A Summary of a Proposed Recommended Practice

Traffic Access and Impact Studies for Site Development

BY THE TRANSPORTATION PLANNERS COUNCIL OF THE INSTITUTE OF TRANSPORTATION ENGINEERS

A broad range of local agency requirements and technical procedures for conducting site traffic access and impact studies has evolved over a period of time. This has led to inconsistencies and even disagreements on how such studies should be performed and reviewed and what elements should be addressed. The Institute of Transportation Engineers (ITE) has sponsored the development of this recommended practice to provide a basis for consistency in these studies. It is hoped that this consistency will lead to greater technical credibility and fuller use of the conclusions and recommendations of such studies.

This report describes the key elements required for preparing and reviewing traffic access and impact studies for new and expanding land developments. This recommended practice has been prepared for use by practicing traffic/transportation engineers and planners, including public agency reviewers involved in the development approval process.

This is the summary of a report that is being proposed as a Recommended Practice of the Institute of Transportation Engineers.

This Proposed Recommended Practice has been developed in accordance with formally adopted Institute procedures designed to help ensure that a representative cross-section of parties are given opportunities to provide input. It should be noted that the recommendations are guidelines, not an exclusive set of acceptable procedures. They are not necessarily intended to supersede specific local, regional, or state requirements, although those agencies may wish to modify their requirements as a result. It will, however, assist developers, study preparers, and reviewers to understand what constitutes a complete traffic access/impact study and report.

It is important that there be latitude for addressing unique case-by-case situations. Valid new procedures for predicting traffic needs and impacts should also be considered as they are developed. All input received to date was considered by the task force so that this report would represent the best consensus obtainable on the state-of-the-art at the time of approval.

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Review Process

The local agency review process should encourage and ensure:

- A realistic awareness of other developments that are committed, planned, proposed, and/or permitted under existing zoning.
- A thorough and objective review of the material presented in the traffic access/impact study report.
- Recommendations regarding development of a comprehensive site access system, including complementary and effective off-site improvements and/or developer participation (if needed), to achieve an efficient and safe transportation system within and adjacent to the development site.
- Open discussions between the agency

and the developer regarding transportation aspects of site development.
- Fair assessment of impacts and need for improvements.

Preparation, Review, and Timing of Study

Site traffic access/impact studies should be prepared under the supervision of qualified, experienced, and registered transportation engineers with specific training in traffic and transportation engineering and several years of experience related to preparing traffic studies for existing or proposed developments. The ability to forecast and analyze traffic needs for both developments and roadway systems is essential.

Traffic access and impact study reviews should be conducted by transportation engineers in agencies that are responsible for development review and approval. In some cases, adjacent jurisdictions that may be impacted by the development should also be offered an opportunity to review the studies. The review process should include detailed analyses by the traffic and transportation professionals who are responsible for operating roadways and for planning and implementing roadway improvements (for example, municipal, county, state, or regional planning agencies). Regardless of the reviewing agency or department, the reviews should be carried out by individuals with adequate applicable training and experience in traffic/transportation engineering.

Under normal circumstances there are several stages in the development process for which traffic access/impact studies may be appropriate:

- Land subdivision application
- Project platting request
- Environmental assessment
- Site plan approval
- Building permit application
- Formation of special-purpose district
- Development agreements (phased agreement, pro-offers, etc.)
- Amendments to comprehensive plans
- Permits for major driveways
- Annexations

Such studies should be completed for proposed developments in accordance with local criteria, but should include at a minimum the rezoning (or zoning variance) and site plan review stages.

Recommended Threshold for Study

In considering transportation aspects of land development, an important question encountered early in the process is: "Under what conditions is a traffic access/impact study needed?"

In general, a complete traffic access/impact study should be conducted whenever a proposed development will generate 100 or more additional (new) peak direction (inbound or outbound) trips to or from the site during the adjacent roadway's peak hour or the development's peak hour. This site trip generation is an appropriate threshold for the following reasons:

1. One hundred vehicles per hour represents approximately 15% of the capacity of a curb travel lane under signalized control.
2. One hundred additional vehicles per hour can change the level of service of an intersection approach.
3. Left- or right-turn lanes may be needed to satisfactorily accommodate site traffic without adversely impacting through traffic.

