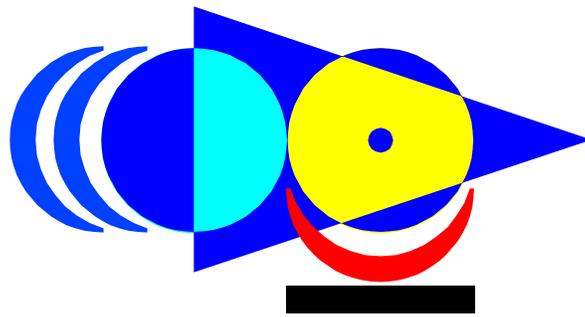


# Project Traffic Forecasting

H A N D B O O K





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## ACKNOWLEDGMENTS

This Project Traffic Forecasting Handbook offers guidelines and techniques on the Design Traffic Forecasting Process. This Handbook supplements the Project Traffic Forecasting Procedure Topic No. 525-030-120 by providing more guidance in producing the design traffic parameters AADT,  $K_{30}$ ,  $D_{30}$ , and T.

This document is a continuation of FDOT's effort to develop an improved traffic forecasting procedure. In order to determine the actual method in use throughout the Districts, and to standardize these methodologies, a statewide survey was conducted by interviewing engineers and planners who produce or use traffic forecasts. A task team was formed to draft a compilation and explanation of the standardized design traffic forecasting methodologies. The result is this Project Traffic Forecasting Handbook. It represents a consensus approach to traffic forecasting.

The major contributors include: Bob McCullough, Emmanuel Uwaibi, Fawzi Bitar, Frank Sullivan, Joey Gordon, John Crane, Lap Hoang, Mike Tako, Susan Sadighi, Bruce Dietrich, Dennis Wood, Frank Broen, Imran Ghani, Jim Baxter, John Kuhl, Louis Reis, Rafael DeAraza, and Ward Swisher. Special credit should go to Harshad Desai for helping the task team reach this consensus.





## CHAPTER ONE

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**INTRODUCTION AND OVERVIEW**

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**1.1 PURPOSE**

This handbook offers guidelines and techniques on the **Project Traffic Forecasting Process** for use by FDOT staff and consultants providing traffic parameters required by project design. This handbook may be used by local governments and other agencies to review highway projects. This handbook provides instructions for **Corridor Traffic Forecasting**, **Project Forecasting** and **Equivalent Single Axle Loading (ESAL) Forecasting**.

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**1.2 INTRODUCTION**

This handbook supplements the Project Traffic Forecasting Procedure Topic No. 525-030-120 and consists of eight chapters with three Appendices:

**Ch 1 Introduction and Overview**

This chapter describes general guidelines, definitions, and techniques to be used in the Project Traffic Forecasting Process. It also outlines the responsibilities of FDOT, the Central Office, and Districts related to the *Project Traffic Forecasting Procedure* and *Project Traffic Forecasting Handbook*.

**Ch 2 Traffic Data Sources and Factors**

Seasonal Factor, Axle Correction, and Estimates of AADT,  $K_{30}$ ,  $D_{30}$ , & T

This chapter describes the different types of traffic counters in operation, the current traffic data collection methodologies used in the State of Florida, the estimation and tabulation of Seasonal Factors (SF), axle correction factors, Annual Average Daily Traffic (AADT), Design Hour Factor ( $K_{30}$ ), Directional Design Volume Factor ( $D_{30}$ ), and Percent Trucks (T) for the current year.

**Ch 3 Project Traffic Forecasting Parameters,  $K_{30}$  &  $D_{30}$** 

This chapter explains how  $K_{30}$  and  $D_{30}$  are estimated for future years on state roads. It discusses what are acceptable value ranges of  $K_{30}$  and  $D_{30}$  by roadway type and roadway functional classification based on local and national data. Also, it provides an example estimating  $K_{30}$  and  $D_{30}$  for the design year.



#### **Ch 4 Traffic Forecasting with Travel Demand Models**

This chapter provides a description of the appropriate methods and procedures for forecasting future traffic in urban areas with a travel demand model (FSUTMS). Also, it suggests methods for using traffic assignment models, analysis of trip assignment model results, examination of local land use plans and other indicators of future development in the project traffic forecasting process.

#### **Ch 5 Traffic Forecasting without a Travel Demand Model**

This chapter provides a description of the appropriate methods of performing trend analysis and examination of local land use plans, gasoline sales, and other indicators of future growth in the project traffic forecasting process.

#### **Ch 6 Converting Model Volumes to DDHV**

This chapter describes the appropriate methods for converting model volume outputs to Average Annual Daily Traffic (AADT) volumes. This process is essential for generating Directional Design Hourly Volumes (DDHV) which are used in the evaluation of roadway link and intersection levels of service.

#### **Ch 7 Estimating Intersection Turning Movements**

The purpose of this chapter is to provide a method for balancing turning movement volumes at intersections. The TURNS5A spreadsheet is explained and reviews of other techniques developed by the Districts are summarized.

#### **Ch 8 Equivalent Single Axle Loading (ESAL) Forecast**

This chapter describes the guidelines and techniques of forecasting Equivalent Single Axle Load (ESAL) volumes for use in pavement design.

#### **Appendix A**

Observed  $K_{30}$ ,  $D_{30}$ , Peak-To-Daily and the difference between Peak-To-Daily values on selected locations in Florida for 2000 and 2001.

#### **Appendix B**

Letter from FHWA concerning use of appropriate K-Factors for traffic forecasting.

#### **Appendix C**

District Planning and Modeling Contacts.



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## 1.3 AUTHORITY

Sections 334.03 (25), 334.044 (1) (b) and (c), 334.044(2), (10), (12), (13), (15), (19), and (21), 334.046(1)(b) and (c) and (2), 334.063, 334.17, 334.24, 334.273(4), and 338.001(5), **Florida Statutes** (F.S.).

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## 1.4 REFERENCES

**A Policy on Geometric Design of Highways and Streets**, American Association of State Highway and Transportation Officials (AASHTO), 1990

**Project Traffic Forecasting Procedure**, Florida Department of Transportation, Topic No. 525-030-120, June 21, 2000.

**FSUTMS User Manual Version 5.3**, Florida Department of Transportation, Systems Planning Office, August 1998.

**Florida Annual Traffic Classification Report**, Florida Department of Transportation, Transportation Statistics Office.

**General Interest Data Collection**, Florida Department of Transportation, Transportation Statistics Office, Topic No. 525-020-305, November 9, 1994.

**Highway Capacity Manual (HCM 2000)**, Transportation Research Board.

**Manual on Uniform Traffic Studies**, Florida Department of Transportation, Traffic Engineering Office, January 2000.

**Flexible Pavement Design Manual**, Florida Department of Transportation, Pavement Management Office, Topic No. 625-010-002, March 1995.

**Portland Cement Concrete Pavement Evaluation System (COPES)**, M. L. Darter, J. M. Becker, M. B. Snyder and R. E. Smith, National Cooperative Highway Research Program Report 277, Transportation Research Board, September 1985.

**Rigid Pavement Design Manual**, Florida Department of Transportation, Pavement Management Office, Topic No. 625-010-006, September 1996.

**Traffic Forecasting for Pavement Design**, Harshad Desai, *et. al.*, Federal Highway Administration, Washington, D.C., FHWA-TS-86-225, 1988.

**Traffic Monitoring Guide**, Federal Highway Administration, December 16, 1992.

FDOT uses the latest version of each reference listed. These documents can be obtained from the Office of Maps and Publications, 488-9220 or through FDOT Infobase under CICS.



## 1.5 DEFINITIONS

Terms in this handbook are used as defined in the most recent editions of the **Highway Capacity Manual (HCM)**, **A Policy on Geometric Design of Highways and Streets (AASHTO)**, **Florida Annual Traffic Classification Report (FATCR)** and the **Project Traffic Forecasting Procedure**. Modeling terms which are used in Travel Demand Models (Chapter 4) are followed by (MODEL). The following terms are defined to reflect their meaning in this **Project Traffic Forecasting Handbook**:

**ACTION PLAN** — A document identifying low cost, short-term, and major capacity improvements necessary to bring a controlled access facility to Florida Intrastate Highway System (FIHS) standards within 20 years.

**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. (AASHTO)

**AAADT**



**ANNUAL AVERAGE 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 with weekly and monthly factors. (AASHTO)

**AAWDT**

**ANNUAL AVERAGE WEEKDAY TRAFFIC** — The estimate of typical traffic during a weekday (Monday through Friday) calculated from permanent data.

**AREA OF INFLUENCE** — The geographical transportation network of state and regionally significant roadway segments on which the proposed project would impact five percent or more of the adopted peak hour level of service maximum service volume of the roadway, and the roadway is, or is projected to be, operating below the adopted level of service standard in the future.

**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.

**ADT**

**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. (AASHTO)

**AXLE CORRECTION 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. (AASHTO)



## 1.5 DEFINITIONS — continued

**BASE COUNT** — A traffic count that has not been adjusted for axle factors (effects of trucks) or seasonal (day of the week/month of the year) effects. (AASHTO)

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

**BASE YEAR** — The initial year of the forecast period.

**BASE YEAR (MODEL)** — The year the modeling system was calibrated, from which projections are made.

**CALIBRATION (MODEL)** — An extensive analysis of a travel demand model based on census, survey, traffic count and other information.

**CAPACITY** — The maximum rate of flow at which persons or vehicles can be reasonably expected to traverse a point or uniform segment of a lane or roadway during a specified time period under prevailing roadway, traffic and control conditions; usually expressed as vehicles per hour or persons per hour. (HCM)

**CORRIDOR** — A broad geographical band that follows a general directional flow connecting major origins and destinations of trips and that may contain a number of alternate transportation alignments.

**CORRIDOR TRAFFIC FORECASTING** — The process used to determine the required number of lanes within a corridor to meet anticipated traffic demands. (see Figure 1.2)



**CORRIDOR TRAFFIC STUDY** — The long range system data forecast that includes projected link volumes and other data necessary to determine the number of lanes needed on a particular roadway and that includes the analysis of transportation alternatives for the corridor.

**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. (AASHTO)

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

**CUTLINE** — A cutline is similar to a screenline; however, it is shorter and crosses corridors rather than regional flows. Cutlines should be established to intercept travel along only one axis. (MODEL)



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## 1.5 DEFINITIONS — continued

**DTV**            **DAILY TRUCK VOLUME** — The total volume of trucks on a highway segment in a day.

**DAMAGE FACTOR** — (*see* Load Equivalency Factor).

**DEMAND VOLUME** — The traffic volume expected to desire service past a point or segment of the highway system at some future time, or the traffic currently arriving or desiring service past such a point, usually expressed as vehicles per hour. (HCM)

**DESIGN HOUR** — The 30th highest hour of the design year.

**DESIGN HOUR FACTOR** — Proportion of 24-hour volume occurring during the design hour for a given location or area. (*see also* K-FACTOR) (HCM)

**DHT**            **DESIGN HOUR TRUCK** — The percent of trucks expected to use a highway segment during the 30th highest hour of the design year. The adjusted, annual design hour percentage of trucks and buses (24T+B) divided by two. (FATCR)

**DHV**            **DESIGN HOUR VOLUME** — The traffic volume expected to use a highway segment during the 30th highest hour of the design year. The Design Hour Volume (DHV) is related to AADT by the “K” factor.

**DH2** — The adjusted, annual design hour medium truck percentage. It is the sum of the annual percentages of Categories 4 and 5 (Figure 2.2), adjusted to 24 hours, and divided by two. (FATCR)

**DH3** — The adjusted, annual design hour heavy truck percentage. It is DHT minus DH2, or the sum of the adjusted annual percentages of Categories 6 through 13 (Figure 2.2), divided by two. (FATCR)

**DESIGN PERIOD** — The number of years from the initial application of traffic until the first planned major resurfacing or overlay. (AASHTO)



## 1.5 DEFINITIONS — continued



**PROJECT TRAFFIC** — A forecast of the 30th highest hour traffic volume for the design year. Project Traffic Forecasting projections are required by FDOT for all design projects.

**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 designed.

**DRI**

**DEVELOPMENT OF REGIONAL IMPACT** — Any development which, because of its character, magnitude, or location, would have a substantial effect upon the health, safety, or welfare of citizens of more than one county. (F.S. 1993 LAND AND WATER MANAGEMENT)

**DDHV**

**DIRECTIONAL DESIGN HOUR VOLUME** — The traffic volume expected to use a highway segment during the 30th highest hour of the design year in the peak direction.

**D**

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



$D_{30}$  — The proportion of traffic in the 30th highest hour of the design year traveling in the peak direction.

$D_{100}$  — The proportion of traffic in the 100th highest hour of the design year traveling in the peak direction.  $D_{100}$  is often used in calculating the level of service for a roadway.

$D_{200}$  — The proportion of traffic in the 200th highest hour of the design year traveling in the peak direction.

$D_F$  — Directional distribution factor for  $ESAL_D$  equation. Use 1.0 if one-way traffic is counted or 0.5 for two-way. This value is not to be confused with the Directional Factor ( $D_{30}$ ) used for planning capacity computations.

**ESAL**

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



**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. (see Figure 1.4)



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## 1.5 DEFINITIONS — continued

**FACTOR** — A number that represents a ratio of one number to another number. The factors used in this handbook are K, D, T, Design Hour Factor, Peak Hour Factor and Seasonal Factor. The Load Equivalency Factor adjusts pavement damage calculations.

**FIHS**      **FLORIDA INTRASTATE HIGHWAY SYSTEM** — A highway network adopted by the Legislature that delineates an interconnected statewide system of limited access facilities and controlled access facilities to be developed and managed by FDOT to meet certain criteria and standards in a 20-year time period. The system, which will be part of the total State Highway System, will be developed and managed by FDOT for high-speed and high-volume traffic movements.

**FSUTMS**    **FLORIDA STANDARD URBAN TRANSPORTATION MODELING STRUCTURE** — The standard model for projecting traffic flow in the State of Florida.

**FTP**        **FLORIDA TRANSPORTATION PLAN** — A statewide, comprehensive transportation plan, to be annually updated, which is designed to establish long range goals to be accomplished over a 20-25 year period and to define the relationships between the long range goals and short range objectives and policies implemented through the Work Program.

**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. (HCM)

**HOV**        **HIGH OCCUPANCY VEHICLE** — Any vehicle carrying two or more passengers.

**IJR**        **INTERCHANGE JUSTIFICATION REPORT** — The documentation submitted through FDOT to FHWA to determine if a new interchange on an interstate is allowed.

**IMR**        **INTERCHANGE MODIFICATION REPORT** — The documentation submitted through FDOT to FHWA to determine if modification to an existing interchange on an interstate is allowed.



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## 1.5 DEFINITIONS — continued

**INTERMEDIATE YEAR** — Any future year in the forecast period between the base year and the design year, typically halfway between the opening year and the design year.

**k** **k-FACTOR** — An adjustment factor applied to a gravity model, based on specific, relevant social and economic conditions that affect travel patterns. A modeling term which should not be confused with the K-Factor. (MODEL)

**K** **K-FACTOR** — The proportion of Annual Average Daily Traffic (AADT) occurring in an hour.

**K<sub>30</sub>** **K<sub>30</sub>** — The proportion of Annual Average Daily Traffic (AADT) occurring during the 30th highest hour of the design year. Commonly known as the Design Hour Factor.

**K<sub>100</sub>** — The proportion of Annual Average Daily Traffic (AADT) occurring during the 100th highest hour of the design year. Commonly known as the Planning Analysis Hour Factor.

**K<sub>200</sub>** — The proportion of Annual Average Daily Traffic (AADT) occurring during the 200th highest hour of the design year.

**L<sub>f</sub>** **LANE FACTOR** — Converts directional trucks to the design lane trucks. Lane factors can be adjusted to account for unique features known to the designer such as roadways with designated lanes.

**LOS** **LEVEL OF SERVICE** — A qualitative assessment of a roadway's operating conditions or the average driver's perception of the quality of traffic flow. A LOS is represented by one of the letters A through F, A for the freest flow and F for the least free flow. Planners and engineers approximate these qualitative representations quantitatively with equations, now computer programed. Quantitative criteria for the different LOS are provided in the Highway Capacity Manual 2000 as published by the Transportation Research Board, National Research Council, Washington, D. C., and Rule 14-94 Florida Administrative Code, Level of Service Standards. (LOS MANUAL)

**LINK** — The spatial representation of the transportation system, which may or may not constitute a one-to-one correspondence to the actual major components of the transportation system being modeled. There are three primary attributes which describe a link: facility type, area type, and the number of lanes. (MODEL)

**LOAD EQUIVALENCY FACTOR** — The ratio of the number of repetitions of



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## 1.5 DEFINITIONS — continued

an 18,000 pound (80-kN) single axle load necessary to cause the same degree of pavement damage as one application of any axle load and axle number combination. A Load Equivalency Factor is commonly referred to as a damage factor.

**LGCP**      **LOCAL GOVERNMENT COMPREHENSIVE PLAN** — The plan (and amendments thereto) developed and approved by the local governmental entity pursuant to Chapter 163, F.S., and Rule Chapter 9J-5, Florida Administrative Code, and found in compliance by the Florida Department of Community Affairs.

**LONG RANGE PLAN** — A document with a 20-year planning horizon required of each Metropolitan Planning Organization (MPO) that forms the basis for the annual Transportation Improvement Program (TIP), developed pursuant to 23 United States Code 134 and 23 Code of Federal Regulations Part 450 Subpart C.

**MASTER PLAN** — A document identifying both short-term and long-term capacity improvements to limited access highways (Interstate, Turnpike and other expressways) consistent with policies and standards to meet FHHS standards. Master Plans shall also identify potential new or modifications to existing interchanges.

**MOCF**      **MODEL OUTPUT CONVERSION FACTOR** — The MOCF is used to convert the traffic volumes generated by a traffic demand model (PSWADT) to AADT. The MOCF is the average of the 13 weekly Seasonal Factors (SF) during the peak season.

**MADT**      **MONTHLY AVERAGE DAILY TRAFFIC** — The estimate of mean traffic volume for a month, calculated by the sum of Monthly Average Days of the Week (MADWs) divided by seven; or in the absence of a MADW for each day of the week, divided by the number of available MADWs during the month. (AASHTO)

**MADW**      **MONTHLY AVERAGE DAYS OF THE WEEK** — The estimate of traffic volume mean statistic for each day of the week, over the period of one month. It is calculated from edited-accepted permanent data as the sum of all traffic for each day of the week (Sunday, Monday, and so forth through the week) during a month, divided by the occurrences of that day during the month. (AASHTO)

**MSF**      **MONTHLY SEASONAL FACTOR** — A seasonal adjustment factor derived by dividing the AADT by the MADT for a specific TTMS count site.



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## 1.5 DEFINITIONS — continued

**OPENING YEAR** — One year beyond the scheduled beginning of construction as defined in the five year Adopted Work Program for a project. This is normally provided by the project manager.

**PHF**            **PEAK HOUR FACTOR** — The hourly volume during the maximum hour of the day divided by the peak 15-minute rate of flow within the peak hour; a measure of traffic demand fluctuation within the peak hour. (HCM)

**PEAK HOUR-PEAK DIRECTION** — The direction of travel (during the 60-minute peak hour) that contains the highest percentage of travel.

**PEAK SEASON** — The 13 consecutive weeks of the year with the highest traffic volume.

**PSCF**            **PEAK SEASON CONVERSION FACTOR** — Used to convert a 24-hour count representing the average weekday daily traffic to PSWADT.

**PSWADT**        **PEAK SEASON WEEKDAY AVERAGE DAILY TRAFFIC** — The average weekday traffic during the peak season. FSUTMS traffic assignment volume represents Peak Season Average Weekday Traffic (PSWADT) projections for the roads represented in the model highway network. For Project Traffic Forecasting Reports, the PSWADT should be converted to AADT using a MOCF.

**p/d**            **PEAK-TO-DAILY RATIO** — The highest hourly volume of a day divided by the daily volume.

**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. (*see* TTMS — Telemetry Traffic Monitoring Site)

**PTMS**        **PORTABLE TRAFFIC MONITORING SITE** — Automatic Traffic Recorders that are temporarily placed at specific locations throughout the state to record the distribution and variation of traffic flow.



## 1.5 DEFINITIONS — continued



**PROJECT TRAFFIC FORECASTING** — The process 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. (see Figure 1.3)

**RCI**

**ROADWAY CHARACTERISTICS INVENTORY** — A database maintained by TranStat which contains roadway and traffic characteristics data for the State Highway System, including **current year** traffic count information such as AADT and the traffic adjustment factors,  $K_{30}$ ,  $D_{30}$ , and T.

**SCREENLINE** — An imaginary line which intercepts major traffic flows through a region, usually along a physical barrier such as a river or railroad tracks, splitting the study area into parts. Traffic counts and possibly interviews are conducted along this line as a means to compare simulated model results to field results as part of the calibration/validation of a model. (MODEL)

**SF**

**SEASONAL FACTOR** — Parameters used to adjust base counts which consider travel behavior fluctuations by day of the week and month of the year. The Seasonal Factor used in Florida is determined by interpolating between the Monthly Seasonal Factors for two consecutive months. (AASHTO)

**SERVICE FLOW RATE** — The maximum hourly rate at which persons or vehicles can be reasonably expected to traverse a point or uniform section of a lane or roadway during a given time period (usually 15 minutes) under prevailing roadway traffic, and control conditions while maintaining a designated level of service, expressed as vehicles per hour or vehicles per hour per lane. (HCM)

**TARGET YEAR** — The final year of the forecast period; *i.e.*, the design year, or the future year for which roadway improvements are designed.

**T<sub>f</sub>**

**T-FACTOR** — Truck Factor; the percentage of truck traffic during the peak hours.



**T<sub>24</sub>** — The percentage of truck traffic for 24 hours (one day). T<sub>24</sub> is the same as 24T+B in the Florida Annual Traffic Classification Report.

**24T+B**

**24-HOUR TRUCK + BUS PERCENTAGE** — The adjusted, annual 24-hour percentage of trucks and buses (Categories 4 through 13 in Figure 2.2) as defined in the Florida Annual Traffic Classification Report.



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## 1.5 DEFINITIONS — continued

- 24T**            **24-HOUR TRUCK PERCENTAGE** — The adjusted, annual 24-hour percentage of trucks (Categories 5 through 13 in Figure 2.2) as defined in the Florida Annual Traffic Classification Report.
- 30HV**            **THIRTIETH HIGHEST HOUR VOLUME** — For all edit-accepted hours of data during a one-year period, the 30th highest hourly traffic volume. This volume is commonly used as a representative hour of traffic volume in roadway design. (AASHTO)
- TAZ**            **TRAFFIC ANALYSIS ZONE** — The basic unit of analysis representing the spatial aggregation for people within an urbanized area. Each TAZ may have a series of zonal characteristics associated with it which are used to explain travel flows among zones. Typical characteristics include the number of households and the number of people that work and/or live in a particular area. (MODEL)
- TRAFFIC BREAK** — A continuous section of highway that is reasonably homogenous with respect to traffic volume, vehicle classification, and general physical characteristics (e.g., number of through lanes), with beginning and ending points at major intersections. Traffic breaks are determined through engineering judgment by the Districts and are recorded in the Roadway Characteristics Inventory (RCI).
- TCI**            **TRAFFIC CLASSIFICATION INVENTORY** — A database maintained by TranStat which contains both historical and current year traffic count information including AADT and the traffic adjustment factors,  $K_{30}$ ,  $D_{30}$ , and T.
- TRAFFIC VOLUME COUNT** — Any short-term count taken by a portable axle counter on a roadway. Sometimes referred to as a raw count.
- TranStat**        **TRANSPORTATION STATISTICS OFFICE** — The FDOT Central Office in Tallahassee that monitors and reports statistical traffic information for the State Highway System.
- TTMS**            **TELEMETRY 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 TranStat Office via telephone lines.



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## 1.5 DEFINITIONS — continued

**TRUCK** — Any heavy vehicle described in FHWA Scheme F (*see* Figure 2.2), Classes 4-13; *i.e.*, buses and trucks with six or more tires. Class 14 is available for state definition of a special truck configuration not recognized by Scheme F. At the present time, only Classes 1-13 (Classes 1-3 are motorcycles, automobiles, and light trucks) are used in Florida.

**VALIDATION (MODEL)** — An analysis of a travel demand model based on traffic count and other information (but does *not* include origin/destination survey data). A validation is usually less extensive than a calibration.

**VHT**      **VEHICLE HOURS OF TRAVEL** — A statistic representing the total number of vehicles multiplied by the total number of hours that vehicles are traveling. The VHT is most commonly used to compare alternative transportation systems. In general, if alternative “A” reflects a VHT of 150,000 and alternative “B” reflects a VHT of 200,000 it can be concluded that alternative “A” is better in that drivers are getting to their destinations quicker. (MODEL)

**VMT**      **VEHICLE MILES OF TRAVEL** — A statistic representing the total number of vehicles multiplied by the total number of miles which are traversed by those vehicles. The VMT is used on a region-wide basis as a measure of effectiveness to compare system performance to other urbanized areas. (MODEL)

**V/C**      **VOLUME TO CAPACITY RATIO** — Either the ratio of demand volume to capacity or the ratio of service flow volume to capacity, depending on the particular problem situation. This is one of the six factors used to determine the level of service.

**WIM**      **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, or axle group or combination thereof, by measurement and analysis of dynamic forces applied by its tires to a measuring device. (AASHTO)

**WORK PROGRAM** — The five-year listing of all transportation projects planned for each fiscal year by FDOT, as adjusted for the legislatively approved budget for the first year of the program.



## 1.6 ACRONYMS

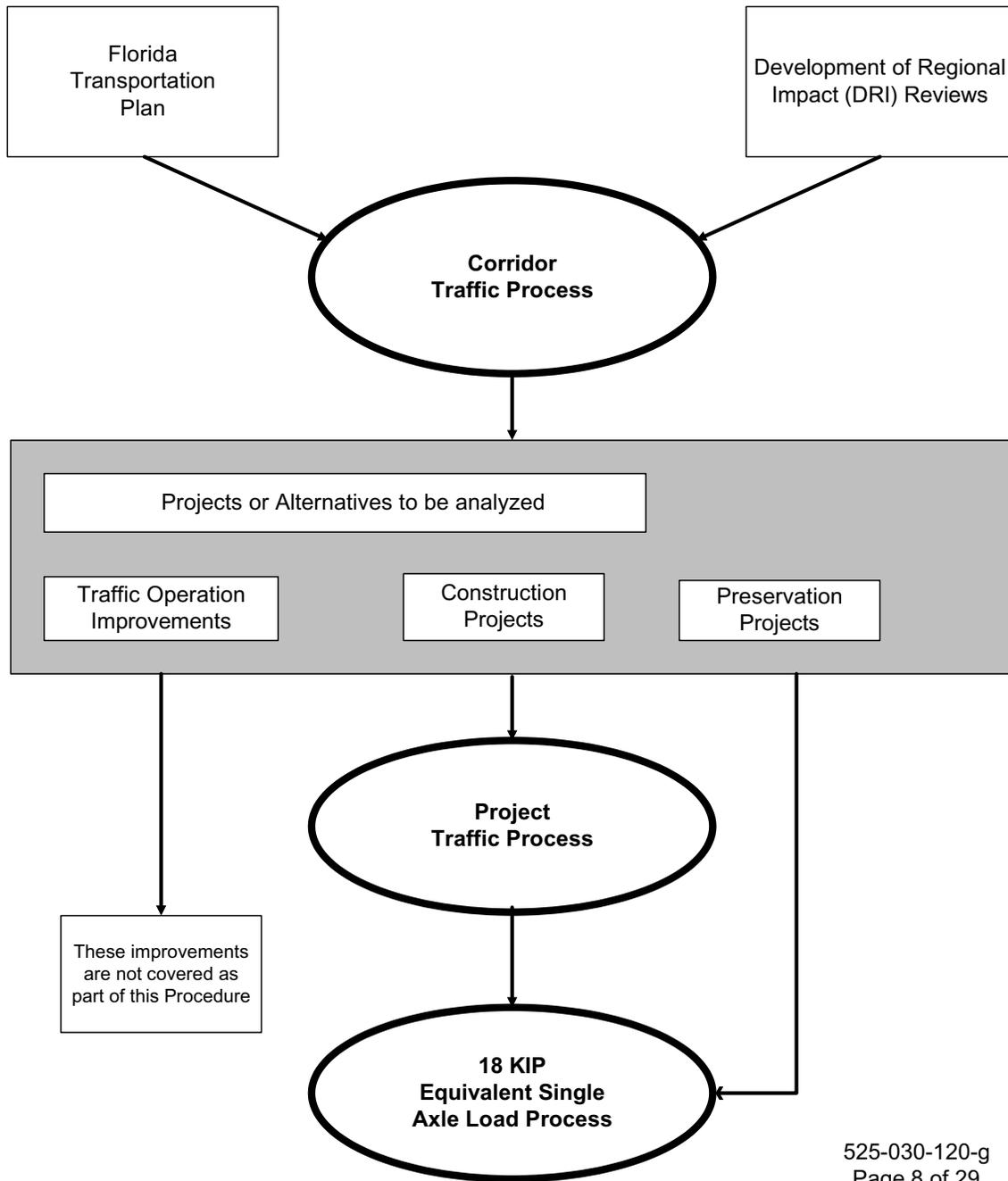
The following is a list of the acronyms used throughout this handbook:

### ACRONYM

ADT	Average Daily Traffic
AADT	Annual Average Daily Traffic
D	Directional traffic split
$D_{30}$	Proportion of traffic in the peak direction for the 30th highest hour
DHV	Design Hour Volume
DDHV	Directional Design Hour Volume
DHT	Design Hour Truck Percentage
ESAL	Equivalent Single Axle Load
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FIHS	Florida Intrastate Highway System
FM	Financial Management
FPI	Financial Project Identifier
FSUTMS	Florida Standard Urban Transportation Model Structure computer program
HCM	Highway Capacity Manual
$K_{30}$	Ratio of DHV to AADT for the 30th highest hour
$L_f$	Lane Factor
LGCP	Local Government Comprehensive Plan
LOS	Level of Service
MOCF	Model Output Conversion Factor
MPO	Metropolitan Planning Organization
PD&E	Project Development and Environment
PHF	Peak Hour Factor
PTMS	Portable Traffic Monitoring Site
PSWADT	Peak Season Weekday Average Daily Traffic
RCI	Roadway Characteristics Inventory database
SF	Seasonal Factor
T	Truck Factor
TCI	Traffic Characteristics Inventory database
TTMS	Telemetric Traffic Monitoring Site
V/C	Volume to Capacity Ratio
WPA	Work Program Administration
WPI	Work Program Item (First 6 digits of FPI)



# Traffic Forecasting Process



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Figure 1.1 Traffic Forecasting Process



## 1.7 BACKGROUND

Project Traffic Forecasting estimates are needed for Planning and Project Development and Environmental (PD&E) studies and construction plans which lead to construction, traffic improvements, and pavement design projects. FDOT's Roadway Plans Preparation Manual requires Project Traffic and its major parameters to be posted on the Typical Section sheets. This handbook supplements the information described in the Project Traffic Forecasting Procedure (Topic No. 525-030-120).

The Project Traffic Forecasting Procedure describes in detail the three forecasting processes to forecast traffic. Figure 1.1 outlines the relationship between Corridor Traffic Forecasting, Project Traffic Forecasting, and Equivalent Single Axle Load processes.

The Florida Transportation Plan (FTP) and Developments of Regional Impacts (DRIs) designate where traffic studies will be performed. Once an area has been designated, then the Corridor Traffic Forecasting Process determines the total number of lanes required for a corridor or system of roads. This system-wide information is used to select which Work Program Administration (WPA) projects or alternatives will be analyzed. The three major types of projects are Traffic Operation Improvements, Construction Projects and Preservation Projects.

Construction projects require both the Project Traffic Forecasting Process and the Equivalent Single Axle Load (ESAL) Process to be performed. Preservation Projects, which are usually resurfacing projects, only require the ESAL process to determine the appropriate Load Equivalency Factor for the pavement to be laid. Traffic Operation Improvements, such as improving shoulders or turn lanes and restriping roads, are not covered under this procedure.

Corridor Traffic Forecasting and Project Traffic Forecasting projects require forecasts of Annual Average Daily Traffic (AADT) and Design Hour Volumes (DHV). AADT and DHV are related to each other by the ratio commonly known as the K-factor.

The Association of State Highway and Transportation Officials (AASHTO) suggests, and the Federal Highway Administration (FHWA) requires, that  $K_{30}$  be used for all design hour traffic projections. The overall truck volume and AADT are related to each other by the T-factor. The total impact of truck traffic on pavement design is expressed in units of ESALs, which represent truck axle weights converted into 18,000 pound (18-KIP) loads carried by a single, four-tire axle. The metric equivalent is 80,000 newtons (80-kN).



# Corridor Traffic Forecasting Process

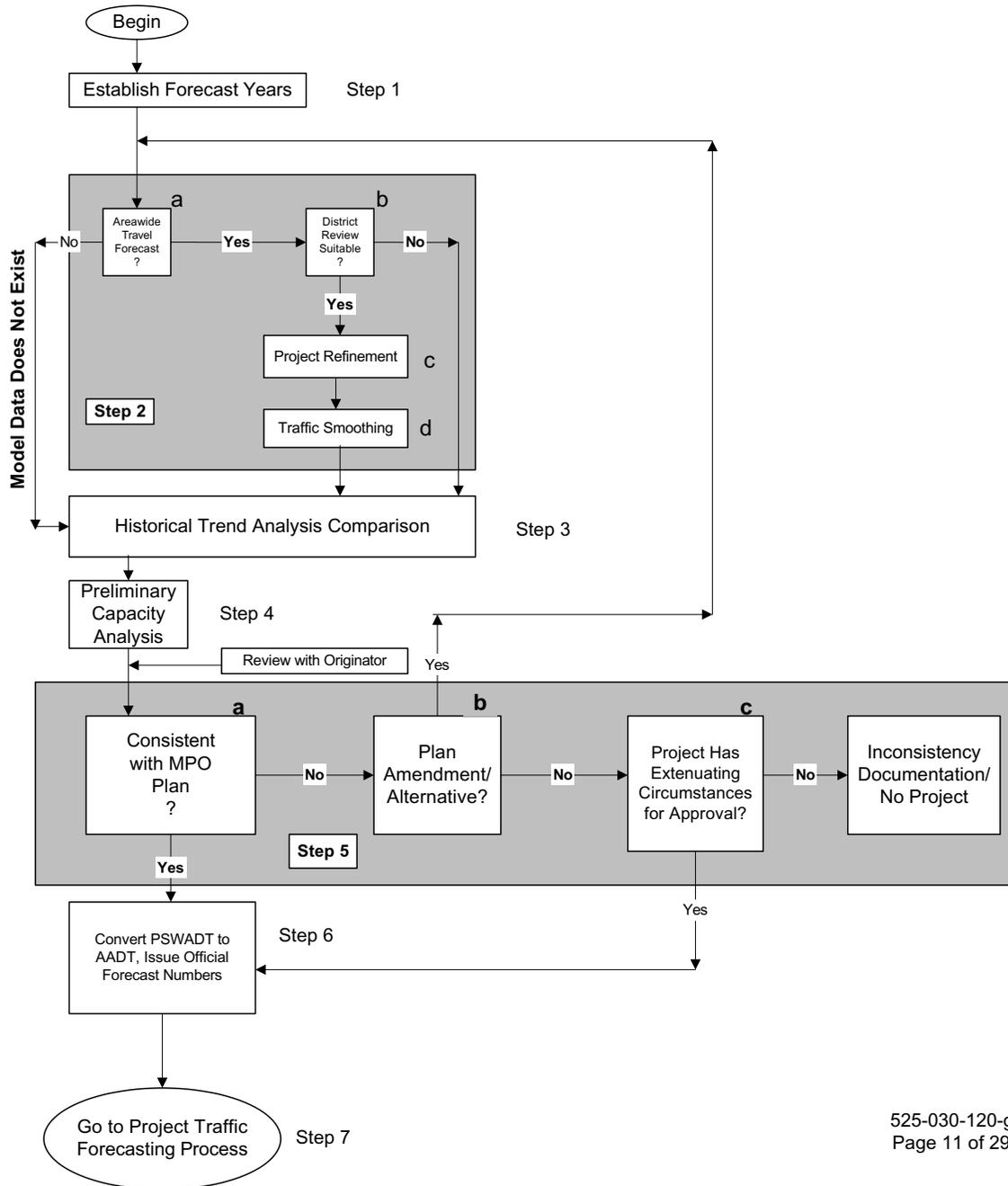


Figure 1.2 Corridor Traffic Forecasting Process



### 1.7.1 Corridor Traffic Forecasting



Corridor Traffic Forecasting is used to determine the required number of lanes within a corridor or system to meet anticipated traffic demands. Corridor Traffic Forecasting is required prior to the establishment of a new alignment or the widening of existing facilities. Corridor traffic models are usually calibrated to forecast traffic for a specific corridor and are usually more specific than the urban area or statewide models and more general than a project specific model. Models calibrated to forecast general corridor traffic for systems planning applications should be checked to ensure they have the required specificity.

Figure 1.2 illustrates the seven-step Corridor Traffic Forecasting Process. Each step described in Figure 1.2 is explained in this handbook.



