ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

TRAFFIC HANDBOOK

NOVEMBER 2013

Prepared by the
Traffic Information Systems Section
System Information and Research Division
in cooperation with
Federal Highway Administration

This document was funded in part by the Federal Highway Administration, U.S. Department of Transportation. The views and opinions of the authors expressed herein do not necessarily state or reflect those of the U.S. Department of Transportation.

ARKANSAS STATE HIGHWAY
AND TRANSPORTATION DEPARTMENT

NOTICE OF NONDISCRIMINATION

The Arkansas State Highway and Transportation Department (Department) complies with all civil rights provisions of federal statutes and related authorities that prohibit discrimination in programs and activities receiving federal financial assistance. Therefore, the Department does not discriminate on the basis of race, sex, color, age, national origin, religion or disability, in the admission, access to and treatment in the Department's programs and activities, as well as the Department's hiring or employment practices. Complaints of alleged discrimination and inquiries regarding the Department's nondiscrimination policies may be directed to Joanna P. McFadden Section Head - EEO/DBE (ADA/504/Title VI Coordinator), P. O. Box 2261, Little Rock, AR 72203, (501) 569-2298, (Voice/TTY 711), or the following email address: joanna.mcfadden@arkansashighways.com.

This notice is available from the ADA/504/Title VI Coordinator in large print, on audiotape and in Braille.

TABLE OF CONTENTS

TABLES AND FIGURES

APPENDICES

CHAPTER 1
INTRODUCTION AND OVERVIEW

This handbook offers procedures on traffic monitoring practices and techniques for use by Arkansas State Highway and Transportation Department (AHTD) staff and consultants for project design, planning studies, and environmental documentation. This handbook should be used by local governments and other agencies to provide traffic data for design of non-AHTD projects receiving Federal funding. This handbook provides instructions for traffic forecasting, turning movement count forecasting, Equivalent Single Axle Loading (ESAL) forecasting, and testing and certification procedures for equipment, and development of Highway Performance Monitoring System data.

This handbook documents traffic forecasting data collection, and procedures as required in 23 CFR 500 Subpart B.

REFERENCES

- *A Policy on Geometric Design of Highways and Streets*, American Association of State Highway and Transportation Officials (AASHTO), 2011
- *Highway Capacity Manual*, (HCM 2010), Transportation Research Board
- *Traffic Monitoring Guide*, Federal Highway Administration, 2001
- *AASHTO Guidelines for Traffic Data Programs*, AASHTO 2009
- *AHTD Technical Services Field Manual*, AHTD, Planning and Research Division, Technical Services(Renamed as Traffic Information System Section in 2013), 1988
- *Highway Performance Monitoring System Field Manual,* Federal Highway Administration, Office of Highway Policy Information, 2013
- *NCHRP Report 365 – Travel Estimation Techniques for Urban Planning,* 1998
- *NCHRP 01-37A: Development of the Guide for the Design of New and Rehabilitated Pavement Structures,* 2002

DEFINITIONS

ADJUSTED COUNT — An estimate of a traffic statistic calculated from a base traffic count that has been adjusted by application of axle, seasonal, or other defined factors.

AVERAGE ANNUAL DAILY TRAFFIC — The total volume of traffic on a highway segment for one year, divided by the number of days in the year. This volume is usually estimated by adjusting a short-term traffic count using monthly factors.

ARTERIAL — Signalized streets that serve primarily through traffic and provide access to abutting properties as a secondary function, having signal spacings of two miles or less and turning movements at intersections that usually do not exceed 20 percent of total traffic.

AVERAGE DAILY TRAFFIC — The total traffic volume during a given time period (more than a day and less than a year) divided by the number of days in that time period.

AUTOMATIC TRAFFIC MONITORING SITE — Automatic Traffic Recorders that are permanently placed at specific locations throughout the state to record the distribution and variation of traffic flow by hour of the day, day of the week, and month of the year, from year to year, and transmit the data to the Traffic Information Systems Section Office via telephone lines and cellular modems.

AXLE ADJUSTMENT FACTOR — The factor developed to adjust vehicle axle sensor base data for the incidence of vehicles with more than two axles, or the estimate of total axles based on automatic vehicle classification data divided by the total number of vehicles counted.

BASE COUNT — A traffic count that has not been adjusted for seasonal and axle effects.

BASE DATA — The unedited and unadjusted measurements of traffic volume, vehicle classification, and vehicle or axle weight.

BASE YEAR — The initial year of the forecast period.

COUNT — The data collected as a result of measuring and recording traffic characteristics such as vehicle volume, classification, speed, weight, or a combination of these characteristics.

COUNTER — Any device that collects traffic characteristics data. AHTD utilizes Permanent Continuous Counters, Permanent Continuous Classification and Weigh-In-Motion (WIM) Counters, Portable Axle Counters, and Portable Vehicle Counters.

DESIGN YEAR — Usually 20 years from the Opening Year, but may be any time within a range of years from the present (for restoration type projects) to 20 years in the future (for new construction type projects). The year for which the roadway is being designed.

DESIGN HOUR VOLUME — Design hour is defined as an hour with a traffic volume that represents a reasonable value for designing the geometric and control elements of the facility HCM. Normally, it refers to the 30th highest 60-minute volume in the whole year.

DIRECTIONAL DISTRIBUTION — The percentage of total, two-way peak hour traffic that occurs in the peak direction.

EQUIVALENT SINGLE AXLE LOAD — A unit of measurement equating the amount of pavement deflection caused by an axle or group of axles, based on the loaded weight of the axle group, to the deflection caused by a single axle weighing 18,000 lbs (80-kN).

ESAL FORECASTING PROCESS — The process required to estimate the cumulative number of 18-KIP (80-kN) ESALs for the design period; used to develop the structural design of the roadway.

FACTOR — A number that represents a ratio of one number to another number.

FORECAST PERIOD — The total length of time covered by the traffic forecast. It is equal to the period from the base year to the design year. For existing roads, the forecast period will extend from the year in which the forecast is made, and thus must include the period prior to the project being completed as well as the life of the project improvement.

FREEWAY — A multilane divided highway having a minimum of two lanes for exclusive use of traffic in each direction and full control of access and egress (includes Interstates).

K-Factor — It is defined as the proportion of the AADT that occurs during the peak hour. It is calculated as the 30th highest hour volume as a percent AADT for ART stations and the highest hour volume as a percent AADT for 24-hour or 48-hour portable stations.

PERMANENT COUNT — A 24-hour traffic count continuously recorded at a permanent count station.

PERMANENT COUNT STATION — Automatic Traffic Recorders that are permanently placed at specific locations throughout the state to record the distribution and variation of traffic flow by hours of the day, days of the week, and months of the year, from year to year.

PORTABLE TRAFFIC MONITORING SITE — Specific locations throughout the state at which automatic traffic recorders are temporarily placed to record the distribution and variation of traffic flow.

SEASONAL FACTOR — Factor used to adjust short term counts for monthly fluctuations. The seasonal factor is calculated by dividing the monthly traffic by the average monthly traffic for an entire year.

TRAFFIC FORECASTING — The process used to estimate traffic conditions used for determining the geometric design of a roadway and/or intersection and the number of 18-KIP (80-kN) ESALs that pavement will be subjected to over the design life.