Judgment must also enter into the process. In some cases, although a development will generate fewer trips than the peak hour, peak direction threshold of 100 trips, a study may be necessary because of a localized safety or capacity deficiency, such as:

1. Current traffic problems in the local area, such as a high-accident location, confusing intersection, or an intersection in need of a traffic signal.
2. The current or projected level of service of the roadway system adjacent to the development, which will be significantly affected.
3. The sensitivity of the adjacent neighborhoods or other areas that may be perceived as being impacted.
4. The proximity of existing or proposed site driveways to other driveways or intersections.
5. The ability of the adjacent, existing, or planned roadway system to handle increased traffic, or the feasibility of improving the roadway system to handle increased traffic.
6. Other specific problems or deficiencies that may be affected by the proposed development or affect the ability of the development to be satisfactorily accommodated.

Table 1 contains suggested baseline criteria for site traffic access/impact studies. These can be used as a starting point in deciding when and how such a study should be performed. These criteria should be adjusted for each study area, depending on the above-listed considerations.

Table 1. Recommended Baseline Criteria for Site Traffic Access/Impact Studies

	Criteria
Trip Generation Threshold	100 newly generated vehicle trips in the peak direction (inbound or outbound) during the site peak traffic hour.
Analysis Area	All roads, ramps, and intersections through which peak hour site traffic composes at least 5% of the existing capacity on an intersection approach, or roadway sections on which accident potential or residential traffic character is expected to be significantly impacted.

NOTES: Additional criteria are discussed in other sections of the report.
Criteria are starting point for deciding when and how a study should be performed (criteria should be adjusted based on recommendations discussed in "Recommended Threshold for Study" section).

Study Area

In large part, the contents and extent of a traffic impact study depend on the location and size of the proposed development and the conditions prevailing in the surrounding area.

An inappropriately large analysis area will unnecessarily increase costs and time for the developer, the study preparer, and the reviewer. In determining how large the study area should be, a general rule of thumb is to include in the analysis those roadways on which at least 5% of peak hour capacity at an intersection approach will be composed of trips predicted to be generated by the new development (see Table 1). Traffic that

composes more than 5% of a roadway's capacity can represent a noticeable impact to most drivers. In areas where site traffic composes less than 5% of roadway capacity, at a minimum the intersections adjacent to the site should be analyzed.

Care should be taken to include in the study all known congested locations that may be impacted by the proposed development.

Study Horizon

The selection of years for which the study results are to be characterized (the study horizon) may be directly related to local plan horizons, development phasing (for this and other projects), or major transportation system changes.

Table 2 suggests horizons that may be appropriate for developments of various sizes.

Peak Traffic Hour(s)

The overall purpose of most studies is to show how traffic generated by the development project will impact the transportation system. In general, the critical time period for traffic generated by a given project is directly associated with the peaking characteristics of both the project-related travel and the area's transportation system.

The peaking characteristics of the adjacent street and highway system can be determined through analyses of traffic count data. In many cases, the data are available from secondary sources; in other cases, such data need to be collected. However, care should be taken to consider potential changes in peaking characteristics over time, particularly in growing areas.

Consideration should also be given to weekend and other typically off-peak traffic. Some land uses generate their peak traffic on evenings or weekends, while some uses are relatively inactive during the normal weekday. It is therefore recommended that weekend and other typically off-peak conditions be reviewed to determine if a more detailed analysis is required.

Field Reconnaissance and Data Collection

After defining the study area with local transportation and/or other reviewing officials, one should review any major land use or transportation system changes that have occurred or are expected in the study area during the study period. Traffic generated by all approved and reasonably expected development in the study area should be included in the analyses; appropriate information should be obtained.

The collecting of available data should be accompanied by a detailed reconnaissance of the project site, area roadways, and the surrounding vicinity. This should include recording all relevant characteristics needed for the analysis plus observations of existing traffic conditions.

Current data should also be collected to supplement available information as necessary. New data should be obtained in surveys consistent with procedures described in the current edition of the *Manual of Traffic Engineering Studies*.[1]

Non-Site Traffic Forecast

Estimates of non-site traffic (traffic that is not generated by the site in question) are required to complete the analysis of horizon year conditions. These estimates characterize the estimated "base" conditions without development of the subject site.

Non-site traffic consists of two components:

- through traffic, consisting of all movements through the study area without origin or destination in the study area, and
- traffic generated by all other developments in the study area (trips having an origin or destination in the study area).

There are three principal methods of projecting non-site traffic: "build-up," area transportation plan data or modeled volumes, and trends or growth rates. Each has its own appropriate use and is based on different data, which may be available or generated as part of the site traffic access/impact study.

