Wyoming Low-Volume Roads Traffic Volume Estimation

Phase III

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This proposal is for Phase III of the Wyoming Low-Volume Roads Traffic Volume Estimation study. Phase I included a review of the various models which have been implemented for estimating traffic volumes for low-volume roads, the development and verification of two regression models for Wyoming, and the development, implementation, and verification of a travel demand model for four counties in south eastern Wyoming. Phase II expanded the use of the travel demand model to the rest of Wyoming as well as incorporating agricultural crop production related freight trips and oil production related freight trips. This third phase will incorporate tourism related data into the travel demand model and develop methods to estimate traffic volume near tourism destinations in Wyoming.

Background

Tourism trips occupy a major part of traffic volume, especially in frequently visited areas. Historically, transportation planning has been led by urban and metropolitan planning. Much of this effort has been directed towards reducing traffic congestion and providing adequate capacity. More recently, there has been increased emphasis on estimating traffic on rural low-volume roads driven at least in part by safety and air quality concerns. So far, tourism traffic is barely recognized in travel demand model due to available data in this field.

Recent advances in GIS software's analytical capabilities allow for more sophisticated analyses of transportation networks and the traffic they carry. Techniques that even a decade ago would not have been seriously considered may now be possible. Improved analytical capabilities may allow for more information to be extracted from the same data collections efforts. Additionally, with more sophisticated analytical methods, traffic counting, and other data collections efforts can be focused more efficiently.

In an effort to enable estimation of traffic for low-volume roads in Wyoming, WYDOT funded a study to develop traffic estimation models. Phase I of the study was carried out from 2013 to 2015. The first stage involved the determination of models appropriate for cost-effective traffic volume estimation for low volume roads, implementation of the models, and recommendations for their implementation. Two model types – regression model and a travel demand model - were developed in Phase I. Phase II of the study was carried out from 2015 to 2017. The second stage reviewed the model developed in the earlier phase and streamlined the transportation analysis zone (TAZ) delineation process with rules that ensured the process could be replicated across the State. In addition to the person trips generated in Phase I, additional trip generation sources – agricultural crop production related freight trips and oil production related freight trips – were included in an updated model for estimating traffic volumes.

