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Montana Weigh-in-Motion (WIM) and Automatic Traffic Recorder (ATR) Strategy

http://www.mdt.mt.gov/research/projects/planning/wim.shtml

Introduction

Traffic data supports a myriad of transportation related activities, from system planning, to roadway design, to system operation and maintenance. Traffic data typically collected include traffic volume, vehicle classification (Federal Highway Administration (FHWA) Types 1-13), and vehicle weight. In light of its importance, FHWA has established requirements on the development, implementation, and continued operation of a traffic monitoring system for highways in each state, and further has established federal traffic data reporting requirements. Two types of data collection systems are generally employed in continuously collecting these data at permanent sites on a highway network, namely, Automatic Traffic Recorder (ATR) and Weigh-in-Motion (WIM) systems. ATR systems variously collect traffic volume, vehicle classification and speed data, while relatively more expensive WIM systems also collect vehicle weight data. Data collection coverage across the system is significantly extended by the use of short term traffic counts conducted at numerous additional sites around the state with portable equipment.

This project was conducted to comprehensively evaluate the existing Traffic Count Program of the Montana Department of Transportation (MDT) and to provide recommendations for potential program improvements. While both short term counts and permanent data collection programs were considered in this study, its focus was on permanent counter (ATR and WIM) programs, with a further emphasis on the WIM program.

What We Did

Seven major tasks were completed for this project, namely:

1. A review of the state-of-the-practice was conducted, which included a comprehensive examination of the literature related to traffic data collection technologies, data transmission and processing methodologies, data users and uses, and data collection site selection and prioritization processes. The review also included a survey of traffic data collection practices in peer states.
2. A detailed description of MDT's traffic data collection program was developed focusing on current equipment, facilities, and practices. Specifically, the number and nature of data collection sites was documented, as were the data collection technologies used, typical installation layouts, data communication technologies, personnel and administrative structure, management structure and job duties, program costs, and planning practices related to the prioritization of future sites and future goals of the overall program.
3. An examination of current data collection, analysis, and dissemination practices was completed and preliminary work was performed toward identifying areal and/or seasonal traffic patterns around the state and the associated economic activities that drive them.
4. A survey of current and potential traffic data users was conducted to capture their uses of the existing traffic data provided by MDT, as well as what new data and/or data products (i.e. aggregation/ presentation schemes) they desired to better support their activities.

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5. A review of the current traffic factor groupings was completed, and three potential alternative groupings were investigated. The current traffic factor groupings are based on the nature of a route's use, and generally coincide with highway functional classification. The three alternative grouping schemes investigated were based on: 1) vehicle type, i.e., commercial versus non-commercial, and functional classification, 2) area of the state and its dominant economic activity, i.e., agriculture, recreation/tourism, rural and urban, and functional classification, and 3) a simplified functional classification scheme, i.e., interstate versus non-interstate with subcategories of rural and urban.
6. A methodology for the prioritization of new WIM and ATR sites was developed to increase the objectivity of the site selection/prioritization process. This methodology systematically considers factors critical in the site selection process, such as improvement in data collection coverage/accuracy by traffic factor group, contribution to weight enforcement activities, etc., to ensure proposed sites are justified and optimally located. This methodology can also be used to assess the efficacy and possible retirement of existing sites.
7. Based on the findings from the previous six tasks, the overall adequacy of MDT's data collection effort was assessed, and recommendations were made on areas/activities for possible improvement.

What We Found

The state-of-the-practice review found many technologies can be used to collect traffic data, but, typically, the more-established technologies consist of inductance loops and piezoelectric sensors for ATRs; piezoelectric sensors, bending plate, and single load cells for WIMs; and pneumatic tubes for short-term counts. Many communication technologies are used to transmit traffic data, including landline, cellular, and high-speed wireless and network systems. Many software packages exist for data processing and quality checking. Also, like MDT, several states are using WIMs in Virtual Weigh Stations and real time weight enforcement.

The Traffic Data Collection and Analysis (TDCA) Section of MDT is responsible for short-term and permanent traffic data collection, processing, QA/QC and analysis, as well as data presentation and display. The 106 permanent count sites across the state (including both ATR and WIM systems) are shown in Figure 1. The TDCA Section consists of fourteen permanent employees, a supervisor, a unit supervisor, and three seasonal staff. The total annual program cost (labor, equipment, supplies, travel, contracted services, personnel training, etc.) is approximately 1.9 million dollars.