The "build-up" technique will normally provide the most accurate and most easily traced results, especially for analysis of developments in areas of moderate growth over a period of 10 years or less. Use of transportation plan data, if locally credible and adaptable to the study year, is generally the second best method, but it is particularly useful for large developments that will be built over a long period in an area of high growth. It should be noted, however,

Table 2. Appropriate Study Horizons

Development Size	Suggested Horizon(s)
Small (generating less than 500 peak hour trips)	Anticipated opening year, assuming full buildout and occupancy.
Moderate, single phase (500-1000 peak hour trips)	1. Anticipated opening year, assuming full buildout and occupancy. 2. Adopted transportation plan horizon year if the development is significantly larger than that included in the adopted plan or in forecasts for the area.
Large, single phase (over 1000 peak hour trips)	1. Anticipated opening year, assuming full buildout and occupancy. 2. Adopted transportation plan horizon year.
Moderate or large, multiple phase	1. Anticipated opening years of each major phase, assuming buildout and full occupancy of each phase. 2. Anticipated year of complete buildout and occupancy. 3. Adopted transportation plan horizon year. 4. Additional years when major area transportation improvement is completed.

NOTE: Trips generated based on rates in *Trip Generation*.[2]

that 20-year forecasts may be too distant to be applicable in some cases or accurate enough for operational analyses. If neither of the first two methods can be used, then the growth rate method is appropriate.

These methods should be carefully considered based on the study issues and objectives, available data, and reviewing agency preferences or requirements. The final selection should be made only after discussions with the reviewing agency.

Changes to the present or assumed transportation network should be determined from local and state capital improvement programs and plans that have approved funding schedules for implementation. A realistic assessment of timing and certainty should be made. It is critical not to assume improvements that *might or might not* be made in the future. On the other hand, omission of a likely improvement may result in inaccurate traffic estimates and a distorted analysis. The credibility of the entire study may hinge on whether the base transportation system assumptions are credible. The review agency should concur with assumptions of improvements.

The impacts of transportation system changes must be estimated. Diversion of volumes from other facilities to new or improved facilities should be estimated. These changes, whether they are relatively minor or major, can raise or lower traffic volumes at a particular location by enough to affect levels of service.

In areas with significant transit service, changes in modal split should be considered. Only areas with existing or committed frequent service should be identified as having significant impact potential.

It is critical to make sure that corridor volumes are consistent both before and after the reassignment. This can be done by using a screenline technique to compare corridor volumes crossing strategically selected lines drawn perpendicular to the corridor.

Site Traffic Forecast

One of the most critical elements of site impact studies is estimating the amount of traffic to be generated by a proposed development. This is usually done by using trip generation rates, which are commonly expressed in trips per unit of development.

Trip generation rates are often the most critical factor in assessing impacts and needs for a proposed development. A small difference in a forecasted trip generation rate may result in a significant change in the resulting transportation decisions and financial commitments. The outcome of the entire site impact study can depend solely on the question of appropriate trip generation rates. Trip generation rates must therefore be determined carefully and must be defensible using a combination of available data and professional judgment.

The following basic steps should be followed in determining the appropriate trip generation rate:

- Check availability of local trip generation rates for comparable sites.
- If time and funding permit and local data for similar developments are not available, conduct trip generation studies at sites with characteristics similar to those of the proposed development. Characteristics of land uses surveyed and the statistical validity of the sample must be considered in determining their validity.
- Check national sources for an applicable range in trip rates.[2-4]
- Determine the design level of traffic to be utilized for the analysis and select appropriate rates.
- Determine any adjustments that may be applied to trip rates to account for the specific characteristics of the development in question (e.g., high transit usage, true mixed-use development). Account for internal or multiple-purpose trips within large developments.
- Select the most appropriate trip generation rates.
- Document the reasons for any variation from normally recognized generation rates and for assumptions unique to the development being studied.

A table should be provided in the study report showing the categories and quantities of land uses, with the corresponding appropriate trip generation rates or equations (with justification for selection of one or the other), and resulting number of trips. For large developments that will be phased in over time, the table should also provide expected trip generation for each significant phase.

Sources

The source(s) of trip generation estimates to be utilized should be agreed upon by the preparer of the traffic study and the agencies that have study review and approval authority. These sources should be referenced in the study report.

If existing data samples are very limited, additional local data should be collected at a credible number of similar sites to provide a trip generation estimate.