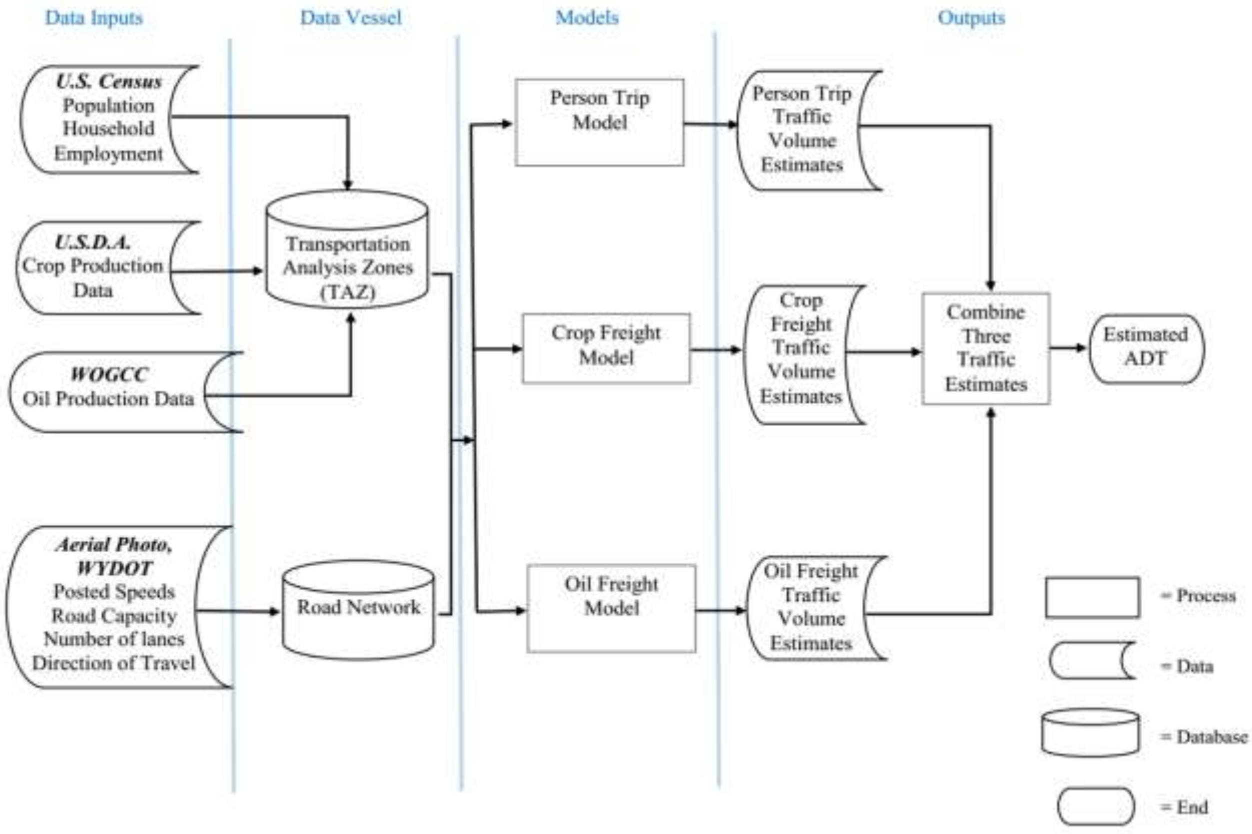

Figure 1. Overview of model development process in Phase I and Phase II

Tourism in Wyoming

Tourism is the second largest industry in Wyoming. Wyoming welcomed 8.5 million visitors in 2016 (Wyoming Office of Tourism 2017). Yellowstone and Grand Teton National Parks are among the top 10 most-visited national parks in 2016. In addition, based on a recent survey, Wyoming ranked 16 for best road-trip U.S. states for summer. As one of the least populated states in the U.S., Wyoming is famous for wilderness landscapes, historic towns, ranches, and cowboy cultures. Figure 2 shows some major points of interest in Wyoming. Tourism-related activities in Wyoming include but not limited to outdoor adventure, recreation, and entertainment. The combination of low population density and natural scenery makes Wyoming a good place for epic road trips. Figure 3 shows the road trip itineraries in Wyoming recommended by the Wyoming Office of Tourism. The itineraries include: Salt to Stone, which covers Flaming Gorge National Recreation Area and Fossil Butte National Monument; Rockies to Tetons, which covers some mountain ranges and Grand Teton National Park; Park to Park, which covers some state parks and historic towns; Black to Yellow, which covers Black Hills National Forest, Devils Tower National Monument, and Bighorn Canyon National Recreation Area.

Figure 2. Things to do in Wyoming

Figure 3. Road Trip Itineraries (Wyoming Office of Tourism 2017)

Objectives

There are three basic goals of this project. First, the travel demand model developed in Phase I and II will be enhanced by including tourism impacts in the model. The second goal will be to implement the model for the whole State of Wyoming. The model will apply tourism-related travel behavior parameters in the four-step modeling process to estimate traffic volumes. Finally, an analysis will be carried out to determine the seasonality in tourism travel demand and the impact of tourism travel on local transportation system.

By accomplishing these three goals, a more efficient means of providing low-volume roads traffic information will be developed for the entire state; this will support a wide variety of design, planning, and management functions on both the state and county road networks.

Using improved models will make better traffic volume estimates possible with the same data, thereby lowering costs and improving the quality of traffic information. By taking advantage of better software and better models, more and higher quality information may be provided, leading to improvements in safety and other planning efforts.

Benefits of Low-Volume Road Traffic Estimation

As part of the federally mandated Highway Performance Management System (HPMS), each state is required to provide summary data for their rural minor collector and local road networks. A primary element of this summary data is the total vehicle miles traveled on these roads.

Traffic flows and volumes are primary pieces of information when making transportation design, planning, safety, administration and management decisions (Wang and Kockelman 2009, Sharma et al 2000, Seaver et al 2000). Unfortunately, resource constraints often restrict agencies from conducting counts at all areas of interest (Pulugurtha and Kusam 2012). In Florida, improved estimates of travel on local roads are used to “apportion federal funds, estimate vehicle emissions, determine crash rates, and prepare bridge condition ratings” (Blume et al 2005). In Australia, better estimates of low-volume roads’ traffic are used to more equitably assign the prices paid by heavy vehicles for using the low-volume roads network (ARRB 2005). The utility of traffic flow information, combined with the prohibitive expense of counting traffic on a high percentage of the many low-volume roads, makes an easy, inexpensive method for estimating low-volume road traffic highly desirable.

AASHTO recognizes a number of benefits from traffic data; some of these are relevant to lowvolume roads, while others are not. Those which may be relevant to low-volume roads include: project selection; pavement design; safety analysis; pavement and bridge management systems; traffic simulation; traffic forecasting; air quality; and implementation of access controls. In addition to these direct agency benefits, further benefits identified include those to: commerce and economic development; motel and service station chains; chambers of commerce; and litigation tort claims (AASHTO 1992).

Two recent motivating factors for increased low-volume road traffic counting and estimating efforts relate to their roles in air quality and in safety mitigation. It is widely recognized that traffic fatality rates on rural roads are higher than on other roads. With better estimates of traffic on low-volume county and secondary state roads, better targeted and more effective safety improvement efforts can be made. In broader terms, better estimates of traffic volumes on lowvolume roads will allow for more effective planning and more efficient operations.

Better traffic models on lower volume roads will allow more information to be obtained with minimal additional data, and perhaps more information may be provided with less data. This improvement would allow for more cost effective management of both county and secondary state roads. Traffic originating on county roads usually ends up on state highways. The ability to apply comprehensive traffic models to the state's lower volume roads will provide a better understanding of traffic on our state's low-volume, rural roads, thereby allowing for more effective planning. More effective planning will lead to a safer and more efficient statewide transportation network.