The ATR systems around the state collect volume, speed, and vehicle classification data. The WIM systems collect data on axle/gross vehicle weight (in addition to volume and speed data). The data are quality control checked for "reasonableness" both automatically and by experienced TDCA personnel based on physical limits on the parameters being measured and on their historic recorded values. The data are used to determine various characteristics of the traffic operating on the state's highways, such as annual average daily traffic (AADT), vehicle miles of travel (VMT), equivalent single axle loads (ESALs), etc. Traffic data are disseminated through a variety of publications, interactive maps and software applications, and are generally available on the internet or upon request. MDT also uses the Traffic Count Database System (TCDS), a commercial software package that allows those within MDT (notably including MCS enforcement) and external data sharing partners, including metropolitan planning organizations and other local agencies, to view timely speed, volume and weight data.

Large local/regional fluctuations in traffic volumes and in the composition of the traffic stream are encountered on many of Montana's highways both temporally and spatially, as the state's economy is agriculture, natural resource extraction and tourism intensive. The identification and characterization of these flows is important to ensure they

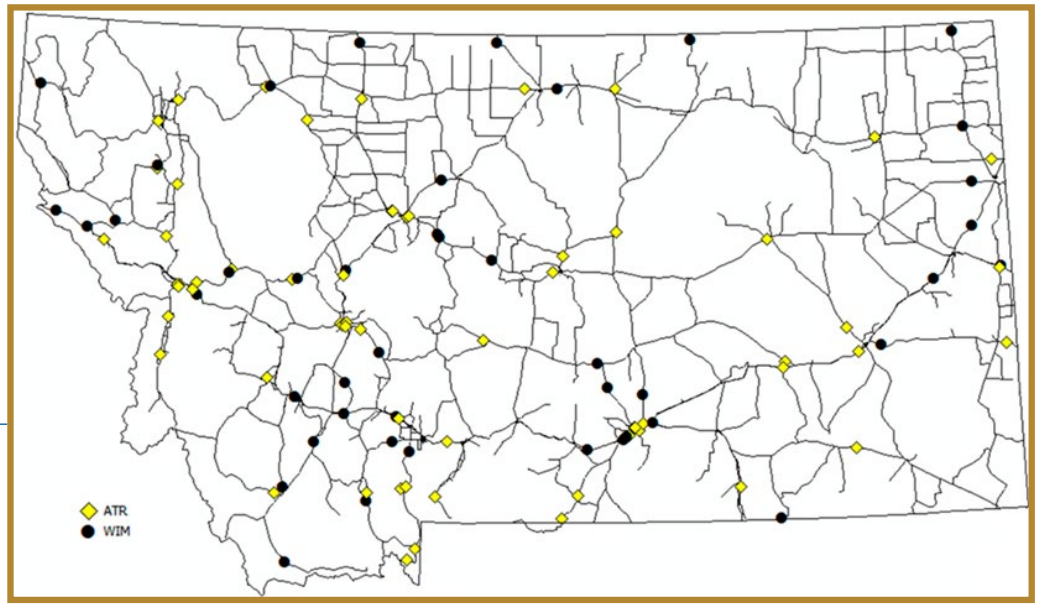

Figure 1: WIM and ATR Sites (MDT GIS Data; ESRI ArcMap).

are being captured by data collection efforts (see Figure 2 for example modeling of agricultural truck flows).