# Project Design Traffic Forecasting Process

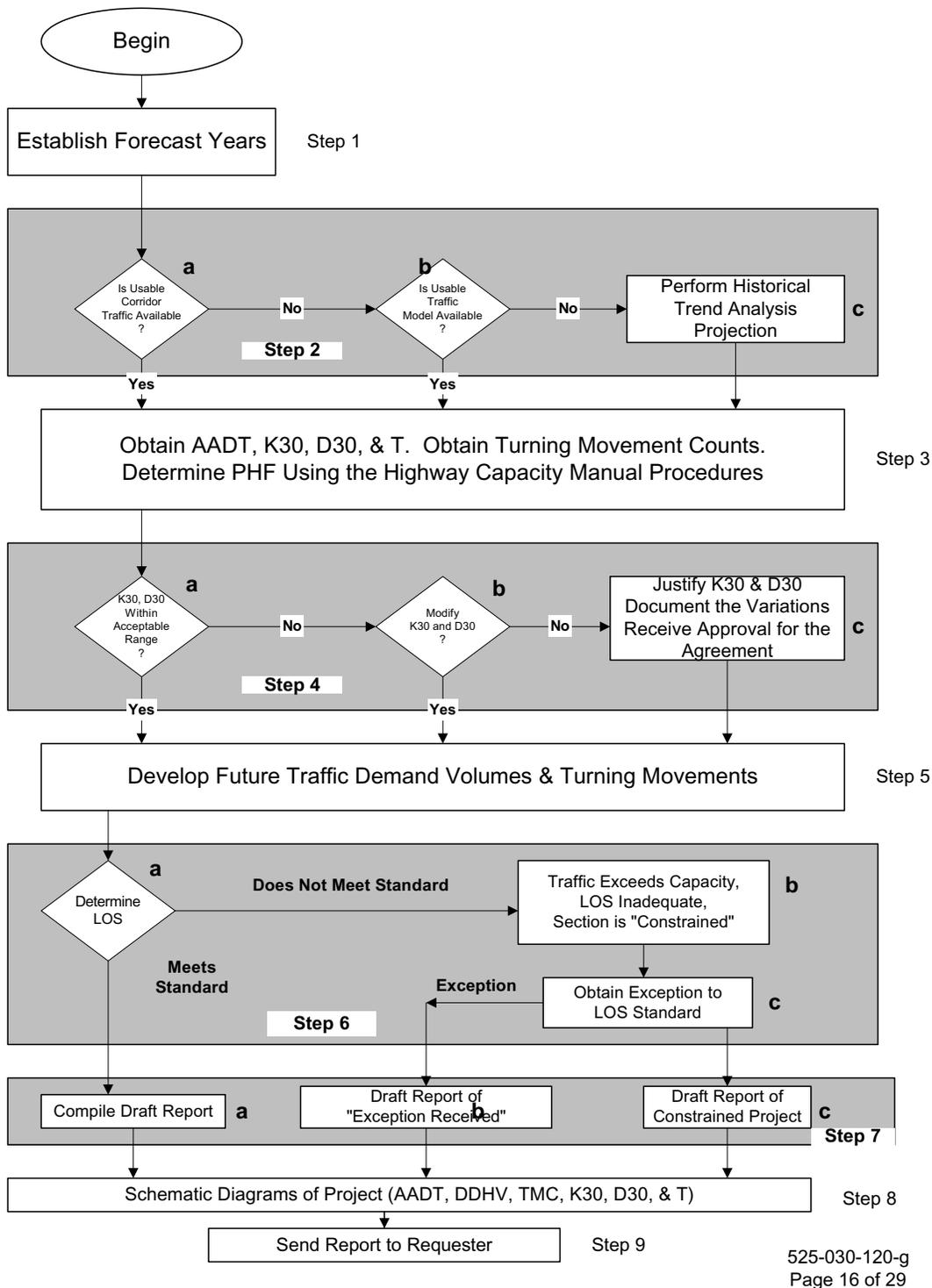


Figure 1.3 Project Traffic Forecasting Process



## 1.7.2 Project Traffic Forecasting



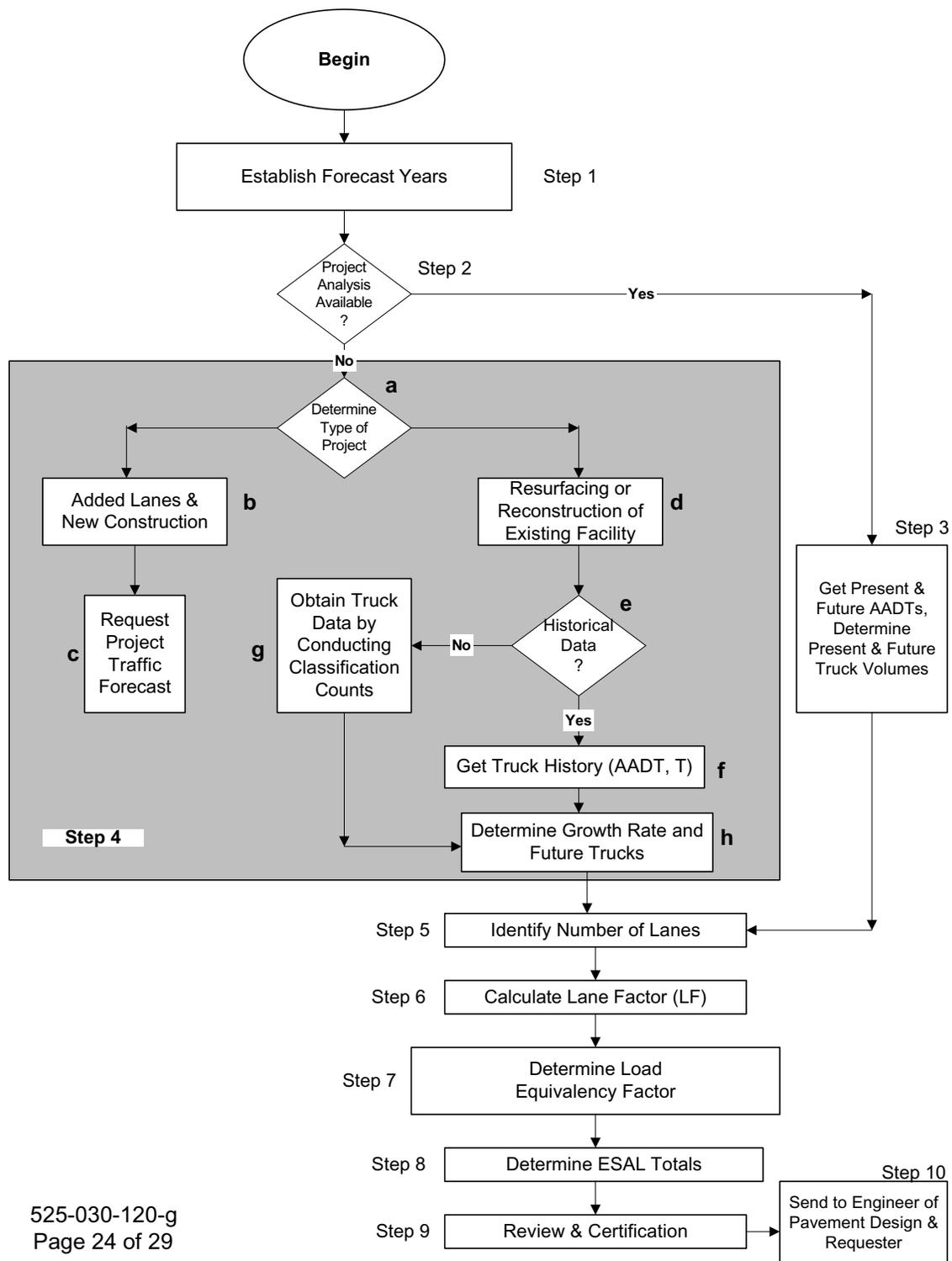
All Project Traffic Forecasting projections using the Corridor Traffic Forecasting Process will also require the more rigorous examination of the Project Traffic Forecasting Process. The Project Traffic Forecasting Process estimates traffic conditions used for determining the geometric design of a roadway and/or intersection and the number of 18-KIP ESALs that pavement will be subjected to over the design life. Project Traffic Forecasting is required for reconstruction, resurfacing, adding lanes, bridge replacement, new roadway projects, and major intersection improvements. This process differs from Corridor Traffic Forecasting in that it is site specific, covers a limited geographic area, and is more detailed.

The Project Traffic Forecasting Process consists of nine steps which are outlined in Figure 1.3. This handbook focuses on the Project Traffic Forecasting Process. Therefore, the steps shown in Figure 1.3 are explained in greater detail throughout this handbook.

Figure 1.3



# ESAL Forecasting Process



525-030-120-g  
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Figure 1.4 ESAL Forecasting Process



### 1.7.3 Equivalent Single Axle Loading (ESAL) Forecasting



The Equivalent Single Axle Loading (ESAL) Forecasting Process is necessary for pavement design for new construction, reconstruction, or resurfacing projects. The pavement design for new alignment and reconstruction projects requires a structural loading forecast using the 18-KIP (80-kN) ESAL Forecasting Process. 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 needed to calculate axle loads expressed as ESALs.

The ESAL Forecasting Process outlines nine steps to be taken to develop the expected ESALs for the life of highway projects. These steps are shown in Figure 1.4, and are covered in greater detail in Chapter 8 of this handbook.



## **1.8 QUALITY ASSURANCE REVIEWS (QARs)**

Quality Assurance Reviews are conducted by TranStat personnel in each district to monitor the process and compliance with approved FDOT policies, procedures, rules, guidelines, and standards. Quality assurance tasks and responsibilities of the districts and Central Office are assigned in Sections 1.9 and 1.10 of this chapter.

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## **1.9 GENERAL DISTRICT RESPONSIBILITIES**

The districts are responsible for fulfilling the following duties:

1. Prepare project traffic forecasting reports commonly known as Project Traffic Forecasting reports.
2. Submit copies of the written report to TranStat and other requesting office(s).
3. Have the report signed by the persons responsible for producing it. Each report should include the signatures and printed (or typed) names of the persons who made the forecast and reviewed the report. When more than one person is directly involved in making a forecast, each should certify the results. In such cases, it is permissible for the basic certification statement to be modified to reflect the work of each person; i.e., for one to certify the volume forecast and another to certify the ESAL forecast. The report reviewer's role is intended as quality control (i.e., reviewing for completeness and compliance with policies, procedures, standards, guidelines, and good professional practice). When a consultant prepares a forecast report, the consultant will sign the report as the author and a district staff person will sign as the reviewer.
4. Have the report accepted or rejected in writing by the office requesting the project traffic forecast. A report found unacceptable should be returned to the author for modification with specific comments.
5. Participate in Quality Assurance Reviews (QARs).



## 1.10 GENERAL CENTRAL OFFICE RESPONSIBILITIES

TranStat has the responsibility to fulfill the following duties:

1. Provide training and related documents for Project Traffic Forecasting to the districts.
2. Review project traffic forecast reports produced by the districts. This review is intended to serve as an advisory to the district staffs preparing such reports.
3. Conduct Quality Assurance Reviews (QARs) in accordance with the adopted plan for the Office of the State Transportation Planner. QARs will focus on the manner in which project traffic forecast reports are prepared and the written background material used in producing the forecast.

## 1.11 TRUTH IN DATA PRINCIPLE

The controlling truth-in-data principle for making project traffic forecasts is to express the sources and uncertainties of 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. For the designer of the project, this means being able to compensate for uncertainty of, for example, projections of total pavement loading by using a design reliability factor. For the producer of the traffic forecast, it means clearly stating the input assumptions and their sources, and providing the forecast in a form that the user can understand and use.

## 1.12 PRECISION OF DATA

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

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



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## CHAPTER TWO

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### TRAFFIC DATA SOURCES AND FACTORS

Seasonal Factor, Axle Correction, and Estimates of AADT,  $K_{30}$ ,  $D_{30}$ , & T

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#### 2.1 PURPOSE



Traffic data is the foundation of highway transportation planning and is used in making numerous decisions. Since accurate traffic data is a very crucial element in the transportation planning process, understanding and implementing the process accurately can lead to better design decisions. This chapter describes the following terms as they relate to the current year:

- Different types of traffic counting equipment
- Traffic data collection methods used in Florida
- Seasonal Factors
- Axle Correction Factors
- Annual Average Daily Traffic (AADT)
- Design hour factor ( $K_{30}$ )
- Directional distribution factor ( $D_{30}$ )
- Truck percentages (T)
- Estimating AADT
- Level of Service (LOS) Analysis

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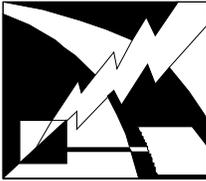
#### 2.2 BACKGROUND

The Florida Department of Transportation (FDOT) collects and stores a broad range of traffic data to assist highway engineers in maintaining and designing safe, state-of-the-art, and cost effective facilities. Traffic data is collected by the Central Office, districts, local governments, and consultants and includes volume and vehicle classification counts, speed surveys, and truck weight measurements. TranStat is responsible for collecting, processing, and storing traffic data from the permanent count locations throughout the State of Florida. The districts, using road tubes, permanent loop sensors, or other devices are responsible for collecting traffic data throughout the district, editing the data, and uploading the traffic data to the mainframe.



## 2.3 TRAFFIC ADJUSTMENT DATA SOURCES

The continuous count and classification program is designed to collect vehicular and classification traffic counts 24 hours a day throughout the year. The portable seasonal classification program is designed to collect classification counts for a short term (24 to 72 hours). The various types of traffic monitoring sites used in Florida during 2000 are presented in Figure 2.1. In 2000, FDOT collected traffic count and traffic factor information at 7,900 sites throughout Florida.



### 2.3.1 Permanent Continuous Counts

The TranStat staff collects traffic data through permanently installed traffic counters located throughout the state. These **Telemetry Traffic Monitoring Sites (TTMSs)** 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 TranStat via telephone lines. Florida's continuous count program has been expanded from the original 10 sites in 1936, to 285 sites. Presently, FDOT is working with local jurisdictions to obtain the data from their continuous counters and thus Florida will have over 300 permanent counters in operation. The permanent counters provide the user with day-to-day traffic information throughout the year. The traffic information collected will be used to produce the AADT, K, and D for each permanent counter location. The information is also used to estimate seasonal factors,  $K_{30}$ , and  $D_{30}$  for design applications.

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 two loops with a weight sensor (piezo or bending plate) are required to collect vehicle weight data.

### 2.3.2 Permanent Continuous Classification Counts

FDOT has approximately 250 permanent continuous classification counters. The TranStat staff collects classification data based on the classification of the vehicle according to FHWA Scheme F (see Figure 2.2). Also, TranStat has a Weigh-in-Motion (WIM) count program which collects vehicle classification and weight. These classification counts are collected daily and are used to produce AADT, K, D, and T. These counts are also used to calculate axle correction factors,  $K_{30}$ ,  $D_{30}$  and T for design applications.



## TRAFFIC MONITORING SITES IN FLORIDA

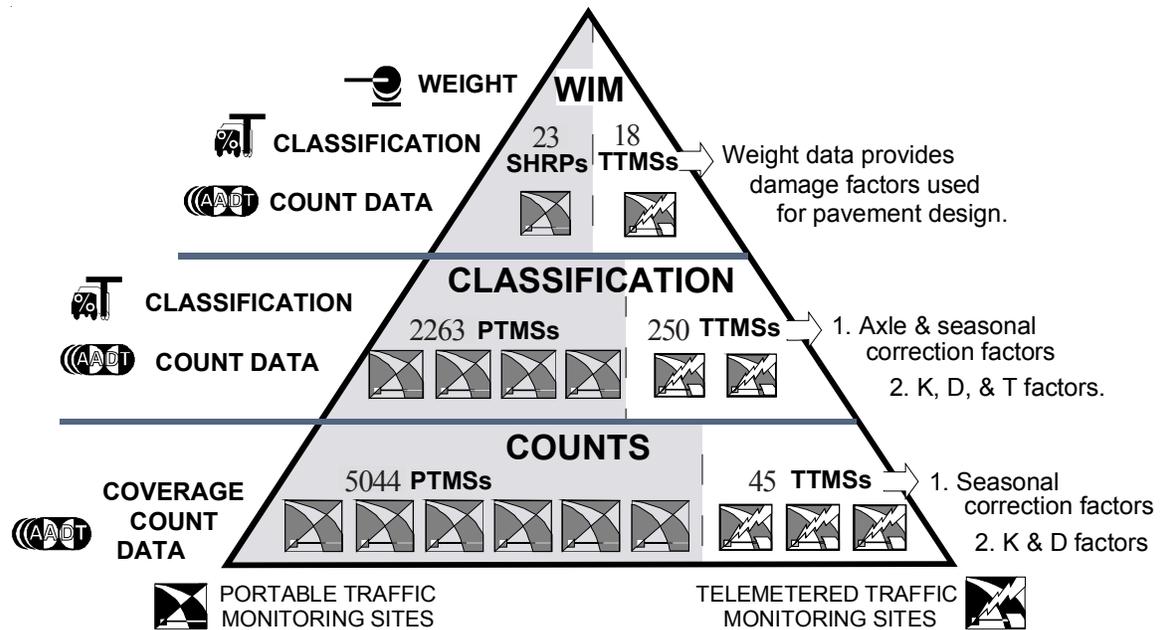
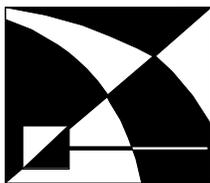


Figure 2.1 Florida's Traffic Monitoring Sites Used in 2000 to Collect Traffic Counts and Adjustment Factors

### 2.3.3 Portable Seasonal Classification Counts



FDOT has approximately 2,000 locations where portable seasonal classification counts are performed. These **Portable Traffic Monitoring Sites (PTMSs)** are automatic traffic recorders that are temporarily placed at specific locations throughout the state to record the distribution and variation of traffic flow. Seasonal classification counts are used to develop the axle correction factors and truck percentages during the year. These counts are performed one or more times a year (24 - 48 hours each) as deemed necessary to capture the seasonal truck variation. The classification counts will be used to estimate the axle correction factor and percentage of trucks.



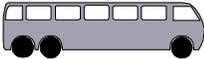
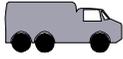
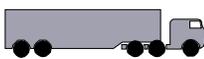
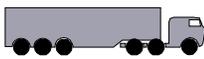
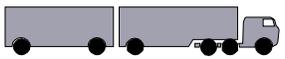
<b>FHWA CLASSIFICATION SCHEME "F"</b>			
CLASS GROUP		DESCRIPTION	NO. OF AXLES
<b>1</b>		MOTORCYCLES	2
<b>2</b>		ALL CARS	2
		CARS W/ 1-AXLE TRAILER	3
		CARS W/ 2-AXLE TRAILER	4
<b>3</b>		PICK-UPS & VANS 1 & 2 AXLE TRAILERS	2, 3, & 4
<b>4</b>		BUSES	2 & 3
<b>5</b>		2-AXLE, SINGLE UNIT	2
<b>6</b>		3-AXLE, SINGLE UNIT	3
<b>7</b>		4-AXLE, SINGLE UNIT	4
<b>8</b>		2-AXLE, TRACTOR, 1-AXLE TRAILER (2S1)	3
		2-AXLE, TRACTOR, 2-AXLE TRAILER (2S2)	4
		3-AXLE, TRACTOR, 1-AXLE TRAILER (3S1)	4
<b>9</b>		3-AXLE, TRACTOR, 2-AXLE TRAILER (3S2)	5
		3-AXLE, TRUCK, W/ 2-AXLE TRAILER	5
<b>10</b>		TRACTOR W/ SINGLE TRAILER	6 & 7
<b>11</b>		5-AXLE MULTI-TRAILER	5
<b>12</b>		6-AXLE MULTI-TRAILER	6
<b>13</b>	ANY 7 OR MORE AXLE		7 or more
<b>14</b>	NOT USED		
<b>15</b>	UNKNOWN VEHICLE TYPE		

Figure 2.2 FHWA Vehicle Classification Scheme "F"



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## 2.4 SHORT-TERM TRAFFIC COUNTS

These counts are primarily performed by the districts, local agencies and consultants. They are responsible for field counts using various portable traffic counting devices. These counts are collected using axle counters and/or vehicle counters.

Portable traffic counters frequently use rubber hoses that record by sensing the number of axles. These counters are small enough to be transported, contain a power 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. Some traffic volume counters with axle sensors record volumes on punched tape or printed paper tape. Newer units utilize electronic storage and require special software and/or hardware to download the collected data. The downloaded data can be transferred directly to a computer or may be printed in a report format. Another type of portable unit adheres to the road surface in the middle of a lane. The unit uses magnetic vehicle detectors rather than axle sensors and records bumper to bumper length and speed in a variety of length and speed groups. The unit requires a special computer to download the data.

### 2.4.1 Portable Axle Counters

If the counting device measures the “number of axles,” an axle factor is assigned to the specific count location based on the trucking characteristics of that location. The axle correction factor is applied to the count and then the count is seasonally adjusted.

### 2.4.2 Portable Vehicle Counters

If the counting device counts the “number of vehicles,” the count site will require no axle corrections.

### 2.4.3 Seasonal Adjustments

All short-term counts must be adjusted to reflect the seasonal changes in traffic volumes. TranStat determines the Seasonal Factor Category using traffic data collected from permanent count locations. The districts assign a Seasonal Factor Category to each short-term traffic count site. The basic assumption is that seasonal variability and traffic characteristics of short-term and permanent counts are similar.

The Seasonal Factors,  $K$ , and  $D$  are used to estimate the average  $K_{30}$  and  $D_{30}$  for system level analysis.



## 2.5 TRAFFIC ADJUSTMENT FACTORS

Two traffic adjustment factors are calculated by TranStat and can be accessed through the DOT Infobase under IMS from the **Roadway Characteristics Inventory (RCI)** and the **Traffic Characteristics Inventory (TCI)** databases. RCI contains only the current year information, while TCI contains both current and historical information. The continuous counts and the seasonal classification counts provide the necessary information to establish traffic adjustment factors. In the absence of any continuous counts within a county, TranStat borrows seasonal factors from adjacent counties and develops seasonal factors for those counties. These adjustment factors are later applied to the short-term counts to estimate AADT,  $K_{30}$ ,  $D_{30}$ , and T.

### 2.5.1 Seasonal Factor (SF)

The Monthly Seasonal Factor (MSF) for a particular month in a particular location is derived from the Annual Average Daily Traffic (AADT) for a location divided by the Monthly Average Daily Traffic (MADT) for a specific month at that count site:

$$\text{MSF} = \frac{\text{AADT}}{\text{MADT}}$$

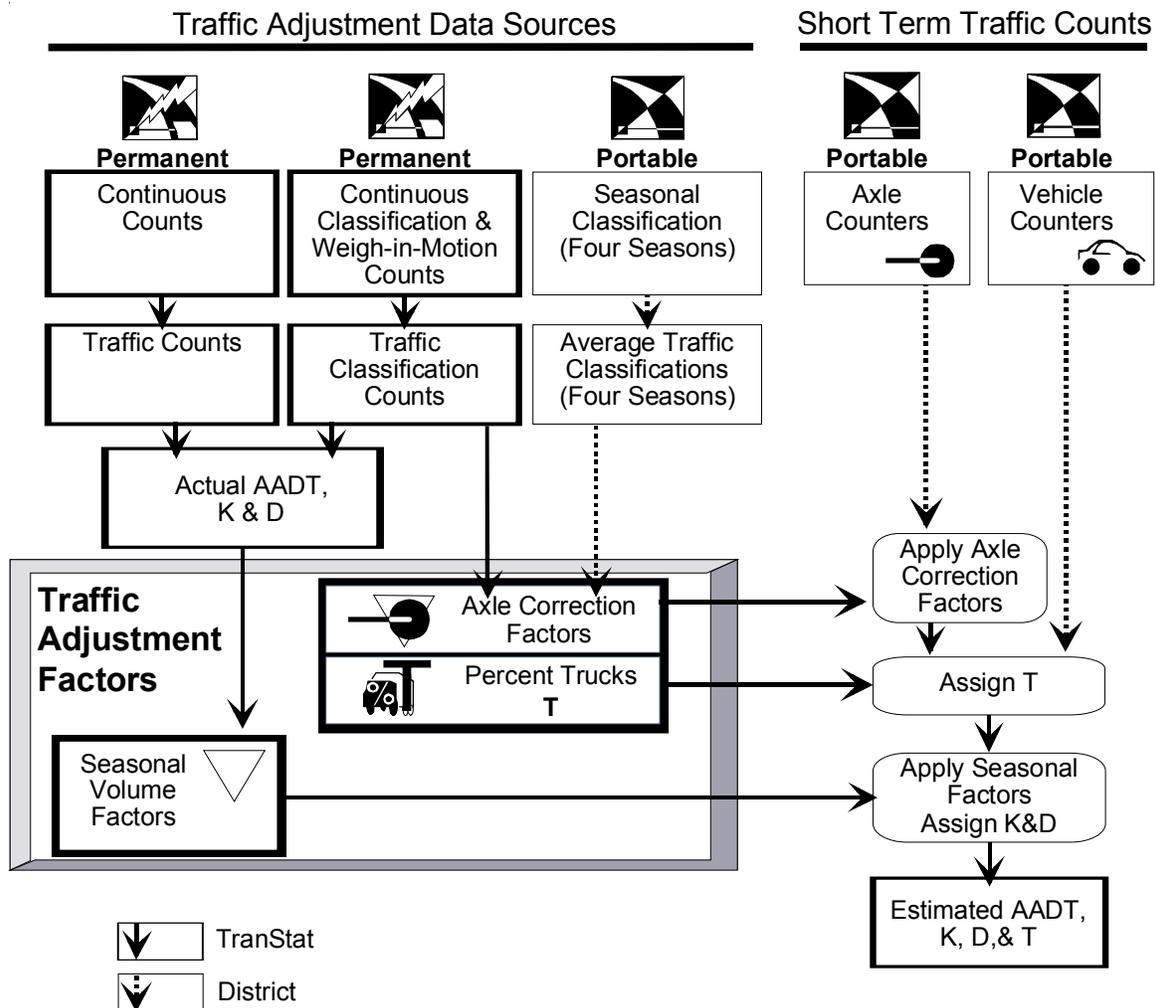
Weekly **Seasonal Factors (SF)** are developed by interpolating between the monthly factors for two consecutive months. The Seasonal Factors are calculated for each week of the year for each permanent count station and printed in a Peak Season Factor Report. Figure 6.1 shows an example of a Peak Season Factor Report showing the SF. The SF and Axle Correction Factors are used to convert ADT to AADT.

### 2.5.2 Axle Correction Factor

The Axle Correction Factors are determined by using the data from continuous classification counts and portable seasonal classification counts following the guidelines described in the *FHWA Traffic Monitoring Guidelines*.



## TRAFFIC COUNTS, SEASONAL FACTORS, AXLE CORRECTIONS, AND ESTIMATED AADT, K, D, & T



- \* Traffic Adjustment Factors are assigned to each Short Term Traffic Count for every Section Break of the State Highway System

Figure 2.3 The Process Used to Estimate AADT, K, D, & T

Actual AADT, K, D, and T data are collected from permanent, continuous counters. AADT, K, D and T are *estimated* for all other locations using portable counters. The information collected from Traffic Adjustment Data Sources is used to determine the traffic adjustment factors: Axle Correction Factors, Percent Trucks, and Seasonal Volume Factors. These adjustment factors are applied to short-term traffic counts taken by portable axle and vehicle counters to estimate AADT, K, D, and T for every section break of the State Highway System.



## 2.6 AADT, $K_{30}$ , $D_{30}$ , & T

For Project Traffic Forecasting purposes, the data collected on Florida's road system is used to measure the values identified as AADT, K, D, and T. AADT, K, and D are the three critical numbers which determine the geometric design of a road. T is the critical value for pavement design. AADT is the most important value used in traffic forecasts, because K, D, and T are factors which are related to AADT.

The Telemetry Traffic Monitoring Sites (TTMSs) collect data 365 days a year at more than 250 count stations throughout Florida. For these TTMS sites, actual AADT, K, D and T are measured. This information provides a statistical basis for estimating AADT, K, D and T for all other traffic counts where short-term traffic counts are obtained.

### 2.6.1 Annual Average Daily Traffic (AADT)



The **Annual Average Daily Traffic (AADT)** is the estimate of typical daily traffic on a road segment for all days of the week, Sunday through Saturday, over the period of one year. 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.

**Average Daily Traffic (ADT)** is obtained by a short-term traffic count. Short-term traffic counts are commonly referred to as “raw counts” or simply “traffic counts.” ADT is typically a 72-hour traffic count collected on Tuesday, Wednesday, and Thursday divided by three. However, ADT can be based on the simple average of any short-term traffic count at least 24 hours long. 24-hour and 48-hour traffic counts are often taken to measure ADT and converted to AADT for traffic forecasting projects. For traffic forecasts, the Weekly Correction Factor (SF) and Axle Correction Factor should be used to convert ADT to AADT.

$$\text{AADT} = \text{ADT} \times \text{SF} \times \text{Axle Correction Factor}$$

When the ADT is multiplied by the Seasonal Factor and Axle Correction Factor assigned to that site, it will provide a statistically accurate count for the entire year at that site known as AADT.



### 2.6.2 K and $K_{30}$

**$K_{30}$**  K is the proportion of AADT occurring in an hour. The K-Factor is critical in traffic forecasts because it defines the peak hours of road use, typically traffic going to work and coming home. Since this is when the roads will be the most used, it is appropriate to design the system to handle this level of congestion.

It is not financially feasible, however, to build for the peak hour of the year, so the 30th highest hour of the year has been chosen (*see* Section 3.3.1) as the design hour.  $K_{30}$  is the proportion of AADT occurring during the 30th highest hour of the design year. Traffic projections are expressed as AADT and Design Hour Volume (DHV). AADT and DHV are related to each other by the ratio commonly known as  $K_{30}$ , as expressed in the equation:

$$\text{DHV} = \text{AADT} \times K_{30}$$

$K_{30}$  should be measured and not artificially computed using a mathematical equation. However, it is not possible to measure  $K_{30}$  at every count site, so the information gathered by the permanent count sites is used to estimate  $K_{30}$  when short-term traffic counts are used. The basic assumption is that  $K_{30}$  is based on roadway type and land use characteristics and remains relatively constant over time (as long as the roadway type and land use characteristics stay constant). Therefore, an accurate estimate of  $K_{30}$  for the current roadway system will be a reasonable estimate of  $K_{30}$  for the design year.

### 2.6.3 D and $D_{30}$

**$D_{30}$**  The **Directional Distribution (D)** of traffic is also important in determining the LOS for a road. D is the percentage of total, two-way peak hour traffic which occurs in the peak direction.  $D_{30}$  is the proportion of traffic in the 30th highest hour of the design year traveling in the peak direction. Like  $K_{30}$ ,  $D_{30}$  is a measured value which is assumed to remain constant over time.

The **Direction Design Hourly Volumes (DDHV)** for the design year should be the basis of the geometric design. The DDHV is the product derived by multiplying the DHV and  $D_{30}$ :

$$\text{DDHV} = \text{DHV} \times D_{30}$$



### 2.6.4 Percent Trucks (T)



The most critical factor to pavement design is the percentage of trucks using a roadway. 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. Calculations use the factor **T**, the percentage of trucks for 24 hours (one day).

Because there are numerous classes of trucks (*see* Figure 2.2), and different applications of truck data, various definitions of truck percentages are used. These truck definitions are all calculated as percentages. Some truck percentage definitions include:

**T<sub>f</sub>** — The percentage of truck traffic during the peak hours.

**T<sub>24</sub>** — The percentage of truck traffic for 24-hours (one day). **T<sub>24</sub>** is the same as **24T+B** in the Florida Annual Traffic Classification Report.

**24-HOUR TRUCK + BUS PERCENTAGE (24T+B)** — The adjusted, annual 24-hour percentage of trucks and buses (Categories 4 through 13).

**24-HOUR TRUCK PERCENTAGE (24T)** — The adjusted, annual 24-hour percentage of trucks (Categories 5 through 13).

**DESIGN HOUR TRUCK (DHT)** — The percent of trucks expected to use a highway segment during the 30th highest hour of the design year. It is determined by dividing the adjusted, annual 24-hour percentage of trucks and buses (**24T+B**) by two.

**DH2** — The adjusted, annual design hour medium truck percentage. It is determined by taking the sum of the annual percentages of Categories 4 and 5 (Figure 2.2), adjusted to 24-hours, and dividing by two.

**DH3** — The adjusted, annual design hour heavy truck percentage. It is determined by subtracting **DH2** from **DHT**, or by taking the sum of the adjusted annual percentages of Categories 6 through 13 (Figure 2.2), and dividing by two.



The traffic forecasting “T” is the same as  $T_{24}$  or  $24T+B$  as defined above. It includes the trucks and buses from Categories 4 through 13. The truck volume and AADT are related to each other by a ratio commonly known as “T.” The **Daily Truck Volume (DTV)** can be derived by multiplying AADT x T.

$$DTV = AADT \times T$$

For traffic forecasting purposes, the **Design Hour Truck (DHT)** is defined as T divided by two, based on the assumption that only half as many trucks travel on the roadway during the peak hour. The DHT is derived by dividing T by two.

$$DHT = \frac{T}{2}$$

The truck percentage is usually assumed to be constant over time. More research is being performed both nationally and in Florida to determine if the current assumptions can be improved.

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## 2.7 EXAMPLE OF ESTIMATION OF AADT

As indicated previously, traffic adjustment factors on the State Highway System are calculated by TranStat based on the continuous count program. These factors are used to estimate AADT, K, D, and T, which can be accessed through the DOTNET from RCI or TCI databases. The AADT, K, D, and T for the current year are available in RCI under Feature 331.

To estimate AADTs along roadways not on the state system, a short-term traffic count must be conducted (as described earlier). For traffic counts obtained using portable axle counters, apply the axle correction factors and then apply the Seasonal Factors (SF). If the counts were obtained using portable vehicle counters, apply the appropriate seasonal factors. Assuming that the truck characteristics are similar to the axle correction category, and traffic characteristics are similar to the seasonal category, then AADT,  $K_{30}$ ,  $D_{30}$ , and T can be estimated.



**EXAMPLE**

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

Step 1. Establish logical termini for a traffic break on a state highway section.

Section	Beginning Milepost	Ending Milepost
010200	2.339	8.575

Step 2. Locate a traffic count site which reasonably represents traffic for the defined traffic section break and number the count site for future reference.

Count Site	Section	Milepost
010021	010200	4.000

Step 3. Assign a Seasonal Factor (Weekly Volume Factor) category and Axle Correction category for the site defined in Step 2.

Count Site	Section	Milepost	Volume Category	Axle Category
010021	010200	4.000	0100	0101

For the third week of January 2000 the following factors are found in the Weekly Volume Factor Category Table (Figure 2.4 below) and Weekly Axle Factor Category Table (Figure 2.5 below).

Seasonal Factor = .92

Axle Factor = .96

Week	Date	SE	WECF
1	01/01/2000 - 01/01/2000	0.96	1.12
2	01/02/2000 - 01/08/2000	0.94	1.09
* 3	01/09/2000 - 01/15/2000	0.92	1.07
* 4	01/16/2000 - 01/22/2000	0.90	1.05
* 5	01/23/2000 - 01/29/2000	0.88	1.02
* 6	01/30/2000 - 02/05/2000	0.86	1.00
* 7	02/06/2000 - 02/12/2000	0.85	0.99
* 8	02/13/2000 - 02/19/2000	0.83	0.97
* 9	02/20/2000 - 02/26/2000	0.83	0.97
* 10	02/27/2000 - 03/04/2000	0.83	0.97
* 11	03/05/2000 - 03/11/2000	0.83	0.97
* 12	03/12/2000 - 03/18/2000	0.83	0.97

EXAMPLE

Week	Date	0001 USA, CR 765-AIRPORT
1	01/01/2000 - 01/01/2000	0.96
2	01/02/2000 - 01/08/2000	0.96
3	01/09/2000 - 01/15/2000	0.96
4	01/16/2000 - 01/22/2000	0.96
5	01/23/2000 - 01/29/2000	0.96
6	01/30/2000 - 02/05/2000	0.96
7	02/06/2000 - 02/12/2000	0.96
8	02/13/2000 - 02/19/2000	0.96
9	02/20/2000 - 02/26/2000	0.96
10	02/27/2000 - 03/04/2000	0.96
11	03/05/2000 - 03/11/2000	0.96
12	03/12/2000 - 03/18/2000	0.96
13	03/19/2000 - 03/25/2000	0.96

EXAMPLE

Figure 2.4  
Weekly Volume Factor Category Report

Figure 2.5  
Weekly Axle Factor Category Report



Step 4. The AADT for the highway section is calculated by multiplying the traffic count by the appropriate Seasonal Factor and the Axle Correction Factor for the week of the year in which the count was collected.  $K_{30}$  and  $D_{30}$  are assigned as an average for a volume category and T is assigned as an average for an axle category.

$$AADT = \text{Traffic Count} \times \text{Seasonal Factor (SF)} \times \text{Axle Correction Factor}$$

*Note that the previous year's factors are applied to the current year's data.*

If the data collected at Milepost 4.000 on January 10, 2000 is 10,000 vehicles/day, applying the Seasonal Factor 0100 (.92) and Axle Correction Factor 0101 (.96) then AADT can be calculated as follows:

$$\begin{aligned} AADT &= 10,000 \times .92 \times .96 \\ AADT &= 8,832 \\ AADT &= 8,800 \text{ (after rounding)} \end{aligned}$$

Step 5. The values of  $K_{30}$  and  $D_{30}$  can be found in the Volume Factor Category Summary Report (Figure 2.6 below). T is reported in the Annual Vehicle Classification Report (Figure 2.7 below). The 2000 reports which apply to this example are shown in the figures below.

