March 2000
Issue 1, Volume 4

Making rural travel and transportation safer, more efficient and convenient through high quality research, education, collaboration and outreach activities.

Western Transportation Institute
Montana State University-Bozeman

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Did you know....

Thirty-nine percent of vehicle miles traveled occur in the rural transportation environment. Unfortunately, fifty-eight percent of all fatal accidents also occur in the rural setting.

Source: US DOT

Rural Transportation Research Gains Momentum

As we enter the new millennium, rural transportation research continues to gain momentum. WTI keeps working on forming long-term mutually beneficial partnerships which allow us to leverage partner funding to further extend the research opportunities in areas where traditional funding is not available. As such, research at WTI focuses on a broad-based multi-disciplinary program which seeks to advance the state-of-the-practice in rural transportation. The following areas were determined as most applicable to the theme of "making rural travel and transportation across all surface transportation modes safer, more efficient, and more convenient", and thus will be the focus of upcoming research at WTI.

- Weather and Winter Maintenance
- Transportation and Tourism
- Transit/Mobility
- Native American Transportation Issues
- Institutional Issues and Partnerships
- Safety and Human Factors
- Applications of Advanced Technology for Remote Monitoring and Diagnostics

SAFE PASSAGE Pavement Model Update

By:

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Safe Passage refers to a project being conducted on U.S. Interstate 90 through Bozeman Pass, Montana, which is concerned primarily with weather related highway operations and motorist safety. Montana's northern Rocky Mountain climate obligates an emphasis on winter weather concerns, including the critical issue of pavement icing. A computational model to calculate pavement temperatures is under continuing development as an integral component of the *Safe Passage* roadway information system. *Safe Passage* is designed to utilize rural Intelligent Transportation Systems (ITS) technologies including Road and Weather Information Systems (RWIS), Variable Message Signs (VMS), Highway Advisory Radio (HAR) and a Rural Traffic Management Center (RTMC).

RWIS provide valuable, real time, site-specific meteorological and pavement temperature information to a central location where decisions regarding an appropriate course of action to ensure highway safety may be made. A limitation in being able to accurately decide on a correct response is in extrapolating limited pavement temperature data to that of the road surface between meteorological stations. The thermal effects of sunlight, shadowing and radiant heat exchange with the surrounding landscape, particularly in mountainous areas, cause significant differences in pavement temperature even on sections of road which are in close proximity to one another. However, it is economically impossible to configure the entire highway system with sensors, so extrapolation between sites is a necessity to obtain an accurate modeling effort.

The concept behind the modeling effort was based on the adaptation of a computational model used by the U. S. military as a tool to model the surface temperatures of vehicles for use in infrared imagery. The infrared signature of a vehicle in essence indicates the characteristic surface temperatures of a vehicle subjected to a set of meteorological conditions. This modeling approach essentially constructs the three-dimensional vehicle by defining a surface composed of a collection of flat plates termed "facets". For this project, the facet concept was extended to terrain where recent developments in Geographic Information Systems (GIS), along with the widespread availability of Digital Elevation Maps (DEM) now offer the potential for practical implementation of such a model.

Surrounding landscape features including aspect, elevation, and surface material properties, including vegetation, exposed soil, rock or snow all influence the pavement temperatures. The influence on pavement temperature due to the energy exchange was determined by the thermal properties of the surrounding terrain materials such as albedo, emissivity, and conductivity. Each facet has a view factor defined, which is in essence what it would "see looking out", given its orientation with respect to the sky and the other facets making up the landscape. These view factors were used to incorporate shadowing, sun angle and the orientation for surface to surface radiation.

The first step in constructing the thermal model was to fabricate maps for the region of interest. An important aspect of the development of the model and a driving force in its implementation is that it be fully transportable in the sense that the process developed be easily adaptable to future geographic areas of interest. GIS's were employed to produce files for elevation, road and vegetation maps. The pilot study was developed in the Rocky Canyon section of I-90 near Bozeman Pass from milepost 313 to 319. (See topo map on page 3.)