WEIGH-IN-MOTION — The process of estimating a moving vehicle's static gross weight and the portion of that weight that is carried by each wheel, axle, axle group or combination thereof, by measurement and analysis of dynamic forces applied by its tires to a measuring device.

ACRONYMS

The following is a list of the acronyms used throughout this handbook:

ADT	Average Daily Traffic
AADT	Annual Average Daily Traffic
AADTT	Annual Average Daily Truck Traffic
AASHTO	American Association of State Highway and Transportation

	Officials
AHTD	Arkansas State Highway and Transportation Department
ATMS	Automatic Traffic Monitoring Site
ATR	Automatic Traffic Recorder
D-Factor	Directional Distribution
DHV	Design Hour Volume
DDHV	Directional Design Hour Volume
DHT	Design Hour Truck percentage
ESAL	Equivalent Single Axle Load
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
HPMS	Highway Performance Monitoring System
K-Factor	Design/Planning Analysis Hour Factor
MEPDG	Mechanistic Empirical Pavement Design Guide
PTMS	Portable Traffic Monitoring Site
T%	Truck Percent
WIM	Weigh In Motion

CHAPTER 2

BACKGROUND

GUIDING PRINCIPLES AND STANDARDS

The truth-in-data principle and precision of data are both applied when preparing and documenting traffic forecasts.

TRUTH-IN-DATA PRINCIPLE

The controlling truth-in-data principle for making traffic forecasts is to document the sources and any uncertainties in the forecast. The goal of the principle is to provide the user with the information needed to make appropriate choices regarding the applicability of the forecast for particular purposes. Practices and conditions under which the data are collected are to be reported. Editing of traffic data is to be documented and a record of the original data is to be retained. Any variability in the data is to be reported. At present, all data is stored digitally for an indefinite period. To the project designer, this means being able to compensate for uncertainty of, for example, projections of total pavement loading by using a design reliability factor. For the traffic forecast analyst, it means clearly stating the input assumptions and their sources, and providing the forecast in a form that the user can understand and use.

PRECISION OF DATA

To reflect the uncertainty of estimates and forecasts, volumes shall be reported according to the AASHTO rounding standards:

Table 2.1 Rounding Conventions – Calculation of AADT

Forecast Volume	Round to Nearest
<100	10
100 to 999	50
1,000 to 9,999	100
10,000 to 99,999	500
> 99,999	1,000

CHAPTER 3
TRAFFIC DATA SOURCES AND FACTORS

PURPOSE

Traffic data is the foundation of highway transportation planning and design and is used in making numerous decisions. Since accurate traffic data is a very crucial element in the transportation planning and design process, understanding and implementing the data collection process accurately can lead to better decisions. This chapter describes the following items that are part of the traffic data collection and adjustment process:

- Types of traffic counting equipment,
- Traffic data collection methods,
- Seasonal Factors,
- Axle Correction Factors,
- Annual Average Daily Traffic (AADT),
- Truck percentages (T%), and
- Estimating AADT.

BACKGROUND

The AHTD collects and stores a broad range of traffic data for the planning, design, and maintenance of state-of-the-art, and cost effective facilities. Traffic data that is collected includes volume and vehicle classification counts, speed data, and truck weight measurements. The Traffic Information Systems Section is responsible for collecting, processing, and storing traffic data from the permanent and temporary count locations throughout the State of Arkansas using road tubes, permanent in pavement sensors, and other traffic data collecting equipment.

TRAFFIC ADJUSTMENT DATA SOURCES

The continuous count and classification program is designed to collect vehicular and classification traffic counts and weight data 24 hours a day throughout the year. The number of counts and locations are determined on an as needed basis and in accordance with Section 3, Chapter 3 of the Traffic Monitoring Guide (TMG). The portable classification and volume program is designed to collect classification and volume counts for a short term (24 to 72 hours).

PERMANENT COUTINUOUS COUNTS

The Traffic Information Systems Section staff collects traffic data through permanently installed traffic counters located throughout the State. These permanent count stations continuously record the distribution and variation of traffic flow by hours of the day, days of the week, and months of the year, from year to year, and transmit the data to the central office via telephone lines and cellular communication. The permanent counters provide the user with day-to-day traffic information throughout the year. The traffic information collected is used to produce the AADT for each permanent counter location. The information is also used to estimate seasonal factors. Permanent traffic counters use inductive loops to detect vehicles and record the traffic volumes for each hour. A single loop is required to collect traffic volume data. Two loops are required to collect speed data. Two loops and an axle sensor are required to collect vehicle classification data, and one loop with two weight sensors (piezoelectric sensors, bending plates, or load cells) are required to collect vehicle weight data.

Permanent Continuous Classification Counts

The Traffic Information Systems Section staff collects classification data based on the classification of the vehicle according to FHWA (see Figure 1). Also, AHTD has a Weigh-in-Motion (WIM) count program, which collects vehicle classification and weight data. These classification counts are collected daily and are used to produce AADT and T% as well as axle and seasonal adjustment factors.

SHORT-TERM TRAFFIC COUNTS

Short-term traffic counts are performed by the Traffic Information Systems Section staff and contractors. These counts are conducted with various portable traffic counting devices. The counts are collected using axle counters and/or vehicle counters. Portable traffic counters generally use rubber hoses that record by sensing the number of axles. These counters are small enough to be transported. They contain a power