The user of trip generation data should take into account where the data were collected. For example, national data bases contain data that were collected almost exclusively at suburban locations or outlying areas within the central cities. Adjustments to these rates may have to be considered to reflect the study site, including the availability of public transportation and paratransit, the number of walk-ins, and the proximity of other developments.

Rate Variations

Trip rates or equations for an average weekday are appropriate for most, but not all, land uses. Uses such as shopping centers, banks, and restaurants exhibit different daily patterns that should be taken into account. For some land uses, Friday or Saturday trips are greater than average weekday trips; since Friday (or Saturday) occurs 52 times a year, that day, rather than the average weekday, may be the design or analysis period for those uses. Seasonal variations are also important for some land uses.

Pass-by Trips

It is usually assumed that all trips entering and exiting a new development are new trips, which were not made to or through the area prior to the development being completed. However, a portion of these trips may be "captured" from trips already being made to other existing developments on the adjacent street system or merely passing by on the way from one place to another. This is particularly true for non-residential developments. The driveway volume for a new development may therefore be significantly different from the amount of traffic the development adds to adjacent street systems. Retail establishments, restaurants, banks, service stations, and convenience markets attract people from the passing stream of traffic; hence, such trips are called pass-by trips.

Only limited data are available to adjust the trip generation rates for pass-by trips. The information on pass-by trips included in the ITE trip generation report should be reviewed.[2] Because of the limited data available, adjustments should be applied carefully. If pass-by trips are a major consideration for the land use in question, studies and interviews at similar land uses should be conducted or referenced.

Mixed-Use Developments

Most of the trip generation rate data available have been developed from measurements at isolated single-use developments. When different land uses are combined at a site, simply adding the single-use rates together can result in a total trip generation estimate that is too high because it has not accounted for internal trip making among on-site land uses. The latest edition of *Trip Generation* provides some information on this subject.[2] Any significant differences between sums of single-use rates and proposed mixed-use estimates should be justified in the study report.

Unusual Land Uses

From time to time, it will be necessary to estimate the trips expected to be generated by a special or unusual land use type. In those cases, it will be difficult to obtain information from existing databases or to collect data at sites with such land uses. In these cases, judgment must be used to identify another land use or combination of land uses that may exhibit similar trip generation characteristics to the land use in question, and for which data are available or can be collected. The reasoning and data used in developing a trip generation rate for special/unusual generators should be justified and explained in the report.

Site Traffic Distribution and Assignment

The distribution and assignment of site traffic to the roadway system is necessary to analyze the impacts of the proposed project on roadway links and intersections within the study area. After an estimate of the total traffic into and out of the site has been made, the next step is to distribute and assign that traffic (including captured trips) to the roadway system. The trip distribution step produces origin-destination trip estimates. The assignment step produces estimates of how much of the site traffic will use each access route between the origins and destinations.

The directions from which traffic will access the site can vary depending on many factors, including:

- Type of proposed development and area from which it will attract traffic,
- Competing developments (if applicable),
- Size of proposed development,
- Surrounding land uses and population, and
- Conditions on surrounding street system.

Influence Area

Prior to trip distribution of site-generated trips, an influence area should be defined. The influence area should contain a high percentage (approximately 80% or more) of the trip ends that will be attracted to the site. If a market study has been done, it should be used in establishing the influence area. If no market study is available, an influence area should be established based on a reasonable documented estimate. There are various other methodologies that can be used to estimate site traffic distribution. Two of the most common involve establishing an influence area based on a reasonable maximum convenient travel time to the site or delineating area boundaries based on locations of competing developments. The former is more typically utilized; selection of either of these last two methods should be based on characteristics of the development.

Distribution Methods

The three most common acceptable methods for estimating trip distribution are analogy, trip distribution model, and surrogate data. (These methods are described more fully in the complete report.)

Whichever method is used, trip distribution should be estimated and analyzed for each horizon year. A multi-use development may require more than one distribution and coinciding assignment for each phase (for example, residential and retail phases on the same site). Consideration should also be given to whether inbound and outbound trips will have similar distributions. In some cases, these distributions will be different because of tripmaker or roadway system characteristics.

