

PART 2, CHAPTER 5

TRAFFIC ANALYSIS

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PART 2, CHAPTER 5

TRAFFIC ANALYSIS

5.1 OVERVIEW

5.1.1 Purpose

This chapter provides guidance for preparing the traffic forecast and analysis for Project Development and Environment (PD&E) Studies. Guidance is provided on scoping the traffic analysis effort, traffic data requirements, analysis methodology and documentation.

Traffic analysis (also referred to as traffic study) is an evaluation of the interaction between demand and supply of a transportation facility to determine how efficient the facility is serving the demand. This analysis forms the basis for evaluating the performance of project alternatives and design concepts based on demand, capacity, operational performance, environmental impacts and safety concerns. Traffic analysis is one of the methods used to determine transportation needs during the Planning phase and PD&E Study. Additionally, traffic analysis produces data needed to support project-level environmental analyses such as noise and air quality impacts.

Traffic analysis is one of the critical activities for a PD&E Study and can impact the project schedule. It is important that the Project Manager understand the effort associated with traffic data collection, forecasting and analysis. Each transportation project is unique and the approach for individual projects might differ. As such, when developing the project traffic data and performing the corresponding analysis, there must always be a balance between the project's goals and objectives, available schedule and budget, and the complexity of the analysis to be performed. The Project Manager should always reach an early agreement with project reviewers and the lead agency on the traffic analysis approach and parameters for the analysis. Such agreement is vital to project success as it helps to avoid misunderstanding between traffic analysts and reviewers of traffic analysis reports that may negatively impact the project development schedule.

Traffic analysis procedures in this chapter references guidance from other Florida Department of Transportation (FDOT) procedures, manuals and handbooks. The chapter also references national guidance such as the *Highway Capacity Manual (HCM)* and Federal Highway Administration's (FHWA) *Traffic Analysis Toolbox*. The chapter assumes transportation practitioners who perform traffic analyses for FDOT projects possess sufficient knowledge of traffic flow theory and traffic engineering including guidance documented in FDOT and national publications.

5.1.2 Definitions

The following definitions apply to terminology used in this chapter:

Annual Average Daily Traffic (AADT) - 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.

Average Daily Traffic (ADT) - 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.

Axle Correction Factor - The factor developed to adjust vehicle axle sensor-based 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.

Crash Modification Factor (CMF) – A multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.

Design Hour - An hour with a traffic volume that represents a reasonable value for designing the geometric and control elements of a facility.

Design Year - The year for which the project is designed; 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).

Directional Design Hour Volume (DDHV) - The traffic volume expected to use a highway segment during the design hour of the design year in the peak direction.

Directional Distribution (D Factor) - The percentage of the total two-way peak hour traffic that occurs in the peak direction.

Level Of Service (LOS) - A quantitative stratification of a performance measure that represents quality of service of a transportation facility measured on an A-F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst.

Model Output Conversion Factor (MOCF) - A factor used to convert the traffic volumes generated by a travel demand forecasting model Peak Season Weekly Average Daily Traffic (PSWADT) to AADT. The MOCF is the average of the 13 consecutive weeks during which the highest weekday volumes occur and when the sum of Seasonal Factors (SF) for those 13 weeks are the lowest. MOCF is used during model validation to convert AADT to PSWADT for the base year model network should also be used for adjusting future year model volume.

Peak Season Weekday Average Daily Traffic (PSWADT) - The average weekday traffic during the peak season. Florida Standard Urban Transportation Model Structure (FSUTMS) traffic assignment volume represents PSWADT projections for the roadways represented in the model highway network. For ***Project Traffic Forecasting Reports***, the PSWADT should be converted to AADT using a MOCF. Although not all FSUTMS models report traffic assignment volume in PSWADT, there are currently several model outputs throughout the State that require conversion from PSWADT to AADT using MOCF.

Peak Spreading – The expansion of peak period of traffic, from the traditional one-hour peak to multi-hour peak period, as the demand to use the facility surpasses capacity.

R-Squared Value - A statistical measure of how well the fitted regression line approximates the real data points.

Regression Analysis – A statistical process for estimating the relationship between a dependent variable and an independent variable.

Seasonal Factor (SF) - Parameters used to adjust base counts which consider travel behavior fluctuations by day of the week and month of the year.

Standard K (K Factor) - A factor used to convert AADT to a peak hour volume. Standard K values are statewide fixed parameters that depend on the general area type (location) and facility type (roadway characteristics). Values less than 9% typically represent a multi-hour peak period rather than a peak hour. Standard K does not apply to emergency evacuation routes and managed lanes.

Statewide Acceleration And Transformation (SWAT) - A project management approach which streamlines project delivery by following a structured process to develop project scopes and schedules; reduce duplicate work, perform initial data collection and analysis ahead of PD&E, or concurrently perform design activities with PD&E when possible.

Truck Factor (T_{24}) – The percentage of truck traffic during a 24-hour period.

Traffic Saturation – Refers to traffic operating conditions in which the traffic demand is equal to or exceeds the capacity of a facility.

5.2 PROCEDURE

Traffic analysis for a PD&E Study includes developing objectives of analysis, identifying key performance measures to evaluate the project alternatives, determining analysis approach and tools to be used, determining data needs, collecting and analyzing data and documenting the results. Techniques for traffic analysis are found in the following publications:

- **HCM** – Published by the Transportation Research Board, the **HCM** contains concepts, guidelines and methods for computing LOS for freeways, highways (two-lane and multilane), urban streets and intersections (signalized and unsignalized).
- [**FDOT Traffic Analysis Handbook**](#) – The **FDOT Traffic Analysis Handbook** provides guidance and general requirements for the uniform application of traffic analysis tools for roadway corridors, interchanges and intersections analyses.
- [**FDOT Project Traffic Forecasting Procedure, Topic No. 525-030-120**](#) – The **Project Traffic Forecasting Procedure** offers guidelines and techniques for forecasting traffic (with and without a travel demand model), calculating Annual

Average Daily County (AADT) from short term counts, calculating Directional Design Hourly Volume (DDHV), estimating intersection turning movements and calculating Equivalent Single Axle Load (ESAL) forecasts.