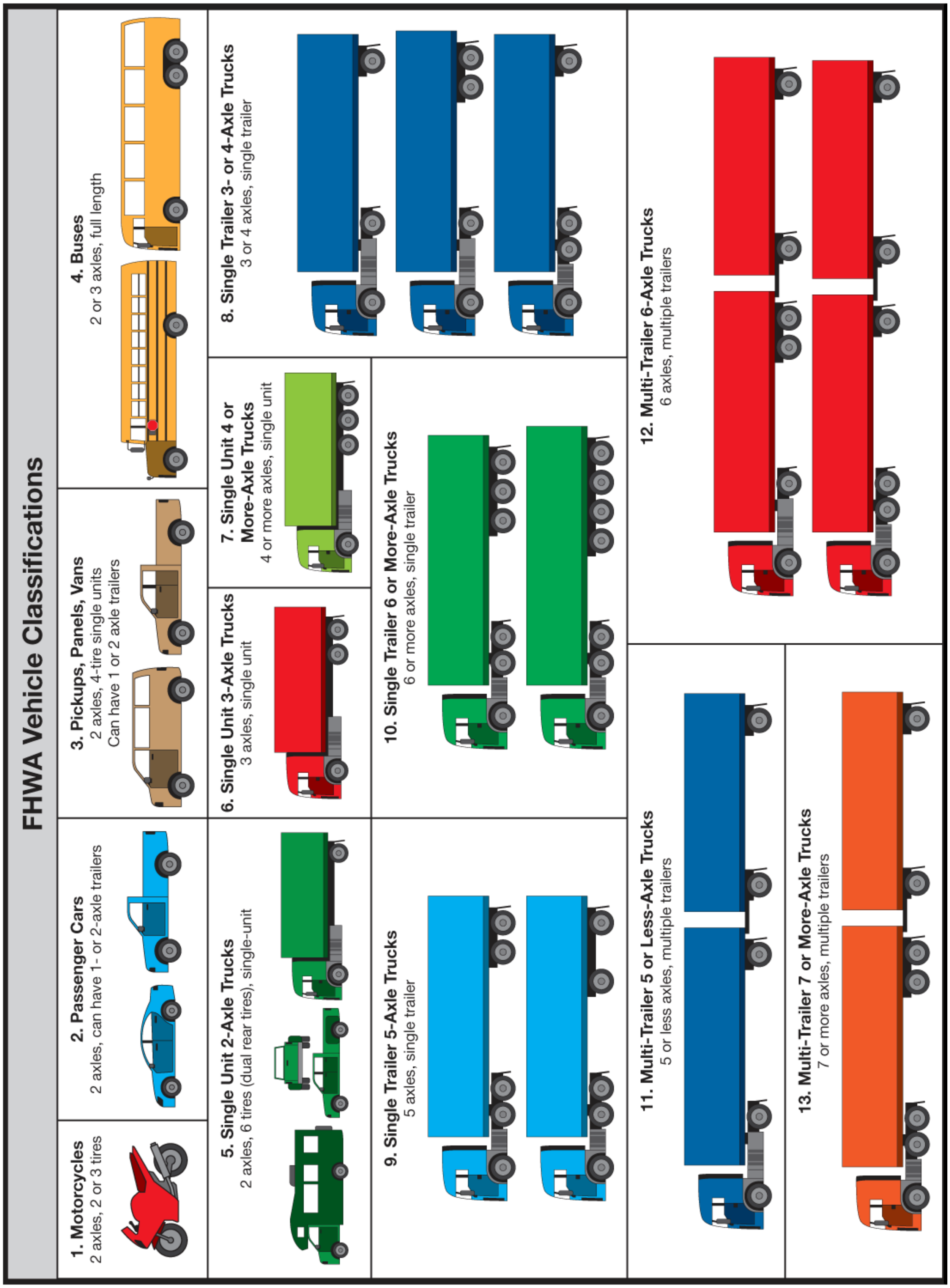

Figure 3.1:FHWA Vehicle Classification Source: TxDOT

source, and may be easily secured to a telephone pole, fence post, sign post, tree, etc. They may include time period recording or cumulative counts. Most units utilize electronic storage and require special software and/or hardware to download the collected data. The downloaded data is transferred directly to a computer or may be printed in a report format.

Portable Axle Counters

Portable Axle Counters are the simplest type of counter available. They count the number of axles that cross the location. To develop an AADT from these counts, axle and seasonal factors must be applied. See the following section for a discussion of the types of factors.

Portable Vehicle Counters

Portable Vehicle Counters are more sophisticated than axle counters. They use an Arkansas-specific algorithm to determine the number of vehicles by type that cross them. The types of vehicles are based on FHWA's Vehicle Classification (see Figure 3.1). These counts must be seasonally factored to develop them into the AADT. The following table shows the type of counts in Arkansas.

Table 3.1

Type of Counts

Count Type	Cycle	Duration
All Volume	Annual	48-Hours
All Classification	Annual	48-Hours
NHS Volume*	Annual	48-Hours
NHS Classification*	Annual	48-Hours

*NHS Volume and Classification numbers are included in the All Volume and Classification numbers.

Portable Seasonal Classification Counts

In addition to the regularly scheduled annual counts, the AHTD has numerous locations where seasonal classification counts are performed. These counts are done to keep up with seasonal traffic patterns in various parts of the state, specifically locations that have different seasonal patterns, like routes to the State's various recreational areas. These counts are performed one or more times a year (24 - 48 hours each), as deemed necessary, to capture the seasonal variation.

TRAFFIC ADJUSTMENT FACTORS

Two traffic adjustment factors are calculated by the Traffic Information Systems Section. Permanent count stations provide the necessary information to establish the adjustment factors. In the absence of any continuous counts within a county, these adjustment factors are applied to the short-term counts to develop AADT.

Seasonal Adjustment Factor

All short-term counts must be adjusted to reflect the seasonal changes in traffic volumes. Traffic Information Systems Section determines the seasonal factor using traffic data collected from permanent count locations. Traffic Information Systems Section assigns a seasonal factor to each short-term traffic count site based on functional classification of the roadway and the month in which the counts were taken. An example of a Seasonal Adjustment Factor Table is shown in Appendix B. Contact Traffic Information Systems Section for a current Seasonal Factor Table.

Axle Adjustment Factor

The Axle Adjustment Factors are determined by using the data from continuous classification count stations following the guidelines described in the *FHWA Traffic Monitoring Guide*. Axle adjustment factors are calculated for each functional classification group by the Traffic Information Systems Section. An example of an Axle Adjustment Factor Table is shown in Appendix B. Contact Traffic Information Systems Section for a current Axle Adjustment Factor Table.

ANNUAL AVERAGE DAILY TRAFFIC

The Annual Average Daily Traffic (AADT) is the estimate of typical daily traffic on a segment of road for all days of the week, Sunday through Saturday, over the period of one year. The AADT is determined by dividing the total volume of traffic on a highway segment for one year by the number of days in the year. The AADT is the best measure of the total use of a road, because it includes all traffic for an entire year. The Average Daily Traffic (ADT) is obtained by a short-term traffic count. The ADT is typically a 48-hour traffic count collected between Monday and Thursday and averaged to reflect one day. However, the ADT can be based on any short-term traffic count during a minimum 24 hour period. Seasonal and axle adjustment factors are used to convert the ADT to the AADT. When the ADT is multiplied by the seasonal and axle adjustment factors assigned to that site, it will provide a statistically accurate count for the entire year at that site known as the AADT. All of the adjusted counts are then checked to determine if a recount is needed. The checks consist of checking the percent difference from the historical trend, the 3 year average, the 90th percentile, and the previous year count. The percent differences are based on volume for each one of the four checks. If the adjusted count does not pass at least one check, a recount is needed and notification is given to either the contractor or the AHTD staff to conduct the recount. In addition to these checks, traffic for each vehicle type is also checked against the year before's data for the classification stations.

PERCENT TRUCKS

The most critical factor in pavement design is the amount of truck traffic using a roadway. This is generally expressed as the percentage of trucks as part of the AADT. The structural design is primarily dependent upon the heavy axle loads generated by commercial traffic. The estimated future truck volume is needed for calculating the 18-KIP (80-kN) ESALs for pavement design. Because there are numerous classes of trucks and different applications of truck data, various definitions of truck percentages are used. These truck definitions are all calculated as percentages.

Example

To determine traffic parameters for a short-term ADT count conducted along a section on the State Highway System, the following example shows the steps to be performed:

1. Locate a traffic count site which reasonably represents traffic for the defined section of highway and number the count site for future reference.
2. Determine the appropriate seasonal factor and axle adjustment factor.
3. The AADT for the highway section is calculated by multiplying the traffic count by the appropriate seasonal factor and the axle adjustment factor. AADT = Traffic Count X seasonal factor X axle adjustment factor.

OTHER CALCULATED FACTORS

Two other factors are calculated for the purposes of design and other traffic analyses. the “K” Factor and Directional Distribution (DD).