$K_{30} = 10.21$   $D_{30} = 52.20$   $T = 12.29$  are the factors found in the summary reports for this example

Print Date: May 08, 2002		Florida Department of Transportation Transportation Statistics Office																								
		2000 Volume Factor Category Summary Report																								
Category	MM	CHARLOTTE COUNTYWIDE																								
Co	Site	Dir	Et	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sun	Mon	Tue	Wed	Thu	Fri	Sat	"K"	"K30"	"D"	AADT
81	0014	E		0.93	0.84	0.83	0.93	1.03	1.09	1.09	1.03	1.18	1.01	0.95	0.95	1.23	1.01	0.99	0.94	0.94	0.89	1.08	9.62	8.98	54.74	13,800
81	0014	W		0.94	0.84	0.83	0.92	1.03	1.08	1.09	1.03	1.18	1.02	0.96	0.96	1.28	1.02	0.98	0.94	0.93	0.88	1.07				
81	0014	E		0.91	0.84	0.83	0.94	1.04	1.09	1.08	1.07	1.09	1.00	0.94	0.94	1.38	1.01	1.00	0.94	0.94	0.90	1.08				
81	0228	E		0.95	0.86	0.88	0.94	1.02	1.18	1.13	1.11	1.13	1.04	1.08	0.97	1.29	1.00	0.95	0.94	0.94	0.89	1.08	10.21	9.68	52.20	18,897
81	0228	E		0.95	0.86	0.88	0.94	1.02	1.18	1.12	1.10	1.13	1.04	1.08	0.97	1.29	0.99	0.95	0.94	0.94	0.89	1.08				
81	0228	W		0.95	0.86	0.88	0.94	1.02	1.18	1.13	1.11	1.13	1.04	1.08	0.96	1.30	1.00	0.95	0.94	0.94	0.89	1.08				

Figure 2.6 Volume Factor Category Summary Report

EXAMPLE

Print Date: May 08, 2002		Florida Department of Transportation Transportation Statistics Office	
		Annual Vehicle Classification Report	
		Count Year 2000	
County:	00- CHARLOTTE		
Site:	Co Site Mile Post	AADT	Description
0021	0010000 9.84	16,000	SR 45/US 41, SE OF CR 75/WALLGATOR CREEK CH185
Form Class:	14 - Urban Other Principal Arterial		
		Summary Daily Statistics	
		Daily	Design Hour
		24T&B = 12.29	DHF = 6.14
		24T = 11.39	
		max = 4.71	max = 2.35
		max = 7.58	max = 3.79

Figure 2.7 Annual Vehicle Classification Report

EXAMPLE



## 2.8 EXISTING TRAFFIC CONDITION INFORMATION

### 2.8.1 Seasonal Adjustments

Data for existing roads are collected at established traffic monitoring sites within the project's limit. A **classification count** should be taken at the established traffic monitoring site in each of the current traffic breaks included in the project's limits. When the traffic monitoring site for a traffic break is located outside the project's limits, the data may still be collected at the established site. As an alternative, the traffic break can be subdivided at the project boundary and a new traffic monitoring site established within the project's limits. Subdivision of a traffic break must be approved in advance by the District Statistics Administrator/Engineer.

Directions on conducting classification counts are contained in the General Interest Data Collection Procedure. Traffic counts cannot be accepted without seasonal adjustments. These adjustments are applied as described in Section 2.5 (Traffic Adjustment Factors). Acceptable data should be uploaded to the TCI for use in making the annual AADT estimate and for later use in making the project traffic forecast. Only those classification counts made during the last 12 months should be used as base year traffic data. Surveys made by other than FDOT personnel should follow FDOT's procedures.

### 2.8.2 Directional Distribution

FDOT practice requires the use of two different D-factors (directional distribution) for capacity analysis (**D**) and pavement design (**D<sub>F</sub>**). The Ds described in traffic monitoring site reports are the ones used for capacity analysis. In Florida, values for D range between 50 and 80 percent (*see* Section 3.6).

A road near the center of an urban area often has a D near 50, traffic volumes equal for both directions. A rural arterial may exhibit a significantly higher D because traffic is either traveling toward an urban area (morning) or traveling away from an urban area (evening). Section 3.3.1 explains D in more detail.

The D-factor used for pavement design (**D<sub>F</sub>**) is typically 50 percent for two-way roads or 100 percent for one-way roads. Base year directional bias in pavement loading will be used to determine the ESAL forecast **D<sub>F</sub>**. Whether a different directional bias exists for loaded trucks is found by visually monitoring the traffic using the road to identify any repeating traffic, and seeking the source or destination of the traffic. One example might be concrete delivery truck traffic whose source is a concrete mixing plant down the road. Another example would be a railroad siding serving as a destination for pulpwood trucks. In both cases, the **D<sub>F</sub>** used for ESAL forecasting and subsequent pavement damage will be between 50 and 100 percent (*see* Section 8.4.2).

Roadway environment data, such as number of lanes and functional classification, are taken from the traffic monitoring site description record and RCI.



## 2.9 LEVEL OF SERVICE (LOS) OPERATIONAL ANALYSIS

The **Level of Service (LOS)** analyses are to be performed in accordance with the most current Highway Capacity Manual (HCM) procedures and FDOT's Level of Service standards. The Highway Capacity Manual procedures for freeway Level of Service are based on the following equation (*see* Chapter 6 for practical example):

$$SF_i = MSF_i \times N \times f_w \times f_{hv} \times f_p$$

Where:

$SF_i$  = Service Flow Rate;

$MSF_i$  = maximum service flow rate for LOS  $i$  under prevailing roadway and traffic conditions for one lane in one direction, in vph;

$N$  = number of lanes in one direction of the freeway;

$f_w$  = factor to adjust for the effects of restricted lane widths and/or lateral clearances;

$f_{hv}$  = factor to adjust for the effect of heavy vehicles (trucks, buses, and recreational vehicles) in the traffic stream; and

$f_p$  = factor to adjust for the effect of driver population (tourist, student, senior citizens, etc.).

The HCM procedures are acceptable methods for LOS determination, lane call, and intersection laneage. HCM software or equivalent software approved by FDOT may also be used. There are several Lotus templates which may accurately determine LOS, and may be used if appropriately documented.

## 2.10 NUMBER OF LANES REQUIRED

Project traffic forecasts ultimately are used to determine how many lanes a corridor or project may require. Using the best available current year data, and projecting future values of DDHV,  $SF_i$ , and Peak Hour Factor (PHF), the number of lanes can be estimated.

The DDHV estimates divided by the service flow rate per lane for a required LOS and PHF, will determine the number of lanes required in the peak direction. Using the HCM methodology described in Section 2.9 above to calculate the Service Flow Rate per lane, the number of lanes can be determined by applying the following equation:

$$\text{Number of lanes} = \frac{\text{DDHV}}{(\text{Service Flow Rate per lane} \times \text{PHF})}$$



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## CHAPTER THREE

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**TRAFFIC FORECASTING PARAMETERS,  $K_{30}$  &  $D_{30}$** 

---

**3.1 PURPOSE** **$K_{30}$** 

**Annual Average Daily Traffic (AADT)** estimates are readily available from FDOT or a local traffic counting program. Traffic parameters ( $K_{30}$  and  $D_{30}$ ) are required to convert AADT into Design Hour Volume (DHV) for a design project. The parameters

 **$D_{30}$** 

which are discussed in this chapter forecast factors for *future* years. This chapter explains the following:

- $K_{30}$  and  $D_{30}$
- Establishing forecast years
- Sources of  $K_{30}$  and  $D_{30}$
- Acceptable value ranges of  $K_{30}$  and  $D_{30}$  by roadway type
- Methodology to estimate  $K_{30}$  and  $D_{30}$  for future years

---

**3.2 INTRODUCTION**

The K-factor is the ratio of the hourly two-way traffic to the two-way AADT. The **Design Hour Factor ( $K_{30}$ )** is the relationship between the 30th highest hour volume and the AADT for the design year. FHWA requires that the  $K_{30}$  be used for all traffic projections used for design projects. It is important to know that the K-factor is descriptive; *i.e.*, it represents the ratio of two numbers (as stated above).  $K_{30}$  should **not** be artificially computed by using a mathematical equation.  $K_{30}$  is used to determine the **Design Hour Volume (DHV)**.

The **Directional Distribution (D)** is the percentage of the total, two-way peak hour traffic traveling in the peak direction.  $D_{30}$  is the proportion of traffic in the 30th highest hour of the design year traveling in the peak direction. The directional distribution is an essential parameter used to determine the Directional Design Hour Volume (DDHV). The DDHV should be the basis of geometric design.

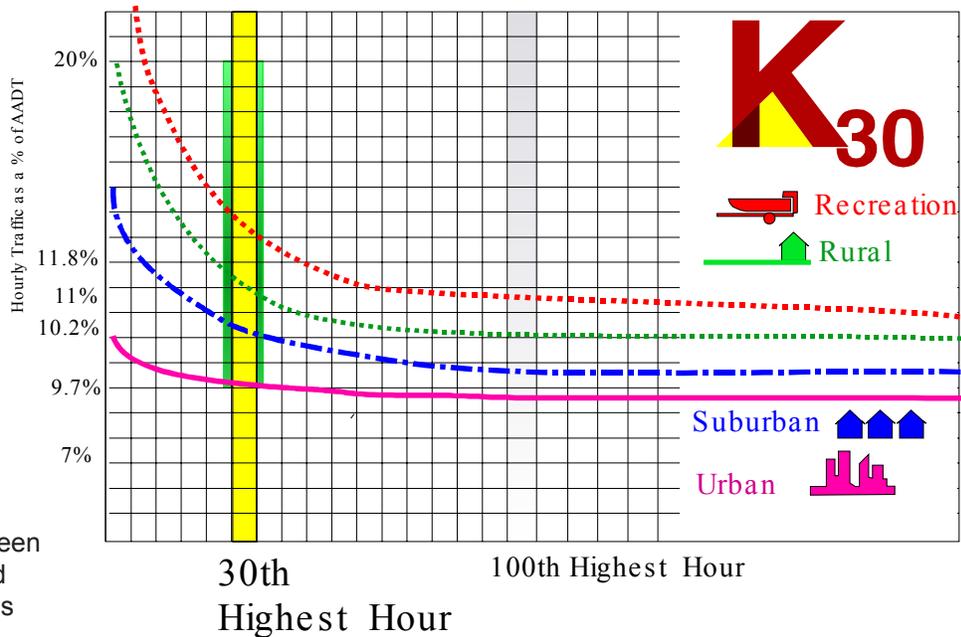


Figure 3.1  
Relation Between  
Peak-hour and  
AADT Volumes

### 3.3 DESIGN HOUR FACTOR — $K_{30}$

Capacity analysis focuses on the traffic monitored at an intersection or along a highway during a particular peak hour. The peak hour most frequently used to design roads and intersections is the 30th highest hour occurring during the design year. The amount of traffic occurring during this hour is called the **Design Hour Volume (DHV)**.  $K_{30}$  is the ratio of the DHV to the AADT. DHV is derived by multiplying the AADT by the estimated  $K_{30}$  (for the design year) based on data collected at telemetered traffic monitoring site surveys.

$$DHV = AADT \times K_{30}$$

The K-factors represent typical conditions found around the state for relatively free-flow conditions, and are considered to represent typical traffic demand on similar roads. The magnitude of the K-factor is directly related to the variability of traffic over time. Rural and recreational travel routes which are subject to occasional extreme traffic volumes generally exhibit the highest K-factors. The millions of tourists traveling on Interstate highways during a holiday are typical examples of the effect of recreational travel periods. Urban highways, with their repeating pattern of home-to-work trips, generally show less variability and, thus, have lower K-factors.



The 1985 Highway Capacity Manual notes that when the K-factor is based on the 30th highest hour of annual traffic, it has three general characteristics:

1. The K-factor generally decreases as the AADT on a highway increases.
2. The K-factor generally decreases as development density increases.
3. The highest K-factors generally occur on recreational facilities, followed by rural, suburban, and urban facilities in descending order.

Figure 3.1 shows the relation between the highest hourly volumes and AADT on arterials taken from an analysis of traffic count data covering a wide range of volumes and geographic conditions. The curves in Figure 3.1 were prepared by arranging all of the hourly volumes of one year, expressed as a percentage of AADT, in a descending order of magnitude. The curves represent the following facilities: rural, suburban, urban, and the average for all locations studied. They represent a highway with average fluctuation in traffic flow.

Analysis of these curves leads to the conclusion that the hourly traffic used in design should be the **30th highest hourly volume** of the year, abbreviated as **30 HV**. The reasonableness of 30 HV as a design control is indicated by the change that results from choosing a somewhat higher or lower volume. The curves in Figure 3.1 steepen quickly to the left of the 30th highest hour, indicating much higher volumes for only a few hours. The curves flatten to the right, indicating many hours in which the volume approaches 30 HV. The decision to use 30 HV is also based on the economics of roadway construction. State officials adopted the use of AASHTO guidelines, so that the roadway will experience a limited number of hours of congestion per year. The excessive expense of building a roadway to handle the first highest hour of the year would typically be prohibitive.

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### 3.4 DIRECTIONAL DISTRIBUTION — $D_{30}$

A highway with a high percentage of traffic in one direction during the peak hours may require more lanes than a highway having the same AADT but with a lower percentage. This percentage of traffic in one direction is referred to as **Directional Distribution (D)**.

During any particular hour, traffic volume may be greater in one direction than the other. An urban route, serving strong directional demands into the city in the morning and out of it at night, may display as much as a 2:1 imbalance in directional flows. Figure 3.2 illustrates the directional distribution on a highway in Florida (Site 0207, September 14, 1994).

Directional distribution is an important factor in highway capacity analysis. This is particularly true for two-lane rural highways. Capacity and LOS vary substantially based on directional distribution because of the interactive nature of directional flows on such facilities. Queuing, slowness of traffic, land use impact and capacity are some of the considerations which affect the directional distribution.

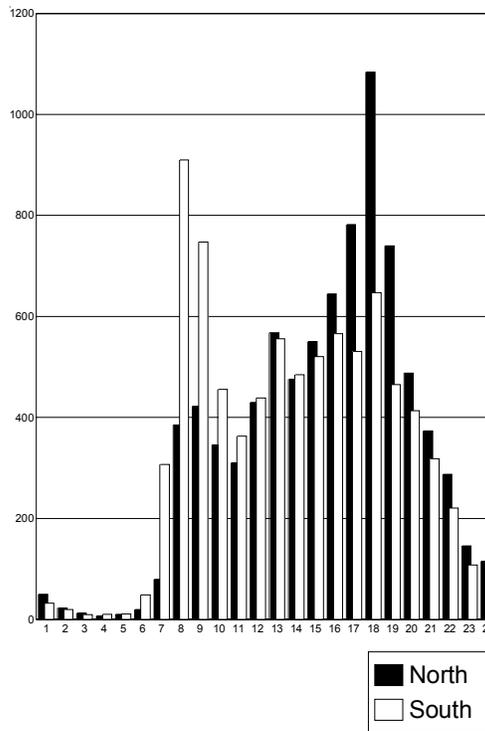


Figure 3.2  
Directional Distribution  
Peak-hour Volumes

Although there is no explicit consideration of directional distribution in the analysis of multilane facilities, the distribution has a dramatic impact on both design and LOS. As indicated in Figure 3.2, urban radial routes have been observed to have up to two-thirds of their peak hour traffic in a single direction. Unfortunately, this peak occurs in one direction during the morning and in the other in the evening. Thus both directions of the facility must be adequate for the peak directional flow. This characteristic has led to the use of reversible lanes on some urban freeways and arterials.

The directional distribution is an essential traffic parameter used to determine the **Directional Design Hour Volumes (DDHV)** for the design year and should be the basis of the geometric design. The DDHV is the product obtained by multiplying the DHV and the Directional Traffic Split ( $D_{30}$ ):

$$DDHV = DHV \times D_{30}$$

TranStat is responsible for calculating and estimating the  $K_{30}$  and  $D_{30}$  factor tables which will be used for project traffic forecasting. These tables will include a range of factors of  $K_{30}$  and  $D_{30}$  for each statistically recognizable set of road and traffic conditions. The  $K_{30}$ -factor table is derived using the permanent traffic counters located throughout the State of Florida. The  $D_{30}$ -factor table is derived using the permanent traffic counters located throughout the State of Florida and short-term traffic counts obtained using portable traffic counters. These data are reported in the 200th Highest Hour Traffic Count Report shown in Figures 3.5 and 3.6.



### 3.5 DEMAND VOLUME

The term **demand volume** means the traffic volume expected to desire service past a point or a segment of the highway system at some future time, or the traffic currently arriving or desiring service past such a point, usually expressed as vehicles per hour. When demand exceeds capacity, the peak hour factor will approach 1.0 due to delayed traffic. If this situation of delayed traffic occurs, the observed condition is considered to be a constrained condition.

True demand cannot be directly measured on congested roads, and traffic surveys cannot be used to measure traffic demand during peak traffic hours. Under this situation, demand  $D_{30}$  is estimated based on FDOT's 200th Highest Hour Traffic Count Reports using the traffic data for unconstrained sites with similar roadway and geographic characteristics. The term "demand traffic" is used to distinguish the resulting DHV projections from those which may be constrained by capacity limitations.

### 3.6 ESTABLISHING FORECAST YEARS

The following guidelines should be followed to develop opening and design year traffic forecasts.

Project Type	Design Period	Opening Year	Design Year
Roadway Construction	20 years	WP* + 1 year	OY + 20 years
Resurfacing	20 years	WP + 1 year	OY + 20 years**

\* WP = 1st year of construction in FDOT Adopted Work Program; OY = Opening Year

\*\* Refer to FDOT Pavement Design Manual for detailed information. Consult the project manager if there is a conflict with requested years.

The base year is the first year of the forecast period. For an existing road, the base year is the year in which the forecast is made. For a proposed road, the base year is generally the first year in which the road will be open to traffic. The base year of a new road may be other than the opening year, to match the applicable traffic assignment model, if necessary.

*For example:*

If a new road is expected to open in 2004 and the travel demand forecasting model is validated to produce 2002 traffic volumes, the base year could be set at 2002. The forecast period would have to be adjusted accordingly to reach the target year.



### 3.7 SOURCES OF $K_{30}$ AND $D_{30}$

The  $K_{30}$  and  $D_{30}$  for each segment of highway were estimated according to methodology described in Chapter 2. This methodology uses information from the following four sources. Refer to Section 2.6 for a detailed description about how  $K_{30}$  and  $D_{30}$  can be estimated by using data collected from the telemetry sites. The Traffic Classification Report and 200th Highest Hour Traffic Count Report are available from the annual Florida Traffic Information CD-ROM.

#### 3.7.1 Roadway Characteristics Inventory (RCI)

RCI is a database maintained by TranStat which contains roadway and traffic characteristics data for the State Highway System. **Current year** traffic count information such as AADT and the traffic adjustment factors,  $K_{30}$ ,  $D_{30}$ , and T is available. (see Section 8.5 for example)

#### 3.7.2 Traffic Classification Inventory (TCI)

TCI is a database maintained by TranStat which contains both historical and current year traffic count information including AADT and the traffic adjustment factors,  $K_{30}$ ,  $D_{30}$ , and T.

#### 3.7.3 Annual Vehicle Classification Report

The Annual Vehicle Classification Report is a data summary of Florida's efforts to classify the highway vehicle traffic at all classification sites (permanent and portable) for the past calendar year. Each station's location is selected for the specific contribution it can make to its district and to the statewide TCI. The locations of these stations are shown on county maps (see Figure 3.3). This report can be found in the Florida Traffic Information CD-ROM.

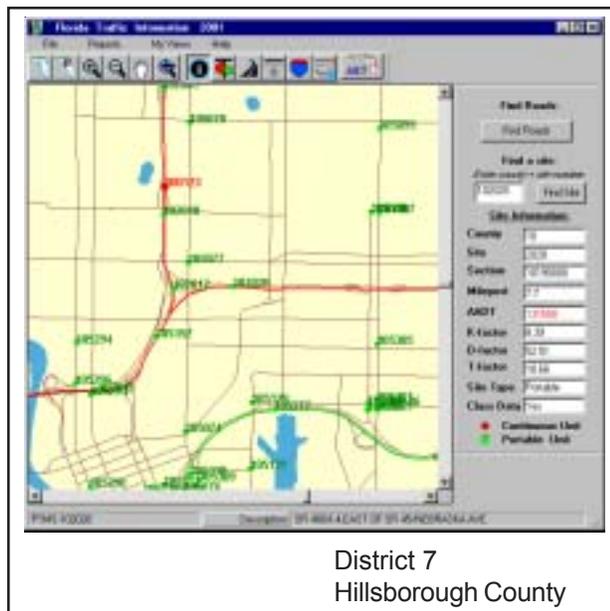


Figure 3.3  
Map From Florida Traffic  
Information CD

District 7  
Hillsborough County



Print Date: June 06, 2002		Florida Department of Transportation Transportation Statistics Office Annual Vehicle Classification Report Count Year 2001		
County: 10 - HILLSBOROUGH				
Site:	Co Sec Sub:	MilePost:	AADT:	Description:
2028	10190000	7.70	131,500	SR. 4004-4.EAST OF SR. 45(NEBRASKA AVE
Func. Class: 11 - Urban Principal Arterial -- Interstate				
Survey Type: P	PORTABLE		Duration(In Days):	2
			Annual Average Daily Volume	Percentage
Class	01	MOTORCYCLES	342	0
Class	02	CARS	93,667	71
Class	03	PICK-UPS AND VANS	21,947	17
Class	04	BUSES	2,065	2
Class	05	2-AXLE, SINGLE UNIT TRUCKS	6,720	5
Class	06	3-AXLE, SINGLE UNIT TRUCKS	776	1
Class	07	4-AXLE, SINGLE UNIT TRUCKS	171	0
Class	08	2-AXL TRCTR W/1 OR 2-AXL TRLR, 3-AXL TRCTR W/1-AXL T	2,867	2
Class	09	3-AXLE TRACTOR W/2-AXLE TRLR	736	1
Class	10	3-AXLE TRACTOR W/3-AXLE TRLR	421	0
Class	11	5-AXLE MULTI-TRLR	79	0
Class	12	6-AXLE MULTI-TRLR	0	0
Class	13	ANY 7 OR MORE AXLE	171	0
Class	14	NOT USED	0	0
Class	15	OTHER	1,525	1
			131,500	100

<b>Summary Daily Statistics</b>			
	<b>Daily</b>		<b>Design Hour</b>
24T&B	= 10.66	DHT	= 5.33
24T	= 9.09		
24H	= 3.97	DH3	= 1.99
24M	= 6.69	DH2	= 3.34

Classes: Passenger Vehicles 01-03, Truck and Buses 04-13, Trucks 05-13, Medium Trucks 04-05, Heavy Trucks 06-13  
\* The Totals for Volume and Percentage are rounded.

Page: 1

Figure 3.4 shows the distribution of 15 categories of vehicles at each station from the report. Each vehicle is classified according to one of the 15 FHWA categories (see Figure 2.2), including the Not Used or Other categories. The total number of vehicles for all surveys at each station is totaled by vehicle class. The total number of vehicles by class is divided by the combined total volume to generate the percentages of vehicles in each class.

Figure 3.4  
Example of Site 102028 from the Traffic Classification Report

**EXAMPLE**

### 3.7.4 200 Highest Hour Report

This annual report gives traffic count information on the highest 200 hours at all of the TTMSs where sufficient data are available during the past calendar year. Figures 3.5 and 3.6 show an example for Site 102028 in Hillsborough County. These sites are located throughout Florida, primarily on the State Highway System. The information in this report includes the location, AADT, hourly counts covering the 200 highest hours by direction, the D-factor, and the K-factor for each site. The low count and high count columns provide the directional volumes for the hour shown. The sum of these is tabulated as a total count for the hour. The date, day, and hour when that volume occurred are also reported.

The listed information provides the basis for determining the DHV and directional split. The DHV is based on the 30th highest hour. The normally reported K and D factors are derived for the 30th highest hour. However, to provide data for the evaluation of annual traffic flow patterns, the K and D factors have been calculated for each of the 200 hours at every site. The Design D factor is the average directional split of the 28th through 32nd hours.



Print Date: May 09, 2002

Florida Department of Transportation

Transportation Statistics Office

200 Highest Hour Report

Count Year 2000

County:	75								<b>Valid Data</b>
Site:	0130								Hours 6,000
Description:	I-40.8 MI SOUTH OF SR-482 (TTMS)								Days 250
Location:	75280000	Milepost:	7.50						Weeks 47
AADT:	143,280								Months 12

Position	Counts					Collection			"D" Factor	"K" Factor
	Total Count	Low Dir	Low Count	High Dir	High Count	Day	Date	Hour		
1	10,537	W	5,248	E	5,289	Fri	10/20/2000	18	50.19	7.35
2	10,335	W	5,116	E	5,219	Thu	10/19/2000	18	50.50	7.21
3	10,287	W	5,134	E	5,153	Thu	05/25/2000	18	50.09	7.18
4	10,275	W	5,086	E	5,189	Thu	06/22/2000	16	50.50	7.17
5	10,255	W	4,865	E	5,390	Thu	11/09/2000	18	52.56	7.16
6	10,219	E	4,982	W	5,237	Fri	07/28/2000	16	51.25	7.13
7	10,181	E	4,878	W	5,303	Fri	06/09/2000	16	52.09	7.11
8	10,169	E	4,993	W	5,176	Fri	11/17/2000	16	50.90	7.10
9	10,165	E	4,847	W	5,318	Fri	08/04/2000	16	52.32	7.09
10	10,136	E	4,986	W	5,150	Fri	05/19/2000	16	50.81	7.07
11	10,123	W	5,037	E	5,086	Fri	11/03/2000	18	50.24	7.07
12	10,111	E	4,842	W	5,269	Fri	06/02/2000	16	52.11	7.06
13	10,071	E	4,820	W	5,251	Thu	05/25/2000	17	52.14	7.03
14	10,062	W	5,004	E	5,058	Thu	02/10/2000	18	50.27	7.02
15	10,062	W	4,759	E	5,303	Tue	11/07/2000	18	52.70	7.02
16	10,044	E	4,893	W	5,151	Fri	10/27/2000	16	51.28	7.01
17	10,043	W	4,727	E	5,316	Thu	11/02/2000	18	52.93	7.01
18	10,028	E	4,932	W	5,096	Fri	05/12/2000	16	50.82	7.00
19	10,027	W	4,984	E	5,043	Thu	07/20/2000	16	50.29	7.00
20	10,025	W	4,866	E	5,159	Fri	05/19/2000	18	51.46	7.00
21	10,023	W	4,885	E	5,138	Fri	08/18/2000	18	51.26	7.00
22	10,022	W	4,688	E	5,334	Thu	06/15/2000	18	53.22	6.99
23	10,020	E	4,931	W	5,089	Fri	11/03/2000	16	50.79	6.99
24	10,017	W	4,982	E	5,035	Fri	06/09/2000	18	50.26	6.99
25	10,009	E	4,995	W	5,014	Fri	09/22/2000	17	50.09	6.99
26	10,002	E	4,984	W	5,018	Fri	10/13/2000	18	50.17	6.98
27	10,001	W	4,941	E	5,060	Thu	05/25/2000	16	50.59	6.98
28	9,998	W	4,927	E	5,071	Fri	10/27/2000	19	50.72	6.98
29	9,991	W	4,783	E	5,208	Wed	06/21/2000	18	52.13	6.97
30	9,990	E	4,740	W	5,250	Fri	05/26/2000	16	52.55	6.97
31	9,990	W	4,885	E	5,105	Fri	07/14/2000	18	51.10	6.97
32	9,974	W	4,869	E	5,105	Fri	10/20/2000	19	51.18	6.96
33	9,969	W	4,907	E	5,062	Fri	09/22/2000	16	50.78	6.96
34	9,963	W	4,890	E	5,073	Fri	11/17/2000	18	50.92	6.95
35	9,960	W	4,809	E	5,151	Wed	06/28/2000	16	51.72	6.95
36	9,958	W	4,822	E	5,136	Fri	04/07/2000	18	51.58	6.95
37	9,957	E	4,929	W	5,028	Fri	01/14/2000	16	50.50	6.95
38	9,951	W	4,748	E	5,203	Thu	07/20/2000	18	52.29	6.95
39	9,950	W	4,656	E	5,294	Thu	06/01/2000	18	53.21	6.94
40	9,943	W	4,736	E	5,207	Wed	02/23/2000	18	52.37	6.94
41	9,941	E	4,956	W	4,985	Fri	09/01/2000	16	50.15	6.94
42	9,934	W	4,745	E	5,189	Tue	02/22/2000	18	52.23	6.93
43	9,932	E	4,941	W	4,991	Fri	09/01/2000	18	50.25	6.93

Design Hour Data  
 Design "D" = 51.54 (Average of 28th-32nd hour)  
 Design "K" = 6.97

EXAMPLE

Figure 3.5  
 Hours 1 through 40 for  
 Site 102028 from the 2000  
 200th Highest Hour Traffic  
 Count Report



Print Date : May 09, 2002

Florida Department of Transportation  
 Transportation Statistics Office  
**200 Highest Hour Report**  
 Count Year 2000

<b>County:</b> 75									<b>Valid Data</b>
<b>Site:</b> 0130									<b>Hours</b> 6,000
<b>Description:</b> I-4,0.8 MILESOUTH OF SR-482 (TTMS)									<b>Days</b> 250
<b>Location:</b> 75280000	<b>Milepost:</b> 7.50								<b>Weeks</b> 47
<b>AADT:</b> 143,280									<b>Months</b> 12

Position	Counts					Collection			"D" Factor	"K" Factor
	Total Count	Low Dir	Low Count	High Dir	High Count	Day	Date	Hour		
173	9,584	E	4,360	W	5,224	Sat	05/20/2000	17	54.51	6.69
174	9,584	W	4,461	E	5,123	Thu	08/31/2000	18	53.45	6.69
175	9,583	W	4,668	E	4,915	Fri	09/08/2000	19	51.29	6.69
176	9,583	W	4,672	E	4,911	Thu	09/28/2000	16	51.25	6.69
177	9,579	E	4,598	W	4,981	Thu	02/17/2000	17	52.00	6.69
178	9,579	W	4,477	E	5,102	Thu	03/02/2000	18	53.26	6.69
179	9,577	E	4,639	W	4,938	Fri	07/14/2000	17	51.56	6.68
180	9,575	W	4,630	E	4,945	Sat	11/18/2000	15	51.64	6.68
181	9,570	W	4,536	E	5,034	Wed	06/07/2000	18	52.60	6.68
182	9,569	W	4,674	E	4,895	Thu	10/19/2000	19	51.15	6.68
183	9,568	E	4,755	W	4,813	Fri	06/23/2000	17	50.30	6.68
184	9,568	E	4,595	W	4,973	Fri	10/13/2000	17	51.98	6.68
185	9,567	W	4,712	E	4,855	Wed	06/07/2000	17	50.75	6.68
186	9,566	W	4,633	E	4,933	Mon	07/17/2000	16	51.57	6.68
187	9,565	W	4,708	E	4,857	Fri	02/18/2000	16	50.78	6.68
188	9,557	W	4,414	E	5,143	Fri	04/07/2000	19	53.81	6.67
189	9,557	W	4,602	E	4,955	Tue	06/20/2000	16	51.85	6.67
190	9,555	E	4,762	W	4,793	Fri	08/04/2000	17	50.16	6.67
191	9,550	W	4,356	E	5,194	Wed	07/12/2000	18	54.39	6.67
192	9,549	E	4,670	W	4,879	Fri	05/05/2000	19	51.09	6.66
193	9,547	E	4,357	W	5,190	Thu	11/09/2000	9	54.36	6.66
194	9,546	W	4,597	E	4,949	Thu	05/04/2000	16	51.84	6.66
195	9,546	W	4,507	E	5,039	Mon	10/16/2000	18	52.79	6.66
196	9,539	W	4,574	E	4,965	Wed	05/31/2000	18	52.05	6.66
197	9,538	W	4,610	E	4,928	Fri	08/25/2000	18	51.67	6.66
198	9,537	E	4,686	W	4,851	Wed	02/23/2000	17	50.87	6.66
199	9,537	W	4,725	E	4,812	Thu	08/17/2000	16	50.46	6.66
200	9,532	W	4,489	E	5,043	Wed	02/02/2000	18	52.91	6.65

-----  
**Design Hour Data**  
 Design "D" = 51.54 (Average of 28th, 32nd hour)  
 Design "K" = 6.97

EXAMPLE

Figure 3.6  
 Hours 173 through 200 for  
 Site 102028 from the 2000  
 200th Highest Hour Traffic  
 Count Report



### 3.8 ACCEPTABLE $K_{30}$ VALUES

**$K_{30}$**  The  $K_{30}$  and related DHV are influenced by the timing of trips during the day.  $K_{30}$  will be lower on roads which serve many trip making purposes distributed during the day. Roads which serve few purposes will normally exhibit high hourly variance. Figure 3.7 below shows the recommended  $K_{30}$  values to be used (if telemetry sites on roads similar to a project are unavailable to estimate  $K_{30}$ ) for project traffic forecasting.

RECOMMENDED K-FACTORS ( $K_{30}$ ) FOR TRAFFIC FORECASTING

Road Type	$K_{30}$			Standard Deviation
	Low	Average	High	
Rural Freeway	9.60	11.8	14.6	1.43
Rural Arterial	9.40	11.0	15.6	1.42
Urban Freeway	9.40	9.7	10.0	0.28
Urban Arterial	9.20	10.2	11.5	0.92

Figure 3.7

The values in Figure 3.7 are taken from FDOT's telemetered traffic monitoring sites and represent the ratio of the 30th highest volume hour to the AADT. Unconstrained sites are identified when the roadway's LOS falls below the approved LOS standards. The K factor data for all the telemetered sites are represented in FDOT's 200th Highest Hour Traffic Count Report.

For design of a highway improvement, the variation in hourly traffic volumes should be measured and the percentage of AADT during the 30th highest hour determined. Where such measurement cannot be made and only the AADT is known, use should be made of 30th-hour percentage factors ( $K_{30}$  and  $D_{30}$ ) for similar highways in the same locality operated under similar conditions.

Figure 3.8 is a section of a report of *2000 Annual Average Daily Traffic Report*. Each year the table will be updated to provide the newly calculated factors.

If the  $K_{30}$  for a specific project is outside the range of Florida's unconstrained telemetry sites (Figure 3.7), then the justification for the unusual number must be made in the traffic report. Justification for all decisions relating to the K-factor must be written, and high or low values must be especially well documented.



Print Date: May 09, 2002

Florida Department of Transportation  
Transportation Statistics Office

**2000 Annual Average Daily Traffic Report**

County : 75 ORANGE

Site	Type	Description	Direction 1	Direction 2	AADT Two-Way	"K" Factor	"D" Factor	"T" Factor
0002	P	SR-500, 0.178 MI NW OF C-437 (RVL)	14,500 N	16,000 S	30,500 C	8.88 F	58.08 F	10.85 F
0005	P	ON SR-436, 0.39 MI W OF SEMINOLE CO. (UC)	24,000 E	24,500 W	48,500 C	8.88 F	58.08 F	4.35 A
0018	P	SR-50, 0.115 MI W OF SR-439(UVL)	25,500 E	25,000 W	50,500 S	8.88 F	58.08 F	4.92 F
0030	P	SR-15, 0.14 MI N OF C-506 (UV)			25,500 S	8.88 F	58.08 F	4.19 F
0031	P	ON SR-551, 0.1 MI N OF SR-15 (UVL)	14,000 N	14,000 S	28,000 C	8.88 F	58.08 F	1.46 F
0032	P	SR-15, 0.237 MI SE OF SR-551(UVL)	6,900 N	6,800 S	13,700 C	8.88 F	58.08 F	4.19 F
0036	P	ON SR-551, 0.1 MI N OF SR-50 (UV)	0	0	27,000 C	8.88 F	58.08 F	1.46 F
0037	P	SR-50, 0.646 MI E OF SR-551(UVL)	23,000 E	23,000 W	46,000 C	8.88 F	58.08 F	6.32 F
0038	T	SR 50, 0.5 MI E SR-545/12 MI W OF ORLANDO (TTMS)	17,365 E	17,621 W	34,986 C	8.57 A	57.60 A	4.92 A
0044	P	SR-500, 1.443 MI N OF C-506 (UVL)	22,500 N	24,500 S	47,000 C	8.88 F	58.08 F	6.68 F
0045	P	SR-500, 0.657 MI S OF SR-408 (UVL)	19,000 N	18,500 S	37,500 C	8.88 F	58.08 F	6.68 F
0051	P	SR-527, 0.07 MI N OF C506 (TO WEST) (SBD=5204)(UV)	26,000 N	0	26,000 C	8.88 F	99.99 W	1.46 F
0054	P	SR-527, 0.25 MI N OF SR-482 (UV)	0	0	40,000 C	8.88 F	58.08 F	1.46 F

Figure 3.8

Figure 3.9 shows the  $K_{30}$  value ranges representative of the national roadway conditions. These value ranges were obtained from the Highway Capacity Manual (HCM). Appendix B is a letter dated September 21, 1993, and specifies the FHWA acceptable maximum and minimum values for K-factors. The letter states, "These K-factors range from a maximum value of 0.20 for Rural Freeways to a minimum value of 0.09 for Urban Freeways."