- ***FHWA Traffic Analysis Toolbox*** – The ***FHWA Traffic Analysis Toolbox*** includes a Primer that presents a high-level overview of the different types of the traffic analysis tools. The Toolbox also provides guidance on the selection of and application of traffic analysis tools, interpretation of performance measures and other pertinent information.
- ***FDOT Traffic Engineering Manual (TEM), Topic No. 750-000-005*** – The ***TEM*** provides traffic engineering standards and guidelines to be used for State Highway Systems by the FDOT. It provides guidance for signs, signals, markings and specialized traffic operational topics.
- ***FDOT Manual of Uniform Traffic Studies (MUTS), Topic No. 750-020-007*** – The purpose of the ***MUTS*** is to establish minimum standards for conducting traffic engineering studies for roads under the jurisdiction of the FDOT. In addition, local government traffic engineering agencies are recommended and encouraged to use the ***MUTS*** as a guideline for conducting studies within their area of responsibility.
- ***American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM)*** – The ***HSM*** provides a variety of methods for quantitatively estimating crash frequency or severity at a variety of locations.
- ***Transit Capacity and Quality of Service Manual, Transit Cooperative Highway Research Program Report 165*** – The Transit Capacity and Quality of Service Manual provides quantitative techniques for calculating the capacity and other operational characteristics of bus, rail, demand-responsive, and ferry transit services, as well as transit stops, stations, and terminals.

5.2.1 Traffic Analysis Objectives

Given the importance of traffic forecasting and analysis regarding the PD&E Study schedule, the Project Manager should meet with the project team at the beginning of the project to establish the traffic analysis objectives. The composition of the project team will vary depending on the type of the project, but will generally include FDOT planning and environmental staff and consultant traffic and PD&E staff. The objectives of the traffic analysis must reflect the purpose and need for the project and be measurable. Measurable objectives are essential for a comparable evaluation of project alternatives.

Before establishing traffic analysis objectives, the Project Manager and project team must review the purpose and need for the project, previously completed planning studies and the Efficient Transpiration Decision Making (ETDM) ***Programming Screen Summary Report***. These documents are essential to determining the scope of work.

5.2.2 Level of Traffic Analysis Effort

5.2.2.1 Traffic Analysis Scope

PD&E Studies vary in size and type, resulting in project traffic forecasting and analysis with varying levels of detail. The FDOT Project Manager should develop the scope of the traffic analysis effort based on the need for the project and the analysis objectives. The items that inform the traffic analysis scope are traffic study limits, design years, air quality and noise analysis requirements, and special components for traffic analysis, such as freight, transit, origin-destination.

Traffic forecasts and analysis may be prepared as part of a planning study or advanced prior to the PD&E Study. Therefore, the FDOT Project Manager must review and consider previously completed traffic analysis activities when determining the level of traffic analysis needed during the PD&E phase.

The scope or level of traffic analysis includes the analysis methodology, tools and documentation. This decision should be made after reviewing any previously completed planning and traffic operational studies in the project area. Additionally, the following items must be reviewed when determining the level of effort needed to conduct traffic analysis:

- Elements that relate to the transportation problem being analyzed.
- Traffic analyses conducted prior to the PD&E phase to determine their adequacy for inclusion in the PD&E Study as per **23 CFR Part 450**.
- Existing operating conditions to determine the degree of traffic saturation.
- Facility type and geographic context. This includes review of current or future major traffic generators in the vicinity of the project.
- Presence of Intelligent Transportation Systems (ITS) technology.
- Proposed improvements for the project.
- Need for tolling.

Therefore, the Project Manager should begin with an understanding of what level of analysis is needed and use that information to develop the data collection effort. For instance, with regard to future traffic projections, a PD&E Study for a rural corridor may only require the forecast of daily traffic demand in order to evaluate alternatives. An express lanes PD&E Study would require the forecast of peak period traffic volumes for both general use lanes (non-tolled lanes) and for the express lanes (variable tolled lanes). Additionally, a PD&E Study for an over-saturated intersection or corridor may require extending both geographic area of analysis and analysis time period to accommodate actual traffic demand and bottlenecks.

It would also help for the Project Manager to work with various stakeholders and decision makers to understand the expected outcome of the study. This will help to reach agreement on analysis methods and assumptions early in the process which is vital to the success of the project. Additionally, the Project Manager must consider other analyses (economic, air and noise) which are dependent on the output of the traffic analysis and incorporate them into the scope. The Project Manager should prepare the traffic analysis schedule and estimate the staffing requirements based on the agreed upon traffic analysis scope.

5.2.2.2 Using Planning Phase Traffic Analyses

Project traffic forecasts and traffic analysis may be prepared prior to the PD&E phase as part of a corridor, feasibility, interchange access, or any project following the SWAT process. In addition, project forecasts and traffic analysis are often conducted to determine transportation problems as part of a system-wide transportation needs plan. These planning studies may also be used to support the purpose and need for projects. Some of the traffic operational studies performed during the Planning phase have the same level of detail as those conducted during a PD&E Study. For instance, an Interchange Access Request (IAR) traffic analysis for interstate system follows a process that is agreed upon by FHWA, FDOT and the interchange access applicant. During the project scope development stage, the Project Manager should explore opportunities to reuse or incorporate by reference detailed planning analyses (such as those prepared in support of IAR studies) in the PD&E Study.

Title 23 U.S.C. § 139(f)(4)(E)(ii) allows the lead agency to eliminate from detailed consideration an alternative proposed in an Environmental Impact Statement (EIS) if the alternative was considered in an metropolitan planning process. Additionally, **23 CFR Part 450** allows for decisions and analyses conducted during transportation planning to be used for the **NEPA** study. It is essential for the FDOT Project Manager to review the traffic analysis methods and results and coordinate with FHWA (for projects that require FHWA approval) before incorporating them into the PD&E Study. For projects that require FHWA approval, FHWA determines the applicability of the traffic analysis methods used and validity of the previous study results before they can be reused or incorporated by reference in a PD&E Study.

For non-federal projects, the Project Manager should review applicability of the transportation planning products for use in the PD&E Study early in the scope development stage. The Project Manager should involve planning staff when determining applicability of the products.

