2008

Project Traffic Forecasting Handbook

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 FDOTs 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.

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CHAPTER ONE

INTRODUCTION AND OVERVIEW

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**.

1.2 INTRODUCTION

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

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 TURNS5-V02 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.

Appendix D

Turns5-V02 Balancing Logic.

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.).

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, TopicNo. 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, TrafficEngineering Office, January 2000.

Flexible Pavement Design Manual, Florida Department of Transportation, PavementManagement 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)

AADT **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.

1.5 DEFINITIONS - Continued

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)

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)

1.5 DEFINITIONS - Continued

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.

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)

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)

1.5 DEFINITIONS - Continued

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)

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.

1.5 DEFINITIONS - Continued

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. D100 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.

DF — Directional distribution factor for ESALD 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.

ESALEQUIVALENT 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.

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.

1.5 DEFINITIONS - Continued

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 OCCUPANCYVEHICLE** —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.

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.

1.5 DEFINITIONS - Continued

K_{30}

K_{30} — 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_{100} — 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_{200} — The proportion of Annual Average Daily Traffic (AADT) occurring during the 200th highest hour of the design year.

L_f **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 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.

1.5 DEFINITIONS - Continued

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 FIHS 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 if the traffic demand model does not generate the AADT directly. 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.

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. The Peak Season Average Weekday Traffic (PSWADT) should be converted to AADT using a MOCF when the traffic demand model does not directly generate the AADT. This is because some FSUTMS traffic assignment volume generates PSWADT projections for the roads represented in the model highway network, while the AADT should be reported in the Project Traffic Forecasting Reports.

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.

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

T_{24} — The percentage of truck traffic for 24 hours (one day). T_{24} is the same as 24T+B in the Florida Annual Traffic Classification Report.

24T+B — **24HOUR 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.

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.

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)

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).

Traffic Forecasting Process

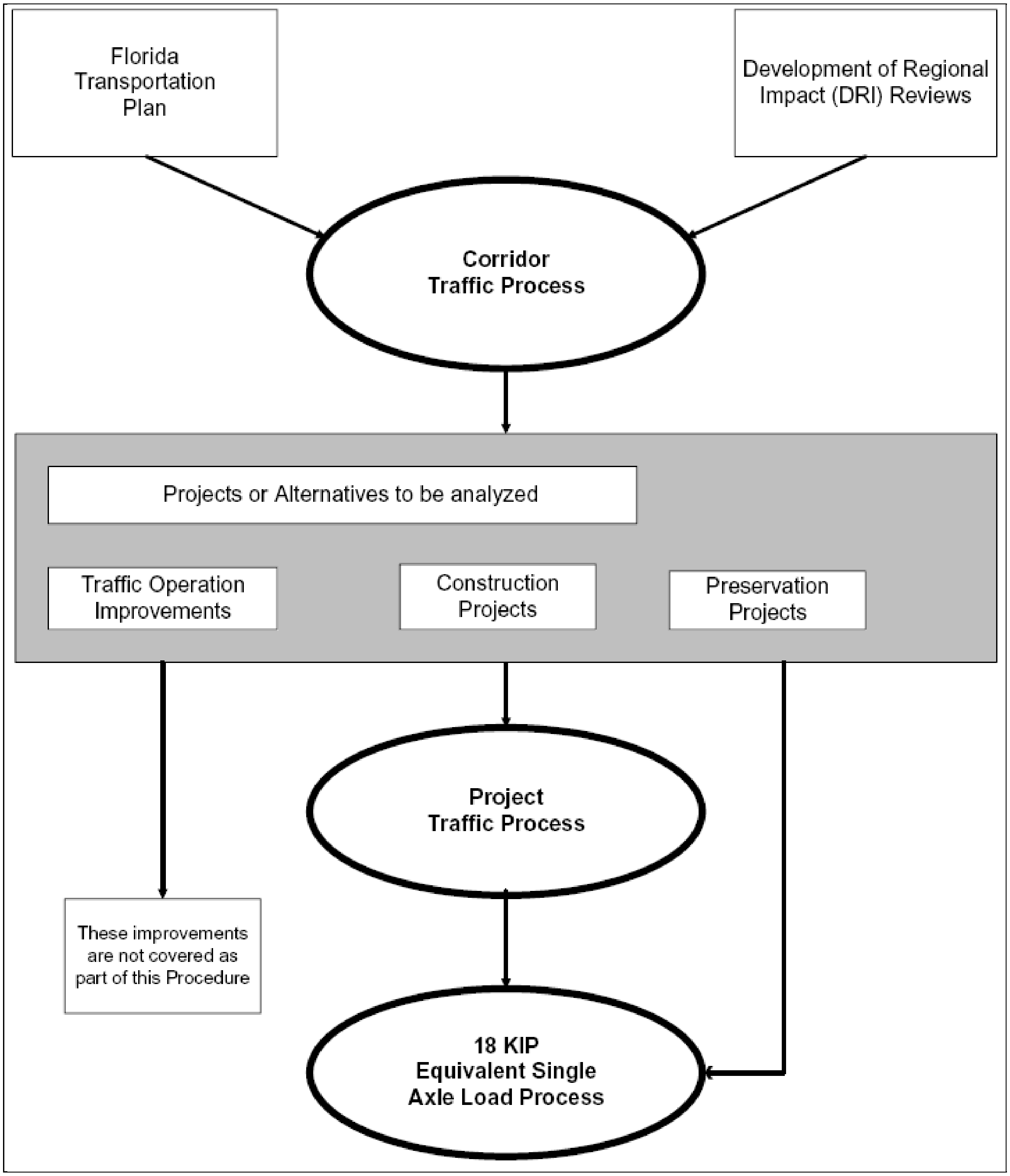

Figure 1.1 Traffic Forecasting Process

1.7.1 Corridor Traffic Forecasting

Corridor projects usually require the development of travel projections which are used to make decisions which have important capacity and capital investment implications. Corridor Traffic Forecasting determines the required number of lanes within a corridor to meet the future anticipated traffic demands. The traffic forecasting is required before establishing a new alignment or widening of existing facilities.

1.7.2 Project Traffic Forecasting

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. Project Traffic Forecasting is also 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.

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. While the total volume of traffic influences the geometric requirements of the highway, the percentage of commercial traffic and frequency of heavy load applications have the major effects on the structural design of the roadway. 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 are detailed in Chapter 8 in this handbook.

1.8 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.

1.9 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

TRAFFIC DATA SOURCES AND FACTORS

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

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

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

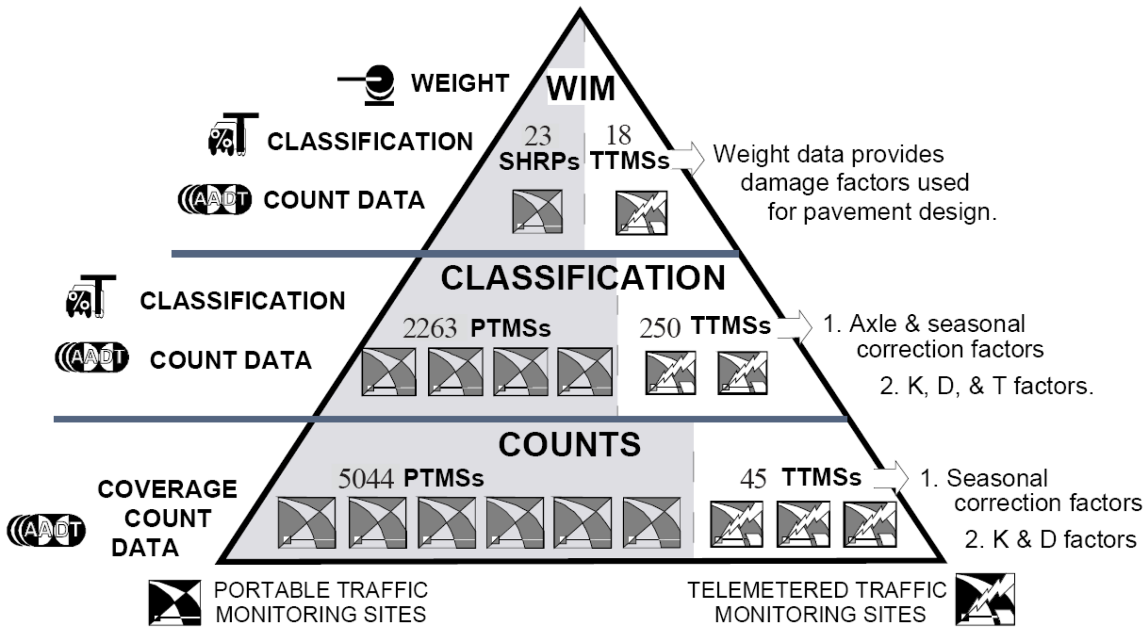


Figure 2.1 Florida's Traffic Monitoring Sites Used in 2000 to collect Traffic Counts and Adjustments Factors

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.

FHWA CLASSIFICATION SCHEME "F"

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

Figure 2.2 FHWA Vehicle Classification Scheme "F"

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:

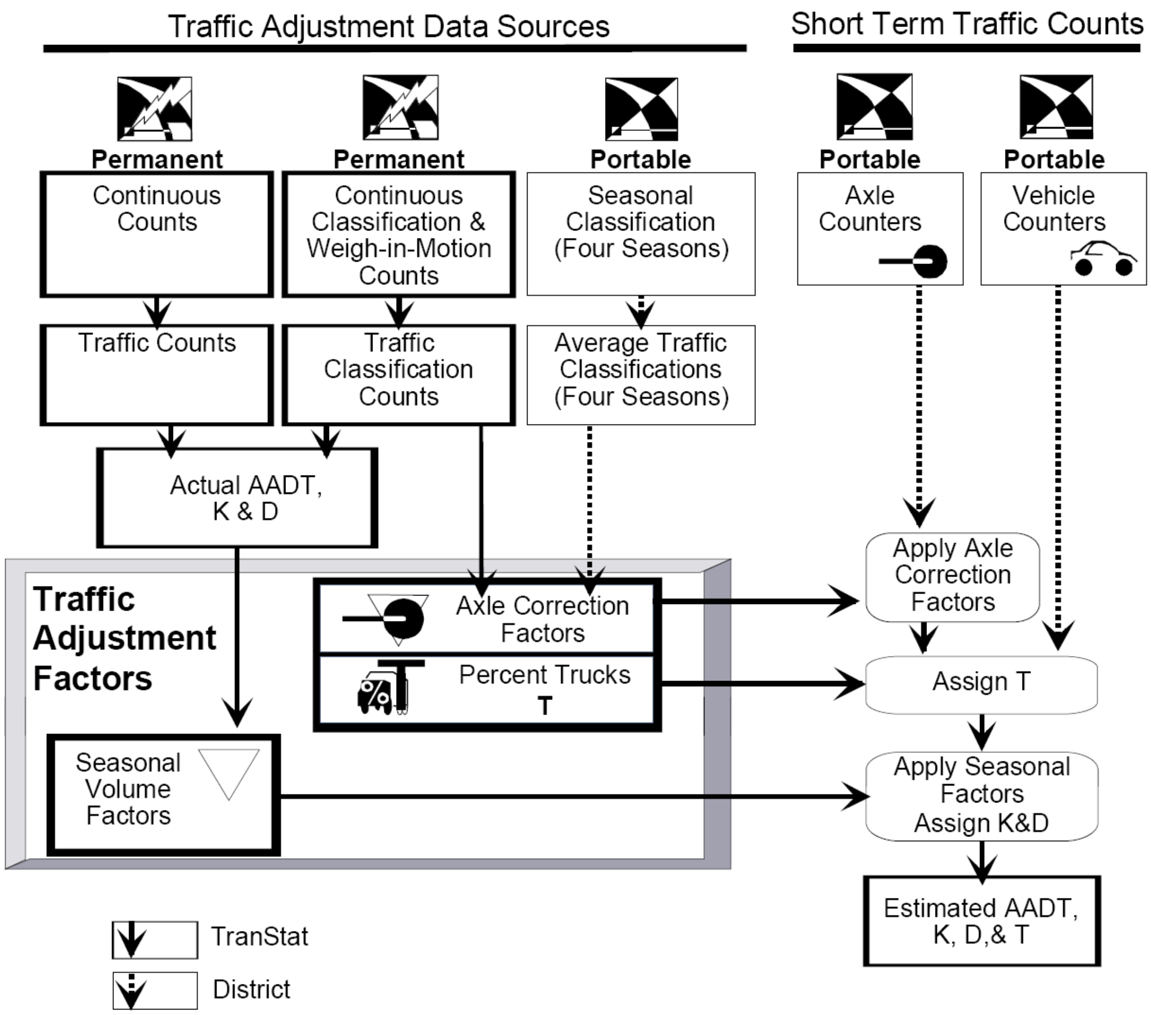
$$MSF = \frac{AADT}{MADT}$$

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 4.6 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.

$$AADT = ADT \times SF \times Axle\ Correction\ Factor$$

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.

AADT data are based on site specific counts, if available, and the Department's traffic count program. K_{30} and D_{30} are based on the ***200th Highest Hour Traffic Count Report*** and T is based on the site specific classification counts, if available, and the ***Florida Annual Traffic Classification Report***. K_{30}, D_{30} and T values are available from the Department's Roadway Characteristics Inventory (RCI) and Traffic Characteristics Inventory (TCI) mainframe databases. PHF can be established for the category of roads (*see* the most recent ***Highway Capacity Manual*** for guidance). 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 and T factor. This will allow the identification of the peak hour of the day and the peak direction during that peak hour. Obtain existing turning movement counts from intersection studies or other resources during the identified peak hour. If these are not available, collect turning movement counts for major signalized intersections only using the procedure for Summary of Vehicle Movements described in the FDOT ***Manual on Uniform Traffic Studies***, **Topic No. 750-020-007**.

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:

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

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}

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}:

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

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:

$\mathbf{T_f}$ — The percentage of truck traffic during the peak hours.

$\mathbf{T_{24}}$ — The percentage of truck traffic for 24-hours (one day). T_{24} 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.

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	8.575	2.339

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	Milepoint
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	Milepoint	Volume	Axle Category
010021	010200	4.000	0100	0101

For the third week of January 2007 the following factors are found in the Weekly Volume Factor Category Table (**Error! Reference source not found.** below) and Weekly Axle Factor Category Table (**Error! Reference source not found.** below) .

