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Office of the Secretary of Transportation

How to Limit Traffic Congestion in Your Community

February 1984

TECHNOLOGY SHARING REPRINT SERIES

Prepared for
Housatonic Valley Council
of Elected Officials

HOUSATONIC VALLEY
COUNCIL OF ELECTED OFFICIALS
Old Town Hall, Route 25
Brookfield Center, Connecticut 06805
775 - 6256

How To Limit Traffic Congestion In Your Community

Prepared for

HOUSATONIC VALLEY COUNCIL OF ELECTED OFFICIALS

by

Wilbur Smith and Associates

in cooperation with

R. S. Bryan and Associates

February 1984

Foreword

This report was originally done by a consultant to the Housatonic Valley Council of Elected Officials, whose jurisdictions are located in the southwestern part of Connecticut just over the state's border with New York. The document was designed as a resource for local planning and zoning commissions, especially those without transportation professionals or staff.

A large part of the document, particularly in its first and third sections, deals with the legal authority of Connecticut towns to control traffic. As such, the document contains quite a bit of material on statutes and court decisions which are specific to Connecticut. However, much of this material may be of interest to other state and local governments, if for no other reason than to see how one set of jurisdictions has structured its legal approach to a fairly common problem.

The document also includes a substantial amount of material which should be of use under a variety of legal conditions and structures. This includes discussions of issues which should be addressed in a traffic impact study, a review of typical off-site roadway modifications, and a variety of planning procedures successfully employed by communities to limit congestion. As such, the document should be of broad applicability, assisting both local planning commissions and planners and engineers working with these groups.

The body of this document is reproduced essentially unchanged from the text as originally published.

HOUSATONIC VALLEY
COUNCIL OF ELECTED OFFICIALS

Old Town Hall, Route 25
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February, 1984

To The Members of Local
Land Use Commissions:

Our Council is pleased to forward to you this practical booklet which, if utilized, will help to limit the growth of traffic congestion. No matter where we live, we experience traffic congestion, either in our own or adjacent communities. We must therefore work together in common interest toward the best possible management of our roadways.

While joint lobbying and cooperation can bring a fair share of available roadway improvement funds into the Region, we can help ourselves by taking low cost actions locally to match the growth of traffic volumes with the capacity of existing and planned roadways. This can be accomplished through an upgrading of local administrative and planning mechanisms.

Suggested techniques are presented herein. We urge you to make use of them.

Sincerely yours,

Mary Anne Guitar

Mary Anne Guitar
Chairman

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and their HVCEO Representatives

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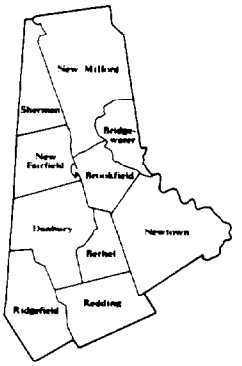

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Contents

Introduction and Overview

A primary goal of the municipal chief executives in the Housatonic Valley Region is to maintain and improve the quality of life in the Region. Residents of the area are almost unanimous in their feeling that traffic congestion, if allowed to grow unchecked, will reduce that quality. The purpose of this document is to place into the hands of local commission members practical administrative tools that can help to match the inevitable growth of traffic volumes with the capacity of existing and planned roadways. These techniques are an important supplement to publicly financed increases in roadway capacity and cannot simply be substituted for such investments. Since this topic deals with the intensity of development, care has been taken to balance the interests of the public and private sectors.

Section 1 reviews the legal basis for traffic planning. A simplified history of the relationships between traffic, planning and zoning in Connecticut is given. The goal of this section is to identify the ample authority that exists for municipal use of the practical techniques offered in Sections 2 and 3.

Section 2 is designed to increase the planning or zoning commission members' understanding of site specific traffic impact analysis techniques in order to make full and proper use of the authority outlined in Section 1. Whether a community decides to make use of the model administrative techniques offered in Section 3, the submission of traffic impact data by developers in support of permit applications will undoubtedly continue. Thus, use of this Section will help to upgrade the local commission members' ability to take informed positions on the traffic impact statements prepared for proposed developments.

Section 3 offers model administrative techniques, based upon the authority defined in Section 1, for addressing land use-transportation-congestion relationships and how longer range goals for congestion avoidance can be reinforced within local planning and zoning. Relationships of the local traffic planning process to the state's authority to regulate traffic is reviewed, along with a discussion of driveway permits.

The **Appendix** presents the following useful items:

A. A summary of selected Connecticut Supreme Court cases where the relationship of land use to traffic is addressed;

B. Zoning mechanisms for addressing traffic congestion that are currently in use in the Housatonic Valley Region;

C. Model zoning provision for traffic and access used successfully by other communities;

D. Glossary of terms commonly used by traffic engineers; and,

E. Bibliography of useful reports.

Section 1
Legal Basis For Traffic Planning

1.0 Use of the Street
2.0 Plan of Development and Traffic

A street or highway is a conduit for travel and has a measurable capacity. It is similar to a pipe that can carry a predictable amount of liquid depending upon size, pitch, friction along the edges and pressure.

The fundamental feature of a public street or highway is a strip of land having a specific width and location and being in the jurisdiction of the state or municipality by ownership in fee, by dedication or by prescription as a result of public use. That strip of land is commonly set up with a motor vehicle travelway, but it is also used by pedestrians (some with sidewalk facilities), cyclists (some with designated bikeways) and by a variety of pipes and wires for electric, telephone, cable TV, water, sewer, gas, steam and storm drainage utilities. Along with free speech and the right to vote, the availability of public streets and highways is a vital adjunct to the American way of life.

1.0 Use of the Street

Best use and management of the street and highway system is often essential, and here the municipal land-use agencies, such as planning and zoning commissions, have an important role. Occupants of property along a given segment of street or highway enjoy the access available and ability to travel elsewhere. A segment may have special value for abutting occupants by reason of convenience and known location for customers. Non-abutters, however, also rely upon that same segment for travel from point to point. Volumes of highway use on a given segment, then, may be generated by abutting occupants or by activities at distant points. Safe and convenient use of the street or highway involves consideration of local and through travel uses and a variety of highway facility and traffic management techniques that encourage safety, ease flow, and distribute "right of way" among the users.

2.0 Plan of Development and Traffic

Section 8-23 of the Connecticut General Statutes (CGS) provides that the municipal planning commission "shall prepare, adopt and amend a plan of development...". The plan "shall show the commission's recommendation for the most desirable use of land...for residential, recreational, commercial, industrial and other purposes and for the most desirable density of population...". These purposes generate and attract the users of the street and highway system, who on given segments may be safely accommodated or may be subjected to congestion and hazards.

Sec. 8-23 goes on to specify that the plan of development "may also show the commission's recommendation for a system of principal thoroughfares, parkways, bridges, streets and other public ways ...", so that the commission can address the land use and transportation relationships and needs.

These words, quoted from the Statutes, were first adopted by the Connecticut General Assembly in 1947 under Chapter 45 (now Chapter 126). Provision for an official local planning agency, however, was created much earlier. A 1918 statute provided that a town meeting was authorized "to raise a commission on the town plan" and the principal assignment given the commission was to lay out streets and highways by a mapping procedure and to assess the property benefits and damages resulting from the layout. The 1918 authority carries through to current time as Sec. 8-29 of the planning statutes.

Planning commissions have long been assigned a responsibility for features of the public street and highway system. In 1918 and by Sec. 8-29 that responsibility included administrative abilities -- to map existing and new rights-of-way. In 1947 the land-use considerations were specified, along with ability to re-

commend a system of thoroughfares and streets. Also in 1947 planning commissions were given authority to review and approve subdivisions of new lots and streets laid out by private individuals, and the commission could prescribe the standards for the layout of these streets, specify their improvement and require them to be "in harmony with existing or proposed principal thoroughfares shown in the plan of development ... especially in regard to safe intersections with such thoroughfares, and so arranged and of such width, as to provide an adequate and convenient system for present and prospective traffic needs." (Sec. 8-25, CGS).

While responsibility for the street and highway system is shared among many municipal and state agencies, a municipal planning commission's special assignments are:

1. The plan of development that can coordinate recommendations for land use, densities, and the street and highway system (Sec. 8-23, CGS);

2. Sole authority to approve subdivisions of land into three or more lots, including those with new streets (Sec. 8-25, 8-26, CGS);

3. Responsibility to review and report on municipal improvement projects, including streets, to be carried out by other municipal agencies (Sec. 8-24, CGS);

4. Ability to lay out streets, unless otherwise provided by ordinance (Sec. 8-29, CGS); and,

5. Authority to approve street layouts by private individuals, whether or not new lots are created, if the commission has adopted sub-division regulations (Sec. 13a - 71, CGS).

3.0 Zoning and Traffic

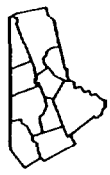
Almost two decades before there was clear statutory emphasis on land use recommendations by planning commissions, there was zoning. General enabling legislation to establish municipal zoning commissions, with sole authority to adopt zoning regulations, was enacted by the Connecticut General Assembly in 1925 as Chapter 29 (now Chapter 124). That general statute was patterned after the nationally recognized "Standard Zoning Enabling Act" which to this day has served as a guide for legislation in most states.

Zoning commissions are "authorized to regulate ... the height, number of stories and size of buildings and other structures; the percentage of the area of the lot that may be occupied; the size of yards, courts and other open spaces; the density of population and the location and use of buildings, structures and land for trade, industry, residence and other purposes... " (Sec. 8-2, CGS). In doing so, the zoning commission "may divide the municipality into districts ...".

The zoning regulations "shall be made in accordance with a comprehensive plan, this precedes the plan of development concept and shall be designed to lessen congestion in the streets; to secure safety from fire, panic, flood and other dangers; ... and to facilitate the adequate provisions for transportation ..." Regulations are to be made with reasonable consideration for the character of the district and its peculiar suitability for particular uses, among other factors.

What was "congestion in the streets" in the late 1920's? Streets were conduits as they are today, and users were pedestrians, cyclists, street cars, horsedrawn wagons and those rapidly multiplying motorcars. Congestion would be the accumulation of users to an extent or in an unorganized manner so as to reduce convenience, impair safety, cause noise and dust, and create perils and air pollution.

Zoning does not regulate the behavior of persons using the street or highway, nor does it create travelways, rights-of-way and user management devices. These are the responsibility of other public agencies. It was recognized in the late 1920's, however, that somehow the use and development of property (abutting or elsewhere) and the bulk and position of buildings had something to do with a



community need - to lessen congestion in the streets - and would for that reason, among others, be an appropriate, required, and constitutional purpose of regulation.

One can wonder about the degree to which current zoning plans for districts, uses, densities and permissible floor area in most municipalities have addressed the community issue of "congestion in the streets" and the facilitation of an adequate system of transportation. At a given time there may be no significant problem, especially since the full extent of the "zoning envelope" has not been used by the market. There are Connecticut municipalities where the seams of the zoning envelope are bulging, there is congestion in the streets and either costly and disruptive street improvements are made, or the public speaks of "How did this mess happen?; I don't go there any more; That's why I moved to another town."

Through zoning, the municipality has the ability to address by regulatory measures those features of development (use, bulk, location and site layout) which eventually lead to congestion in the streets - use of the street conduit beyond its safe and convenient capacity. By a combination of good standards and site layout review, zoning commissioners can assess the impacts of individual projects on the street and highway system in terms of overall volume to capacity, and safety and delays. In most communities, however, the plan of zoning currently in effect needs re-evaluation and the techniques for project review can be improved. Rethinking of zoning with the aid of sound planning is the logical way to go.

4.0 Reminders by the Court

Connecticut General Statute Chapters 124 for planning and 126 for zoning are called "enabling legislation," setting forth the duties, responsibilities and procedures of the commissions if they are to be created. Sec. 8-23 provides that the planning commission shall show in its plan the land-use recommendations and may show a system of streets and highways. Under Sec. 8-25 the planning commissions' subdivision regulations shall provide that proper provision is made for new streets that are in harmony with the plan of development and provide a safe and convenient system. By Sec. 8-2 zoning commissions are authorized to regulate use, bulk and density of development, but only in accordance with a comprehensive plan which shall be designed to lessen congestion in the streets and facilitate adequate provision for transportation. If the enabling statutes are invoked by a municipality, it is mandatory that features of land use, transportation and congestion be adequately addressed.

A municipal plan of development and the comprehensive plan of zoning will typically position shopping, industry, multiple dwellings and other significant traffic generators along or near major streets or expressway interchanges. This seems a practical approach, and sometimes the plans are well considered, including the street and traffic improvements that will be needed in the future. More often than not, however, the capacity of the street and highway system has not been measured against the traffic generation potentials of plan of development proposals and the use and bulk allowed by zoning. Although persons have statutory opportunity to have court review of townwide plans and comprehensive plans of zoning on constitutional, legal and rational bases, there have been no Connecticut Supreme Court decisions that directly address the adequacy of land use, bulk, transportation and congestion relationships for the municipality as a whole.

Nevertheless, the Connecticut courts have not only confirmed that proper street systems and lessening congestion in the streets are valid functions of planning and zoning, but have reminded town planners that these are mandatory considerations. Issues come to the court in particular controversies over zone changes, new local regulations and local project approval decisions. Examples where land use, traffic and congestion issues are directly addressed by the Connecticut Supreme Court are summarized in Appendix A.

Section 1
Legal Basis For Traffic Planning

4.0 Reminders by the Court

Planning and zoning commissions are authorized and mandated to address land use, transportation and congestion in the streets. These elements are a matter of concern:

- When a project is proposed and involves an action to rezone, approve a subdivision, grant a zoning variance or special permit or approve a specific site development plan; and;
- With regard to the plan of development and comprehensive plan of zoning that is already in place in the community.

Section 2 is designed to increase the planning or zoning commissioners' awareness and understanding of site-specific traffic impact analysis techniques. Section 3 will review local administrative techniques for addressing land use-transportation-congestion relationships and how to plan and zone for congestion avoidance.

Section 2
Traffic Planning and Assessment

This Section has been prepared to assist in assessing potential traffic impacts and transportation changes resulting from changes in land use by providing an easily understood, informational resource. It will enhance the ability of commission members and others to make more informed and confident decisions on traffic impact issues. It is expected to be particularly useful in the Housatonic Valley Region, which is experiencing a high degree of development and development interest.

It is important to emphasize that not all of the elements presented in this Section will be relevant to all traffic evaluation reports, or all locations. Rather, a maximum of information is presented covering a wide range of potential issues and subjects. Small traffic generators and projects in center city areas may require variations to these procedures.