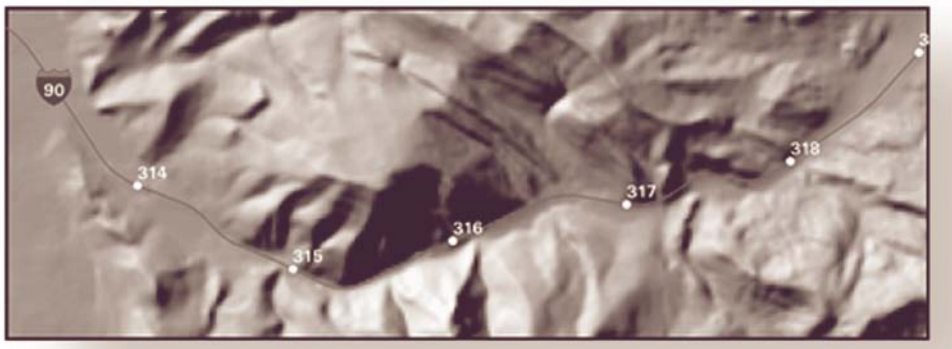
Several base layers including elevation, roads, mile markers, and vegetation were required to complete the maps. Only a few years ago development of a model of this sort for widespread application was not feasible due to the lack of a digital GIS information database. Elevation data is now widely available with additional detailed databases for roads, vegetation, soils etc. becoming more widespread. Elevation data was compiled from a United States Geological Survey (USGS) 30 meter DEM. Road and milepost data was available from databases developed by the Montana Department of Transportation. All data

was then projected into the desired coordinate system of UTM meters, NAD83. Maps used in the pilot thermal model used simplified vegetation, which assumed for initial model development, that the terrain consisted of interstate highway running through grasslands. Future maps could easily be constructed which will utilize more appropriate and varied features.

Next ASCII formatted DEM and GIS terrain material files were read by the WinTherm/RT thermal model. The model then associated the specified numerically categorized material provided by the GIS for each cell to the appropriate properties of that material. These thermal properties (e.g. thermal conductivity, albedo etc.) were applied so that temperatures were calculated based on the current or forecasted environmental conditions. Topography was derived from the DEM. The following geometric influences were determined; slope and elevation, terrain self-shadow and obscurations, cell-to-cell reflections and emissions as well as directional solar load on a sloped surface. The first principle thermal model was then employed to calculate the temperatures associated with each cell. Calculated results of the surface temperatures were color linked for display as a time sequence map.

The initial objective of this study was to determine the feasibility of providing a sophisticated computational highway thermal model as a tactical decision aid for use in winter maintenance. The notion was to utilize data collected by highway meteorological stations, in combination with information bases from other existing resources such as the U. S. Geological Survey digital elevation maps and GIS to calculate pavement temperature. At this point, we feel that although additional ground truth data is needed to verify and refine the model, and upgrades to some of the modeling components warranted, the concept is sound. The thermal model will assist in the *Safe-Passage* project effort by providing highway maintenance personnel with information to analyze and the ability to assess the calculated thermal-mapping concept. Maintenance managers will then be in a position to provide valuable advice on how the information provided might best be utilized in the operational setting.

The thermal modeling aspect of the Safe Passage project is viewed as the initial implementation phase in an evolutionary engineering process. Timing for the practical application of the model is quite good. Geographic information databases are expanding, which will provide for ease of developing additional sites. Even during the course of this study, desktop computers reasonably available to highway managers have significantly increased in capacity and speed. Current progress in mesoscale meteorological models that will provide the data required for forecasting pavement temperature have been maturing in this same time frame. Results of the computational thermal mapping were very promising and when incorporated into a comprehensive roadway information system such as *Safe Passage* should prove useful to highway maintenance operations including cost effectively dealing with timely, site-specific anti-icing decisions and informing the public of potential safety issues.



New Research Projects Selected For FY00

The following six projects were selected for University Transportation Center funding for the period October 1999-September 2000. The U.S. Department of Transportation's Research and Special Programs Administration provides funding for WTI's University Transportation Center.

Animal-vehicle Crash Mitigation Using Advanced Technologies With the advent of Intelligent Transportation Systems and an increased focus on technological solutions, many feel the problem of animal vehicle crashes should be re-examined. This UTC project will supplement the larger FHWA pooled fund project to investigate the most promising roadway or vehicle-based animal detection/driver warning systems to mitigate animal vehicle crashes.

Photo courtesy of Montana LTAP

Development of a Surface Transportation and Weather Decision Support Tool and Strategic Plan for Improved Highway Maintenance and Operations In order to provide for safe and efficient winter highway maintenance and operations, departments of transportation must know the road-weather conditions; have confidence in the information accuracy; provide road condition information to travelers and then forecast those conditions so that maintenance staff can allocate resources to manage the conditions. This project will seek to define the system requirements, review related initiatives and sensor technologies, review standards and develop procurement specifications, and finally define training needs and requirements of effective system utilization.