2 Seasonal Factor

```
 2007 Peak Season Factor Category Report - Report Type: ALL
Category: 0100  CHARLOTTE COUNTYWIDE
                                                MOCF: 0.86
Week           Dates                SF          PSCF
========================================================================
  1     01/01/2007 - 01/06/2007    1.05         1.23
  2     01/07/2007 - 01/13/2007    0.99         1.16
  3     01/14/2007 - 01/20/2007    0.92         1.07
* 4     01/21/2007 - 01/27/2007    0.90         1.05
* 5     01/28/2007 - 02/03/2007    0.89         1.04
* 6     02/04/2007 - 02/10/2007    0.87         1.02
* 7     02/11/2007 - 02/17/2007    0.85         0.99
* 8     02/18/2007 - 02/24/2007    0.84         0.98
* 9     02/25/2007 - 03/03/2007    0.83         0.97
*10     03/04/2007 - 03/10/2007    0.82         0.96
```

EXAMPLE

Figure 2.4 Weekly Volume Factor Category Report

0.99 Axle Factor

```
            2007 Weekly Axle Factor Category Report - Report Type: ALL

     County: 01 - CHARLOTTE

Week         Dates                        0101
                               US41,MCKENZIE-KINGS
 1   01/01/2007 - 01/06/2007              0.99
 2   01/07/2007 - 01/13/2007              0.99
 3   01/14/2007 - 01/20/2007              0.99
 4   01/21/2007 - 01/27/2007              0.99
 5   01/28/2007 - 02/03/2007              0.99
 6   02/04/2007 - 02/10/2007              0.99
 7   02/11/2007 - 02/17/2007              0.99
 8   02/18/2007 - 02/24/2007              0.99
 9   02/25/2007 - 03/03/2007              0.99
10   03/04/2007 - 03/10/2007              0.99
```

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 = Traffic Count x Seasonal Factor (SF) x 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 16, 2007 is 10,000 vehicles/day, applying the Seasonal Factor 0100 (.92) and Axle Correction Factor 0101 (.99) then AADT can be calculated as follows:

AADT = 10,000 x .92 x .99
AADT = 9,108
AADT = 9,100 (after rounding)

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} = 10.34 D_{30} = 54.95 T = 9.33 are the factors found in the summary reports for this example

2007 Volume Factor Category Summary Report - Report Type: DISTRICT

Category: 0100 - CHARLOTTE COUNTYWIDE

	Jan	Feh	Mar	Apr	May	Jun	Jul	Aug	Sep	Ocr	Nov	Dec	Sun	Mon	Tue	Wed	Thu	Fri	Sar	"K"	"K100"	"D"	AADT
010228 E	0.94	0.86	0.82	0.91	1.02	1.08	1.11	1.10	1.13	1.08	1.05	1.03	1.39	0.99	0.93	0.92	0.92	0.88	1.14				
010228 W	0.94	0.85	0.82	0.90	1.02	1.08	1.12	1.11	1.13	1.08	1.05	1.03	1.41	1.00	0.93	0.92	0.91	0.87	1.13				
010220 D	0.94	0.06	0.02	0.90	1.02	1.00	1.12	1.11	1.13	1.00	1.05	1.03	1.40	1.00	0.93	0.92	0.92	0.00	1.13	11.00	10.24	52.45	25110
019917 N	0.91	0.89	0.84	0.92	1.01	1.08	1.10	1.08	1.10	1.08	1.03	1.07	1.38	0.99	0.95	0.93	0.92	0.86	1.13				
019917 S	0.91	0.85	0.84	0.94	1.03	1.08	1.10	1.09	1.12	1.06	1.03	1.06	1.31	0.98	0.95	0.93	0.92	0.89	1.14				
019917 B	0.91	0.87	0.84	0.93	1.02	1.08	1.10	1.09	1.11	1.07	1.03	1.07	1.35	0.99	0.95	0.93	0.92	0.88	1.13	10.34	9.58	54.95	15210

Figure 2.6 Volume Factor Category Summary Report

```
                                     Florida Department of Transportation
                              Annual Vehicle Classification Report   Report Type: ALL
                                              Count Year 2007

County: 01 - CHARLOTTE
Site    Co Sec Sub     MilePost     Description
0021    01010000       9.838        SR 45/US 41, SE OF CR 765/ALLIGATOR CREEK   CH185
Func. Class: 14 - Urban Other Principal Arterial
Survey Type: Portable          Duration:   1 Days          Annual Average Daily           Summary Daily Statistics
                                                          Volume          %                Daily         Design Hour
Class 01 MOTORCYCLES                                           90       0.52          24TKB =  9.33%    DHT =  4.67%
Class 02 CARS                                               11669      68.24          24T   =  9.28%
Class 03 PICK UPS AND VANS                                   3745      21.90          24H   -  6.42%    DH3 -  3.21%
Class 04 BUSES                                                 10       0.06          24M   -  2.91%    DH2 -  1.46%
Class 05 2-AXLE, SINGLE UNIT TRUCKS                           400       2.05
Class 06 3-AXLE, SINGLE UNIT TRUCKS                           205       1.67
Class 07 4-AXLE, SINGLE UNIT TRUCKS                            62       0.36
Class 08 2-AXL TRCTR W/ 1 OR 2-AXL TRLR, 3-AXL TRCTR W/ 1-A   388       2.27
Class 09 3-AXLE TRACTOR W/ 2-AXLE TRLR                        339       1.99
Class 10 3-AXLE TRACTOR W/ 3-AXLE TRLR                         16       0.10
Class 11 5-AXLE MULTI-TRLR                                      2       0.01
Class 12 6-AXLE MULTI-TRLR                                      0       0.00
Class 13 ANY 7 OR MORE AXLE                                     5       0.03
Class 14 NOT USED                                               0       0.00
Class 15 OTHER                                                  0       0.00

                                                            17100     100.00
```

Figure 2.7 Annual Vehicle Classification Report

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_F). 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 (DF) 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 DF. 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 DF 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. The LOSPLAN software package can reasonabily determine the LOS for planning purposes, 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:

$$Number\ of\ Lanes = \frac{\boldsymbol{DDHV}}{Service\ Flow\ Rate\ Per\ Lane\ \times \boldsymbol{PHF}}$$

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CHAPTER THREE

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

3.1 PURPOSE

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 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.

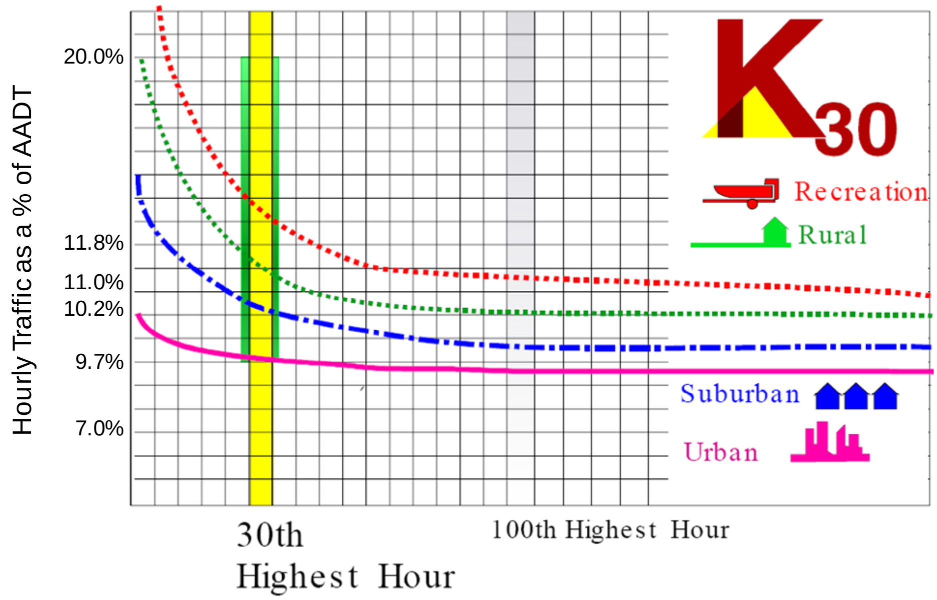


Figure 3.1

Relation between Peak-Hour and AADT Volume

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. $_{D}$HV 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.

3.4 DIRECTIONAL DISTRIBUTION - D_{30}

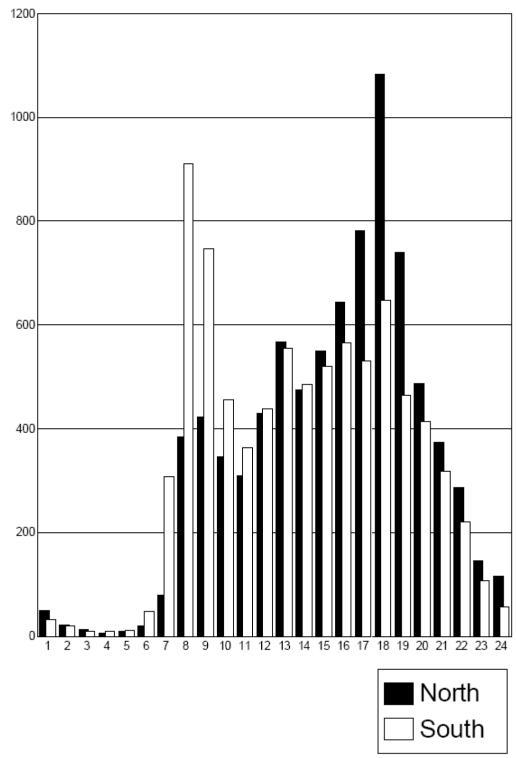
A highway with a high percentage of traffic in one direction during the peak hours may require more lanes than a highway having the same AADT but with a lower percentage. This percentage of traffic in one direction is referred to as **Directional Distribution (D).**

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

Traffic Volume Directional Distribution



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 Figure 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 200^{th} 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, interim, and design years traffic forecasts.

Project Type	Design Period	Opening Year (OY)	Interim Year	Design Year
Roadway Construction	20 years	WP* + 1 year	OY + 10 years	OY + 20 years
Resurfacing	20 years	WP + 1 year	OY + 10 Years	OY + 20 years**

* WP = 1^{st} year of construction in FDOT Adopted Work Program

** 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 same as the base year of the traffic assignment model. 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.

The interim year is halfway between the opening and design year, which is normally ten years after the opening year. The interim analysis is important to identify situations where projects might fail in the design year, and how long the project would provide acceptable operations.

The calibrated base year of the model will usually be different than the opening year of the proposed project. Likewise, the forecast year of the model may be different than the design year of the project. Standard modeling procedures, such as interpolation and extrapolation, should be employed to ensure that the model will provide traffic assignments for both the opening and design year of the project.

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 DVD-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 DVD-ROM.

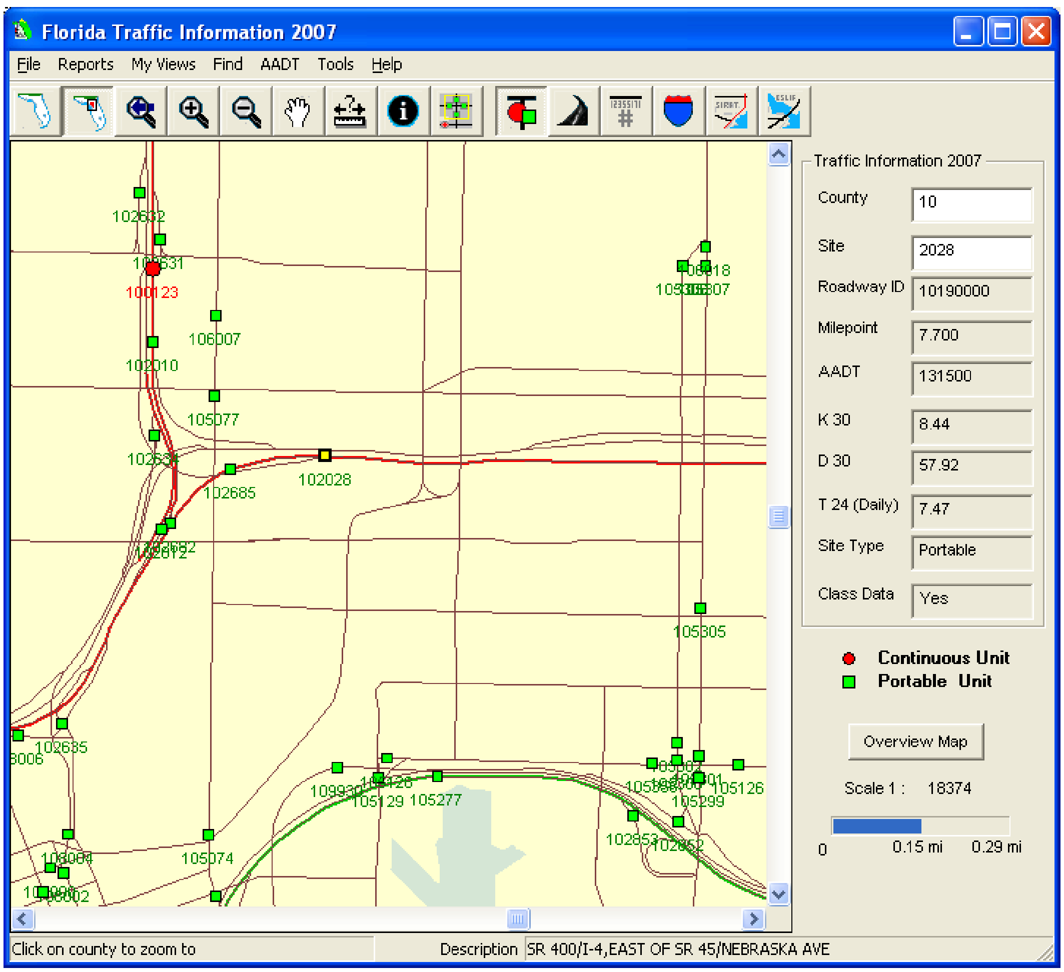


Figure 3.3 Map from Florida Traffic Information DVD

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.

```
                              Florida Department of Transportation
                    Annual Vehicle Classification Report - Report Type: ALL
                                       Count Year 2007

County: 10 - HILLSBOROUGH
Site    Co Sec Sub    MilePost    Description
2028     10190000        7.700    SR 400/I-4,EAST OF SR 45/NEBRASKA AVE
Func. Class: 11 - Urban Principal Arterial -- Interstate
Survey Type: Portable        Duration:   1 Days      Annual Average Daily          Summary Daily Statistics
                                                    Volume            %                Daily         Design Hour
Class 01 MOTORCYCLES                                   899          0.68          24T&B =  7.47%    DHT =  3.73%
Class 02 CARS                                        97588         74.21          24T   =  7.27%
Class 03 PICK-UPS AND VANS                           23196         17.64          24H   =  4.63%    DH3 =  2.31%
Class 04 BUSES                                         258          0.20          24M   =  2.84%    DH2 =  1.42%
Class 05 2-AXLE, SINGLE UNIT TRUCKS                   3475          2.64
Class 06 3-AXLE, SINGLE UNIT TRUCKS                   1109          0.84
Class 07 4-AXLE, SINGLE UNIT TRUCKS                    261          0.20
Class 08 2-AXL TRCTR W/ 1 OR 2-AXL TRLR, 3-AXL TRCTR W/ 1-A   1722   1.31
Class 09 3-AXLE TRACTOR W/ 2-AXLE TRLR                2522          1.92
Class 10 3-AXLE TRACTOR W/ 3-AXLE TRLR                 167          0.13
Class 11 5-AXLE MULTI-TRLR                              62          0.05
Class 12 6-AXLE MULTI-TRLR                              17          0.01
Class 13 ANY 7 OR MORE AXLE                            224          0.17
Class 14 NOT USED                                        0          0.00
Class 15 OTHER                                           0          0.00
                                                   -------        ------
                                                    131500        100.00
```

Figure 3.4 Example of Site 102028 from the Traffic Classification Report

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
Site: 0130
Description: I-4,0.8 MI.SOUTH OF SR-482 (TTMS)
Location: 75280000 **Milepost:** 7.50
AADT: 143,280

Valid Data
Hours 6,000
Days 250
Weeks 47
Months 12

Position	Total Count	Low Dir	Low Count	High Dir	High Count	Day	Date	Hour	"D" Factor	"K" Factor
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

Page: 1

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

County: 75
Site: 0130
Description: I-4,0.8 MI SOUTH OF SR-482 (TTMS)
Location: 75280000 **Milepost:** 7.50
AADT: 143,280

Valid Data
Hours 6,000
Days 250
Weeks 47
Months 12

Position	Counts: Total Count	Low Dir	Low Count	High Dir	High Count	Collection: Day	Date	Hour	"D" Factor	"K" Factor
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

Page: 5

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

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.

Figure 3.7 RECOMMENDED K-FACTORS (K_{30}) FOR TRAFFIC FORECASTING

Road Type	Low	K_{30} Average	High	Standard Deviation
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

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	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
003:	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	1.45 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	1.45 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 ORLANDC (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	6.63 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	6.63 F
005:	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	1.45 F
0054	P	SR-527, 0.25 MI. N OF SR-482 (UV)	0	0	40,000 C	8.88 F	58.08 F	1.45 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."