Traffic studies are often prepared to assess the impact on existing or planned roadways of a proposed change in land use, such as a new development or modification of an existing facility. Typically, they are prepared for the applicant by a registered professional engineer as part of a planning or zoning application, with review and approval the responsibility of local and state agencies, as required. The traffic report describes potential traffic impacts and, where necessary, possible mitigating measures. A typical report describes the proposed land-use changes; existing roadway conditions and those expected subsequent to project implementation; and, the ability of the roadways to properly accommodate the anticipated future combined traffic. Future traffic is composed of the sum of traffic generated by the proposed land use and the expected future highway volumes which would occur without project implementation.

Reflecting the essential elements contained in a typical traffic impact study, this Section consists of the following five parts:

- Part 1.0-Site Description;
- Part 2.0-Existing Conditions;
- Part 3.0-Roadway Adequacy;
- Part 4.0-Site Generated and Future Traffic; and,
- Part 5.0-Project Assessment.

Each describes the material which should be included in corresponding sections of a typical traffic impact study to adequately assess a project.

1.0 SITE DESCRIPTION

The initial portion of a site study report presents information pertaining to:

- 1.1 - Proposed Project Parameters;
- 1.2 - Adjacent Existing and Proposed Conditions; and,
- 1.3 - Scope of Study.

1.1 Proposed project parameters include a description of the location of the site, parcel size, the existing and proposed land uses, the size of the proposed development, the access roadways, and the study area.

Study area boundaries are determined on the basis of the size, type, and location of a proposed development. A more detailed explanation of the selection of the appropriate study area and area of influence is presented in Part 4-Site Generated and Future Traffic. The boundaries for study should be coordinated between the applicant and the local reviewing agency.

1.2 Adjacent existing and proposed conditions are described to facilitate any necessary planning coordination and reflect the impact of committed land-use changes or transportation network improvement projects proposed by public agencies.

1.3 The scope of the study or a summary should be presented. This should also indicate the study purpose, sponsors, study goals and objectives, and specific responsibilities of the organization preparing the study. For a typical traffic impact study, the scope of work would include a review of existing land use and transportation conditions; anticipated site traffic volumes and patterns; projection and assessment of future land use and transportation conditions, both with and without the proposed changes in land use; and, if necessary, suggested improvements.

2.0 EXISTING CONDITIONS

These data include:

- 2.1 - Roadway network characteristics;
- 2.2 - Traffic volumes, variations, and validity; and,
- 2.3 - Planned improvements.

A description of the existing land use and transportation conditions is necessary to afford a comparison with anticipated future conditions, with and without the proposed project. A description of existing conditions should indicate whether the roadway network is adequately serving existing traffic volumes.

Existing information needs to be as current as possible and ideally should be no more than two years of age. Sources of existing data include local, regional and state agencies, and special surveys.

2.1 Roadway network characteristics are those physical attributes which are required to accurately analyze roadway capacity and adequacy. Examples of these data include:

- Number of travel lanes and direction of flow;
- Lane and shoulder widths;
- Curb cut inventory;
- Traffic operating speeds and speed limits;
- **Roadway geometry** - sharp grades or curves;(1)
- **Traffic control devices** - location and type of operation;
- Location and type of bus stops;
- Available **sight distances;**
- Pavement, sidewalk, and curb condition;
- Traffic related accident experience;
- On-street and off-street parking regulations and availability; and,
- Other physical features.

(1) Throughout this text technical words or phrases having special significance are printed in bold type, and are defined in Appendix D.

Existing information from local and state traffic engineering divisions should be collected and authenticated by investigations of the site and surrounding areas.

2.2 Traffic volumes are a measure, or count, of moving vehicles per unit of time. Where recent existing volume data within the last two years or less are not available, or at locations experiencing rapid change, special surveys are usually conducted. These should be undertaken during the periods when the greatest traffic volumes are expected on the roadways adjacent to the site and leading to/from the proposed land use. These busiest periods, or **peak hours,** may not coincide.

To assess roadway adequacy the period to be considered is the **design hour** -- the largest total hourly volume experienced on a "typical day" on the adjacent roadway. For example, as shown in the following table, the busiest weekday traffic hour of a shopping center may occur between 7:00-8:00 P.M., while the traffic on the adjacent highway may peak at 4:30-5:30 P.M. The design hour is determined by contrasting the total traffic volumes due both to highway and shopping center activity for the 7:00-8:00 P.M. and 4:30-5:30 P.M. periods. The most critical in terms of **roadway adequacy,** is considered the weekday design hour.

When planning major new roadway facilities, state and municipal agencies employ a **Design Hour Volume** (DHV) representing the **30**th **highest hourly volume** experienced during a year. As these agencies may be considering future planning horizons of 20 years or longer, this DHV is appropriate. For site developments, where the planning horizon is typically five years or less, a design hour reflecting a typical **peak design hour,** as described above, is more appropriate.

Average Daily Traffic (ADT) may be required to compare existing and future traffic flows. Daily highway or site traffic volumes are not used in determining the adequacy of a roadway system, however.

Hourly Variations - Traffic volumes vary throughout the day, with surges occurring in one, two or three peak hours. These variation patterns are relatively consistent throughout the week, with different characteristics exhibited on weekends. A comparison of daily traffic volumes from successive years provides an indication of traffic growth patterns and rates in the study area.

TYPICAL PEAK FLOW PERIODS FOR SELECTED LAND USES

RESIDENTIAL	7:00-9:00 A.M. Weekdays 4:00-6:00 P.M. Weekdays
SHOPPING	7:00-9:00 P.M. Weekdays 12:00-4:00 P.M. Weekends
OFFICE	7:00-9:00 A.M. Weekdays 4:00-6:00 P.M. Weekdays
INDUSTRIAL	Varies With Employee Shift Schedule
RECREATIONAL	Varies With Type Of Activity

Directional Variations - Consistent variations in directional traffic flow are common during peak hours due primarily to commuting patterns --that is from home to work in the A.M., and back home in the P.M. Other factors creating directional variations relate to heavy shopping days, holidays, and special events.

Daily Variations - Variations in traffic volumes occur between days of the week. Volumes observed on Tuesdays, Wednesdays, and Thursdays are considered representative of local weekday traffic patterns, as they avoid the impact of weekend or extended weekends which influence the other four days. Similarly, volumes occurring on weekdays preceding or following holidays are not considered typical of area traffic flows.

Seasonal Variations - Variations in traffic volumes on a seasonal basis are due largely to significant changes in travel patterns, such as pre-Christmas, shopping and vacation periods. By gathering traffic volumes every day of the year using permanent counters embedded in the roadway, state organizations determine the ADT or **Annual Average Daily Traffic** (AADT) volume on various roadway categories (e.g., arterials, local roads, interstate highways and expressways). Using data gathered at many locations, the relationship between volumes occurring on any day of the year and the ADT and DHV volume can be established, and seasonal adjustments derived. Thus, traffic volumes recorded on any day can be factored to represent the activity on an average day. It should be noted that while daily volumes fluctuate significantly, weekday peak-hour volumes are fairly consistent throughout the year, and thus are not modified on a seasonal basis.

Traffic Count Validity-Manual traffic counts detailing turning movements and lane volumes are usually conducted for a two-to-four hour period spanning the expected peak traffic hours. If conducted on a typical day, this is considered a representative and valid counting period. Extensive research by traffic engineers has shown this to be a reliable method. Holidays, adverse weather conditions, construction and abnormal events preclude collection of representative traffic volume data. If adequate data describing historical daily and hourly variations are available, shorter counting periods can be used and factored to indicate a representative peak hour. For example, when a counting program is conducted over a large area, such as an entire city or along an arterial route, it is possible to conduct 30, 15, or 5-minute sample counts, every 2 hours, 1 hour, or 15-minutes, respectively, at intersections while continuous volume counts are gathered at an adjacent control station. Using data from the control station, the sample counts can be reliably adjusted to reflect the peak hour.

Machines are usually used to obtain all day counts, but normally cannot record vehicle turning movements or classify vehicle type. All day counts can be used to determine when the peak period occurs, and relationships between the peak 15-minutes, the peak hour, and the daily volumes at a given location. Thus, peak-hour data can be estimated from available ADT data, if these relationships have been pre-measured in the vicinity of the site.

2.3 Planned improvements by others include scheduled or proposed roadway, intersection, and/or signal improvements in the vicinity of the site. When implemented, these should have a significant favorable impact upon the movement of traffic to or from the site. Available details describing planned improvements, to be implemented prior to or immediately after project completion, should be presented in the report. These details include:

- Type of improvement;
- Size and extent of the improvement;
- Location of the improvement;
- Traffic analysis and data prepared for improvements; and,
- Anticipated implementation schedule.

These details can have a significant impact on the adequacy of the roadway system and the travel routes used by site traffic. Regional, local, and state transportation planning officials should be contacted to determine the scheduled roadway improvements in the site environs.

3.0 ROADWAY ADEQUACY

Roadway adequacy reflects the ability of a roadway network to accommodate an anticipated volume of traffic. Such an assessment forms the heart of a traffic impact study. It normally consists of comparing the **capacity** of the road with the existing or anticipated future **volumes.** Volume/capacity ratios reflect the proportion of the total capacity that is actually utilized. These ratios, in turn, define **levels of service** (LOS).

Other factors may also affect the adequacy of a roadway system. These include its clarity and continuity, operating speeds, and accident patterns. These too, should be considered. Accordingly, this part of the report includes:

- 3.1 - Levels of Service;
- 3.2 - Capacity Analysis Methodology Process; and,
- 3.3 - Other Measures of Roadway Adequacy.

An evaluation of the adequacy of the roads in the vicinity of the site should be prepared for three conditions:

- Existing peak-hour traffic volumes;
- Design year peak-hour traffic volumes without site traffic; and,
- Design year peak-hour traffic volumes with site traffic.

The analysis process leading to the forecast of design year volumes is presented later in this Section.

3.1 Level of service reflects driver satisfaction with a number of factors that influence the degree of traffic congestion. These factors include speed and travel time, traffic interruption, freedom to maneuver, safety, driving comfort and convenience, and delays. Transportation professionals utilize six levels of service to describe traffic flow conditions. Commonly accepted definitions for each category are presented and illustrated on the following page. The six levels, and their uses are:

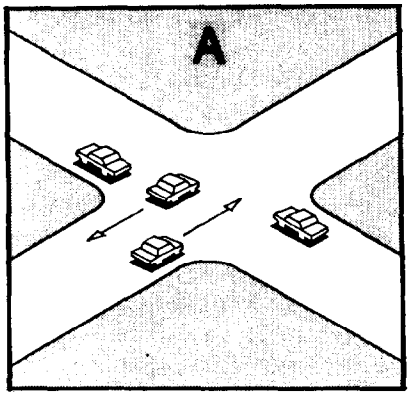
- LOS A, the highest level, describes a condition of free flow, with low volumes and high speeds with little or no delay. There is little or no restriction in maneuverability due to the presence of other vehicles. Drivers can maintain their desired speeds and can proceed through signals without having to wait unnecessarily;
- LOS B, affording above average conditions, is typically accepted for design of rural highways;
- LOS C is normally utilized as a measure of "average conditions" for design of facilities in suburban and urban locations. It is also considered acceptable in rural locations;
- LOS D, considered acceptable during short periods of time, is often used in large urban areas;
- LOS E represents the actual capacity of a roadway; and,
- LOS F is described as forced flow and is characterized by demand volumes greater than the roadway capacity as complete congestion occurs and, in an extreme case, the volume passing a given point drops to zero. Under these conditions motorists seek other routes in order to bypass congestion, thus impacting adjacent streets.

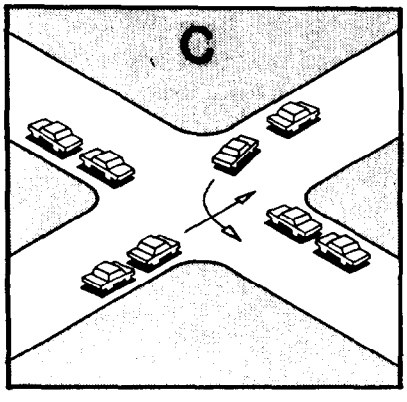
Definitions of service levels differ for intersections and roadway segments, for city streets, and for controlled access highways. In urban and suburban areas, where intersections are closely spaced, traffic signals usually govern arterial and street capacity. Thus, in an urban or suburban location roadway adequacy is assessed at intersections as part of a traffic impact analysis.

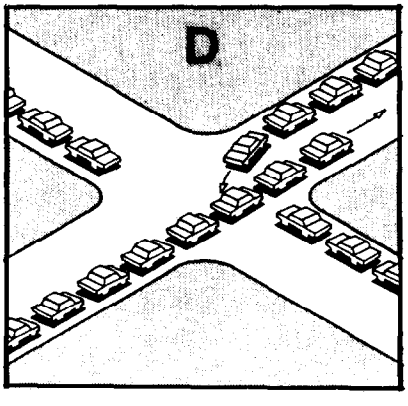
LEVEL OF SERVICE DEFINITIONS

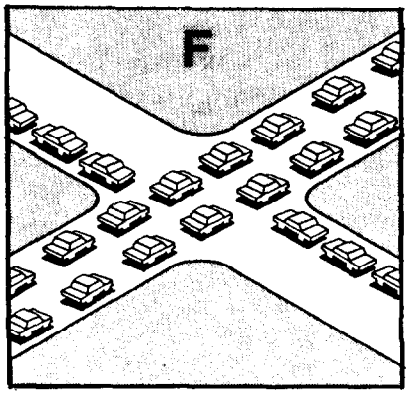
L.O.S.	ROADWAY SEGMENTS OR CONTROLLED ACCESS HIGHWAYS	INTERSECTIONS
A	Free flow, low traffic density.	No vehicle waits longer than one signal indication.
B	Delay is not unreasonable, stable traffic flow.	On a rare occasion motorists wait through more than one signal indication.
C	Stable condition, movements somewhat restricted due to higher volumes, but not objectionable for motorists.	Intermittently drivers wait through more than one signal indication, and occasionally backups may develop behind left turning vehicles, traffic flow still stable and acceptable.
D	Movements more restricted, queues and delays may occur during short peaks, but lower demands occur often enough to permit clearing, thus preventing excessive backups.	Delays at intersections may become extensive with some, especially left-turning vehicles waiting two or more signal indications, but enough cycles with lower demand occur to permit periodic clearance, thus preventing excessive back-ups.
E	Actual capacity of the roadway involves delay to all motorists due to congestion.	Very long queues may create lengthy delays, especially for left turning vehicles.
F	Forced flow with demand volumes greater than capacity resulting in complete congestion. Volumes drop to zero in extreme cases.	Backups from locations downstream restrict or prevent movement of vehicles out of approach creating a storage area during part or all of an hour.