K- FACTOR

It is defined as “The proportion of the AADT that occurs during the peak hour” in HCM (2010). It is a factor used for design and analysis of traffic flow on highways. In conforming to HPMS field manual (2013), it is calculated by dividing the 30th highest hour volume by the AADT for ATR stations and dividing the highest volume by the highest hour volume by the AADT for the portable stations (48-hour or 24-hour).

DIRECTIONAL DISTRIBUTION

In the design of highways with more than two lanes and on two lane roads where important intersections are encountered or where additional lanes are to be provided later, knowledge of the hourly traffic for each direction of travel is essential. A multilane highway with high percentage of traffic in one direction during the peak hours may need more lanes than a highway having the same ADT but with a lower directional flow. Therefore, directional traffic is calculated. The method used by AHTD is as follows: Directional counts stations are carefully selected throughout the state. The volume for each direction is collected hourly and then the peak hour volume is used to calculate the percentage flowing in the peak direction.

CHAPTER 4

TRAFFIC FORECASTING WITHOUT TRAVEL DEMAND MODEL

PURPOSE

The purpose of this section is to suggest methods for traffic forecasting using trend analysis results, local land use plans, and other indicators of future development in the project.

INTRODUCTION

This section provides a description of the appropriate methods and gives examples for forecasting future traffic.

BACKGROUND

Traffic forecasts are normally based on historical trends. Normally a linear growth is assumed. When historical AADT data is used, a linear regression is calculated using available traffic history. Forecasters rely on different techniques depending on the available information. Ideally, 20 years of data is used to calculate traffic. Growth rates from historic traffic counts, adjusted to the AADT by application of factors, are derived and checked for reasonableness. The growth rates are then applied to a base year count and projected forward to the design year. Starting with 2011 data, yearly growth factors and 20-year growth factors were generated for each county in the State. Starting with 2012 data, growth factors were calculated statewide by functional class, statewide by Highway District, and functional class by Highway District. Contact Traffic Information Systems Section for the most recent growth rates.

TRAFFIC FORECASTING PROCEDURE FOR DESIGN

Data Assembly

The following items should be assembled, when available and applicable, in preparing a Traffic Forecast:

1. Map showing project location and other roadway location drawings of the facility

for which traffic projections are being required. Detailed location maps should be provided by the requesting AHTD Division or Section.

2. Resources for determining traffic growth trends.
3. Historical traffic count data.

Check Forecast for Reasonableness

The user should review expected land use changes in the vicinity and determine whether projected traffic growth is consistent with the projected growth of population, employment, or other variable and adjust if necessary. If, for example, a new shopping center, office park, tourist attraction, etc., is expected to be built prior to the design year, then projections based on historical traffic trends may underestimate the design year traffic. In such cases, Institute of Transportation Engineers (ITE) trip generation rates could be used to establish daily and peak hour trips for the new land uses. A logical distribution of resulting site generated trips to available roadways should be based on knowledge of local travel patterns and used to adjust the traffic forecast. Conversely, the closing of an existing traffic generator would most likely cause a reduction of the traffic forecast.

Development of Turning Movement Traffic Forecast

If the subject roadway intersection is existing, use observed daily turning movement percentages at existing intersections to convert future year link volumes to turning movement forecasts. Otherwise, logical turning movement percentages must be derived from observation of other roadways located in similar environments and/or specialized software that will calculate turning percentages utilizing the approach volumes. Note that the observed turning percentages are valid for future year forecasts only if land use and transportation network characteristics remain constant or if projected changes in those characteristics are proportional to the existing pattern. Review daily turning movements for consistency with special traffic generators, and transportation network characteristics in the vicinity. Use the ITE trip generation and logical trip distribution approach to adjust, if necessary.

The user should balance adjusted daily turning movement volumes to achieve directional symmetry. A simple way to accomplish this is to sum the opposing traffic movements and divide by two. There may be some situations when balancing the intersection may not be appropriate.

Final Review and Documentation

The user should perform final quality control review for reasonableness of projections. The assessment of reasonableness should examine traffic projections in comparison with observed traffic and historical trends, prospective roadway improvements, and land use projections. The quality control review should also include error checks to ensure that input traffic numbers have been correctly transcribed and traffic forecasting computations have been made correctly.

SUMMARY

A project's traffic forecast should reflect an evaluation of the effect of future traffic growth relative to historical trends, the addition of major development, the diversion of traffic to nearby facilities, and the impact of capacity constraints. The traffic forecast should be made using the best available resources and engineering judgment. Results should be compared to any available travel demand models where appropriate.

CHAPTER 5

TRAFFIC FORECASTING WITH TRAVEL DEMAND MODEL

PURPOSE

The purpose of this chapter is to provide guidance in the application of travel demand models and in the development of traffic projections for projects such as route specific studies, corridor studies and pavement design at AHTD.

INTRODUCTION

This chapter introduces travel demand modeling, what models are available at AHTD, and the procedure for conducting traffic forecasting with travel demand models.

TRAVEL DEMAND MODEL

Travel demand modeling provides system-level traffic forecasts used to identify transportation needs in the development of long range transportation plans. The resulting transportation plans provide a basis for the more detailed evaluation required for specific project development. A travel demand model includes elements such as roadway and transit networks, and population and employment data to calculate the expected demand for transportation facilities. These models are developed by AHTD in conjunction with the Metropolitan Planning Organizations (MPOs) to be used as a tool to prepare traffic forecasts.

There are four steps in the travel demand model process:

1. Trip Generation determines the frequency of origins or destinations of trips in each zone by trip purpose, as a function of land use and household demographics, and other socio-economic factors.
2. Trip Distribution matches origins with destinations, often using a gravity model function.
3. Mode Choice computes the proportion of trips between each origin and destination that use a particular transportation mode.
4. Trip Assignment allocates trips between an origin and destination by a particular mode to a specific route.

MODEL AVAILABILITY

AHTD has been conducting travel demand modeling at increasing levels of sophistication approximately 25 years. Transportation modeling has evolved from using a mainframe and punch cards to a PC environment using TransCAD software. Currently, TransCAD models maintained by the MPOs include NARTS (Benton and Washington Counties), which was established in 2000, and CARTS (Pulaski, Faulkner, Lonoke, and Saline Counties), which was updated in 2002. The Arkansas Statewide Travel Demand Mode (ARTDM) was accepted September, 2012. The ARTDM covers the entire state and is used in conjunction with the MPO models whenever applicable.

PROCEDURE

The process recommended for using a model to project traffic is as follows:

1. *Model Selection*

Selection of the appropriate model to be applied should be made based upon project location limits and the specific roadway. For projects which lie within an urbanized MPO, the MPO model should be used. Frequently, the statewide model will also be used to verify the results. Projects which lie outside the MPO area boundaries may be able to utilize the statewide model when its forecasting feature becomes available. If no model is available, refer to Chapter 4- Traffic Forecasting Without a Travel Demand Model.

2. *Review of Model Applicability*

Prior to using a particular model, a review of the base and forecast year projections should be made within the project study area to ensure that it is functioning properly within that study area. If the level of accuracy in the calibrated/validated base year model is determined to be unacceptable for the purposes of forecasting traffic for a project, then the model should not be used.

