MPC-431
January 1, 2013- December 31, 2013

Project Title:
Connected Vehicle Weather Data for Operation of Rural Variable Speed Limit Corridors

University:
University of Wyoming

Principal Investigators:
Rhonda Young
Associate Professor
Dept of Civil and Architectural Engineering
1000 E University Ave.
Laramie, WY 82071
rkyoung@uwyo.edu
307-766-2184

Research Needs:
The term Connected Vehicle refers to the federal initiative to develop and deploy a fully connected transportation system where data is shared between different vehicles and between vehicles and the transportation infrastructure which shows promise for addressing mobility and safety issues (RITA, 2012). With respect to impacts to the transportation system due to weather events there is an area of Connected Vehicle applications specific to road weather where weather data can be collected from existing on-board vehicle systems to support the operations of the roadway segments during weather events (FHWA, 2011a). Vehicle data could then be shared among other travelers or to the roadway agency operating the road.

Weather data that can be collected from on-board vehicle systems include the barometric pressure, windshield wiper settings, air temperature, ABS Brake Status, traction and stability control, and differential wheel speeds (Drobot, 2009). The hope is that eventually vehicle manufacturers will begin integrating technology into their cars at the factory that will allow transmission to roadside data receivers but until this happens the vehicle system data must be read through a Can-bus reader. This raw data can then be processed into weather data useful for roadway operations through the use of a Vehicle Data Translator or VDT (Drobot et al, 2011).

Variable speed limits (VSL) are an intelligent transportation system (ITS) application where regulatory speed limits are posted based on real-time conditions in an effort to improve roadway capacity and/or safety. Rural applications of VSL are primarily focused on improving safety and are typically weather based to address safety concerns due to hazardous weather conditions. The Wyoming Department of Transportation began implementing VSL systems to address weather safety concerns in February of 2009 and currently have five VSL corridors in the state (Buddemeyer et al., 2010). Four of these corridors are located along

Interstate 80 that runs along the southern edge of the state and the latest VSL implemented in October of 2012 is located on a two-lane rural highway that runs across the Wind River Range called South Pass. VSL corridors operate by reacting to real time conditions to post regulatory speed limits so they rely heavily on real time data. A VSL control strategy can be implemented to collect and analyze data to develop suggested speed limits to be implemented by the roadway operator. For weather based control strategies, the weather data is typically collected from roadway weather information systems (RWIS).

RWIS are a common technology deployed by DOTs to collect weather and pavement condition data and are located in close proximity to roadway segments. Currently the FHWA Clarus Initiative shows 2,253 RWIS stations in the U.S. and western Canada (FHWA, 2011b). While the deployment of RWIS stations has seen a large increase in recent years they are still snapshots of weather conditions. When the first WYDOT VSL system was implemented in February of 2012 the 35 mile corridor between the towns of Rawlins and Laramie had a single RWIS station. Since that time the 12 additional RWIS stations were installed when the corridor was lengthened to 52 miles in order provide better coverage of the roadway but that still leaves on average 5 miles between weather stations.

Research into the development of a control strategy for the WYDOT VSL corridors is ongoing but a weather and speed based strategy is currently being tested on the Elk Mountain corridor. Through this research, extensive monitoring of weather variables for three and half winters has been performed. The proposed research would look at the applicability of integrating Connected Vehicle weather data from the Vehicle Data Translator into this control strategy for the Elk Mountain VSL corridor to see if the VSL operations could be improved. The hope is that the continuous data from the VDT would supplement the RWIS data along the corridor to provide a more complete picture of road conditions. The more accurate and reliable the VSL control strategy can become the higher the likelihood of good speed compliance would be. Better speed compliance and lower speed deviations are surrogate measures for improved safety of the corridor.

Research Objectives:
The objective of this research work is to investigate the applicability integrating Connected Vehicle weather data into the existing weather-based control strategy for a rural VSL corridor in an effort to improve the control strategy and increase safety along the corridor.

Research Methods:
To determine the applicability of using connected vehicle weather data for operation of rural VSL corridors, vehicle-based data will be collected from vehicles that frequently travel the existing Elk Mountain VSL corridor located between the towns of Rawlins and Laramie in Southeastern Wyoming. This corridor has been operated as a VSL corridor since February of 2009 and has been extensively studied in previous research. The corridor is also heavily instrumented with 20 radar speed sensors and twelve road weather information systems (RWIS) stations. Initial conversations with Wyoming Department of Transportation (WYDOT) maintenance officials indicated that it would be feasible to instrument WYDOT maintenance

vehicles with the aftermarket can-bus readers. Data acquired from the vehicles during 4-6 storm events during the 2013-2014 winter season would then be processed through the Vehicle Data Translator that was developed by the National Center for Atmospheric Research (NCAR) to convert it into weather data. Connected vehicle weather data and RWIS data for the same time periods would be merged and compared to determine the level of correlation between the two data sets.