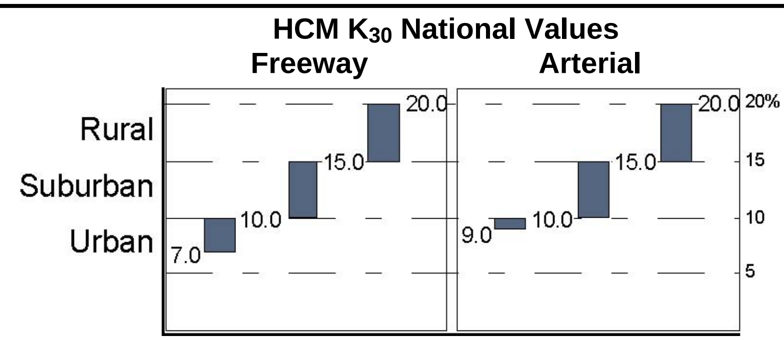


Figure 3.9

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. FHWA suggests the minimum value of the demand K to be 9% for urban projects.

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:

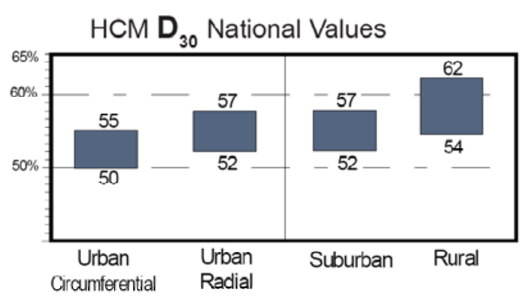
Step 1. First determine if a D_{30} value is within an acceptable range of demand D_{30} values, using Figure 3.10.

Figure 3.10 RECOMMENDED D-FACTORS (D_{30}) FOR TRAFFIC FORECASTING

Road Type	Low	D_{30} Average	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

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 200[th] 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.



The national values for D range from 50% to 62% based on facility type as shown.

Figure 3.11

3.10 ADJUSTING THE K-FACTOR

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, Right-of-Way, 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

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 Nonstandard K_{30} and D_{30} Values

If K_{30} and D_{30} values lower than FHWA standards are to be used, the prior approval of FHWA is required before continuing the Project Traffic Forecasting Process.

3.13 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 ”

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

4. 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.

	Year	AADT	K_{30}	No. of Lanes	Type of Facility
min	96	19,348	10.8	4	Freeway
max	93	23,001	14.1	4	Freeway

	K_{30} *I-10 Site 156*	K_{30} *Florida Data*	K_{30} *National Data*
Observed Minimum	10.8	9.60	10.00
Observed Maximum	14.1	14.60	15.00

5. 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

3.14 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.

SITE 156 ESCAMBIA COUNTY
I-10, 1.5 mile west of U.S. 90
48260 - 4.10
Rural/Suburban

YEAR	AADT	D_{30}	No. of Lanes	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 ”

3. 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-10 *Site 156*
Observed Minimum	**51.5**
Observed Maximum	**56.2**

4. 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-10 Site 156*	D_{30} *Florida Data*	D_{30} *National Data*
Observed Minimum	**51.5**	**52.0**	**52.3**
Observed Maximum	**56.2**	**57.0**	**57.3**

5. 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

3.15 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	K_{30}	D_{30}	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-10 Site 156	D_{30} National Data	D_{30} State Data
Observed Minimum	51.5	52.00	52.3
Observed Maximum	56.2	57.00	57.3

	K_{30} I-10 Site 156	K_{30} National Data	K_{30} State Data
Observed Minimum	10.8	9.60	10.00
Observed Maximum	14.1	14.60	15.00

Recommend	**K_{30}**	**D_{30}**
	11.00	**52.00**

EXAMPLE

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CHAPTER FOUR

TRAFFIC FORECASTING WITH TRAVEL DEMAND MODELS

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. First, the definition and the components of Corridor Traffic Forecast and Project Traffic Forecast is introduced in Section 4.2. Sections 4.3 through 4.6 discuss what a traffic forecasting user should know about how modeling outputs are used in the development of traffic forecasting. Sections 4.7 through 4.15 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. The rest of the chapter explains the process of converging the model outputs into **Average Annual Daily Traffic (AADT).**

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

- **Model Output Conversion to AADT**
  - General travel demand model issues

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.

4.2 CORRIDOR AND PROJECT TRAFFIC FORECASTING

4.2.1 Corridor Traffic Forecasting

Corridor Traffic Forecasting determines the required number of lanes within a corridor to meet the future anticipated traffic demands. The traffic forecasting is required before establishing a new alignment or widening of existing facilities. Corridor models are special application models that are usually calibrated to forecast traffic for a certain corridor and are usually more specific than the urban area or statewide model and less specific than project forecasting models. The calibrated models to forecast general corridor traffic for systems planning application purposes should be checked to ensure that they have the required specificity for project details required for project traffic forecasting using design traffic criteria.

Corridor Traffic Forecasting Process studies are needed to determine future traffic volumes and long range system data needed (such as link volumes) for the areawide highway or transportation network. A corridor may be designated by a local government in its Comprehensive Plan.

A corridor study containing a corridor traffic forecast may document the need for new or upgraded transportation facilities within the corridor. The corridor process may be required for traffic flow analyses of large area, such as those needed in the preparation of Development of Regional Impact (DRI) applications for development approval, Strategic Intermodal System/Florida Intrastate Highway System (SIS/FIHS) Master and Action Plan reports, and the major transportation investments required by federal regulation in metropolitan areas.

All project traffic projections using the Corridor Traffic Forecasting Process will also require the more rigorous examination of the Project Traffic Forecasting Process. For planning applications, the model is often used with a feedback loop to provide for changing or amending approved plans such as the MPO Long Range Transportation Plan, the LGCP, or WPA. Revisions to these plans may or may not require more detailed analysis associated with project traffic forecasting using design traffic criteria. The District Director of Transportation Development or his/her designee will be responsible for carrying out the Corridor Traffic Forecasting Process unless assigned elsewhere by the District Secretary.

Figure 4.1 illustrates the seven-step Corridor Traffic Forecasting Process.

Corridor Traffic Forecasting Process

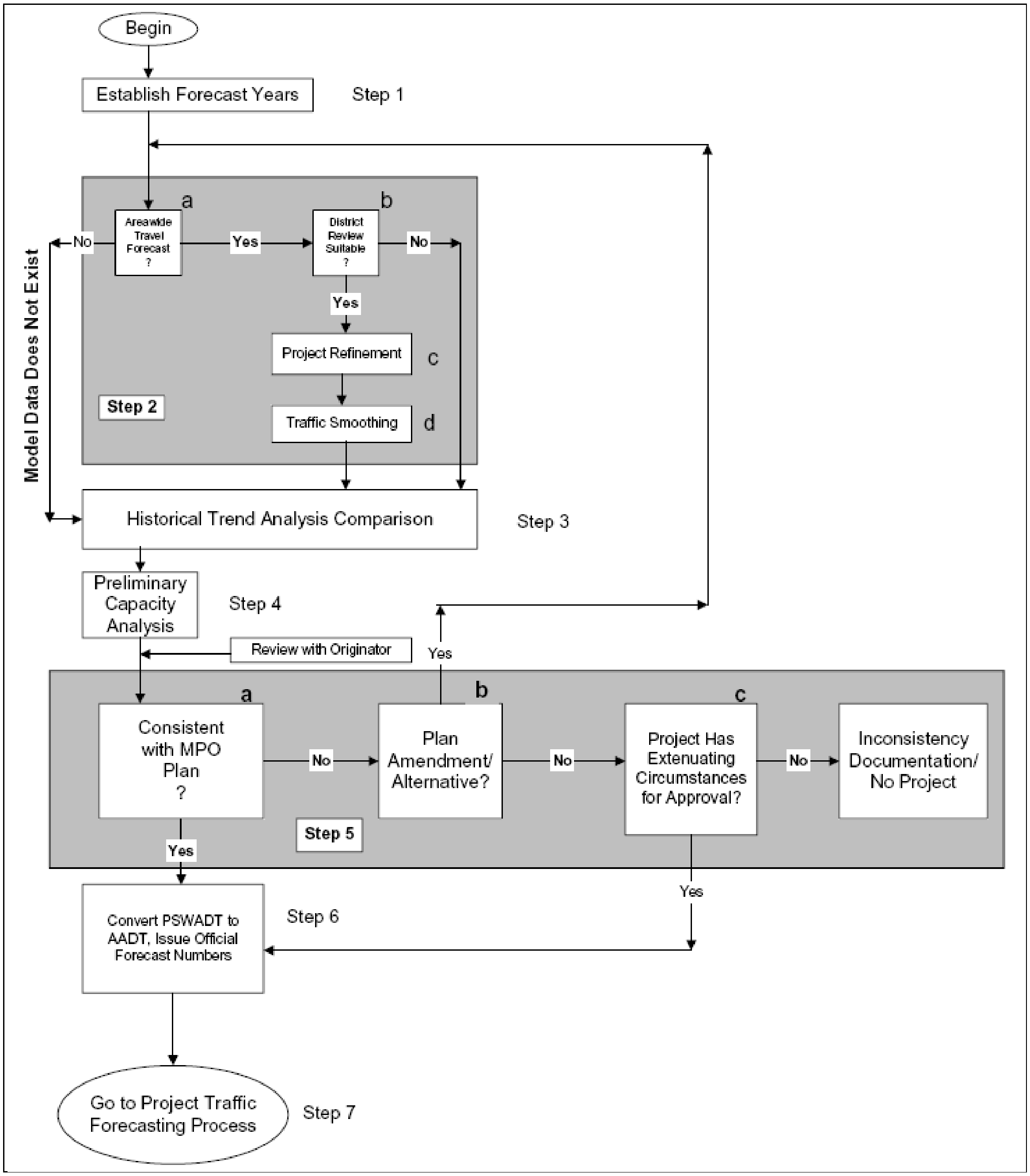

Figure 4.1 Corridor Traffic Forecasting Process

4.2.2 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 4.2. This handbook focuses on the Project Traffic Forecasting Process. Therefore, the steps shown in Figure 4.2 are explained in greater detail throughout this handbook.

While the general corridor traffic may be detailed enough to identify the needs for specific improvements, the final project traffic forecasting data needed for a specific project, (such as a link or intersection) may require more refined or specific project traffic analysis. Project traffic studies identify specific link volumes, turning movements, and other project-specific data necessary for the geometric design of, and operational improvements to roadways or intersections. This process is different from the corridor process since the project traffic studies are site specific, covers a limited geographic area, and are more detailed. The project traffic process forecasts traffic conditions and turning movements used for designing the configuration and number of lanes for proposed projects as defined in the ***FDOT Adopted Work Program***. These projects will be selected by the Districts and assigned a Financial Management (FM) Number. Other uses could be to identify the project traffic requirements for the Interstate and Intrastate Highway Systems, the Interchange Justification Report process, the Interchange Modification Report process, and the Master and Action Plans for the SIS/FIHS.

The steps in the Project Traffic Forecasting Process shown in assists with preparing project traffic consistent with design traffic criteria. The numbered steps described below correspond to the steps identified in the figure.

Project traffic forecasting is usually required for determining the number of lanes required to meet the future anticipated traffic demand. Project traffic forecasting is required for reconstruction, resurfacing, adding lanes, bridge replacement, approaches to bridges, new roadway projects, and major intersection improvements. The District Director of Transportation Development or his/her designee will be responsible for carrying out the project traffic forecasting process unless this responsibility is assigned elsewhere.

Project Design Traffic Forecasting Process

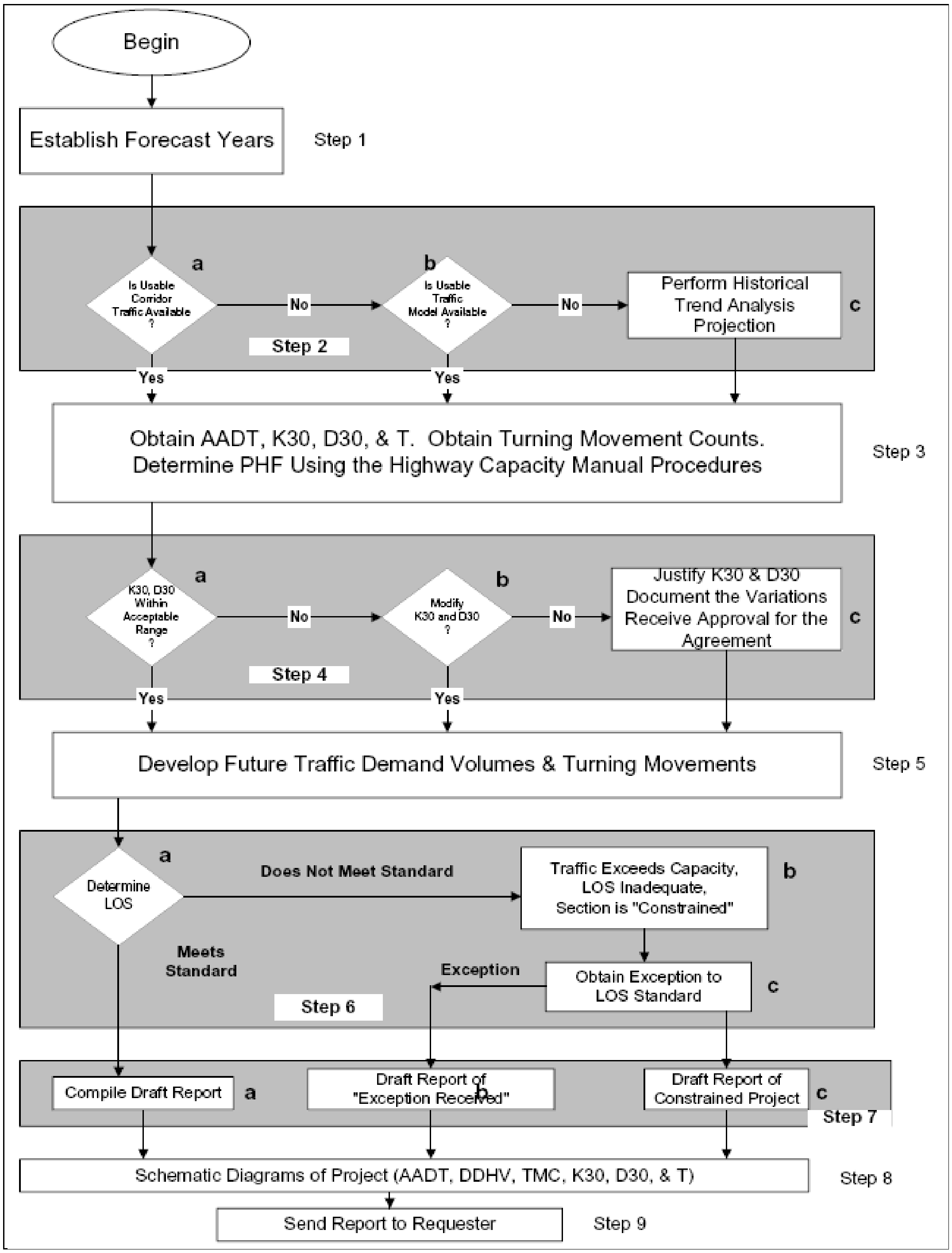

Figure 4.2 Project Traffic Forecasting Process

4.3 MODELING BACKGROUND FOR TRAFFIC FORECASTING

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 for District Planning and Modeling Contacts for the telephone numbers of District Planning Office personnel.

4.4 MODEL SELECTION

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.

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. Since the availability of models varies from district to district, the District Planning Office should be contacted to confirm the correct model to be used.

4.4.1 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 ATraffic Model be followed instead as detailed in Chapter 5.

4.4.1.1 Areawide Travel Forecast Model

Determine if the corridor resides in a region with an existing areawide traffic forecast model. If more than one traffic model is available, the selected model should depend on the hierarchy of available models (e.g., master plan, urbanized (MPO) model, Turnpike, county, city, corridor or project). The District Planning Manager or his designee can provide the current status of the MPO model, and ensure that the model used for project traffic forecasting is consistent with the adopted urban area model. Intermodal/ multimodal and HOV modeling should be considered where applicable. If a traffic model is available, perform appropriate District review.