3. *Modify Interim and Forecast Year Network/Land Use*

In forecasting interim and design year traffic, it may be necessary to incorporate recent changes in land use and/or changes in the network that are not reflected in the approved interim and design year data sets. These changes should not be made without coordination by AHTD and the MPO, if applicable.

4. *Execute the Model Stream*

The model stream should be executed to generate the traffic forecasts required for the project. The model traffic assignments can be reviewed in two ways. The model traffic assignment can be taken from the output file generated during the running of the program, or from the network plots. The model traffic can also be visually evaluated.

5. Evaluate Model Traffic Output

The forecast model traffic must be evaluated for reasonableness. The best method of evaluation is to develop a traffic forecast based on historical trends. This trend based forecast should then be compared the forecast generated by the model. Differences in volume in excess of 10% in high volume areas or 4,000 vehicles per day in other areas should be further evaluated in an effort to explain the disparity. Valid explanations for differences between the historical trend and model forecast may include land use changes, new facilities, congested conditions or other considerations which may not be reflected in either the model or the historical trend analyses projection. All of these issues must be taken into consideration when evaluating the traffic forecasts.

6. Document the Traffic Forecast

Tabulation of the forecasts for the interim and design year with appropriate documentation of the methodology and reasonableness evaluation should be included in an individual section of the traffic report. This information should then be utilized in the development of forecast year turning movements, axle loadings and LOS (Level of Service) analyses.

SUMMARY

Models can be useful tools in developing traffic projections. However, since travel demand models are “planning” vs. “design” tools, the system-level traffic projections must be properly evaluated for reasonableness and consistency in light of current conditions and those indicated by trends analysis.

CHAPTER 6
INTERSECTION TURNING MOVEMENT COUNTS

PURPOSE

The purpose of this chapter is to provide the methodology for estimating intersection turning movements and techniques for balancing turning movements.

INTRODUCTION

Future year estimates of peak hour intersection turning movements are required for intersection design, traffic operations analyses, traffic signal warrant analyses and signal design, phasing, and timing. Various methods and procedures have been developed to estimate peak hour turning movement volumes from daily traffic volumes. Most of these methods rely heavily on existing intersection turning movement count data and professional judgment.

BACKGROUND

Generally speaking, the degree of accuracy that can be obtained from intersection balancing methods depends on the magnitude of incremental change in land use and travel patterns expected to occur between the base year and future design year conditions.

Balancing techniques are used to adjust existing counts as well as model generated counts. The assignment of future turn paths is estimated, and often the departure and arrival between intersections on the same link will require manual balancing. Existing counts need to be balanced because the turning movements occurring at some driveways may not be included in traffic counts. The driveways, which may not be counted, are often commercial strip centers, gas stations, banks, and other developments with curb cuts that influence the traffic at intersections. To account for the missing driveway information, balancing techniques are used to generate turning movement traffic volumes.

The algorithms that are used involve the application of an iterative procedure that balances future year turning movements based on existing turning movement counts, approach volumes, and turn proportions. Spreadsheets are utilized for the efficient implementation of intersection balancing methods. The following sections of this chapter present an overview of each of the primary methodology used by AHTD including the input data required.

TURNING MOVEMENT COUNT PROCEDURE

Traffic count machines are set to obtain both a 24-consecutive hour vehicle traffic count of the inbound vehicles, broken into 15 minute intervals, and a total volume count for outbound vehicles for the same time period. Counts are taken Monday through Thursday only. All pertinent land use information (e.g., businesses, major driveways, shopping centers, etc.) and a sketch showing these should be provided. Posted speed limits on all legs of the intersection should be included on the sketch also. Manual count and classification for a total of six hours using the periods 7:00 a.m. to 10:00 a.m. and 3:00 p.m. to 6:00 p.m. are provided. Traffic classifications are the four major vehicle types defined in the *Technical Services Field Manual*. An ASCII file, which includes the manual count data in one-hour intervals and which identifies the location, in a format acceptable to the AHTD, should also provided. Count duration is 24 hours.

PROJECTED TURNING MOVEMENT COUNT PROCEDURE

Projected turning movements which have no counts available are calculated by using iteration programs. Applied growth factors are developed using linear regressions of historical data and then checked to see if these growth factors are applicable to the area in question.

SUMMARY

In summary, turning movement procedures are carefully designed to provide a clear and accurate view of the intersection over the projected life of the design.

CHAPTER 7
EQUIVALENT SINGLE AXLE LOAD FORECAST

PURPOSE

This chapter provides guidelines to calculate the design Equivalent Single Axle Load (ESAL). The guidelines provide instructions in the techniques of forecasting traffic loads for use in pavement design. This chapter covers:

- Truck Forecasting Process
- ESAL Equation
- Steps for producing yearly ESALs

All references to damage units show the U.S. Customary unit (18-KIP).

BACKGROUND

While geometric design requires the total volume of traffic, structural design is primarily dependent upon the heavy axle loads generated by commercial traffic. The pavement design of new roadway construction, reconstruction, or resurfacing is based on accumulated 18-KIP (80-kN) ESALs. Truck traffic and damage factors are essential for calculating axle loads expressed as ESALs. Therefore, it is important to determine truck volume for the facility over the forecast period. Estimates are based on an analysis of historical truck traffic data.

Truck traffic data is collected by means of vehicle classification counts, which may be either part of AHTD's standard vehicle classification counting program or a special vehicle classification study, depending on the location of the project. There are currently 13 vehicle classification types ranging from motorcycles (Class 1) to seven or more axle multi-trailer trucks (Class 13). However, only vehicle classes 4 through 13 are used for the purpose of determining and forecasting ESALs and truck traffic (see Figure 1 for a list of vehicle classification types and definitions). The damage factor estimates are based on analysis of historical traffic weight data collected from WIM permanent data collection sites. The traffic data is combined with other data such as highway location, facility type, number of lanes, highway direction, T%, lane factor, and truck equivalency factor, to estimate the accumulated 18-KIP (80kN) ESALs from the opening year to the design year of the project.

ESAL forecasting is performed as requested by the Roadway Design and State Aid Divisions as well as the ten Highway Districts. Forecasting should encompass a period of 20 years from the anticipated year that the project is opened to traffic. This allows the designer to select the appropriate design period for pavement design.

PROJECTIONS

Predictions of future truck volume are based on the traffic history. Several factors can influence future truck volume such as land use changes, economic conditions and new or competing roadways. The change in traffic over time can be a straight line, an accelerating (compound) rate, or a decelerating rate. A pavement design may be part of new construction or reconstruction with the addition of lanes, where a diversion effect from other facilities may be a concern.

ACCUMULATIONS

The accumulations process calculates a series of truck volumes, corresponding to successive years, by interpolating between the base (opening) year and the design year. The 18-KIP (80-kN) ESALs to develop the design are calculated for each year, accumulated, and printed in a table.

TRAFFIC BREAKS

If a project has two or more obviously different traffic patterns within the project limits and the current volumes determined differ significantly, the project segment is broken where appropriate, and an ESAL forecast is provided for each segment of roadway.

SUMMARY

The ESAL forecast is vitally important in determining the structural number required for flexible pavement and the depth required for rigid pavement. Proper attention to input and good engineering judgment should be used when developing the ESAL forecast.