Tourism travel poses some transportation planning considerations, which typically differ from commuter travel and commercial transport issues. Transportation is a key to accessing major tourism attractions and it can be a critical element of the operation of visitor attractions. Effective transportation planning on low-volume roads for tourism can produce appropriate solutions for balancing the traffic needs of different traveler groups during peak tourism seasons or special events (NCHRP 2004).

Highway Performance Monitoring System

> "A biennial Conditions & Performance estimate of the future highway investment needs of the nation is mandated by Congress (23 U.S.C. 502(h)) for the United States Department of Transportation (U.S. DOT) to prepare for its customers. Highway Performance Monitoring System (HPMS) data are used for assessing highway system performance under the U.S. DOT and FHWA's strategic planning and performance reporting process in accordance with requirements of the Government Performance and Results Act (GPRA, Sections 3 and 4) and for apportioning Federal-aid highway funds under the Transportation Equity Act for the 21st Century (TEA-21), (23 U.S.C. 104). To address these needs, the HPMS was first developed in 1978 as a national highway transportation system database." (FHWA 2012)

States are required to provide statewide summaries for non-federal aid rural minor collector and local roads. Statewide summary data includes:

- Information on travel
- System length
- Vehicle classification by:
  - Functional class
  - Area type
    - Rural
    - Small urban
    - Urbanized
- Land area
- Population by area type

The statewide summaries include four individual databases, which are:

1. Statewide

    - Population
    - Land area
    - Daily travel, VMT
    - Length
        - Rural *or* small urban
        - Paved or unpaved
2. Vehicle travel activity by:
    - Vehicle type
    - Functional system group
        - Rural and Urban
            - Interstate
            - Other Arterial
            - Other (Collectors and Locals)
3. Urban summaries for local classification
    - Travel data
    - Population
    - Land area
4. County summaries o
    - Length, including NHS
        - Rural minor collector
        - Local o
    - Ownership
        - Public
        - Private
    - Include park roads, military roads, toll roads, public roads at an airport, school or university, and roads under the jurisdiction of the Bureau of Indian Affairs (FHWA 2012)

Compliance with the federal data requirements, particularly the vehicle mile traveled estimates on the lower volume roads, should be carried out as efficiently as possible. Therefore, the best possible models should be used, both to improve information quality and to minimize data collection costs.

Literature Review

Traffic volume estimation began in earnest during the 1930's using manual counts. In the 1940's, mechanical counters became common (Albright 1991a). Right after World War II, a national study examined the accuracy and precision of traffic counts using sample periods of 24, 48 and 72 hours. It was concluded that for low-volume roads with several hundred vehicles per day, a 48-hour count was adequate. It was also recognized at this time that seasonal, daily and hourly variation was also significant, and that these variations need to be accounted for when using sample counts (Petroff 1947). During the 1950's, efforts were made to evaluate traffic specifically on low-volume roads. Early attempts at classifying and categorizing rural traffic took place in two rural districts in western Minnesota in the 1950's where local roads were classified as either 'resort' – roads serving lakes and fishermen – or 'farm' – roads serving farms and farmers. Considerable improvements in traffic estimates were achieved using this categorization approach (Darrell et al 1958). Though earlier analytical approaches had assumed that counts in roads near each other would be similar, it was recognized during the 1950's that adjustment factors based on similar road use provided better results than simply adjusting traffic counts based on proximity (Albright 1991a).

Over the next few decades, other elements of traffic data analysis became apparent. Primary among these is that traffic distribution is not normal. Therefore, simply examining the mean of traffic volumes does not completely describe traffic on a given road or road network. Also, it must be kept in mind when performing statistical analyses that many procedures assume data normality and homogeneity of variance, which may not be valid for traffic volume data (Albright 1991b).

Over the years, the most common method for estimating traffic flows has used the 'four-step model.' This model uses trip generation, trip destination, mode choice, and route choice to predict traffic flows on roads and streets. In urban areas, this approach has worked quite well (McNally 2007).

While traffic evaluation in urban areas became highly advanced and sophisticated, rural traffic assessments on low-volume roads did not see such advances (Mohammad et al 1998). A study of local roads, both urban and rural, was conducted on traffic counts collected by the Georgia Department of Transportation. Unfortunately, the models they generated did not perform particularly well on rural roads. However, by using some stratification – grouping roads by whether they were paved or unpaved and by whether they were within the metropolitan statistical area – and performing cluster regression analysis with data from the U.S. Census Bureau, reliable models were developed. It was also suggested that clusters might be based on counties rather than on demographic patterns to yield useful models (Seaver et al 2000).

More recently, spatial effects are re-emerging as GIS technology improves. A technique known as 'Kriging' involves examining the spatial distribution of error terms (Wang and Kockelman 2009). Other efforts to achieve the goal of applying spatial corrections involve the use of applying boundaries based on land use categories such as urban, small urban, and rural (FHWA 1994).