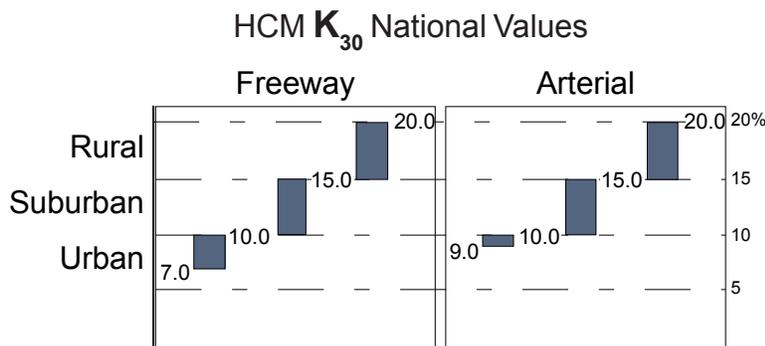


Figure 3.9

For the acceptable range of values refer to the HCM National  $K_{30}$  Values (Figure 3.9) and to the September 21, 1993, letter from FHWA (Appendix B). If the values are acceptable, develop future DDHV. However, if the  $K_{30}$  is not within the acceptable range of values the user must modify  $K_{30}$  within the ranges in the HCM consistent with FHWA standards.

TranStat and the districts use this process to estimate  $K_{30}$  which is published in the 200th Highest Hour Traffic Count Report. Note that a user would not produce  $K_{30}$ , but an understanding of its derivation is useful to anyone working with traffic forecasting parameters.



### 3.9 ACCEPTABLE $D_{30}$ VALUES



The directional distribution factor,  $D$ , is based on the 200th Highest Hour Traffic Count Report and referred to as  $D_{30}$ . The  $D_{30}$  values are also available from FDOT's RCI and TCI databases. If traffic counts for the project site are not available, obtain 24 (urban) or 48 (rural) hour classification counts to determine hourly traffic volume distribution. This will allow the identification of the peak hour of the day and peak direction during the peak hour.

To determine if a  $D_{30}$  value is acceptable for a project traffic forecasting projection, the following three steps are necessary:

- Step 1. First determine if a  $D_{30}$  value is within an acceptable range of demand  $D_{30}$  values, using Figure 3.10.

RECOMMENDED D-FACTORS ( $D_{30}$ ) FOR TRAFFIC FORECASTING

Road Type	Low	Average $D_{30}$	High	Standard Deviation
Rural Freeway	52.3	54.8	57.3	1.73
Rural Arterial	51.1	58.1	79.6	6.29
Urban Freeway	50.4	55.8	61.2	4.11
Urban Arterial	50.8	57.9	67.1	4.60

Figure 3.10

- Step 2. The user should use the 200th Highest Hour Traffic Count Report (see Figure 3.5) for establishing  $D_{30}$  for unconstrained sites.
- Step 3. If the site is "constrained," **Demand D** should be used. Demand  $D$  is estimated based on the 200th Highest Hour Traffic Count Report using traffic data for unconstrained sites with similar roadway characteristics. Select the appropriate  $D_{30}$  value by analyzing the traffic characteristics and comparing them with unconstrained traffic counts locations.

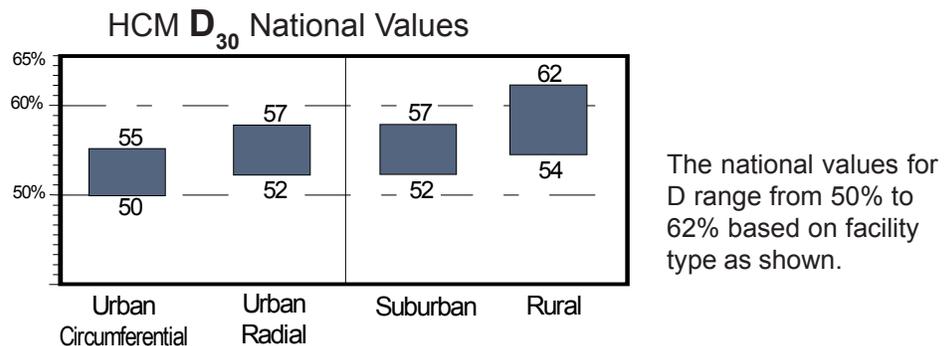


Figure 3.11



### 3.10 ADJUSTING THE K-FACTOR

**K<sub>30</sub>** The initial K-factor is the average K-factor for the road type in the design year. For traffic forecasting purposes, some compensating adjustment to the average rate is required. A higher K-factor on rural routes may be expected as a result of tourist or recreational trips in the traffic flow during the design hour. For example, the highest K-factor in the Rural Arterial group (15.6%) was found on the primary north-south access route to Panama City Beach, US 231 just south of SR 20, on Labor Day 1990. Thus, the main adjustment needed to compensate for site-specific conditions is to reflect the influence of tourist trips.

An additional site-specific adjustment may be required to reflect the nature of the road in local traffic patterns, i.e., whether the road serves cross-town, radial, circumferential, or trip terminal traffic. The decision process for applying this adjustment will also lead to an estimate of when the DHV will occur, an important part when considering the timing of multiple peak traffic patterns.

Here are some examples of how the K-factor adjustment process works:

- Interstate 10 between Alabama and I-75 would have a downward adjustment to the average K-factor; this section of Interstate freeway has less than average tourist travel. (This example points out that two roads in the same area — US 231 and I-10 can have different traffic patterns.)
- Portions of rural I-75 may exhibit higher than average K-factors; traffic forecasting estimates for these segments will need to reflect K-factors toward the upper part of the observed range.
- Urban Interstate freeways show little variance and would receive no adjustments.
- The Urban Arterial group also shows little variance, as the lowest value (8.2%) appears to be a statistical anomaly; the next lowest value was a full point higher. Any adjustments to the average K-factor for these routes would reflect trip continuation from a connecting rural route.
- Local access roads have a high traffic volume variance associated with the pattern of land use activities. An office park has high inbound traffic in the morning, mixed inbound/outbound traffic at lunch time, and high outbound traffic in the evening. A residential subdivision will have high outbound traffic in the morning and high inbound traffic in the evening. Multi-family housing developments often show peak volumes later in the evening, around 7-8 PM.



A K-factor which is too high may result in over-design for the design year, but continuing traffic growth in most instances will soon use the “excess” capacity. A too low K-factor will lead to early congestion and the need for additional capacity, a situation that is far more costly in the long run. Thus, a K-factor which is too low will generally produce higher life-cycle costs due to the reduced functional life of the project improvements. The use of a system-level demand K-factor, adjusted slightly for local conditions, will reduce the chance of underestimating the K-factor.

When policy or funding limits the capacity that can be provided, the designer needs to know the actual traffic demand so that the design can better accommodate the expected congestion. In the case of a freeway capacity project, one possible technique to reduce the effect of the anticipated congestion would be to design longer and/or wider ramps for queue storage to prevent queues extending back into mainline lanes. If the design hour volume were deliberately held low, the designer would not be aware of the congestion problem and could not prevent its dangerous effects.

---

### 3.11 ADJUSTING THE D-FACTOR

**D<sub>30</sub>** On 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 volume in each direction of travel is essential for design.

For the same AADT, a multilane highway with a high percentage of traffic in one direction during the peak hours may require more lanes than a highway having the same AADT with a lesser percentage. During peak hours on most rural highways, from 55 to 70 percent of the traffic is in one direction. For two multilane highways carrying equal traffic, one may have a one-way traffic load 60 percent greater than the other during the peak hours. As an example, consider a rural road designed for 4,000 vehicles per hour (vph) total for both directions. If during the design hour the directional distribution is equally split, or 2,000 vph in each direction, two lanes in each direction may be adequate. If 80 percent of the DHV is in one direction, at least three lanes in each direction would be required for the 3,200 vph; and if the 1,000 vehicles per lane criterion is rigidly applied, four lanes in each direction would be required.

Traffic distribution by directions during peak hours is generally consistent from year to year and from day to day on a given rural road, except on some highways serving recreational areas. The measured directional distribution may be assumed to apply to the DHV for the future year for which the facility is designed, except for urban highways. For urban highways, as the land use changes, directional distribution tends to the lower end of the facility type (*see* Figure 3.11). Ultimately, urban roads reach a value of 50 percent, traffic flowing equally in both directions.



### 3.12 ESTIMATING $K_{30}$ EXAMPLE

The following is an actual example which illustrates the process of obtaining the necessary data in order to make a  $K_{30}$  recommendation.

1.  $K_{30}$  is based on site-specific data related to either telemetry site(s) located on the facility of the project or on telemetry site(s) located on roads with similar geometric and traffic characteristics. If an existing telemetry site is available, the  $K_{30}$  data is reported in the 200th Highest Hour Traffic Count Report. Every state road will be assigned to a certain factors category. If the information for  $K_{30}$  is not reported in the 200th Highest Hour Traffic Count Report, the user should refer to the RCI mainframe database to obtain the  $K_{30}$  information. This  $K_{30}$  value is estimated based on system, facility type and Seasonal Factor (SF) category assigned by the district.
2. Document all the available  $K_{30}$  data and sort them by year. If sufficient data is available the user should report up to 20 years of past data. Along with  $K_{30}$  data the user must note changes in roadway characteristics for every year, for example, changes in the number of lanes, facility type, and whether the facility is operating under constrained conditions, etc.

---

#### SITE 156 ESCAMBIA COUNTY

I-10, 1.5 mile west of U.S. 90

48260 - 4.10

Rural/Suburban

YEAR	AADT	$K_{30}$	No. of Lanes	Facility	Type of LOS
93	23,001	14.1	4	Freeway	A
94	22,018	11.6	4	Freeway	A
95	23,837	11.2	4	Freeway	A
96	22,231	10.8	4	Freeway	A
97	24,927	12.0	4	Freeway	A
98	25,142	11.3	4	Freeway	A
99	26,046	11.3	4	Freeway	A
00	26,233	11.5	4	Freeway	A

Existing LOS — “ A ”



- Summarize the information in a table (if more than one year of data is available) and note the minimum and maximum observed  $K_{30}$ .

	YEAR	AADT	K30	No. of Lanes	Type of Facility
<i>min</i>	96	19,348	<b>10.8</b>	4	Freeway
<i>max</i>	93	23,001	<b>14.1</b>	4	Freeway

- The user must determine the  $K_{30}$  for the roadway based on the observed traffic data throughout the State of Florida (see Figure 3.7). Also, the user should obtain  $K_{30}$  based on the national observed data as presented in the HCM (see Figure 3.9). Develop a table which summarizes the findings and includes the minimum and maximum observed  $K_{30}$  for the project based on Statewide and national data.

	$K_{30}$ <i>I-10</i> <i>Site 156</i>	$K_{30}$ <i>Florida</i> <i>Data</i>	$K_{30}$ <i>National</i> <i>Data</i>
Observed Minimum	10.8	9.60	10.00
Observed Maximum	14.1	14.60	15.00

- Based on this information and past experience, the user estimates the acceptable  $K_{30}$  that should be used for this project and makes recommendations through the District Office for final concurrence by the Systems Planning Office and FHWA (if federal funding is involved).

In this example, Site 156 is a Rural/Suburban, unconstrained freeway. The observed data is within the acceptable range of Figure 3.9 HCM table between 10.0 (Urban) and 15.0 (Rural). The data suggests a historical trend toward a value of 11.0. Experience dictates that a recommendation of 11.00 be used.

**$K_{30}$                       Recommend                       $K_{30}$     11.00**

EXAMPLE



### 3.13 ESTIMATING $D_{30}$ EXAMPLE

The following is an actual example which illustrates the process of obtaining the necessary data in order to make a  $D_{30}$  recommendation.

1.  $D_{30}$  is based on site-specific data related to either telemetry site(s) located on the facility of the project or on telemetry site(s) located on roads with similar geometric and traffic characteristics. If an existing telemetry site is available, the  $D_{30}$  data is reported in the 200th Highest Hour Traffic Count Report. Every state road will be assigned to a certain factor category. If the information for  $D_{30}$  is not reported in the 200th Highest Hour Traffic Count Report, the user should refer to the RCI mainframe database to obtain the  $D_{30}$  information. This  $D_{30}$  value is estimated based on system, facility type and Seasonal Factor (SF) category assigned by the district.
2. Document all the available  $D_{30}$  data and sort them by year. If sufficient data is available the user should report up to 20 years of past data. Along with  $D_{30}$  data the user must note changes in roadway and land use characteristics for every year; for example, changes in the number of lanes, facility type, and whether the facility is operating under constrained conditions, anticipated land use changes, etc.

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#### SITE 156 ESCAMBIA COUNTY

I-10, 1.5 mile west of U.S. 90

48260 - 4.10

Rural/Suburban

---

YEAR	AADT	D30	No. of Lanes	Type of Facility
93	23,001	52.3	4	Freeway
94	22,018	55.5	4	Freeway
95	23,837	52.4	4	Freeway
96	22,231	51.5	4	Freeway
97	24,927	53.3	4	Freeway
98	25,142	53.2	4	Freeway
99	26,046	56.2	4	Freeway
00	26,233	54.8	4	Freeway

---

Existing LOS — “A”



- Summarize the information in a table (if more than one year of data is available) and note the minimum and maximum observed  $D_{30}$ .

	$D_{30}$ <i>I-10</i> <i>Site 156</i>
Observed Minimum	51.5
Observed Maximum	56.2

- The user must determine the  $D_{30}$  for the roadway based on the observed traffic data throughout the State of Florida (see Figure 3.10). Also, the user should obtain  $D_{30}$  based on the national observed data as presented in the Highway Capacity Manual (see Figure 3.11). Develop a table which summarizes the findings and includes the minimum and maximum observed  $D_{30}$  for the project based on statewide and national data.

	$D_{30}$ <i>I-10</i> <i>Site 156</i>	$D_{30}$ <i>National</i> <i>Data</i>	$D_{30}$ <i>State</i> <i>Data</i>
Observed Minimum	51.5	52.0	52.3
Observed Maximum	56.2	57.0	57.3

- Based on this information and past experience, the user estimates the acceptable  $D_{30}$  that should be used for this project and makes recommendations through the District Office for final concurrence by the Systems Planning Office and FHWA (if federal funding is involved). Using the values from Figure 3.11, the Suburban minimum of 52.00 is acceptable and requires no additional adjustment.



**Recommend**

$D_{30}$  **52.00**

EXAMPLE



### 3.14 $K_{30}$ AND $D_{30}$ EXAMPLE SUMMARY

The following is the complete example which illustrates the process of obtaining the necessary data in order to make a  $K_{30}$  and  $D_{30}$  recommendation.

#### SITE 156 ESCAMBIA COUNTY

I-10, 1.5 mile west of U.S. 90  
48260 - 4.10  
Rural/Suburban

YEAR	AADT	K30	D30	No. of LANES	Type of Facility
93	23,001	14.1	52.3	4	Freeway
94	22,018	11.6	55.5	4	Freeway
95	23,837	11.2	52.4	4	Freeway
96	22,231	10.8	51.5	4	Freeway
97	24,927	12.0	53.3	4	Freeway
98	25,142	11.3	53.2	4	Freeway
99	26,046	11.3	56.2	4	Freeway
00	26,233	11.5	54.8	4	Freeway

Existing LOS — “ A ”

	$D_{30}$ <i>I-10</i> <i>Site 156</i>	$D_{30}$ <i>National</i> <i>Data</i>	$D_{30}$ <i>State</i> <i>Data</i>
Observed Minimum	51.5	52.00	52.3
Observed Maximum	56.2	57.00	57.3
	$K_{30}$ <i>I-10</i> <i>Site 156</i>	$K_{30}$ <i>Florida</i> <i>Data</i>	$K_{30}$ <i>National</i> <i>Data</i>
Observed Minimum	10.8	9.60	10.00
Observed Maximum	14.1	14.60	15.00
<b>Recommend</b>	$K_{30}$ <b>11.00</b>	$D_{30}$ <b>52.00</b>	

EXAMPLE



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## CHAPTER FOUR

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**TRAFFIC FORECASTING WITH TRAVEL DEMAND MODELS**

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**4.1 PURPOSE**

This chapter provides guidance in the application of models to develop traffic projections for route specific (PD&E) studies, corridor studies and resurfacing type projects. This chapter also provides an overview of modeling for traffic engineers and an overview of traffic forecasting requirements for modelers. Sections 4.1 through 4.4 discuss what a traffic forecasting user should know about how modeling outputs are used in the development of traffic forecasting. Sections 4.5 through 4.10 discuss what modelers should know about the traffic forecasting process in order to develop traffic projections which meet the needs of traffic forecasting engineers. Some guidance is repeated in each section in order to make each section stand alone. This chapter explains the following:

- **Modeling Background for Traffic Forecasting Engineers**
  - How to select a model
  - How to apply a model
- **Traffic Forecasting Background for Modelers**
  - General travel demand model issues
  - Resurfacing Project modeling methodology
  - Corridor or Project Design modeling methodology

This method applies only to locations that have adopted/endorsed models available. Specific guidance can be obtained from the appropriate offices listed in Appendix C - District Planning and Modeling Contacts.

If an acceptable model is not available, then refer to Chapter 5 – Traffic Forecasting Without a Traffic Model.

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**4.2 MODELING BACKGROUND FOR TRAFFIC FORECASTING**

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The primary purpose of travel demand models has been to provide systems 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 developments. Project Traffic Forecasting Reports are the documents which contain the supporting traffic forecasts used in establishing specific improvements, including cross section requirements, lane calls for corridors, intersection/interchange geometry, and pavement design.



Models can be useful tools in developing the traffic projections necessary for the Project Traffic Forecasting Report. However, since travel demand models are “planning” vs. “design” tools, the systems level traffic projections must be properly evaluated for reasonableness and consistency in light of current conditions and those indicated by trends (*see* Chapter 5 – Traffic Forecasting Without a Traffic Model).

The standard model structure for projecting systems traffic in the State of Florida is the Florida Standard Urban Transportation Modeling Structure (FSUTMS). District Planning Office approved models are generally **validated** for the most recent census year using data derived from the census such as population, number of housing units, employment, and school enrollment. When origin and destination (O&D) journey data is available for the census year, the model is more finely tuned and output results are considered **calibrated**. In Florida, most models are validated due to the large expense of O&D surveys.

A calibrated/validated model is one which can replicate traffic counts for the census year by using population and employment data for the same year. The model is then used to forecast future volumes using projected population and employment. If a project is being developed which is not already included in the FSUTMS model, then the model can be modified to test the effects of the new roadway or land use. The modified model is then “revalidated” to help ensure that the forecasted traffic volumes are accurate. The “revalidation” process is not as rigorous as required for a complete system-wide calibration of the model.

In general, models that have been adopted by the MPOs and/or local jurisdictions should be used to develop traffic forecasting. Other models that may be approved for use by the District Planning Office include Regional, Turnpike and Statewide models. Validated models that are used by the District Planning Office, the MPOs and/or local jurisdictions should not be modified or “revalidated” without consent and approval of those agencies. Since the availability of models varies from district to district, the District Planning Office should be contacted to obtain a list of available FSUTMS models. See Appendix C – District Planning and Modeling Contacts for the telephone numbers of District Planning Office personnel.

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### 4.3 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 area, the MPO adopted model should be used. Projects which lie *outside* the MPO area boundaries may be able to utilize other District Planning Offices’ approved models such as the Regional, Turnpike, or Statewide (rural areas only) models. The District Planning Office should be contacted to confirm the correct model to be used. If no model is appropriate, refer to Chapter 5 – Traffic Forecasting Without a Traffic Model.



### 4.3.1 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 they are 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 until the District Planning Office and/or the agency having jurisdiction over the model has addressed the situation. Models are generally calibrated on a system-wide level and not on a corridor or project specific level. The Project Traffic Report stage is **NOT** the appropriate place to perform a recalibration of a base year model application. Should the calibration of the model remain an issue, it is suggested that the procedure for Traffic Forecasting Without A Traffic Model be followed instead.

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## 4.4 USE OF MODEL OUTPUT IN TRAFFIC FORECASTING

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

### 4.4.1 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 and approval from the District Planning Office and the agency responsible for the model (i.e., MPO or local agency).

Changes made to the model should be consistent with the methodology prescribed in the latest version of the FSUTMS User's Manual and should be fully documented in a manner which would allow another individual to make the same changes and obtain the same results. This material should then be reviewed with the District Planning Office and the agency responsible for the model to obtain consensus on the results. Models used to develop traffic projections for Master Plans, Action Plans, and IJR/IMRs are good examples of model applications which may require modifications.



#### **4.4.2 Execute the Model Stream**

The model stream should be executed to generate the traffic forecasts required for the Traffic Reports in accordance with the FSUTMS User's Manual.

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 FSUTMS program, or from the network plots. The model traffic can also be visually evaluated by utilizing the current network editing program (e.g. HNIS/HNISE).

#### **4.4.3 Evaluate Model Traffic Output**

The forecasted model traffic must be evaluated for reasonableness. The best method of evaluation is to develop a traffic forecast based on historical trends following the steps identified in Chapter 5. This trend based forecast should then be compared to those generated by the model. Differences in volume in excess of 10% in high volume areas or 4,000 vehicles per day should be further evaluated in an effort to explain the disparity. Model traffic assignments must be converted from PSWADT to AADT before comparing with the traffic projection based on historical trends.

If valid explanations for the differences cannot be determined, then either the model or the trend volumes may not be appropriate for use in the Traffic Report. 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. Complete documentation of the traffic projection process, including reasonableness evaluation, should be included in the Traffic Report. Where the forecasted model traffic is to be utilized for alternative corridor assignments, additional evaluation for reasonableness should be performed. Screen lines and overall distribution of traffic assignments within the evaluated areas should also be considered.

#### **4.4.4 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 analyses as defined in this manual.



## 4.5 TRAFFIC FORECASTING BACKGROUND FOR MODELERS

The following sections provide guidance for the use of models to develop traffic projections for project, corridor, and resurfacing type projects. This chapter applies only to areas where an adopted/endorsed model is available. Data requirements and the level of modeling effort vary by the type of project (i.e., resurfacing, corridor, project).



Resurfacing projects require the development of future AADT projections only and, of the project types, require the least accuracy. As a result, the modeling effort required to develop travel projections for resurfacing projects is the least involved of the project types. Generally, a properly calibrated (area-wide) model can be directly applied without the need for additional evaluation or validation efforts. (*see* Sections 4.6 and 4.8)



Corridor projects usually require the development of travel projections for either new or existing corridors but, in either case, are used to make decisions which have important capacity and capital investment implications. As a result, an evaluation of the model's ability to accurately project travel demand in the corridor area should be made prior to its use. Based on the results of this evaluation, additional corridor specific validation and/or model refinement efforts may be necessary. (*see* Sections 4.6 and 4.10)



Specific project travel demand projections require the highest accuracy. These projections are commonly used to develop laneage requirements and intersection designs, and evaluate the operational efficiency of proposed improvements. An evaluation of the model's ability to accurately project travel demand in the project area should be made prior to its use. Based on the results of this evaluation, additional project specific (subarea and/or corridor) model refinement efforts may be necessary. (*see* Sections 4.6 and 4.10)

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## 4.6 GENERAL TRAVEL DEMAND MODEL ISSUES

The standard model for projecting traffic flow in the State of Florida is the Florida Standard Urban Transportation Model Structure (FSUTMS). Most FDOT approved models in urbanized areas are models approved by the local MPOs. Since the availability of models varies from district to district, the District Planning Office should be contacted to obtain a list of the available FSUTMS models. (*see* Appendix C for the telephone numbers of District Planning Offices).



### 4.6.1 Travel Demand Model Selection

The use of a particular FSUTMS based model will depend on the type of project, the location of the project and the availability of a model for that area. The following FSUTMS models are currently being used throughout the state:

- Master Plan models
- MPO Urban Area Transportation Study (UATS) models
- Statewide models (rural areas only)
- Turnpike models
- Regional models
- City or County models

The primary factors to be considered in the selection of an appropriate model are as follows:

- Is it a FSUTMS based model?
- Is it approved by the District Planning Office?
- Does the model cover the geographic area of interest?
- What is the validation status (model-wide, sub-area, corridor, and/or project)?
- Is accurate and up-to-date socio-economic data for both base and future years available?
- Which model type (Urban, Regional, Statewide) is required?
- What is the required model accuracy?

A Master Plan model is developed for specific corridors or projects. MPO UATS models are used in urban areas. The Statewide Model is usually used in rural areas. If a Turnpike or Regional Model is used, its acceptability for use should be determined before use. There are two different Turnpike models which are used to forecast either capacity or revenue. The Turnpike Revenue Model has been validated to produce conservative revenue traffic forecasts and should not be used to produce the desired traffic forecasts.

The use of a non-FSUTMS model is normally not acceptable in areas where a FSUTMS based model has been developed. However, if all adopted/endorsed FSUTMS models are shown to be inadequate for future travel demand forecasts, a non-FSUTMS model may be recommended, or a combination of approaches may be used. In such cases, it should be documented why any of the adopted/endorsed FSUTMS models cannot be used. The District Planning Office should be contacted for approval prior to the use of a non-FSUTMS model.



## 4.6.2 Travel Demand Model Accuracy Assessment

An approved model is usually in an acceptable condition. However, if the model is not up to the desired standard, the following are typical steps which should be followed to bring the model up to an acceptable standard. The selected travel demand model should be analyzed, modified, and validated, as appropriate, to ensure its capability to accurately forecast future traffic volumes.

The validation process should include a review of all available land use, socio-economic and transportation network data to be used in the model. The District Planning Office should approve all data inputs used in the validation process, and the validation effort must be completely documented and approved prior to its use.

### 4.6.2.1 Evaluation of Base Year Conditions

The validation of the base year model is performed to ensure the ability of the model to replicate base year conditions. The validation of the base year model is performed by comparing base year counts to the modeled volumes using the criteria as shown in Figure 4.1.

It is important to establish what type of counts were used for the model as well as what conditions the socio-economic data reflects. Most UATS models use counts which reflect the most congested period of the year (13-week peak season of the year). Three types of counts are common to model inputs: AADT converted to PSWADT, hourly counts converted to PSWADT, and direct PSWADT counts. Since models can vary significantly, the District Planning Office should be contacted to establish what type of model should be used or what modification is required to convert the model output to project traffic forecasting requirements.

### 4.6.2.2 Model Accuracy Assessment

Prior to using a travel demand model for forecasting, it is important to verify that the entire model has been validated. The model validation should be given a subjective review prior to its use in order to determine if there have been any changes that could affect the model validation. If the validation is outdated, it may be necessary to perform an entire network validation using more recent data or consider using the methods of Chapter 5 in this handbook.

The EVAL module of the FSUTMS program is used in many areas of the state to perform systems evaluation activities and to assist in validating a model. EVAL output includes information on vehicle miles of travel (VMT), vehicle hours of travel (VHT), average travel speed, and comparisons of



simulated traffic volumes to observed traffic counts. The FSUTMS model validation process involves several checks of the traffic assignment's accuracy in simulating observed traffic counts.

In general, model simulated link volumes are expected to be accurate enough to correctly determine the required number of lanes for roadway design. This means that the acceptable error should be no more than the service volume (at the design LOS) for one lane of traffic. This reference service volume is a higher percentage of total traffic for low volume roads than for high volume roads.

**TRAFFIC ASSIGNMENT ACCURACY LEVELS**

Validation Check	Scale of Computation	Level of Accuracy
Assigned VMT/Count VMT	Area	±5%
Assigned VHT/Count VHT	Area	±5%
Volume-Count Ratio	Screenlines	+10% (> 50,000 VPD) +20% (< 50,000 VPD)
Volume-Count Ratio	Cutlines	+10% (> 50,000 VPD) +20% (< 50,000 VPD)
Assigned VMT/Count VMT	Facility Type, Area Type, No. Lanes	+15% (> 100,000 VMT) +25% (< 100,000 VMT)
Assigned VHT/Count VHT	Facility Type, Area Type, No. Lanes	+15% (> 20,000 VHT) +25% (< 20,000 VHT)
Percent Root Mean Square Error	Area	35% - 50%
Percent Root Mean Square Error	Link Volume Groups	25% (> 50,000 VPD) 30%-100% (< 50,000 VPD)

**Figure 4.1**

Source: Model Update Task C: "Develop Standardized Distribution and Assignment Models," Table 3.

**4.6.2.3 Base Year Model Refinements**

The following is a series of refinements which are commonly used in the validation of the Base Year Network:

- The network should be updated to ensure proper representation of traffic patterns through the inclusion of parallel roadway links, collector, and other secondary roads within the project area of influence. Acceptable refinements include changes in facility type, area type, and the number of lanes.
- The Traffic Analysis Zone (TAZ) centroid connectors and their location should be examined and adjusted if necessary.



- The socio-economic data in the TAZs should be updated within the project area of influence.
- Trips generated by prominent activity generators should be compared and evaluated with the actual traffic counts. If differences exist, TAZ productions or attractions should be adjusted utilizing the EDATAS input file.
- Travel characteristic data should be modified using updated origin and destination surveys and other data sources (where appropriate).

Note that none of the refinements outlined above should be made without just cause.

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## 4.7 DEVELOPMENT OF FUTURE YEAR TRAVEL DEMAND

After the validation for the model, as a whole, is approved, and appropriate future land use data has been assembled, the model is usually ready to determine the future year traffic forecast for resurfacing projects. If the model is used for corridor or project analysis, additional validation procedures might need to be executed (*see* Section 4.10 for more details)

### 4.7.1 Evaluation of Future Year Conditions

In order to project traffic for a given year, appropriate future year data inputs are required. For each of the future analysis years, the following travel demand forecasting model inputs should be summarized:

- transportation network
- socio-economic/land use data

Each of these factors should be updated to reflect the approved elements of the MPO financially feasible long range plan, Master Plans and planned development mitigation infrastructure improvements anticipated to be in place in each analysis year.

Since the timing of land use and network changes is not usually a known quantity, it is often appropriate to use the modeled data in a regression analysis with the historical data in order to obtain an AADT for any given year.



### **4.7.2 Reasonableness Checks for Future Years**

Future year traffic volumes cannot be validated against existing traffic counts. The model output must be checked and certified. The modeled volume changes for each year of analysis and for each alternative network should be evaluated against the expected changes. Although expected changes cannot be accurately quantified, approximate changes should be estimated. For example, if the region's growth is expected to continue, freeway volumes should increase with some relationship to the trend. The average percent of change between years should be relatively constant unless some special factors affect the growth, such as roadway improvements along parallel facilities.

The model-generated volumes for the future years should be reviewed for logical traffic growth rates. The general growth trends prevalent in the area should be determined and compared with the modeled traffic volumes. The future year model volumes should be compared against the appropriate historical count data (PSWADT, AADT, etc.). If an unexplained growth rate exists, a thorough review of the base and future year land use, socio-economic data and network coding should be performed. Logical reasons for any anomalies should be documented. A careful comparison is required, especially for urbanized areas where growth may be higher along undeveloped corridors while on an area-wide basis it may be much lower.

### **4.7.3 Acceptable Model Refinements for Future Years**

Models do frequently provide insights into traffic route selection that might not be readily apparent. However, where model results do not appear to be reasonable, the deviations must either be explained or acceptable revisions to the network, land use, or socio-economic data need to be made. If the model results are not reasonable and cannot be corrected, then use the historical traffic forecasting processes described in Chapter 5.



## 4.8 RESURFACING PROJECT TRAFFIC FORECASTING PROCEDURE



Resurfacing projects require the development of future AADT projections only and, of the project types, requires the least accuracy. As a result, the modeling effort required to develop travel projections for resurfacing projects is the least involved of the project types. Generally, a properly validated (area-wide) model can be directly applied without the need for additional evaluation or validation efforts.

### 4.8.1 Travel Demand Model Accuracy Assessment

The selected travel demand model must be analyzed, modified, and validated, as appropriate, to ensure its capability to accurately forecast future traffic volumes. In most cases the Travel Demand Model is already in acceptable condition; if not, refer to Section 4.6.2.

### 4.8.2 Travel Demand Forecasting Model Adjustment Procedures

After the validation of the whole model is approved, the model is ready for determining the future year traffic forecasts for resurfacing projects. Refer to the previous sections for a discussion on Evaluation of Future Year Conditions (Section 4.7.1), Reasonableness Checks for Future Years (Section 4.7.2) and Acceptable Model Refinements for Future Years (Section 4.7.3).

### 4.8.3 Executing the Model Stream

After receiving consensus from the local planning staff on any proposed modifications for land use/network for the interim and design year, the model stream should be executed to generate the traffic forecasts required for the Project Traffic Forecasting Reports in accordance with the FSUTMS User's Manual.

### 4.8.4 Documentation of 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 Project Traffic Forecasting Report. This information will then be utilized in the development of axle loadings as defined in this handbook.



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## 4.9 CORRIDOR OR PROJECT TRAFFIC FORECASTING PROCEDURE



Corridor projects usually require the development of travel projections which are used to make decisions which have important capacity and capital investment implications. Prior to using the model, an evaluation of the model's ability to accurately project travel demand in the corridor area should be made. Based on the results of this evaluation, additional corridor specific validation and/or model refinement efforts may be necessary.



Specific project travel demand projections require the highest accuracy. These projections are commonly used to develop laneage requirements and intersection designs, and evaluate the operational efficiency of proposed improvements. An evaluation of the model's ability to accurately project travel demand in the project area should be made prior to its use. Based on the results of this evaluation, additional project specific (subarea and/or corridor) model refinement efforts may be necessary.

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## 4.10 TRAVEL DEMAND MODEL ACCURACY ASSESSMENT

The selected travel demand model should be evaluated to determine its accuracy at both the model wide and project specific levels. Often, additional validation work will be required in the project area of influence before the model results are acceptable for use in a project analysis. This section discusses the general approach which should be followed to properly validate a sub area of the model for a project (site-specific) analysis. The model validation for the entire network is discussed in Section 4.6.2.

### 4.10.1 Evaluation of Base Year Conditions

The selected model should be run using base year data to evaluate its ability to accurately replicate base year ground counts within the study area. Be sure the counts are in the same units as the model output (*see* Section 4.6.3).

#### 4.10.1.1 Project Model Accuracy Assessment

Prior to using a travel demand model for forecasting, it is important to verify that the entire model has been validated. The validation process that should be used for the model wide validation is discussed in Section 4.6. Once it has been established that the entire model has been validated properly, the project area of influence (*see* Section 1.5 — Definitions) needs to be analyzed on its level of accuracy.



#### **4.10.1.2 Base Year Land Use**

The base year land use data should be analyzed within the project area of influence for its accuracy and consistency with local comprehensive plans. Local Planning Agencies and MPOs should be contacted to verify the land use within the project area of influence. Within the project area of influence, all existing Traffic Analysis Zones (TAZs) should be analyzed based on their size and the number of trips they generate. Trip end summaries for zones of interest in the project area of influence should be evaluated for reasonableness. It may be necessary in the project area of influence to refine the existing TAZ structure to obtain a better assignment. Special care must be taken to correctly code the new centroid connectors.

#### **4.10.1.3 Base Year Network Data**

The model base year network within the project area of influence should also be evaluated to see if all of the major highways are coded appropriately. Additional roadways might need to be added to the network to provide better loading points for newly created TAZs/centroid connectors, and to allow for an improved path building process. The coding of all roadways within the area of influence should be checked with regards to their facility type and number of lanes.

#### **4.10.1.4 Base Year Counts**

An analysis should be conducted to identify whether a sufficient amount of counts are available within the project area of influence. If critical links are missing counts then additional counts should be obtained. If any roadways have been added to the network, the availability of counts should be checked for these added roadways. An analysis should be conducted to add screenlines, which might require additional counts, within the project area of influence to create the ability to quickly analyze the accuracy of the distribution patterns. These additional counts would have to be adjusted to the base year of the study as well as to the units the model uses (axle adjustments, AADT, ADT, PSWADT, etc.). Note that this may be a costly endeavor, and not always feasible or desirable, based on the production schedule of certain projects.



#### 4.10.1.5 Base Year Project Model Evaluation Criteria

Project evaluation compares assigned volumes of the network validated model to observed volumes reported in the model validation year within the project area of influence on a link by link basis. If Planning is not satisfied with the ability of the model to replicate base year traffic volumes on the facilities within the project area of influence, model refinements are required. This project model validation will not constitute a major validation of the model itself. It normally should not include changes to the speed-flow relationships or the imposition of socio-economic correction ( $k$ ) factors.

The basis for comparison and the specific criteria are as follows:

- Base year (model) runs should be compared with the base year (model) ground counts in the project area of influence on a link by link basis. The assigned volume comparison will indicate where specific network coding changes may be required. Traffic volumes assigned to a link in the project area of influence that significantly vary from the ground counts could point to a coding problem. The maximum desirable error for link volumes is shown in Figure 4.1. The error is determined as the percent deviation of assigned link volumes from ground counts expressed in the model.
- Screenline comparisons within the project area of influence should be made. These comparisons should confirm the ability of the model to replicate existing travel movement.
- Agreement between model and counted volumes must not be forced by making changes to the model that will significantly affect other areas outside the project area of influence and the network validity. Care must be taken to ensure that “lack of fit” is not simply moved from one link to another.