CHAPTER 8
TRAFFIC INPUTS TO MEPDG SOFTWARE

PURPOSE

The new Pavement Design Guide – Mechanistic-Empirical Pavement Design Guide (MEPDG) requires significantly more traffic inputs than the equivalent single axle load (ESAL) used for traffic characterization in previous versions of the AASHTO Guide for Pavement Design. This Chapter provides guidelines to generate these new traffic inputs for Roadway Design Division to implement Darwin-ME, the software developed under the new design guide. This Chapter covers

- Traffic Inputs for MEPDG
- Data Sources
- Tools and Procedure

BACKGROUND

Structural design is primarily dependent upon the heavy axle loads generated by commercial traffic. Currently, the pavement design of new roadway construction, reconstruction, or resurfacing is based on accumulated 18-KIP (80-kN) ESALs. As the Department transitions to new design process, the development of the new traffic inputs will be integrated into our current process.

The MEPDG developed under project NCHRP 1-37A initiative is a significant advancement in pavement design. However, it is substantially more complex than the 1993 AASHTO Design Guide and it requires more inputs from designers. The inputs spread widely from climate, traffic, material, construction, to performance and maintenance data. Traffic Information Systems Section is responsible for generating required traffic inputs for the implementation of Darwin-ME in the department.

TRAFFIC INPUTS

MEPDG requires four basic categories of traffic data for the structural pavement design. These inputs are used for estimating the magnitude, configuration and frequency of the loads that are applied throughout the pavement design life.

1. Truck traffic volume – base year information including: Two-way annual average daily truck traffic (AADTT), Percent of trucks in design direction, Number of lanes in the design direction, Percent of trucks in design lane, Vehicle (truck) operational speed.
2. Truck traffic volume adjustment factors consist of monthly adjustment, Class Distribution, Hourly Distribution, and Traffic Growth.
3. Axle load distribution factors
4. General traffic inputs: Number axles/trucks, Axle configuration, Wheel base

AXLE LOAD DISTRIBUTION FACTORS

The axle load distribution factors represent the percentage of the total axle applications within each load interval for a specific axle type (single, tandem, tridem, and quad) and vehicle class (see Figure 1). It can be determined from WIM data. Default values for load spectral determined from the Long-Term Pavement Performance (LTPP) database is provided in the MEPDG software for Level 3 (national level). Level 1 (site specific) and Level 2 (statewide/regional) data for Arkansas need to be generated in the Traffic Information Systems Section (See the following section for more information).

TOOLS AND PROCEDURE

PrepME is a MEPDG database supporting software that was developed under TRC0702. It compiles all required inputs for MEPDG software in a database. The data used in PrepME to generate the traffic inputs for MEPDG includes: Station description data, Traffic volume data (ATR format, or FHWA #3 record), Vehicle classification data (FHWA # 4 Card, or C-card), and Truck weight data (FHWA W-card). These data are obtained from the WIM stations maintained in Traffic Information Systems Section.

The traffic inputs generated from PrepME include the following files that are ready to be used in Darwin-ME.

HourlyTrafficPercentage.txt
VehicleClassDistribution.txt
MonthlyAdjustmentFactor.txt
TrafficGrowth.txt

Traffic.txt

GeneralTraffic.txt

AxlesPerTruck.txt

Single.alf

Tandem.alf

Tridem.alf

Quad.alf

SUMMAY

In order to generate appropriate traffic inputs for different projects, proper WIM station(s) that best represents the traffic characteristics of the project site should be carefully selected. LTPP recommended National default inputs should be referred to when evaluating the reasonableness of the results generated in PrepME.

CHAPTER 9

HIGHWAY PERFORMANCE MONITORING SYSTEM DATA NEEDS

INTRODUCTION

Several traffic products are developed for use by the Highway Performance Monitoring System (HPMS). These include AADTT for single and combination unit trucks, Peak Hour percent trucks for single and combination unit trucks, D-Factor, and K-Factor. These factors are developed in the Traffic Database and are exported for use in the HPMS. These products (and others that are used in their development) are described below. Please note that the data needs for HPMS are not necessarily the same type of data that are developed for other uses.

DATA ITEMS

Truck Type

Single-Unit trucks is defined as all vehicles in classes four through seven (buses through four or more axle, single-unit buses) as defined by the FHWA Vehicle Classification (see Figure 1). Combination-Unit trucks is defined as all vehicles in classes eight through thirteen (four or less axle, single-trailer trucks through seven or more axle, multi-trailer trucks) as defined by the FHWA Vehicle Classification (see Figure 1).

Peak Hour

Peak Hour is the four highest consecutive 15-minute intervals. Two different peak hour calculations are made. For ATR stations, the peak hour is determined by examining valid data for the whole year and determining the peak hour of the year. For Classification stations, the peak hour is the peak hour within the 48-hour time frame.

AADTT

AADTT is the percent of the AADT that is made up of trucks. This can be calculated for all trucks or for just single-unit or combination-unit trucks.

Peak Hour Percent Trucks

Peak Hour percent trucks is a ratio of the number of trucks (by type unit) in the peak hour of the day for all vehicles divided by the total AADT for all vehicles. This ratio is multiplied by 100 to make it a percent. An example of this is: The AADT is 100,000 for a road and it has been determined that the peak hour is 4:45 to 5:45. During this peak hour, 1,500 single unit trucks are part of the traffic stream. The Peak Hour Percent Single Unit trucks is (1500/100,000) X 100, which is equal to 1.5%. It should be noted that this calculation is for HPMS only and bears no similarity to the percent trucks in the peak hour.

K-Factor

K-Factor is the peak hour volume as a percentage of the AADT. It is calculated by dividing the 30th highest hour volume by the AADT for ATR stations and dividing the highest volume by the highest hour volume by the AADT for the portable stations (48-hour or 24-hour).

Directional Factor

Directional factor is the percent of the peak hour volume in the peak direction. It is calculated by dividing the higher peak hour directional volume by the peak hour volume. The hour used to calculate K-factor should also be used to calculate D-factor.

CHAPTER 10
TESTING AND CERTIFICATION PROCEDURES

PURPOSE

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 requires that the traffic system handbook be based on the concepts described in the *AASHTO Guidelines for Traffic Data Programs* and the *FHWA Traffic Monitoring Guide* and shall be consistent with the *HPMS Field Manual*. These requirements have been carried forward into subsequent highway laws. The policies of the AHTD Planning and Research Division regarding traffic data recorder testing and certification are modeled after these standards. These standards will govern the frequency of testing, duration of testing, and minimum precision for the various types of recorders being certified.

FREQUENCY OF TESTING

Each new traffic data recorder purchased shall be initially tested and certified prior to assigning it to field use. After the unit is placed into service it will be re-tested and certified once every three years. Any traffic data recorder which is repaired shall be tested and certified prior to returning to field service.