SOURCE: A Policy on Design of Design of Urban Highways and Arterial Streets - AASHTO, 1973 based upon material published in Highway Capacity Manual, National Academy of Sciences, 1965.









The level of service determination is a quantitative assessment of a qualitative matter and thus is subject to variations in perception. It is an average value reflecting traffic conditions over some time period; usually the peak 15-minutes, whereas motorists encounter an intersection only momentarily. This momentary encounter forms their impression of level of service which may be better or worse than the technical assessment of conditions.

3.2 Capacity analysis methodology is the procedure employed by traffic and transportation professionals for determining level of service. In Connecticut, the Department of Transportation (ConnDOT) utilizes methods presented in the 1965 Highway Capacity Manual, published by the National Academy of Sciences, Transportation Research Board and Intersection Capacity Analysis Charts and Procedures, published by the Traffic Institute, Northwestern University. These assess the capacity of a roadway or intersection in terms of vehicles per hour, volume/capacity ratios, and is often employed for detailed designs. However, a trend is emerging whereby critical lane analysis procedures are more commonly employed.

The critical lane analysis techniques for signalized and unsignalized intersections, described in the January, 1980 Interim Materials on Highway Capacity, Transportation Research Circular Number 212, are also widely used and accepted, especially where the operation of an intersection is being evaluated as part of a planning analysis. Each method is based on traffic volume/capacity relationships.

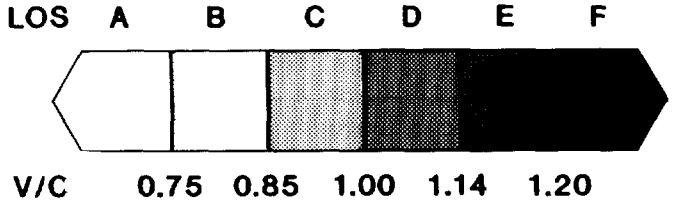
Factors affecting roadway capacity and levels of service include:

Roadway Segments
- Roadway types;
- Number of lanes;
- Width of lanes;
- Shoulder clearances;
- Alignment and grades;
- Traffic compositions;
- Average highway speeds;
- Passing sight distances; and,
- Geographical locations.

Intersections
- Travel lanes (or approach widths);
- Parking conditions;
- Turning movements patterns;
- Percentage of trucks and buses;
- Traffic signal operations;
- Geographical locations and adjacent land uses;
- Flow variations during the peak hours;
- Approach lane distributions;
- Pedestrians; and,
- Location of bus stops.

Typical roadway capacities are presented in terms of vehicles per lane per hour on non-signalized roadway segments and vehicles per lane per hour of **green time** at signalized locations. For LOS C on a one-way expressway segment, the maximum service volume--the volume unaffected by grades, proportion of trucks or buses, shoulder clearances, highway type or other factors--is 1,400 to 1,600 passenger cars per lane per hour. This range reflects possible flow variations within the peak period and the relative utilization of lanes on multilane facilities. The LOS E maximum service volume, or theoretical capacity, is about 2,000 passenger cars per lane per hour on a multilane expressway. On two-lane, two-way highways the areas available for passing, roadway grades and the proportion of bus and truck traffic influence service levels. The LOS C service volume for a two-lane, two-way highway, without signals, for both directions totals 1,400 passenger cars per hour. On a two-lane, two-way highway, the LOS E service volume represents a total of about 2,000 passenger cars per hour in both directions, if there is no passing. Existing research is suggesting up to 2,800 passenger cars per hour on two-way, two-lane roads, depending upon the directional distribution. At signalized intersections, where LOS C represents about 1,200 to 1,400 passenger cars per lane per hour of green time, capacity is influenced by the signal operation, and physical characteristics of the intersection approach among other factors. At signalized intersections, LOS E is about 1,650 to 1,800 passenger cars per lane per hour of effective green time.

Volume-to-Capacity Ratios are used on roadway segments and at intersections along with travel speed on roadway segments, to identify level of service. For each service level, the 1965 Highway Capacity Manual defines a range, bounded by V/C ratios, and travel speeds, where appropriate. Analysis techniques commonly used by traffic engineers employ a V/C ratio of 1.00 to represent LOS C. In these cases the "C" represents the service volume at LOS C and not the theoretical capacity--LOS E. Using a V/C of 1.00 to represent either LOS C or LOS E is acceptable as long as the selected base is used consistently and clearly indicated.



TYPICAL RELATIONSHIP BETWEEN V/C RATIO AND LEVELS OF SERVICE

The V/C ratios defining levels of service vary based on the type of roadway and intersection, and its configuration. The ranges shown above are typical, assuming a V/C ratio of 1.00 represents the upper boundary of LOS C.

3.3-Other measures of roadway adequacy, in some instances, may be necessary to present a clear indication of the anticipated impacts resulting from a project. These include:

- Accident and safety analyses;
- Pedestrian studies;
- Queueing analyses; and,
- Gap analyses.

Travel time and delay measurements, which are useful in traffic assignment procedures, are typically employed to contrast "before and after" conditions when evaluating traffic operations in central cities and along arterial routes. They are not usually used in traffic impact studies for land-use changes.

Accident analyses are conducted to ascertain causal relationships and to create measures to better protect the public. These would be required within site study reports at locations which are known or suspected to have high accident rates. Types of information used in accident analyses include:

- Location of accident;
- Type of accident;
- Number of accidents with injuries or fatalities;
- Time of accident;
- Driver characteristics;
- Vehicle characteristics;
- Extent of vehicular damages;
- Location and description of traffic control devices;
- Regulations in force;
- Roadway and weather conditions;
- Possible violations; and,
- Probable causes.

Pedestrian studies and analyses of pedestrian movements are conducted to:

- Increase pedestrian safety;
- Reduce pedestrian-vehicle conflicts;
- Minimize vehicle delays; and,
- Establish the need for pedestrian crosswalks or pedestrian signals.

Facilities that generate, or are near high volume pedestrian generators, such as schools or hospitals, may require pedestrian studies. Projects which involve persons with transportation handicaps, such as nursing or convalescent homes, or senior citizen housing projects, may require special consideration for pedestrian crossings.

Queue analysis is a possible, but lesser used, measure of traffic performance at non-signalized and signalized intersections, merge and access points. Within traffic impact study reports, queueing studies are most commonly performed at signalized and non-signalized intersections. Queueing analyses are useful in determining the required lengths of left-turn storage lanes, the stacking area at drive-in windows and parking facility entrances, and other instances where queues of vehicles are expected to form. Analyses of these queues

can assure that vehicle backups do not interrupt adjacent traffic flows. Additionally, where a roadway is operating at an unsatisfactory service level, queue lengths provide a readily visualized measure of the existing or expected conditions, and give an appreciation of the unsatisfied demand.

Gap analyses, another measure of adequacy applicable in selected instances, observe the number and length of headways or gaps between moving vehicles. The frequency, or availability, of acceptable gaps is important in determining the need for various traffic control devices. For example, side street traffic controlled by a STOP sign entering a major street will be delayed unnecessarily if the gaps on the main street flow are insufficient in frequency or duration to permit vehicles to enter. **Gaps** are measured by timing the distance between the arrival of the front end and rear end of successive vehicles at a given point. The length of gap considered acceptable by a driver is a function of:

- STOP vs YIELD sign control;
- Type of vehicle maneuver;
- Number of lanes on major road; and,
- Prevailing speeds.

For example, for entering traffic controlled by a STOP sign at a two-lane major road, drivers will accept a minimum of a 7.0-second gap if the prevailing speed is 30 mph, while an 8.0-second gap is required at 55 mph. Depending on the situation, acceptable gaps vary from 5 to 10 seconds.

The number of acceptable gaps in a traffic stream is proportional to the traffic volume and any downstream metering by signals or other control devices. As the number of available gaps decreases, the time a vehicle will have to wait in order to enter the traffic stream increases. While there is no standard as to length of reasonable or acceptable waiting time, unsignalized intersection approaches have a potential capacity of between 600 to 1,000 passenger cars per lane per hour, depending on length of the acceptable gap, and the flow of cross traffic on the major street.

4.0 SITE GENERATED AND FUTURE TRAFFIC

A forecast of traffic generated by the proposed project is required to properly assess traffic impacts. The process of developing site-generated traffic volumes consists of:

- 4.1 - **Trip generation** - projecting the total volume of site generated trips;
- 4.2 - **Trip distribution** - estimating the approach/departure direction site vehicles will use;
- 4.3 - **Trip assignment** - determining the specific routes and streets which site traffic will follow; and,
- 4.4 - **Future traffic conditions** - superimposing site generated traffic upon the anticipted future traffic expected to occur without the proposed land-use change - resulting in the combined volumes.

The combined future volumes, reflecting projected traffic activity with site development, are compared with the available roadway capacity to indicate roadway adequacy and the traffic impact.

4.1 Trip generation is the process of estimating the volume of trips going to or leaving the development. Trip generation varies with the type of land use proposed. Factors considered include:

- Size of development;
- Parking availability;
- Development characteristics;
- Amenities provided;
- Location of facility;
- Access considerations;
- Modal choice; and,
- Peaking characteristics.

Trips are generated using rates of trips per unit of measurement (e.g., trips per dwelling unit or square feet of office) observed at existing similar facilities. These rates are used to directly project the number of trips which can be expected during a typical suc-

cessful day or given hour based on the size of the facility, its location, and the type of use anticipated.

A widely accepted source of trip generation rates is the Institute of Transportation Engineers (ITE) Trip Generation Guide. Sample trip generation rates from this source are presented in the following table, while other sources are presented in the Bibliography. In addition, local traffic engineers may have recent trip generation rate data for existing facilities in their area, which could be relied upon for the development of traffic estimates for similar type and size projects in the same area. For example, ConnDOT has published trip generation data based upon staff observations. In some areas or for certain unusual projects, these trip generation rates must be modified to reflect a greater proportion of persons arriving as pedestrians, or via transit or ridesharing.

TRIP GENERATION RATE SUMMARY

LAND USE	TRIPS PER:(1)	TYPICAL VEHICLE TRIP GENERATION RATES: Average Weekday (In and Out)	A.M. Peak Hour (In and Out)(2)	P.M. Peak Hour (In and Out)(2)	Peak Hour of Generator (In and Out)
Residential					
Single Family	D.U.	10.0	0.8	1.0	1.0
Apartment	D.U.	6.1	0.5	0.7	0.7
Condominium	D.U.	5.2	0.4	0.5	0.5
Retail					
Neighborhood Shop. Ctr.	1,000 GLA	66.7	1.7	5.9	6.6
Community Shop. Ctr.	1,000 GLA	41.9	2.3	5.5	4.8
Regional Shop. Ctr.	1,000 GLA	37.2	0.6	3.1	3.8
Supermarket	1,000 GBA	125.5	0.5	8.8	15.7
Restaurant (excludes drive-ins)	1,000 GBA	74.9	1.0	6.1	10.4
Hotel	Room	10.5	0.9	0.7	0.9
Office					
General	1,000 GBA	12.3	2.3	2.2	2.3
Medical	1,000 GBA	54.6	0.9	3.9	5.3
Industrial					
General	1,000 GBA	5.4	0.9	1.1	1.0
Industrial Park	1,000 GBA	7.0	0.9	1.0	1.0
Manufacturing	1,000 GBA	3.9	0.8	0.8	0.8
Medical Care					
Hospital	Bed	11.4	1.0	1.2	1.4
Nursing Home	Bed	2.6	0.1	0.2	0.4
Other					
Drive-In Bank	1,000 GBA	192.0	5.4	25.3	28.4
Walk-In Bank	1,000 GBA	169.0	4.4	16.7	35.8

(1) D.U. = Dwelling Unit, GLA = Gross Leaseable Area (square feet), GBA = Gross Building Area (square feet), NSF = Net Square Feet, typically about 85 percent of the gross building area.
(2) These rates represent the volumes expected to occur during the typical peak commuter hours (7:00-9:00 A.M.) and (4:00-6:00 P.M.). Many land uses exhibit peak hours outside these periods.
SOURCE: Trip Generation, 3rd Edition, Institute of Transportation Engineers, 1983.

Other methods - In certain instances, where the type or character of a proposed land use is unique, existing trip generation rates may not be available or appropriate. For example, trip generation rates for museums are not included in the Guide. These rates are not readily available, since museums vary significantly--a local museum of history, a children's science museum and a nationally recognized primary destination--such as the Baseball Hall of Fame, would all be expected to exhibit different trip generation characteristics and rates. In these instances, trip generation rates can be estimated using other data to project the number of person trips which will be made to and from a facility, based on its size, location, and use. These person trips can be converted to vehicle trips taking into consideration expected modes of travel (transit ridership and walking), vehicle occupancy and other data.

The process of generating trips using both the ITE Guide or the second procedure for a 180,000-square foot office are illustrated below.

Exceptions - The volumes resulting from the ITE Guide or other procedures may not always represent the additional traffic on the adjacent streets due to the proposed land use. This may be true at multi-use developments or certain convenience markets, for example. In multi-use projects containing several land uses, such as a combined retail-office development, the number of vehicle trips expected is less than the total which occurs from each land use, if they were located on isolated sites. This is due to on-site pedestrian activity between land uses and a single vehicle trip serving several purposes. There is insufficient data available to quantify the extent of this vehicle trip reduction on a general basis, as it varies depending on land uses and locations.

- USING ITE TRIP GENERATION GUIDE

  1. From Guide: "1.87 entering vehicle trips per 1,000 gross square feet of building area, during A.M. peak hour."

  2. A.M. Peak Hour Entering Traffic = 180,000 x $\frac{1.87}{1{,}000}$ = 336.6, say 335 entering vehicles. (rounded to the nearest five vehicles)

- USING OTHER DATA
  (Assumes trip generation rates not available or not applicable).

  1. Peak Hour Vehicle Trips = Land Use x Expected Persons per Area x Absenteeism x Peak Hour Factor x Mode Choice x Vehicle Occupancy.

  2. Peak Hour Vehicle Trips =
     180,000-square feet x 3.5 employees/1,000 square feet
     x 90 % (10% absenteeism due to illness, vacation, travel away from office)
     x 85% (proportion entering during peak hour)
     x 85% (by private auto)
     x 1 vehicle/1.2 persons (carpooling
     = 341 entering vehicles, or 340 (rounded to the nearest five vehicles)

NOTE: Typically, these values would be estimated in cooperation with the owner, developer, or the specific requirements of the local review agency.