Tourism in Travel Demand Model

In tourism planning, evaluation in new and expanded transportation facilities can serve to support the operation and development of attractions (such as national parks) and identify needs for future maintenance. More focus has recently been given to the transportation systems in and near national parks because of the levels of visitor demand exceeding the transportation infrastructure within many parks (White 2007). As a result, various studies have assessed the cost-effectiveness and practicality of alternative transportation solutions, including roads, parking, bus service, trams, and other forms of transit facilities (NCHRP 2004).

The use of tourism-related travel data in travel demand model is one of the ways for transportation planners to incorporate tourism issues into their forecasting, planning, and design processes. A variety of government agencies and private organizations have become involved in issues regarding tourism and recreation travel. Most commonly, state and regional transportation planning agencies take the lead in identifying travel issues and needs for all travel segments for tourism and recreational development. Overall, 42% of the state DOTs and 54% of the other agencies reported that they regularly make use of tourism travel forecasts. Among the state

DOTs that do make use of tourism forecasts, the dominant use is for transportation planning (NCHRP 2004).

Other State DOTs' Tourism Travel Demand Models

1. Utah DOT Transportation Model for the 2002 Winter Olympic Games

Before the 2002 winter Olympic games, the Utah DOT used the CORSIM travel forecasting simulation model and applied that model to determine Olympics-related peak-period traffic volumes. The travel forecasting model addressed three planning levels: (1) the Olympic global level, (2) the corridor level, and (3) the interchange/intersection level. Analysis at each of these levels was for the purposes of addressing different issues. From the Olympic global level, the Salt Lake City Olympic Committee published a transportation guidebook for all Olympic-related travelers, listing travel time tables for different trip segments. The corridor-level analysis tested ways to reduce congestion and improve travel time through a critical 20-mile stretch of the corridor. The decision was to campaign for a reduction in truck volumes in the peak direction during peak travel periods to and from Olympic venues. The analysis at the interchange/intersection level pointed toward numerous infrastructure and traffic control improvements. Overall, the transportation modeling helped inform and define strategies to manage travel demand, and the result was a well-functioning transportation system during the Olympic Games (NCHRP 2004).

2. Central Florida's Regional Model for Tourism and Commuter Trips

Florida DOT District Five office (covering the Orlando region) developed a model to provide more accurate forecasts of tourism travel to central Florida. The goal was to produce more policy-sensitive forecasts to inform ongoing transportation planning efforts. The model covered more detailed dynamics of trip generation and allocation by visitors to a destination. The model included three tourist trip purposes: Disney tourist (Disney to and from hotel), Disney resident (Disney to and from homes in the Orlando area), and Disney external/internal (Disney to and from external stations). Additional attraction-oriented trip generation was also considered for Universal Studios and Orlando International Airport. The study was successfully completed, with both the Orlando Urban Area Transportation Structure and FDOT District 5 district-wide model incorporating the results into the transportation planning (FDOT-District Five 2007).

A number of transportation agencies have expressed the need for specific improvements in the availability and detail of tourism travel data. The most widely requested forms of data are tourism origin–destination patterns, followed by tourism visitor traffic counts and tourism industry employment data. Data that reflect the seasonal characteristics of tourism travel and meaningful geographic regions will help to further the accuracy of modeling results for state DOT planning efforts. More studies and models developed by other transportation agencies will be reviewed during Phase III.

Summary

There is a growing need for integrating aspects of tourism–recreation travel into statewide and regional transportation planning. This study will make use of tourism data to address traffic on local and collector roads.

One element making this the time to consider tourism in transportation planning is the growing number of visitors to the national parks. There is a wide range of issues need to be addressed at the intersection of tourism travel and the transportation system currently available to carry visitors into, out of, and around a region for nonwork-related trips.

Another element making this the time to develop traffic models is the availability of more sophisticated traffic analysis software. As GIS and related software development has progressed, more comprehensive traffic analyses have become possible.

A final element making this the time to address traffic estimates on lower volume roads is the large number of collector and local roads that are nearing the end of their service lives. Many roads and streets initially paved or treated with asphalt, particularly those built in the 1940's through the 1960's, are now experiencing deterioration related to both aging of the asphalt and in many cases to substantial increases in heavy truck traffic. Therefore, an inexpensive means of estimating traffic on the state's many miles of lower volume roads is highly desirable. It will allow for more effective planning and management of the state's rural collector and local road networks.

Findings of Phase I

Phase I of the study involved two tasks. The first task was to develop models for predicting traffic volumes on low-volume roads. This task was carried out to develop three traffic prediction models. The models were a linear regression model, a logistic regression model, and a travel demand model. The second task was to verify the utility of the models developed for the state of Wyoming. The two regression models were verified for the entire state of Wyoming. The travel demand model was verified for four counties in south eastern Wyoming – Laramie, Converse, Goshen, and Platte counties. Traffic count data were collected from across the entire state of Wyoming and used for developing and verifying the regression model. Count data from south eastern Wyoming were used for the verification of the travel demand model. A summary of the findings and recommendations of phase I are presented below.