TRAFFIC RECORDER TEST PRECISION

Permanent traffic volume counting recorders shall be certified to count traffic volumes within ±2 % of actual count. Portable traffic counting devices/recorders shall be certified to count traffic volumes within ± 5 % of actual count. Automatic Vehicle Classification (AVC) recorders shall be properly calibrated and certified to identify 95% of all traffic. Within the traffic stream being classified, the AVC recorder shall properly classify 90% of all single unit trucks, 90% of all single tractor trailer trucks, and 90% of all multi-trailer trucks in terms of the number of axles making up the vehicles. Automatic Weight and Classification System (AWACS) recorders should be able to collect gross weights of truck with ± 10% of the actual average static gross vehicle weight. The recorder should be able to collect classification data to the standards of AVC recorder.

TRAFFIC RECORDER TEST OBJECTIVES

Cumulative traffic volume counters shall be tested with a simple axle count or manual count over a defined period of time concurrent with the recorders operation. The results of the recorder's count will be compared to the manual data to verify and certify the recorder's accuracy. Problems such as double counting, defective sensor input/air switches, and other malfunctions should be identified during this test.

TESTING AND CERTIFICATION

The testing and certification of traffic counters and recorders shall be accomplished to verify the adequacy of the counters and recorders. Thereafter each counter and recorder will be re-certified once every three years. Because of the number and time involved to certify the volume counters, a modified test procedures will be employed. The modified procedure will include manual classifications, manual volume count and machine comparisons to certify each counter.

TRAFFIC RECORDER MAINTENANCE AND RECORDS

Any needed repairs or maintenance shall be performed prior to field certification. Counters shall be returned to the manufacturer if repairs cannot be made at the Traffic Information Systems Section recorder shop or if counters are under warranty. Maintenance records for each counter or recorder must include the original date of testing and certification. Maintenance records will also contain information on counters and recorders that fail certification and dates of repair. All malfunctions, dates of repairs, and dates of recertification will be kept for each traffic counter and recorder.

PORTABLE TRAFFIC VOLUME COUNTERS

Bench testing of all portable volume counters shall be performed to assure that the air switches, electronic components, and batteries are in working order. In order to provide a baseline test for volume counters, two accurate portable traffic volume counters shall be tested and certified by a manual count and a manual classification. Manual classification will then be adjusted to an axle count. The axle count will be divided by two to create a volume count. The volume recorder count, the manual count, and the adjusted classification count will be compared to each other. If the counts vary by less than 1% the recorder will be considered certified for base line use. These base line counters shall be tested and certified annually to maintain a high level of confidence in their accuracy.

AUTOMATIC VEHICLE CLASSIFICATION RECORDERS

AVC recorders shall be tested with a manual count/classification performed over a defined period of time concurrent with the recorders operation. The results of the recorder's count/classification will be compared to the manual data to verify and certify the recorder's accuracy. Problems including defective axle classification schemes, malfunctioning input sensors and air switches, and defective electronic components should be discovered during this test.

AUTOMATIC WEIGHT AND CLASSIFICATION SYSTEM RECORDERS

AWACS recorders shall be tested by comparing static weights to comparable WIM weights. Making a manual classification concurrent with the recorders operation will check classification data from the AWACS recorder. The results of the recorder's count/classification will be compared to the manual data to verify and certify the recorder's accuracy. Speed data will be verified by using a radar gun to check the AWACS recorders accuracy. Once the AWACS traffic recorder has been tested and certified, the data should be monitored frequently to recognize any abnormalities, which may develop between periodic testing. Problems including defective axle classification schemes, malfunctioning input sensors modules and defective electronic components should be discovered during this test. Portable volume count and counter/classifier recorders shall be tested and certified under low (< 35 MPH) and high speed (> 50 MPH) as well as low (<10,000 vehicles per day (vpd)) and high volume (>10,000 vpd) conditions.

Appendix A

Turning Movement

Quality Control Statement

The Consultant will certify that they have followed the standards contained in the FHWA Traffic Monitoring Guide, the AASHTO Guideline for Traffic Data Programs, and the Highway Performance and Monitoring System Program Field Manual. These standards will govern the frequency of testing, duration of testing, and the minimum precision for various types of devices used for Turning Movement Counts (TMC). To ensure that the highest quality is reached, the Consultant will provide documentation to verify these tests, upon request by the Department.

A random number system will be utilized to determine when and where a Department employee will check a TMC site. The Department employee will check the setup of equipment to ensure that it adheres to the standards noted above. The Department employee will perform a manual count for one of the six accepted hours for performing manual counts. The manual counts from both parties during the same time period will be compared and should yield an error of less than one percent. The manual counts will also be compared to the machine counts for the same time period to determine the machine error. This error should be less than ten percent. Additionally, at least half of the total counts should yield less than five percent error. Any disputes will be handled in a timely manner, as laid out in the Contract, and appropriate action taken.

Appendix B

Note: Contact Traffic Information Systems Section for the updated versions of the following information.

Seasonal Adjustment Factors

Axle Adjustment Factors

County and Statewide Growth Factors

SEASONAL ADJUSTMENT FACTORS

Count Year 2013

The following factors combine both monthly and day-of -week adjustments. These adjustments are used to estimate average annual daily traffic (AADT) from a single raw traffic count. ATR data were used to compute these factors. These factors are used in conjunction with axle adjustment factors to adjust volume counts.

Rural Functional Classification

	Interstate* 01	Freeways Expressways 02	Principal Arterial 03	Minor Arterial 04	Major Collector 05	Minor Collector 06	Local 07
Jan	1.11	1.09	1.10	1.07	1.06	1.06	1.06
Feb	1.08	1.02	1.05	1.03	1.02	1.02	1.02
Mar	1.00	0.99	1.00	0.99	0.99	0.99	0.99
Apr	1.01	0.99	0.99	0.99	0.97	0.97	0.97
May	0.98	0.98	0.96	0.97	0.96	0.96	0.96
Jun	0.95	0.96	0.95	0.97	0.97	0.97	0.97
Jul	0.94	0.98	0.96	0.99	0.99	0.99	0.99
Aug	0.99	0.98	1.00	1.00	1.01	1.01	1.01
Sep	0.98	1.00	1.01	1.00	1.00	1.00	1.00
Oct	0.99	1.01	0.99	0.99	1.00	1.00	1.00
Nov	1.00	0.98	1.00	1.00	1.01	1.01	1.01
Dec	1.04	1.04	1.05	1.05	1.04	1.04	1.04

Urban Functional Classification

	Interstate* 01	Freeways Expressways 02	Principal Arterial 03	Minor Arterial 04	Major Collector 05	Minor Collector 06	Local 07
Jan	1.06	1.08	1.06	1.04	1.03	1.03	1.03
Feb	1.00	1.03	1.01	1.00	0.99	0.99	0.99
Mar	1.03	0.99	1.01	1.00	0.97	0.97	0.97
Apr	1.01	0.98	0.97	0.95	0.95	0.95	0.95
May	0.99	0.98	1.02	0.97	0.96	0.96	0.96
Jun	0.97	0.97	0.97	0.98	0.98	0.98	0.98
Jul	1.00	0.99	1.00	1.03	1.04	1.04	1.04
Aug	0.99	0.98	0.99	0.98	0.99	0.99	0.99
Sep	1.01	0.99	1.00	0.99	1.02	1.02	1.02
Oct	0.99	0.99	0.95	0.99	1.01	1.01	1.01
Nov	1.05	1.01	1.01	1.02	1.02	1.02	1.02
Dec	1.04	1.02	1.06	1.06	1.07	1.07	1.07

Local roads use no adjustment factors for volumes less than 500 vehicles per day. Those with volumes greater than or equal to 500 are adjusted using the factors for the next higher functional classification.
*These factors were obtained by averaging the previous three years data.