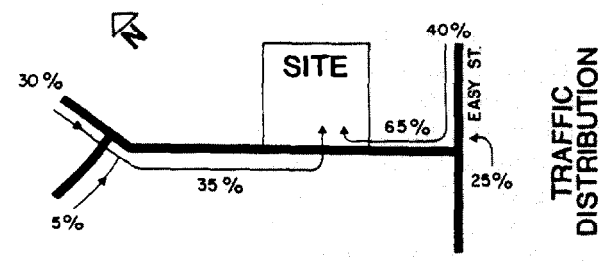
A reduction in external volumes also occurs when a proposed land use is expected to attract patrons from existing traffic passing the site. For example, some persons traveling to a more distant convenience market passing the site may divert to the closer store once it is open. As entering vehicles will include some existing highway traffic, it is not appropriate, in this instance, to sum both highway and site traffic in order to estimate the total combined traffic volume. Only limited data are available quantifying this reduction, which is generally less than 20 percent, for such generators as some retail facilities, certain restaurants, banks, service stations, and convenience markets.

In summary, a large part of estimating trip generation is based on professional judgment and requires an understanding of the type of activities which will occur at the site.

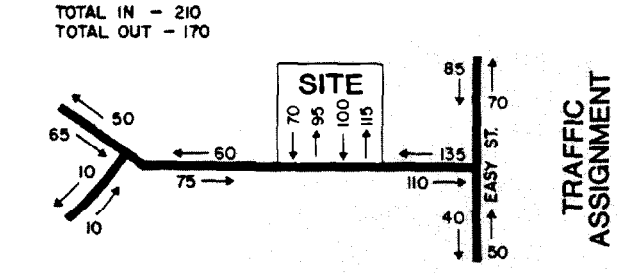
4.2 Trip distribution is an estimate of the approach direction to the site of the estimated trips. Vehicles are distributed among the appropriate approach directions. The end product is X% from the north , Y% from the east, etc. Basic data used to establish directional approach to the site include:

- Surveys of similar nearby projects and existing travel patterns;
- Available employee data from census, planning agencies, employers, etc.;
- Market surveys indicating the sources of potential patrons; and,
- Local population and employment information.

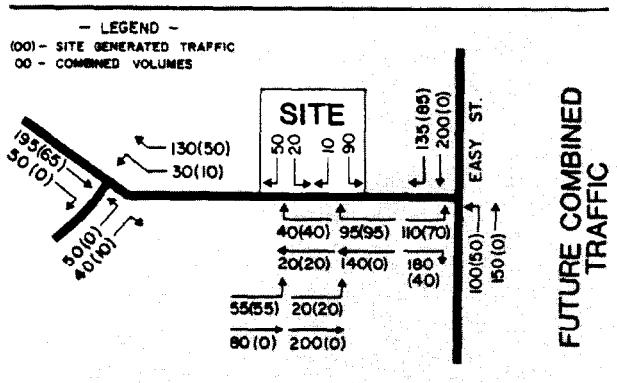
For typical projects, the routing of trips can be established by **origin-destination** patterns at similar nearby projects or proportional distribution of trips or population based on existing or future concentrations of trip origins. For example, the population distribution within 20 miles of an office can be used to derive a trip distribution pattern of employees traveling to and from the office. This assumes that future employees will reside in a pattern comparable to the existing population. Judgment is necessary when estimating how far employees will travel and whether their characteristics will be similar to the existing population. This effort results in the development of site approach and departure distributions, as illustrated below.



ANTICIPATED
SITE TRAFFIC APPROACH DISTRIBUTION



ANTICIPATED
A.M. PEAK HOUR SITE TRAFFIC VOLUMES



ANTICIPATED
COMBINED A.M. PEAK HOUR TRAFFIC VOLUMES
(8:00 - 9:00 A.M.)

4.3 Trip assignment is the actual assignment of vehicle trips to the individual segments of the roadway network. It is the final phase in the generation of site traffic demand. The traffic assignment process uses the trip generation and trip distribution data to place vehicle trips on surrounding roadways. For example, the proportion of vehicles approaching from the north are assigned to specific streets and travel routes. Assumptions are made regarding travel distance and time, costs, safety and travel delays, and reflecting planned driveway or access points.

It is common in the assignment process to assume trips will be made via the shortest or fastest route, minimizing cost and maximizing safety. Vehicles are assigned to the network using these assumptions. Adjustments are then made to the assignment recognizing local traffic patterns and using sound engineering judgment. Known committed roadway improvements, especially those on the surrounding network, are also important inputs in assigning traffic.

The **area of influence** is the roadway network section impacted by the proposed land use to the extent that a traffic impact analysis is justified. A small traffic generator project necessitates a smaller analysis area than a major traffic generating development. However, there are many other factors including degree of change which determine the limits of the area of influence. Accordingly, the study analysis limits are generally based upon professional judgment and discussions between the reviewing agency and the applicant, reflecting the anticipated degree of change on the adjacent roadways. The matrix, shown below, provides a conceptual basis of relating degree of change and volume of traffic generated to the area of influence.

GENERALIZED GUIDELINE FOR ESTABLISHING TRAFFIC AREAS OF INFLUENCE OF A NEW PROJECT

	ANTICIPATED SITE TRAFFIC AS PERCENT OF HIGHWAY TRAFFIC			
PROJECT LOCATION	Less Than 1 %	1-5%	5-10%	More Than 10%
Rural	Site Entrance	Nearest Intersection	Nearest Major Intersection	Nearest Arterial/ or 2-3 Intersections
Suburban	Site Entrance	Nearest Signalized Intersection	Nearest Major Intersection	Nearest Major Arterial/Interstate
Outlying Business District	Site Entrance	Nearest Intersection	Nearest Major Arterial	Nearest Arterial
Central Business District	Site Entrance	Nearest Intersection	1-2 Blocks	Nearest Arterial

SOURCE: Wilbur Smith and Associates.

4.4 Future traffic conditions are represented by the anticipated volume of vehicular traffic on the adjacent roadway network. Forecasts of the future conditions consist of two elements:

- Projected future traffic by itself (e.g., if no development were to occur); and,
- Projected future traffic combined with site-generated traffic.

For projects expected to be completed within a 5 to 10-year period, the initial step is to establish a growth rate which can be applied to existing traffic volumes to project design year traffic. The design year is usually considered to be the first full year of operation after completion of project construction. For longer range forecasts, more sophisticated traffic projection procedures are commonly employed. The application of the anticipated growth rate to existing traffic volumes results in future peak-hour traffic volumes without the site traffic. The future traffic volumes are considered as base future conditions.

Traffic from other land-use changes impacting the roadways serving the site--either approved, pending, or under construction--should be reflected in projections of future base conditions. It is not reasonable to include traffic which may be generated by adjacent, but yet undeveloped, parcels where development plans have not been scheduled. It is the municipality's responsibility to coordinate overall land-use intensity with roadway adequacy by undertaking traffic and land-use coordination studies, similar to the examples presented in Section 3. Values frequently used in developing a growth rate include:

- Population-income-employment growth;
- Historical traffic volume growth;
- Traffic projections prepared as part of known planned roadway improvements; and,
- Long range regionwide transportation and/or land-use studies, which can be obtained from state or regional agencies.

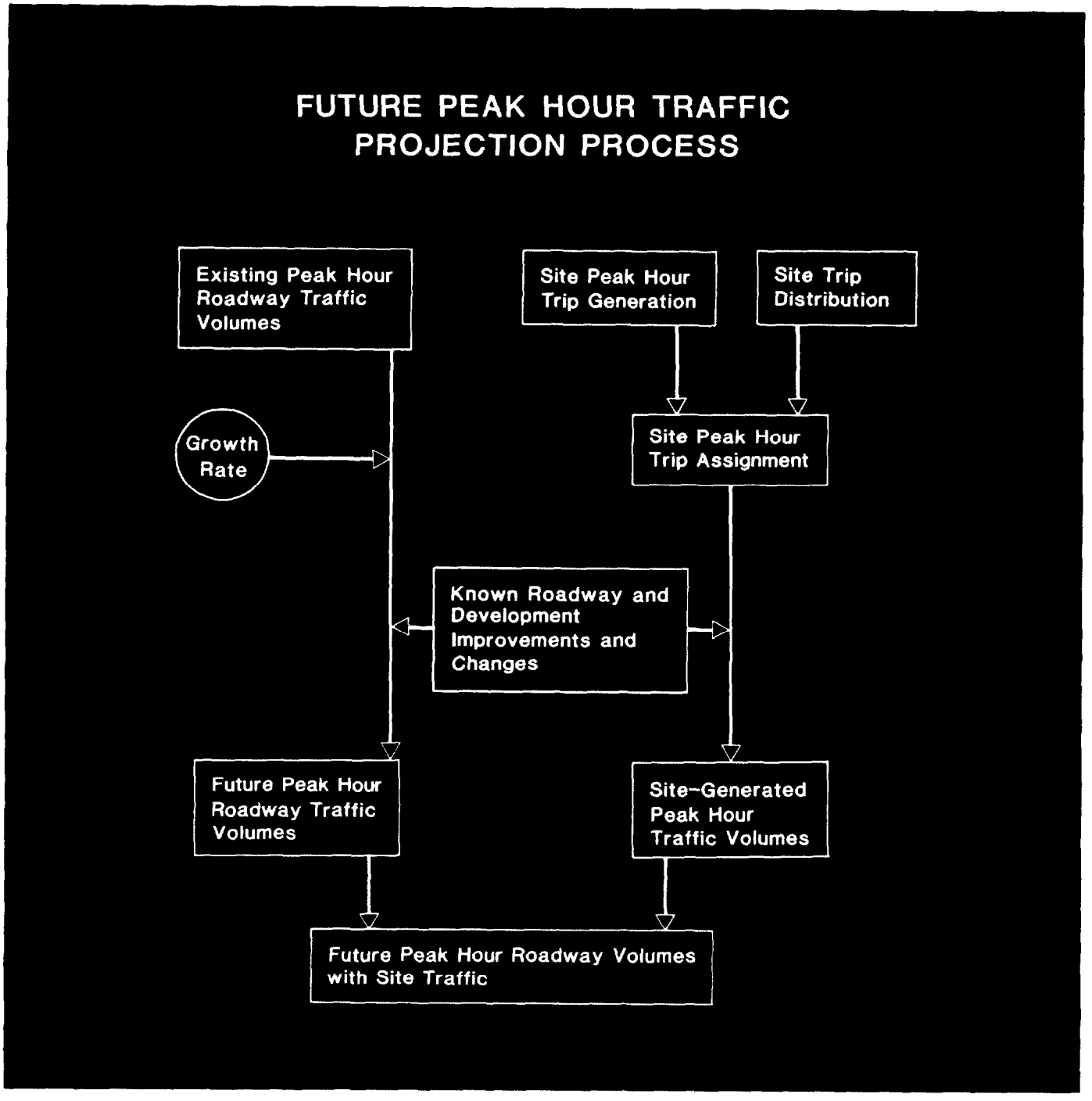
The last step in estimating future conditions is superimposing peak-hour, site-generated traffic on the future base traffic volumes. This creates the anticipated peak-hour future combined traffic volumes. These future volumes are compared with the roadway capacity to determine the adequacy of the system and the relative impact of the proposed land-use change. The process for developing future peak-hour roadway traffic volumes is illustrated on the next page.

5.0 PROJECT ASSESSMENT

- 5.1 - Recommended Improvements;
- 5.2 - Examples of Improvements Funding;
- 5.3 - On-Site Circulation Adequacy; and,
- 5.4 - Parking.

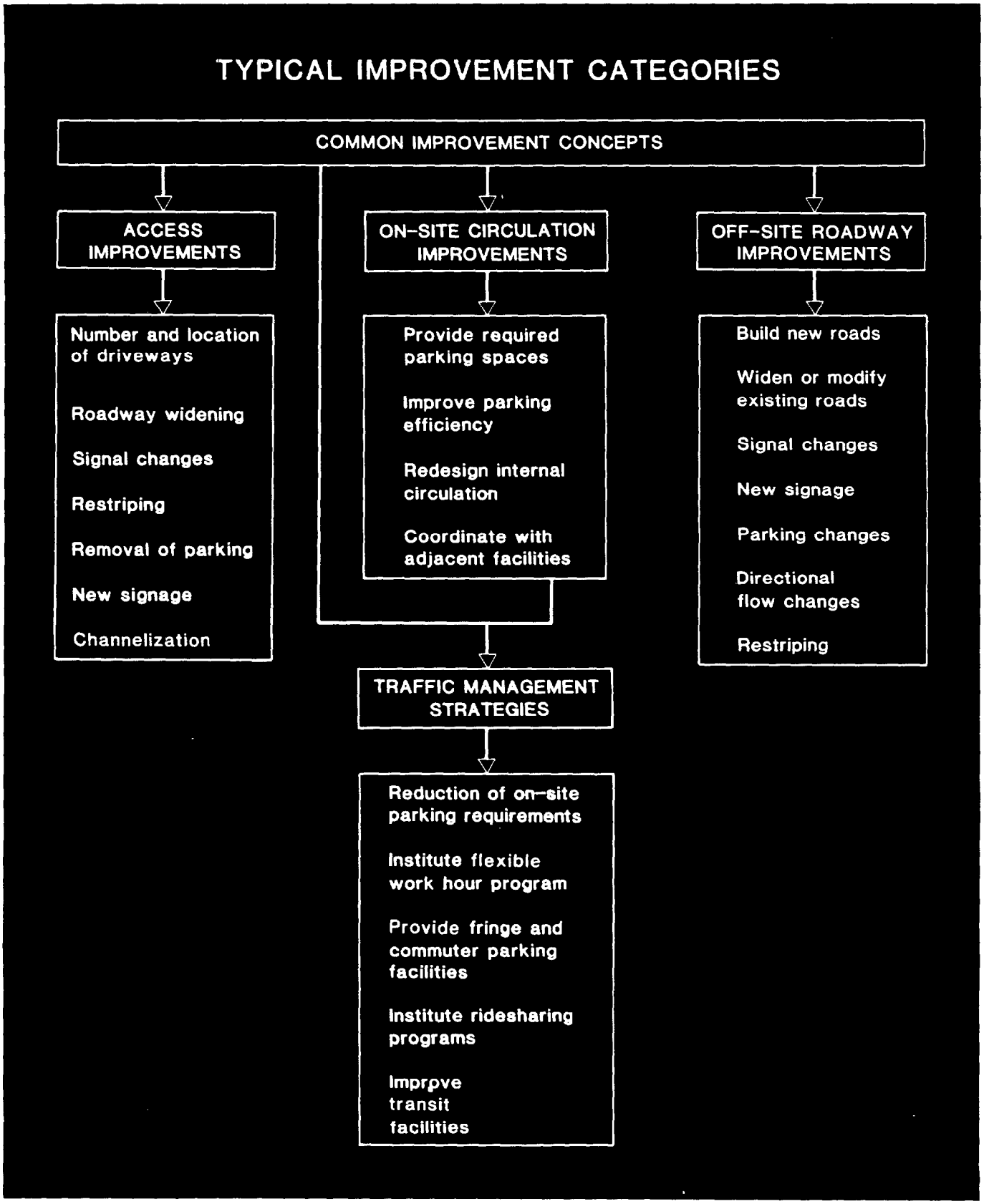
5.1 Recommended improvements vary significantly as they relate to the project's scale and roadway adequacy. Suggested improvements may be incorporated, if necessary, to provide acceptable levels of service, safe traffic operations, and efficient traffic flow. If improvements are recommended, future service levels should be evaluated with the proposed modifications in place. Among those often proposed include:

- Installing new, or modifying existing, traffic control signals;
- Providing exclusive turn lanes;
- Clearing sight lines for motorists;
- Increasing curb radii, or modifying existing traffic islands;
- Increasing the number or width of travel lanes by roadway widening, or other means; and/or,
- Altering travel direction, turning movements, or on-street parking regulations.