Assignments

Trip assignment should be made considering logical routings, available roadway capacities, left turns at critical intersections, and projected (and perceived) minimum travel times. In addition, multiple paths should often be assigned between origins and destinations to achieve realistic estimates rather than assigning all of the trips to the route with the shortest travel time. The assignments should be carried through the external site access points and in large projects through the internal roadways. When the site has more than one access driveway, logical routing and possibly multiple paths should be used to obtain realistic driveway volumes. The assignment should reflect conditions at the time of the analysis.

Assignments can be accomplished either manually or with applicable computer models.

If a thorough analysis is required to account for pass-by trips, the following procedure should be used:

1. Determine the percentage of pass-by trips in the total trips generated.
2. Estimate a trip distribution for the pass-by trips.
3. Perform two separate trip assignments, based on the new and pass-by trip distributions.
4. Combine the pass-by and new trip assignments.

Upon completion of the initial site traffic assignment, the results should be reviewed to see if the volumes appear logical given characteristics of the road system and trip distribution. Adjustments should be made if the initial results do not appear to be logical or reasonable.

Redevelopment Projects

Traffic estimates for any site with current traffic activity should reflect not only new traffic associated with the site's redevelopment, but also the trips subtracted from the traffic stream because of the removal of a land use.

The traffic impact report should clearly depict the total traffic estimate and its components.

Analysis

Level of Service

Capacity analyses should be performed

at each of the major street and project site access intersection locations (signalized and unsignalized) within the study area. In addition, analyses should be completed for roadway segments deemed sensitive to site traffic. These may include such segments as weaving sections, ramps, internal site roadways, parking facility access points, and reservoirs for vehicles queuing off site and on site. Other locations may be deemed appropriate depending on the situation.

The recommended level-of-service analysis procedures are detailed in the most recent edition of the *Highway Capacity Manual*.[5] The definition and procedures for calculating the levels of service are different from those used in other methods. In most urban areas, the overall level-of-service ratings A, B, C, and D are normally considered acceptable for signalized intersections (levels C or better are considered desirable); level-of-service E or F is normally undesirable.

The operational analyses in the *Highway Capacity Manual* should be used for analyzing existing conditions, traffic impacts, access requirements, or other future conditions for which traffic, geometric, and control parameters can be established.

Several other factors should also be analyzed. These include:

- Safety,
- Circulation patterns,
- Traffic control needs,
- Transit needs or impacts,
- Transportation system management,
- Neighborhood impacts,
- Adequacy of on-site parking facilities (and off-site parking facilities, if any are to be used for site-generated parking),
- Pedestrian and bicycle movements, and
- Service and delivery vehicle access.

Identification of Impacts, Needs, and Common Deficiencies

Analysis and plan development are conducted in an iterative process that is required for each time horizon and key location. The analysis is intended to show the relationship between operations and geometry and to assess deficiencies, as well as identify alternatives for further consideration.

For example, an assessment of internal circulation will show the relationship between external access points and building access locations, drop-off points, delivery points, and parking locations.

The analyses described above plus the planning principles described later in the report provide the basis for identifying transportation deficiencies and needs related to the proposed developments. These analyses should be conducted for base conditions (without the proposed project) and again with the proposed project to ascertain the incremental impact of the project and the incremental needs it generates.

When the analyses indicate that a particular location is projected to operate at a desirable level of service, then no improvements are required. If, however, deficiencies are recognized, then improvements in access, geometry, or operations must be investigated. When reasonable improvements cannot sufficiently accommodate projected traffic, more detailed assessments of project size, land use, or development phasing may be required. It is important to assess a range of alternatives to provide options that are viable, efficient, economical, and potentially acceptable to the community.

Phasing of major projects is often required in areas where the existing infrastructure may be limited and extensive improvements are needed. Many major projects require improvements to the area roadway infrastructure, both internally and externally. The nature of these improvements and their timing can be related to the phasing of the development, as well as the changes within the region as a whole.

Site Access and Off-Site Improvements

Before any recommendations can be reached, a set of objectives must be established. The recommendations should provide safe and efficient movement of traffic to and from and within and past the proposed development, while minimizing the impact to non-site trips. Other objectives may also be identified; route continuity, circulation system comprehensibility, and progression of traffic flow are all important.

In general, the target level of service should be established in municipal guidelines or in discussions with representatives of the review agency. Within urban areas it is recommended that either of the following two levels of service be adopted as the goal of the analysis:

1. All intersections should operate at level-of-service D (or better) during the peak traffic (design) hour of the roadway system, or
2. In areas where current levels of service are D or worse, this baseline level of service must be maintained or improved after development. For example, if the level of service prior to the development is E, then once the development is in place, the level of service must be at least E. Where the level of service is F, the project must result in estimated delay being no worse than the "non-site" condition. Cost-effective improvements may, of course, boost the level of service above F or E. Such factors as safety may also warrant these improvements.