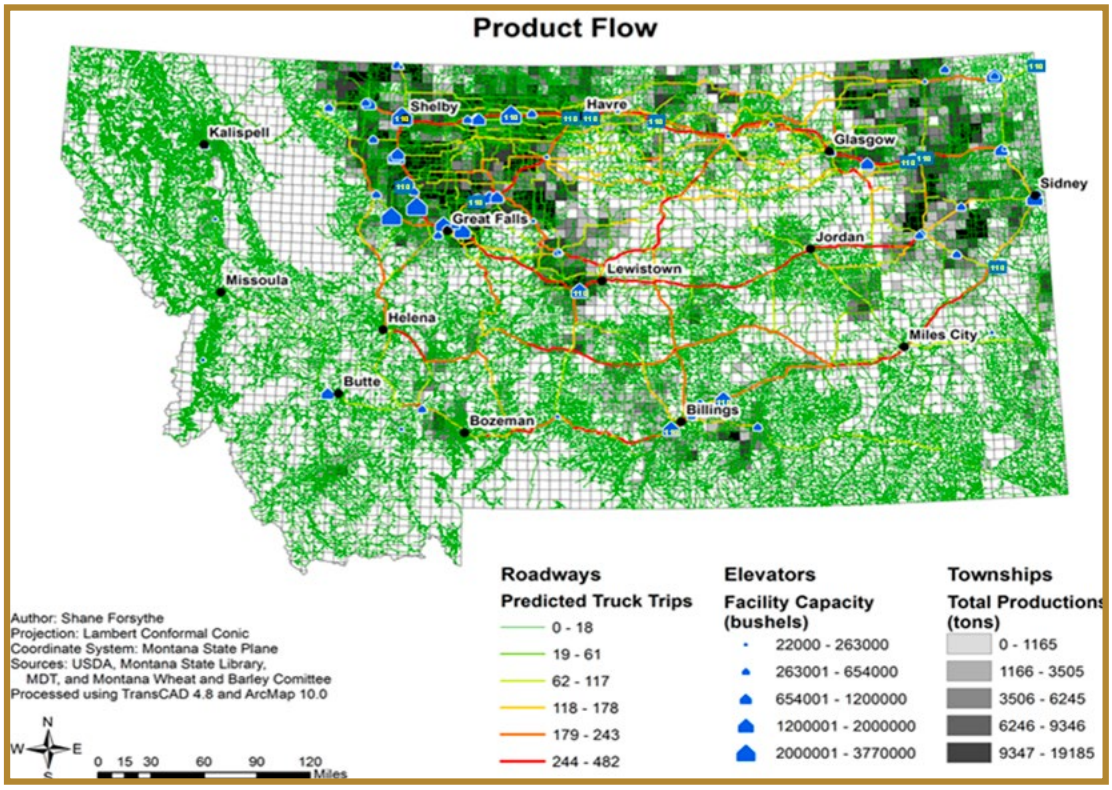

Figure 2: Estimated Daily Truck Trips, Harvest Season, Wheat and Barley.

From the survey of traffic data users, it was found that users, both within and outside MDT, are well satisfied with the information being provided. Data are primarily being used for planning, design and safety analysis purposes, with the most frequently used data being AADT, ESALs, and percentage of trucks. The data was described by users as vitally important, supporting, for example, numerous federal reporting requirements which are directly tied to the funding that a state department of transportation receives. However, some data may not be provided in as timely a manner as necessary to optimally support reporting requirements. For example, much of the traffic data required for submittal to FHWA as part of the Highway Performance Monitoring System (HPMS) isn't available until sometime in May, which can make it difficult to prepare for the submittal deadline in June. Certain ATV, pedestrian, and transit data are desired by some users, but these data may be outside the scope of typical traffic data collection activities. The majority of survey respondents currently made use of the MDT TDCA website, and, those that use it, found it valuable.

The traffic factor group analysis investigated three alternative approaches to the current groupings used by MDT that are based primarily on the nature of a route's use, and generally categorized by highway functional classification. The alternatives were grouping by 1) vehicle type, i.e., commercial versus non-commercial, and functional classification, 2) area of the state and its socio-economic characteristics, and functional classification, and 3) simplified functional classification scheme, i.e., interstate versus non-interstate with subcategories of rural and urban. In considering the first alternate grouping scheme, commercial vehicles were found to have different patterns of operation over the year compared with all vehicles, particularly during weekend days, and using separate adjustment factors for commercial traffic may be beneficial. The second grouping scheme (by area and dominant economic activity), while generating reasonably accurate adjustment factors, may be somewhat impractical to implement. Notably, the assignment of stations to an economic group is generally subjective in nature. The third grouping scheme (interstate versus non-interstate, rural or urban), has merit in that it simplifies the estimation and use of adjustment factors without compromising accuracy. A hybrid traffic factor grouping scheme that uses the simplified classification scheme coupled with subdivision by commercial versus non-commercial vehicles may be the most promising alternative.

In a resource constrained environment, it is essential that future WIM/ATR sites be selected to optimally support the objectives of the overall data collection program and the WIM/ATR site prioritization methodology developed should help in this regard. Optimization of WIM/ATR site selection is complicated, in that traffic data is collected to support several activities of competing priorities. A potential approach to developing a methodology that ensures the factors important in the selection of future sites are systematically considered with consistent application of agency priorities is a weighted sum model (WSM). In this case, the outcome of the WSM is a numerical ranking for a potential site, based on: a) how well the site meets various agency selected criterion, and b) the priority of that criterion in the selection process, also as established by the agency (Table

1). The results of the WSM are not expected to be the sole input used in the site selection decision-making process, as the problem is complicated, but the WSM will provide a systematic, quantitative input in this regard. The WSM should also be an effective tool in evaluating the efficacy and potential retirement of existing data collection sites.