Other improvements, which are sometimes incorporated in the planning of a site development include promoting transit and ridesharing, flexible or staggered employee work hours, and other transportation management options to reduce traffic demands and the resulting impacts.

To assure traffic signals and STOP signs are installed only where necessary, a series of **warrants** have been developed and accepted. For state approval, a signal must meet one of the warrants presented in the Manual of Uniform Traffic Control Devices, a summary of which is presented in the following table. The


TYPICAL IMPROVEMENT CATEGORIES
COMMON IMPROVEMENT CONCEPTS
ACCESS IMPROVEMENTS
ON-SITE CIRCULATION IMPROVEMENTS
OFF-SITE ROADWAY IMPROVEMENTS
Number and location of driveways
Roadway widening
Signal changes
Restriping
Removal of parking
New signage
Channelization
Provide required parking spaces
Improve parking efficiency
Redesign internal circulation
Coordinate with adjacent facilities
Build new roads
Widen or modify existing roads
Signal changes
New signage
Parking changes
Directional flow changes
Restriping
TRAFFIC MANAGEMENT STRATEGIES
Reduction of on-site parking requirements
Institute flexible work hour program
Provide fringe and commuter parking facilities
Institute ridesharing programs
Improve transit facilities

TRAFFIC CONTROL SIGNAL WARRANTS

WARRANT	BOTH APPROACHES OF MAJOR STREET (1) (vehicles/hour for 8 hours)	HIGHER VOLUME APPROACH OF MINOR STREET (1) (vehicles/hour for 8 hours)
1. Minimum Vehicular Volume (depends on number of lanes)	500 to 600	150 to 200
2. Interruption of Continuous Traffic (depends on number of lanes)	750 to 900	75 to 100
3. Minimum Pedestrians	600 or more plus 150 or more pedestrians crossing streets	--
4. School Crossing	insufficient number of adequate gaps to allow children to cross	--
5. Progressive Movement	to maintain proper vehicle grouping between successive signals	--
6. Accident Experience	five or more accidents susceptible to correction by signal control within a 12-month period	--
7. Systems - two major street	800	--
8. Combination	80 percent of two of the first three warrants	--

(1) Need not be eight consecutive hours, but must represent the same hours for the major and minor streets.

SOURCE: Adapted from Manual of Uniform Traffic Control Devices, 1978.

technical definition of each warrant in the Manual provides some exceptions, such as when traffic speeds exceed 40 mph. These are more precisely explained in the Manual than in the following summary.

5.2 Improvement funding will vary depending upon the scale and type of project. On-site improvement costs are the responsibility of the developer, while off-site costs are often mutually absorbed by the developer and public sector in a variety of ways depending on the development and its perceived value to the community. For example:

- **Project A** - All off-site roadway improvements, including two new expressway interchanges and required widening of local streets, were funded by state and local governments for this project. The project involved the relocation of over 3,000 employees into an undeveloped section of Connecticut;

- **Project B** - As part of the zoning approval process for this new office building project, the owner and the state each agreed to fund half of all estimated off-site design and construction costs, with an agreed maximum limit as the owner's participation;

- **Project C** - The owner of a 200,000 square foot office building was required to fund, at his expense, widening of an adjacent roadway for a distance of approximately one-half mile, plus the cost of modifying an existing interchange;

- **Project D** - The developer of a regional shopping mall was required to construct a new grade-separated interchange, serving the mall; and,

- **Project E** - The developer of a regional shopping mall was required to pay a pro-rata share of the cost of 14 separate roadway improvements. His contribution was in proportion to the percent of the estimated mall traffic on each roadway segment, with his actual costs not determined until after subsequent bid taking.

At smaller projects, having less impact upon the community, it is typical for a developer to fund installation of a new or modified traffic signal, or minor roadway widening. In some instances, the state or local government may fund the entire roadway improvement. The process is often subject to negotiation.

5.3 On-site circulation adequacy should be discussed in the traffic impact study as it relates to the size of the project. For major projects with circulation roadway networks, the following issues should be considered:

1. Circulation within and to/from parking areas;
2. Off-street loading/unloading of goods and refuse;
3. Access for fire and emergency vehicles; and,
4. Pedestrian crossings of vehicle paths.

5.4 Parking analyses may be part of a site study report to determine the need for more parking or the adequacy of existing parking. Attention may focus on the adequacy of existing or proposed on-site parking to accommodate the anticipated site demand considering its location, land use and size.

On-site parking facilities should accommodate anticipated employee, visitor, and service vehicles. Space for off-street loading and unloading of deliveries, goods, and trash should be provided. In some locales, it may be appropriate to designate separate areas for parking compact cars or vehicles used by ride-sharing groups.

The procedures to limit traffic congestion described in this Section are typically employed in response to a specific land-use change or development. Other procedures are available to limit congestion in anticipation of possible future land-use changes. These techniques are described in the next Section.

Section 3
Administrative Tools to Avoid Congestion

1.0 Authority of the State and Localities

Both the municipalities and the State of Connecticut have the authority to regulate traffic generators and control traffic management systems. Although there are overlapping features of state and local authority as well as differences in approach, the two levels can complement each other--working toward the goal of congestion avoidance.

State and local traffic authorities address safety and convenience features of traffic on the street. Highway and public works agencies have responsibilities for travelways, structures, drainage and rights-of-way. Planning and zoning commissions are an important part of the team. All would use the appropriate traffic analysis procedures described in Section 2 as a basis for administrative tools reviewed in this Section. This Section describes the authority of the state and localities with respect to traffic planning (1.0); local zoning administrative procedures to limit traffic congestion (2.0); and, long-range planning tools successfully employed in other communities for congestion avoidance (3.0).

1.0 AUTHORITY OF THE STATE AND LOCALITIES

To regulate traffic safety and congestion issues related to proposed land-use changes the State of Connecticut utilizes permitting procedures for major traffic generators and encroachment on state highways, while individual municipalities in the state have a local traffic authority whose responsibilities include traffic regulation.

1.1 Major Traffic Generators - In 1951 the State of Connecticut passed a law establishing a permit system for major traffic generators--then visualized as open air theaters. The State Traffic Commission (STC), comprising the Commissioners of Transportation, Motor Vehicles and Public Health and Safety, administers the law which is now Sec. 14-311 of the Connecticut General Statutes. In essence, this statute states that no person or public agency shall build, expand, establish or operate any development generating large volumes of traffic, having an exit or entrance on, or abutting or adjoining any state highway or substantially affecting state highway traffic without obtaining from the STC a certificate that the facility will not imperil the public safety. Thus, the statute applies not only to developments having direct access onto a state highway, but also to those whose land abuts a state highway, and those that do not, but by the nature of their traffic, substantially affect state highway traffic.

Within the context of Sec. 14-311, generating large volumes of traffic is defined as providing 200 or more parking spaces. The STC reviews certificate applications and determines whether or not site access and/or off-site roadway improvements are required to mitigate any adverse traffic impacts resulting from a traffic generator. Any and all improvements required as a result of this review are to be borne by the applicant at no cost to the state or municipality.

Development projects requiring an STC Sec. 14-311 certificate today* are as follows:

- o any new land-use development providing 200 or more parking spaces;
- o any such existing development generating large volumes of traffic when there is to be an increase of 50 or more parking spaces;
- o change of use in existing structure substantially affecting state highway traffic; and,
- o other expansions to square footage of existing development, such as a fast-food restaurant, proposed to occupy a portion of an existing shopping center parking lot, even though total parking supply may actually decrease.

Under present procedures, the STC utilizes ConnDOT as an agency to assist in the review of certificate applications. Before construction begins, State Highway Encroachment Permit and/or a local driveway permit may also be needed.

*Amended 4/11/84 to include any development with a gross floor area of 100,000 sq. ft. or more.

Historically, however, the opportunities for the STC and ConnDOT to work with the municipality in determining the relative traffic impact of a development were not always fully realized. Therefore, effective October 1, 1983, the state passed Public Act 83-362 providing a better mechanism for encouraging the state and municipalities to work together in assessing such projects. Specifically, this new law states that no local building official is compelled by other codes and regulations, and shall not issue a building or foundation permit to any person or agency to build, expand, establish or operate a major traffic generator until the person or agency provides to the building official a copy of the STC Certificate, or a "negative" determination, indicating a certificate is not required. The law empowers the STC to have the building or operating of such a facility stopped immediately. This process seeks to assure that a municipality will not be burdened with undue traffic congestion and that the safety of the public will not be compromised.

The Sec. 14-311 process does not eliminate the responsibility of each municipality to review traffic impact of individual projects, but instead it offers safeguards, on the state level, to assure that a project plan is in the best interest of all highway users. In fact, the STC only takes action on an application after needed local planning and zoning approvals have been given. When the STC receives an application it acknowledges receipt in writing to the applicant. A copy of this acknowledgement is forwarded to the local traffic authority (LTA). Thus, the LTA, if concerned about a particular project, is in a position to provide advice on its merits to the STC.

During the course of the STC's review of an application a ConnDOT engineer, on behalf of the STC, makes contact locally to determine the status of planning or zoning action on the application. There is no standardized procedure as to which local body or staff person must be contacted in each town.

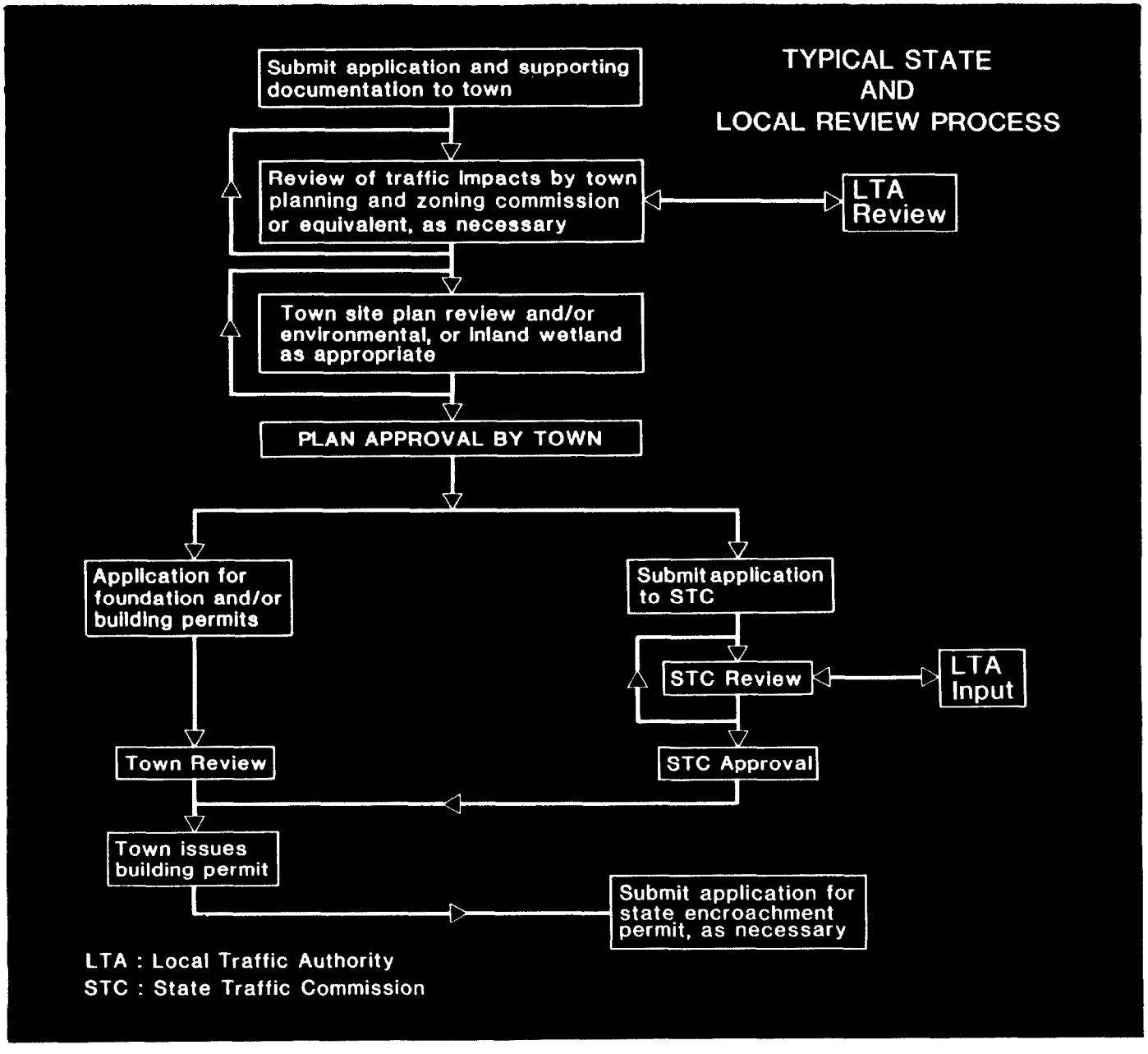
So that differences between local and state requirements for traffic, as well as related grading, signs and setbacks can be identified and resolved, local plannning and zoning agencies should seek to formalize with the STC an agreement as to which local staff person will be contacted. In this way, there will be created a communications mechanism by which issues involving local site approval requirements can be channeled to the STC. Local land-use boards should also keep the LTA informed of their views on traffic impacts so that the LTA can provide more valuable input to the STC.

One weakness of the existing state approval process is its inability to be aware of all developments and to require those that should do so to apply. Therefore, it is in the best interests of local land-use agencies to require certain applicants for local permits to provide evidence that they are seeking a state permit.