#### 4.10.2 Existing Year Model Refinements

The commonly used model refinements include the following:

- The network should be updated to ensure proper representation of traffic patterns through the inclusion of parallel roadway links, collectors, and other secondary roads within the project area of influence. Acceptable refinements include changes in facility type, area type and number of lanes.
- The TAZ centroid connectors and their location need to be examined and adjusted if necessary.



- The socio-economic data in the TAZs should be updated to reflect the existing year. The whole model's ZDATA should be updated.
- Trips generated by prominent activity centers should be compared and evaluated with the actual traffic counts (where appropriate). If differences exist, TAZ productions or attractions must be adjusted using the ZDATA3 input file.
- Travel characteristic data should be modified within the TAZs using updated origin and destination surveys and other data sources (where appropriate).

Note that none of the adjustments outlined above should be made without just cause.

Once all refinements have been completed, the entire model should be rerun. An analysis should first be conducted on the entire model to ensure that the refinements in the project area of influence did not negatively impact the overall model validation (*see* Section 4.4.2). When it has been established that the entire model operates on the same level of accuracy or perhaps at an improved level, the project area of influence should be analyzed on its accuracy (*see* Figure 4.1 for standards) and its size. If significant changes occur outside the preliminary project area of influence, determine whether changes to the project area of influence are required. Based on this analysis it should be determined if the project area of influence should be expanded to include the affected facilities and if other development mitigation infrastructure improvements are required.

Expansion of the project area of influence may also require reexamination of the base year model volumes with the base year ground counts throughout the expanded project area of influence. If the project model evaluation is not acceptable through the entire expanded project area of influence, it may be required to make further base year model refinements to achieve acceptable volumes and repeat travel demand forecasting. Close coordination should take place with the District Planning Office to reach a level of accuracy that is acceptable, as described in Section 4.6.2.



## **4.11 TRAVEL DEMAND FORECASTING MODEL ADJUSTMENT PROCEDURES**

After the validation of the model (as a whole and within the project area of influence) is accepted, the model is ready to use for future year traffic forecasts.

### **4.11.1 Evaluation of Future Year Conditions**

The validated model will require appropriate future year data inputs to perform traffic forecasts for the future years. In each of the future years, the following travel demand forecasting model inputs should be summarized:

- transportation network
- socio-economic/land use data
- travel characteristics

Each of these factors should be updated to reflect the approved elements of the MPO financially feasible long range plan, Master Plans and planned development mitigation infrastructure improvements anticipated to be in place in each analysis year.

### **4.11.2 Future Years Land Use**

Any land use changes within or adjacent to the project area of influence (different from the land use in the model TAZ input) that could cause a significant change in trip generation should be identified. It is important that the adequacy of the socio-economic data be established and reflected in the project area of influence. ZDATA changes should be coordinated with the agency responsible for the model being used.

### **4.11.3 Future Years Network**

For the future year, the elements of the five year work program, MPO Transportation Improvement Program (TIP), and committed development mitigation improvements should be considered as planned and programmed improvements. Urban models include improvements for 20 to 25 years in the future. Generally, this is the starting point. It may be appropriate to use this data and to interpolate or extrapolate AADT as necessary.

For discussion on Reasonable Checks for Future Years and Acceptable Model Refinements for Future Years refer to Sections 4.7.2 and 4.7.3.



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## 4.12 EVALUATE MODEL TRAFFIC OUTPUT

The forecasted model traffic must be evaluated for reasonableness by the traffic forecasting engineer. The best method of evaluation is to develop traffic forecasts based on historical trends following the steps identified in Chapter 5. These trend based forecasts should then be compared to those generated by the model. Differences in volume in excess of 10% in high volume areas or 4,000 vehicles per day should be further evaluated in an effort to explain the disparity. Model traffic assignments should be converted from PSWADT to AADT before comparing with the traffic projection based on historical trends. If valid explanations for the differences cannot be determined, then either the model or the trend volumes may not be appropriate for use in the Project Traffic Forecasting Report. 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.

Complete documentation of the traffic projection process, including reasonableness evaluation, must be included in the Project Traffic Forecasting Report. Where the forecasted model traffic is to be utilized for alternative corridor assignments, additional evaluation for reasonableness must be performed. Screenlines and overall distribution of traffic assignments within the evaluated areas must also be considered.

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## 4.13 DOCUMENTATION OF TRAFFIC FORECAST

When using model output for determining project traffic forecasting, plots of the study area should be maintained in the file. 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 Project Traffic Forecasting Report. This information should then be utilized in the development of forecast year turning movements, axle loadings and LOS analyses as defined in this handbook.



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CHAPTER FIVE

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**TRAFFIC FORECASTING WITHOUT A TRAFFIC MODEL**

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**5.1 PURPOSE**

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

**5.2 INTRODUCTION**

This section provides a description of the appropriate methods and examples for forecasting future traffic in areas without a model, and provides a basis of comparison to model forecasts in areas with a model.

**5.3 BACKGROUND**

For areas without a model, forecasts are normally based on historical trends; growth rates may also be developed utilizing gasoline consumption reports, census data, and by working with the county, city, and their comprehensive plans. Normally a linear growth is assumed. When historical AADT data is used, a linear regression is calculated using the most recent ten years of data, when available. Special care should be used to negate counts that might be obviously out of sync with other years.

Forecasters rely on different techniques depending on the available information. Growth rates from historic traffic counts, adjusted to AADT by application of factors, are derived and checked for reasonability. The growth rates are then applied to a base year count and projected forward to the design year. Also, it is important to consider the capacity when extrapolating. Projections should show traffic **demand**, and not be constrained. The roadway itself does the constraining as traffic becomes congested. If the demand is for a six-lane facility and a four-lane is being designed, it should be noted in the Project Traffic Forecasting Report that four lanes will not be adequate for a 20-year design, and steps should be taken to address the potential short fall. To arbitrarily constrain traffic does nothing to address future congestion.



## 5.4 PROJECT TRAFFIC FORECASTING PROCEDURE WITHOUT A MODEL

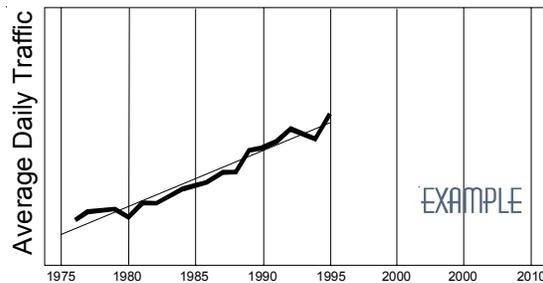
### 5.4.1 Data Assembly

The following items should be assembled, when available and applicable, in preparing a Project Traffic Forecast, when a travel demand model is not available (also *see* Section 5.5 — Available Resources):

1. Mapping or other roadway location drawings of the facility requiring traffic projections (Project Location Map).
2. Graphical representation of existing lane arrangements (SLD, aerial photography, intersection sketches, etc.).
3. Resources for determining traffic growth trends:
  - a) Historical traffic count data (current plus nine earlier years of mainline traffic preferred but if ten years of data is not available, current plus four or more earlier years of mainline and/or intersection approach volumes).
  - b) Gas sales records.
  - c) Land Use Mapping System (LUMS).
4. Traffic factors:
  - a) **K<sub>30</sub>** — This factor is derived from permanent traffic count stations with similar environments and unconstrained volumes as identified in FDOT's 200 Highest Hour Traffic Count Report. The design "K" presented in this report represents 30th highest hour. If the location is known on the State Highway System, current information can be obtained from RCI Feature 331.
  - b) **D<sub>30</sub>** — This factor can be derived from one of the following: the permanent traffic count station that the K<sub>30</sub> factor was taken from, an FDOT Classification Station in or near the study area or a 72-hour project specific classification count taken within the project limits. The Design 'D' factor is the average of D-factors for 28th through 32nd hour.
  - c) **T** — The T factor, for either 24 hours or the design hour, can be derived from either an FDOT Classification Station in or near the study area or a 72-hour project specific classification count taken within the project limits.
5. Local Government Comprehensive Plan (land use and traffic circulation elements).

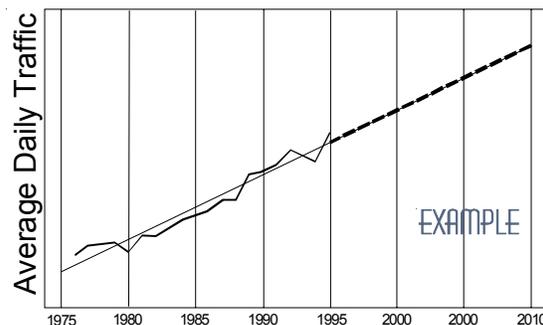


6. Description of existing and future land uses which contribute traffic that would use the proposed facility.
7. Current Highway Capacity Manual (HCM) and relevant software.
8. Current FDOT Level of Service Manual and relevant spreadsheets based on the HCM methods.
9. The opening and design years.
10. Current and historical population data.



#### 5.4.2 Establish Traffic Growth Trend

1. Plot historical AADT at a convenient scale with traffic volume on y axis and year of count on x axis (leaving room for future year and traffic growth).
2. Use least squares regression analysis combined with graphical representation of traffic growth trends.
3. If historical count data are insufficient, prepare a similar analysis of alternative indicators (gas sales data, LUMS, population data).



#### 5.4.3 Develop Preliminary Traffic Projection

1. Use empirically derived traffic growth trend equation to compute design year traffic volume.

**OR,**

2. Use graphical methods to project traffic volume from growth trend history to the design year.

#### 5.4.4 Check Forecast For Reasonableness

1. If future year geometric and traffic control design characteristics are firmly established (i.e., fixed by adopted plan(s) or constraints) determine the future capacity of the roadway section. If design is flexible enough to satisfy unconstrained demand, skip to Step 3.



2. Compare the projected demand traffic volume to the available capacity. A constrained volume may be given, instead of an unattainable volume (e.g. a four-lane facility is 15 percent over capacity today and the project is for a six-lane facility, with trend analysis projections exceeding capacity for a six-lane facility). It should be noted in the Project Traffic Forecasting Report that the facility being designed will not be adequate for a 20-year design period.
3. 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 would underestimate the design year traffic. In such cases, 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 be expected to cause a reduction of the traffic forecast.

#### 5.4.5 Develop Project Traffic Forecast in Detail

1. If the subject roadway intersection is existing, use observed daily turning movement percentages at existing intersection(s) 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.
2. Review daily turning movements for consistency with special traffic generators, and transportation network characteristics in the vicinity. Use the ITE generation and logical trip distribution approach to adjust, if necessary.
3. Balance adjusted daily turning movement volumes to achieve directional symmetry. A simple way to do 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. See Chapter 6 for a more detailed discussion about projecting intersection turning movements.



Note that the TURNS5 spreadsheet will balance the turning movements automatically with approach volumes and "first guess" turning percentages.

4. Use  $K_{30}$  and  $D_{30}$  factors to develop directional design hour traffic projections in the peak periods. AM and PM forecasts usually involve reversing the peak direction of flow.
5. Review the AM and PM design hour volumes for consistency with the trip generation activity pattern of the projected land uses in the vicinity and adjust if necessary. Such adjustments are made with reference to observed differences in travel characteristics such as numbers of trips and directional splits that occur during morning and evening peak periods. Directional traffic counts collected at local land use sites may provide the necessary data or the ITE Trip Generation Manual may be used to obtain the peak period trip generation characteristics of various land use/special generator sites.

#### 5.4.6 Analysis of Projections

1. For Project Traffic and Intersection Analysis Reports for use in District Environmental studies, the following analysis should be performed:
  - a) Perform intersection analysis utilizing the most recent version of the HCM software. Adjust auxiliary lane requirements as necessary to obtain an acceptable LOS. Justification must be made for any and all lanes added above and beyond the existing conditions. Only Transportation System Management improvements may be necessary to satisfy the projected demands.
  - b) Perform arterial analysis utilizing the most recent version of the ART\_PLAN software. Adjust intersection analysis as necessary to obtain an acceptable LOS.
2. For ESAL forecasting to be used in pavement design, perform LOS analysis utilizing the appropriate LOS spreadsheet. The LOS "D" volume derived for the appropriate number of lanes can be utilized in calculating the 18-KIP (80-kN) ESAL.

#### 5.4.7 Final Review and Documentation

1. 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 perform error checks to ensure that input traffic numbers have been correctly transcribed and traffic forecasting computations have been done correctly.



2. Prepare Project Traffic Forecasting Memorandum documenting procedures, assumptions, and results.
3. Prepare Project Traffic Certification Statement (*see* Project Traffic Forecasting Procedure, Figure 4) and obtain an authorized signature.

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## 5.5 AVAILABLE RESOURCES

In areas where a model is not available, resources have to be identified for assisting in the preparation of traffic forecasts. The following list presents available resources which could be reviewed in developing future traffic projections for areas without models and for checking traffic forecasts for areas with models:

- Historical county traffic growth rates, FDOT TranStat Publications
- Historical traffic counts, FDOT TranStat or district offices
- “National Cooperative Highway Research Program (NCHRP) Report” 255, “Highway Traffic Data for Urbanized Area Project Planning and Design”
- NCHRP 187, “Quick-Response Urban Travel Estimation Techniques and Transferable Parameters, Users Guide”
- Property appraisal data, Property Appraisal Office
- Local Government Comprehensive Plans (land use, traffic circulation, and transportation elements), FDOT district office/local government office
- Land Use Mapping System (LUMS)
- Area DRI/Applications for Development Approval (ADA), FDOT district office/regional planning council
- “Trip Generation Manual”, Institute of Transportation Engineers (ITE) (Current Version)
- Gas sales records, Governor’s Energy Office
- Motor vehicle registrations, Department of Highway Safety and Motor Vehicles
- MPO Long-Range Plan

Examples of factors, when available, which need to be taken into consideration in making forecasts for areas where models are not available are as follows:

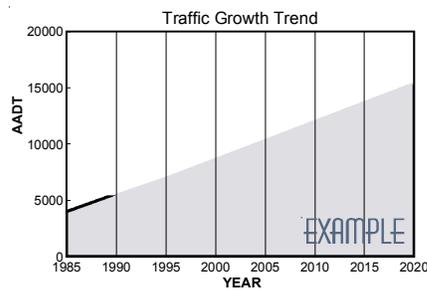
- Population
- Density
- City size
- LOS (existing)
- LOS standards
- Transit alternatives



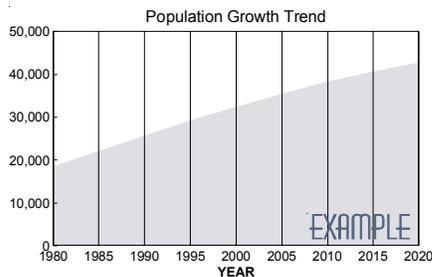
- Auto ownership
- Household income
- Residential/non-residential mix
- Freeway diversion
- Other unique area considerations
- Current and historical population data

## 5.6 PASCO COUNTY EXAMPLE

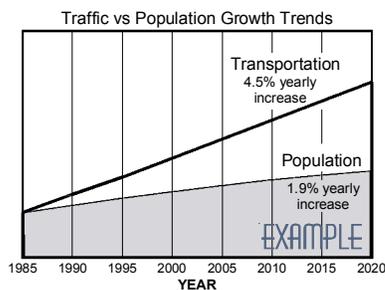
In Pasco County there is no acceptable model to forecast future traffic. The forecasting procedures used included trend projections for the year 2020 derived from straight-line growth based on historical traffic data from FDOT Count Station # 13 located on the



project. The growth trend at this station showed an average annual increase of 320 AADT. The growth trend which occurred between 1985 and 1994 was assumed to be applicable for forecasting existing traffic to the year 2020. Based on that assumption, traffic on this segment is expected to increase from 7100 AADT in 1994 to 15,500 AADT in 2020. This growth trend calculates to an average 4.5% linear increase per year.



According to FDOT's Population Projections 1995-2020, Pasco County is expected to increase in population from 28,700 in 1994 to 42,800 in 2020. The population projection calculates to an average 1.9% linear increase per year.



A comparison was then made to historical data. Pasco County's population increased from 18,599 in the 1980 census to 25,773 in the 1990 census. This was a 38.6% increase over a 10-year period, or an average 3.86% linear increase per year. By comparison, traffic increased from 2,000 AADT in 1980 to 5,800 in 1990. This is 290% over a 10-year period, or an average 29% linear increase per year. Therefore, it is apparent that the trend forecast which shows



future traffic increasing at a rate faster than the rate of population growth is not inconsistent with past trends. This is not surprising as SR 80 has been designated as part of the FIHS due to its importance on a regional and statewide level. With regard to the crossroad facilities, it was determined that the 1.9% annual linear increase for future population growth is also applicable to these facilities.

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## 5.7 SUMMARY

A project 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. Also, results obtained from travel demand models should be compared to forecasts by alternative procedures, such as a simple trends analysis, to check for reasonableness.

All of the districts rely on trend analyses for areas where models do not exist and as a guide for checking the model projections.



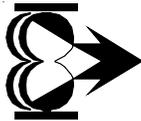
## CHAPTER SIX

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## CONVERTING MODEL VOLUMES TO DDHV

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### 6.1 PURPOSE



This chapter explains the procedure to convert daily model volumes into **Directional Design Hourly Volumes (DDHV)**.

### 6.2 INTRODUCTION

This chapter describes the appropriate methods for converting model volume outputs to **Average Annual Daily Traffic (AADT)** volumes. DDHV, obtained from the conversion of AADT, is used in the evaluation of roadway link and intersection LOS. This chapter also provides a method to obtain DDHV in constrained facilities.

### 6.3 BACKGROUND

FSUTMS uses many of the TRANPLAN modules for a major portion of the modeling structure. The various FSUTMS standard models simulate peak season trip productions and attractions from zonal distributions of residential, employment, and socio-economic input data. FSUTMS traffic assignment volumes represent **Peak Season Weekday Average Daily Traffic (PSWADT)** projections for the roads represented in the modeled highway network. The peak season is the 13 consecutive weeks of the year with the highest traffic volume demand. PSWADT is acceptable for planning purposes, yet road design criteria require the 30th highest hour of traffic of the year which is usually estimated from AADT.

A **Model Output Conversion Factor (MOCF)** is applied to the model generated PSWADT to obtain AADT. The MOCF is unique to the model being used and must be obtained from FDOT's Systems Planning Office. The other factors required to obtain **Design Hour Volume (DHV)** and DDHV from AADT are  $K_{30}$  and  $D_{30}$ . To assure consistency throughout Florida, districts should use a MOCF to convert PSWADT volumes from a FSUTMS model to AADT.

Project specific data are used to derive factors for obtaining DDHV from AADT. Project specific factors should be within the ranges of factors developed by FDOT from permanent count stations (*see* Figures 3.7 and 3.10). In most instances, there is adequate flexibility within the FDOT factors for application to individual projects.



### 6.4 DEVELOPMENT OF CONVERSION FACTORS

Weekly factors obtained from FDOT permanent count stations around the state are used to prepare annual updates of **Peak Season Conversion Factors (PSCFs)**. The PSCFs are used to convert a 24-hour count, representing the average weekday daily traffic, to PSWADT.

#### Sample Peak Season Factor Report for Bay County

Print Date: May/09/2002

Florida Department of Transportation  
Transportation Statistics Office  
**2000 Peak Season Factor Category Report**

BAY RECREATIONAL  
Category: 4600

MOCF = 0.75

Week	Dates	SF	PSCF
1	01/01/2000 - 01/01/2000	1.86	2.48
2	01/02/2000 - 01/08/2000	1.66	2.21
3	01/09/2000 - 01/15/2000	1.47	1.96
4	01/16/2000 - 01/22/2000	1.41	1.88
5	01/23/2000 - 01/29/2000	1.35	1.80
6	01/30/2000 - 02/05/2000	1.29	1.72
7	02/06/2000 - 02/12/2000	1.23	1.64
8	02/13/2000 - 02/19/2000	1.17	1.56
9	02/20/2000 - 02/26/2000	1.07	1.43
10	02/27/2000 - 03/04/2000	0.97	1.29
11	03/05/2000 - 03/11/2000	0.88	1.17
12	03/12/2000 - 03/18/2000	0.78	1.04
13	03/19/2000 - 03/25/2000	0.80	1.07
14	03/26/2000 - 04/01/2000	0.83	1.11
15	04/02/2000 - 04/08/2000	0.86	1.15
16	04/09/2000 - 04/15/2000	0.88	1.17
17	04/16/2000 - 04/22/2000	0.87	1.16
18	04/23/2000 - 04/29/2000	0.85	1.13
19	04/30/2000 - 05/06/2000	0.84	1.12
* 20	05/07/2000 - 05/13/2000	0.82	1.09
* 21	05/14/2000 - 05/20/2000	0.81	1.08
* 22	05/21/2000 - 05/27/2000	0.79	1.05
* 23	05/28/2000 - 06/03/2000	0.76	1.01
* 24	06/04/2000 - 06/10/2000	0.74	0.99
* 25	06/11/2000 - 06/17/2000	0.72	0.96
* 26	06/18/2000 - 06/24/2000	0.71	0.95
* 27	06/25/2000 - 07/01/2000	0.70	0.93
* 28	07/02/2000 - 07/08/2000	0.69	0.92
* 29	07/09/2000 - 07/15/2000	0.68	0.91
* 30	07/16/2000 - 07/22/2000	0.73	0.97
* 31	07/23/2000 - 07/29/2000	0.78	1.04
* 32	07/30/2000 - 08/05/2000	0.84	1.12
33	08/06/2000 - 08/12/2000	0.89	1.19
34	08/13/2000 - 08/19/2000	0.94	1.25
35	08/20/2000 - 08/26/2000	0.98	1.31
36	08/27/2000 - 09/02/2000	1.01	1.35
37	09/03/2000 - 09/09/2000	1.05	1.40
38	09/10/2000 - 09/16/2000	1.09	1.45
39	09/17/2000 - 09/23/2000	1.13	1.51
40	09/24/2000 - 09/30/2000	1.16	1.55
41	10/01/2000 - 10/07/2000	1.20	1.60
42	10/08/2000 - 10/14/2000	1.23	1.64
43	10/15/2000 - 10/21/2000	1.27	1.69
44	10/22/2000 - 10/28/2000	1.35	1.80
45	10/29/2000 - 11/04/2000	1.43	1.91
46	11/05/2000 - 11/11/2000	1.52	2.03
47	11/12/2000 - 11/18/2000	1.60	2.13
48	11/19/2000 - 11/25/2000	1.66	2.21
49	11/26/2000 - 12/02/2000	1.73	2.31
50	12/03/2000 - 12/09/2000	1.80	2.40
51	12/10/2000 - 12/16/2000	1.86	2.48
52	12/17/2000 - 12/23/2000	1.73	2.31
53	12/24/2000 - 12/30/2000	1.60	2.13
54	12/31/2000 - 12/31/2000	1.47	1.96

Note: "\*" indicates peak season week

**EXAMPLE** Page 1

Figure 6.1 Peak Season Factor Report



The Peak Season Factor Report includes the MOCF for each site. It identifies the 13 week peak season for each TTMS location and provides a multiplying factor (PSCF) for each week to convert a weekday 24-hour count to a PSWADT. It also provides a **Seasonal Factor (SF)** for each week to convert 24-hour weekday traffic counts to an AADT. A sample Peak Season Factor Report is shown in Figure 6.1 for Bay County site 0053.

#### 6.4.1 MOCF Derivation

The SF for each week is derived by interpolating between the Monthly Seasonal Factors (MSFs). The MSF is derived by dividing the AADT by the Monthly Average Daily Traffic (MADT) (*see* Section 2.4). The highest weekday volume occurs when the SF for a week is the lowest. The peak season is the 13 consecutive weeks during which the *highest* weekday volumes occur. The 13 week highest weekday volume occurs when the sum of SF for those 13 weeks is the lowest. The average SF of the 13 weekly SFs during the peak season is called the MOCF. MOCF used in validation to convert AADT to PSWADT for the base year model network should be used for adjusting future year model volume. The MOCF should be used when a model output (PSWADT) needs to be converted to AADT (*see* Section 6.4).

#### 6.4.2 Conversion Calculations

The **Peak Season Conversion Factor (PSCF)** is obtained by dividing the weekly SF by the MOCF. This factor should be used to obtain PSWADT from a short-term traffic count. For example, to convert a 24-hour count of 10,485 taken from Site 0053 on January 5, 1994 to PSWADT, use Figure 6.1 to find the PSCF for the week of January 2-8.

$$\begin{aligned} \text{Daily Count} \times \text{Peak Season Conversion Factor} &= \text{PSWADT} \\ 10,485 \text{ (Daily Count)} \times 2.21 \text{ (PSCF)} &= 23,170 \rightarrow 23,000 \text{ (PSWADT)} \end{aligned}$$

The SF is used to convert any weekday 24-hour count to AADT (*see* Section 2.4 for more information). For example, the same count above could be converted to AADT as follows:

$$\begin{aligned} \text{Daily Count} \times \text{Seasonal Factor} &= \text{AADT} \\ 10,485 \text{ (Daily Count)} \times 1.66 \text{ (SF)} &= 17,403 \rightarrow 17,500 \text{ (AADT)} \end{aligned}$$

The Peak Season Conversion Factor Report, Figure 6.3, shows the MOCF for a number of sites. Notice that each *site* has only *one* MOCF, but there is a PSCF and SF for each site for every week of the year as shown in Figure 6.1. Each district selects which counters are to be used to calculate the MOCF for each segment of the State Highway System. The final conversion factor may come from a single counter or a group of counters chosen by the district staff.



### 6.5 CONVERTING PSWADT TO AADT

FDOT has developed the MOCF to convert PSWADT volumes obtained from FSUTMS models to AADT volumes. Weekly PSCFs are available for the following seven categories based on the available data:

<u>Category</u>	<u>Roadway Description</u>
1	Urban Arterial
2	Rural Arterial
3	Urban Interstate
4	Tourist/Recreation Interstate
5	Rural Interstate
6	Urban Turnpike
7	Rural Turnpike

A sample of the FDOT Peak Season Conversion Factors is included in Figure 6.3

To obtain AADT, multiply the Peak Season Weekday Average Daily Traffic by the Model Output Conversion Factor.

$$AADT = PSWADT \times MOCF$$

#### EXAMPLE

Using Figure 6.3 as an example, obtain AADT by multiplying the model assigned link volume (PSWADT) by the appropriate MOCF found at the bottom of the table. If the model for Orange County/Disney link shows an assigned volume of 26,148 daily, AADT is obtained as follows:

$$26,148 \text{ (Model Output)} \times 0.96 \text{ (MOCF)} = 25,102 \rightarrow 25,000 \text{ AADT}$$

In another example, Figure 6.2 shows MOCFs by Count Sites (Permanent Count Stations). If the model shows an assigned volume of 30,052 at Count Site 460053, then AADT is calculated as follows:

$$\begin{array}{r}
 30,052 \text{ (Model Output)} \\
 \times \quad 0.83 \text{ (MOCF)} \\
 \hline
 = \quad 24,943 \text{ AADT} \\
 \rightarrow \quad 25,000 \text{ AADT}
 \end{array}$$

Figure 6.2  
MOCF Report

CoSite	MOCF
460053	0.83
460166	0.74
460192	0.91
470173	0.96
480082	0.97
480156	0.88
480159	0.98
490060	0.87
500054	0.93
500220	0.94
530050	0.82
530117	0.97
530218	0.90
549901	0.96

EXAMPLE



## EXAMPLE

Print Date: May/09/2002		Florida Department of Transportation Transportation Statistics Office			MOCF = 0.96
ORANGE 14 DISNEY		2000 Peak Season Factor Category Report			
Category: 7549	Week	Dates	SF	PSCF	
	1	01/01/2000 - 01/01/2000	1.04	1.08	
	2	01/02/2000 - 01/08/2000	1.06	1.10	
	3	01/09/2000 - 01/15/2000	1.08	1.13	
	4	01/16/2000 - 01/22/2000	1.06	1.10	
	5	01/23/2000 - 01/29/2000	1.05	1.09	
	6	01/30/2000 - 02/05/2000	1.03	1.07	
	7	02/06/2000 - 02/12/2000	1.02	1.06	
	8	02/13/2000 - 02/19/2000	1.00	1.04	
	9	02/20/2000 - 02/26/2000	0.99	1.03	
	10	02/27/2000 - 03/04/2000	0.98	1.02	
	11	03/05/2000 - 03/11/2000	0.97	1.01	
	12	03/12/2000 - 03/18/2000	0.96	1.00	
	13	03/19/2000 - 03/25/2000	0.97	1.01	
	14	03/26/2000 - 04/01/2000	0.98	1.02	
	15	04/02/2000 - 04/08/2000	0.98	1.02	
	16	04/09/2000 - 04/15/2000	0.99	1.03	
	17	04/16/2000 - 04/22/2000	0.99	1.03	
	18	04/23/2000 - 04/29/2000	0.99	1.03	
	19	04/30/2000 - 05/06/2000	0.98	1.02	
	* 20	05/07/2000 - 05/13/2000	0.98	1.02	
	* 21	05/14/2000 - 05/20/2000	0.98	1.02	
	* 22	05/21/2000 - 05/27/2000	0.98	1.02	
	* 23	05/28/2000 - 06/03/2000	0.97	1.01	
	* 24	06/04/2000 - 06/10/2000	0.96	1.00	
	* 25	06/11/2000 - 06/17/2000	0.96	1.00	
	* 26	06/18/2000 - 06/24/2000	0.95	0.99	
	* 27	06/25/2000 - 07/01/2000	0.95	0.99	
	* 28	07/02/2000 - 07/08/2000	0.94	0.98	
	* 29	07/09/2000 - 07/15/2000	0.94	0.98	
	* 30	07/16/2000 - 07/22/2000	0.95	0.99	
	* 31	07/23/2000 - 07/29/2000	0.96	1.00	
	* 32	07/30/2000 - 08/05/2000	0.97	1.01	
	33	08/06/2000 - 08/12/2000	0.98	1.02	
	34	08/13/2000 - 08/19/2000	0.99	1.03	
	35	08/20/2000 - 08/26/2000	1.01	1.05	
	36	08/27/2000 - 09/02/2000	1.02	1.06	
	37	09/03/2000 - 09/09/2000	1.04	1.08	
	38	09/10/2000 - 09/16/2000	1.06	1.10	
	39	09/17/2000 - 09/23/2000	1.05	1.09	
	40	09/24/2000 - 09/30/2000	1.04	1.08	
	41	10/01/2000 - 10/07/2000	1.02	1.06	
	42	10/08/2000 - 10/14/2000	1.01	1.05	
	43	10/15/2000 - 10/21/2000	1.00	1.04	
	44	10/22/2000 - 10/28/2000	1.01	1.05	
	45	10/29/2000 - 11/04/2000	1.01	1.05	
	46	11/05/2000 - 11/11/2000	1.02	1.06	
	47	11/12/2000 - 11/18/2000	1.03	1.07	
	48	11/19/2000 - 11/25/2000	1.03	1.07	
	49	11/26/2000 - 12/02/2000	1.03	1.07	
	50	12/03/2000 - 12/09/2000	1.04	1.08	
	51	12/10/2000 - 12/16/2000	1.04	1.08	
	52	12/17/2000 - 12/23/2000	1.05	1.09	
	53	12/24/2000 - 12/30/2000	1.07	1.11	
	54	12/31/2000 - 12/31/2000	1.08	1.13	

Note: "\*" indicates peak season week

Figure 6.3 Peak Season Factor Category Report



## 6.6 DEVELOPMENT OF DESIGN HOUR TRAFFIC VOLUMES

Design hour traffic is produced by applying  $K_{30}$  and  $D_{30}$  factors to AADT projections following appropriate adjustments as outlined in the Project Traffic Forecasting Procedure. The AADT projections may be the result of the conversion of model generated traffic projections (such as FSUTMS) or they may be produced by means of other techniques, such as trend analysis or growth factor application.

The  $K_{30}$  factor converts the 24-hour AADT to an estimate of two-way traffic in the 30th highest hour of the year which is required for design purposes. The result is called a Design Hour Volume or DHV. Appropriate  $K_{30}$  factors for design purposes at any given project location are developed from data obtained from permanent count stations around the state and are updated periodically by FDOT. The  $K_{30}$  factor used for design should represent unconstrained demand (i.e., it should be obtained from data measured at a location where the 30th highest hour traffic is not constrained by available capacity). See Section 6.8 for constrained facilities.

The  $D_{30}$  factor converts any DHV two-way traffic volume to an estimated Directional Design Hour Volume or DDHV. Appropriate  $D_{30}$  factors are developed and updated in the same manner described above. By convention, the  $D_{30}$  factor always pertains to the peak direction of traffic flow during the design hour.

Using both (i.e.,  $K_{30}$  and  $D_{30}$ ) factors, the estimated DDHV is obtained by the following equations:

$$\text{DDHV (Peak Direction)} = \text{AADT} \times K_{30} \times D_{30}$$

$$\text{DDHV (Opposing Direction)} = \text{AADT} \times K_{30} \times (1 - D_{30})$$

Using the above procedures, DDHV project traffic forecasts are generated for roadway links and intersection turning movements as needed to satisfy design requirements.



## 6.7 LOS OPERATIONAL ANALYSIS

The Highway Capacity Manual (HCM) procedures should be used for obtaining LOS. FDOT's 2002 LOSPLAN Software may be used in conjunction with HCM. Traffic Forecasting calculations require  $K_{30}$  to produce 30th highest hour traffic projections. FDOT Generalized LOS Tables are **not** applicable for traffic forecasting analysis because they are based on  $K_{100}$  and intended to be used for general planning applications.

The LOS analyses are to be performed in accordance with the most current procedures in the HCM and FDOT's Quality/Level of Service Handbook.

FDOT's procedures are acceptable methods for LOS determination, lane call, and intersection laneage. HCM equivalent software approved by FDOT may also be used.

FDOT's LOSPLAN software was developed specifically for project development applications. Elements of LOSPLAN include:

TEMPLATE	Road Type
ARTPLAN	arterials
FREEPLAN	freeways
MIGHPLAN	uninterrupted flow two-lane and multilane highways

The software is based on the 2000 Highway Capacity Manual Update.

Determine LOS using the most recent LOSPLAN or HCM procedures which include intersections, mainline segments, HOV lanes, ramps, and weaving lanes. Compare the results with FHWA and FDOT LOS design standards. One of three different draft reports will be required based on the results. The three draft reports are as follows: LOS Standards Met, Constrained, Exception Received.



### 6.7.1 LOS Standards Met

If the project traffic forecasting LOS meets or exceeds the LOS standards, compile a draft report. This report should include all supporting documents used for the project traffic forecasting process. The draft report should document traffic parameters AADT,  $K_{30}$ ,  $D_{30}$ , and T. It should be stated that the project traffic forecast LOS meets or exceeds the LOS design standard.

### 6.7.2 Constrained

If the project traffic forecast LOS does not meet the minimum LOS design standards, the proposed project section must be designated as “constrained.” The draft report of a constrained project should document traffic parameters AADT,  $K_{30}$ ,  $D_{30}$ , and T. It should be stated that the project traffic forecast LOS does not meet the LOS design standard.

### 6.7.3 Exception Received

If an exception to the minimum LOS design standard for federal participation on the project is to be requested of FHWA, document that the project will improve current traffic conditions and will relieve congestion even if the desired LOS can not be obtained. If an exception to the LOS standard is received and agreement for federal participation is reached with FHWA, draft a Project Traffic Forecasting Report. The draft report should document traffic parameters AADT,  $K_{30}$ ,  $D_{30}$ , and T. It should include a statement that the project traffic forecast LOS does not meet the LOS design standard and a statement about the “exception received.”

If no exception to the LOS design standard was granted, compile a draft report as in Section 6.7.2.



## 6.8 CONSTRAINED FACILITIES

By FDOT definition, “Constrained roadways are roads on the State Highway System which FDOT has determined will not be expanded by the addition of two or more through lanes because of physical, environmental, or policy decision.” Further, “Physical constraints primarily occur when intensive land use development is immediately adjacent to roads, thus making expansion costs prohibitive. Environmental and policy constraints primarily occur when decisions are made not to expand a road based on environmental, historical, archaeological, aesthetic, or social impact considerations” (Source: “Quality/Level of Service Handbook,” 2002.)

For model project traffic projections, the FSUTMS model would be coded to reflect the constrained number of lanes and standard traffic forecasting procedures which apply. Traffic smoothing adjustments are, as with other model forecasts, to be reviewed in the development of model traffic forecasts.

For trend and other traffic projections, procedures such as the National Cooperative Highway Research Program (NCHRP) Report 187, “Distribution of Assigned Volumes Among Available Facilities” should be considered. Per the report,

“The underlying assumption of the redistribution procedure is that forecast-year volumes on parallel facilities tend to be distributed proportionally to the volumes as observed on the facilities in the base year. Further stated, if no capacity changes (widening, new facilities, etc.) occur between the year observations were made and the forecast year, the forecast-year volumes on the links intercepted by the screenline are inclined to be proportional to the base-year volume. All capacity changes to the forecast-year system are interpreted as new facilities - including widening of existing facilities.”