Linear Regression Model

The linear regression model was developed to predict traffic volumes using socioeconomic and roadway characteristics from 13 randomly selected counties in Wyoming. A logarithmic transformation of traffic volume (dependent variable) was necessary to ensure a constant error variance and a linear scatter in the residual plots. The final model predictors were; land use (categorized into cropland, pastureland, industrial and subdivision), pavement type (categorized into pave and unpaved), access to highway, and population. The model analysis indicated an R square value of 0.64 for the final model. The application of the model in estimating traffic volumes in counties not included in the model development indicated consistencies in prediction accuracy. Pearson's correlation was used to confirm the linear association between predicted traffic volumes and actual traffic volumes. The Pearson's correlation value for the counties used in developing the model was 0.687 and that for counties not used in developing the model was 0.610. A Root Mean Square Error (RMSE) value of 73.4% was obtained for the model.

Logistic Regression Model

A second regression model was developed for estimating traffic volumes using logistic regression. Unlike the linear regression model that estimated discrete traffic volumes, the logistic regression model predicted the probability of a road's volume falling within a selected threshold. The data from the 13 randomly selected counties used in developing the linear regression model were also used in developing the logistic regression model. Data from nine of the remaining counties were used to verify the prediction accuracy of the model. Five logistic regression models were developed to determine the odds of a road's ADT falling below five thresholds. The thresholds used are as follows:

Threshold 1: ADT of 50 or less

Threshold 2: ADT of 100 or less

Threshold 3: ADT of 150 or less

Threshold 4: ADT of 175 or less

Threshold 5: ADT of 200 or less

A sixth equation converted the odds (obtained from one of the five model equations) into a probability of the road's ADT falling below the threshold of interest. A calculated probability of 0.5 or more meant a road's ADT is within the threshold of interest, whereas roads with probabilities less than 0.5 have ADTs outside the threshold. The model was also verified and found to have an acceptable prediction accuracy ranging from 78% to 89%.

Travel Demand Model

The travel demand model was developed for four counties in south eastern Wyoming using the four-step process. The steps were trip generation, trip distribution, mode choice, and highway assignment. Parameters and procedures from the NCHRP Report 365 and the ITE Trip Generation report were used in the model development. Transportation analysis zones were created by aggregating census blocks to ensure that none of the zones had a population of zero. Estimates from the travel demand model were calibrated and validated by comparing estimated traffic volumes to actual traffic volumes on 100 roads in the study area. A RMSE of 50.33% and an R square value of 0.74 were obtained from the verification process. These results were found to be consistent with traffic volume estimations for low-volume roads in other studies. The presence of special generators (oil and gas, mines, and plants) and the methodology used in delineating transportation analysis zone low population rural areas were pointed out as issues that could be addressed to improve the model's estimation accuracy in future studies.

Based on the results of the model verification processes, recommendations were made to utilize the regression models for quick estimates due to their swiftness and ease of implementation. Travel demand models were found to be relatively more accurate in predictions compared to the regression models and so were recommended for implementation by WYDOT. Further recommendations were made to improve the travel demand model by developing a TAZ delineation methodology for Wyoming low-volume roads. Recommendations were also made to include special generators such as oil and gas fields, mines, and plants in the models. The improved travel demand model was recommended for expansion to include the remaining 19 counties and its reliability and accuracy verified.

Findings of Phase II

Phase II reviewed the model developed in the earlier phase and streamlined the transportation analysis zone (TAZ) delineation process with rules that ensured the process could be replicated across the State. In addition to the person trips generated in Phase I, additional trip generation sources – agricultural crop production related freight trips and oil production related freight trips – were included in an updated model for estimating traffic volumes. Input data for the model were collected from the US Census, the US Department of Agriculture, and the Wyoming Oil and Gas Conservation Commission. Wyoming was divided into four regions and delineation of TAZs for each region was done concurrently to stay ahead of schedule.

A four-step model was implemented for Wyoming with a modification that excluded the traditional mode choice step. The person trip model was based on the model developed in Phase I that utilized demographic and employment data to estimate traffic volumes. In the case of the freight trips (crop production related trips and oil production related trips), crop production in each TAZ was computed in tons and the result was divided by the hauling capacity of a truck to determine the truck trips required to haul the crop produced in the TAZ to the crop elevator. For oil production, an estimate of oil produced in each TAZ and the associated waste water production and the water demands were computed in barrels. The capacity of a typical truck was then used to convert the barrels of products produced in a day into truck trips. The resulting trips for personal travel, crop production, and oil production activities were then combined to obtain the estimated total traffic volumes in the network.

After obtaining traffic volume estimates for the low-volume county roads, the traffic volume estimates were compared to actual traffic counts to verify the utility of the model. The R-square values for the four regions ranged from 60 percent to 90 percent.