5.2.3 Performance Measures of Effectiveness

Assessment and comparison of project alternatives require the selection of performance Measures of Effectiveness (MOEs) that fit the goals and objectives of the analysis. The traffic analysis computes MOEs that are used to quantify the existing and future operating conditions of the project. The appropriate MOEs help to compare and contrast the performance of various alternatives in achieving a project's traffic operational objectives.

One of the primary MOEs is Level of Service (LOS). However, LOS is not effective when the facility is characterized with oversaturated conditions where the demand to use the facility exceeds capacity. Typically in urban areas, traffic analysis may result in LOS F for all alternatives, which will not help in differentiating between alternatives. Under such conditions, the Project Manager must select the appropriate MOEs based on the needs and context of the individual project. It is important that all stakeholders associated with the project agree to the MOEs selected before the project team begins the analysis, since data requirements and traffic analysis tools are closely related to MOEs.

Other than LOS, a highway traffic analysis can use the following MOEs:

- Throughput
- Vehicle Miles of Travel
- Volume/capacity ratio
- Travel time
- Travel speed
- Total delay at intersections
- Queue length
- Number of stops
- Density
- Travel time variance
- Travel time reliability
- Hours of congestion

Typical MOEs for safety analysis include:

- Actual crash rate
- Number of fatalities
- Crash severity level
- Economic loss

Typical MOEs for transit analysis include:

- Passenger trips

- Average headway
- % of population served
- Total fare box revenue
- Passenger wait time
- Travel reliability
- Vehicle loads
- Span of service

Typical MOEs for environmental/economic analyses include:

- Vehicle Miles of Travel
- Vehicle Hours of Delay
- Vehicles Hours of Travel
- Travel speed
- Emissions
- Number of crashes
- Travel time saving

5.2.4 Traffic Analysis Tools

The traffic analysis can vary from looking up service volumes tables for LOS to detailed microsimulation analysis. The tools selected for conducting the traffic analysis must correlate the complexity of the project with the magnitude of the traffic problem. Sophisticated tools and methods such as microsimulation must be used only for very complex problems such as those that require interactions of road users or involve oversaturated, congested conditions. The default tool for the analysis should be **HCM**-based tools, as they are least complex and require less data. The analyst must also consider limitations of the tools when selecting proper analysis methods that meet the project needs. The Project Manager and project team should refrain from selecting a simple tool that does not fit the analysis objectives simply because of familiarity or lack of resources.

The most common tools available to FDOT include:

- Generalized Service Volume Tables, found in the [Quality / Level of Service Handbook](#) and LOSPLAN may be used for general planning level analyses and

high-level concepts screening. These tools should not be used for operational analyses.

- Highway Capacity Software (HCS) based on the most recent **HCM**, Synchro and SIDRA are primary tools for analysis of locations that are isolated, not congested or do not require an understanding of interactions between various users.
- CORSIM and VISSIM, are primarily tools for analyzing areas that require an understanding of interactions between various users or transportation systems and/or experience oversaturated, congested conditions. These tools can also analyze unconventional project concepts or the performance of the entire network/system.
- **HSM** tools such as spreadsheets, Crash Modification Factors (CMF), and Safety Analyst which can be used to conduct quantitative safety analyses.

The [Traffic Analysis Handbook](#) contains guidance for selecting the proper traffic analysis tools. Depending on project conditions or needs, the analysis may use tools other than those listed in this section or discussed in the [Traffic Analysis Handbook](#). Prior to using alternative tools other than listed in the [Traffic Analysis Handbook](#), the analyst must submit a request and provide justification to the FDOT Project Manager.

5.2.5 Data Collection

Data required for traffic analysis depends on various factors such as project context, analysis method and performance MOEs. At the outset of the project, the FDOT Project Manager and project team must gather all existing available traffic information from FDOT databases, past studies, prior projects, and other analysis performed within the project area. This information is essential to understanding general knowledge of the project area and identifying any gaps in data that must be included in a data collection plan. Even when review of existing data indicates the data is sufficient, the project team must conduct field reviews. Field reviews or observations are necessary to confirm data and review driving characteristics and operational conditions. Aerial and satellite imageries can provide useful information about physical characteristics of the analysis area but they should not replace field reviews.

The data collection effort may need to consider several modes of transportation. [FDOT's Complete Streets Policy, Topic No. 000-625-017](#) requires that a roadway accommodate all modes and users of all ages and abilities. Therefore, depending on project context, data collection should include information about transit stops, boarding and alighting, headways, pedestrian counts and bicycle counts. Data related to pedestrian generators and attractors should be considered in urban contexts.

The data collection plan must include the traffic analysis area, which may exceed the project limits. Examples of traffic studies where the data collection plan must extend beyond the PD&E Study limits are:

- **Interchange Access Request Studies** - Interchange access requests may require analysis of the interchanges upstream and downstream of the project location and the crossroad up to one half-mile in either direction of the proposed access change. The geographic breadth of the analysis should be coordinated with the District's Interchange Review Coordinator (IRC) and FHWA (for projects on the interstate system). See *Interchange Access Request Users Guide* for more guidance.
- **New Corridor Studies** - New corridor studies require a general understanding of the total demand, operations, and safety for the corridor traffic analysis area, which includes roadways adjacent to the proposed roadway.
- **Bottlenecked and Oversaturated Roadway Facilities** - The analysis area must include operational constraint points or sections (limited physical capacity) that restrict the roadway from processing the traffic demand, thus causing recurring congestion. The constraints may require extension of the analysis area beyond the predefined area of influence. Downstream bottlenecks cause queue spillbacks, while upstream bottlenecks may meter the flow and cause demand starvation within the project area.
- **Coordinated Freeways and Arterials** – Project sections or points that are part of a coordinated arterial and/or Coordinated Freeways and Arterials (CFA) network may require extension of the traffic analysis area to include coordinated signals.
- **Lane Repurposing** – Project converting (repurposing) existing lanes to dedicated bus lanes, parking lanes, or bicycle lanes may require a system wide analysis to evaluate the impact of traffic diverting to adjacent major roadways.
- **Projects with Transit Routes** – Transit ridership on a project is based on several factors including accessibility (a measure of how an individual can pursue a desired mode at a desired location at a desired time). Accessibility can include park and ride lots and transfer between modes, which may be located outside the PD&E study limits. Additionally, terminal stations where transfers take place may be located outside the PD&E Study limits.