In other words, the existing capacities are used as guidelines for developing traffic forecasts. Adjustments are to be made to the distribution for the constrained facility in relation to the impact that the constrained capacity has on the overall existing distribution capacity and future capacity.

The constrained condition might cause the constrained facility to exceed accepted minimum LOS standards. Several iterative steps may be needed prior to finalizing DHV and DDHV so that project volumes will meet FDOT accepted standards. Use of standard  $K_{30}$  factors should be reviewed for applicability in converting constrained facility AADTs, based on model PSWADTs or based on manual projections, to DHVs and DDHVs. The DHVs and DDHVs may be governed by the capacity of the constrained facility rather than the standard  $K_{30}$  factor.

When a desired number of lanes cannot be achieved because of a determination that the subject facility is constrained, the Project Traffic Forecasting Procedure requires an analysis of whether or not an acceptable LOS could be obtained at the constrained facility by reducing its traffic load. Methods for achieving such traffic reductions include



### CONSTRAINED FACILITY LOS BREAKDOWN YEAR

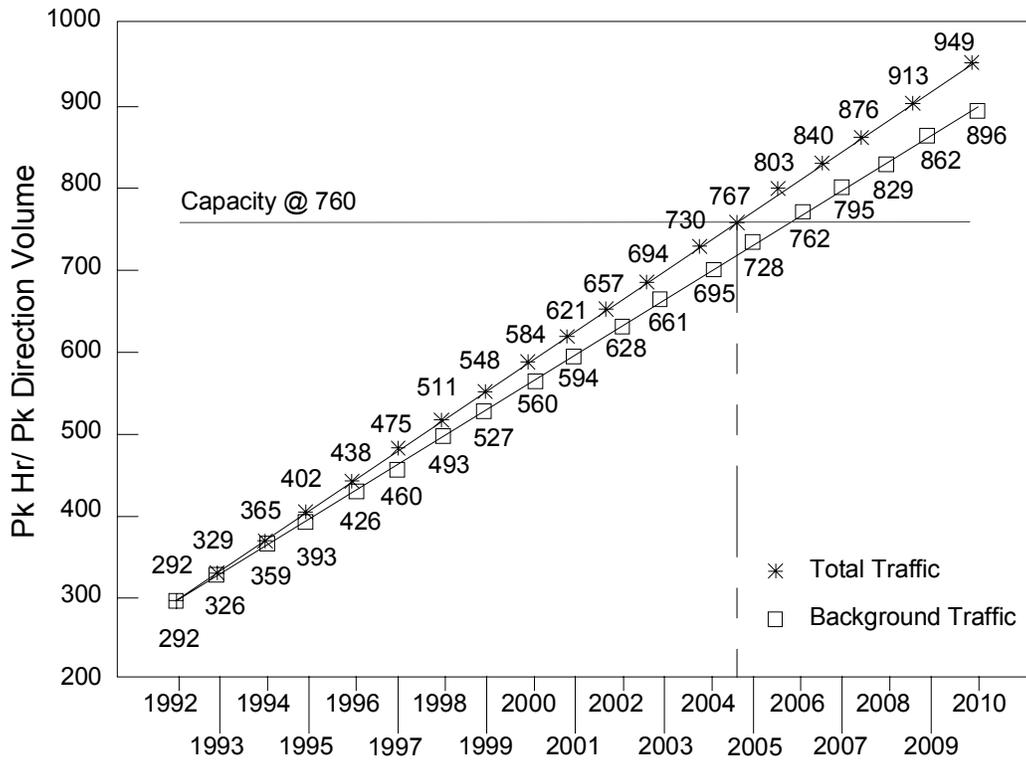


Figure 6.4 Constrained Facility LOS Example

improving a parallel facility, increasing vehicle occupancy, providing transit alternatives, implementing congestion pricing strategies, offering staggered work hour programs, or applying restrictions to future growth. The congestion reduction strategies may require a return to the Systems Planning step for a reiteration of the network configuration, available mode attributes, land use, trip generation, distribution, mode choice, and assignment components to revise previous system traffic forecasts. After the reiteration, the DHVs and DDHVs are redeveloped.

In the project development phase, it is critical to estimate the year when the constrained facility will fail to operate at a desirable LOS. A simple procedure for obtaining the breakdown year involves obtaining existing and future year DDHV traffic projections for the constrained facility. Trend analysis is applied to the data to obtain intermediate and additional traffic projections. The projected DDHVs are compared to the minimum LOS volume and the year of breakdown is identified as shown in Figure 6.4. It should be emphasized that actual future year LOS for arterial facilities depends on the expected delay at signalized intersections and overall arterial speed.



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## 6.9 SUMMARY

The MOCF for converting the model output PSWADT to AADT should be obtained from the Systems Planning Office. The  $K_{30}$  and  $D_{30}$  factors used to derive DHVs and DDHVs from AADTs should fit within the established FDOT ranges. For the evaluation of forecast methodology and traffic operations, the HCM procedures are recommended. Other software emulating HCM methodology may be approved by the district as long as input variables are provided to run HCM for comparison.

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## 6.10 PRACTICAL EXAMPLES

This chapter contains three practical examples relating to the development and analysis of traffic forecasting volumes. Section 6.10.1 — “Example 1 - Development of DDHVs from Model PSWADTs,” demonstrates how recommended procedures are applied in converting FSUTMS model volumes to project design volumes. The second example in Section 6.10.2 — “Example 2 - Obtaining Design Factors,” illustrates how system wide design factors, together with field observed factors, can be evaluated to make recommendations for design factors to be used for project specific traffic analysis. The third example in Section 6.10.3 — “Example 3 - HCM LOS Volumes,” provides an example for how HCM can be used in the development of site specific LOS service flow volumes.



### 6.10.1 EXAMPLE 1 – Development of DDHVs from Model PSWADTs

Assume, as an example, that an urban interstate highway in Orlando is being studied for future widening. Existing laneage within the study area is to be widened from four lanes to six lanes. Following a mini-calibration within the study area, the Year 2010 Urban Area Transportation Study projects 75,000 PSWADT on the studied link for the existing plus committed network (year 2000).

Consider the project as an urban freeway. The MOCF for this urban interstate is 0.921 (see Figure 6.1). Accordingly, the following AADT derivation applies:

$$\begin{aligned}\text{AADT} &= \text{PSWADT} \times \text{MOCF} \\ &= 75,000 \times 0.921 \\ \text{AADT} &= 69,075 \text{ vpd}\end{aligned}$$

As outlined in the FDOT Project Traffic Forecasting Procedure, the design factors for urban freeways range between 0.940 to 0.100 for  $K_{30}$  (Figure 3.7) and between 0.504 to 0.612 for  $D_{30}$  (Figure 3.10). Given the high distribution of tourist trips and existing field traffic counts for the studied link, the observed  $K_{30}$  factor of 0.08 and  $D_{30}$  factor of 0.50 indicate constrained roadway conditions. However, the Department's 200th Highest Hour Traffic Count Report indicates a  $K_{30}$  of 0.094 and a  $D_{30}$  of 0.55 for unconstrained facilities with the corresponding facility and area types. The resulting unconstrained DHV and DDHV are derived below:

$$\begin{aligned}\text{DHV} &= \text{AADT} \times K_{30} \\ &= 69,075 \times 0.094 \\ \text{DHV} &= 6,493 \text{ vph} \\ \text{DDHV} &= \text{DHV} \times D_{30} \\ &= 6,493 \times 0.55 \\ \text{DDHV} &= 3,571 \text{ vph}\end{aligned}$$



## 6.10.2 EXAMPLE 2 – Obtaining Design Factors

The following example describes the procedure that was used to develop traffic forecasting factors for an Interchange Modification Report (IMR) prepared for a location covered by an approved MPO travel forecasting model.

As a preparatory step, the FSUTMS based model was used to perform a mini-validation for the IMR study area. Seasonal adjustment factors were then applied to convert the model generated PSWADT to represent AADT. For further conversion of AADT to DDHV, traffic forecasting factors are required.

Several sources were consulted in reviewing applicable traffic forecasting factors. A permanent count station exists in the IMR study area. It provided area specific  $K_{30}$  factors for rural interstate. In 1990, per FDOT's "200th Highest Hour Traffic Count Report," the  $K_{30}$  factor was calculated as 9.40% and the  $D_{30}$  factor was calculated as 61.49%. In 1991, the  $K_{30}$  factor was 9.05% and the  $D_{30}$  factor was 57.12%. Three day 24-hour field traffic counts were also gathered on selected roadway links in the IMR study area. The average interstate project K and D factors were 7.48% and 52.64% respectively. The average non-interstate project K and D factors were 9.35% and 70.33% respectively. Field observed T factors were 10.6% daily and 5.6% peak hour on the interstate. On the intersecting roadway, T factors were 5.3% daily and 8.6% peak hour.

Site-specific factors were derived by FDOT Central Office for the IMR study area. The site-specific factors were based on system-wide design factors set by FDOT for the state. The interstate route was recommended to have an average or higher rural  $K_{30}$  factor in the short-term to reflect higher recreational and tourist trips (11.8% to 14.6%). In the long-term, as the interstate transitions into an urban interstate roadway, an urban interstate  $K_{30}$  factor towards the high end of the range was recommended (~10.0%). An average value is applicable for non-interstate roadways (rural–11.0%, urban–10.2%). Site specific  $D_{30}$  factors were not recommended, other than to emphasize that in the long range, future  $D_{30}$  factors will be reduced to reflect the transition of the study area to an urbanized area. Site-specific T factors were not recommended except for the design hour which should be half of the daily percentage.

Based on a review of the field and site specific FDOT recommendations, the following design factors were selected:

### $K_{30}$ factor:

- 9.6% for all roadways (interstate and non-interstate for study years 2000, 2010, and 2020;

### $D_{30}$ factors:

- 55% for the intersecting roadway;
- 60% for other non-interstate roadways in study years 2000, 2010, and 2020;



- 60% for the interstate mainline and ramps in study year 1998 (Build and No Build);
- 57% for the interstate mainline and ramps in study years 2010 and 2020 (build and no build);

**Truck factors:**

- 6% daily/3% peak hour for the non-intersecting roadways in study years 2000, 2010, and 2020;
- 12% daily/6% peak hour for the interstate mainline and ramps in study year 2000, 2010, and 2020; and
- 4% daily/2% peak hour for other roadways in study years 2000, 2010, and 2020.

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### 6.10.3 EXAMPLE 3 – HCM LOS Volumes

This example is taken directly from the Highway Capacity Manual.

1. **Description** - A two-lane rural highway carries a peak hour volume of 180 vph and has the following characteristics:
  - a. **Roadway characteristics** - 60 mph design speed; 11 ft. lanes; 2 ft. shoulders; mountainous terrain; 80% no passing zones; length = 10 miles.
  - b. **Traffic characteristics** - 60/40 directional split; 5% trucks; 10% recreational vehicles; no buses; 85% passenger cars.

At what LOS will the highway operate during peak periods?

2. **Solution** - The solution is found by comparing the actual flow rate to service flow rates computed for each LOS. The actual flow rate is found as:

$$v = V/PHF$$

where:  $V = 180$  vph (Given);  
 $PHF = 0.87$  (Default value, Table 8-3, 200 vph)  
 and:  $v = 180/0.87 = 207$  vph

Service flow rates are computed from Equation. 8-1:

$$SF_i = 2,800 \times (v/c)_i \times f_d \times f_w \times f_{HV}$$

$$f_{HV} = 1/[1 + P_T(E_T - 1) + P_R(E_R - 1) + P_B(E_B - 1)]$$

where:  $v/c = 0.02$  for LOS A, 0.12 for LOS B, 0.20 for LOS C, 0.37 for LOS D, 0.80 for LOS E (Table 8-1, mountainous terrain, 80% no passing zones);



$$f_d = 0.94 \text{ (Table 8-4, 60/40 split);}$$

$$f_w = 0.75 \text{ for LOS A through D, 0.88 for LOS E}$$

(HCM Table 8-5, 11 ft. lanes, 2 ft. shoulders);

$$E_T = 7 \text{ for LOS A, 10 for LOS B, C, 12 for LOS D, E}$$

(HCM Table 8-6, mountainous terrain);

$$E_R = 5.0 \text{ for LOS A, 5.2 for LOS B-E}$$

(HCM Table 8-6, mountainous terrain);

$$P_T = 0.05 \text{ (Given); and}$$

$$P_R = 0.10 \text{ (Given).}$$

then:

$$f_{HV}(\text{LOS A}) = 1/[1 + 0.05(7 - 1) + 0.10(5.0 - 1)] = 0.588$$

$$(\text{LOS B, C}) = 1/[1 + 0.05(10 - 1) + 0.10(5.2 - 1)] = 0.535$$

$$(\text{LOS D, E}) = 1/[1 + 0.05(12 - 1) + 0.10(5.2 - 1)] = 0.508$$

and:

$$SF_A = 2,800 \times 0.02 \times 0.94 \times 0.75 \times 0.588 = 23 \text{ vph}$$

$$SF_B = 2,800 \times 0.12 \times 0.94 \times 0.75 \times 0.535 = 127 \text{ vph}$$

$$SF_C = 2,800 \times 0.20 \times 0.94 \times 0.75 \times 0.535 = 211 \text{ vph}$$

$$SF_D = 2,800 \times 0.37 \times 0.94 \times 0.75 \times 0.508 = 371 \text{ vph}$$

$$SF_E = 2,800 \times 0.80 \times 0.94 \times 0.88 \times 0.508 = 941 \text{ vph}$$

If the actual flow rate of 207 vph (which represents the flow rate during the peak 15 minutes of flow) is compared to these values, it is seen that it is higher than the service flow rate for LOS B (127 vph), but it is less than the service flow rate for LOS C (211 vph). Therefore, the LOS for the highway is C for the conditions described.

Source/Note: See the “Highway Capacity Manual, Special Report 209,” for referenced equations and tables (page 8-23).



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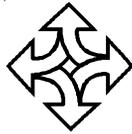
## CHAPTER SEVEN

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## ESTIMATING INTERSECTION TURNING MOVEMENTS

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### 7.1 PURPOSE



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

This chapter highlights the past and current practices for projecting the intersection turning movements, including a user's guide to TURNS5A. This chapter explains the following:

- Need for balancing
- TURNS5A methodology
- TURNS3
- TMT00L, J.K. TURNS
- Manual Technique
- Model, Volume Technique
- Growth Factor Technique
- NCHRP 255
- H. J. Van Zuylen
- Summary of techniques

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### 7.2 INTRODUCTION

Future year estimates of **peak hour intersection turning movements** are required for intersection design, traffic operations analyses and DRI/site impact evaluations. In most major urban areas, traditional travel demand forecasting models such as the Florida Standard Urban Transportation Model Structure (FSUTMS) can provide forecasts of daily intersection turning movement volumes. This section discusses the use of FSUTMS to provide daily intersection turning movement volumes. Model turns are considered to be highly suspect and are used only in cases where new alignments are being developed. Manual methods have also been used in both urban and rural areas where models are not available. Because of the difficulties involved in generating peak hour volumes directly from an urban area model for every possible intersection within a given study area, 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.



## 7.3 BACKGROUND

A review of the methods currently available for use in developing intersection turning movements indicates that many of the methods can be categorized as “**intersection balancing**” methods. 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.

These balancing techniques are used to adjust existing counts as well as model generated counts. The balancing techniques are also done for corridor development. The assignment of future turn paths is estimated, and often the departure and arrival between intersections on the same link will require manual balancing. The algorithms used for the balancing may not be capable of achieving the desired tolerance. 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, and other curb cuts which influence the traffic at intersections. The roadway network coded in the model generally includes all important freeways, arterials, other collectors, and local roads. However, some collectors and local roads that are not coded may be the key roadways serving the specific project influence area. To account for the missing roadways and missing driveway information, balancing techniques are used to generate turning movement traffic volumes.

Most algorithms that have been developed to date are somewhat interrelated and involve the application of an iterative procedure that balances future year turning movements based on existing turning movement counts, approach volumes and/or turn proportions. Spreadsheets are usually utilized for the efficient implementation of “intersection balancing” methods. These balancing methods can be used for peak hour volumes required by traffic operations engineers, future traffic movements for traffic forecasting engineers, or any other application which requires balancing intersection movements.

The following sections of this chapter present an overview of each of the primary methodologies used by FDOT including the input data required and the relative ease of application. The majority of districts are using TURNS5A, and a users manual has been developed for TURNS5A to supplement the **Project Traffic Forecasting Procedure**. Additional methodologies that are currently used by FDOT include TMT00L and the Manual Method. The methods suggested by H. J. Van Zuylen,<sup>1</sup> and applied by Hauer et al.,<sup>2</sup> Mark C. Schaefer, and others<sup>3</sup> as well as pertinent methods included in “Highway Traffic Data for Urbanized Area Project Planning and Design” National Cooperative Highway Research Program (NCHRP) 255 Report<sup>4</sup>, are also discussed in Sections 7.10 and 7.11.

### ENDNOTES

- 1 "The Estimation of Turning Flows on a Junction," Traffic Engineering Control, Vol. 20, No. 12, Dec. 1979
- 2 "Estimation of Turning Flows from Automatic Counts," Transportation Research Board, Record No. 795, 1981.
- 3 "Estimation of Intersection Turning Movements from Approach Counts," ITE Journal, October 1988.
- 4 "Highway Traffic Data for Urbanized Area Project Planning and Design" National Cooperative Highway Research Program (NCHRP), TRB Record No. 255, December 1982.
- 5 TURNFLOW (Copyright 1988, Mark C. Schaefer), supported and distributed by the McTrans Center, University of Florida, 512 Weil Hall, Gainesville, FL 32611-2083
- 6 TURNS3, developed by FDOT, District 1, 801 Broadway Avenue, Bartow, Florida 33830
- 7 "Estimation of Turning Flows from Automatic Counts," Transportation Research Board, Record No. 795, 1981.



## 7.4 TURNS5A BACKGROUND

Generally, the accepted program for determining future year turning movements is TURNS5A. TURNS5A combines the most desirable features from the TURNFLOW and TURNS3 & 4 programs. It is used to develop future year turning movements based on one of two methods. The first method allows for the user to enter an existing year AADT and specify simple growth for three other periods (normally project opening, mid-design and design years). The second method allows for the user to input an existing year AADT and model forecast year AADT. The program will then interpolate or extrapolate for three other periods. It provides output of AADTs and DHVs, and allows for comparisons and smoothing to ensure that the user is producing reasonable results.

TURNS5A was developed by Transportation Engineering, Inc. and Greiner, Inc., as a tool for the estimation of future turning volumes. TURNS5A is an Excel (Version 5.0 or higher) template which was developed by merging together two other programs currently in use by several districts of FDOT and creating a user driven menu and “file folder” windows for easier use. TURNFLOW<sup>5</sup> and TURNS3<sup>6</sup> form the basic framework of the TURNS5A program.

TURNFLOW is an Excel 9 template that provides a spreadsheet structure for estimating intersection turning movements when only approach volumes are known. The spreadsheet uses a technique for solving and balancing turning movement volumes based on an initial estimate of turning proportions entered by the user. The program iteratively balances volumes until a minimum tolerance is reached. This procedure was developed by E. Hauer, E. Pagitsas and B.T. Shin<sup>7</sup>, as previously indicated.

TURNFLOW and its documentation can be obtained from the McTrans Center of the University of Florida. It should be noted that the software is copyrighted and the TURNS5A program creators have secured its use for FDOT. Other uses or applications not associated with TURNS5A should contact the program’s developer, Mr. Mark Schaefer, prior to using it.

TURNS5A combines the intersection balancing component of TURNFLOW with the same basic setup relating to output, menu options and format similar to TURNS3. TURNS3 provides estimates of intersection turning movements and produces traffic volume outputs in a format suitable for use in various traffic analysis reports associated with preliminary, PD&E/EMO and Design studies. TURNS3 was developed by FDOT's District One Office.

The use of the TURNFLOW program to balance intersection turning movements was chosen since the program balances inbound and outbound volumes for each approach. Since AADT’s are normally developed first in the traffic forecasting process, the program balances these values to achieve equal flow as is normally common to daily traffic flows. Design Hour Volumes (DHV) are then developed by applying approved  $K_{30}$  and directional distribution ( $D_{30}$ ) factors.



## 7.5 TURNS5A METHODOLOGY

TURNS5A is designed to develop future turning volumes based on AADT volumes for the existing year and growth rates or by using an existing year AADT and model year AADT. When using a model year the program can calculate (interpolate/extrapolate) project years (normally opening, mid-design and design years). The program will also develop three future years of AADT values by use of the existing year volumes and user specified growth rates (simple compounding) for each projection year.

The TURNS5A program will project future year AADT volumes and balance each year based on an initial guess of turning percentages for each AADT movement. Each year requested will be balanced using these initial guesses. It is recommended that the user input for these percentages be based on actual approach counts for the intersection. The initial guess will influence balanced AADT turning movement output. The balancing of the program does not produce exactly equal reciprocating movements for AADTs, thus the TURNFLOW “balanced” AADTs are further refined by adding each reciprocating movement together and rounding to the nearest hundred. This is done within the output section of the program (OUT1 described later). Balancing is done regardless of model generated growth or manually input growth rates. An example of the balancing logic used by TURNS5A is included in Appendix D.

### 7.5.1 Options for Future Traffic Growth

The program allows for two options in developing future year AADTs. The choice for either option is entered during the data input component of the program (described later). The two options were selected as they are the most common applications encountered during the development of project traffic forecasts.

### 7.5.2 Option 1 - FSUTMS Model Traffic Available?

The program will prompt the user (if using input prompts) if they developed future year volumes with FSUTMS. If yes, the user will input the existing year, year of the model, opening, mid-design, design years and AADTs for existing and model years. The program will then interpolate/extrapolate for the years requested.



### 7.5.3 Option 2 - Specify Growth Rates for Each Project Year

If the user does not select the FSUTMS Model Traffic Available option, the program will default to inputs for existing, opening, mid-design, design years, growth rate inputs (decimal values) and existing year AADT to project future year traffic volumes. Growth rates for each desired year are entered separately. The growth is compounded simply or via straight-line interpolation ( $(1 + (N * \text{growth rate})) * \text{Existing Year AADT}$ , where  $N = \text{Desired year} - \text{Existing year}$ ) rounded to the nearest hundred. The ability to enter differing growth rates for each year allows the user to simulate non-linear growth by changes in each growth rate from year to year. Growth rates based on compounding can also be simulated by either varying each year (slightly increasing the growth rate over time) or by simply recalculating the compounded growth to be simple growth.

In either option, the user can change years and obtain other periods to allow for year to year or multiple years (as required by FIHS studies) to evaluate the use of Transportation System Management (TSM) measures or other phased improvements.

It is important to note that the accuracy of predicted volumes is a function of the implied accuracy of user inputs. Existing and model year AADTs should be closely evaluated and checked for consistency with actual or proposed conditions for the roadway system under evaluation. Traffic counts should be checked for reasonableness of volumes and evaluated to identify vehicle flows into and out of the system for the existing condition. Reasonable assumptions for the model year must also be determined by the user. Random input of unchecked volumes or turning percentages will lead to errors of program closure (turning movement balancing) or unrealistic output values.

DHVs are calculated based on user developed  $K_{30}$  and  $D_{30}$  factors. Inputs are provided to enter factors for mainline and side streets. The  $K_{30}$  and  $D_{30}$  for the side streets are used to produce DHVs that are reasonable as compared to actual traffic counts (peak turning movements) or to vary conditions in the future. The  $D_{30}$  values for the mainline for each direction (east/west or north/south) must add to one. However, side street  $D_{30}$  values can be any number less than one to simulate peaks inbound or outbound of the intersection. Again, this option is provided to allow for more flexibility in providing design hour conditions.



## 7.6 MENU OPTIONS

Upon loading the program in EXCEL, the program will automatically be positioned at the main menu (START file folder). The following menu will appear

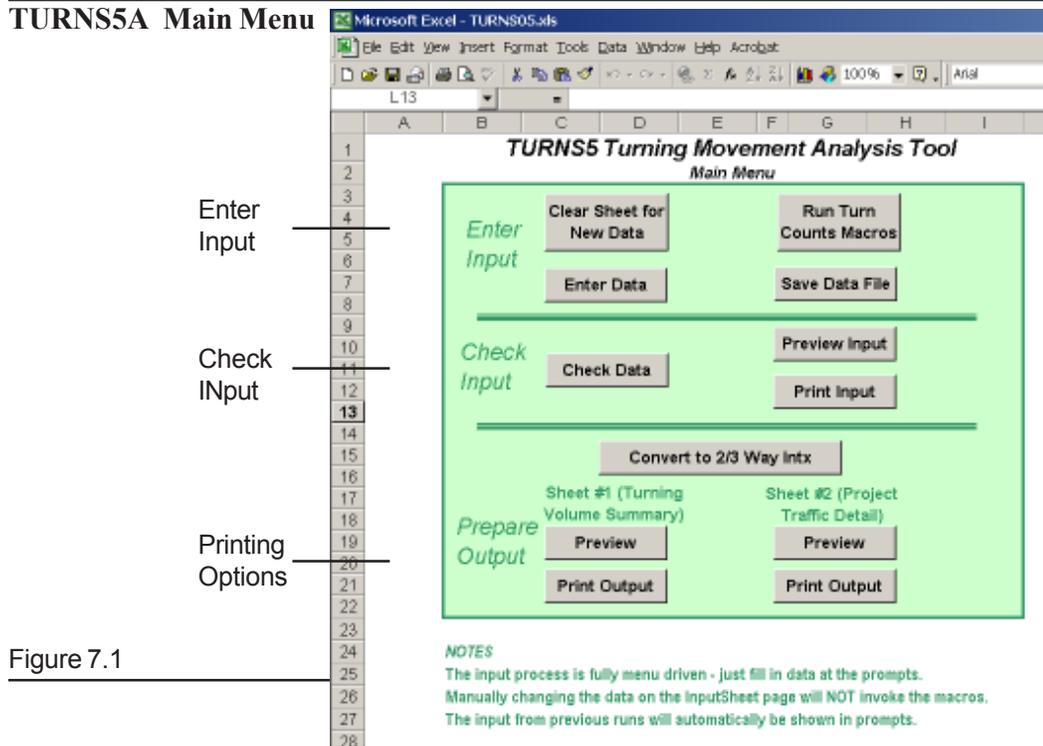


Figure 7.1

### OUT1 Screen Map

See Figure 7.5	Existing Year AADT	First Year AADT
	Second Year AADT	Third Year AADT
See Figure 7.6	Existing Year DHV	First Year DHV
	Second Year DHV	Third Year DHV
See Figure 7.7	Existing Year AADT	Existing Compared to First Year AADT
	Existing Compared to Second Year AADT	Existing Compared to Third Year AADT
See Figure 7.8 to Second Year	Actual Count Compared to Existing Year DHV	Actual Count Compared to First Year DHV
	Actual Count Compared to Third Year DHV	Actual Count Compared to Third Year DHV

The separate areas denoted above by the double lines are the individual output pages when the screens are printed.

Figure 7.2



### 7.6.1 File Folders

Each option is invoked simply by using the cursor on the push-buttons or file folder tabs for each selected option or desired file folder the user wishes to access.

START: Is the main menu.

INPUT: File folder with all input data.

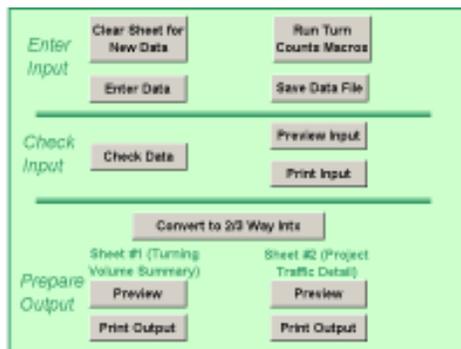
OUT1: Output folder number 1 contains the AADTs, DHVs, AADT comparisons and DHV comparisons. The screens are aligned as shown in Figure 7.2.

OUT2: The Initial Turning Movement Summary file folder with the directional daily volumes after being balanced using the TURNFLOW methodology. These values are further balanced in the OUT1 file folder. Please refer to the appended sample calculation using the TURNFLOW methodology.

CALCS: The file folder which does the TURNFLOW balancing. This area is for review only as the cells are protected (locked).

MACROS: The file folder which contains all the macros in the program. This area is for review only as the cells are protected (locked).

### 7.6.2 Main Menu Options:



CLEAR SHEET FOR NEW DATA: Clears any previous data within the program spreadsheets.

ENTER DATA: Allows the user to select which option to input data. The program will ask the user to select prompts or manual input. When using the **prompted** input command, the user must enter in data and use the “enter key” after each entry. **Be careful not to use the cursor keys as this will interrupt the input sequence.** At the end of each page of input the

user will be asked if the entered data is OK? If the user responds NO, then it will prompt the user through all data on that page. After the first page of input, the user will also be asked whether the AADTs for growth or growth rates were derived using an FSUTMS model. If the response is YES for FSUTMS, the cursor will go to those input areas and the program will interpolate/extrapolate desired years. If the response is NO, the cursor will go to the growth rate developed future AADT section of the program. Again, after completing this page of input the user will be asked if all input is OK?



The final input page asks for the initial turning percentages (in decimal form) to be entered, closure for the TURNFLOW balancing (default of 0.01 should be entered) and the actual turning movement counts the user wishes to use as a comparison against DHVs calculated by the program. The user will be asked again if all input data is correct. If YES, the user has completed the data input portion of the program using the prompted commands and will be returned to the main menu. To print out and check the information, first check if the right printer is selected in the ExcelFILE Printer Setup and press the PRINT\_3 button in the menu and it will be printed to the selected printer.

If the user responds NO to the prompted input option, the cursor will be positioned at the first input box of the first page of input. Simply enter data in the highlighted boxes and use the cursor key to traverse the input areas. The pages are located directly beneath each other and have directions to what cells to go to after “Y” or “N” has been entered in the FSUTMS Model input box. Once all manual data input is completed, use the cursor and select the START file folder to continue with the program.

**CONVERT TO 2/3 WAY INTS:** This command will set up or “build” intersections with two or three legs. It will allow the user to visually delete zero or unused approach legs, as appropriate. This menu option is not required when working on a four-legged intersection.

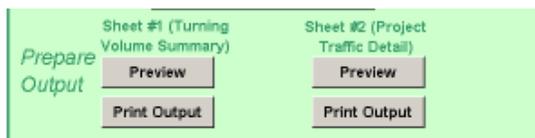
**RUN TURN COUNTS MACROS:** This command must be used to calculate balanced values after inputs are complete. The calculations are all macro driven.

**SAVE DATA FILE:** This command saves data entered.





### 7.6.3 Printing Options



PRINT\_1: Prints the data showing the AADTs, DHVs, AADT comparisons and DHV comparisons. This output is included in the final Project Traffic Forecasting Report. The screens are aligned as shown below.

#### Screen Map

See Figure 7.5	Existing Year AADT	First Year AADT
	Second Year AADT	Third Year AADT
See Figure 7.6	Existing Year DHV	First Year DHV
	Second Year DHV	Third Year DHV
See Figure 7.7	Existing Year AADT	Existing Compared to First Year AADT
	Existing Compared to Second Year AADT	Existing Compared to Third Year AADT
See Figure 7.8	Actual Count Compared to Existing Year DHV	Actual Count Compared to First Year DHV
	Actual Count Compared to Second Year DHV	Actual Count Compared to Third Year DHV

The separate areas denoted above by the double lines are the individual output pages when the screens are printed.

PRINT\_2: Prints the OUT2 data. This output is the Initial Turning Movement Summary with the directional daily volumes after being balanced using the TURNFLOW methodology. These values are further balanced in the OUT1 file folder as defined previously. This output is for review only.

PRINT\_3: Prints the INPUT data sheet.

SAVE\_IT: Will automatically invoke the Excel FILE Save command. Each file will be approximately 750k, so that saving to floppy diskettes will allow only one intersection per diskette. Select the appropriate directory as normal, name the file, and select the save key within the Excel Save window.



### TURNS5 ANALYSIS SHEET - INPUT

Analyst:   
 Date:   
 Highway:   
 Intersection:   
 From:   
 To:   
 County:

Is the Mainline Oriented North/South?  Yes  No

K Factors: Mainline   
 Side Street

D Factors: Mainline   
 Side Street   
 Westbound (WB)   
 Eastbound (EB)

Do you have FT/SUTMS Model Year traffic from which you would like to interpolate/extrapolate for project years? (Y/N)  Yes  No

If "Yes" go to #1047 If "No" go to #1031

---

Enter Year and Growth Rates from Base Year:

Year	Rate (1.0% = 0.0)	
	Mainline	Side Street
Base	2001	
Opening	2011	
Mid	2021	
Design	2031	

Growth Function:  Linear  Exponential  Decaying

Enter Base Year AADTs for Volume Comparison:  
 (growth rates are used to calculate other project years)

From West Approach	From East Approach	From North Approach	From South Approach	TOTAL
0	0	0	0	0

---

Enter Project and Model Years

Year
Base
Opening
Mid
Design
Model

Enter Base and Model Year AADTs for Volume Comparison:  
 (volumes for other project years are calculated by interpolation)

	From West Approach	From East Approach	From North Approach	From South Approach	TOTAL
1996	1300	3700	5100	6000	10700
2020	1900	5500	7500	7500	15900

---

1st Guess Actual/Counted  
Turning %s for Traffic AADT Balancing for 1996

(EB LT)	West-to-North	35%	48
(EB THRU)	West-to-East	4%	2
(EB RT)	West-to-South	61%	5
(WB LT)	East-to-South	62%	62
(WB THRU)	East-to-West	2%	3
(WB RT)	East-to-North	36%	72
(SB LT)	North-to-East	4%	91
(SB THRU)	North-to-South	95%	1390
(SB RT)	North-to-West	1%	37
(NB LT)	South-to-West	2%	12
(NB THRU)	South-to-North	90%	2491
(NB RT)	South-to-East	8%	167

(must be done manually)

Desired Closure:

Figure 7.3 TURNS5A Data Input Sheet



## 7.7 DATA INPUT SHEET

Information is entered into the data input sheet(s) (*see* Figure 7.3) either manually or by the menu prompt option. All data, with one exception, must be entered for either a FSUTMS projected growth or growth rate option. The input of Actual Traffic Counts is the only input not required to calculate future year traffic volumes. General data inputs are:

---

### 7.7.1 Data Input Page 1:

Analyst: Name of the person entering data.

Highway: Road Name and scenario being analyzed.

Example: SR 26 No Build (or Build, etc.)

Intersection: Name of the intersecting road.

From: Name or location of project beginning.

To: Name or location of ending.

County: Name of the county where project is located.

N/S Orientation

of Mainline: Y (Yes) will orient mainline from bottom to top.

N (No) will orient mainline from left to right.

K Factors: Enter  $K_{30}$  values for mainline and side street. Used in developing DHVs for peak hour analysis. The side street  $K_{30}$  can be used to adjust volumes for reasonableness.

D Factors: Enter  $D_{30}$  values for mainline and side street.  $D_{30}$  values for both directions of mainline must add to one.  $D_{30}$  values for the side street can be any value less than or equal to one. Adjustments to  $K_{30}$  and  $D_{30}$  for the side street can be made to allow for adjustments to DHVs for reasonableness.



### 7.7.2 Data Input Page 2:

#### **If using FSUTMS Model Year Traffic:**

Base Year: Normally existing year or year of count information.

Model Year: Future year of the FSUTMS traffic.

Opening: Opening year of the project or first period.

Mid Year: Interim year of the project or second period

Design: Design year of the project or third period

Note: Any years between the base and model year or after the model year may be entered at any increment.

Enter Base and Model Year AADTs in highlighted areas.

#### **If using traffic developed from growth rates:**

Base, Opening, Mid and Design years as described above.

Growth Rates: Opening — Growth Rate from Base to Opening Year.

Mid — Growth Rate from Base to Mid Year.

Design — Growth Rate from Base to Design Year.

Note: All growth rates should be entered as decimals (1.0% = 0.01).

Enter Base Year AADTs in highlighted areas.



---

### 7.7.3 Data Input Page 3:

“1st Guess” Turning

Percentages for

AADT Balancing:

User’s estimate of turn percentages. It is recommended that this input be based on existing AADT flows or other accepted procedures. The “1st Guess” will impact how the program balances AADT flows. After running the program, adjustments can be made to these percentages to change AADT flows. This combined with  $K_{30}$  and  $D_{30}$  side street modifications can adjust DHV turns. Side street  $K_{30}$  and  $D_{30}$  should be modified first when adjusting DHV values.

**Actual Traffic Counts:** Normally, the total one-hour volume of the highest hour (peak) of the intersection for the count day. This is used to compare TURNS5A project DHVs to actual conditions for peak hour analysis of various years. The user should note that the DHVs should be higher (representing  $K_{30}$  design hour) than the actual count values and should be compared for reasonableness. These counts do not have to be factored by axle or seasonal adjustment factors as they are just for comparison.

**Desired Closure:** User default is 0.01. Represents the cut-off point for balancing of AADT turning movements in the program.

A note about the closure value for the TURNFLOW balancing: The value of 0.01 is the maximum tolerance. Values <0.01 may be used but will provide minimal benefit in the balancing calculations. Values >0.01 are not recommended.