4.4.1.2 Model Applicability Revision

All models used for project traffic forecasting must be approved by the District Planning Manager or his/her designee and determined to be suitable for forecasting traffic for the design project. The suitability check should include percent-root-mean-square (%RMS) and screen line in base year evaluations. If the model is acceptable, perform project refinement. If not, perform historical trend analysis comparison.

4.4.1.3 Project Refinement

The base and future year model forecasts shall be reviewed. Within the corridor study area of influence for the model review, take into consideration parallel facilities, competing facilities, transit services, network revisions, disaggregation of zones, and socioeconomic data when refining the model traffic to be more project specific. After making the needed model revisions to make the model more project specific, apply traffic smoothing. Some ***FSUTMS*** traffic demand models are calibrated to forecasts the peak season weekday average daily traffic (PSWADT). When applicable, the peak season output must be converted to AADT before being used for project traffic forecasting applications using design traffic criteria.

4.4.1.4 Traffic Smoothing:

Refine the project traffic forecast model to eliminate anomalies and to make results consistent. When this is not possible, manual traffic smoothing using other methods will require the project traffic report to include objective justification that has been approved by the District prior to completing the project traffic forecast.

4.5 SUITABILITY OF OUTPUTS AND MODELS

This step determines if the corridor traffic forecasting outputs or other traffic models are appropriate for the analysis and consists of three sub-steps.

4.5.1 Corridor Traffic Data Usability

Determine if corridor traffic data are available and usable for the Project Traffic Forecasting Process and is consistent with design traffic criteria. Corridor traffic should not be used if the traffic and number of lanes are not consistent with the LGCP and/or the adopted MPO Long Range Transportation Plan. If the corridor traffic data are consistent, use the corridor traffic forecast procedure. If corridor traffic is not available, consult the District MPO liaison to determine if other traffic forecasting models are available.

4.5.2 Traffic Model Availability

If a traffic model is available, determine which model to select for the project. The selected model should depend on the hierarchy of available models (e.g.

master plan, regional or urbanized area model, and local). The District Planning Manager or his/her designee can provide the current status of the MPO model, and ensure that the model used for project traffic forecasting is consistent with the adopted urban area model. Determine if the selected traffic forecast model is suitable for performing the analysis. The suitability check should include percent-root-mean-square (%RMS) and screen line in base year evaluations. If the traffic model is usable, then use the corridor traffic forecast. If no traffic model is available or suitable for the project, perform historical trend analysis projection.

4.5.3 Historical Trend Analysis

While not all capacity improvement corridor projects may use a corridor traffic model and some projects may be in geographic areas where such a model does not exist, certain capacity improvement corridor projects, such as additional lanes, should use the corridor traffic model. If the project is not significant enough to cause traffic diversion, and traffic can be shown to follow past history trends, historical trend analysis may be used to forecast future traffic, as in widening or resurfacing project. Such a project would not cause a traffic diversion and trend forecasting could be justified. A statement of the adopted methodology should be included with the final Corridor Traffic Forecasting Report.

When performing a historical trend analysis, care must be taken to compare similar types of traffic outputs, which means that, PSWADT, must be compared to PSWADT, and AADT must be compared to AADT. For instance, an estimated ground count (AADT) must be converted to PSWADT before comparing with the model output PSWADT. The model output PSWADT must also be converted to AADT and compared to an AADT ground count. In all cases, the traffic compared consists of both AADT and PSWADT before evaluation.

A historical trend analysis shall be compared with traffic forecasts from areawide studies, if available, to test for trend analysis reasonableness. Perform a historical trend analysis projection based on available historical counts, population growth, employment, gasoline sales, and other appropriate growth indicators. If the trend analysis fails the test of reasonableness, the causes should be identified. An example of a traffic forecast that could be higher than the historical trend would be the addition of lanes or new land development in the area of influence. An example of a traffic forecast that could be justified to be lower than the historical trend would be a future congested facility identified by the preliminary capacity analysis.

4.6 USE OF MODEL OUTPUT IN TRAFFIC FORECASTING

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

4.6.1 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 IJRs/IMRs are good examples of model applications which may require modifications.

4.6.2 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 Standards and Documentation. The model traffic assignments can be reviewed by displaying the loaded traffic network within the FSUTMS platform.

4.6.3 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. IF the traffic demand models does not generate the AADT directly, 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.

4.6.4 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.

4.7 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.

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.

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.

4.8 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).

4.8.1 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.

4.8.2 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.

4.8.2.1 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.

4.8.2.2 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.

Figure 4.3 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)

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

4.8.2.3 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, post speed, and 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.

4.9 CONSISTENCY WITH THE ADOPTED MPO LONG RANGE AND/OR THE LOCAL GOVERNMENT COMPREHENSIVE PLAN (LGCP)

There are three steps need to be performed to verify the project consistency with the MP long range or local government comprehensive plan. Below is a description of these steps.

4.9.1 Consistency with the Plan(s)

The number of lanes needed to accommodate future travel demands shall be compared with the existing MPO Long Range Transportation Plan in metropolitan areas and LGCPs and plan amendments found in compliance by the Department of Community Affairs. If consistent with the comprehensive plans, prepare the AADT by converting the PSWADT to AADT when applicable. If the project is not consistent with the approved plans, go to the Plan Amendment/Alternative.

4.9.2 Plan Amendment/Alternative

If the corridor traffic forecast results are inconsistent with the MPO Long Range Transportation Plan and/or LGCP, or a Department approved plan, the Department may examine transportation alternatives (such as public transportation alternatives or parallel routes). If this analysis does not resolve the inconsistency, request the District Director of Transportation Development or his/her designee to modify either the existing FDOT plans (such as Action or Master Plans) or initiate the process to request the local government to amend the LGCP or the MPO to revise its Long Range Plan. In any event, the party that requested the corridor study should be notified of the inconsistency and be involved in the decision to remedy it. If alternative transportation improvements are to be tested, redo the project traffic forecast process and perform calculations for the new alternative. If the local government and/or the MPO or the FDOT does amend or revise the applicable plans, prepare the AADT by converting the PSWADT to AADT when appropriate. If the local government and/or the MPO or the FDOT does not amend or revise applicable plans, go to step described in Section 4.9.3.

4.9.3 Inconsistency Documentation/No Project

If the District Director of Transportation Development or his/her designee approves the project due to extenuating circumstances, include a statement in the Corridor Traffic Forecasting Report that the requested project is not consistent with the approved or adopted plan (insert name of plan) and proceed to convert PSWADT to AADT. State in the report the process that was taken in Section 4.9.2 above and the decisions made. Include in the document any written letters or agreements generated as part of the activities in Section 4.9.2. If the project is not viable, indicate in the conclusion of the report that the study resulted in a "No Project."

4.10 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 4.12 for more details)

4.10.1 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
- 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.

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.

4.10.2 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.

4.10.3 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.

4.11 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.

4.11.1 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 4.8.2.

4.11.2 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 4.10.1), Reasonableness Checks for Future Years (Section4.10.2) and Acceptable Model Refinements for Future Years (Section 4.10.3).

4.11.3 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 Standards and Documentation.

4.11.4 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.

4.12 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 4.8.2.

4.12.1 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 4.8.2).

4.12.1.1 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 4.8. 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.

4.12.1.2 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.

4.12.1.3 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.

4.12.1.4 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.

4.12.1.5 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.

4.12.2 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 4.6.2). 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 Figure 4.3 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 4.8.2.

4.13 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.

4.13.1 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.

4.13.2 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.

4.13.3 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.

4.14 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. When appropriate, 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.

4.15 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.

4.15.1 Turning Movements Schematics

Schematic diagrams of the project should be completed if turning movements are involved. These diagrams should show AADTs, turning movements, K_{30}, D_{30}, and T factors.

4.15.2 Certification

A certified report including K_{30}, D_{30}, T, base year AADT, forecasted AADTs, and an 18-KIP ESAL forecast (if applicable) should be sent to the requestor with copies sent to the appropriate District personnel. The project traffic shall be certified using the certification statement form shown in Figure 4.4. If an 18-KIP ESAL is requested, use the certification form shown in Figure 7. All assumptions used in the estimation process and all the conditions to be considered when using the data should be included in the final report.

Project Traffic

Financial Project ID ________________________

State Road No. ________________________

County ________________________

"I have reviewed the Project Traffic to be used for design of this project. I hereby attest that is has been developed in accordance with the FDOT **Project Traffic Forecasting Procedure** using historical traffic data and other available information."

____
Name

____
Signature

____
Title

____
Organizational Unit

____
Date

Source: FDOT Roadway Plans Preparation Manual, Chapter 19, Volume I.

Figure 4.4 Project Traffic Forecasting Certification Statement

18-KIP Equivalent Single Axle Loads (ESAL)

Financial Project ID ________________________

State Road No. ________________________

County ________________________

"I have reviewed the 18-KIP Equivalent Single Axle Loads to be used for pavement design on this project. I hereby attest that these have been developed in accordance with the FDOT Project using historical traffic data and other available information."

____
Name

____
Signature

____
Title

____
Organizational Unit

____
Date

Figure 4.5 18-KIP ESAL Certification Statement

4.16 THE MODEL OUTPUT CONVERSION

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. The output of the FSUTMS can generate either the **Annual Average Daily Traffic (AADT)** or the **Peak Season Weekday Average Daily Traffic (PSWADT)**. FSUTMS traffic assignment volumes represent 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 only to the models generate the PSWADT to convert it into 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.

4.17 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 **MOCF** = 0.75
Category: 4600

	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 4.6 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 4.6 for Bay County site 0053.

4.17.1 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).

4.17.2 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 4.6 to find the PSCF for the week of January 2-8.

Daily Count x Peak Season Conversion Factor = PSWADT
10,485 (Daily Count) x 2.21 (PSCF) = 23,170 ➔ 23,000 (PSWADT)

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:

Daily Count x Seasonal Factor = AADT
10,485 (Daily Count) x 1.66 (SF) = 17,403 ➔ 17,500 (AADT)

The Peak Season Conversion Factor Report, Figure 4.8, 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 4.6. 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.

4.18 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:

Category	Roadway Description
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 4.8

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

AADT = PSWADT x MOCF

EXAMPLE

Using Figure 4.8 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 (Model Output) x 0.96 (MOCF) = 25,102 ➔ 25,000 AADT

In another example, Figure 4.7 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:

30,052 (Model Output)
x 0.83 (MOCF)
= 24,943 AADT
➔ 25,000 AADT

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

Figure 4.7

MOCF Report

EXAMPLE

Print Date: May/09/2002

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

ORANGE I4 DISNEY MOCF = 0.96
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

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Figure 4.8 Peak Season Factor Category Report

Note that this conversion must be made for project traffic forecasting using design traffic criteria. If the traffic assignment from the model is to be used for corridor forecasting, PSWADT must be converted (e.g., the mean of the 13^{th} peak season weekly factors) to AADT before the traffic assignment is suitable for performing the Project Traffic Forecasting Process required to complete the project traffic forecast. If the traffic forecast is based on historical trend analysis, the process does not require any data conversion.

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CHAPTER FIVE

TRAFFIC FORECASTING WITHOUT A TRAFFIC MODEL

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:

   K_{30} — 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.

   D_{30} — This factor can be derived from one of the following: the permanent traffic count station that the K_{30} 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.

   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.

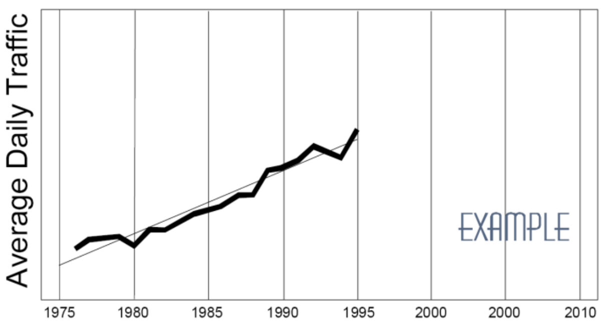
7. Current Highway Capacity Manual (HCM) and relevant software.

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

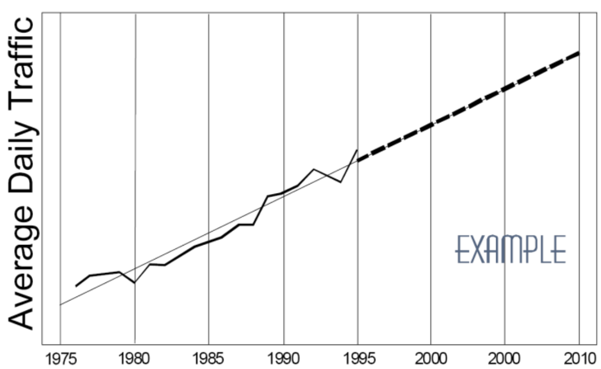


1. Plot historical AADT at a convenient scale with traffic volume on y-axis and year of count on x-axis (leaving room for future year and traffic growth).

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 constraint(s) 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. If traffic counts for the project site are not available, identify the peak hour of the day and the peak direction by obtaining 24 (urban) or 48 (rural) hour classification counts to determine hourly traffic volume distribution and T factor. Obtain existing turning movement counts from intersection studies or other resources during the identified peak hour. If these are not available, collect turning movement counts for major signalized intersections only using the procedure for Summary of Vehicle Movements described in the ***FDOT Manual on Uniform Traffic Studies***, **Topic No. 750-020-007**.

3. 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.

4. 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.

5. 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.

6. 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) Intersection Analysis: 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. Refer to the ***Quality/Level of Service Handbook*** to determine the most appropriate tool to perform the intersection analysis.

   b) Arterial Analysis: Adjust intersection analysis as necessary to obtain an acceptable LOS. Refer to the ***Quality/Level of Service Handbook*** to determine the most appropriate tool to perform the arterial analysis.

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.

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

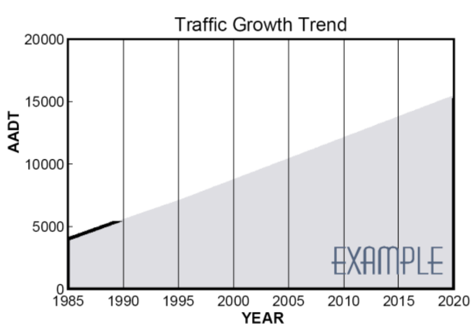
- Motor vehicle registrations, Department of Highway Safety and Motor Vehicles
- MPO Long-Range Plan
- Bureau of Economic and Business Reaearch

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:

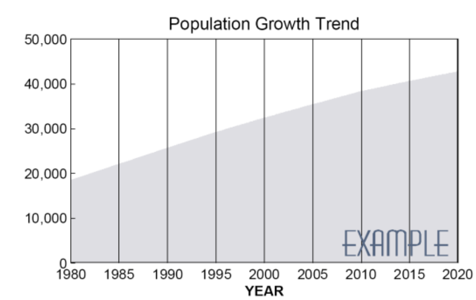
- Population
- Density
- City size
- LOS (existing)
- LOS standards
- Transit alternatives
- Auto ownership
- Household income
- Residential/non-residential mix
- Freeway diversion
- Other unique area considerations
- Current and historical population data

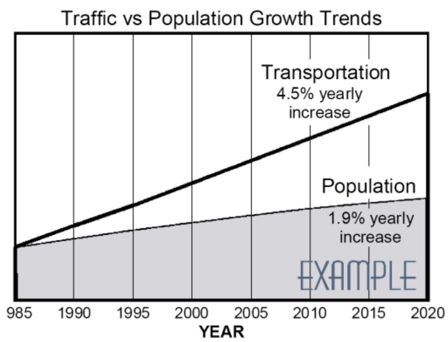
5.6 PASCO COUNTY EXAMPLE

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.

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.

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DIRECTIONAL DESIGN HOURLY VOLUME ESTIMATES

6.1 PURPOSE

This chapter explains the procedure to convert Average Annual Daily Traffic (AADT) into **Directional Design Hourly Volumes (DDHV)**.

6.2 INTRODUCTION

This chapter describes the methodology of converting **Average Annual Daily Traffic (AADT)** volumes into Directional Design Hourly Volumes (DDHV). The 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 DEVELOPMENT OF DESIGN HOUR TRAFFIC VOLUMES

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.