As mentioned previously, the existing Elk Mountain VSL corridor has been extensively studied over the past several years and part of this earlier research was to develop a weather and speed based control strategy for the setting of posted speed limits. To determine the impact of connected vehicle data on VSL operations the control strategy would be applied to three different cases: 1) RWIS data only, 2) Connected Vehicle data only, and 3) combined RWIS and Connected Vehicle data to determine the change in VSL operations for the three cases during different storm events. Statistical analyses of the cases will be run to determine the differences in VSL operations to determine the suitability of connected vehicle weather data to either enhance or replace roadside weather data.

Expected Outcomes:
The outcome of the project will be a recommendation on the suitability of the connected vehicle data to enhance or replace traditional roadside weather data sources for the operation of rural

Relevance to Strategic Goals:
The primary focus area for this research is Rural Transportation Operations. The research also addresses issues relating to Heavy Vehicles and Commercial Trucks and Freight Security since the study corridor is 50-70% freight vehicles that incur large losses due to reduced safety and road closures.

Educational Benefits:
A case study for use in graduate level courses on the topic of Intelligent Transportation Systems would be developed from the study.

Work Plan:
The methodology for meeting the research objective stated above is broken down in to the following tasks:

1. Install Can-bus readers on WYDOT District 1 maintenance vehicles that frequently drive the Elk Mountain corridor.
2. Run vehicle data from the corridor through NCAR’s Vehicle Data Translator and combine data readings with RWIS data from the same period.
3. Rerun estimation models for the VSL corridor control strategy with enhanced data set to determine how the control strategy would change with the addition real-time vehicle-based weather data.
4. Perform simulations of existing and revised control strategies to determine how VSL operation would have changed for past storm events under the two strategies.
5. Analyze data, summarize findings and generate final report and journal articles.

Provide a description of the major tasks or steps in the project, along with an expected timeline. The tasks should be numbered and an expected completion date assigned to each one. Instead of calendar dates, the timeline should be expressed in months from the starting date. Typically, a work plan includes steps such as the completion (and testing) of questionnaires, lab tests, field tests or data collection efforts, input or focus group meetings, and critical steps such as the initial runs and calibrations of models. A draft report and other milestone events should be included, as well as a technology transfer plan that includes a research seminar via the Transportation Learning Network and/or plans to collaborate with an LTAP or TTAP center (if appropriate). If the research is basic in nature, other dissemination methods may be substituted for the TLN, LTAP, or TTAP distribution channels.

Project Cost:

MPC:	$100,568
Matching	$103,939
Total:	**$204,507**

Source of Matching Funds: University of Wyoming match of faculty salary and/or teaching assistantships

TRB Keywords:
Intelligent Transportation Systems, Connect Vehicles, Weather, Variable Speed Limits

References:

Buddemeyer, Jenna, Rhonda Young, and Brendan Dorsey-Spitz. (2010) "Rural Variable Speed Limit System for Southeast Wyoming" *Transportation Research Record 2189,* Pages 37-44.

Dropot, S., M. Chapman, T. Jensen, G. Wiener, E. Schuler, and C. Johansen. *An Analysis of Temperature and Pressure Data from Connected Vehicles in the Developmental Testbed Environment*. University Cooperation for Atmospheric Research, NCAR FHWA-JPO-10-062.

Drobot, S., M. Chapman, B. Lambi, G. Wiener, and A. Anderson. (2011) *The Vehicle Data Translator 3.0 System Description*. University Cooperation for Atmospheric Research, NCAR FHWA-JPO-11-127.

FHWA. (2011) *Road Weather and the Connecting Vehicle: Improving Road Weather Awareness*. USDOT Road Weather Management Publication: FHWA-JPO-11-138.

FHWA. (2011) *Weather and the Connected Vehicle*. Presented at the 2011 National Rural ITS Conference. http://www.nritsconference.org/downloads/Presentations11/SessionA2_Murphy.pdf

Research and Innovative Technology Administration. (2011) *Developments in Weather Responsive Traffic Management Strategies*. FHWA-JPO-11-086.

Research and Innovative Technology Administration. (2012) Connected Vehicle Research. USDOT http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm. Updated November 15, 2012.