for Executive Board members or their representatives, invited guests or speakers, or other general meeting attendees. Friends of Aurora (FOA) will pay reduced registration fees as determined by the Program Administrator.

Other Aurora meetings, including business meetings, committee meetings and working sessions, will generally be restricted to Board or committee members, their designated representatives, and other invited guests. At the discretion of the Executive Board or appropriate Committee Chair, however, these meetings may be opened to broader participation. The registration fees for such meetings will be set by the Executive Board, Program Administrator or Committee Chair, as appropriate.

Registration fees collected by the host state in excess of the meeting facilities costs are the property of Aurora and are to be used to defray the cost of other Aurora expenses. Host states, or the Management Consultant, shall provide a meeting expense summary to the Program Administrator after each meeting.

Internet Web Site

The Aurora Program will maintain an Internet web site for use by members and non-members. The public portion of the web site will be used to disseminate information deemed important by the Executive Board to non-member agencies, and will include general information concerning the Aurora Program, information on member agencies, and any information relating to completed projects. In addition, a portion of the web site will be restricted to Aurora members only. This section will include meeting and conference call minutes and project status reports.

Mailing Lists

The Program Administrator will maintain a mailing list of all organizations and individuals eligible to receive approved Aurora materials. This will be used as the basis for distribution of minutes of general meetings, meeting announcements, approved technical reports, press releases and newsletters (if available).

All active member entities will be included on this mailing list.

Organizations or individuals which are not on the mailing list, but which attend or pay the registration fee for a general Aurora meeting, may receive minutes and other materials associated with that meeting.

Technical Committee Procedures

Aurora technical committees study those areas of interest identified by the Executive Board. To date, two technical committees have been established by the Executive Board. These committees are the Membership Outreach Committee and the Web Site Review Committee.

The Membership Outreach Committee is responsible for keeping up on potential new membership opportunities by assisting the management consultant in the development of outreach materials and to be the key point of contact for potential new members. The Membership Outreach Committee will meet as necessary, as instructed by the Executive Board to address issues that arise concerning membership. The Executive Board will assign participation in the Membership Committee.

The Web Site Review Committee is responsible for monitoring web site items and reviewing potential new changes to the site, including proposed links to RWIS-related Internet sites. The Web Site Review Committee consists of the Program Chair, Vice-Chair, and Immediate Past Chair. The process for adding Internet links to the Aurora web site is as follows:

1) An item (Internet link, paper, etc.) is sent to the management contractor to have posted on the "members only" side of the Aurora web site for one month.

2) Upon receipt and posting of the item, the management contractor will send out an e-mail through the "Aurora Reflector" notifying the Aurora Board of the posting.

3) After one month, the suggested link will move to the public "links" section of the web site.

4) During that one-month, an Internet Review Committee (consisting of the chair, vice chair, and immediate past chair) will contact the management consultant and express support or non-support for the posting. Unanimous support of the committee is needed for movement to the public Links page.

5) Any Aurora Board member can call for a vote of the membership concerning the appropriateness of a posting. Majority vote of the members voting rules. This vote will usually occur at an Aurora Board meeting or conference call.

THE AURORA PROGRAM
MEMORANDUM OF UNDERSTANDING WITH ENTERPRISE POOLED FUND
Drafted: May 2, 2002

Introduction

This Memorandum of Understanding ["MOU"] serves as a non-binding agreement between the ENTERPRISE Pooled Fund and the Aurora Program, hereafter referred to as the "parties".

The ENTERPRISE Pooled Fund and the Aurora Program have acknowledged that developing a formal relationship will leverage both parties' resources on a project basis where cooperation would result in mutual benefit. This agreement identifies two specific mechanisms by which the parties of this agreement may cooperate. Both of these mechanisms are described in a generic fashion. The cooperation mechanisms identified herein may be modified or amended with approval of both parties. Signatures on this agreement do not bind either organization to any cooperation; rather they indicate recognition of the mechanisms by which the organizations may cooperate. Should either mechanism be executed, specific arrangements will be agreed at the time, and documented either by email exchanges or minutes of conference calls or meetings.

Anticipated Benefits

The anticipated benefits of this agreement are as follows:

- Expedited cooperation between groups to complete projects that are of mutual benefit to both parties; and
- The ability to use and leverage the technical and financial resources of both parties without formal agreements for each coordinated activity.

Candidate Mechanisms for Cooperation

Both cooperation mechanisms described below have proven successful between pooled fund projects in other coordinated efforts. This MOU documents these potential cooperation mechanisms and allows the parties to select the most appropriate arrangement for each coordinated effort.

The following summaries describe the proposed mechanisms for cooperation between the parties specified:

Mechanism #1 – Exchange of Funds for Cooperative Efforts:

In the event that the parties wish to cooperate on a project and leverage member states' resources, either party may transfer funds to the other party for participation in a selected project. In this event, funds from the Administrative state of either Aurora or ENTERPRISE may transfer funds to the Administrative state of the other party. It is expected that the expenditure of these funds would be in accordance with the Annual Work plan of both ENTERPRISE and Aurora, or through an approved amendment to the annual work plan.

Participation in the activities of each project will be determined on a case-by-case basis. However, as in past cooperative efforts, should the parties agree to jointly fund a project, both parties would be active in the review of deliverables, and feedback given to contractors performing the efforts. A member of one party will be designated as Project Champion, and will be responsible for oversight of the project. The parties would also agree to coordinate on progress of project tasks, as necessary, and keep each agency informed on progress.

Mechanism #2 – Cooperation Without Exchange of Funds:

In the event that the parties of this agreement wish to cooperate together to perform a project by leveraging efforts without the exchange of funds, each party may use resources, such as information exchanges, best practices, in-kind contributions of member agencies, and lessons learned available through one or both parties. Under this mechanism, in the event that either ENTERPRISE or Aurora are performing or considering a project that requires additional complementary efforts that are suited to the resources available to the other party, the parties may request a cooperation where ENTERPRISE or Aurora would perform one or more tasks using resources available to them. Should both parties of this agreement determine it is appropriate to cooperate, the parties agree to coordinate on progress of project tasks, and to keep each agency informed on progress.

Signatures:

For ENTERPRISE:

_____ _____

Mr. Manny Agah Date
ENTERPRISE Chair

For AURORA:

_____ _____

Mr. Alfred Uzokwe Date
Aurora Program Chair