Once the data collection study area has been defined, the next step is to decide what type of information is to be collected. The tools used to develop and analyze alternatives also affect the data collection effort. Microsimulation analyses require more detailed data than analytical methods or *HCM*-based tools. The data collection plan for a microsimulation analysis must contemplate and include data needed for the proper calibration and validation of the model to be used in the analysis.

5.2.5.1 Types of Data Collection

The data collection effort can be divided into three categories—roadway characteristics, traffic characteristics, and operations and safety characteristics. The type of the traffic

study will determine the requirement and level of detail in which elements in each category are to be collected. The following are the data elements for each category.

Roadway Characteristics

- Number of lanes
- Lane widths
- Presence of auxiliary lanes
- Length of auxiliary lanes
- Intersection types (signalized, stop controlled, roundabout, grade separated)
- Roadway geometrics (curvature, intersection configuration, grades)
- Number of turn lanes
- Turn lane storage lengths
- Presence of on-street parking
- Presence of transit lanes
- Presence of transit stops
- Type of transit stops (bus bays or bus stops)
- Presence of bicycle lanes
- Bicycle lane width
- Presence of sidewalks
- Sidewalk distances from travel lanes
- Shoulder widths
- Lateral clearances
- Presence of railroad crossings
- Type and location of toll plazas—electronic vs. cash toll collection

Multimodal Travel Characteristics

- AADT

- Vehicle classification and vehicle mix
- Truck Percentages
- Turning Movements Counts
- Pedestrian Counts
- Bicycle Counts
- Boarding and alighting at transit stops
- Transit Hours of Operation
- Transit Headways
- Route Ridership
- Running time information
- Utilization of special facilities (e.g., bus on freeways, transit centers, transit stops)
- Frequency of train service at railroad crossings
- Peak Hour Factors
- Origin-Destination (OD) survey for general vehicles and/or trucks

Operations & Safety Characteristics

- Posted Speed Limits
- Average Travel Speeds (highway and transit)
- Signal Timings
- Locations of detectors and traffic signal heads
- Queue locations and queue lengths
- Number of crashes and location of crashes
- Severity of crashes (fatal, injury or property damage) and their contributing causes

FDOT and other agencies have developed the following databases containing several roadway, traffic, safety and operations characteristics, which can be used to supplement the data collection effort:

- FDOT Florida Transportation Information (FTI) DVD and Florida Traffic Online (FTO) <http://www2.dot.state.fl.us/FloridaTrafficOnline/viewer.html>
- FDOT Traffic Characteristic Inventory (TCI) Database
- FDOT Roadway Characteristic (RCI) Database
- Regional Integrated Transportation Information System at University of Maryland (RITIS)
- FDOT Crash Analysis Reporting (CAR) System Database

5.2.5.2 Duration of Data Collection

The Project Manager should work with the project team to determine the appropriate duration of the data collection effort. Data collected over multiple days provides a higher degree of confidence and is more robust if random events like traffic crashes or equipment failure occur during part of the data collection period. Data collection cost does increase with duration and therefore, the Project Manager must balance these competing considerations with the goals of the study. The project team must first review existing data, such as the ones from FTI DVD and/or FTO, to determine 24-hour demand profiles. Demand profiles are a useful tool to estimate the duration of the data collection. In the absence of existing data, use the *HCM, Chapter 3* for examples of monthly, weekly, and hourly variation in traffic volumes for rural and urban routes to determine the length of the data collection period.

The data collection effort should be guided by the following:

- The FDOT [Project Traffic Forecasting Handbook](#) recommends that traffic counts be collected on Tuesday, Wednesday, or Thursday. To ensure the data is representative of average (typical) traffic conditions, traffic counts should not be collected during the summer or on holidays since travel patterns during these times cannot be assumed to be representative of typical weekdays.
- Traffic counts collected over a 72-hour period is recommended. Collection of data over a 72-hour period is preferred over single-day to avoid poor and faulty information (data) due to equipment failures, human errors, traffic incidents, among other reasons. However, if the roadway is a typical commuter traffic route and there is adequate history (5 to 10 years) of traffic counts, a 24-hour to 48-hour count may be sufficient. A 24-hour to 48-hour traffic count must be validated against historical counts.
- Classification counts from a Telemetered Traffic Monitoring Site (TTMS) or Portable Traffic Monitoring Site (PTMS) can be used as long as such site exists within the vicinity of the project. In absence of a permanent count station, 72 consecutive hours of vehicle classification counts should be collected. Counts for less than 72 hours are not recommended because of random variations that may

be brought by equipment failures, human errors, traffic incidents, among other reasons.

- Intersection turning movements should generally be collected during the AM and PM peak periods for 72-hour period. For urban arterials serving predominantly commuter traffic, turning movement counts over a 24-hour to 48-hour period may be sufficient provided there is historical validation data. If heavy truck traffic is anticipated in the study area, truck counts should also be collected as part of the intersection turning movement count.

Roadways serving commercial uses, shopping centers, and schools may peak during the midday period or during the weekends. The Project Manager should review the FDOT or local traffic count synopsis report to determine if midday turning movement counts are required.

If there is no history of traffic counts, conduct a 72-hour approach and departure counts at the intersection so that you can extrapolate the peak hour turning movements to daily turning movements. Software like TURNS 5 requires the user to input 2-way approach AADT approach volumes for every leg of the intersection.

- Intersection turning movement counts must include bicycle and pedestrian movements. Bicycle and Pedestrian usage varies considerably with location. Peak period counts may be adequate in areas with light pedestrian/bicycle usage. Downtown areas, university campuses, and areas with heavy pedestrian and/or bicycle usage should be counted for an 8-hour period.
- Crash data should be obtained for the most recent five years. If five years of crash data are not available, use a minimum of three years with a corresponding explanation. Due to changes to the **Florida Traffic Crash Report** implemented by the Department of Highway Safety and Motor Vehicles in 2011, it may not be possible to compare certain fields like crash type across five years.
- Transit projects can vary from new fixed guideway systems to Bus Rapid Transit (BRT) projects. The data collection for such projects depends on the type of project. For areas with existing transit service, the analyst should consult with the local transit agency before beginning any data collection. Transit agencies and providers are required to develop a 10-year Transit Development Plan (TDP). These TDPs usually contain a significant amount of data that can be used for transit studies, such as socio-economic data, transportation system characteristics, market research and system surveys, public transportation service performance and trends, among other useful information. The data collection effort may vary among routes depending on the ridership. For example, low ridership routes may only require a 7 to 10-day period of data collection to capture a sufficiently robust sample of responses. Additional details about data collection activities for environmental analysis can be found in [Part 1, Chapter 14, Transit Project Delivery](#).