7.7.4 Program Outputs

<b>URNS5 INITIAL TURNING VOLUME SUMMARY</b>									
<b>Highway:</b>		S.R. 45				<b>County:</b> Marlon			
<b>Intersection:</b>		Rainbow Square Shop				<b>Analyst:</b> Advanced PTF			
<b>From:</b>		C.R. 40/CF 484				<b>Date:</b> 9-May-02			
<b>To:</b>		Rainbow Square Shop							

Approach-To-Approach	2001	2001		2011		2021		2031	
	Initial Estimate	Final Estimate	Turning Volume	Final Estimate	Calculated Volume	Final Estimate	Turning Volume	Final Estimate	Calculated Volume
West-To-North (LT)	0.46	0.342	700	0.344	900	0.346	1100	0.347	1300
West-To-East (Thru)	0.05	0.056	100	0.056	200	0.056	200	0.056	200
West-To-South (RT)	0.49	0.602	1300	0.599	1600	0.598	2000	0.597	2300
<b>Total Flow From West:</b>			<b>2100</b>		<b>2700</b>		<b>3300</b>		<b>3800</b>
East-To-South (LT)	0.44	0.585	700	0.583	900	0.582	1100	0.581	1300
East-To-West (Thru)	0.14	0.076	100	0.076	100	0.076	100	0.076	200
East-To-North (RT)	0.42	0.339	400	0.341	500	0.342	700	0.343	800
<b>Total Flow From East:</b>			<b>1200</b>		<b>1500</b>		<b>1900</b>		<b>2300</b>
North-To-East (LT)	0.05	0.053	400	0.053	500	0.053	600	0.053	700
North-To-South (Thru)	0.73	0.843	5900	0.843	7600	0.842	9200	0.842	10900
North-To-West (RT)	0.22	0.104	700	0.104	900	0.104	1100	0.105	1300
<b>Total Flow From North:</b>			<b>7000</b>		<b>9000</b>		<b>10900</b>		<b>12900</b>
South-To-West (LT)	0.23	0.162	1300	0.162	1700	0.161	2000	0.161	2400
South-To-North (Thru)	0.71	0.743	5900	0.744	7600	0.744	9300	0.745	10900
South-To-East (RT)	0.06	0.095	800	0.094	1000	0.094	1200	0.094	1400
<b>Total Flow From South:</b>			<b>8000</b>		<b>10300</b>		<b>12500</b>		<b>14700</b>

PLEASE NOTE: These are the Initial Balanced Turning Movements. They are directional.  
The volumes as shown in the the output Turning Movement Diagrams have been smoothed to reflect two-way flow.

Figure 7.4

This is a tabulated output of balanced volumes for each year. The table provides initial (user input) turn percentages, adjusted turn percentages and AADTs for each movement.

See Figure 7.5



See Figure 7.6

See Figure 7.7



See Figure 7.8

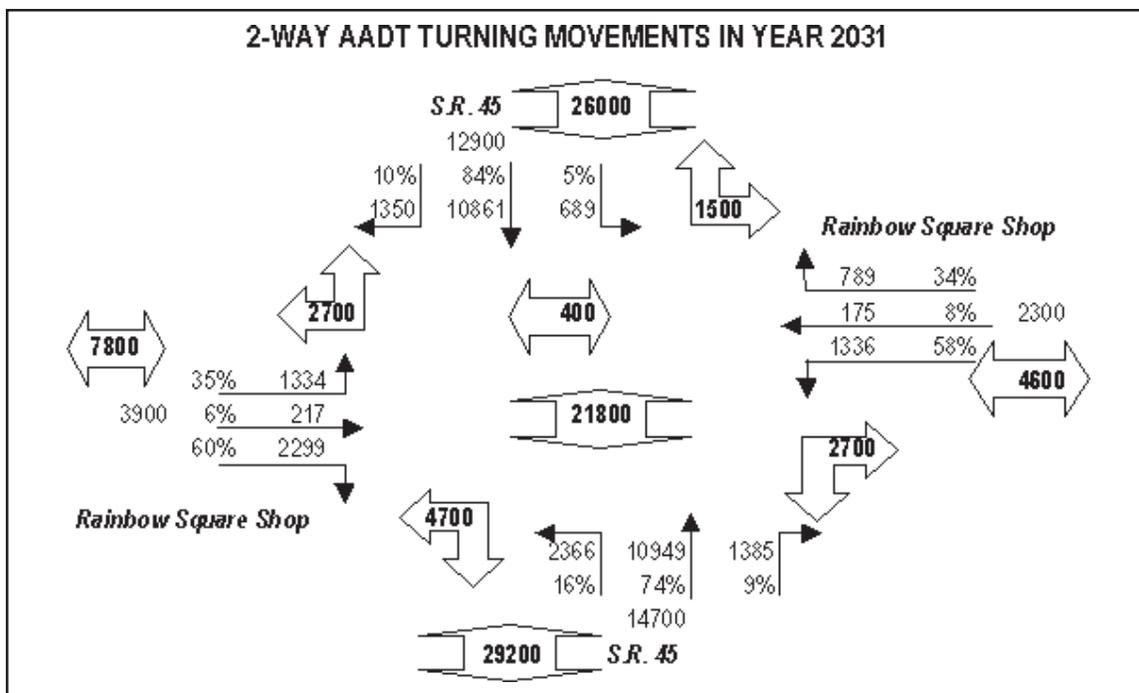


Figure 7.5 Provides AADTs for each year in graphic format.

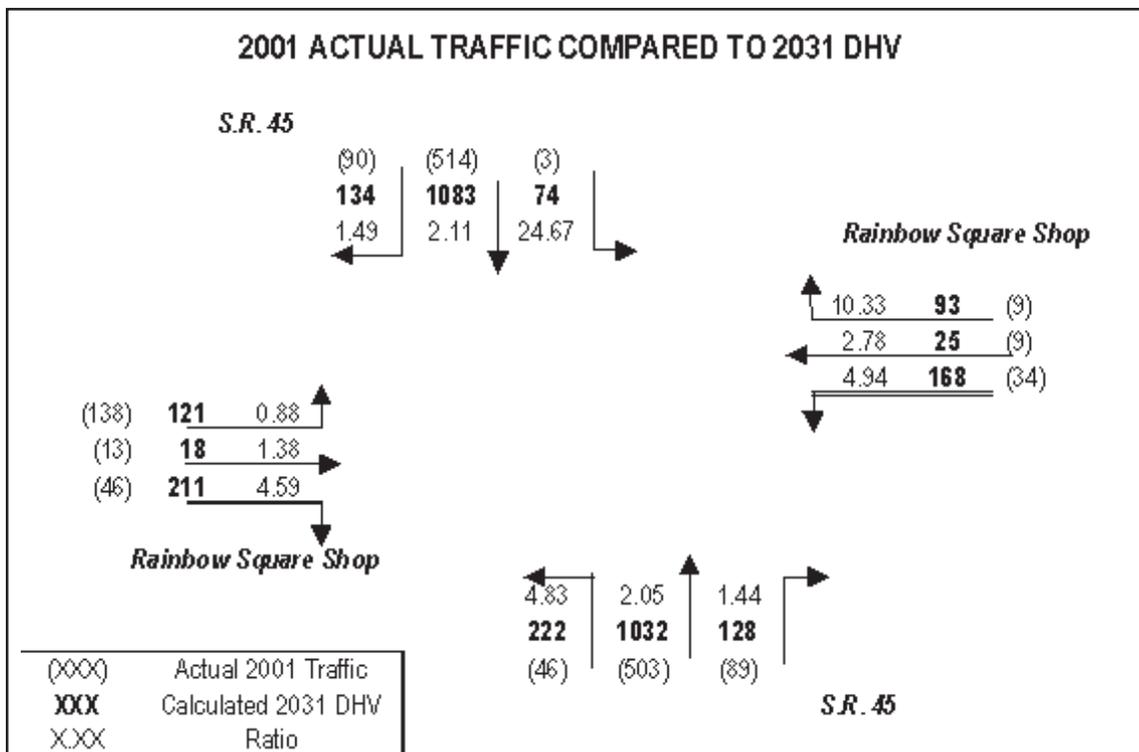


Figure 7.6 Provides DHVs for peak hour evaluation. Uses  $K_{30}$ ,  $D_{30}$  factors for mainline and side street.

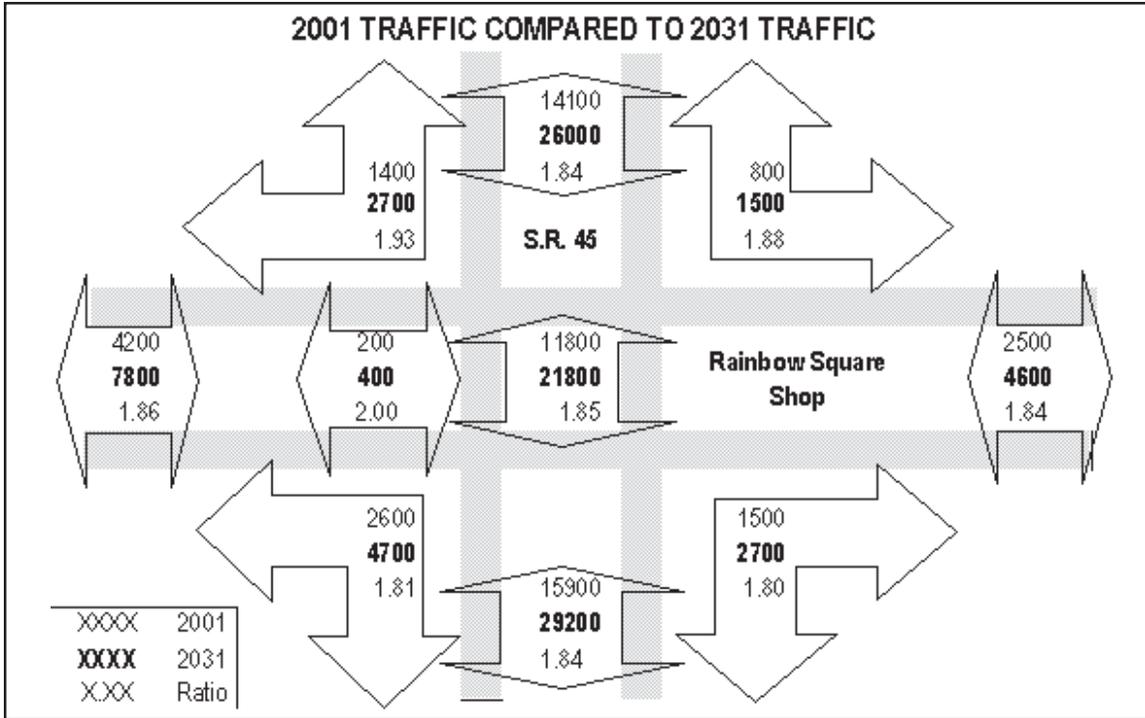


Figure 7.7 Shows a comparison of existing AADTs to future years to evaluate growth.

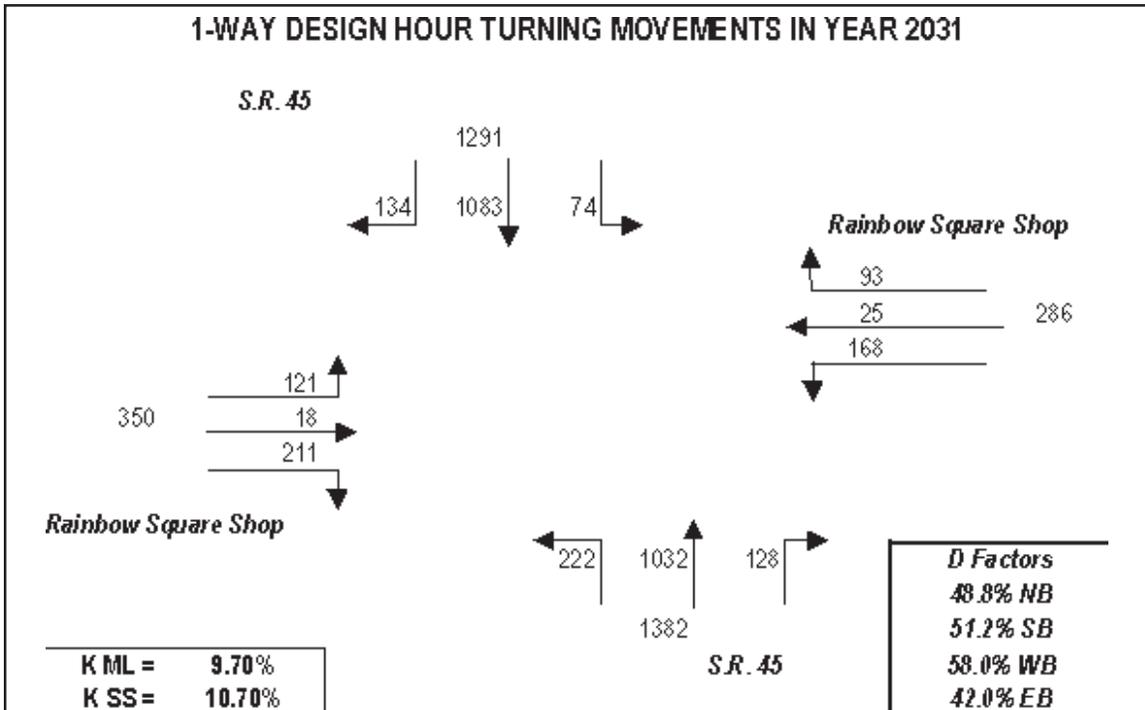


Figure 7.8 Shows a comparison of existing peak hour information (counts) to DHVs developed from the program. In addition it provides the user with growth for turns during peak conditions.



## 7.8 TURNS5A SPREADSHEET

The TURNS5A program is a spreadsheet program which combines the features of the TURNS3 and the TURNFLOW programs. It requires similar input parameters as the TURNS3 program and furnishes similar results. The program enables the user to easily operate the spreadsheet and requires only basic knowledge of Windows and Excel. However, the user should have a thorough knowledge of basic traffic engineering principles and be familiar with development of traffic forecasts by non-automated processes. The following observations can be made:

### Required Input Data

- Existing year AADTs
- “First guess” turning movement proportions for AADTs
- Growth rates to be used or model year AADTs
- K and D factors for mainline and side streets

### Output Produced

- Balanced daily and design hour turning movement forecasts
- Base (Existing) year, opening (first) year, mid (second) year and design (third) year forecasts

### Features

- Very user friendly
- Quick results
- Requires Excel

### 7.8.1 Summary Evaluation

TURNS5A seems to be based on an acceptable state of practiced methodology for estimation of turning movements. The districts will be provided with the software and training for TURNS5A by TranStat to produce projected turning movements. In addition, a users manual will also be provided.

TURNS5A applications are, however, somewhat constrained for situations where existing turning movement data are not available (i.e., projecting turns for a new intersection without a FSUTMS model). The Growth Factor Technique (Section 7.13) is recommended where no model exists.



## 7.9 TURNS3

TURNS3 was developed by FDOT's District One Planning Office to provide future estimates of turning volumes. TURNS3 is a Lotus 1-2-3 (Version 2.2 or higher) template which can produce turning movement estimates for up to six intersections. The turning volumes are manually adjusted by the user based on messages output by the program to indicate if the conditions as entered by the user are balanced for an existing condition. The procedure is repeated for an additional model or mid-design year condition. The program uses straight-line interpolation of growth to develop interim (opening year) and design year conditions. In addition, the program:

- 1) Develops DHV for the interim and design year conditions
- 2) Provides a comparison for existing and modeled year AADT to check for reasonableness of growth
- 3) Allows the user to manually input traffic diversions that may be the result of existing or proposed parallel facilities.

The information in this section is taken from the “TURNS3 Tutorial” as provided by the FDOT District One Planning Office. This document provides a general overview of the TURNS3 program. The Tutorial should be consulted by the reader for more extensive detailed information.

The TURNS3 program is a spreadsheet program which develops sets of daily and peak hour turning movements for desired base and future year forecasts. Specifically, the following observations can be made with respect to its application:

### **Required Input Data**

Turning movement proportions  
Base year and model year daily approach volumes  
K and D factors

### **Output Data**

Balanced daily and peak hour turning movement forecasts  
Base year, interim year, model year, and 20-year forecasts

### **Features**

Moderately user friendly  
Quick results  
Lotus 1-2-3 (version 2.2 or higher) required



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## 7.10 TMTOOL

The District Four programs consist of two spreadsheets and one computer program. The main spreadsheet, TMTOOL.WK1, is set up for intersection turning movement forecasts where detailed information is available. The J. K. TURNS spreadsheet is used to furnish preliminary projections where existing turn information is unavailable, or the intersection is non-existent. There is also a GWBASIC based computer program for calculating initial turning movements. The following comments relate to the application of the TMTOOL.WK1 spreadsheet:

### **Required Input Data**

- Turning movement distributions
- Base year daily approach volumes
- Future year growth factors
- K and D factors

### **Output Data**

- Balanced A.M. and P.M. peak hour turning movement forecasts
- Base year and up to three future year forecasts

### **Features**

- Very user friendly
- Quick results
- Lotus 1-2-3 required

---

## 7.11 MANUAL METHOD

The District Two manual procedure consists of a simple calculation technique for obtaining balanced turning movement volumes from approach volumes at three-legged and four-legged intersections. Appendix E shows an example of the methodology used by District Two. The required input data, output produced, and associated features of the District Two manual procedure are reviewed below:

### **Required Input Data**

- Approach volumes
- Possibly K and D factors

### **Output Produced**

- One set of balanced turning movement forecasts

### **Features**

- Simple application
- Relatively time consuming
- Manually calculated



## 7.12 MODEL VOLUMES TECHNIQUE

This procedure entails taking the model generated daily approach and/or turning movements and converting the volumes to daily and/or peak hour turning movement forecasts. The following observations apply:

### Required Input Data

- Possibly existing year turning movement counts/distributions
- Model daily approach and/or turning movement volumes
- K and D factors

### Output Data

- Balanced daily turning movement forecasts
- Peak hour turning movement forecasts
- Forecasted only for available model years

### Features

- Moderately easy application
- Relatively time consuming
- Manually calculated
- One set of turning movement forecasts per model year

---

## 7.13 GROWTH FACTOR TECHNIQUE

To establish future year turning movement forecasts, the growth factor method relies on the application of projected growth factors to existing year traffic data. The following attributes can be listed for its forecast method:

### Required Input Data

- Existing turning movement counts
- Future year growth factors
- Possibly K and D factors

### Output Data

- Daily and/or peak hour turning movement forecasts
- One set of turning movement forecasts

### Features

- Moderately easy application
- Relatively time consuming
- Manually calculated



## 7.14 METHODS IN THE NCHRP 255 REPORT

The NCHRP 255 Report suggests three methods for estimating intersection turning movements. These methods are:

- Ratio Method
- Difference Method
- Iterative Method

The first two methods assume that relative and absolute differences between the estimated and *observed* turn volumes will remain constant over time. Therefore, future turn volumes generated from models are adjusted according to “ratios” or “differences” calculated from base year estimated and observed turn movement volumes. The iterative procedure requires base year counts of intersection approaches. The iterative method employs the traditional Fratar method, which has been widely used in practice to balance trip tables.

The iterative method is based on an *incremental* procedure of applying implied growth between base year and future year to actual traffic counts. Growth rates are derived from the model. The iterative procedures would require *observed* turning movements for *all* intersections under study. This method is not applicable to new intersections for which base year counts are not available. The Fratar method would produce reasonable results for either developed areas or areas expected to experience moderate growth in land use.

The above methods could also be used for areas without a model (e.g., rural areas) when some information on existing (and/or historical) travel and expected growth are available. Estimates would have to be made for the future approach volumes. Also, existing turning movement data would have to be used judiciously relative to the expected growth characteristics of the area of the proposed roadway improvement.



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## 7.15 H. J. VAN ZUYLEN METHOD

A method suggested by H. J. Van Zuylen involves an iterative balancing of possible turning movements based on the initial estimate of the turning proportions. This method was applied by Hauer *et al.* to estimate turning movements for 145 intersections in the Toronto area using proportions from the base year traffic counts. For this application, *average* turning movement proportions were calculated (based on actual counts from 145 intersections) by correlation to the following five facility type approaches:

- CBD
- Arterial to Arterial
- Arterial to Collector
- Collector to Arterial
- Collector to Collector

Hauer applied the averages to the actual peak hour traffic counts by approach and compared the resulting turning movements to actual turning movements. Hauer indicates that, “there appears to be a surprisingly close correspondence between the actual and the estimated flows.” Hauer also concludes that, “when the obtainable accuracy is sufficient for the purpose at hand, the method may be an attractive alternative to the conduct of a field survey by observers.”

Mark C. Schaefer applied the above method to estimate turning movements to 58 signalized, four-legged intersections in the Denver, Colorado metropolitan area. Schaefer indicates that “the technique described by Hauer *et al.* provides a quick method of estimating intersection turning movements based on prespecified inbound and outbound link volumes.” He concludes that “the algorithm’s greatest use [is] in the development of intersection turning movements from the link volumes generated by traffic forecasting models.” Van Zuylen’s method has also produced reasonable results in England. Mountain and Westwell<sup>8</sup> “tested the accuracy of using historical turning movement records in their analysis of 69 signal-controlled, four-way intersections in Merseyside, England.”

The Van Zuylen method relies on the approach volume generated from the model and *average* turning movement proportions calculated from actual counts *by approach type*. This method should produce more accurate results for developed urban areas where only marginal changes in land use are expected.

8 "The Accuracy of Estimation of Turning Flows from Automatic Counts," Traffic Engineering and Control, January 1983.



## 7.16 SUMMARY

In summary, there are some differences inherent to each of the used turning movement methods. Specifically, each of the methods differs in the amount of data input and the information which is generated. The following conclusions can be drawn:

- TURNS5A, the spreadsheet being recommended, is an improved version incorporating the best of all the spreadsheets being used by the Districts (TURNS3 & 4, TMT00L, J.K.TURNS, and GWBASIC). It can be used to develop turning movements for *existing and non-existing intersections*. TURNS5A can provide turning movement projections where detailed existing and future year data input parameters are available and applicable. TURNS5A is also well suited for obtaining preliminary balanced turning movement projections where only approach volume information is available and/or applicable.
- The model volume and growth factor methods provide turning movement projections where *less detailed existing and/or future year data input parameters are available and/or applicable*. The growth factor method may require adjustments to account for shifts in traffic patterns.
- For *5 year forecasts*, the growth factor method provides realistic results for existing intersections where traffic patterns are not expected to change substantially. Five year projections using other methods should be checked for reasonableness in comparison to existing counts, where available.

Based on their review, the Project Traffic Task Team recommends the use of TURNS5A to forecast turning movements. If any other balancing method is used, then the input variables required to run TURNS5A should be provided to the Project Traffic engineers so that TURNS5A could be used as a comparison.



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## CHAPTER EIGHT

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## EQUIVALENT SINGLE AXLE LOADING (ESAL) FORECAST

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### 8.1 PURPOSE



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

- Truck Forecasting Process
- $ESAL_D$  Equation
- Steps for producing yearly ESALs

All references to damage units show the U.S. Customary unit (18-KIP) followed by the metric unit kilonewton (80-kN).

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### 8.2 BACKGROUND

While geometric design requires the total volume of traffic, cars and trucks, 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) **Equivalent Single Axle Loads (ESALs)**. Truck traffic and damage factors are essential information required to calculate axle loads expressed as ESALs. Therefore, it is very important to determine truck volume for the facility over the design 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 FDOT's Vehicle Classification Reporting Program or a special Vehicle Classification study. 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 2.2 for a list of vehicle classification types and definitions).

The damage factor estimates are based on analysis of historical traffic weight data collected from "Weigh-In-Motion" (WIM) surveys. The survey data is combined with other data such as highway location (rural/urban), highway type (freeway/arterial and collector), number of lanes, highway direction ( $D_F$ ), **percent trucks** ( $T_{24}$ ), **lane factor** ( $L_F$ ), and **truck equivalency factor** ( $E_F$  or  $E_{80}$ ), to estimate the accumulated 18-KIP (80-kN) ESALs from the opening year to the design year of the project.

ESAL forecasting is required for all resurfacing, new construction, addition, or reconstruction projects. It should encompass a period of 20 years from the anticipated



year the project is opened to traffic, allowing the designer to select the appropriate design period for pavement design.

### 8.2.1 Projections

Predictions of future truck volume are often based on traffic history. Several factors can influence future truck volume such as land use changes, economic conditions and new or competing roadways. Truck volume may decrease, remain constant, or increase. The change may be described as 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. Such a project, where the growth pattern is expected to differ from the historical pattern, will be subject to a “Project Analysis”. This analysis should include consideration of historical trends (area-wide or project location specific), land use changes, and an evaluation of competing roadways.

### 8.2.2 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 (*see* Figure 8.1).

### 8.2.3 Traffic Breaks

If a project has two or more traffic breaks within the project limits and the current volumes determined differ significantly, the project is broken where appropriate and separate forecasts are provided to the Pavement Design Engineer.



Table 4

<b>18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2</b>							
PROJECT TRAFFIC FOR PD&E and DESIGN ANALYSIS INFO / FACTORS							
YEARS: 1996 to 2022							
SECTION #: 0		SEGMENT #: 1		ITEM #:			
FLEXIBLE PAVEMENT URBAN HIGHWAY				0.890			
SN=5/THICK		S.R. 434/S.R. 414 Interchange					
YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF	EF
1996	48300	105	0	0.5	2.18%	0.610	0.890
1997	49200	106	0	0.5	2.18%	0.608	0.890
1998	50200	108	0	0.5	2.18%	0.607	0.890
1999	51200	110	0	0.5	2.18%	0.605	0.890
2000	52100	112	0	0.5	2.18%	0.603	0.890
2001	53100	114	0	0.5	2.18%	0.602	0.890
2002	54100	116	116	0.5	2.18%	0.600	0.890
2003	55000	117	233	0.5	2.18%	0.599	0.890
2004	56000	119	352	0.5	2.18%	0.597	0.890
2005	56900	121	473	0.5	2.18%	0.596	0.890
2006	57900	122	595	0.5	2.18%	0.595	0.890
2007	58900	124	719	0.5	2.18%	0.593	0.890
2008	59800	126	845	0.5	2.18%	0.592	0.890
2009	60800	128	973	0.5	2.18%	0.591	0.890
2010	61700	129	1102	0.5	2.18%	0.589	0.890
2011	62700	131	1233	0.5	2.18%	0.588	0.890
2012	63700	133	1366	0.5	2.18%	0.587	0.890
2013	64600	134	1500	0.5	2.18%	0.586	0.890
2014	65600	136	1636	0.5	2.18%	0.584	0.890
2015	66600	138	1774	0.5	2.18%	0.583	0.890
2016	67500	140	1914	0.5	2.18%	0.582	0.890
2017	68500	141	2055	0.5	2.18%	0.581	0.890
2018	69500	143	2198	0.5	2.18%	0.580	0.890
2019	70400	145	2343	0.5	2.18%	0.579	0.890
2020	71400	146	2489	0.5	2.18%	0.577	0.890
2021	72400	148	2637	0.5	2.18%	0.576	0.890
2022	73400	150	2787	0.5	2.18%	0.575	0.890
Opening to Mid-Design Year ESAL Accumulation (1000s):							1250
Opening to Design Year ESAL Accumulation (1000s):							2671
I have reviewed the 18 kip Equivalent Single Axle Loads (ESAL's) to be used for pavement design on this project. I hereby attest that these have been developed in accordance with the FDOT Project historical traffic data and other available information.							
Prepared by: Luis E. Diaz, P.E.		Planning Manager		TEI			
Name		Title		Org. Unit or Firm		Date	
Signature _____							
Susan Sadighi		Technical Applications Supervisor		FDOT			
Name		Title		Org. Unit or Firm		Date	
Signature _____							

EXAMPLE

Figure 8.1 Printout from ESAL-V01.XLS spreadsheet program



## 8.3 TRUCK FORECASTING PROCESS

### 8.3.1 Historical and Current Truck Volume

Historical and Current Truck Volume data is available from FDOT's Vehicle Classification Program (use Traffic Characteristics Inventory data). This may be used for estimating future truck traffic for projects whose limits encompass an FDOT classification station location. They may also be used for comparing roadways with similar characteristics (*e.g.*, traffic, land use, etc.).

### 8.3.2 Truck Growth Factor (Percent of Growth)

If a FDOT vehicle classification station is located within the project limits and the traffic forecast was not generated by FDOT's Florida Standard Urban Transportation Model Structure (FSUTMS) program, a truck growth factor may be used.

To determine the growth factor for a specific FDOT vehicle classification station, a historical trends analysis should be performed using Percent-Root-Mean-Square (%RMS). If the result of this analysis is reasonable, it may be used for calculating future truck volumes. (*see* Figure 8.2).

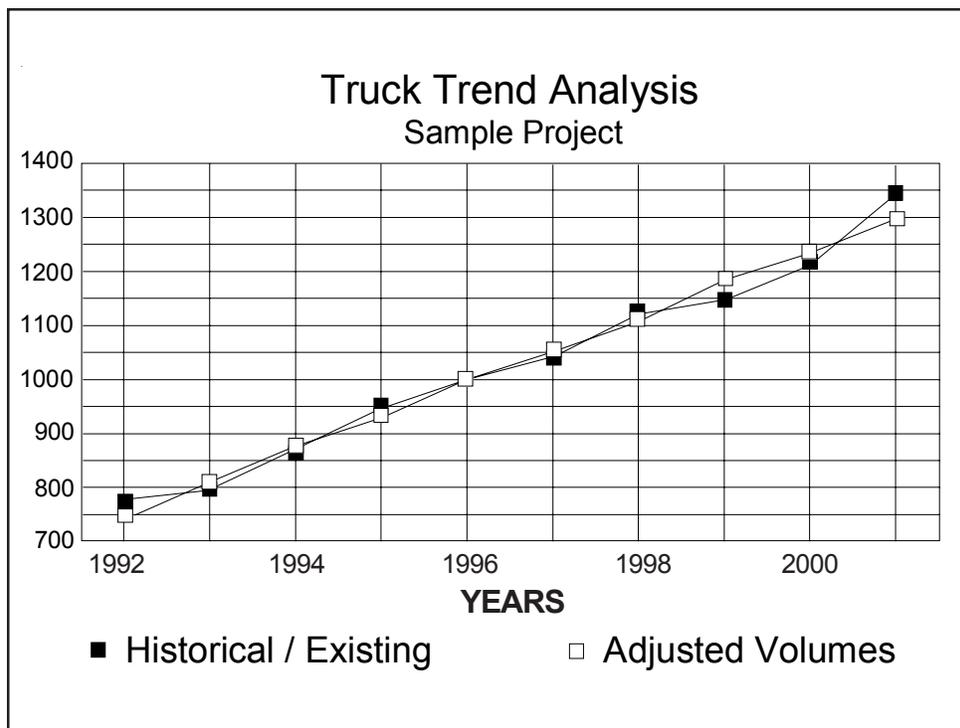


Figure 8.2 Truck Trend Analysis example



### 8.3.3 Percent Trucks ( $T_{24}$ )

If there are no FDOT classification stations located within the project limits and the traffic forecast for a project is generated using either FSUTMS or a Historical Trend Analysis, then  $T_{24}$  may be used.

$T_{24}$  can be determined using the following methods:

- a. **Vehicle classification station data** — If a FDOT vehicle classification station is located within the project limits, the Percent Trucks ( $T_{24}$ ) is available using Traffic Characteristics data. The total percent of Class 4 to 13 vehicles can be applied to the project traffic projections to determine future truck volumes.
- b. **Vehicle classification data collection** — If there is no FDOT vehicle classification station located within the project limits, then field data should be collected. Prior to implementing the field data collection, care should be taken to identify reasonable traffic breaks. The duration of the study should be scheduled to ensure data collection that would reflect an *average* day of truck traffic within the study area. Be sure to consider seasonal differences which may significantly increase the average traffic counts. For example, a count taken when numerous trucks carry ripe produce to market might dramatically increase the  $T_{24}$  average for the year.

**Note:** Prior to accepting the field data counts, they should be checked by comparing them to FDOT's RCI. If there is a minor difference, use the higher value. If the difference is large, then the field data should be checked for reasonableness, the differences resolved, and the comments fully documented.

The results of the data collection should provide a numeric and percent breakdown of all 13 vehicle classification types.

- c. **Roadway Characteristics Inventory (RCI)** — If there is no FDOT vehicle classification station located within the project limits, and due to existing physical conditions of the project roadway field data collection is not possible, then  $T_{24}$  values can be obtained through FDOT's RCI - Feature 331 (*see* Figure 8.15).

The results obtained by any of the above methods should provide the total percent of vehicles in Classes 4 to 13. This can be applied to the project traffic projections to determine the future truck volumes.

$T_{24}$  is then assumed to hold the same relationship to AADT unless some known development will change the future truck traffic.



### 8.3.4 Future Truck Volumes

Future truck volumes can be calculated by using either of the following examples below:

- a. Multiply the base year average truck volume by a factor of one plus the number of years times the growth rate.

$$\text{Future trucks} = (\text{Base Year Average}) \times [1 + (\text{Years} \times \text{Rate})]$$

Example:

Assume that a year 2003 future truck volume is desired. The growth period equals 19 years (2003 - 1984 = 19). The base year traffic (shown in the Figure 8.2, 1984 average trucks) of 811 is factored by the 19 years and by the rate of 7.5 percent.

$$\begin{aligned} \text{Future trucks} &= (811) \times [1 + (19 \times .075)] \\ &= (811) \times (2.425) \\ &= 1966.7 \end{aligned}$$

This results in a year 2003 estimate of 1966.7 which would be rounded to 2000.



- b. Expanding the Percent-Root-Mean Square (%RMS) method by extending the best fit straight-line to the desired design year. (see Figure 8.3).

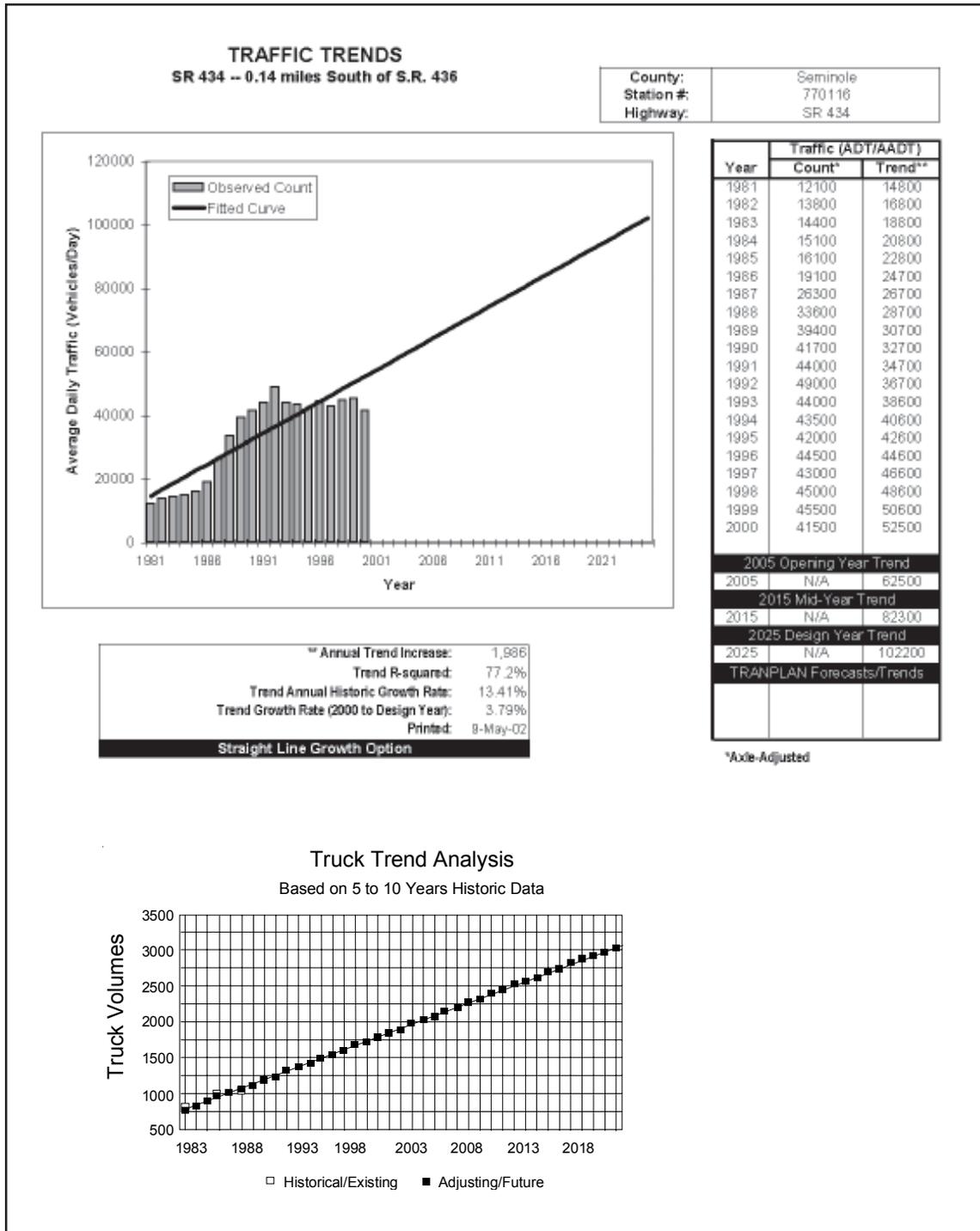


Figure 8.3 Regression Analysis Example For Future Years



## 8.4 DESIGN REQUIREMENTS

### 8.4.1 ESAL<sub>D</sub> Equation

The predicted traffic loading to be furnished by the planning group is the cumulative 18-KIP (80-kN) ESAL axle applications expected on the design lane.

