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Driveway and Street Intersection Spacing

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DRIVEWAY AND STREET INTERSECTION SPACING

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FOREWORD

This TRB Circular was developed by TRB's Committee on Access Management. A task force was organized to conduct the effort and was chaired by Jerry Gluck, Principal Associate, Urbitran. The committee recognized the lack of adequate guidelines for designing streets and highways from an access management perspective. The development of specific guidelines and standards was not attempted, but the task force has assembled examples of current practice that should be useful to highway agencies.

The task force has produced an excellent report through a volunteer effort, which is very much appreciated. Members of the task force included Philip B. Demosthenes, Salvatore J. Bellomo, Arthur Jay Eisdorfer, Ronald K. Giguere, Del Huntington, Frank J. Koepke, Dane Ismart, Gary Sokolow, and Vergil G. Stover. Additional TRB publication support was provided by James P. Douglas.

DEDICATION

This TRB Circular is dedicated to the memory of Dr. Salvatore J. Bellomo, P.E., who passed away on June 7, 1994. Sal had a 30-year career filled with significant professional achievements and advanced the state of the art in many diverse areas of transportation planning. For his many accomplishments, he received the James Laurie Prize for professional contributions to the advancement of transportation engineering from the American Society of Civil Engineers.

In recent years, Sal was active in issues related to access management. He was the principal investigator of an FHWA project that developed guidelines for providing access to transportation systems and was the editor-in-chief of the *Proceedings of the First National Access Management Conference*, held in Vail, Colorado, in 1993. He was a founding member of the TRB Committee on Access Management and a member of the task force that prepared this TRB Circular.

Hugh McGee

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INTRODUCTION

The spacing of access for driveways and streets is an important element in the planning, design, and operation of roadways. Access points are the main source of accidents and congestion. Their location and spacing directly affect the safety and functional integrity of streets and highways. Too many closed spaced street and driveway intersections, for example, increase accident potential and delays and preclude effective traffic signal coordination. Too few inhibit access and over-concentrate traffic.

Despite the importance of access spacing for driveways and streets, it is often overlooked in current roadway and site planning efforts. Part of the problem stems from the constraints posed by existing streets and developments. However, the lack of sound spacing standards and guidelines is an equal, if not more important, constraint.

This circular on driveway and street intersection spacing has been developed in response to the need for information that may be applied in the development of sound spacing practices. It is a compilation of the contemporary practice that illustrates the basic considerations for spacing standards and guidelines and that describes current state, county, and local spacing requirements.

OVERVIEW OF ACCESS MANAGEMENT

Streets and highways constitute a valuable resource as well as a major public investment. It is essential to operate them safely and efficiently by managing the access to and from abutting properties. Owners have a right of reasonable access to the general system of streets and highways. Roadway users also have certain rights. They have the right to freedom of movement, safety, and efficient expenditure of public funds. The need to balance these competing rights is especially acute where significant changes to the transportation system and/or land use have occurred or are envisioned to occur. The safe and efficient operation of the transportation system calls for effectively managing the highway access, via driveways or streets, to adjacent developments. This requires the proper spacing of streets and driveways.

Access management provides a systematic means of balancing the access and mobility requirement of streets and roads. Simply stated access management is the process that manages access to land development while simultaneously preserving the flow of traffic on the surrounding public road system in terms of safety, capacity, and speed.

States ordinarily manage access through their police powers which enable them to regulate individual rights for the public welfare. Courts have generally upheld these police powers whenever reasonable access is maintained. The application of police powers to manage access must be part of a general policy and must be reasonably consistent.

The key elements of a modern access management program involve: developing an access classification system; defining the allowable access level and access spacing for each class of highway; providing a mechanism for granting variances when reasonable access cannot be provided; and establishing a means for enforcement of the program. These requirements, along with appropriate design standards, are best included in an Access Code — such as those adopted in Colorado, Florida, and New Jersey. A comprehensive access code provides a predictable, systematic, supportable and equitable basis for making and enforcing access decisions.

The specific techniques for managing access to developments involve the application of established traffic engineering and roadway design and planning principles that:

- Limit the number of conflicts,
- Separate basic conflict areas,
- Reduce interference with through traffic due to turns into or out of a site,
- Provide sufficient spacing between at-grade intersections,
- Maintain progressive speeds along arterials, and
- Provide adequate on-site storage areas.

The application of these principles will minimize disruptions to the through traffic, caused by driveways and intersections. Their application will also ensure safe and efficient access to adjacent land developments.

ACCESS MANAGEMENT BENEFITS

Access management increases the spacing and reduces the number and variety of events to which drivers must respond. This translates into fewer accidents, travel time savings, and preservation of capacity. These benefits are documented in information from a variety of sources.