5.2.6 Project Traffic Forecasting

Project Traffic forecasting is the process of estimating the future year traffic demand for a given project. It includes estimating daily volumes and peak hour demand volumes. Daily volumes are represented by AADT while peak hour demand is represented as Design Hour Volume (DHV). Transportation practitioners use AADT and DHV to not only determine geometric features of the roadway, but also assess operational performance of the facility.

There are two options for forecasting traffic volumes:

- With a Travel Demand Model
- Without a Travel Demand Model

[The Project Traffic Forecasting Handbook](#) details the FDOT traffic forecasting process for both options. Documentation of traffic forecasts and analysis must detail the selection of the preferred forecasting method, as well as the application of said method in the analysis.

5.2.6.1 Forecasting using a Travel Demand Model

The traffic forecasting for a project must begin with the most recently adopted version of a travel demand model. This model should have been used to develop the most recent Long Range Transportation Plan (LRTP). This model represents the latest planning assumptions regarding population, employment, land use, transportation plans, and revenue, and is referred to as the “adopted model”.

Before using any travel demand model, the project traffic analyst must determine if the model meets the area wide validation standards established by the FDOT Systems Traffic Modeling Office and published in the [FSUTMS-Cube Framework Phase II – Model Calibration and Validation Standards Report](#).

With the development of the Florida Statewide Model, all 67 counties within the State of Florida are now covered by at least one travel demand model. The determination of the preferred model for each study is dependent on a number of factors, such as project location, analysis years, available data, transportation mode (e.g., freight, transit, automobile). District Planning Office concurrence on the preferred travel demand model is required prior to commencing the traffic forecasting process.

Finally, most of the travel demand models are validated to peak season travel conditions. The traffic volumes generated by the model represent Peak Season Weekday Average Daily Traffic (PSWADT) and must be converted to AADT using the Model Output Conversion Factor (MOCF). In such cases, the following formula shall be applied:

$$\text{AADT} = \text{PSWADT} * \text{MOCF}$$

Subarea or Corridor Validation

In some cases, the travel demand model will meet the validation standards based on area wide statistics, but will perform poorly for the specific area or corridor under study. Such scenarios require subarea or corridor validation to improve the forecast within the project limits. In a subarea or corridor validation, a smaller area or corridor is extracted from the regional model and the validation process is restarted with the goal of improving statistics such as volume/count ratios, root mean square error (RMSE), estimated-over-absorbed transit trips. The subarea or corridor validation effort is not as intensive as the regional/Metropolitan Planning Organization (MPO)/county model validation, because it uses a smaller roadway network. Further information about the Subarea/Corridor Validation standards can be found in the [**FSUTMS-Cube Framework Phase II – Model Calibration and Validation Standards.**](#)

Additional details regarding forecasting using a travel demand model can be found in Chapter 3 of the [**Project Traffic Forecasting Handbook.**](#)

Time of Day Model

Travel demand models were originally designed to produce future travel demand at the daily level. Most of the analysis done to determine geometric requirements of roadways and intersections is done for the design hour. Until recently, the process of converting AADT to peak hour assumed that 10% of the AADT occurred during the peak hour. While this process produces reasonable results in smaller urbanized areas where the peak period is limited to one hour, it fails in highly congested urban areas where the peak period spreads beyond the typical one hour.

The broadening of traffic flow profiles to multiple-hour peak periods is referred to as peak spreading. As the traffic congestion worsens during the peak hour, many drivers either leave early or delay the trip to avoid the peak hour. In some cases, they seek an alternative route or switch modes. As a result, the traffic generally traveling during the peak hour shifts to the adjacent shoulder hours.

To address multi-hour congestion problems, many urban areas have developed a Time of Day (TOD) model that forecasts traffic for the AM peak period, midday period, PM peak period and night/rest of the day period. TOD models require traffic count data by time of day to ensure accurate validation by time of day. This adds to the level of complexity for validation checks and the Project Manager should consult with District Planning Office or MPO traffic modeling staff before using the TOD model.

5.2.6.2 Forecasting without Travel Demand Models

Projects located in areas without an MPO travel demand model or in areas where the Florida Statewide Model or the MPO travel demand model is not performing well may have to rely on a combination of historic trends or population growth for traffic forecasting.

Historic Trend Projections

The historic trends analysis should be based on a minimum of 10 years of data. A regression analysis is performed on the most recent 10 years of traffic counts in order to obtain a trend equation. Any obvious outliers should be removed from the data set and an explanation provided. Only trend equations with an R-square value of at least 75% should be used to estimate the future year traffic volumes. Trend analysis is not sensitive to capacity constraints and care should be exercised when projected traffic demand exceeds capacity.

Growth Rates

Historic trends analysis works well for areas with stable land use, transportation network and growth patterns. In areas that are experiencing significant growth, construction of parallel facilities and changes in land use should rely on growth rates based on a combination of population and employment growth.

Once the growth rate has been determined and checked for reasonableness, it can then be applied to a given base year count and projected forward to the future analysis years.

For additional details, see Chapter 4 of the [Project Traffic Forecasting Handbook](#).

5.2.6.3 Calculating AADT and DDHV

AADT

Traffic counts are usually collected over a 24-to 72-hour period through the placement of portable traffic counters. These counters are usually rubber hoses placed across the roadway that record the number of axles. These counters are small enough to be easily transported and contain a power source and can be easily secured to stationary objects such as a telephone pole, fence post, tree.