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.

Turning movement forecasts should reflect the logical effects of future year land use and transportation network improvements on the traffic pattern at a given location. In general, if the pattern of land use and transportation system characteristics is expected to change, turning movement patterns are also likely to change over time. Existing turning movements and model simulation results (when available) provide useful starting points for the turning movement forecasting process. The need for turning movement forecast refinements should be determined by careful review of the chosen starting point. The forecaster must use K_{30}, D_{30} and current turning percentages, if available, to calculate turning volumes during the design hour.

6.4 LOS OPERATIONAL ANALYSIS

The level of service (LOS) must be determined on a project-to-project basis since each project has its own charactersitics that might not applied on ther projects. The project manager should determine the tool to be used in order to determine the LOS by consulting the ***Quality/Level of Service Handbook*** published by the FDOT Systems Planning Office.

However, it should be noted that 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, while traffic forecasting calculations require K_{30} to produce 30th highest hour traffic projections.

The LOS analysis could include, but not limited to, intersections, mainline segments, HOV lanes, ramps, and weaving lanes. Compare the results with FHWA and FDOT LOS design standards. Based on the comparison against the FHWA and FDOT LOS design standards, one draft report will be reported out of three possible draft reports. The three possibilities are: LOS Standards Met, Constrained Project, and Exception Received.

Project traffic using design traffic criteria is a forecast of the 30th highest hour traffic volume for the design year, and is required by the Department for all design projects.

Some of the ***FSUTMS*** forecasts PSWADT which represents the 100th highest hour traffic for the year. This is the typical day traffic for the busy season of the year. If the mode does not directly forecast the AADT, the model forecast (PSWADT) shall be converted to the corresponding forecasted AADT in the final step of this process. This AADT is used to derive the 30th hour traffic.

This evaluation must be completed before analyzing consistency with the MPO Long Range Transportation Plan or the LGCP. If the capacity analysis indicates a potential problem or inconsistency with any approved plans, the analyst needs to inform the District Planning Manager and the project manager who requested the project traffic forecast.

6.4.1 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 also 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.

6.4.2 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.

6.4.3 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 6.4.2.

6.5 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 (widenings, 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

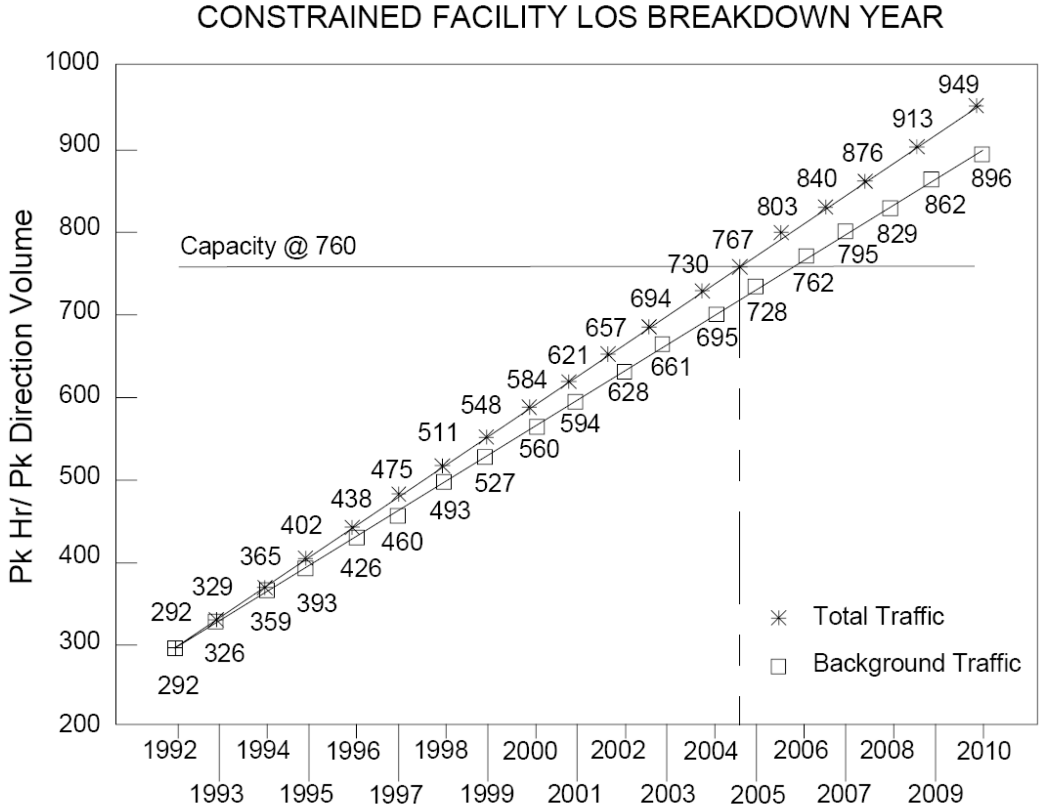

Figure 6.1 Constrained Facility LOS Example

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 6.1. It should be emphasized that actual future year LOS for arterial facilities depends on the expected delay at signalized intersections and overall arterial speed.

6.6 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 LOS determination and evaluation of forecast methodology and traffic operations, the project manager should determine most appropriate methodology to to determine the LOS, such as HCM procedures, LSOPLAN, or microscopic simulation environment.by consulting the ***Quality/Level of Service Handbook*** published by the Systems Planning Office.

6.7 PRACTICAL EXAMPLES

This chapter contains three practical examples relating to the development and analysis of traffic forecasting volumes.

Section 6.8.1 — "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 6.8.2 — "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 6.8.3 — "Example 3 - HCM LOS Volumes," provides an example for how HCM can be used in the development of site specific LOS service flow volumes.

6.7.1 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 4.6). Accordingly, the following AADT derivation applies:

AADT	=	PSWADT x MOCF
	=	75,000 x 0.921
AADT	=	69,075 vpd

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:

DHV	=	AADT x K_{30}
	=	69,075 x 0.094DHV
	=	6,493 vph
DDHV	=	DHV x D_{30}
	=	6,493 x 0.55
DHV	=	3,571 vph

6.7.2 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, 2910, and 2020.

6.7.3 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:

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

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

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 (Table 8-4, 60/40 split);

fw = 0.75 for LOS A through D, 0.88 for LOS E

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

E_T = 7 for LOS A, 10 for LOS B, C, 12 for LOS D, E

(HCM Table 8-6, mountainous terrain);

E_R = 5.0 for LOS A, 5.2 for LOS B-E

(HCM Table 8-6, mountainous terrain);

P_T = 0.05 (Given); and

P_R = 0.10 (Given).

then:

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

(LOS B, C) = 1/[1 + 0.05(10 - 1) + 0.10(5.2 - 1)] = 0.535

(LOS D, E) = 1/[1 + 0.05(12 - 1) + 0.10(5.2 - 1)]= 0.508

and:

SF_A = 2,800 x 0.02 x 0.94 x 0.75 x 0.588 = 23 vph

SF_B = 2,800 x 0.12 x 0.94 x 0.75 x 0.535 = 127 vph

SF_C = 2,800 x 0.20 x 0.94 x 0.75 x 0.535 = 211 vph

SF_D = 2,800 x 0.37 x 0.94 x 0.75 x 0.508 = 371 vph

SF_E = 2,800 x 0.80 x 0.94 x 0.88 x 0.508 = 941 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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ESTIMATING INTERSECTION TURNING MOVEMENTS

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 TURNS5-V02 Spreadsheet. This chapter explains the need for balancing turning movements and the TURNS5-V02 methodology

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 TURNS5-V02 Spreadsheet, and a users manual has been developed for TURNS5-V02 to supplement the **Project Traffic Forecasting Procedure**.

Additional methodologies that have been used by FDOT include TMTOOL and the Manual Method. The methods suggested by H. J. Van Zuylen[1], and applied by Hauer et al.[2], Mark C. Schaefer, and others[3] 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[4]. These methods will not be discussed in this Handbook andare not recommended since they are not well-suited with the Project Traffic Forecasting Database, and they require more time and efforts to be stored in the database.

7.4 TURNS5-V02 BACKGROUND

Generally, the accepted program for determining future year turning movements is TURNS5-V02. TURNS5-V02 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

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.

allows for comparisons and smoothing to ensure that the user is producing reasonable results.

TURNS5-V02 was developed by Transportation Engineering, Inc. and Greiner, Inc., as a tool for the estimation of future turning volumes. TURNS5-V02 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[5] and TURNS3[6] form the basic framework of the TURNS5-V02 program.

TURNFLOW is an Excel 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[7], 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 TURNS5-V02 program creators have secured its use for FDOT. Other uses or applications not associated with TURNS5-V02 should contact the program's developer, Mr. Mark Schaefer, prior to using it.

TURNS5-V02 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.

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

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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.

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, and requires Excel

7.5 TURNS5-V02 METHODOLOGY

TURNS5-V02 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 TURNS5-V02 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 TURNS5-V02 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.

7.5.1.1 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.

7.5.1.2 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 * growth rate)) * Existing Year AADT, where N=Desired year - 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

TURNS5-V02 Main Menu

Enter Input

Check Input

Printing Options

Generate XML File

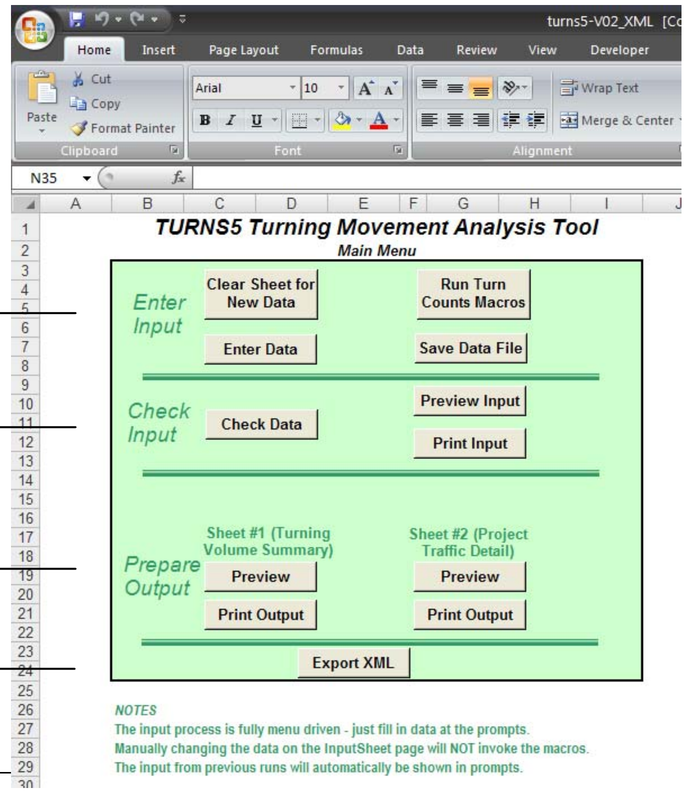


Figure 7.1

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 Comparedto First Year AADT
	Existing Compared toSecond Year AADT	Existing Compared to Third Year AADT
See Figure 7.8	Actual Count Compared toExisting Year DHV	Actual Count Compared to First Year DHV
	Actual Count Comparedto 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.

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.

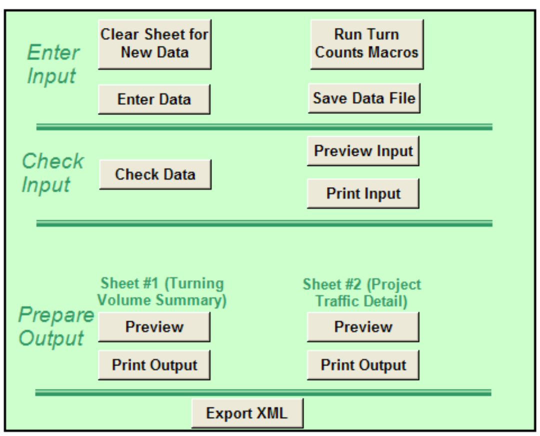
OUT1: Output folder number 1 contains the AADTs, DHVs, AADT comparisons and DHV comparisons. The screens are aligned as shown in Figure 7.2.

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

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?

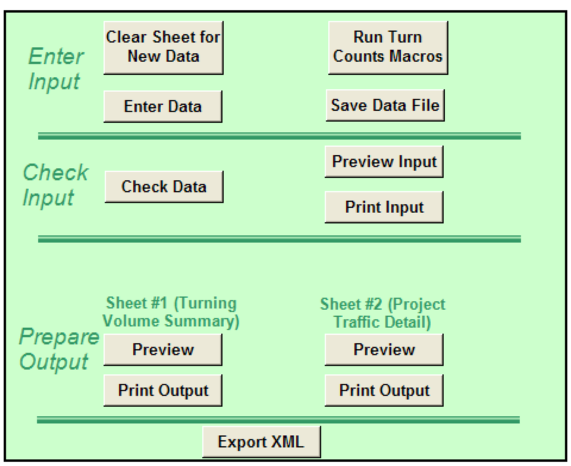
The final input page asks for the initial turning percentages (in decimal form) to be entered, closure for the TURNFLOW balancing (default of 0.01 should be entered) and the actual turning movement counts the user wishes to use as a comparison against DHVs calculated by the program. The user will be 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.

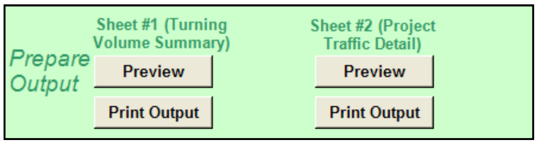
RUN TURN COUNTS MACROS: This command must be used to calculate balanced values after inputs are complete. The calculations are all macro driven.

SAVE DATA FILE: This command saves data entered.

Export XML: This feature allows the TURNS5-V02 to generate an extended markup language file (XML) that can be uploaded to the Project Traffic Forecasting Database.



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 Comparedto First Year AADT
	Existing Compared toSecond Year AADT	Existing Compared to Third Year AADT
See Figure 7.8	Actual Count Compared toExisting Year DHV	Actual Count Compared to First Year DHV
	Actual Count Comparedto 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.

7.6.4 Export XML

This option is used to generate an XML file that summarizes the turning volume traffic forecast inputs and outputs. This file can be easily uploaded to the Project Traffic Forecasting Database.

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.