Trip Generation Parameter Development

Initial trip production and attraction for person trips were computed from the TAZ attribute data and the trip rates obtained from the NCHRP Report 365. Trip rates by purpose for each analysis zone were calculated for three trip purposes – Home-Base Work (HBW), Home-Base Other (HBO), and Non-Home Base (NHB) trips. Home-Based Work trips are trips that have one end at home and the other at work, Home-Based Other trips are all trips with one end at home and the other end at any other place other than work, and Non-Home Based trips are those trips that start and end away from home. The trip equations for crop production related activities were derived using the crop yield per acre divided by the number of harvest days in a year. The result represents a factor for determining the tonnage of the crop produced in a day when applied to crop cover area in acres. This was then converted to trucks by dividing by the tonnage that can be hauled by a truck to obtain the combined factor for each crop. The capacities of the crop elevators serve as the attraction for crop productions. Oil production and attractions were grouped by the products transported to or from the oil wells. The trip rate factor converts the amount in barrels per day to trucks per day. The factor is applied to the data on daily oil and waste water production, and the daily freshwater requirement data. Calibrated trip rate equations are listed in Table 1.

Table 1. Calibrated Trip Rate Equations

Activity	Trip Type		Equation
Person Trips	Production	Home Based Work	8.125*9.2*0.16*Households
		Home Based Other	1.3*9.2*0.6*Households
		Non-Home Based Other	1.3*9.2*0.24*Households
	Attraction	Home Based Work	1.3*1.45*Employment
		Home Based Other	9.0*Retail+1.7*Service+0.5*Other+0.9*Households
		Non-Home Based Other	4.1*Retail+1.2*Service+0.5*Other+0.5*Households
Crop Production Trips	Production	Crops	0.9375*Oats+1.15*Beans+2.484*Corn+1.484*Barley+0.5*Wheat
	Attraction	Elevator	1*Elevator Capacities
Oil Production Trips	Production	Oil Production	0.01*Oil Production
		Waste Water Production	0.01*Waste Water Production
		Freshwater Production	0.01*Freshwater Production
	Attractions	Oil Elevators	0.01*Rail Elevator
		Waste Water Production	0.01*Water Disposal
		Freshwater Demand	0.01*Freshwater Consumption

Data Dictionary Development

Phase II developed a data dictionary which included the sources for all the data used to develop and implement the statewide model. The data dictionary has three parts. The first part describes the input data and their sources, the second part describes the derivation of parameters for freight trip generation, and the final part describes the model outputs. The model outputs were adequate for estimating traffic volumes on low-volume rural roads in Wyoming. However, Phase II indicated lower efficiency in estimating traffic volumes in Region 3 which has a lot of tourism activities. The study therefore recommended a Phase III to include these activities in the model considering the considerable tourism related activities found in Wyoming.

Phase III: Integrating Tourism Travel with Transportation Planning

The tourism data will be integrated into the four-step modeling process to estimate traffic volumes. Figure 4 shows the overall procedures for a tour-based travel demand model.

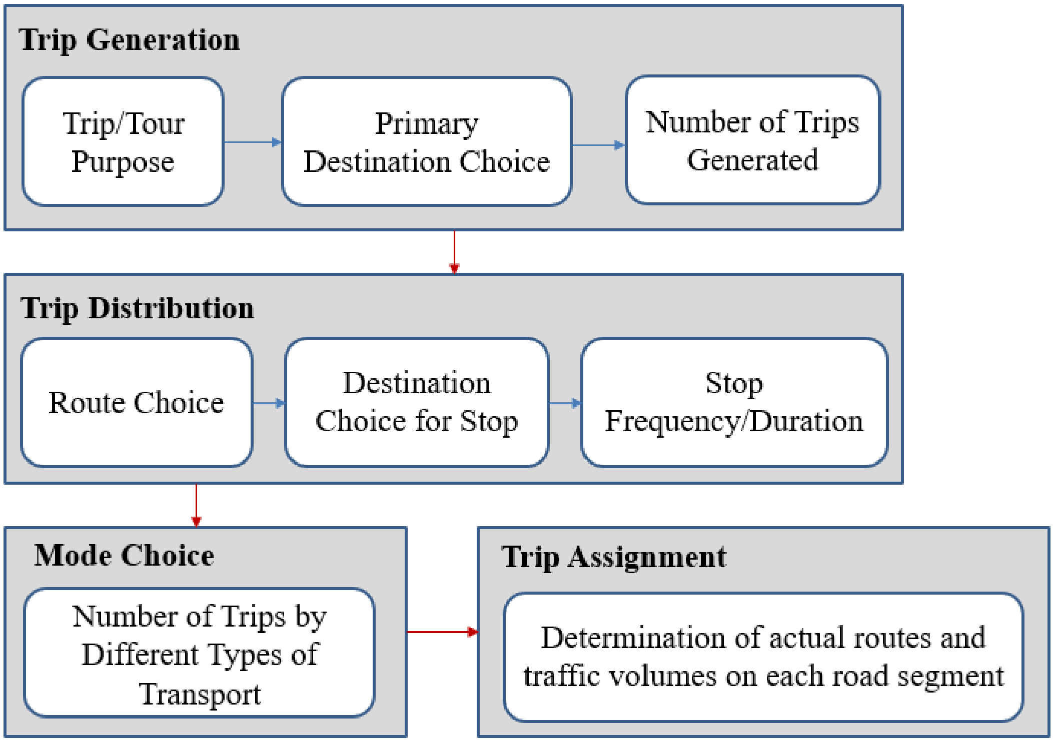

Figure 4. Tour-Based Travel Demand Model

Tasks in Phase III

Task 1: Review Literature, Available Data, and Travel Demand Models Developed by Other States