The subsequent qualitative determinations and judgments concern site access locations and capacities and off-site roadway improvements.

Recommendations for improvements should include both off-site and on-site locations. Recommendations should reflect scheduled and recommended roadway network improvements and additional developments in and near the site. The timing of these elements is important.

Resulting recommendations may be classified into four major categories:

1. Regional or subregional network improvements serving the development site.
2. Local improvements adjacent to the development site.
3. Site specific access improvements.
4. Program changes.

Physical roadway improvements should be described in terms of traffic lanes, intersection improvements, traffic control, general right-of-way needs, and other significant characteristics. Operational or policy actions should be clearly defined.

A detailed discussion regarding development of each type of recommendation is included in the complete report.

It is important to view recommendations for improvements within appropriate time perspectives. Recommenda-

tions should be sensitive to the following issues and questions:

- Timing of short-term and long-term network improvements that are already planned, scheduled, and/or funded.
- Time schedules of adjacent developments.
- Size and timing of individual phases of development.
- Right-of-way needs and availability of additional right-of-way within appropriate time frames.
- Local priorities for both transportation improvements and funding.
- Cost effectiveness of implementing improvements at a given stage of development.
- Necessary lead time for additional design and construction.

Very often a series of improvements needed for a major development may be implemented in more than one order. In such cases, the improvements should be implemented to achieve maximum compatibility with the overall roadway system configuration needed for network effectiveness.

On-Site Planning Principles

An integral part of an overall traffic impact study relates to basic site planning principles: It is extremely important to fully integrate off-site roadway improvements with on-site recommendations.

Internal design will have a direct bearing upon the adequacy of site access points. The identification of access points to the external roadway systems and subsequent recommendations related to the design of those access points are directly related to both the directional distribution of site traffic and the internal circulation system configuration.

In principle, the site plan should include the following:

- Entrance and exit locations, required lanes, and required queuing distances.
- Internal roadway circulation systems to carry vehicles between the access points and parking areas, pick-up/drop-off points, and drive-through lanes.
- On-site truck service bays, routes, turning points, and roadway access points (separate from those of patron or employee vehicles, where possible).
- Optimal building locations developed in conjunction with site planners.
- Appropriate building entrance locations, major parking areas, and pedestrian routes.

It must be understood that simply providing access to a site by means of curb cuts does not necessarily mean that access to the development has been *adequately* addressed. The quality of access as it relates to the internal site circulation and design will have a direct relationship on the quality of traffic flow in and around the site development and a direct impact on public safety.

Access Points

The number of access lanes, adequate vehicle storage, appropriate signing and striping, and provision for pedestrian interaction are all elements that should be fully consistent with requirements of the local jurisdiction for off-site roadway intersection links.

Joint access (the sharing of a driveway access point by two or more properties) is desirable, particularly where property frontages are short and driveway volumes will be low. Such driveways should be located on joint property lines or be accessible via cross access easements on the private property being served by the joint driveway.

Site access points should be located and designed in accordance with the following guidelines:

1. Adequate spacing should be maintained from adjacent street and driveway intersections.
2. If the driveway is proposed to be signalized, it should be located to facilitate traffic progression past the site.
3. Access driveways should intercept approaching traffic as efficiently as possible.
4. Adequate inbound and outbound capacity should be provided in proportion to the distribution of site traffic. The number of driveways should be compatible with site access capacity needs and should minimize adverse impacts on adjacent roads.
5. Two-way driveways should generally intersect adjacent roadways at 75- to 90-degree angles.
6. The capacity of on-site intersections should be sufficient so traffic entering the site does not back up onto the adjacent street.

Vehicular Queuing Storage

Provision for appropriate vehicular exit queuing should be made at all access drives to a development. High-volume entrances should provide sufficient queuing capacity between the street and the internal circulation road or aisle so as to accommodate inbound traffic surges without forcing traffic to queue back onto the external roadway system.

Analyses should be performed to provide usable estimates of necessary queue lengths to be accommodated at signalized intersections.[3] The same procedures should be used for on-site queuing reservoirs and for off-site left- and right-turn lanes.

Drive-in and drive-through developments, such as banks, car washes, and fast-food restaurants, should be provided with adequate queue storage capacity to accommodate normal peak queues.