TURNS5 ANALYSIS SHEET - INPUT

Analyst:	Nabeel
Date:	4-Dec-08
Highway:	US 27
Intersection:	Monroe Street
From:	Lake St
To:	Howard Rd
County:	Leon

Is the Mainline Oriented North/South?
Enter Yes or No
(•) Yes
( ) No

K Factors

Mainline	Sidestreet
7.00%	7.00%

D Factors

Mainline	
50.0%	Northbound (NB)
50.0%	Southbound (SB)
Sidestreet	
50.0%	Westbound (WB)
50.0%	Eastbound (EB)

Do you have FTSUTMS Model Year traffic from which you would like to interpolate/extrapolate for project years? (Y/N)

Enter Yes or No
(•) Yes
( ) No

If "Yes" go to cell C47 If "No" go to cell C31

Enter Year and Growth Rates from Base Year:

	Year	*Rate* (1.0% = 0.01) **Mainline**	**Side Street**
Base			
Opening			
Mid			
Design			

Mainline Growth Function
(•) Linear
( ) Exponential
( ) Decaying

Side Street Growth Function
(•) Linear
( ) Exponential
( ) Decaying

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

From West: EB Approach	*From East: WB Approach*	*From North: SB Approach*	*From South: NB Approach*	***TOTAL***
0	0	0	0	0

Enter Project and Model Years

	Year
Base	2006
Opening	2016
Mid	2026
Design	2036
Model	2036

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

	From West: EB Approach	*From East: WB Approach*	*From North: SB Approach*	*From South: NB Approach*	***TOTAL***
2006	5000	5000	2000	2000	14000
2036	10000	10000	6000	6000	32000

		1st Guess Turning %'s for AADT Balancing	**Actual/Counted Traffic for 2006**
(EB LT)	*West-to-North*	33%	30
(EB THRU)	*West-to-East*	34%	40
(EB RT)	*West-to-South*	33%	30
(WB LT)	*East-to-South*	33%	30
(WB THRU)	*East-to-West*	34%	40
(WB RT)	*East-to-North*	33%	30
(SB LT)	*North-to-East*	33%	30
(SB THRU)	*North-to-South*	34%	40
(SB RT)	*North-to-West*	33%	30
(NB LT)	*South-to-West*	33%	30
(NB THRU)	*South-to-North*	34%	40
(NB RT)	*South-to-East*	33%	30

(must be done manually)

Desired Closure: 0.01

Figure 7.3 TURNS5-V02 Data Input Sheet Sample

7.7.2 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 rocedures. 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 TURNS5-V02 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

TURNS5 INITIAL TURNING VOLUME SUMMARY

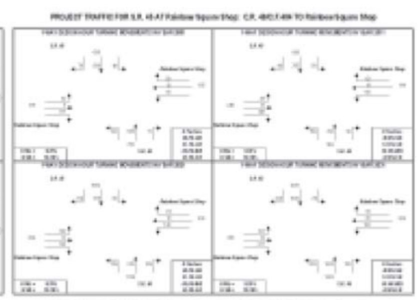
Highway:	S.R. 45	**County:**	Marion
Intersection:	Rainbow Square Shop		
From:	C.R. 40/C.F.484	**Analyst:**	Advanced PTF
To:	Rainbow Square Shop	**Date:**	9-May-02

Approach-To-Approach	2001 Initial Estimate	2001 Final Estimate	2001 Turning Volume	2011 Final Estimate	2011 Calculated Volume	2021 Final Estimate	2021 Turning Volume	2031 Final Estimate	2031 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
Total Flow From West:			**2100**		**2700**		**3300**		**3800**
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
Total Flow From East:			**1200**		**1500**		**1900**		**2300**
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
Total Flow From North:			**7000**		**9000**		**10900**		**12900**
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
Total Flow From South:			**8000**		**10300**		**12500**		**14700**

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

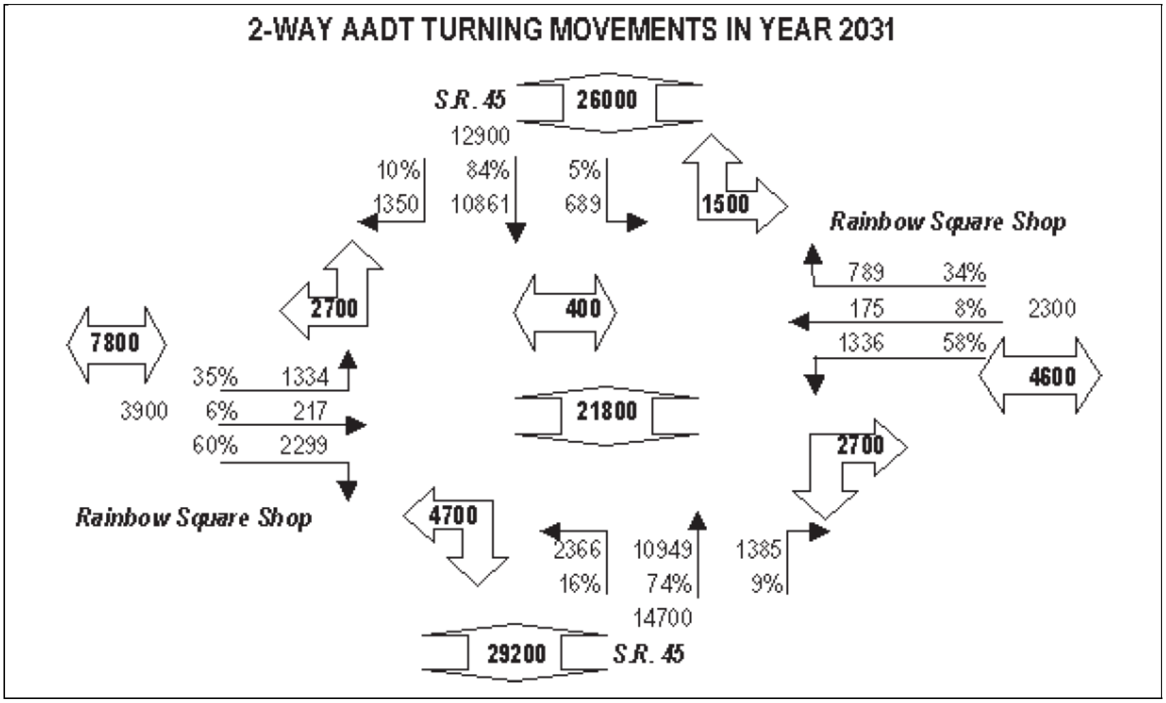


Figure 7.5 Provides AADTs for each year in graphic format.

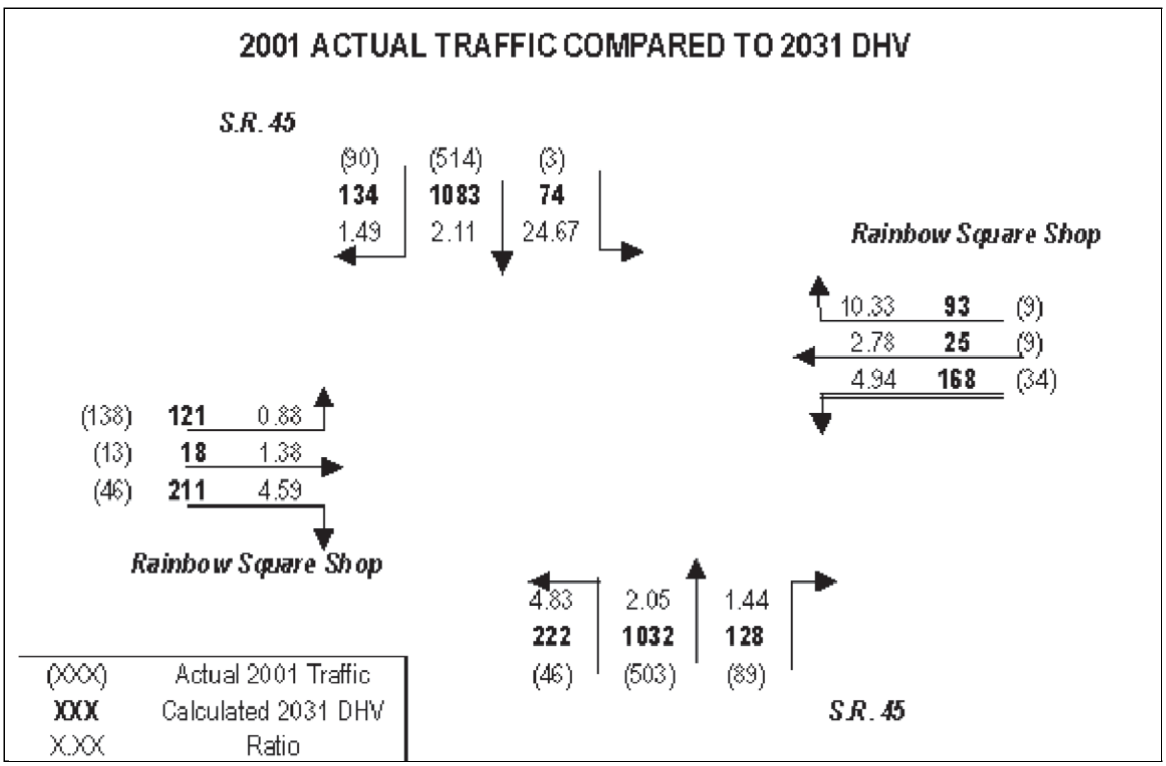


Figure 7.6 Provides DHVs for peak hour evaluation. Uses K_{30}, D_{30} factors for mainline and side street.

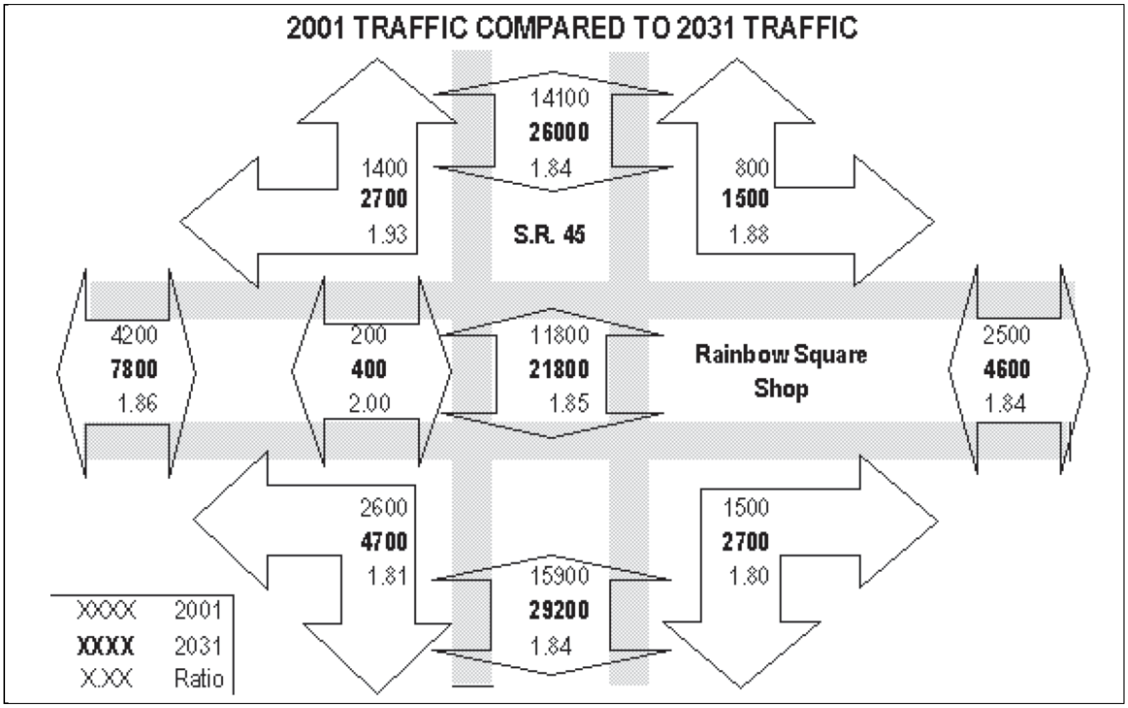


Figure 7.7 **Shows a comparison of existing AADTs to future years to evaluate growth.**

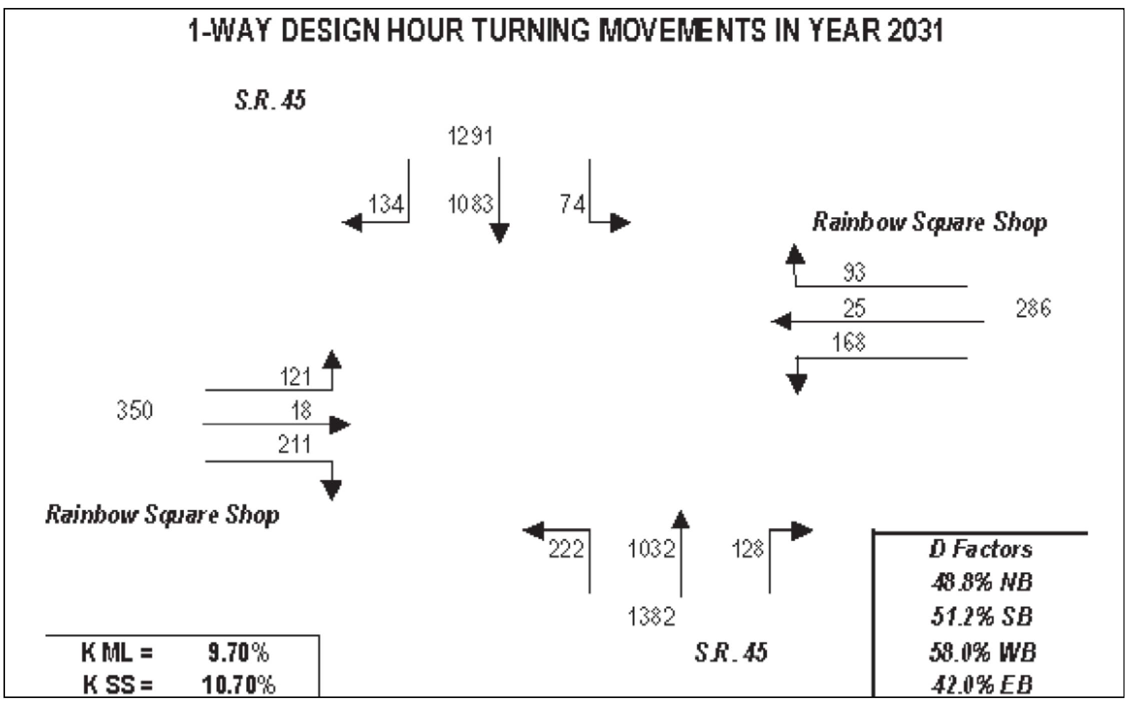


Figure 7.8 **Shows a comparison of existing peak hour information (counts) to DHVs developed from the program. In addition it provides the user with growth for turns during peak conditions.**

7.8 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:

- TURNS5-V02, the spreadsheet being recommended, is an improved version incorporating the best of all the spreadsheets being used by the Districts (TURNS3 & 4, TMTOOL, J.K.TURNS, and GWBASIC). It can be used to develop turning movements *for existing and non-existing intersections*. TURNS5-V02 can provide turning movement projections where detailed existing and future year data input parameters are available and applicable. TURNS5-V02 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 TURNS5-V02 to forecast turning movements. If any other balancing method is used, then the input variables required to run TURNS5-V02 should be provided to the Project Traffic engineers so that TURNS5-V02 could be used as a comparison.

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Chapter Eight

EQUIVALENT SINGLE AXLE LOADING (ESAL) FORECAST

8.1 PURPOSE

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

- Truck Forecasting Process
- ESALD 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).

8.2 BACKGROUND

The Equivalent Single Axle Loading (ESAL) Forecasting Process is necessary for pavement design for new construction, reconstruction, or resurfacing projects. While the total volume of traffic influences the geometric requirements of the highway, the percentage of commercial traffic and frequency of heavy load applications have the major effects on the structural design of the roadway. 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 forecast is vitally important in determining the Structural Number Required (SNR) for flexible pavement and the Depth Required (DR) for rigid pavement.

The 18-KIP ESAL forecasting process outlines steps to be taken to develop the expected ESALs for the life of highway projects. The ***Florida Standard Urban Transportation Modeling Structure (FSUTMS)*** does not forecast heavy truck traffic, and the Department does not presently have a truck forecasting model. Since ***FSUTMS*** does not forecast truck traffic with enough accuracy to obtain heavy truck trip generators, nor model the specific locations of truck terminals, and, in the absence of a departmental truck forecasting model, future truck traffic should be based on the present day truck classification. The percentage of truck traffic is assumed to hold the same relationship to AADT unless some known development will change the future truck traffic. The damage factor estimates are based on analysis of historical traffic weight data collected from "Weigh-In-Motion" surveys. The survey data are combined with other data such as highway location (rural/urban), highway type (Interstate/non-Interstate), number of lanes, highway direction (one-way/two-way), truck traffic, lane factor (L_f), and equivalent truck damage factor. All are used to estimate the 18-KIP ESALs from the opening year to the design year of the project. An Excel Spreadsheet is developed to facilitate the ESAL estimates, and is explained in this chapter.

For purposes of pavement structure design, it is necessary to estimate the cumulative number of 18-KIP ESAL for the design (performance) period. Since truck volume is estimated using the calibrated damage factors. It is important to estimate future truck traffic accurately for the facility during the design period. The District Director of Transportation Development or his/her designee is responsible for carrying out the 18-KIP ESAL Forecasting Process unless assigned elsewhere by the District Secretary. For certain projects, the 18-KIP ESAL may have been calculated. In this case, check the validity of the previous 18-KIP estimates before proceeding to perform the 18-KIP ESAL Forecasting Process.