Task 1.1: Review Model Development Process in Phase I and Phase II

A thorough review of the travel demand model developed in Phase I and Phase II will be carried out. The review will cover model inputs, trip rate equation generation procedures, TAZ development procedures, and model outputs,

Task 1.2 Review Literature and Tourism Travel Demand Model Developed by Other States

A comprehensive review of the academic literature and reports from other State DOTs will be performed. Different types of attractions and different purposes of the state's tourism travels (e.g. outdoor activities, recreation, and entertainment) will also be analyzed to categorize different types of tourism activities.

Task 1.3 Assemble Tourism Data

The input parameters used in the model development will be collected and examined in detail. Potential tourism data sources include statistical data from the National Park Service (NPS), traffic count data from WYDOT, and annual reports from the Wyoming Office of Tourism. The NPS collected a set of statistics that address how many people visit parks and how long they stay. The set is comprised of recreation visit counts and hours, non-recreation visit counts and hours and overnight stays by category. The NPS also provided monthly traffic counts at each entrance to the national parks. Figure 5 shows the entrances to Yellowstone and Grand Teton National Parks. This study will use traffic count data at northeast, east, and south entrances to Yellowstone National Park and all three entrances to Grand Teton National Park to estimate traffic volumes in Northwest Wyoming. Traffic count and visitor data in other destinations will also be collected to estimate traffic volumes in other parts of the state.

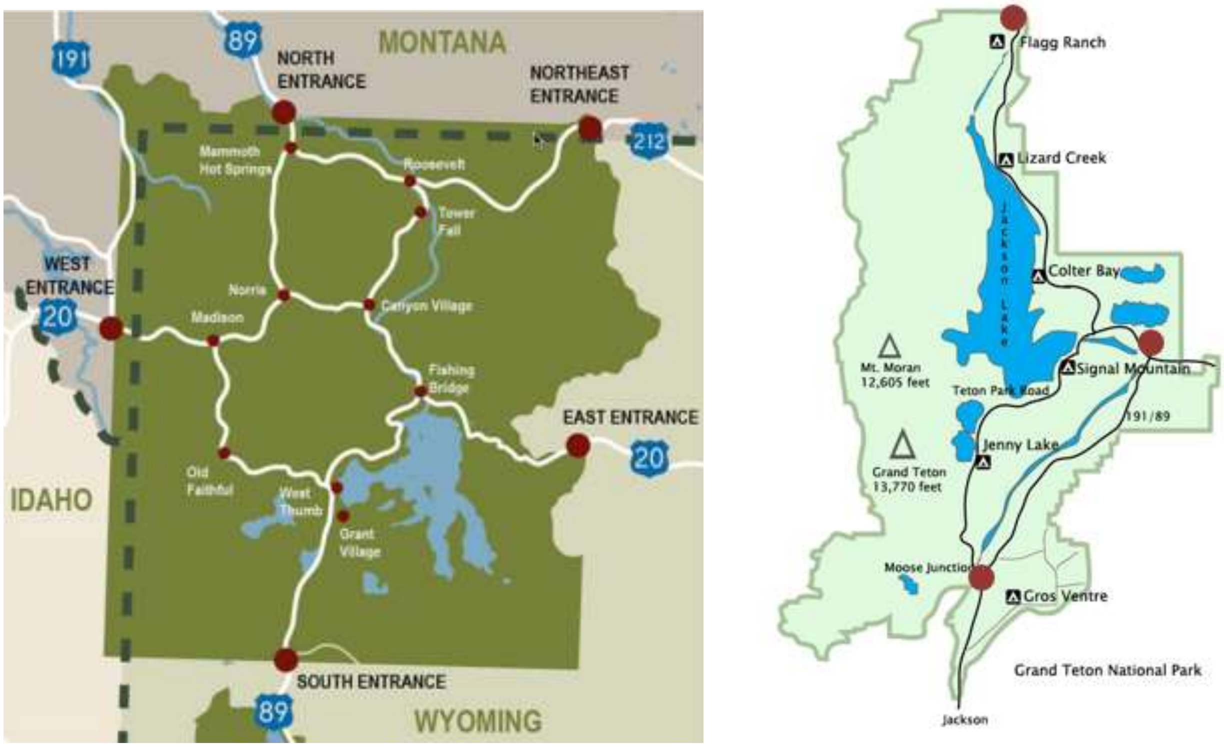

Figure 5. Entrances to Yellowstone and Grand Teton National Parks

Task 1.4 Evaluate and Analyze Data

After collecting tourism data, they will be evaluated with associated location information and they will be stored in the form that can be input in ArcGIS®.

Task 1.5 Integrate Tourism Data

The tourism data will be cleaned up to ensure that they can be integrated into the travel demand model along with census, crop production, and oil production data.