1.2 State of Connecticut—Encroachment Permit - Any land-use development project that requires the construction or modification of a driveway to a state highway, regardless of the number of parking spaces, must also have received a ConnDOT Encroachment Permit (Sec. 13a-143a, CGS). This is another state review/approval process designed to assure the proper design and implementation of such driveways and accompanying off-site improvements. A person or agency has to apply for this Encroachment Permit with a ConnDOT District Office upon completion of the design, but prior to construction of the facility.

Traffic impact and design issues, such as drainage, are reviewed by the district. For example, a developer moving a driveway, even when no expansion or new development is anticipated, must apply for and receive an Encroachment Permit prior to construction. Concurrently, the developer must supply a bond so that the state has the ability to implement and complete any and all improvements detailed in the permit. This is a further procedure to safeguard the public safety on the roadway systems of the state and one requiring coordination with local planning and zoning approvals.

1.3 Local Traffic Authorities - For each municipality in the state, a designated LTA has the legal responsibility for approving changes in traffic operations or reviewing proposals which may impact traffic flow. These may include posting new signs or markings on local streets, changing the direction of traffic flow, or land-use applications which could generate significant traffic volumes. Within the region the designated LTA is usually the first selectman, chief of police, or chairman of the police commission. In other communities, the city traffic engineer, or director of departments of transportation or traffic and parking may be designated. These individuals may seek technical assistance from the town engineer, traffic engineer, or traffic and safety division of the police department in order to analyze the need for traffic improvements or to review proposed land-use changes.



2.0 ZONING ADMINISTRATION

Local zoning regulations typically provide for a plot plan submission prior to authorization to build or to use land. The plot plan is an indicator of lot area, and compliance with front, side and rear yard requirements. Required plot plan information can also include driveway location as well as other features.

Two more comprehensive and useful techniques are often used for zoning administration for larger projects including those that may generate significant volumes of traffic. These are:

1. A site plan submission by the applicant, showing an array of details for buildings, parking, driveways, grading, drainage, landscaping and signs. This plan is usually required for commercial and industrial projects to demonstrate compliance with standards set forth in the zoning regulations (see Sec. 8-3g, CGS).

2. Application for a special permit or special exception for a use that is permitted in a zone, but having unusual characteristics, so that each case must be reviewed to determine compliance with criteria set forth in the zoning regulations (see Sec. 8-2, CGS). A full site plan submission may be required as part of the application, and this procedure is commonly applied to multiple dwellings, convalescent homes and institutions in residential zones.

A site plan submission is typically acted upon by vote of a zoning, planning or combined commission, as the regulations may specify. Authority to act on a site plan may otherwise be delegated to a municipal official such as in Ridgefield, where the planning director has this responsibility. A special permit or exception, however, is acted upon by the zoning, planning, or combined commission or zoning board of appeals, as the regulations may specify, and after notice and public hearing, as required by law. In either procedure, the submission requirements for plans and documents should be spelled out in adequate detail in the regulations, and sufficient standards and criteria, against which the submission is measured, must be specified. Traffic elements of local submission requirements should not only include proposals but related off-site features, such as inventory of nearby roadway conditions, traffic management concepts and curb cuts.

Significant traffic generators can have zoning review under either the site plan or special exception process. Based on legal precedent to date, the special permit/special exception method assures a wider area of discretion on the part of the local commission or board. Thresholds can be established whereby special traffic impact analysis is required and/or the special permit/special exception procedure is invoked, such as by size of a building, number of parking spaces and amount of trips generated. These thresholds can also be adjusted to the type of use and typical traffic generation factors for the use (see example concerning Danbury proposal).

This approach replaces the traditional number of parking spaces and square footage of floor area variables with trips per day as the criteria establishing the threshold for review. This variable could be superior to widely used square footage parameters because the latter do not make allowances for developments that are large in size but generate relatively few trips, such as warehouses, nor do they adequately address developments of relatively small size with the potential for generating lots of traffic, such as fast food establishments.

Zoning could also establish land use/traffic management districts, such as by overlay zones similar to a flood plain district. The overlay would identify a known problem area where new uses and projects meeting or exceeding a predetermined threshold would need, by site plan or special permit/special exception review, to demonstrate conformity to predetermined volume/capacity ratios and other predetermined criteria.

EXAMPLE: Danbury's zoning proposal would require a special exception for uses generating more than 500 vehicle trips per day, with typical thresholds as follows:

LAND USE	THRESHOLD (Facility Site at 500 Vehicle Trips Per Day)
Industrial	90,000 sq. ft.
Hotel, Motel	50 rooms
Hospital	50 beds
Nursing Home	200 beds
General Office	40,000 sq. ft.
Medical Office	7,500 sq. ft.
Retail	7,500 sq. ft.
Restaurant	9,000 sq. ft.
Fast Food Restaurant	1,000 sq. ft.
Gas Station	All Stations
Bank	3,000 sq. ft.
Supermarket	4,000 sq. ft.
Convenience Market	900 sq. ft.

SOURCE: City of Danbury, Planning and Zoning Department.

It is by these procedures that traffic safety and convenience and the lessening of congestion in the streets can be addressed by land use agencies on a project-by-project basis. The municipality has a responsibility to review the traffic impact submission and judge its completeness and implications. Commissions and boards administering zoning may need technical assistance from local staff or other professionals. There will be municipal costs to assure competent review, and, in cases of unusual complexity, ordinary zoning application fees may be insufficient. Municipalities could invoke the provisions of Public Act No. 82-282 and establish by ordinance a schedule of reasonable fees for processing land-use applications.

Each municipality in the Housatonic Valley Region has established some form of zoning procedure, standards and criteria, largely judgmental, for addressing traffic safety and convenience. Examples of mechanisms used in the region are presented in Appendix B.

2.1 Sample Procedures Used Elsewhere in Connecticut: Examples of formalized zoning procedures used successfully in locations outside the region for traffic impact analysis are as follows:

- **Westport:** special permit and site plan submission requirements include a **traffic impact analysis** for "any project containing either 40 or more parking spaces in a new or expanded parking lot or 20,000 or more square feet of gross floor area in a new or expanded building." The traffic analyses are required to include at least the following information: past and present roadway conditions, existing roadway capacity, traffic accidents, existing and projected traffic volumes (ADT, Peak A.M. & Peak P.M.), existing and projected volume/capacity ratios, existing and projected levels of service, and existing and proposed sight lines based on facts and reasonable generation factors for the site and immediately affected road networks and intersections.

  a. The project shall be designed to minimize left turn movements or conflicts on the site and the street.

  b. Driveways shall be designed to achieve clear sight lines based on a minimum 35 mph design speed.

  c. The project design shall consider interconnected parking areas, shared common access drives and future access connections to adjacent property.

d. Where it is projected that the additional traffic resulting from the project will exceed a volume/capacity ratio of 0.8 on the adjacent streets, increase the peak hour volume by 10% or more, or reduce the level of service to "D" or below, the commission shall not approve the project unless and until provision has been made for the improvement of said condition.

- **Stamford:** As stipulated in the City's zoning regulations (Sec. 12-A-9); in addition to the customary review of site plans, the regulations include the following provisions: where one hundred (100) or more parking stalls are to be provided or where the proposed use of the property is the establishment of a fast-food restaurant, the developers shall submit three (3) copies of a traffic and access study prepared by a professional engineer, registered in the State of Connecticut, with expertise in traffic engineering, as a part of the application to the Department of Traffic and Parking. This study shall project traffic flows to be generated by the facility, site orientation of vehicle trips, and existing and future levels of service on the area roadway network. (Chg. 22, 79-007, eff. 9/7/79, Subsection A amended).

This regulation has been incorporated into the zoning regulations to assure that the public safety is insured, regardless of the type development or usage.

The City of Stamford (through its Department of Traffic and Parking), recognizing the relationship between the number of vehicular trips generated and the number of on-site parking spaces, has adopted a policy affording developers (applicants) an opportunity to reduce the number of on-site parking spaces when the development is within reasonable distance from the Stamford Transportation Center, thereby reducing the number of vehicle trips and encouraging the use of the mass transportation facilities.

2.2 Model Zoning Ordinance - Provided in Appendix C is a model zoning provision for traffic and access. The model may be adapted to local needs to increase the ability of land-use agencies to carry out statutory responsibility to address safety and convenience and congestion avoidance.

2.3 Subdivision Administration -Local planning commissions, by subdivision regulations and approval of applications for lot and street layouts, are expected to consider safe and convenient street circulation systems and proper design of intersections and roadways. Subdivision mapping can also address preferred driveway locations for new lots, avoidance of driveways onto throughfares where alternative access is available, combined driveways serving two lots, frontage roads and sight line protection easements at corners.

2.4 Local Driveway Permits - While a ConnDOT Encroachment Permit is required for driveway access to a state highway, most municipalities require a permit for any driveway connection to a town road. Typical local concerns, however, are protections of street drainage, grade over the sidewalk and avoidance of damage to the public travelway. Driveway permit considerations could include traffic safety and convenience as in Norwalk where a Driveway Ordinance is administered by the Department of Traffic and Parking. Plan drawings are required and the ordinance has specific standards for minor and major driveways, minimum and maximum width for one-way and two-way drives, spacing from street corners, construction and drainage and sight distance. A traffic impact report is required for a major driveway and for a minor driveway to a drive-up service facility. Administration of the ordinance is dove-tailed with site plan and plot plan processing under zoning.

3.0 LONG RANGE PLANNING FOR CONGESTION AVOIDANCE

On a project-by-project basis, safe and convenient travel and congestion management can be addressed. A time may come, however, when the capacity of particular street and highway systems is near to a reasonable maximum and additional projects, otherwise permitted by zoning, cannot be accommodated. Developments that arrived early are in place and secure, while those that are proposed later must wait for major street improvements or can never be built. Local planning and zoning should consider the overall package of land use and traffic relationships. Basic elements for study are:

- The existing street and highway system--its capacity, facilities and limitations;
- Existing traffic on the system and projections for general growth;
- The development carrying capacity of the study area, such as under current zoning standards, and the traffic permitted uses could generate; and,
- A comparison of traffic flow and generation potential with street capacity, including adjustments needed in either street improvements or development capacity.

Advance planning for particular street corridors or development areas can also anticipate traffic management requirements and systems. These efforts can be used as a guide for project-by-project site plan and special permit review and for overall adjustment of the land use and traffic relationship.

The nature of planning for congestion avoidance will be tailored to local circumstances. Urban downtowns need an approach different from suburban centers, intertown commercial strips and rural villages. Outlined in the following pages are five model examples of planning for land use and traffic. Each employs techniques and has goals reflecting local circumstances and desires.

Example 1: Guilford, Connecticut - This town of 17,375 people is known for its historic center, sea coast features and suburban and rural environment. It is traversed by U.S. Route No. 1--a 2-lane facility with a 50-foot right-of-way--where the town plan and the zoning map provide retail, office and commercial services, and some industrially zoned land, in a strip pattern. Currently, the highway operates at LOS B to C, but there are concerns that growth may cause reduction in this service level result or the need to widen the highway and demolish buildings. A Route No. 1 study area of 190 acres was defined, and after evaluation of the existing highway and projection of general traffic growth the following occurred:

- Eight study areas having a total of 22 sub-areas were defined, and for each, the land area and potential flow were computed.
- Likely building uses permitted by zoning were assigned to each sub-area and at a practical lot use ratio of 25 percent ground coverage by building, or floor area ratio of 0.25. It was found that the current 702,015 square feet of floor area could increase to 1,638,708 square feet.
- Traffic generation was estimated for the likely uses at peak hour and it was found that a floor area ratio of about 0.15 was the maximum that could be accommodated while maintaining the current level of service.
- Zoning proposals were made which add to the site plan review procedure and standards:

  a. a **Statement of Use** submission to refine the intended use of land and buildings and to estimate the number of persons to occupy or visit the premises and the amount and type of vehicular traffic generated daily and at peak hour;

b. a requirement for a **traffic impact analysis** when 50 or more parking spaces are provided or more than 200 vehicle trips per day will be generated; and,

c. a **maximum floor area ratio** of 0.15 unless the traffic impact analysis demonstrates that greater floor area can be used while maintaining LOS C at peak travel hours on any day of the week, taking into account existing and projected traffic and a permissible 0.15 floor area use of all other lots in the study area.

Example 2: North Salem, New York - This rural town adjoins Ridgefield, Connecticut and has only 4,512 persons. The west side of North Salem, however, is traversed by I-684 and New York Route No. 22. At the Hardscrabble Road interchange of I-684, about 300 acres of land have been zoned for economic development (industry, offices, general commercial) for many years. Hardscrabble Road feeding the area and connecting to I-684 is a 2-lane County Road, not yet upgraded to secondary highway standards. The right-of-way width is 50 feet. Permissible building ground coverage is 20 percent and the floor area ratio is 0.40. Concerns had to do with desirable land uses and the capacity of Hardscrabble Road at LOS C. An interim planning study was made with the following results:

- The 300 acres were divided into three access sectors and for each the buildable land area was estimated and an assumption was made that traffic generation would be 90 percent oriented to the I-684 side and 10 percent to the east.
- Peak-hour traffic estimates were made for four alternate building uses and at different floor area ratios, so that peak-hour lane or direction volumes could be evaluated.
- A conclusion of the study was that current permitted building coverages and floor area ratios are not practical, if the entire 300 acres were developed, and that a 0.10 floor area ratio was in the workable range for an improved 2-lane highway.
- Zoning proposals were made to:
  a. establish 0.10 as the basic floor area ratio;
  b. require traffic impact analysis for larger projects in order to maintain a traffic monitoring program;
  c. safeguard the future right-of-way and traffic convenience of Hardscrabble Road by specifying 10 acres for the minimum lot (subdividable on a single interior access road) and 150 feet setbacks from the road centerline; and,
  d. allow modest increase in the floor area ratio for preferred office use.
- Discussions were opened with the county to study needed long range improvements on the county road.

Example 3: Southbury, Connecticut - This, the fastest growing town in Connecticut, reached a population of 14,156 in 1980. Back in 1975 there was concern for the three mile long, Main Street corridor paralleling I-84 and served by Exits No. 14 and 15. Traffic generation, preferred land uses, appearance, signs, densities, sewage disposal and water supply were issues addressed in a comprehensive study and plan for Southbury Center. This is the retail, office and civic heart of the community. The study defined a planning area boundary which was adopted into the plan of development and placed on the zoning map as a special district. Some 33 sub-areas were defined and for each the preferred land uses and floor area ratios were recommended and adopted in zoning. The plan and zoning were based on traffic generation analysis which demonstrated that Main Street, with full development to the limits specified, could operate as a 2-lane street. All substantial uses are

subject to site development plan approval, and to assist project review, zoning refers to the adopted Center Plan which entails guidelines for:

- Non-access locations at street corners and along the Main Street frontage when side streets are available;
- Probable location for future signalization;
- Preferred locations for driveway access to Main Street based on best sight lines and opportunity for shared driveways to two or more parcels;
- Opportunity for driveway access between lots to avoid inter-lot circulation using Main Street; and,
- Recommendation of locations where a frontage road will be useful for access to a series of lots in a strip.