The short-term traffic count collected over 24 to 72 hours is called the Average Daily Traffic (ADT) or “raw count”. Due to the seasonal variations in traffic, the count must be adjusted by the Seasonal Factor (SF). In addition, the traffic counter only counts the number of axles and not vehicles. The raw traffic count of ADT must be adjusted using the Axle Correction Factor (ACF).

$$\text{AADT} = \text{ADT} * \text{Seasonal Factor} * \text{Axle Correction Factor}$$

Standard K Factor

The K Factor is critical in traffic forecasts because it defines the volume of traffic for which the road is being designed. K factors are developed based on field-collected data over long periods of times. Standard K factors are established statewide for specific areas and facility types, using the data measured at permanent traffic monitoring sites should be applied to AADT to determine the DHV. Standard K factors less than 9.0% essentially represent multi-hour peak period (or peak- spreading) rather than peak hour conditions.

See the [Project Traffic Forecasting Handbook, Chapter 2](#) for the latest FDOT Standard K factors.

D Factor

The **Directional Distribution (D Factor)** is the percentage of the total, two-way design hour traffic traveling in the peak direction. The D Factor is an essential parameter used to determine the DDHV. The D Factor is obtained from traffic counts and checked against the value listed in the FDOT FTI DVD and on the FTO Website.

To determine if a D value is acceptable for project traffic forecasting, the value should be cross-referenced against the acceptable range of demand D factors listed in the [Project Traffic Forecasting Handbook, Chapter 2](#).

Design Hour Volume (DHV) and Directional Design Hour Volume (DDHV)

The DHV is the traffic volume expected to use the roadway segment during the design hour of the design year. The DHV is calculated using the following formula:

$$\text{DHV} = \text{AADT} * \text{K Factor}$$

The DDHV is the traffic volume expected to use the roadway segment during the design hours of the design year in the peak direction. The DDHV is calculated using the following formula:

$$\text{DDHV} = \text{AADT} * \text{K Factor} * \text{D Factor}$$

T Factor (Percent Trucks)

The T Factor measures the percentage of trucks on a daily basis and is the most critical factor in pavement design. The structural design of a roadway is primarily dependent upon on the heavy axle loads generated by commercial traffic and the T Factor measures the percentage of trucks on a daily basis.

For traffic analysis, the Design Hour Truck (DHT) Factor is used to convert trucks to passenger car equivalents. The DHT is calculated by dividing the T Factor by 2 because the percentage of trucks in the traffic is not evenly distributed throughout the day.

5.2.6.4 Reevaluations and Validity of Traffic Forecasts

The majority of traffic forecasting and analysis should be completed during the PD&E phase. Once the traffic forecast and analysis is completed, the subsequent phases (Design and Construction) should use the same traffic data for design and operational purposes such as designing turn lanes, signal timing, or traffic control plans.

Some transportation projects take many years to go from concept to implementation. When a PD&E project advances to design, a reevaluation of PD&E may be required. See [Part 1, Chapter 13, Reevaluations](#) for PD&E reevaluation process. During PD&E

reevaluation, the Project Manager and the project team must decide if the traffic forecast and analysis prepared for the project needs to be updated.

The validity of traffic forecasts depends on changed conditions brought on by:

- Significant “macro-level” changes in the economy and driving habits since the project forecast was prepared. Examples include the effects of economic recession or a sudden increase/decrease in gas prices potentially affecting travel demand.
- Significant change in land uses or growth within the study area. For example, large scale developments, such as sector plans, approved near the study area which have the potential to change traffic patterns.
- Significant changes in the scope of work. For example, the addition of a new alternative that was not previously considered when the traffic model was developed. Model adjustment may be necessary to incorporate changes in trip patterns anticipated within the study area.
- Significant changes in the transportation network near the study area. For example, the construction of major beltways or by-pass routes. Traffic reports prepared before and after the network was changed may contain significant differences in trip distribution patterns.
- Adoption of a new regional travel demand model when the project traffic forecast is more than five years old. An update of the LRTP represents the latest planning assumptions regarding population, employment and land use, and coordinates transportation planning activities within and outside of the MPO area. If the traffic forecast is more than five years old and the MPO has adopted a new LRTP, the Project Manager and the traffic analyst should perform a sensitivity analysis of revised input and model assumptions to determine the magnitude of differences from prior analyses and their effects on past project decisions.

The Project Manager should use conditions discussed above as a guide to determine the validity of previously completed traffic forecasts. The Project Manager and project team must consider any difference in the results to deliver the project decision. The focus should be on consistent conclusions from the analysis, rather than on any minor numerical differences between two different travel demand models outputs.

If there is a significant change in the traffic forecast, the Project Manager must coordinate with the Lead Agency to prepare a reevaluation. The reevaluation may require changes to the analysis methodology in order to update the traffic consistent with the latest LRTP. The Project Manager should document decisions reached with the Lead Agency and other project stakeholders.

If there is no significant change in the traffic forecast, the study team would simply document the change and the sensitivity analysis results in the project files and proceed with the next phase of the project.

5.2.7 Traffic Analysis

Traffic analysis includes capacity and operational analysis to determine how well the project alternatives are meeting the project purpose and need. Detailed evaluation of project alternatives should only proceed on viable or feasible project alternatives (see [Part 2, Chapter 6 Engineering Analysis](#)). Also, the same assumptions and a similar set of tools should be consistently applied to perform traffic analysis for different alternatives in a project.

Depending on the project, the analysis may use the methodologies in the *HCM* or a more sophisticated tool such as microsimulation to analyze the interactions between different users on an entire network.

The decision on selecting the appropriate tool for the project depends on the analysis objectives and the available resources/data. Chapter 4 of the [FDOT Traffic Analysis Handbook](#) describes the various tools available and provides guidance on selecting the proper analysis tools.

5.2.7.1 Capacity Exceeds Traffic Demand

In scenarios where the roadway capacity exceeds traffic demand, all the traffic is accommodated during the time interval under study. There is no spillback of any queues or congestion from one segment affecting adjacent segments.

In such situation, analytical tools like the HCS that can quickly compute LOS and other operational MOEs for individual segments or isolated points should be used. HCS can compute LOS for uninterrupted flow facilities, interrupted flow facilities and multimodal transportation facilities (e.g., pedestrian, bicycle, and transit). HCS guidance on how to conduct analytical analysis is available in the *HCM* and its accompanied software HCS.

5.2.7.2 Traffic Demand Exceeds Capacity

In scenarios where the traffic demand exceeds roadway capacity, the traffic demand is not accommodated during the time interval under study. As a result, congestion and queues spillback to adjacent segments and time intervals. An accurate analysis should analyze the entire time period where traffic demand exceeds capacity and until all the congestion has dissipated.