Task 2: Develop Tourism Travel Demand Model

Task 2.1 Input Data into the Model

Independent parameters will be identified and input into the model along this road network. Road network data obtained from the Tiger/Lines webpage of the US Census will be developed to represent the transportation system in each county. The developed shapefiles will contain data on speed limits, number of lanes, direction of travel, and functional class of the road.

2.2 Run Model

Trip rate equation will be assigned to each input parameter. The enhanced four-step model will be implemented for each county in Wyoming.

Task 2.3 Generate Traffic Volume Estimates

The model will use the TAZ and network datasets of each county to generate traffic volumes for each road in the study area.

Task 2.4 Store Output Data

The estimated traffic volume data will be assembled and stored in ArcGIS® and Excel database files for each county.

Task 2.5 Verify the Utility of the Model for Each County

The utility of the model will be verified by comparing actual traffic volumes to predicted traffic volumes.

Task 3: Determine the Seasonality in Tourism Travel and the Impact of Tourism Travel on Local Transportation System

The tourism travel seasonal patterns (e.g. peak season vs. non-peak season) will be determined. Based on the outputs of the model, an analysis of how tourism travel impacting the local transportation system will be carried out.

Task 4: Create A Database Dictionary and Present Findings and Recommendations

Task 4.1 Develop Recommendations for Statewide Low-Volume Road Traffic Estimation

Recommendations of a data collection sampling method for Wyoming's low-volume roads and an analytical procedure for estimating tourism traffic on Wyoming's low-volume roads will be provided for future transportation planning.

Task 4.2: Prepare A Final Database Dictionary. Present Findings and Recommendations

A final database dictionary will be prepared that documents the model generation and verification processes. The studies' findings and recommendations will be presented in conferences and journal publications.

Timeline

This project will be completed in 20 months assuming June 1, 2018 starting date.

Budget

The WYDOT portion of the budget is shown in Table 2. The University of Wyoming will provide the required match for this study which is $6,000. In addition, the study will be matched with additional funding from MPC. The budget for the MPC funding is shown in Table 3.

Table 2. The WYDOT Portion of the Project Budget.

WYDOT Budget

Project Title: Wyoming Low-Volume Roads Traffic Volume Estimation Phase III

Categories	WYDOT	University Contribution	**Total**
Center Director Salary	$0.00	$0.00	$0
Faculty Salaries/Post Doc	$20,600.00	$3,290.00	$23,890
Administrative Staff Salaries	$0.00	$0.00	$0
Staff Fringe Benefits	$10,712.00	$1,710.80	$12,423
Student Salaries	$11,900.00	$0.00	$11,900
Student Fringe Benefits	$238.00	$0.00	$238
Total Personnel Salaries	$32,500.00	$3,290.00	$35,790
Total Fringe Benefits	$10,950.00	$1,710.80	$12,661
TOTAL Salaries & Fringe Benefits	**$43,450.00**	**$5,000.80**	**$48,451**
Travel	$2,545.00	$0.00	$2,545
Equipment	$0.00	$0.00	$0
Supplies	$455.00	$0.00	$455
Contractual	$0.00	$0.00	$0
Construction	$0.00	$0.00	$0
Other Direct Costs (Specify)*	$4,260.00	$0.00	$4,260
TOTAL Direct Costs	**$50,710.00**	**$5,000.80**	**$55,711**
F&A (Indirect) Costs	**$9,290.00**	**$1,000.16**	$10,290
TOTAL COSTS	**$60,000.00**	**$6,000.96**	**$66,001**
Federal Share	**$60,000.00**		$60,000
Matching Share		***$6,000.96***	$6,001

Table 2. The MPC Portion of the Project Budget.

MPC Budget

Project Title: Wyoming Low-Volume Roads Traffic Volume Estimation Phase III

Categories	MPC Contribution	University Contribution	**Total**
Center Director Salary	$0	$0	$0
Faculty Salaries	$7,600	$22,520	$30,120
Administrative Staff Salaries	$0	$0	$0
Staff Fringe Benefits	$3,952.00	$11,710.40	$15,662
Student Salaries	$17,057	$0	$17,057
Student Fringe Benefits	$341.14	$0.00	$341
Total Personnel Salaries	$24,657.00	$22,520.00	$47,177
Total Fringe Benefits	$4,293.14	$11,710.40	$16,004
TOTAL Salaries & Fringe Benefits	**$28,950.14**	**$34,230.40**	**$63,181**
Travel	$1,857	$0	$1,857
Equipment	$0	$0	$0
Supplies	$455	$0	$455
Contractual	$0	$0	$0
Construction	$0	$0	$0
Other Direct Costs (Specify)*	$4,260	$0	$4,260
TOTAL Direct Costs	**$35,522.14**	**$34,230.40**	**$69,753**
F&A (Indirect) Costs	**$13,911.65**	**$15,232.53**	$29,144
TOTAL COSTS	**$49,434**	**$49,463**	**$98,897**
Federal Share	**$49,434**		$49,434
Matching Share		***$49,463***	$49,463

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