Example 4: Southeast (Brewster), New York - This town of 32 square miles and 11,416 population adjoining Danbury and Ridgefield and is the crossroads for I-84/I-684, Routes 6 and 22 and the Metro-North commuter railroad. Between Brewster and the Danbury line is U.S. Route 6, a 4-lane highway about three miles long that has been by-passed by I-84. Traffic on Route No. 6 operates at speeds up to 55 mph and there is a four-foot wide raised center island with relatively few periodic cuts for turns. Along the highway and the I-84 right-of-way are 300 areas of land zoned for commercial and industrial purposes. Regional development potential in the Danbury-Brewster area appears to have increased marketability for land that has been dormant for many years. The Town conducted a land-use and traffic management study of the strip. The issue was not highway capacity and congestion, but rather one of safe access, management of turning vehicles and best use. Results of the study were:

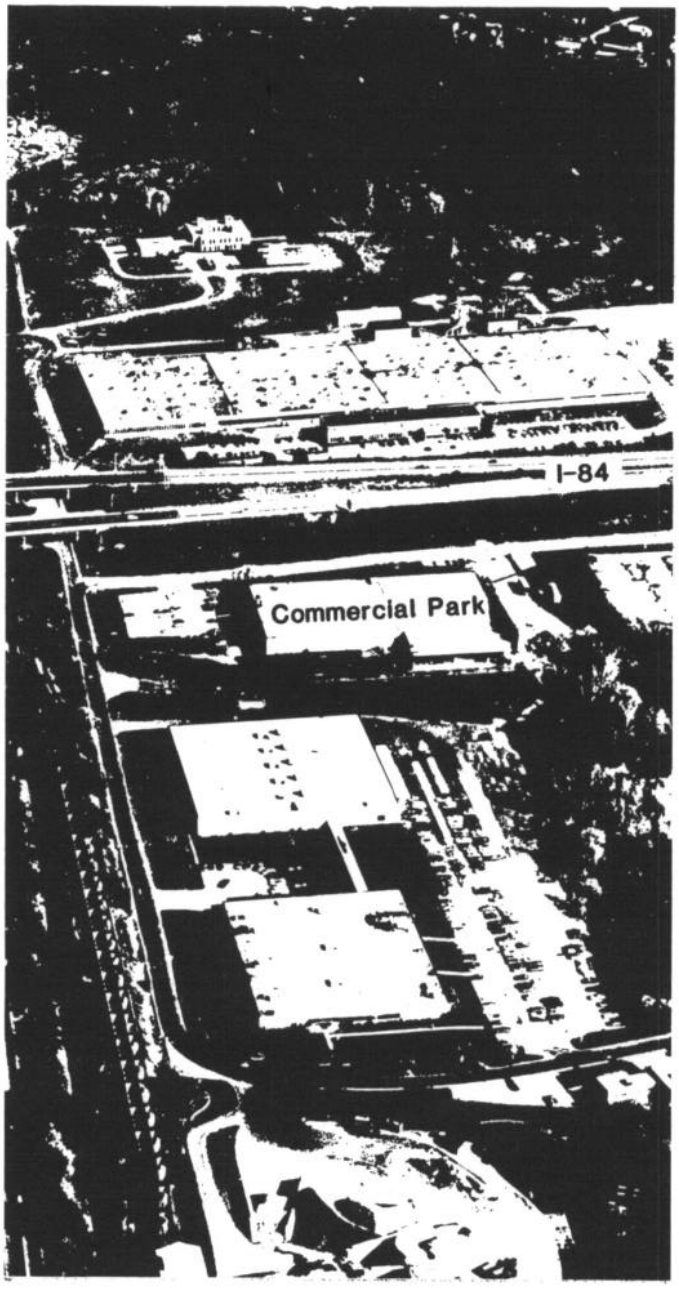
- The raised center island should be retained as a safety feature and additional cuts for left turns should be avoided.
- Land uses, recommended and adopted in zoning, favor office and manufacturing employment and discourage customer in-and-out traffic.
- The entire strip was identified as a single planning and economic development area on the zoning map.
- A traffic management map identifies: preferred driveway locations and non-access locations; proposed common and connecting off-highway driveways; rebuilding and use of sections of Old Route 6 as frontage roads and opportunity to reverse direction; and, locations where "jug handles" or similar turn mechanisms will be appropriate.
- Modification of zoning standards to provide a 40-foot parking setback from the highway for line of sight protection and to encourage single access roads to interior lots having no driveways directly to the highway.

Example 5: Westport, Connecticut - This affluent town of 25,290 persons is crossed by four major roadways (I-95, U.S. Route 1, Merritt Parkway, and Route 33) and is both attractive for new retail and office development and beset with congestion problems in the Routes 1 and 33 corridors. A traffic/land use management study has considered:

- existing traffic and roadway conditions, including 12 critical intersections;
- existing and potential floor area in 14 development areas along the two highway corridors;
- potential trip generation by existing and alternate new land uses; and,
- roadway and intersection capacities and levels of service on the existing roads, with minor improvements.

Four geographic development groups were identified on the two corridors, and floor area

ratios (FAR) for each by type of use were estimated based on an acceptable level of service. An alternative for implementation of a management program is creation of two traffic impact zones as overlays on other districts, and whereby the extent of development or FAR available to a land owner is contingent upon traffic generation characteristics (such as volume and time of concentration) of alternate uses.



Summary

This guide has presented procedures which can be employed by local officials to limit traffic congestion. During the planning process there are two major opportunities available to avoid subsequent congestion. The first occurs during the review of an application for a land-use change. Using their legal authority, outlined in Section 1 and the information presented in Section 2, municipal officials can evaluate traffic analyses accompanying applications. They can evaluate whether a thorough analysis has been conducted, and whether the roadway network with any improvements can properly serve future traffic flows.

The second primary opportunity occurs when municipal officials anticipate major land-use changes and resulting traffic volume increases and take action prior to these changes. By utilizing the administrative tools described in Section 3, municipalities can regulate development in a manner to avoid traffic congestion rather than responding to specific proposals. This process affords a more harmonious and balanced community transportation plan. The HVCEO believes that the Region is truly at a crossroads in its growth and urges that these techniques be utilized.

Appendices

APPENDIX A
CONNECTICUT COURT DECISIONS

A series of cases decided by the Supreme Court of the State of Connecticut, emphasize the importance, ability and obligation of planning and zoning agencies to address safe and convenient access, congestion in the streets and suitable circulation systems.

1. **Gordon v. The City of Stamford,** 145 Conn. 597 (1958)

   The Stamford Zoning Commission made a change of zone on 39 acres of land adjacent to the Merritt Parkway from one-family residential to designed commercial for construction of experimental and research laboratories of a large national corporation. The site was an interior lot, bordered by houses on one-acre lots and having access by a private road serving residential property. The court found that the zoning commission acted illegally, noting that one of the statutory purposes of zoning in Stamford (by special act) is to lessen congestion in the streets. The use of roadways in the vicinity was found to be 2½ times capacity at peak hour and the addition of 400 or more cars would create intolerable congestion.

2. **Whalen v. Town Plan and Zoning Commission of Fairfield,** 146 Conn. 321 (1959)

   The commission made a five-acre change of zone for a neighborhood shopping center on Conn. Route #59 in a growing suburban residential area and in its reasons found that there was sufficient highway right-of-way to make future roadway improvements. The project included a supermarket and parking for 300 cars. The change was held invalid by the court, which in its decision noted that northbound traffic during the 4:30 to 5:30 p.m. peak hour represented 79 percent of the capacity of the road in its present condition and the shopping center would attract 1,300 cars per day. The capacity of the road would be exceeded during that period, and there was no evidence that improvements to increase capacity were contemplated by appropriate authorities. Today the site is occupied by townhouses.

3. **Brustein v. Zoning Commission of the City of Bridgeport,** 151 Conn. 101 (1963)

   At the southeast corner of Westfield Street and Park Avenue (a major artery), a developer's request for rezoning from one-family to an apartment zone was granted to enable construction of a ten-story apartment building. Southerly parts of Park Avenue had four-lane improvements but at this point improvements had not been made and the street narrowed to two-lanes. The zoning commission made the change effective when the developer granted an easement for roadway widening. The court held the change invalid; because while widening of Park Avenue and Westfield Avenue roadways were clearly contemplated, provision of the improvement required appropriation of funds and action by other city agencies and the zoning commissions did not have control over these. It did not appear that the roadway improvement need would clearly be met, so traffic congestion remained a major problem at the time of the rezoning.

4. **Faubel v. Zoning Commission of Ridgefield,** 154 Conn. 202 (1966)

   On petition, the commission added a new light industrial park zone to the regulations and rezoned, from large lot residential to the new zone, some 368 acres of land in the northwest corner of the town adjacent to the City of Danbury and the New York State Line. There was evidence that a new interstate highway (I-84) would soon be located to the north in Danbury and the Town of Southeast, NY. There was also evidence that the rezoned area could accommodate factories with 8,500 to 12,000 employees, using 5,700 to 8,000 cars per day with consequent traffic

congestion. The zoning commission felt this was the only area likely to be suitable for such a use in Ridgefield but conceded that the single feeder road to the area was inadequate and no provision was made for access roads, water, sewer and other supporting requirements. The planning commission recommended against the proposal. The court found that the action of the zoning commission failed to meet statutory requirements for zoning and noted that a) the zoning commission had no control over the provision of necessary streets and other improvements by other agencies, b) the change of zone is dependent for proper functioning on action by other agencies, c) the necessary improvements do not appear to be a probability, d) there is no reasonable assurance that the improvements will be made, e) the planning commission, having Sec. 8-24 public project review authority, recommended against the change, and f) the rezoning sets apart an area of Ridgefield for a use that could not be made of it. Today the Union Carbide corporate headquarters and the new Saw Mill Road interchange on I-84 are located to the north in Danbury.

5. **Samp Mortar Lake Co. v. Town Plan and Zoning Commission of Fairfield,** 155 Conn. 310 (1967)

The company had built 500 houses on a tract of former water supply land that included a reservoir. Below the dam was a mill building which the company used for storage and carpentry and which 25 years earlier was spotted in an industrial district. A rezoning to residential by the commission was upheld by the court even though evidence of monetary loss was presented by the company. The court noted that a nonconforming use could continue but full development of the site for industry would not be permitted. The town's stated interest in controlling traffic and preserving property values in an area of 500 new homes was in part sufficient to justify the change. The building is now an Elk's Club.

6. **Farina v. Zoning Board of Appeals of Trumbull,** 157 Conn. 420 (1969)

The board of appeals granted a special exception for a housing complex subject to the condition that a street "shall be widened at the direction of the town traffic commission so as to be suitable and adequate to handle the traffic generated by the housing project." The court voided the special exception since the board cannot delegate to another agency the duty of determining the extent of the traffic increase due to the project and what corrective measures would be required to accommodate the increase. Decision as to traffic and congestion in the streets should have been part of the decision and made by the board under the criteria of the zoning regulations.

7. **Stiles v. Town Council of West Hartford,** 159 Conn. 212 (1970)

The town council rezoned West Hartford's 30-acre portion of a two-town site for a regional shopping mall, now known as West Farms Mall. Traffic was one of the issues and the court confirmed "that it is not the overall volume of daily traffic but congestion in the streets, that is, density of traffic ..." (emphasis added) that is a matter of concern in adopting zoning. At the public hearing there was expert traffic engineering testimony as to existing and projected highway conditions, recommended improvements and a conclusion that with the improvements there would be assurance of "safe and convenient access for patrons of this center without interference to other highway traffic." There was written evidence from the state highway department agreeing to roadway improvements and assuring construction by the state at the expense of the developer. In addition there was evidence that supporting segments of the inter-

state highway system nearby would soon be in construction. The court upheld the traffic element of the zone change on the basis that the town council could reasonably conclude that the necessary highway actions appeared to be a probability. The mall was built, part of the interstate highway was never completed, and there is congestion.

8. **Lurie v. Planning and Zoning Commission of Westport,** 160 Conn. 295 (1971)

The commission acted simultaneously on three proposals a) an amendment to the plan of development to designate a 62-acre site for a designed development district, b) rezoning of the site from one-family, two-acre lot residential to Design Development District #4-AAA and c) issuance of a special permit for construction of the headquarters of Famous Artists School, an enterprise of significance to the economy and life style of the community. The site was located west of Conn. Route #33 on Partrick Road, a rural road typical of the area. At the time of the hearing, traffic generation was projected and specific improvements needed in Partrick Road and the Rt. #33 intersection, including a school bus stop, were identified. The First and Second Selectmen testified that improvements would be made by the town and the applicant stipulated to responsibilities. The plan was amended, the zone change was made and the special permit was conditioned upon completion of the specific off-site roadway improvements, with responsibility assigned,"in order to insure efficiency and safety." The court upheld the action of the commission where cooperative action is necessary to achieve a desirable result and the permit is reasonably conditioned upon favorable action by other agencies. A key element in this instance was that a conditional special permit was coupled with the zone change, so that the project could not go forward unless the identified traffic improvements were made. Ultimately the project was never built because of external business reasons.

9. **Wilson v. Planning and Zoning Commission of Manchester,** 162 Conn. 19 (1971)

The commission made a zone change on about five acres of land in the Manchester Green area, the result of which would be to accommodate the petitioner's shopping center. At the hearing there was testimony by a traffic expert with regard to large volumes of daily and peak hour traffic in the area and congestion, but that the state has proposals for signal improvements, a street widening is in prospect, other signals will help and a new proposed expressway will divert traffic from the area. "The anticipated traffic can be readily accommodated by the proposed improved travelway and anticipated modernized controls." The court noted that no authority of the town or state acknowledged or verified when and how the traffic improvements would be made "in order to affect the density of traffic in the area" and that "the commission has no authority or control over such matters." In the absence of reasonable assurances of alleviating traffic congestion, the court found that the commission had no authority to change the zone.

10. **Jarvis Acres Inc. v. Zoning Commission of East Hartford,** 163 Conn. 41 (1972)

A petition to rezone 21.7 acres of land on Silver Lane from residential and industrial categories to business for a shopping center was at one time disapproved by the zoning commission and later approved when the Connecticut General Assembly appropriated $5,000,000 to widen and improve Silver Lane. The court found against the rezoning, noted the principle of congestion in the streets and confirmed that the zone change was dependent for proper functioning on action by other agencies over which the commission had no control. There was not enough evidence to

conclude a reasonable probability that improvements would be made, and that if made, there would be relief of the traffic problem already in existence. The court gave a checklist of typical evidence such as state personnel testimony or letters, traffic expert testimony and studies and construction contracts executed with starting and ending dates, none of which were available.