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 (80kN) 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. Figure 8.1 illustrates the ESAL Process steps. These steps are detailed in this Chapter.

ESAL Forecasting Process

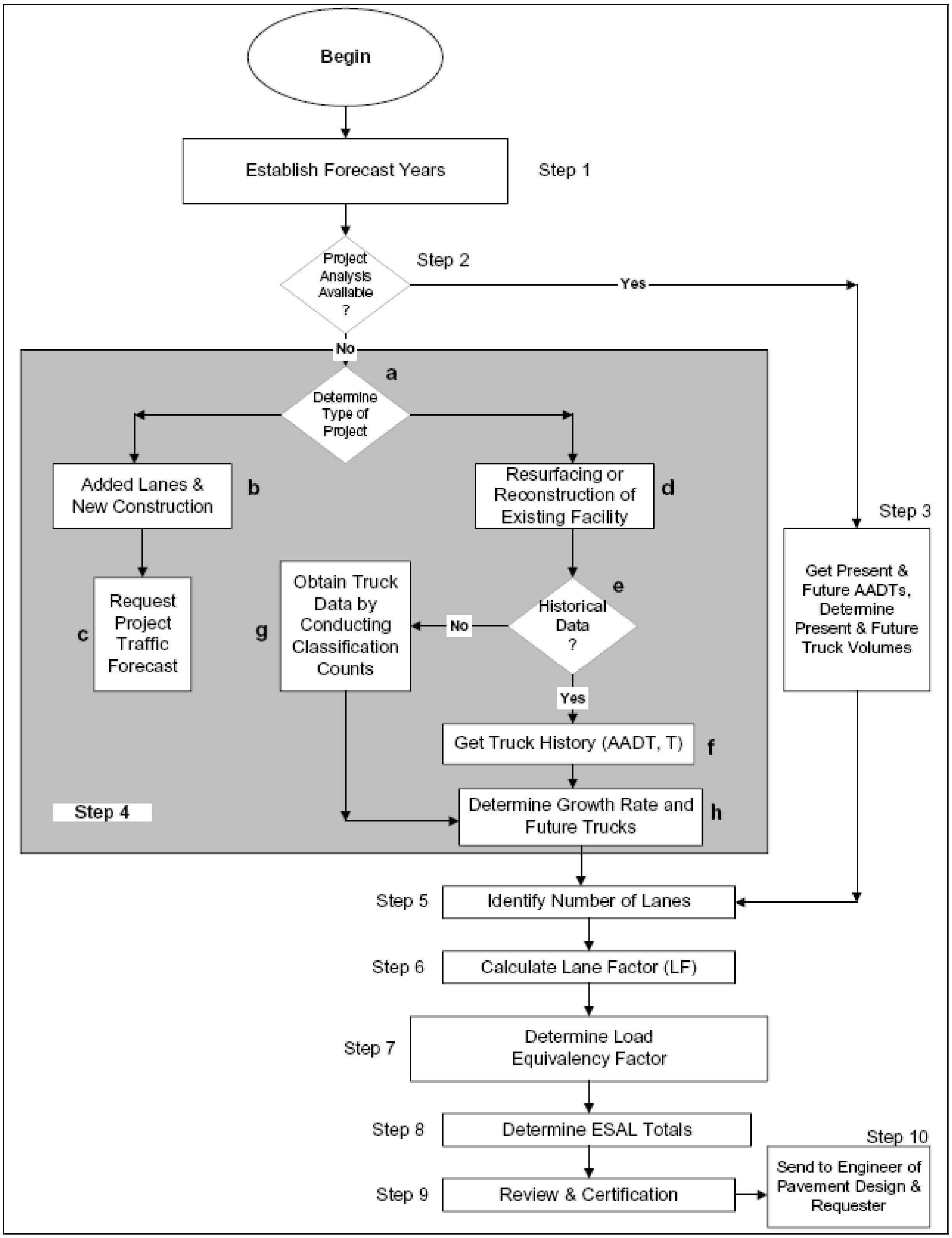

Figure 8.1 ESAL Forecasting Process

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 8.2).

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

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2

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 C

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.

	Name	Title	Org. Unit or Firm	Date
Prepared by:	Luis E. Diaz, P.E.	Planning Manager	TEI	
	Signature			
	Susan Sadighi	Technical Applications Supervisor	FDOT	
	Signature			

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Figure 8.2 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 8.3).

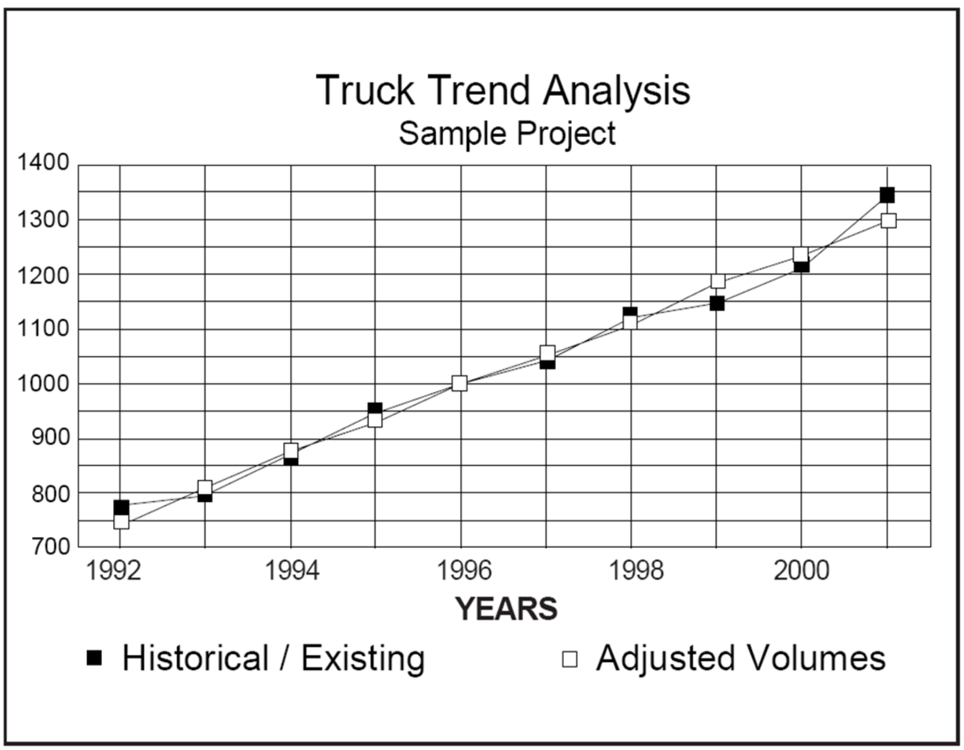


Figure 8.3 Truck Trend Analysis example

8.3.3 Project Traffic Forecast

Determine if a project traffic forecast for the facility has been completed. If a project traffic forecast is available, check the validity of the data to be used in the ESAL calculation. If data are acceptable, obtain existing and future AADTs from the project traffic forecasting report. If the project traffic forecast is not available or invalid, determine the type of project.).

8.3.4 Type of Project

The PTF engineer must request a project traffic forecast for the facility in accordance with the Project Traffic Forecast Process.

18-KIP ESAL analysis primarily depends on truck traffic data. However, future truck traffic depends on the type of the proposed project, and hence the type of project dictates the methodology to be used in the 18-KIP ESAL analysis.

8.3.4.1 New Construction Project

If the project involves the construction of a new road which includes additional lanes that will affect the future traffic characteristics, the Project Traffic Forecast Process should be performed prior to calculating the 18-KIP ESAL.

8.3.4.2 Resurfacing and Reconstruction Projects

If the project involves the resurfacing or the reconstruction of an existing roadway and does not include additional lanes, the historical trend analysis should be performed if historical data are available.

8.3.5 Traffic Forecast

The PTF engineer must request a project traffic forecast for the facility in accordance with the Project Traffic Forecast Process.

8.3.5.1 Historical Data Availability

Obtain existing and future AADTs, and number of lanes from the project traffic forecast analysis. If available, determine present and future truck traffic derived using appropriate T factors from the Florida Annual Traffic Classification Report. If the historical data are not available, or the data cannot be used for the project, obtain truck data by conducting 48 hour vehicle classification counts in accordance with the Traffic Data Collection Procedure. Determine the vehicle growth.

8.3.5.2 Historical Trend Analysis

Determine the vehicle growth rate by performing a historical trend analysis projection based on available historical counts, population growth, gasoline sales, or other appropriate growth indicators. The future truck traffic shall be determined by applying the growth rate to the base year truck traffic for the desired number of years

8.3.6 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 8.16).

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.

8.3.7 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.

Future trucks = (Base Year Average) x [1 + (Years x 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 8.3, 1984 average trucks) of 811 is factored by the 19 years and by the rate of 7.5 percent.

Future trucks = (811) x [1 + (19 x .075)]

= (811) x (2.425)

= 1966.7

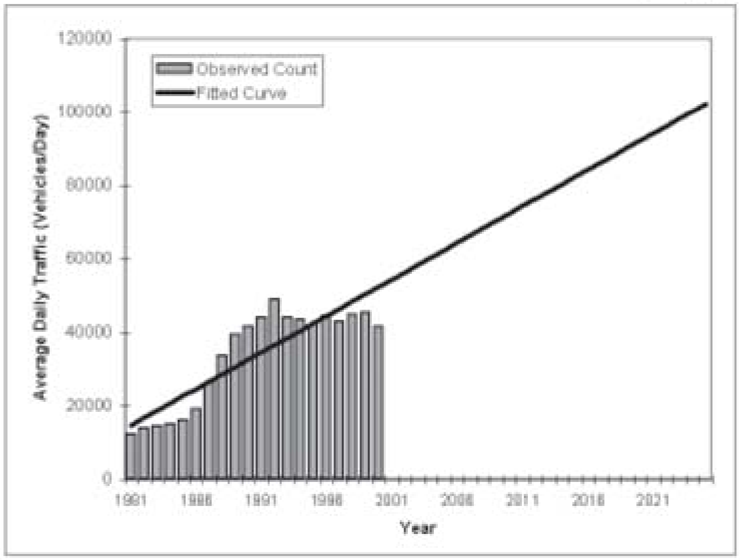
This results in a year 2003 estimate of 1966.7 which would be rounded to 2000.

b. Expanding the Percent-Root-Mean Square (%RMS) method by extending the best fit straight-line to the desired design year. (*see* Figure 8.4).

TRAFFIC TRENDS

SR 434 -- 0.14 miles South of S.R. 436

County:	Seminole
Station #:	770116
Highway:	SR 434



Year	Traffic (ADT/AADT) Count*	Trend**
1981	12100	14800
1982	13800	16800
1983	14400	18800
1984	15100	20800
1985	16100	22800
1986	19100	24700
1987	26300	26700
1988	33600	28700
1989	39400	30700
1990	41700	32700
1991	44000	34700
1992	49000	36700
1993	44000	38600
1994	43500	40600
1995	42000	42600
1996	44500	44600
1997	43000	46600
1998	45000	48600
1999	45500	50600
2000	41500	52500
2005 Opening Year Trend		
2005	N/A	62500
2015 Mid-Year Trend		
2015	N/A	82300
2025 Design Year Trend		
2025	N/A	102200
TRANPLAN Forecasts/Trends		

*Axle-Adjusted

** Annual Trend Increase:	1,986
Trend R-squared:	77.2%
Trend Annual Historic Growth Rate:	13.41%
Trend Growth Rate (2000 to Design Year):	3.79%
Printed:	8-May-02
Straight Line Growth Option	

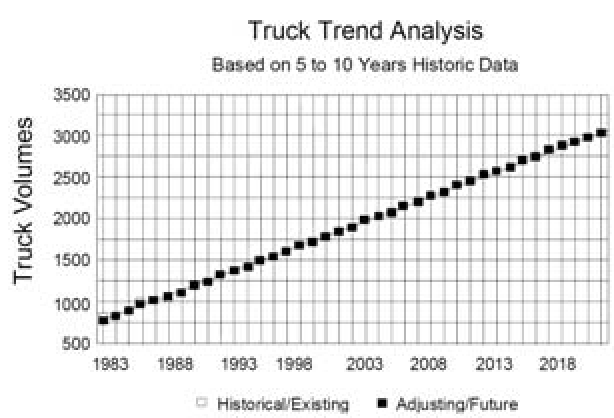


Figure 8.4 Regression Analysis Example for Future Years

8.4 DESIGN REQUIREMENTS

8.4.1 $ESAL_D$ 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:

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

Where:

$ESAL_D$: The number of accumulated 18-KIP (80-kN) Equivalent Single Axle Loads in the design lane for the design period.

i : 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_F, and T_{24}, 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.

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

$AADT_i$: Average Annual Daily Traffic for the year *i*.

T_{24} : Percent heavy trucks during a 24-hour period. Trucks with six tires or more are considered in the calculations.

D_F : 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_{30}) used for planning capacity computations.

L_F : 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_f values can be determined from Figure 8.6.

E_F : 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 EF (E80) values for different types of facilities is shown in Figure 8.5.

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

Figure 8.5 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 $\mathbf{L_F}$ is calculated by using the COPES equation, the graphic solution to the COPES equation, shown in Figure 8.6, or the LF feature provided by the Traffic Loading Forecasting System (NHCRP No. 277 “Portland Cement Concrete Pavement Evaluation System”).

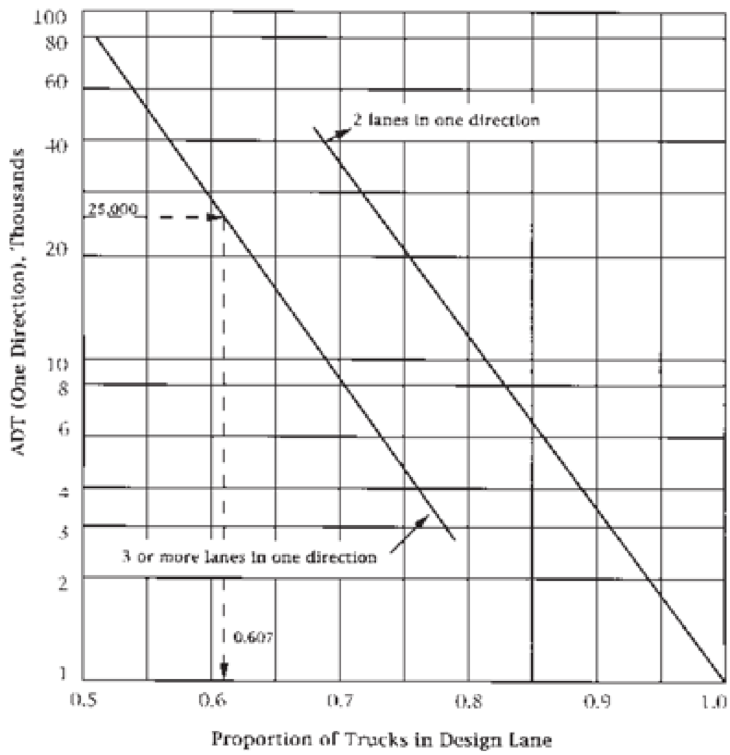


Figure 8.6

COPES Chart

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

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

Where:

LF = 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-WayAADT = 25000
One-Way Lanes = 3 (LV = 1)

L_F = (1.567 -0.0826 x Ln(25000) - 0.12368 x 1)
= (1.567 - 0.0826 x 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 LF 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).

$$E_{80} = \frac{\#\ of\ 18 - KIP\ ESALs\ causing\ a\ given\ loss\ of\ serviceability}{\#\ of\ x - KIP\ axle\ loads\ causing\ the\ same\ serviceability\ loss}$$

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 ($ESAL_D$) should be recomputed, and the structural design determined for the new $ESAL_D$. 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 18KIP (80-kN) ESALD. This example is for I-4 (Section 7) in Polk County.