Field Evaluation Study to Evaluate Intrusive Detection Technology: Intersection Crash Avoidance System The objective of this research is to investigate current state of the art in intrusion detection technologies that could be further developed and applied to an unsignalized high-speed rural intersection with a high accident record. The technology will be applied as part of an Intersection Collision Avoidance System. This study will also evaluate current detection technologies.

A Rating System for Rural Culvert Crossing Repair and Maintenance Culverts provide effective and inexpensive rural roadway passage over small streams and rivers. This project will develop a rating system that evaluates the condition and effectiveness of existing culverts and considers the transportation-related impacts of repair or replacement against the transportation-related impacts of no action. The rating system will help state, county and local decision makers apply resources where they are most needed and effective.

Characterizing Commercial Vehicle Safety in Rural Montana The objective of this research is to characterize commercial vehicle safety levels in rural Montana on basis of carrier, vehicle, driver, cargo and potentially other characteristics using advanced statistical modeling methods. If trends in commercial vehicle safety levels-particularly poor safety levels-can be noted, regulatory and enforcement agencies can better target resources to address these safety-related challenges.

Evaluation of ITS Applications for California National Parks to Encourage Regional Transportation Planning and Enhance Economic Sustainability As visitation continues to increase, our National Parks are becoming increasingly "loved to death." Unfortunately, this is true of the National Parks within California as well. For this project, research will be conducted to inventory the problems and opportunities for advanced transportation technologies for the National Parks in California in close cooperation with state and federal agencies.

Native American Transportation Study Results

By:

Shelley Fleming
Research Assistant
Western Transportation Institute

Tribal transportation has come a long way from the days of the dog and horse. Although America is in the 21st century, tribal transportation remains behind in transportation technologies. To fully understand the conditions of transportation systems on Indian reservations in the Western Region of the United States, WTI conducted a Transportation Needs Survey. The survey was sent to tribal transportation planners on 298 reservations. This survey identified areas of transportation that are working well for tribal members as well as those areas that need improvement. General categories covered in the survey were road improvement systems that are currently being used, funding utilized for transportation improvement and areas of transportation that tribal transportation planners feel need to be examined. The goal of this on-going project is to identify the transportation areas on reservations that need development or improvement and recommend solutions.

The report summarizes the results from the surveys and explores possible Intelligent Transportation Systems (ITS) that could improve tribal transportation. Below are the top three transportation needs from the survey (listed in order of importance).

1. Transportation Challenges
   - Economic Development
   - Improve Safety/Emergency Response
   - Road Accessibility/Maintenance/ Transit
   - Trained Transportation Personnel & Interagency Communication

2. ITS Applications Desired
   - Public Traveler Services/Public Mobility Services
   - Infrastructure Operations and Maintenance
   - Traveler Safety and Security
   - Emergency Services
   - Fleet Management
   - Commercial Vehicle Operations

3. Role of Alcohol in Crash Fatalities
   - 64 % identified alcohol as the major cause of many of their crash fatalities
   - 21 % felt that alcohol is not the cause
   - 15 % of the respondents were unsure

This survey is the first phase of the Tribal Transportation and Safety Improvement Project. It is envisioned that this project will further identify transportation improvements and thereby help increase tourism, create jobs for Indian people, and strengthen tribal sovereignty as it applies to transportation.

The True Costs of ITS Maintenance: A Case Study at Oregon DOT

By:

Chris Strong
Research Associate
Western Transportation Institute

The Western Transportation Institute, in partnership with the Oregon Department of Transportation (ODOT), recently completed a statewide maintenance plan for ODOT's Intelligent Transportation Systems (ITS) infrastructure. The plan addresses the organizational and technical issues that currently confront ODOT with respect to ITS maintenance, and assesses the future issues likely to result from increasing levels of ITS deployment.

The plan has as its foundation information provided through meetings with various groups of ODOT stakeholders, as well as research into ITS maintenance plans for other public agencies and the private sector. Stakeholder input proved valuable not only in identifying critical maintenance issues, but in obtaining institutional buy-in for the need to improve ITS maintenance. Other maintenance plans identified in the literature review provided some insight into how these issues might be addressed. Unfortunately, these plans were inadequate on their own to address ODOT's concerns, because they focused on smaller geographic areas, covered a narrower range of technologies, considered a shorter time horizon, and did not cover the extent of issues which ODOT is currently facing.

The plan provides guidance for ODOT in five major areas.