Overall, MDT's WIM/ATR program was found to be efficiently and effectively meeting traffic data needs, both within and outside MDT. This conclusion is supported by the findings from each task above:

- Data is being collected using accepted technologies researched by TDCA Section personnel as appropriate to conditions in Montana.
- ATR/WIM data collection sites are generally comparable in number with similar states and are located to support the state's traffic/weight factor groups consistent with established practice.
- Data processing includes appropriate quality control checks.
- Data users are well satisfied with the data they are being provided.

That being said, traffic data collection is a dynamic activity, with: a) research continually being done to potentially improve data collection, processing and presentation, and b) ever changing data user needs/priorities. As they have done, the TDCA Section needs to continue to stay abreast of developments in this field, to maintain the efficacy of their efforts. Technologies that can reliably and accurately collect traffic data in urban environments are still a challenge and, as with any new technology that may emerge, MDT must continue to test and ensure new technologies perform as intended in Montana's conditions.

What the Researchers Recommend

Given the overall findings and the adequacy of MDT's traffic data collection efforts, the researchers' recommendations include:

- The TDCA Section has and should continue to consider various improvements in data collection (especially for urban environments) and processing technologies, notably as they potentially advance and as data user needs continue to evolve.
- Work should continue on identifying areas with increased vehicle activity that merit increased data collection coverage to adequately characterize both volume and weight related traffic demands.
- Assessment of the basic structure of the traffic and weight factor groups used by MDT should continue to ensure these groups reasonably represent operations across the highway network; relative to traffic factor groups, the alternative grouping scheme consisting of a simplified classification of interstate versus non-interstate, and commercial versus non-commercial vehicles developed in this project should be considered.
- The site selection/prioritization method developed (WSM model) in this project should be used to improve the objectivity of the site selection planning process and also used in the evaluation of the efficacy and possible retirement of existing sites.
- MDT should continue its practice of vertical integration of data collection activities within a single administrative section to continue to realize the positive technical and fiscal benefits this brings to the overall program.
- Additional staff and/or seasonal staff may benefit the TDCA Section to ensure critical seasonal field work can be completed each year (e.g., equipment maintenance), and to allow various new operational initiatives to be pursued, such as implementation of an improved equipment database to better support system planning/ management decisions.
- The current pavement condition at sites needs to be better evaluated and routinely documented as it is a critical element in system performance.
- The current database of maintenance, repair and pavement information at WIM and ATR sites should be improved to better use this information and better manage these assets.
- Looking toward the future, interest in freight transportation continues to be strong at the federal level, and associated traffic data needs related to freight initiatives should be considered as they become more clearly defined.
- Interest in travel time data and related performance measures is increasing in general across the motoring public and commercial vehicle operators, and MDT should begin investigating how this data can be gathered, disseminated, and utilized by the appropriate groups within MDT.
- Interest in bicycle and pedestrian data is also increasing, and collection of this data should be given appropriate consideration.

Quality/Comprehensiveness of Data						Support of Specific User Activities					Opportunistic/Situational Factors				Other Extenuating Circumstance	
General Coverage within Groups	Geographic Coverage within Groups	Volumetric Coverage within Groups	Route with Increased Activity	Group Importance	Sub-total	Weight Enforce	Pave Design	Speed Related Safety and Other Activities	Homeland Security	Sub-total	Scheduled for Othr Construct Activities	Alignment, Pavement Conditions, etc.	Power and Comm	Sub-total	Score	Explanation
10	10	10	10	5	45	20	10	5	5	40	5	5	5	15	-	-

Table 1: Proposed WIM/ATR Site Prioritization Scheme Criteria and Sample Weights.

For More Details . . .

The research is documented in Report FHWA/MT-17-005/8222-001, http://www.mdt.mt.gov/research/projects/planning/wim.shtml.

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To obtain copies of this report, contact MDT Research Programs, 2701 Prospect Avenue, PO Box 201001, Helena MT 59620-1001, mdtresearch@mt.gov, 406.444.6338.

MDT Implementation Status: March 2017

MDT's response to the implementation recommendations can be found in the implementation report found at http://www.mdt.mt.gov/research/projects/planning/wim.shtml.

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