In such scenarios, a microsimulation traffic analysis that simulates the effect of spillback queues and congestion on adjacent segments should be used. Microsimulation tools use computer models to simulate the interaction of individual users, such as cars, based on specified driver behavior factors. Microsimulation tools must be calibrated to local traffic conditions before being applied in alternatives analysis. **Chapter 7** of the [FDOT Traffic Analysis Handbook](#) and *FHWA Traffic Analysis Toolbox Volumes III and IV* provide guidance on the development, calibration and application of microsimulation tools.

5.2.8 Safety Analysis

Safety analysis includes analyzing crash history (usually five years) within the project limits to assess the existing safety performance and evaluating the potential safety implications of a project. Depending on project context, safety assessment of the project may use **HSM** methodologies and tools. The **HSM** is a collection of analytical procedures and techniques for identifying the causes of crashes and developing solutions for certain types of roadways.

Sound engineering judgment is essential when analyzing, evaluating, interpreting and presenting safety performance of a project in conjunction with other cost, design, operational, and environmental factors. Presentation of the safety performance of a project should be meaningful to both technical and nontechnical audiences.

5.2.8.1 Historical Crash Analysis

An historical crash analysis approach involves descriptive analysis of five years of crash data with respect to crash characteristics such as severity, types, frequency, rates, density, patterns, clusters, and their relationships with crash contributing causes. The results of the historical crash analysis are used to identify or confirm safety problems in the project study area. Understanding of crash characteristics along with crash contributing factors helps to determine and evaluate corrective actions or countermeasures that can be applied to the project alternatives. Crash countermeasures must be selected based on their appropriateness and effectiveness to address specific safety issues and project goals.

The future conditions analysis should examine the safety performance of the alternatives based on project context which includes future traffic volumes, proposed geometrics, modal needs, and traffic control conditions as appropriate. Future conditions analysis must include a discussion of the proposed design context, traffic operational performance and users of the facility. Additionally, safety assessment for future conditions must examine how the proposed alternatives improve upon any existing or potential safety problems. This will include comparison of existing conditions safety performance to that of future no-build and future build conditions.

5.2.8.2 Quantitative Safety Analysis

Quantitative safety analysis involves using **HSM**-based methods that incorporate site specific characteristics and mathematical functions such as safety performance functions (SPFs) and crash modification factors (CMFs) to objectively estimate safety performance measures. An SPF is an equation used to predict the average number of crashes per year at a location as a function of traffic exposure (e.g., volumes of vehicles, bicyclists, pedestrians). It allows an estimation of future safety conditions. A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. It allows estimation of the effectiveness of safety improvements.

The **HSM** based methods are detailed and require a thorough knowledge and experience in their applications and limitations. The advantage of these methods is their ability to make relative comparisons between various project alternatives based on the change in the number of crashes or combinations of crash severities for different contexts. The **HSM** continues to evolve and does not offer the ability to evaluate change on safety performance for every project scenario or context. In some cases, the SPF may require adjustments to Florida conditions because they were developed using national data and may not reflect average Florida conditions. Users of the **HSM** should refer to the State Safety Office for publication of the current Florida specific SPF calibration factors.

The following project development activities can benefit from the use of **HSM**:

- Support purpose and need for the project
- Develop and refine the project alternatives
- Analyze and evaluate project alternatives

The **HSM Part C** predicted methods can calculate historic and anticipated future safety performance of the project. **HSM Part C** is applicable to rural two-lane highways, rural multilane highways, suburban and urban arterials, freeways, and interchanges. **HSM** has specific guidance regarding how to estimate future crashes with and without safety improvements. Additionally, the human factors fundamentals published in the **HSM** can help project analysts identify safety-specific needs for the projects and estimate the potential for safety improvements.

Development and screening of alternatives can use **HSM** predictive methods to quantify the anticipated change in crash frequency and/or severity as the result of changes in geometric features or traffic conditions. If an assessment for a safety-specific project shows that some alternatives would have a negligible or adverse effect on safety performance, those alternatives can be eliminated. The documentation needed to support the elimination of alternatives could therefore include the information derived from the **HSM** methods.

Another method for quantifying safety impacts of project alternatives is a relative comparison of CMFs. This method estimates the relative magnitude of potential safety impacts based on the anticipated percent change in crash frequency based on applicable CMFs. CMFs are published in the **HSM Part D** and the **FHWA's Crash Modification Factors Clearinghouse website** which include a star rating to indicate their quality. CMFs are also used to compare relative safety benefits of potential mitigation measures when selecting a strategy to address an identified safety issue. This method is relatively simple to apply, and when used appropriately can objectively support proposed improvements. CMFs are applicable to roadway segments, intersections, interchanges, special facilities, and various geometric situations.

5.2.9 Environmental Analyses

Environmental analyses such as land use, air quality, and noise impact analyses depend on the outputs of the traffic forecasting and analysis. The most common traffic data required for environmental analyses are AADT, peak hour volumes, peak truck hour volumes and traffic classification. Typical MOEs from the traffic analysis that are used for environmental analyses are listed in **Section 5.2.3**. The Project Manager should work with the District Environmental Administrator and other environmental subject matter experts to determine the scale of traffic data needed for various environmental analyses as early as in the project scope development stage.

5.2.10 Project Traffic Analysis Report

The **Project Traffic Analysis Report** documents the assumptions, methods, traffic forecasts, design traffic, and results of the traffic analysis for the project in plain language and in an easily understood format. It summarizes the data collection effort, input parameters, traffic analysis tools, existing conditions, development of future traffic forecasts, and traffic operational and safety analyses of project alternatives.

The scope of the report depends on the size and complexity of the project, and whether traffic analyses conducted prior to the PD&E phase are going to be incorporated according to **23 CFR Part 450**. Regardless of the complexity, the traffic analysis report should summarize the items presented in **Section 5.2.10.2**.

Traffic analysis reports support decisions regarding project actions. Therefore, the report should concisely present the results of the traffic analysis in a manner that can be readily understood by a variety of audiences, including the general public and non-technical decision-makers. Discussion of the analysis results should be focused and avoid unnecessary information. Additionally, the report should include text that discusses information presented in tables and figures (charts, maps, and diagrams). MOEs presented in tables and figures should be clear, concise, and simple. The report should include other supporting technical data and output from analysis tools in the appendices. Additionally, highly detailed information such as data used to prepare figures and tabular summaries should be placed in the appendices.