11. **Raybestos-Manhattan, Inc. v. Planning and Zoning Commission of Trumbull,** 186 Conn. 466 (1982)

The court confirmed that a new connecting street recommended on an adopted plan of development may become a requirement for approval of a subdivision layout. The owner obtained earlier approval of a two-lot subdivision and the commission at that time announced that "future east-west roads might be required." The second subdivision request was subsequent to the plan amendment and the court noted that the commission authorized to require extension of a street to protect the health, safety and welfare of inhabitants of the town where the commission found there would be increased traffic from the subdivision and saw a need for better access by fire fighting apparatus and police.

APPENDIX B
SUMMARY OF LOCAL ZONING PROCEDURES ADDRESSING TRAFFIC CONGESTION

Some examples of the procedures, standards, and criteria in use at present within the region to address traffic congestion are described in the following paragraphs.

- In **Bethel,** a site plan submission is required for special permit and commercial and industrial uses but traffic is addressed only in parking standards by providing that lot "entrances and exits be so located as to minimize traffic congestion."

- In **Bridgewater,** a "site plan of development" submission is required for special uses and commercial and industrial projects. Special uses are not to "create undue congestion of traffic or people" and the site plan of development is to include "a traffic analysis of future volumes, the condition of town roads serving the proposed use, and the capacity of such roads, with or without improvements, to convey anticipated volumes."

- In **Brookfield,** special traffic analysis is required for a "major shopping center". Institutional uses in residential zones are authorized by a special permit process that includes finding "that no conditions will be created which adversely affect traffic safety or the normal movement of traffic." "Design review approval" is required for most uses including commercial and industrial, and the zoning commission must have "considered and evaluated" the capacity of adjacent and/other streets to handle peak traffic loads, lines of sight, entrance from and egress onto roadways and drives, accessibility for emergency vehicles and equipment, and other conditions which might adversely affect traffic safety.

- In **Danbury,** special permit uses are required to meet criteria that "no conditions will be created which adversely affect traffic safety or normal movement of traffic." A fully detailed site plan is required for commercial, industrial and multiple dwelling projects

and is acted upon by the planning commission. There is a zoning regulation proposal to require that traffic impact data be submitted and considered for projects which would generate 500 or more vehicle trips per day.

- In **New Fairfield,** the community center zone refers to uses that "will not create traffic problems." The zoning commission is to determine that permits issued in the business district "will not create difficult traffic problems."

- In **New Milford,** special permit uses and commercial and industrial projects are subject to site plan and landscaping plan approval. The zoning commission is to consider "traffic circulation within the site, traffic load or possible circulation problems on existing streets, and the amount, location and access to parking."

- In **Newtown** (Town and Borough) plans for commercial, professional and industrial buildings are required, including means of access. The commission may withhold approval if the project "does not make adequate provision for safety to traffic on the public street." Special permit uses are subject to the criteria that "the proposed use shall not create a traffic hazard on existing streets". To be submitted with site plans for the town is "a traffic survey of the area and any other information the zoning commission may reasonably require or the applicant may wish to submit."

- In **Redding,** business uses are authorized after approval of a plot plan showing all information deemed necessary by the zoning commission. A full site plan submission in detail is required in the design industrial district AA and "when the impact of the proposed...use... is anticipated to create such traffic volume or such wheel loads beyond the capacity of the existing town roads..., the developer shall at his own expense construct same to the necessary widths and quality of construction areas the board of selectmen shall determine." criteria for special permit uses include "that existing and proposed facilities for traffic and parking are adequate and proper for the needs of the proposed use and are capable of accommodating the new use without congestion."

- In **Ridgefield,** a fully detailed site plan presentation is required for special permit uses and commercial and industrial projects permitted as of right. A traffic study is required for special permit uses for retail, commercial, office or industrial floor space proposals in excess of 5,000 square feet and may be required for similar as-of-right uses. The study is to evaluate the impact of the proposal on thoroughfares serving and/or affected by the development. Special traffic data and systems to be covered are specified. Special permits are approved by the planning and zoning commission under criteria that include "streets and other rights-of-way shall be of such size, condition and capacity to adequately accommodate the traffic to be generated...and shall not impair the public health, safety or welfare." Site plans for as-of-right uses are acted on by the planning director under the same criteria.

- In **Sherman,** there is a site plan submission requirement for commercial uses and reference to "harmonious relationship" to the neighborhood. Special permit uses, however, must demonstrate harmony and orderly development with respect to streets and "entrance and exit drives...designed as to minimize traffic hazards."

In general, or in detail, all of these municipalities have set up in zoning some mechanism for addressing traffic safety and convenience and potential congestion on a project-by-project basis.

APPENDIX C
MODEL ZONING PROVISION FOR TRAFFIC AND ACCESS

The following are site plan review criteria that could be applied to special permit/special exception uses and to as-of-right uses that generate significant volumes of traffic. To be workable, the plan submission requirements should be clearly specified and sufficient as to all relevant engineering and design data.

General

- **Purpose:** Each use for which a site plan submission is required is a potentially significant addition to a developing or developed area of the town, and to a residential, commercial or industrial neighborhood. It is intended that the site plan for each use be prepared with due consideration for a) the purpose and intent of these regulations, b) coordination with and improvement of systems of vehicular and pedestrian access, drainage, water supply, sewage disposal, lighting, landscaping, wetlands, water courses, buildings and other features that support the neighborhood and c) protection of the public health, safety, welfare, property values and the environment.

Part of Submission Requirement

- **Statement of Use:** a written statement, signed by the applicant, and by the owner if different from the applicant, describing the following in sufficient detail to determine compliance with these regulations and to establish the plan and program basis for review of the site plan submission:

  a. the nature and extent of the proposed use or occupancy;

  b. the number of persons to occupy or visit the premises on a daily basis, including the parking and loading requirements for the use; and,

  c. an estimate of the amount and type of vehicular traffic to be generated on a daily basis and at peak hours.

- **Reports:** written reports concerning the following: for site involving ___ or more spaces or uses projected to generate more than___ vehicle trips per day, a traffic impact analysis, prepared by a recognized traffic engineer, indicating the expected average daily vehicular trips, peak-hour volumes, access conditions at the lot, distribution of traffic, types of vehicles expected and effect upon the level of service of the street giving access to the lot. (see also example of Danbury proposal in Section 3).

Part of Criteria and Standards

- **Plan of Development:** The site plan shall be in conformance with the purpose and intent of any plan of development, including any amendment, program or supplement that is part of the plan, adopted by the commission under the provisions of Chapter 126 of the Connecticut General Statutes and pertaining to the area in which the use is to be located, particularly in regard to but not limited to the following:

  a. the provision of streets, limitations on the location and number of access driveways, and provisions for traffic management;

  b. the setbacks, location and bulk of building and structures; and,

  c. (insert other town specific provisions, as appropriate.)

- **Access and Circulation:** Provision shall be made for vehicular access to the lot and circulation upon the lot in such a manner as to safeguard against hazards to traffic and pedestrians in the street and upon the lot, to avoid traffic congestion on any street and to provide safe and convenient circulation in the street and upon the lot. Access and circulation shall also conform to the following:

  a. Where reasonable alternate access is available, the vehicular access to the lot shall be arranged to avoid traffic

use of local residential streets situated in or bordered by residential districts.

b. Where a lot has frontage on two (2) or more streets, the access to the lot shall be provided to the lot across the frontage and to the street where there is lesser potential for traffic congestion and for hazards to traffic and pedestrians.

c. The street giving access to the lot shall have traffic carrying capacity and be suitably improved to accommodate the amount and types of traffic generated by the proposed use.

d. Where necessary to safeguard against hazards to traffic and pedestrians and/or to avoid traffic congestion, provision shall be made for turning lanes, traffic directional islands, frontage roads, driveways and traffic controls within the streets.

e. Access driveways shall be of a design and have sufficient capacity to avoid queueing of entering vehicles on any street.

f. Driveways into the lot shall have proper grade and alignment, as well as transition grades and sight distances, for safe, convenient and efficient access and shall meet the street right-of-way line and travelway of the street in such a manner as to conform to the standard cross section for the street as may be specified in town road specifications.

g. Where topographic and other conditions are reasonably usable, provision shall be made for circulation driveway connections to adjoining lots of similar existing or potential use i) when such driveway connection will facilitate fire protection services, as approved by the town fire marshall and/or ii) when such driveway will enable the public to travel between two existing or potential uses, open to the public generally, without need to travel upon a street.

h. There shall be no more than one (1) driveway connection from any lot to any street, except that i) separate entrance and exit driveways may be provided where necessary to safeguard against hazards and to avoid congestion and ii) additional driveway connnections may be provided, particularly for but not limited to large tracts and uses of extensive scope, if traffic flow in the street will be facilitated by the additional connection. Driveways shall not exceed ___ feet in width at the street line, or such lesser width as will be sufficient to accommodate the traffic to be generated unless a greater width is required by town ordinance or by the State of Connecticut.

- **Existing Streets:** Where the lot has frontage on an existing street, proper provision shall be made for grading and improvement of shoulders and sidewalk areas within the right-of-way of the street and for provision of curbs and sidewalks, as approved by the commission and in accordance with the pattern of development along the street. Where necessary to provide for suitable access or for a system of neighborhood circulation streets, provision shall also be made for appropriate continuation and improvement of streets terminating at the lot where the use is to be located.

APPENDIX D
GLOSSARY

Acceptable gap - headway between successive vehicles in a traffic stream which another motorist maybe willing to merge safely; usually measured in seconds.

Accident analysis- an investigation of accident trends, rates,types, relationships, and causes for the purpose of applying corrective action.

Area of influence - the portion of the adjacent roadway network which is significantly impacted by a proposed change in land use or traffic operation.

Alignment - the combination of vertical and horizontal curvature, tangents, grades and the transitioning of each into a roadway design.

Annual Average Daily Traffic (AADT) - the total yearly traffic volume divided by the number of days in one year.

Average Daily Traffic (ADT) - the total traffic volume during a time period greater than one day, and less than one year divided by the number of days in that period.

Average Highway Speed - the weighted average of the design speeds within a highway section.

Approach - the individual roadway lanes serving traffic entering an intersection or facility.

Approach traffic - all vehicles entering a facility or intersection.

Capacity - the maximum vehicular volume that has a reasonable expectation of being accommodated by a roadway component under prevailing conditions; usually expressed in vehicles per hour, or vehicles per lane per hour.

Capacity analysis - the process of estimating the maximum traffic volume which a roadway segment or intersection can accommodate under specific service levels.

Central Business District (CBD) - that portion of a municipality in which the dominant land-use is intense business activity, commonly referred to as the downtown area.

Critical lane analysis - a process to determine signalized intersection capacity and service level based upon analysis of approach traffic volumes, conflicting movements, vehicle mix, and signal operation.

Demand - the number of vehicles (or pedestrians) desiring to use a given roadway section during a specified unit of time.

Design Hour Volume (DHV) - the traffic volume selected as forming a basis for future design.

Design year - the calendar year selected for traffic analysis of future transportation and land-use conditions.

Free flow speed - the operating speed of a passenger car on a highway segment not influenced by the presence of other traffic; and only restricted by posted speed limits and roadway geometry.

Gap - the interval, in time or distance, between successive vehicles in a traffic stream, measured from the rear of one vehicle to the front of the succeeding vehicle.

Green time - the period of time during which a clear right-of-way or green signal is displayed for a traffic movement.

Growth rate - the annual rate of change; usually expressed as a percent.

Headway - time or distance spacing between two successive vehicles in a given traffic lane measured front to front.

Local Traffic Authority (LTA) - the individual, within a given town, responsible for traffic operations and control.

Level of Service (LOS) - a description of the operating conditions a driver will experience while traveling on a particular facility.

Major Street - the roadway approach or approaches normally carrying the major or largest traffic volume.

Minor Street - the roadway approach or approaches normally carrying the minor traffic volume.

Modal choice/Mode choice - the method of transportation used in reaching a destination including car, public transit, walking, etc.

Operating speed - the highest overall speed, at which a driver can safely travel under favorable weather conditions and under prevailing traffic conditions.

Origin - destination - information describing the point where a trip began or originated and where it terminated or its final destination.

Peak-hour traffic - the highest number of vehicles passing over a roadway segment during 60 consecutive minutes.

Passenger car - a four-wheeled vehicle including, for capacity analysis purposes, station wagons, taxicabs, limousines, pickups, light vans and trucks, or other vehicles having similiar operating characteristics. Excludes large trucks and buses.

Phase - a portion of a signal time cycle during which an assignment of right-of-way is made to a specific traffic movement(s). A phase is composed of the green, yellow and all-red clearance indications.

Phase Length - the time, usually measured in seconds, of an individual signal phase.

Queue - vehicles stopped or moving in a line where the movement of each is constrained by that of the lead vehicle.

Roadway adequacy - a measure of a roadway segment's ability to accommodate a given traffic level.

Roadway geometry - vertical and horizontal alignment, and roadway cross-section within the right-of-way.

Shoulder - the pavement area at either side of through lanes, sometimes used as breakdown lanes.

Sight distance - the distance visible to the driver of a passenger car, measured along the roadway, to the roadway surface at a specified height. Stopping sight distance is the length required to bring a vehicle to a stop after an object becomes visible to the driver. Passing sight distance is the length required for a driver to safely and comfortably pass a vehicle without interfering with the speed of an oncoming vehicle.

Signal indication - the illuminated traffic signal lens or combination of lenses displayed at the same time.

Site generated traffic - traffic volumes oriented to or caused by land uses on a specific parcel or property.

State Traffic Commission (STC) - a Connecticut Agency.

30th Highest Volume - the hourly volume on a given roadway that is exceeded by 29 hours during a given year.

Traffic control devices - signs, signals, markings or other physical objects which regulate, warn, or guide motorists, and improve the safety and efficiency of traffic flow.

Traffic generator - any facility or land use which attracts or causes traffic. A parking facility is not considered a traffic generator, as it typically serves adjacent land uses.

Trip assignment - the allocation of traffic volumes by direction of travel to specific roadway elements, a planning process.

Trip distribution - the process of estimating the routing direction of traffic approaching and departing a site, a planning process.

Trip generation - the process of estimating the volume of traffic attracted to or resulting from an activity center or traffic generator.

Volume - the number of vehicles passing a given point per unit of time, normally expressed in vehicles per hour (vph)

Warrants - specific criteria used to validate the need for traffic control devices. Design elements used to ensure signals, signs and geometry are not installed unnecessarily, thus impeding efficient traffic flow and safety.

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