- Maintenance model. The first issue of critical importance identified by stakeholders was the lack of a consistent procedure for processing ITS maintenance requests through the organization. To address this, four alternative models were developed and presented to stakeholders in order to identify a consensus.
- Repair prioritization. Survey instruments and

telephone conversations with ODOT staff in various regions and divisions were used to identify what were deemed to be the critical ITS maintenance priorities. These meetings determined that stakeholders perceived device function (e.g. safety vs. operational) to be more important than device technology (e.g. a roadside camera vs. a variable message sign) in assessing what repair priority a given device has.

- Preventative maintenance. The plan included guidelines for appropriate preventative maintenance tasks for ODOT's existing and planned ITS infrastructure that were developed by consultation with ODOT staff, review of other plans and conversations with vendors.
- Resource analysis. In order to properly reflect true maintenance needs, each ITS device was examined on a component level to identify typical preventative and repair maintenance needs, in terms of frequency of repair, duration of maintenance activity, and requisite skill sets. To reflect the varied geography of Oregon, technicians' travel time was a major component in this analysis. These resource needs were compared with estimates of staff availability and training to identify gaps in ODOT's staffing and skill levels. This analysis concluded that plans for increased ITS deployment would quickly outstrip staffing levels, and consequently made recommendations for where contracting would be most appropriate. It was determined that training gaps could be addressed through a continuous process of cross-training between ODOT technicians.
- Maintenance budget. Building on the results of the resource analysis, the plan presented a comprehensive budget that was developed on a per-device and per-region basis. The budget reflects staffing and overhead, contracting costs, spare parts, emergency device replacement, and test equipment.

The plan also included a host of short-term, medium-term and long-term recommendations both for ODOT as well as other agencies seeking to conduct a similar analysis.

The two-volume plan document is available from WTI. To receive a copy of the plan or for further information about this project, please contact Chris Strong at (406) 994-7351 or ChrisS@coe.montana.edu.

WTI Welcomes a New Senior Research Engineer

Kate can be reached at KateH@coe.montana.edu or 406-994-6551

WTI would like welcome Dr. Katharine Hunter-Zaworski as a Senior Research Engineer. She is responsible for a number of rural Intelligent Transportation System (ITS) projects related to transit in small urban and rural environments including several national parks. Prior to her appointment at WTI, she was an assistant professor in the Department of Civil Engineering at Oregon State University for ten years. She received her Ph.D. in Civil Engineering from Oregon State University in 1988. Since 1988, Dr. Hunter-Zaworski has been the principal investigator on a number of research projects related to accessible public transportation. Her main research activities have focused on the development of an Independent Locking Securement (ILS) system for wheeled mobility aids on public transportation vehicles. A U.S. Patent was granted for the device in 1994. Dr. Hunter-Zaworski is also involved in several (ITS) projects related to the development of ergonomic guidelines for Electronic Information Systems, Bus Signal Pre-Emption, Bus Rapid Transit, Data Analysis for the City of Portland Photoradar Study and Low Volume Road Grade Crossings and the High Speed Rail project.

Dr. Hunter-Zaworski received her M.S. Degree in Engineering Science and Mechanics (Rehabilitation Engineering) from the University of Tennessee, and her B.A.Sc. (Mechanical Engineering) from the University of British Columbia. Dr. Hunter-Zaworski had a clinical internship in rehabilitation engineering in Toronto, Canada, where she studied upper extremity prosthetics. Next, she was the Director of the Rehabilitation Engineering Department at G.F. Strong Rehabilitation Centre in Vancouver, B.C. In addition, she was the consultant responsible for all aspects of accessibility related to SKYTRAIN, the accessible rapid transit system in Vancouver B.C. In 1989, she was awarded the Premier's Award for Accessible Design for her work on SKYTRAIN. In 1990, Dr. Hunter-Zaworski assisted B.C. Transit with the implementation of Fixed Route Accessible Bus Service. Dr. Hunter-Zaworski has been a leader in assisting transit agencies with accessibility issues. She has been very active on the Transportation Research Board (TRB) committee for Accessible Transportation and Mobility, and a number of the Institute of Transportation Engineers (ITE) committees. She is currently a National Transit Institute (NTI) Fellow for Advanced Technologies and Innovative Practices, and she was recently appointed to the Transit Cooperative Research Program (TCRP)/TCRP Oversight and Project Selection (TOPS) committee which oversees the TRB-TCRP research program.