Internal Vehicular Circulation

Internal circulation roads should be striped and signed in a manner consistent with the *Manual on Uniform Traffic Control Devices*[6] and be designed to safely and efficiently deliver vehicles to their respective destinations.

The design, alignment, and location of internal circulation roads should be carefully reviewed. Close adherence to the principles used in off-site roadway systems should be maintained.

Service and Delivery Vehicles

Service and delivery vehicles require separate criteria for movement to and from the site.

Vehicle turning paths should be sufficient to accommodate the largest vehicles anticipated to travel on the site, or should accommodate a locally required design vehicle (often an emergency vehicle).

Access points expected to be used by service vehicles should have turning paths sufficient to allow service vehicles to enter and exit the site without encroaching upon opposing lanes or curbed areas.

There should be sufficient separation between external and internal circulation roads to allow service vehicles to be fully stored on the premises without blocking access to parking spaces or internal roadway circulation systems.

Service vehicle routes should be designated and signed between access

points and loading facilities to (*a*) ensure adequate turning paths for service vehicles moving through the site, (*b*) identify those areas on site that need heavy duty pavement, and (*c*) ensure the most direct route for the service vehicle to reach the loading dock.

A sufficient number of loading berths should be provided to accommodate anticipated service and delivery activity.

Building Service Drives

Building service drives are those roadways immediately adjacent to the building and its entrances. They usually serve one or all of four purposes:

1. Fire and/or emergency vehicle access.
2. Pedestrian pick-up/drop-off adjacent to buildings.
3. Internal circulation.
4. Recirculation in parking areas.

These roadways should be designed with sufficient width to accommodate these functional needs.

When reviewing and developing site plans, one overall basic criterion should be applied: the access drives, internal circulation drives, service drives, and parking areas act together as one system and should function and be signed as one system.

As part of the overall site planning, public transportation, pedestrians, and bicyclists should also be considered.

Parking

Parking is addressed in numerous documents. Discussions about specific dimensions, parking angles, and parking ratio requirements are all issues addressed in detail in other publications. In addition to affecting convenience, the number of parking spaces and the design of parking facilities provided may have bearing upon the efficiency and safety of the project.

The Study Report

The purpose of a site traffic access/impact study report is to document the purpose, procedures, findings, conclusions, and recommendations of the study. The most common uses for these reports are to (*a*) provide developers or designers with recommendations on site selection, site transportation planning, and traffic impacts, (*b*) aid public agencies in reviewing the attributes of proposed developments in conjunction with requests for annexation, subdivision, zoning, building permits, or other development reviews, and (*c*) establish or negotiate mitigation requirements where off-site impacts require improvements beyond those otherwise needed. In recent years, such reports have also been used by public agencies to levy impact fees or assess developer contributions to roadway facility improvements.

The documentation for a traffic access and impact study should include, at a minimum:

- Study purpose and objectives.
- Description of the site and study area.
- Existing conditions in the area of the development.
- Anticipated nearby development.
- Trip generation, trip distribution, and modal split.
- Projected future traffic volumes.
- An assessment of the change in roadway operating conditions resulting from the development traffic.
- Recommendations for site access and transportation improvements needed to maintain traffic flow to, from, within, and past the site at an acceptable and safe level of service.

The analysis should be presented in a straightforward and logical sequence. It should lead the reader step-by-step through the various stages of the process and resulting conclusions and recommendations.

The recommendations should specify the time period within which the improvements should be made (particularly if the improvements are associated with various phases of the development construction), the estimated cost of the improvements, and any monitoring of operating conditions and improvements that may be required.

Data should be presented in tables, graphs, maps, and diagrams wherever possible for clarity and ease of review.

To facilitate examination by reviewing agencies, an executive summary of one or two pages should be provided, concisely summarizing the purpose, conclusions, and recommendations.

The report documentation outlined above provides a framework for site traffic access/impact study reports. Some studies will be easily documented using this outline. However, the specific issues to be addressed, local study requirements, and the study results may warrant additional sections.

Comments are being sought to assist the consideration for adoption of the report as an ITE recommended practice. Comments should be submitted by October 15, 1988. Comments, questions, and any requests for a public hearing should be directed to: Professional Programs Department, Institute of Transportation Engineers, 525 School Street, S.W., Suite 410, Washington, D.C. 20014-2729 USA; phone 202/554-8050.

References

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