For complex projects, traffic forecasting and traffic analysis may be prepared under different project tasks and teams. In such projects, it is recommended that traffic forecasting results and traffic analysis be documented in different technical memoranda or reports. See the [Project Traffic Forecasting Handbook](#) for how to prepare a **Project Traffic Forecasting Memorandum**. Traffic analysis reports for projects that are not complex can include the results of traffic forecasting. The approach to documentation (i.e., one **Project Traffic Analysis Report** or multiple technical memoranda) should be included in the scope and agreed upon by the FDOT Project Manager and project team. The **Project Traffic Analysis Report** must be signed and sealed by a professional engineer in accordance with **Chapter 471, Florida Statutes**.

Project Traffic Analysis Reports must be reviewed and checked for quality and reasonableness of the results. The review of reasonableness of traffic projections should include examining and comparing observed traffic and historical trends, proposed roadway and transit network improvements, and land use projections. Quality control review for traffic analysis results should include reviewing methods and assumptions used to develop the analysis, inputs, reasonableness of results, and completeness of the results. Refer to the [FDOT Traffic Analysis Handbook](#) for checklists that may aid the review process.

5.2.10.1 Traffic Analysis Assumptions

The assumptions used to prepare the traffic analysis including traffic projections should be documented so that a reviewer can easily understand the methodology, input values, and analysis results. It is essential for the Project Manager to reach consensus with the project team and lead agency regarding the assumptions during the scope development stage of the project.

The following should be included in the traffic analysis assumptions summary as appropriate.

1. Traffic Forecasting Assumptions Summary
 - a. Traffic forecast method –Travel demand model, historic trend or growth rates
 - b. For the travel demand model, state:
 - i. Date of adoption of LRTP
 - ii. Base model year
 - iii. Horizon year of the travel demand model
 - iv. MPO website which includes documentation of the LRTP
 - c. Changes in land use, economy, population, and employment since the travel demand model was built.
 - d. Data Collection Year
 - e. Analysis years – opening year, design year and interim year (for phased projects)
 - f. MOCF
 - g. K Factor
 - h. D Factor

- i. T Factor
2. Traffic (operational and safety) analysis assumptions summary should include:
 - a. Study Area
 - b. Key input parameters
 - c. Calibration and validation parameters
 - d. Analysis method and/or tools
 - e. Analysis period
 - f. Performance Measures of Effectiveness (MOE)

5.2.10.2 Project Traffic Analysis Report Outline

The following is an outline for the ***Project Traffic Analysis Report***. The report should have headings and subheadings to effectively delineate the sections appropriate to the level of analysis.

1. Traffic Analysis Assumptions—Summary of assumptions for input parameters, analysis years, analysis methodology.
2. Introduction— Brief description of the project with a project location map, traffic analysis objectives, including a project location map.
3. Traffic Analysis Method— Discussion of analysis methodology and assumptions including analysis years, traffic study area, data required, analysis tools including version, and MOE.
4. Existing Conditions Analysis— Summary of balanced turning movement counts for the study intersections/interchanges under existing conditions. Summary of operational and safety analyses for the existing conditions. Microsimulation analysis should also include base model development and calibration documentation. Calibration may be submitted as a standalone document.
5. Development of future year traffic forecast— Depending on the scale of the project, this may be developed and submitted as a standalone document, in which case it should be referenced within the ***Project Traffic Analysis Report***.
6. Alternatives Analysis— Description of project alternatives, assigning of project traffic volumes to alternatives. Summary of operational and safety analyses for each project alternative.
7. Summary of Analysis Results— Discussion of advantages and disadvantages of alternatives with respect to the traffic analysis objectives and goals.

8. Appendix— Raw data used to prepare input and analysis summaries. Other supporting data/information.

5.3 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 2010 Highway Safety Manual

Florida Department of Transportation (FDOT), 2008, FSUTMS-Cube Framework Phase II – Model Calibration and Validation Standards.

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FDOT, 2014. Project Traffic Forecasting Handbook.

<http://www.dot.state.fl.us/planning/statistics/trafficdata/ptf.pdf>

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Federal Highway Administration (FHWA), 2013. Traffic Monitoring Guide.

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FHWA, 2004. Traffic Analysis Toolbox Series.

<http://ops.fhwa.dot.gov/trafficanalysisitools/>

Regional Integrated Transportation Information at University of Maryland.

<http://www.ritis.org>

Title 23, Code of Federal Regulations (CFR) § 450, Appendix A. Linking the

Transportation Planning and NEPA Processes. <http://www.ecfr.gov/cgi-bin/text-idx?SID=ffd5a70592b8f07eb3d383a5e441e880&mc=true&node=pt23.1.450&rgn=div5>

Transportation Research Board (TRB), 2010. Highway Capacity Manual

Washington State Transportation Center, 1998, Peak Spreading Analysis, Review of Relevant Issues and Synthesis of Current Practice

5.4 HISTORY

Traffic forecast for the project was developed using:	
<input type="checkbox"/> Travel Demand Model	<input type="checkbox"/> Growth Rates
Type of Travel Demand Model Used: <input type="checkbox"/> Metropolitan Planning Model <input type="checkbox"/> Other Model _____	<i>Refer to appropriate section of Project Traffic Analysis Report that discusses growth rates</i>
Is the travel demand model based on the latest adopted Long Range Transportation Plan?	
<input type="checkbox"/> YES	<input type="checkbox"/> NO
_____ Date when MPO adopted the latest Long Range Transportation Plan	Explain why?
_____ Base Year of Travel Demand Model	
_____ Horizon Year of Travel Demand Model	
Long Range Transportation Plan documentation is available at (provide web address): _____	
Traffic Data and Factors	
Standard K = _____ D Factor = _____ T _{Daily} = _____	Traffic Counts Collection Year = _____ Opening Year = _____ Interim Year = _____ Design Year = _____
Discuss any changes in land use, economics, population and employment data since the model was built	

Figure 5-1 Project Traffic Assumption Summary