Dr. Hunter-Zaworski is married to Joseph Zaworski, a Mechanical Engineer, and they have a daughter and a son who are twelve year-old twins, a ten year-old son and the perfect dog!

Education

Researcher Invited to Roundtable Talk

Dr. Katharine Hunter-Zaworski was invited to help with an education forum that examined the educational needs of the transportation workforce of the twenty-first century, the tools they need and the issues they will be facing. As a transportation educator for 15 years, she is also an advocate of lifelong learning and feels that the selection of a vocational path and environmental influences begins at a very young age.

While at the annual meeting, Dr. Hunter-Zaworksi and six other educators were invited to a discussion meeting called by Rodney Slater, the US Secretary of the Transportation. This was a fact-finding meeting with transportation educators to seek the grass roots perceptions on transportation education issues and how today's education system is affecting the workforce entering the transportation industry of the twenty-first century.

Dr. Hunter-Zaworski brought up two issues she felt were vitally important for the workforce of tomorrow. As a mother, she realizes not all children will go to college and become professionals with degrees. Some will enter vocational areas, and of these individuals few will work in the transportation sector. She feels that not only does there need to be more respect for the vocational fields, but these front line workers of tomorrow, (e.g. heavy equipment operators), need to be trained in areas such as computers. Twenty-first century equipment will be equipped with things like satellite-driven computers in vehicle cockpits, and these workers need to develop a whole new set of skills. Dr. Hunter-Zaworski believes this education must start at an early age, even as early as grade school.

Students Take an Active Role in WTI Research Efforts

At WTI, students take an active role in projects and graduate students are encouraged to use their project experiences as the basis for their thesis. WTI's recent designation as a University Transportation Center has created significant educational and research opportunities for students. WTI can offset all or a portion of educational costs through generous undergraduate, graduate, and professional advancement fellowships; scholarships and student employment. Currently, students are researching a wide variety of topics including; weigh-in-motion, culverts, tribal transportation, curve warning systems, intrusion detection technology, animal-vehicle crash mitigation, advanced weather information systems, sign inventory and commercial vehicle issues.

In the coming year WTI will partner with the MSU-Bozeman Undergraduate Scholars Program to encourage further undergraduate research involvement. This partnership will further the multi-disciplinary mission of WTI.

Burke Wins Outstanding Student Award for 2000

Congratulations are in order for Patricia Walsh Burke, PE. She has been awarded the Outstanding Student Award for 2000. Ms. Burke is a candidate for a Master of Science Degree in Civil Engineering at Montana State University-Bozeman. Ms. Burke received her Bachelor of Science Degree in Civil Engineering in 1993 from MSU-Bozeman and worked in the private sector for several years before returning to MSU-Bozeman. Her work in the private sector included several transportation and highway projects for both the Montana Department of Transportation and the City of Billings, Montana. Through these projects, Ms. Burke gained valuable transportation experience; however she realized that further education in the transportation field was necessary to reach her career goal of being a project manager. After receiving her professional engineering license in 1997, Ms. Burke started taking transportation courses while working at her full-time engineering position. In May 1999, Ms. Burke was awarded a Professional Advancement Fellowship from WTI to pursue her master's degree. This involved taking a one year leave of absence from her employer and returning full-time to MSU-Bozeman.

Ms. Burke is currently working for WTI on an evaluation of a high-speed rural weigh-in-motion system. This project is located in Central Montana and is being completed for the Montana Department of Transportation.

In addition to her studies, Ms. Burke is involved with the professional state chapters of the Institute of Transportation Engineers (ITE) and the American Society of Civil Engineers (ASCE). She is the Secretary/Treasurer of the Montana Chapter of ITE and has been the Secretary/Treasurer of the Montana Section of ASCE for the past four years. She and her husband reside in Bozeman, Montana and enjoy downhill and cross-country skiing, hiking, golf and cultural activities.

Ms. Burke will graduate in May 2000 with a Master of Science Degree in Civil Engineering and return to MSE-HKM Engineering, her former employer.