The designer must factor the project traffic forecast by direction and by lanes (if more than two lanes). The following equation is used to determine the traffic in the design lane for the design period:

$$ESAL_D = \sum_{i=1}^{i=n} (AADT)_i \times (L_{Fi}) \times T_{24} \times D_F \times E_F \times 365$$

where:

ESAL<sub>D</sub> = The number of accumulated 18-KIP (80-kN) Equivalent Single Axle Loads in the design lane for the design period.

AADT = Average Annual Daily Traffic

T<sub>24</sub> = Percent heavy trucks during a 24-hour period. Trucks with six tires or more are considered in the calculations.

D<sub>F</sub> = Directional Distribution Factor. Use 1.0 if one-way traffic is counted or 0.5 for two-way traffic. This value is not to be confused with the Directional Factor (D<sub>30</sub>) used for planning capacity computations.

L<sub>F</sub> = Lane Factor, converts directional trucks to the design lane trucks. Lane factors can be adjusted to account for unique features known to the designer such as roadways with designated truck lanes. L<sub>F</sub> values can be determined from Figure 8.5.

E<sub>F</sub> = Equivalency Factor, which is the damage caused by one average heavy truck measured in 18-KIP (80-kN) ESALs. These factors should be provided by the Planning Department for each project. They will be reviewed annually and updated if needed by TranStat based on WIM data. An example of E<sub>F</sub> (E<sub>80</sub>) values for different types of facilities is shown in Figure 8.4.

y = The year for which the calculation is made. When y = 1, all the variables apply to year 1. Some of the variables remain constant while others, such as AADT, L<sub>F</sub>, and T<sub>24</sub>, may change from year to year. Other factors may change when changes in the system occur. Such changes include parallel roads, shopping centers, truck terminals, etc.

x = The number of years the design is expected to last. (e.g. 20, 10, ...).



Example of Equivalency Factor $E_F$ ( $E_{80}$ ) for Different Types Of Facilities				
		Flexible Pavement	Rigid Pavement	EXAMPLE
<b>Freeways</b>				
	Rural	0.880	1.380	
	Urban	1.110	1.740	
<b>Arterials</b>				
	Rural	0.990	1.570	
	Urban	1.300	2.020	

Figure 8.4 Equivalency Factors for Different Types of Facilities

### 8.4.2 Directional Distribution Factor ( $D_F$ )

Since the number of trucks represents the total for all lanes and both directions of travel, this number must be distributed by direction and by lanes for design purposes. Two-way directional distribution is usually made by assigning 0.5 (50 percent) of the traffic to each direction. One-ways are assigned 1.0 (100 percent).

Although  $D_F$  is generally 0.5 (50 percent) for most roadways, there are instances where more weight may be moving in one direction than the other. In such cases, the side with heavier vehicles should be designed for a greater number of ESAL units. For example  $D_F$  may be assigned as 0.7 to account for trucks heavily loaded in one direction. (In practice, both directions of an undivided road would probably be designed for the heavier traffic.)

### 8.4.3 Lane Factor ( $L_F$ )

The  $L_F$  is calculated by using the COPES equation, the graphic solution to the COPES equation, shown in Figure 8.5, or the  $L_F$  feature provided by the Traffic Loading Forecasting System (NHCRP No. 277 "Portland Cement Concrete Pavement Evaluation System").

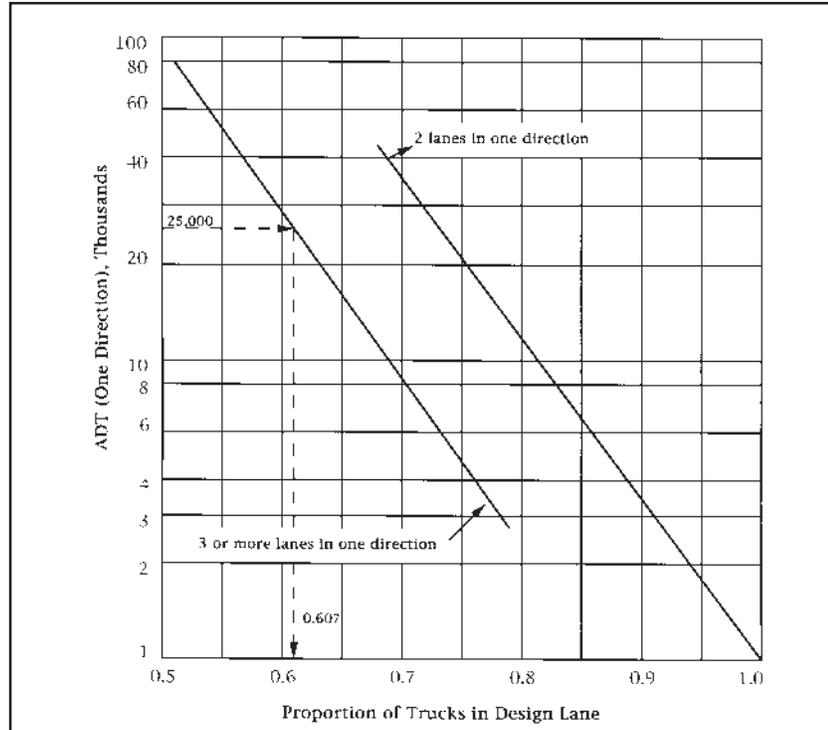


Figure 8.5  
COPES  
Equation

The COPES equation was developed in a research project for the National Cooperative Highway Research Program. The equation for the  $L_F$  is defined as follows:

$$L_F = (1.567 - 0.0826 \times \ln(\text{One-Way AADT}) - 0.12368 \times LV)$$

where:

$L_F$  = proportion of all one-directional trucks in the design lane

$LV = 0$  if the number of lanes in one direction is 2

$LV = 1$  if the number of lanes in one direction is 3 or more

$\ln$  = natural logarithm

Example: One-Way AADT = 25000

One-Way Lanes = 3 ( $LV = 1$ )

$$L_F = (1.567 - 0.0826 \times \ln(25000) - 0.12368 \times 1)$$

$$= (1.567 - 0.0826 \times 10.127 - 0.12368)$$

$$= (1.567 - 0.836 - 0.12368)$$

$$L_F = 0.607$$

As traffic approaches capacity the lane factor for all lanes tends to equal out. Drivers in congestions will follow the path of least resistance and tend to move to the shortest line. The  $L_F$  should be determined for each year that the ESAL is calculated. The Traffic Forecast ESAL-V01.XLS software (an Excel spreadsheet) performs this calculation.



#### 8.4.4 Load Equivalency Factor ( $E_F$ or $E_{80}$ )

The results of the AASHTO Road Test have shown that the damaging effect of the passage of an axle of any mass (commonly called load) can be represented by a number of 18-KIP (80-kN) ESALs ( $E_F$  or  $E_{80}$ ). For example, on flexible pavement, four applications of a 12-KIP (54-kN) single axle were required to cause the same damage (or reduction in serviceability) as one application of an 18-KIP (80-kN) single axle. One 24-KIP (107-kN) axle caused pavement damage equal to three 18-KIP (80-kN) axles. The determination of design ESALs is a very important consideration for the design of pavement structures.

A load equivalency factor represents the ratio of the number of repetitions of an 18-KIP (80-kN) single axle load necessary to cause the same reduction in the Present Serviceability Index (PSI) as one application of any axle load and axle number and configuration (single, tandem, tridem).

$$\text{LEF} = \frac{\text{\# of 18-KIP ESALs causing a given loss of serviceability}}{\text{\# of x-KIP axle loads causing the same serviceability loss}}$$

Different axle loads and axle configurations are converted to equivalent damage factors and averaged over the mixed traffic stream to give a load equivalency factor  $E_F$  ( $E_{80}$ ) for the average truck in the stream. This factor is available as a feature of TLFS.  $E_F$  ( $E_{80}$ ) values used in 18-KIP (80-kN) ESAL calculations can be obtained from TranStat. To calculate the damage factor using TLFS, it is necessary to select either flexible or rigid  $E_F$  ( $E_{80}$ ) factors. The rigid  $E_F$  ( $E_{80}$ ) is based on 12 inch thick pavement with a Terminal Serviceability Index ( $P_T$ ) of 2.5. The flexible  $E_F$  ( $E_{80}$ ) is based on a structural number of 5 with a Terminal Serviceability Index ( $P_T$ ) of 2.5.

It should be noted that load equivalency factors are functions of the pavement parameters, type (rigid or flexible) and thickness. These pavement factors will usually give results that are sufficiently accurate for design purposes, even though the final design may be somewhat different.

When more accurate results are desired and the computed design parameter is appreciably different from the assumed value, the new value should be assumed, the design 18-KIP (80-kN) traffic loading ( $\text{ESAL}_D$ ) should be recomputed, and the structural design determined for the new  $\text{ESAL}_D$ . The procedure should be continued until the assumed and computed values are as close as desired.



### 8.5 STEPS FOR PRODUCING 18-KIP (80-kN)

The following steps are used to generate the 18-KIP (80-kN) ESAL<sub>D</sub>. This example is for I-4 (Section 7) in Polk County.

1. Receive request for 18-KIP (80-kN).

Figure 8.6  
18-KIP Request Memo Example

**MEMORANDUM**  
STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

DATE: August 23, 1995

TO: H. Byron Swartzel, Administrator, Transportation Statistics

FROM: TRACY HOWE, TRAFFIC DATA ENGINEERING

COPIES: GERALD E. CARRIGAN

SUBJECT: REQUEST FOR TRAFFIC DATA

Project Name: I-4 Polk County, SECTION 7

From: EAST OF US 27

To: OSCEOLA COUNTY LINE

Work Program Item Number: 1147943

State Project Number: 16320-3426

Federal Aid Project Number: NA

County: POLK

Project Number to Change Title To: 16320-1426

\*\*\*\*\*

TYPE OF WORK: RECONSTRUCTION

EXISTING LANAGE: 4 LANES

RESULTING TOTAL LANAGE (CHRU LANES):  
 2L  3L  4L  5L  6L  OTHER

OPENING YEAR: 2000

LOCATION MAP ATTACHED:  YES  NO

PROJECT MANAGER: JOE TOWNSEND-SURBERG EXT.: 534 2500

\*\*\*\*\*

PLEASE PROVIDE US WITH THE FOLLOWING:

PREVIOUS TRAFFIC DATA (ATTACHED) NEEDS UPDATE.

TRAFFIC DATA REQUIRED (CURRENT, POST CONST., 5, 10, & 20 YR.)

18 KIP ESAL:  FLEXIBLE  RIGID  BOTH

FUNCTIONAL CLASSIFICATION

DATE REQUESTED FOR RETURN: 12/31/95

EXAMPLE

2. Fill in available information on 18-KIP (80-kN) Information Sheet. Most of this information is found on the request memo.

Figure 8.7  
Fully completed 18-KIP (80-kN) Information sheet

18 KIP (80 kN) INFORMATION SHEET

DATE: \_\_\_\_\_

PREPARED BY: DON R. AMICONE

FPID NO.: 1147943

STATE PROJECT NO.: 16320-3426

FAP NO.: N/A

COUNTY: POLK

PROJECT NAME: I 4 SECTION 7

FROM: EAST OF US 27

TO: OSCEOLA COUNTY LINE

BEGINNING MILE POST: 29.416

ENDING MILE POST: 32.022

FUNCTIONAL CLASSIFICATION: RURAL PRINCIPAL ARTERIAL INTERSTATE

TYPE WORK: RECONSTRUCTION

PAVEMENT DESIGN:  FLEX.  RIGID  BOTH

RESULTING TOTAL LANAGE: 6

EXISTING YEAR 1994 = 58500 AADT

OPENING YEAR 2000 = 71712 AADT

$K_{30} = 10.0\%$

$D_{30} = 55.80\%$

24 HOUR T = 11.93%

DESIGN HOUR T = 5.96%

TRENDS/MODEL INCREASE = 2202

EXAMPLE



3. Sign on to IMS. Go into the RCI files to determine the functional classification using feature code of 121. Enter "RCITS06A [space] 00 [space] County Section Number 000 [space] 121." Print the screen.

```

RCITS06A 00 16320000 121 000.000 032.022 12 1/11/96 15.42.03
          AGENCY- DEPARTMENT OF TRANSPORTATION
RCIB017  ROADWAY CHARACTERISTICS PER ADMINISTRATIVE FEATURE PAGE 1
STATE- FLORIDA COUNTY- 16 POLK SECTION- 320 SUB-SECTION- 000
DESCRIPTION- SR-400/I-4 BEG. AT. - 0.000 MI END. AT. - 32.022 MI
          STATUS- ACTIVE
121 FUNCTIONAL CLASSIFICATION (LENGTH FEATURE) SIDE
   CHARACTERISTIC VALUE UNIT BEG. PT. END. PT.
STATE FUNCTIONAL CLASS PRINCIPAL ARTERIALS CD C 0.000 32.022
FEDERAL FUNCTIONAL CLASS PRINCIPAL ARTERIALS CD C 0.000 32.022
FUNCTIONAL CLASSIFICATION URBAN PA INT CD C 0.000 12.608
FUNCTIONAL CLASSIFICATION RURAL PRIN ART INT. CD C 12.608 32.022

```

Figure 8.8 RCI Feature 121 — Functional classification

4. While still in RCI files use feature codes 212 (number of lanes), 215 (median information), 311 (speed limits), 322 (signal information), and 331 (Traffic Data; AADT, K, D, T) for project. Print these screens as part of the backup documentation.

```

RCITS06A 00 16320000 212 000.000 032.022 12 1/11/96 15.40.22
          AGENCY- DEPARTMENT OF TRANSPORTATION
RCIB017  ROADWAY CHARACTERISTICS PER PHYSICAL FEATURE PAGE 1
STATE- FLORIDA COUNTY- 16 POLK SECTION- 320 SUB-SECTION- 000
DESCRIPTION- SR-400/I-4 BEG. AT. - 0.000 MI END. AT. - 32.022 MI
          STATUS- ACTIVE
212 THRU LANES (LENGTH FEATURE) SIDE
   CHARACTERISTIC VALUE UNIT BEG. PT. END. PT.
NUMBER OF ROADWAY LANES 2 EA L 0.000 7.721
PAVEMENT SURFACE WIDTH 24.0000 FT L 0.000 7.721
NUMBER OF ROADWAY LANES 2 EA R 0.000 32.022
PAVEMENT SURFACE WIDTH 24.0000 FT R 0.000 32.022
NUMBER OF ROADWAY LANES 3 EA L 7.721 8.426
PAVEMENT SURFACE WIDTH 36.0000 FT L 7.721 8.426
NUMBER OF ROADWAY LANES 2 EA L 8.426 32.022
PAVEMENT SURFACE WIDTH 24.0000 FT L 8.426 32.022

```

INQUIRY COMPLETE

Figure 8.9 RCI Feature 212 — Number of lanes



```

RCITS06A 00 16320000 215 000,000 032.022 12 1/11/96 15.42.47
AGENCY- DEPARTMENT OF TRANSPORTATION
RCIB017 ROADWAY CHARACTERISTICS PER PHYSICAL FEATURE PAGE 1
STATE- FLORIDA COUNTY- 16 POLK SECTION- 320 SUB-SECTION- 000
DESCRIPTION- SR-400/1-4 BEG. AT. - 0.000 MI END. AT. - 32.022 MI
STATUS- ACTIVE
215 MEDIAN (LENGTH FEATURE) SIDE
CHARACTERISTIC VALUE UNIT BEG. PT. END. PT.
HIGHWAY MEDIAN WIDTH 48.0000 FT C 0.000 3.044
HIGHWAY MEDIAN TYPE GRASSED CD C 0.000 32.022
HIGHWAY MEDIAN WIDTH 72.0000 FT C 3.044 18.761
HIGHWAY MEDIAN WIDTH 220.0000 FT C 18.761 19.779
HIGHWAY MEDIAN WIDTH 72.0000 FT C 19.779 23.892
HIGHWAY MEDIAN WIDTH 292.0000 FT C 23.892 25.085
HIGHWAY MEDIAN WIDTH 72.0000 FT C 25.085 27.200
HIGHWAY MEDIAN WIDTH 120.0000 FT C 27.200 27.458
HIGHWAY MEDIAN WIDTH 190.0000 FT C 27.458 28.018
HIGHWAY MEDIAN WIDTH 120.0000 FT C 28.018 28.194
HIGHWAY MEDIAN WIDTH 64.0000 FT C 28.194 29.938
HIGHWAY MEDIAN WIDTH 150.0000 FT C 29.938 31.073
HIGHWAY MEDIAN WIDTH 72.0000 FT C 31.073 31.947
HIGHWAY MEDIAN WIDTH 108.0000 FT C 31.947 32.022
INQUIRY COMPLETE

```

Figure 8.10 RCI Feature 215 — Median information

```

RCITS06A 00 16320000 311 000,000 032.022 12 1/11/96 15.43.18
AGENCY- DEPARTMENT OF TRANSPORTATION
RCIB017 ROADWAY CHARACTERISTICS PER OPERATIONAL FEATURE PAGE 1
STATE- FLORIDA COUNTY- 16 POLK SECTION- 320 SUB-SECTION- 000
DESCRIPTION- SR-400/1-4 BEG. AT. - 0.000 MI END. AT. - 32.022 MI
STATUS- ACTIVE
311 SPEED ZONE (LENGTH FEATURE) SIDE
CHARACTERISTIC VALUE UNIT BEG. PT. END. PT.
DATE SPEED ZONE APPR. BY SECT. 060989 DA C 0.000 32.022
OFFSET- RIGHT&LEFT
MAXIMUM SPEED LIMIT 65.0000 MH C 0.000 32.022
OFFSET- RIGHT&LEFT
INQUIRY COMPLETE

```

Figure 8.11 RCI Feature 311 — Speed limits



```

RCITS06A 00 16320000 322 000.000 032.022 12 1/11/96 15.43.42
          AGENCY- DEPARTMENT OF TRANSPORTATION
RCIB017   ROADWAY CHARACTERISTICS PER OPERATIONAL FEATURE PAGE 1
STATE- FLORIDA COUNTY- 16 POLK SECTION- 320 SUB-SECTION- 000
DESCRIPTION- SR-400/1-4          BEG. AT. - 0.000 MI END. AT. - 32.022 MI
          STATUS- ACTIVE
322 SIGNALS
          CHARACTERISTIC (POINT FEATURE) SIDE
          CONTROLLER DESCRIPTION 40(SPCSOP) VALUE UNIT BEG. PT. END. PT.
          FUNDING (OPT) SR539/16004/KATHLEEN ID L 5.097
          MAINTAINING AGENCY NAME CO. ID L 5.097
          DATE AGREEMENT EXECUTED YYMMDD 890301 DA L 5.097
          NON-COUNTED SIGNAL INTERSECTION CONTRL CD L 5.097
          MAINTAINING AGENCY NAME CO. ID R 6.425
          DATE AGREEMENT EXECUTED YYMMDD 890301 DA R 6.425
          NON-COUNTED SIGNAL INTERSECTION CONTRL CD R 6.425
          CONTROLLER DESCRIPTION 40TOP30(SOP 14) PEDS ID R 6.425
          FUNDING (OPT) SR35/700/16210/US98 ID R 6.425
          CONTROLLER DESCRIPTION 40TOP30(SOP 15) PEDS ID L 6.426
          FUNDING (OPT) SR35/700/16210/US98 ID L 6.426
          MAINTAINING AGENCY NAME CO. ID L 6.426
          DATE AGREEMENT EXECUTED YYMMDD 890301 DA L 6.426
          TO PAGE FORWARD--PRESS PA1 KEY

```

Figure 8.12 RCI Feature 322 — Signal information

```

RCITS06A 00 16320000 331 000.000 032.022 12 1/11/96 15.50.32
          AGENCY- DEPARTMENT OF TRANSPORTATION
RCIB017   ROADWAY CHARACTERISTICS PER OPERATIONAL FEATURE PAGE 1
STATE- FLORIDA COUNTY- 16 POLK SECTION- 320 SUB-SECTION- 000
DESCRIPTION- SR-400/1-4          BEG. AT. - 0.000 MI END. AT. - 32.022 MI
          STATUS- ACTIVE
331 TRAFFIC FLOW BREAKS
          CHARACTERISTIC (LENGTH FEATURE) SIDE
          AADT TYPE FINAL ESTIMATE FROM SURVEY CD C 0.000 2.907
          RDWY SECTION AVG "D" FACTOR 54.2200 EA C 0.000 2.907
          AVG. 30TH HI. HR. TRAFFIC / ADT 9.7400 EA C 0.000 2.907
          SECTION AVERAGE T FACTOR 15.7200 EA C 0.000 2.907
          SECTION AVERAGE ADT 67000 EA C 0.000 2.907
          AADT DATE 123194 DA C 0.000 2.907
          AADT TYPE FINAL ESTIMATE FROM SURVEY CD C 2.907 5.097
          RDWY SECTION AVG "D" FACTOR 54.2200 EA C 2.907 5.097
          AVG. 30TH HI. HR. TRAFFIC / ADT 9.7400 EA C 2.907 5.097
          SECTION AVERAGE T FACTOR 15.7200 EA C 2.907 5.097
          SECTION AVERAGE ADT 45500 EA C 2.907 5.097
          AADT DATE 123194 DA C 2.907 5.097
          AADT TYPE FINAL ESTIMATE FROM SURVEY CD C 5.097 6.425
          RDWY SECTION AVG "D" FACTOR 54.2200 EA C 5.097 6.425
          TO PAGE FORWARD--PRESS PA1 KEY

```

Figure 8.13 RCI Feature 331 — Traffic data; AADT, K, D, and T



- Check traffic count location maps for classification stations within the project limits of request for 18-KIP (80-kN) ESALs or close proximity (one mile either side of limits). If there is a classification count station within project limits of request for 18-KIP (80-kN) look at the Traffic Classification Report, locate the station and make a copy of the page for that station (Figure 8.16). This printout will give you the  $T_{24}$ , and Design Hour Truck percentage. If no classification station is within the project limits of the request for 18-KIP (80-kN) ESALs, complete and submit a request memo (Figure 8.17) to TranStat for a 72-hour classification count.

Print Date : May 09, 2002

Florida Department of Transportation  
Transportation Statistics Office  
**Annual Vehicle Classification Report**  
Count Year 2000

County: 10 - HILLSBOROUGH

Site: Co Sec Sub: 2028 10190000    MilePost: 7.70    AADT: 124,500    Description: SR 4004-4 EAST OF SR 45/NEBRASKA AVE

Func. Class: 11 - Urban Principal Arterial - Interstate

Survey Type: P - PORTABLE    Duration(In Days): 2

Class	Description	Annual Average Daily	
		Volume	Percentage
01	MOTORCYCLES	573	0
02	CARS	86,142	69
03	PICK-UPS AND VANS	16,795	13
04	BUSES	1,307	1
05	2-AXLE, SINGLE UNIT TRUCKS	3,362	3
06	3-AXLE, SINGLE UNIT TRUCKS	2,801	2
07	4-AXLE, SINGLE UNIT TRUCKS	847	1
08	2-AXL TRCTR W/1 OR 2-AXL TRLR, 3-AXL TRCTR W/1-AXL T	6,661	5
09	3-AXLE TRACTOR W/2-AXLE TRLR	4,221	3
10	3-AXLE TRACTOR W/3-AXLE TRLR	1,320	1
11	5-AXLE MULTI-TRLR	62	0
12	6-AXLE MULTI-TRLR	12	0
13	ANY 7 OR MORE AXLE	398	0
14	NOT USED	0	0
15	OTHER	0	0
		*****	*****

Summary Daily S

Daily = 16.87

24T = 15.82

72T = 13.11

365T = 3.76

Classes: Passenger Vehicles 01-03, Truck and Buses 04-13, Trucks 05-13, 15  
\* The Totals for Volume and Percentage are rounded.

Figure 8.14  
Example from the Traffic  
Classification Report

Figure 8.15  
72-hour  
Classification  
Count Request  
Memo

**MEMORANDUM**  
State of Florida Department of Transportation

FORM 201-10

Date: October 19, 1993

To: Byron Swartzel, Administrator, Transportation Statistics  
ATTN: Joe Cranford, Supervisor, Traffic Data

From: T. Franklin Black, Traffic Analysis Administrator

Copies To:

Subject: SPECIAL DATA REQUEST

State Project Number: \_\_\_\_\_

Work Program Item Number: \_\_\_\_\_

Federal Aid Project Number: \_\_\_\_\_

Description: \_\_\_\_\_

Date Data Needed: \_\_\_\_\_

72 hour classification count for following location(s):

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

Peak Seasonal Factor for each location:

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

Data Furnished By: \_\_\_\_\_

Date Data Returned to Frank Black: \_\_\_\_\_

Please attach backup documentation.



- Make a list of count/classification stations within project limits of request for 18-KIP (80-kN) ESALs. Check trends notebooks prepared by consultant for count/classification stations. Make copies of these charts to be used for comparison and backup documentation. The yearly trend increase is then projected to the design year (20 years past year of opening). Include the projected calculations for the trends increase in the backup documentation.

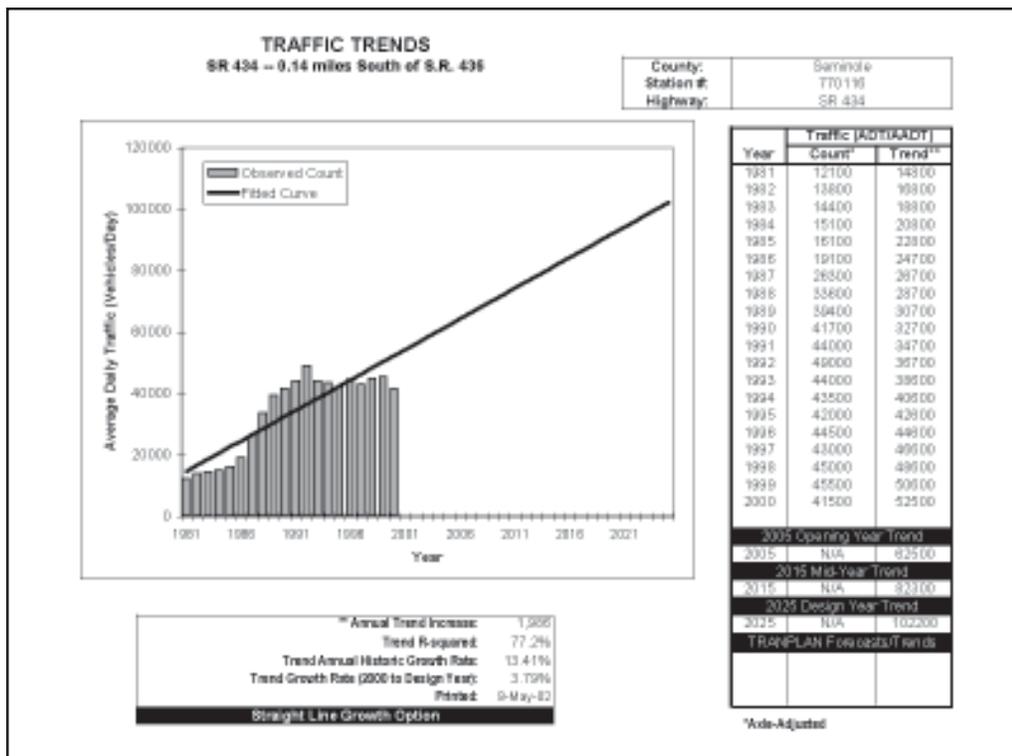


Figure 8.16 Trend Projection

- Request modeling staff to pull up adopted model data for area of project. Post volumes and print the screen. Convert the model data from PSWADT to AADT. Project the AADT from the existing year to the design year (20 years past year of opening). Figure 8.20 shows the Trends Progression for 18-KIP for the Polk County I-4 example. Include the conversion and projection calculations for the model data in the backup documentation.

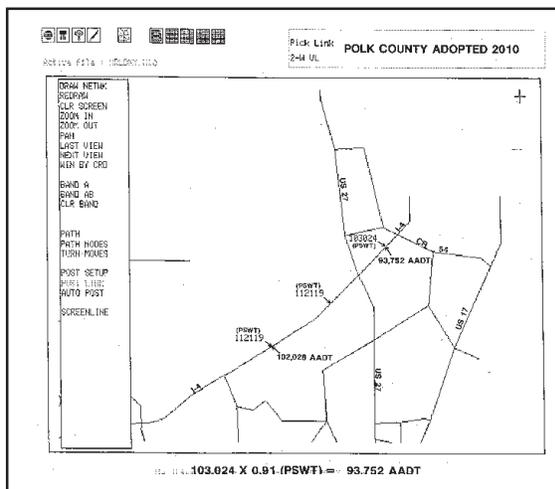


Figure 8.17  
Screen from I-4 Polk  
County Travel Demand  
Model Projection



8. Check to see if a Project Design Traffic Report was prepared within the last two years, covering the limits of the request for the 18-KIP (80-kN) ESALs. Information contained in the Project Design Traffic Report will be the most reliable and the data should be utilized. If a traffic report is not available, the Trends and Model Data are then checked for continuity and reasonableness. If there is no continuity between the two, a decision on the most reasonable data is made and utilized for the 18-KIP (80-kN) ESALs. In areas where Model Data is available, the Model Data is usually the more reliable. Trends Data does not take into consideration diversion to new facilities and may over estimate future traffic.

Table 4

<b>18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2</b>						
PROJECT TRAFFIC FOR PD&E and DESIGN ANALYSIS INFO / FACTORS						
YEARS: 1996 to 2022						
SECTION #: 0		SEGMENT #: 1		ITEM #: 0		
FLEXIBLE PAVEMENT URBAN HIGHWAY 0.890						
SN= 5"THICK			S.R. 434/S.R. 414 Interchange			
YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF EF
1996	48300	105	0	0.5	2.18%	0.610 0.890
1997	49200	106	0	0.5	2.18%	0.608 0.890
1998	50200	108	0	0.5	2.18%	0.607 0.890
1999	51200	110	0	0.5	2.18%	0.605 0.890
2000	52100	112	0	0.5	2.18%	0.603 0.890
2001	53100	114	0	0.5	2.18%	0.602 0.890
2002	54100	116	116	0.5	2.18%	0.600 0.890
2003	55000	117	233	0.5	2.18%	0.599 0.890
2004	56000	119	352	0.5	2.18%	0.597 0.890
2005	56900	121	473	0.5	2.18%	0.596 0.890
2006	57900	122	595	0.5	2.18%	0.595 0.890
2007	58900	124	719	0.5	2.18%	0.593 0.890
2008	59800	126	845	0.5	2.18%	0.592 0.890
2009	60800	128	973	0.5	2.18%	0.591 0.890
2010	61700	129	1102	0.5	2.18%	0.589 0.890
2011	62700	131	1233	0.5	2.18%	0.588 0.890
2012	63700	133	1366	0.5	2.18%	0.587 0.890
2013	64600	134	1500	0.5	2.18%	0.586 0.890
2014	65600	136	1636	0.5	2.18%	0.584 0.890
2015	66600	138	1774	0.5	2.18%	0.583 0.890
2016	67500	140	1914	0.5	2.18%	0.582 0.890
2017	68500	141	2055	0.5	2.18%	0.581 0.890
2018	69500	143	2198	0.5	2.18%	0.580 0.890
2019	70400	145	2343	0.5	2.18%	0.579 0.890
2020	71400	146	2489	0.5	2.18%	0.577 0.890
2021	72400	148	2637	0.5	2.18%	0.576 0.890
2022	73400	150	2787	0.5	2.18%	0.575 0.890
Opening to Mid-Design Year ESAL Accumulation (1000s):						1250
Opening to Design Year ESAL Accumulation (1000s):						2671
I have reviewed the 18 kip Equivalent Single Axle Loads (ESAL's) to be used for pavement design on this project. I hereby attest that these have been developed in accordance with the FDOT Project historical traffic data and other available information.						
Prepared by: Luis E. Diaz, P.E.		Planning Manager		TEI		
Name	Title	Org. Unit or Firm	Date			
Signature						
Susan Sadighi		Technical Applications Supervisor		FDOT		
Name	Title	Org. Unit or Firm	Date			
Signature						

Figure 8.18  
Trend  
Projection  
Results





- To determine the  $K_{30}$  and  $D_{30}$  factors within the project limits of request for 18-KIP (80-kN) where a classification station was found, look in the 200th Highest Hour Traffic Count Report for a facility with similar AADT and similar characteristics. Using good engineering judgement, choose the station best representing the 18-KIP (80-kN) request and use the  $K_{30}$  and  $D_F$  factors for that station. Make copies of those pages to be used as backup documentation.

Print Date : May 09, 2002		Florida Department of Transportation Transportation Statistics Office Annual Vehicle Classification Report Count Year 2000		
County:	10 - HILLSBOROUGH			
Site: Co Sec Sub:	2028 10190000	MilePost:	7.70	
		AADT	124,500	
		Description:	SR 400L-4EAST OF SR 45/NEBRASKA AVE	
Func. Class:	11 - Urban Principal Arterial -- Interstate			
Survey Type:	P - PORTABLE	Duration(In Days):	2	
		Annual Average Daily		
		Volume	Percentage	
Class	01	MOTORCYCLES	573	0
Class	02	CARS	86,142	69
Class	03	PICK-UPS AND VANS	16,795	13
Class	04	BUSES	1,307	1
Class	05	2-AXLE, SINGLE UNIT TRUCKS	3,362	3
Class	06	3-AXLE, SINGLE UNIT TRUCKS	2,801	2
Class	07	4-AXLE, SINGLE UNIT TRUCKS	847	1
Class	08	2-AXL TRCTR W/ 1 OR 2-AXL TRLR, 3-AXL TRCTR W/ 1-AXL T	6,661	5
Class	09	3-AXLE TRACTOR W/ 2-AXLE TRLR	4,221	3
Class	10	3-AXLE TRACTOR W/ 3-AXLE TRLR	1,320	1
Class	11	5-AXLE MULTI-TRLR	62	0
Class	12	6-AXLE MULTI-TRLR	12	0
Class	13	ANY 7 OR MORE AXLE	398	0
Class	14	NOT USED	0	0
Class	15	OTHER	0	0
Summary Daily Statistics				
	Daily	Design Hour		
	24T&B = 16.87	DHT = 8.43		
	24T = 15.82		124,500	100
	AADT = 13.11	ADP = 6.56		
	ADP = 3.76	ADP = 1.88		
Classes: Passenger Vehicles 01-03, Truck and Buses 04-13, Trucks 05-13, Medium Trucks 04-05, Heavy Trucks 06-13				
* The Totals for Volume and Percentage are rounded.				
			Page: 1	

Figure 8.21  
Traffic Classification Report for Station 111

- Open ESAL-V01.XLS. This Excel spreadsheet is a user friendly menu/macro driven tool for input, calculation, and printing of ESALs. From the Trends Progression for 18-KIP (Figure 8.20), enter the existing year, opening year, mid-design year, and design year AADTs.

EXISTING YEAR:	1994	58500
OPENING YEAR:	2000	71712
MID-DESIGN YEAR:	2010	93732
DESIGN YEAR:	2020	115752
D:	0.50	
T:	0.1193	

EXAMPLE

- At the bottom of the 18-KIP (80-kN) Information Sheet enter the type of pavement, number of lanes and the trends/model increase into the spreadsheet.





- Print out the 18-KIP (80-kN) Report and prepare the transmittal memo. Have the Traffic Analysis Administrator sign the memo and 18-KIP (80-kN) Report.

Table 4

<b>18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2</b>							
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2013	64600	134	1500	0.5	2.18%	0.586	0.890
2014	65600	136	1636	0.5	2.18%	0.584	0.890
2015	66600	138	1774	0.5	2.18%	0.583	0.890
2016	67500	140	1914	0.5	2.18%	0.582	0.890
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2020	71400	146	2489	0.5	2.18%	0.577	0.890
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Prepared by: Luis E. Diaz, P.E.		Planning Manager		TEI			
Name		Title		Org. Unit or Firm		Date	
Signature							
Susan Sadighi		Technical Applications Supervisor		FDOT			
Name		Title		Org. Unit or Firm		Date	
Signature							

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Figure 8.23 Report Printout for ESAL-V01.XLS

EXAMPLE



16. Make necessary copies for distribution as follows:
  - a. Original transmittal memo and original 18-KIP (80-kN) Report to requestor.
  - b. Copy of transmittal memo only to the Traffic Analysis Administrator.
  - c. Copy of transmittal memo and 18-KIP (80-kN) Report to reading files.
  - d. Copy of transmittal memo, 18-KIP (80-kN) Report, and all backup documentation to 18-KIP (80-kN) project files.

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## 8.6 SUMMARY

The ESAL forecast is vitally important in determining the Structural Number Required ( $SN_R$ ) for flexible pavement and the Depth Required ( $D_R$ ) for rigid pavement. Proper attention to input and good engineering judgement should be used when developing the ESAL forecast.