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

MEMORANDUM
STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

DATE: August 29, 1995

TO: H. Byron Swartzel, Administrator, Transportation Statistics
FROM: Tracy Hood, Tampa Bay 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 Charge Time To: 16320-1426

TYPE OF WORK: Reconstruction
EXISTING LANAGE: 4 Lanes
RESULTING TOTAL LANAGE (THRU LANES):
(__) 2L (__) 3L (__) 4L (__) 5L (✓) 6L (__) OTHER ____
OPENING YEAR: 2000
LOCATION MAP ATTACHED: (X) YES (__) NO
PROJECT MANAGER: [illegible] EXT.: 534 8500

PLEASE PROVIDE US WITH THE FOLLOWING:
(__) PREVIOUS TRAFFIC DATA (ATTACHED) NEEDS UPDATE.
(X) TRAFFIC DATA REQUIRED (CURRENT, POST CONST., 5, 10, & 20 YR.)
(X) 18 KIP ESAL: (X) FLEXIBLE (__) RIGID (__) BOTH
(__) FUNCTIONAL CLASSIFICATION
DATE REQUESTED FOR RETURN: 12/31/95

EXAMPLE

Figure 8.7

18-KIP Request Memo Example

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

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: 1✓ FLEX. ___ RIGID ___ BOTH
RESULTING TOTAL LANEAGE: 6
EXISTING YEAR 1994 = 58500 AADT
OPENING YEAR 2000 = 71712 AADT
K_{30} = 10.0%
D_{30} = 55.30%
24 HOUR T = 11.93%
DESIGN HOUR T = 5.96%
TRENDS/MODEL INCREASE = 2202

EXAMPLE

Figure 8.8

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

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 FUNTIONAL 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 8.9 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 8.10 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/I-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 8.11 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/I-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 8.12 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/I-4                  BEG.AT.-   0.000 MI    END.AT.-  32.022 MI
                                    STATUS- ACTIVE
322 SIGNALS                             (POINT      FEATURE)          SIDE
        CHARACTERISTIC                       VALUE                UNIT  BEG.PT.  END.PT.
CONTROLLER DESCRIPTION          40(SPCSOP)                        ID L   5.097
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 CONTROL              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 CONTROL              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
```

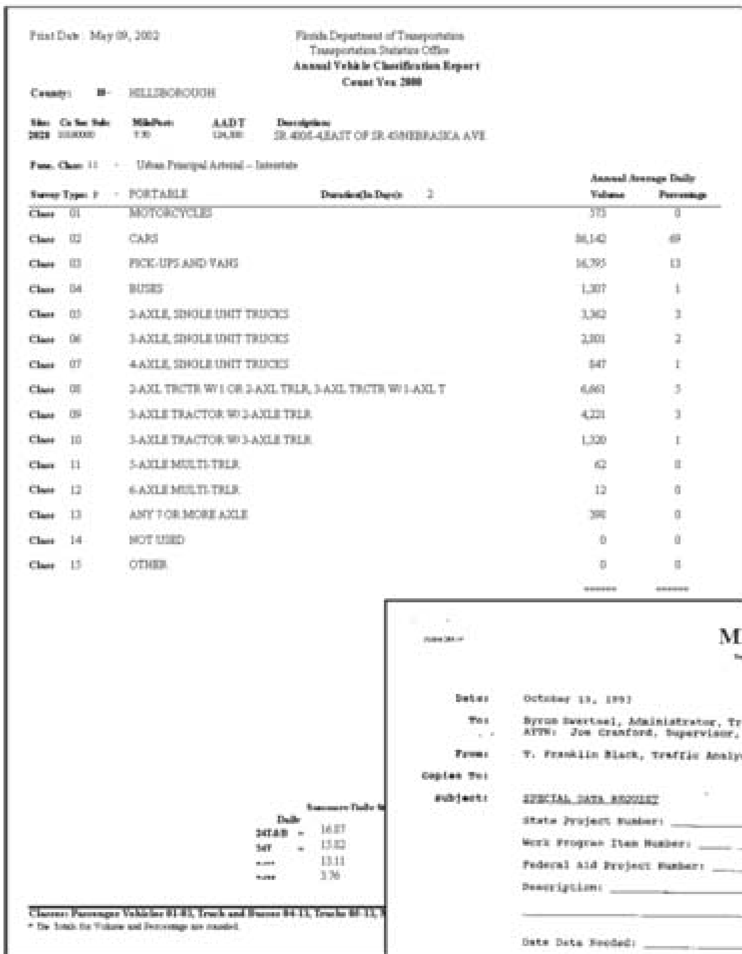
Figure 8.13 RCI Feature 322 — Signal information

```
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/I-4                  BEG.AT.-   0.000 MI    END.AT.-  32.022 MI
                                    STATUS- ACTIVE
331 TRAFFIC FLOW BREAKS                 (LENGTH     FEATURE)          SIDE
        CHARACTERISTIC                       VALUE                UNIT  BEG.PT.  END.PT.
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 8.14 RCI Feature 331 — Traffic data; AADT, K, D, and T

5. 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 8.17). 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 8.18) 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	MilePost	AADT	Description
2028	[illegible]	7.30	124,500	SR 400/I-4 EAST OF SR 45/NEBRASKA AVE

Func. Class: 11 - Urban Principal Arterial – Interstate

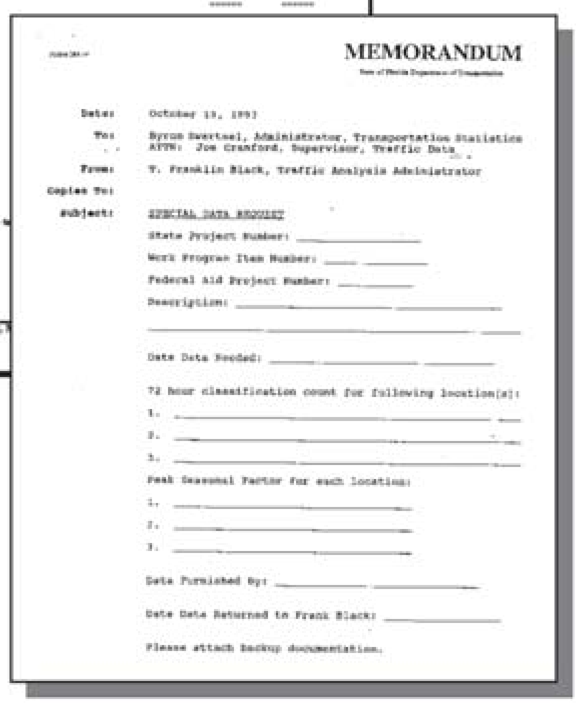
Survey Type: P - PORTABLE **Duration(In Days):** 2

			Annual Average Daily Volume	Annual Average Daily Percentage
Class	01	MOTORCYCLES	373	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	2,301	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	390	0
Class	14	NOT USED	0	0
Class	15	OTHER	0	0
			======	======

Daily		
24T&B	=	16.87
24T	=	15.82
[illegible]		13.11
[illegible]		3.76

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

Figure 8.15
Example from the Traffic Classification Report



MEMORANDUM

Date: October 13, 1993

To: Byron Swertsel, 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):
1. ______
2. ______
3. ______

Peak Seasonal Factor for each location:
1. ______
2. ______
3. ______

Data Furnished By: ______

Date Data Returned to Frank Black: ______

Please attach backup documentation.

Figure 8.16
72-hour Classification Count Request Memo

6. 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.

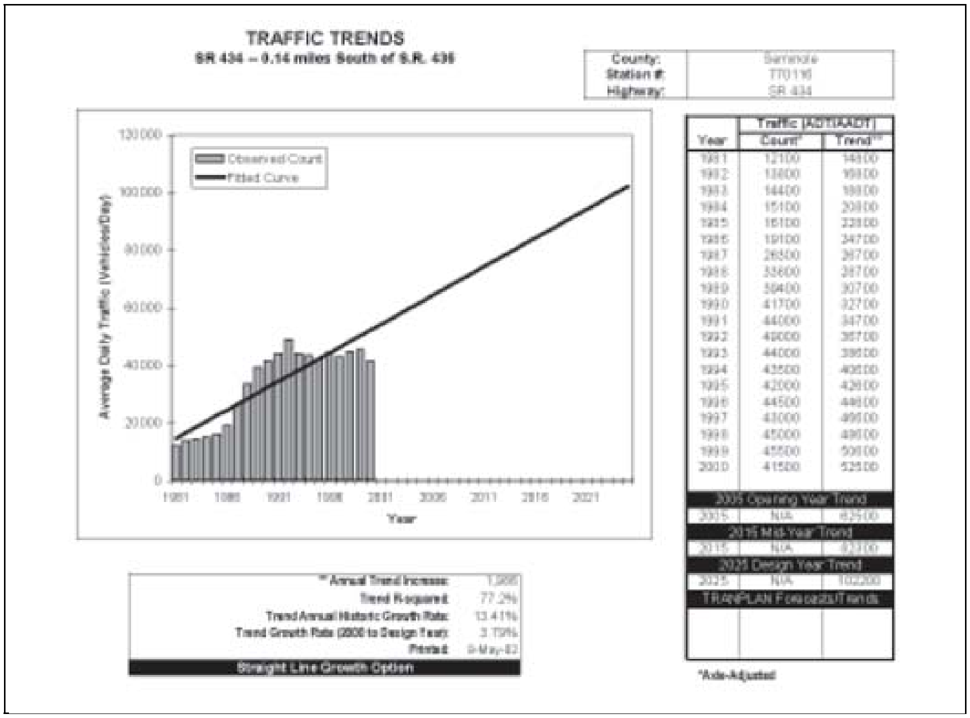


Figure 8.17 Trend Projection

7. 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 8.21 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.

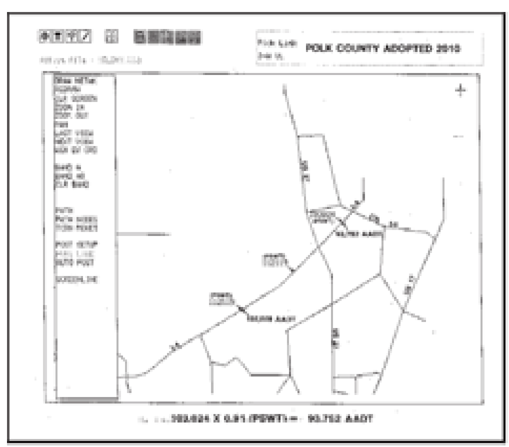


Figure 8.18

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

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2

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 C

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

10

Figure 8.19 Trend Projection Results

9. After receiving the printout for a 72-hour classification count (if necessary), prepare a form for determining T_{24} and Design Hour Truck percentage.

WPI NO.: ______________________
JOB NO.: ______________________
DESCRIPTION: ______________________
____
____

72 HOUR TRAFFIC

DIRECTION	CARS	TRUCKS
SUB-TOTAL		
TOTAL		
PERCENTAGE		

DESIGN HOUR TRAFFIC (______________________)

DIRECTION	CARS	TRUCKS
SUB-TOTAL		
TOTAL		
PERCENTAGE		

NOTE: TOTAL 72 HOUR TRAFFIC ÷ 3 ÷ WEEKDAY SEASONAL FACTOR = AADT

Figure 8.20

Estimating AADT from a 72 -Hour Count

10. From the 72-hour classification count determine the D-Factor (*not* D_F) for the 18-KIP (80-kN) ESAL request.

ESTIMATING D FACTOR

MEASURED DAY	PEAK HOUR	PEAK HOUR VOLUME	PREDOMINANT DIRECTION PEAK VOLUME	OPPOSITE DIRECTION PEAK VOLUME	D
1/22	5-6 PM	1,700	884	816	0.520
1/23	5-6 PM	1,800	1,152	648	0.640
1/24	5-6 PM	1,900	1,102	798	0.580
SUMS	NA	5,400	3,138	2,262	NA
AVERAGES	NA	1,800	1,046	754	0.581

ESTIMATED D = 0.581

Figure 8.21

Estimating AADT from a 72 -Hour Count

11. To determine the K_{30} and D_{30} factors within the project limits of request for 18KIP (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:**	**MilePost:**	**AADT**	**Description:**
2028	10190000	7.70	124,500	SR 400/I-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	Annual Average Daily Percentage
Class	01	MOTORCYCLES	573	0
Class	02	CARS	86,142	69
Class	03	PICK-UPS AND VANS	16,755	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	358	0
Class	14	NOT USED	0	0
Class	15	OTHER	0	0
			======	======
			124,500	100

Summary Daily Statistics

Daily		**Design Hour**	
24T&B =	16.87	**DHT** =	8.43
24T =	15.82		
	13.11		6.56
	3.76		1.88

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

Page: 1

Figure 8.22 Traffic Classification Report for Station 111

12. 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 8.21), 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	

13. 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.

14. Complete the ESAL Excel worksheet. The spreadsheet was developed by the District One Planning Department'sTransportation Planning Section. The ESAL Excel worksheet is available from TranStat.

Table 3

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS

PROJECT TRAFFIC FOR PD&E and DESIGN ANALYSIS INFO / FACTORS

SECTION #: 0
SEGMENT #: 1
ITEM #: 0
PROJECT DESCRIPTION: S.R. 434/S.R. 414 Interchange

LOCATION #: 2
LOCATION DESCRIPTION: S.R. 434, North of S.R. 414

GROWTH RATE FORMULA

A: Interpolation
B: Enter Growth Rate
C: Enter All AADTs
D: New Facility

If "A" select an interpolation function
If "B" enter rate as decimals (1%=1.01)
If "C", or "D" continue to next section

Choose A, B, C, or D here: C

Linear Growth Rate ______
Compounded Growth Rate ______
Decaying Growth Rate ______
(select one)

DESIGN INFORMATION

	Year	AADT
Existing Year	1996	48300
Opening Year	2002	54100
Mid-Design Year	2012	63700
Design Year	2022	73400

Note: AADT values have been rounded to the nearest 100

Daily Direction Split (50% or 100%)	50%
Lanes in One Direction	3
T24 values	
Existing to Opening Year	2.18%
Opening to Mid-Year	2.18%
Mid-Year to Design-Year	2.18%

1995 EQUIVALENCY FACTORS (1)

(selected with an X)

	FLEXIBLE PAVEMENT SN = 5/THICK		RIGID PAVEMENT SN = 12/THICK	
RURAL FREEWAY:	1.050		1.600	
URBAN FREEWAY:	0.900		1.270	
RURAL HIGHWAY:	0.960		1.350	
URBAN HIGHWAY:	0.890	X	1.220	
OTHER (Enter Factor and X):				

(1) Equivalency Factors are based on Updated Pavement Damage Factors Memorandum, dated October 1, 1996.
Lane Factors developed by Copes equation

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.

	Name	Title	Org. Unit or Firm	Date
Prepared by:	Luis E. Diaz, P.E.	Planning Manager	TEI	
	Signature			
Reviewed by:	Susan Sadighi	Technical Applications Supervisor	FDOT	
	Signature			

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Figure 8.23 Data Input Sheet for ESAL-V01.XLS

15. 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

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2

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 C

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

10

Figure 8.24 Report Printout for ESAL-V01.XLS

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.

17. Review and Certification

The estimate shall be reviewed and certified. Figure 8.25 represents the certification statement form to be used.

CERTIFICATION STATEMENT

18 KIP Equivalent Single Axle Loads (ESAL)

Financial Project ID ______________

State Road No. ______________

County ______________

"I have reviewed the 18 KIP Equivalent Single Axle Loads to be used for pavement design on this project. I hereby attest that these have been developed in accordance with the FDOT Project using historical traffic data and other available information."

____
Name

____
Signature

____
Title

____
Organizational Unit

____
Date

Source: FDOT Roadway Plans Preparation Manual, Chapter 19, Volume I.

Figure 8.25 18-KIP ESAL Forecast Certification

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