(l-r): Mortimer L. Downey, Deputy Secretary USDOT; Rodney Slater, Secretary of Transportation; Patricia Burke; Kelley Coyner, FHWA Research and Special Programs Administration

FHWA Peer-to-Peer Workshop Held in Oregon

The FHWA Peer-to-Peer Workshop on Rural ITS was held on Monday, January 31, 2000 in the Redmond Public Library and brought together a number of interested stakeholders from the Central Oregon Region. An effort had been underway for a number of years to establish coordinated general public transportation in the rapidly growing Central Oregon Region. The peer-to-peer workshop was designed to introduce the stakeholders to the concepts of Rural Intelligent Transportation Systems and particularly those that could help with coordination of rural public transportation services. One of the outcomes of the workshop was a commitment by the stakeholders to get coordinated general public transportation on the road. There was a sharing of resources ranging from vehicles by a local dial-a-ride provider to financial resources by the Oregon Department of Transportation (ODOT). The stakeholders agreed to work towards helping ODOT develop a statewide procurement for computer aided dispatch, scheduling and management system. In the meantime the regional partners are working to make the system operational.

Recent Technology Transfer Activities

In the past six months, WTI has engaged in a variety of technology transfer activities in an effort to meet the overall goal of increasing the availability of research results to potential users in a form that can be directly implemented, utilized or applied.

The Western States Tourism Policy Council Conference entitled *Connecting Us All: Partnerships in Travel and Tourism* was held on November 3-5, 1999 in Portland, Oregon, and was sponsored in-part by WTI. This conference sought to bring together the transportation and tourism industries in an unprecedented manner to share and build partnerships for future collaboration. On the final day of the conference, WTI staff members Steve Albert, Kate Hunter-Zaworski and Chris Strong facilitated concurrent "feedback" sessions to elicit the views of the attendees regarding those policies and programs most critical to transportation and tourism. These sessions also sought to determine possible conference follow-up activities.

The 79th Annual Transportation Research Board Meeting was held January 9-13, 2000 and was attended by several researchers from WTI. They gave presentations at a variety of committee meetings as well as the general session. Attracting more than 8,000 transportation professionals from around the world each year, this annual meeting is truly an unparalleled opportunity to share knowledge and perspectives with others to gain a better understanding of the latest developments in transportation policy, practice and research.

In order to increase awareness of the importance of rural transportation research, WTI purchased a highly portable flexi-frame booth that will be displayed at a wide array of transportation conferences and workshops. The booth has new graphics and updated information on projects as well as the UTC program. The booth was displayed at the Northwest Transportation Conference in Corvallis, Oregon on February 1-3, 2000. The theme of this conference was SMART Transportation and the new technology that will carry us into the new millennium. It included sessions on bridge technology, access management, low-volume roads, public transportation, freight, environmental sustainability, and transportation finance. Steve Albert and Kate Hunter-Zaworski moderated at the conference as well as staffing the booth.

By partnering with the California Department of Transportation, WTI has established a video-teleconferencing room. The equipment is owned by Caltrans while WTI provides the phone service and dedicated ISDN lines for the system to operate. This has proved to be a successful venture and WTI is now exploring ways to tap into existing networks such as TEL8 to further its technology transfer capabilities.

Look for the WTI booth at the 40th Annual Intermountain ITE Chapter Meeting in Jackson Hole, Wyoming on May 19, 2000. This meeting draws transportation engineers from a seven state region and will be a great opportunity for WTI to showcase its new projects and share the results from completed projects.

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Classifieds

Research Associate. Rare opportunity to join a progressive leading edge **Intelligent Transportation Systems** (ITS) research team in the heart of Montana. The **Western Transportation Institute** (WTI) of the Civil Engineering Department at **Montana State University – Bozeman** is seeking an energetic individual wishing to live within a hour of Yellowstone National Park, two internationally recognized ski resorts, and five blue ribbon trout rivers to fill a Research Associate position responsible for the development and completion of project tasks related to ITS, transportation planning and traffic engineering. Required: M.S. in civil engineering or a related field and a record of transportation experience in ITS applications, transportation engineering and/or computer systems. For more information about WTI, visit our web site at www.coe.montana.edu/wti. Screening of applications will begin January 17, 2000 and continue until the position is filled. For application information, contact Jeralyn Brodowy, WTI, 416 Cobleigh Hall, P.O. Box 173910, Montana State University-Bozeman, Bozeman, MT 59717 - 3910. Phone: 406/994-6006. ADA/AA/EO/Veteran's Pref.

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This newsletter is published semi-annually by the Western Transportation Institute at Montana State University-Bozeman to inform readers about our research and outreach activities. Readers are encouraged to contact the Principle Investigator for information on specific projects. For general information or to be added to our mailing list contact Robbi Colvin at 406-994-6114, via email at wti@coe.montana.edu or write to: Western Transportation Institute, 416 Cobleigh Hall, PO Box 173910, Montana State University-Bozeman, Bozeman, MT 59717-3910.

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