Prepared: AHTD: P&R: TS-EMB February 5, 2013

URBAN AREAS: AXLE ADJUSTMENT FACTORS
BY FUNCTIONAL CLASSIFICATION
2013 Count Year

Functional Class	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	Statewide Average
01-Interstate	0.63	0.90	0.62	0.89	--	0.84*	--	0.76	0.93	0.62	0.78
02-Other Freeways & Expressways	--	--	0.83	0.96	0.84	0.95*	0.83	--	0.90	0.87	0.88
03-Other Principal Arterials	0.94	0.94	0.93	0.97	0.96	0.98	0.93	0.96	0.95	0.95	0.95
04-Minor Arterials	0.91	0.97	0.96	0.97	0.96	0.99	0.97	0.98	0.97	0.97	0.96
05-Major Collector	0.97	0.99	0.99	0.98	0.97	0.99	0.98	0.97	0.99	0.99	0.98
06-Minor Collector	0.91	0.99	--	0.99	--	--	--	--	0.99	0.99	0.97
07-Local	0.96	0.96	0.97	0.98	--	0.99	0.95	0.96	0.97	0.99	0.96

-- Insufficient Mileage in District to Determine Factors

RURAL AREAS: AXLE ADJUSTMENT FACTORS
BY FUNCTIONAL CLASSIFICATION
2013 Count Year

Functional Class	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	Statewide Average
01-Interstate	0.59	0.87	0.61	0.74	--	0.70	0.62	0.75	--	0.61	0.69
02-Other Freeways & Expressways	0.76	--	0.74	--	0.82	0.90	--	--	--	0.82	0.80
03-Other Principal Arterials	0.85	0.82	0.82	0.87	0.85	0.92	0.84	0.89	0.89	0.83	0.85
04-Minor Arterials	0.82	0.90	0.81	0.94	0.91	0.96	0.89	0.90	0.93	0.90	0.89
05-Major Collector	0.89	0.92	0.89	0.96	0.91	0.95	0.89	0.89	0.97	0.96	0.91
06-Minor Collector	0.94	0.97	0.96	0.97	0.97	0.96	0.95	0.96	0.96	0.93	0.92
07-Local	0.96	0.93	0.95	0.99	0.96	0.98	0.98	0.92	0.92	0.92	0.93

-- Insufficient Mileage in District to Determine Factors

2012 County and Statewide Growth Factors

County Number	County Name	District	Annual Growth Factor 2011 - 2012*	20-year Average Annual Growth Factor**	20-Year Growth Factor***
1	Arkansas	02	1.045	1.02	1.178
2	Ashley	02	1.044	1.013	1.111
3	Baxter	09	1.08	1.015	1.251
4	Benton	09	1.06	1.038	1.427
5	Boone	09	1.072	1.017	1.287
6	Bradley	07	1.039	1.015	1.155
7	Calhoun	07	1.03	1.015	1.148
8	Carroll	09	1.08	1.016	1.291
9	Chicot	02	1.066	1.02	1.182
10	Clark	07	1.067	1.009	1.257
11	Clay	10	1.085	1.044	1.257
12	Cleburne	05	1.058	1.027	1.373
13	Cleveland	07	1.097	1.033	1.34
14	Columbia	07	1.103	1.01	1.199
15	Conway	08	1.065	1.015	1.257
16	Craighead	10	1.034	1.024	1.28
17	Crawford	04	1.052	1.023	1.298
18	Crittenden	01	1.046	1.018	1.174
19	Cross	01	1.071	1.013	1.177
20	Dallas	07	1.06	1.014	1.173
21	Desha	01/02	1.078	1.018	1.146
22	Drew	02	1.066	1.006	1.219
23	Faulkner	08	1.058	1.029	1.4
24	Franklin	04	1.126	1.022	1.379
25	Fulton	05	1.058	1.005	1.279
26	Garland	06	1.065	1.017	1.267
27	Grant	02	1.043	1.005	1.185
28	Greene	10	1.042	1.028	1.271
29	Hempstead	03	1.06	1.007	1.197
30	Hot Spring	06	1.062	1.014	1.253
31	Howard	03	1.065	1.008	1.151
32	Independence	05	1.074	1.015	1.276
33	Izard	05	1.05	1.029	1.284
34	Jackson	05	1.032	1.015	1.183
35	Jefferson	02	1.047	1.013	1.171
36	Johnson	08	1.104	1.011	1.348
37	Lafayette	03	1.094	0.999	1.21
38	Lawrence	10	1.064	1.016	1.239
39	Lee	01	1.058	1.019	1.132

County Number	County Name	District	Annual Growth Factor 2011 - 2012*	20-year Average Annual Growth Factor**	20-Year Growth Factor***
40	Lincoln	02	1.078	1.023	1.27
41	Little River	03	1.073	1.007	1.13
42	Logan	04	1.081	1.011	1.322
43	Lonoke	06	1.07	1.035	1.408
44	Madison	09	1.053	1.032	1.303
45	Marion	09	1.09	1.006	1.326
46	Miller	03	1.047	1.019	1.219
47	Mississippi	10	1.061	1.018	1.204
48	Monroe	01	1.034	1.018	1.137
49	Montgomery	08	1.066	1.016	1.296
50	Nevada	03	1.061	1.001	1.12
51	Newton	09	1.07	1.018	1.272
52	Ouachita	07	1.022	1.003	1.059
53	Perry	08	1.079	1.034	1.309
54	Phillips	01	1.064	1.005	1.117
55	Pike	03	1.093	1.001	1.269
56	Poinsett	10	1.089	1.005	1.241
57	Polk	04	1.053	1.025	1.235
58	Pope	08	1.078	1.015	1.268
59	Prairie	06	1.03	1.03	1.239
60	Pulaski	06	1.039	1.023	1.263
61	Randolph	10	1.061	1.026	1.241
62	Saline	06	1.048	1.032	1.366
63	Scott	04	1.068	1.009	1.2
64	Searcy	09	1.072	1.014	1.27
65	Sebastian	04	1.077	1.017	1.28
66	Sevier	03	1.066	1.001	1.268
67	Sharp	05	1.098	1.011	1.309
68	St. Francis	01	1.082	1.013	1.17
69	Stone	05	1.102	1.018	1.309
70	Union	07	1.074	1.012	1.215
71	Van Buren	08	1.099	1.016	1.389
72	Washington	04	1.069	1.03	1.411
73	White	05	1.044	1.028	1.334
74	Woodruff	01	1.029	1.036	1.126
75	Yell	08	1.094	1.022	1.3
	Statewide		1.06552	1.0174	1.248

* The annual growth factor is calculated by dividing the current year's count by the previous year's count.
** The 20-year average annual growth factor is the average of the annual growth factors for the previous 20 years.
*** The 20-year growth factor calculated by using a linear regression to determine the growth factor using the previous 20 year's counts.