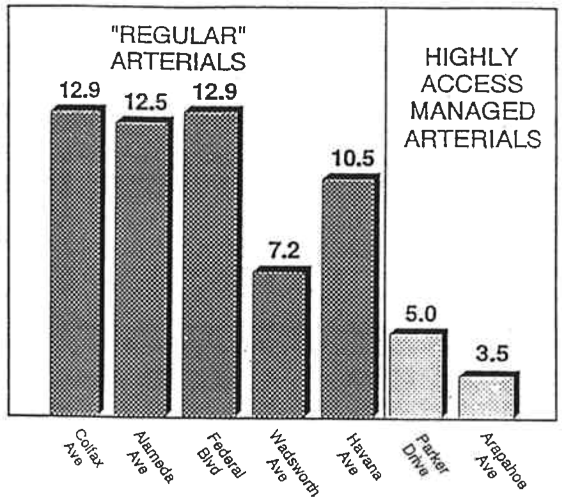

FIGURE 1 Accident reductions attributable to access management.

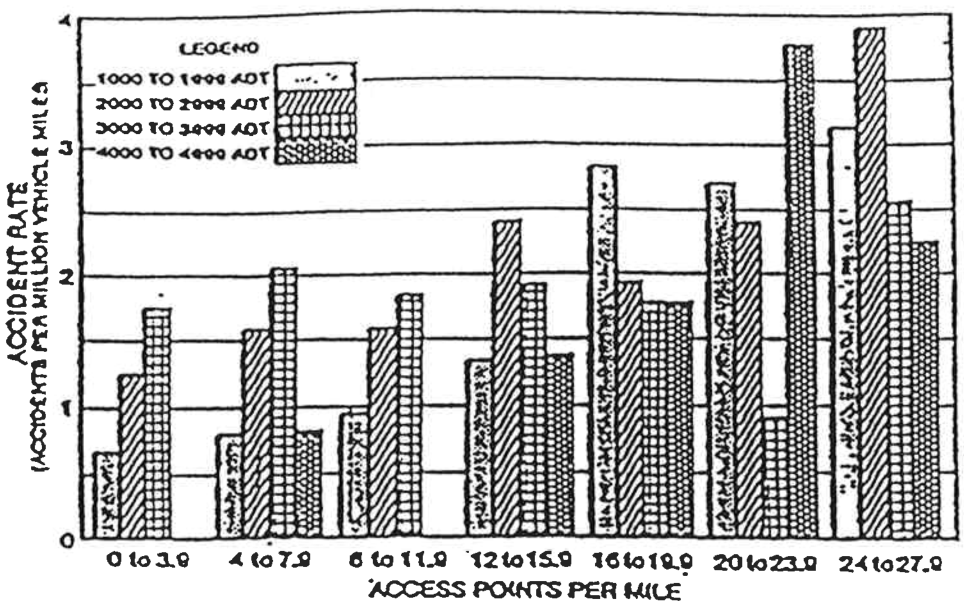

FIGURE 2 Accident rates for road sections with different traffic volumes and access point frequencies.

Safety Benefits

A Policy on Geometric Design of Highways and Streets (1994) (AASHTO "Green Book," page 793), prepared by the American Association of State Highway and Transportation Officials, states that: "The number of accidents is disproportionately higher at driveways than at other intersections; thus their design and location merit special consideration."

Two decades of research have shown that managing access can significantly reduce the frequency and severity of traffic accidents. Studies in Florida, Colorado, and other parts of the nation using access management changes have shown that the accident rate per million miles traveled can be 50 percent less on arterials that have good access management.

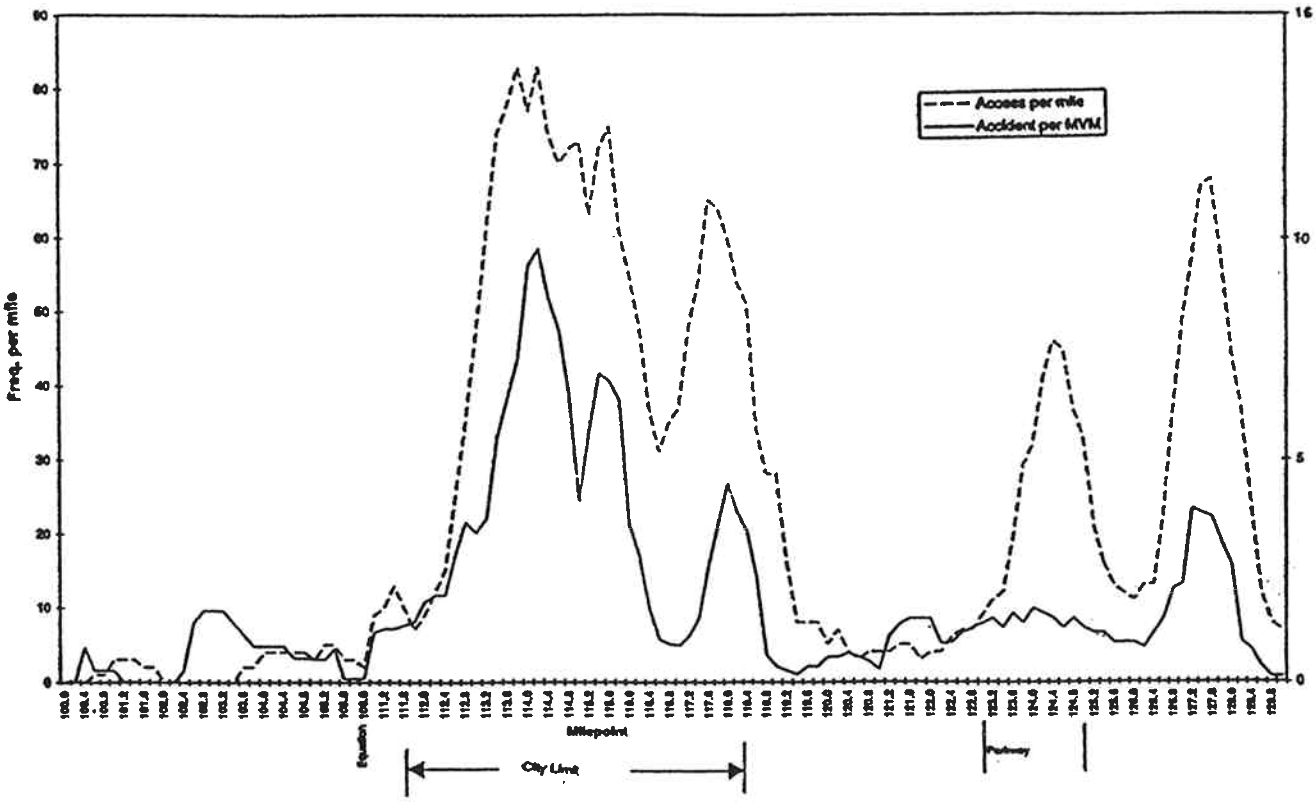

FIGURE 3 Relationship between accidents per million vehicle miles and access points per mile.

● Figure 1 from the Colorado Access Control Demonstration Project (Colorado Department of Transportation and Federal Highway Administration, 1985) shows the dramatic decline in accident rates resulting from access management, including the introduction of driveway controls and a non-traversable median for a portion of the corridor.

● Figure 2 shows how accident rates generally increase as the number of access points per mile increases.

● Figure 3 shows the relationship identified between accidents per million vehicle miles and access per mile for a highway facility in Oregon.

● Figure 4 shows how accident rates per mile increase as the number of driveways per mile increases along a suburban arterial highway in Connecticut.

The pattern among these figures is clear — the greater the frequency of driveways, the greater the rate of traffic accidents.

Non-traversable medians also improve safety since they limit the number of conflicting movements. Research sponsored by Florida, Georgia, and Michigan Departments of Transportation show accident reductions from 15 to 50% where medians have replaced two-way left-turn lanes.

● Figure 5 shows the accident saving in Georgia along high-volume roadways. The accident rates were 15% lower along four-lane roads, and 25% lower along six-lane roads.

● Figure 6 shows that medians resulted in 25% reduction in accident rates along Florida's four- and six-lane arterials.

● Figure 7 shows that medians reduced accident rates by 50 to 60 percent along arterial roads in Michigan.

These accidents reductions clearly show the safety advantages of non-traversable medians. The positive control over left-turns afforded by medians is an extremely effective access management tool.

Enhanced Highway Functional Integrity

Access management maintains the functional integrity of the arterial highway system by preserving capacity.

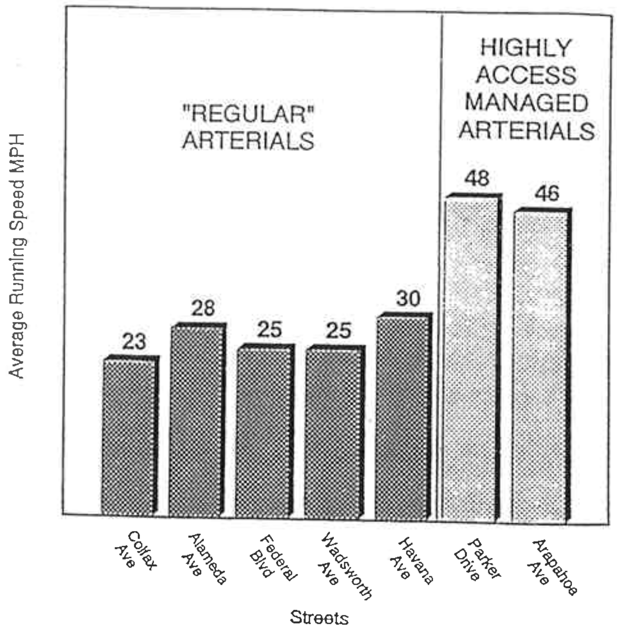

FIGURE 8 Speed increases attributable to access management.

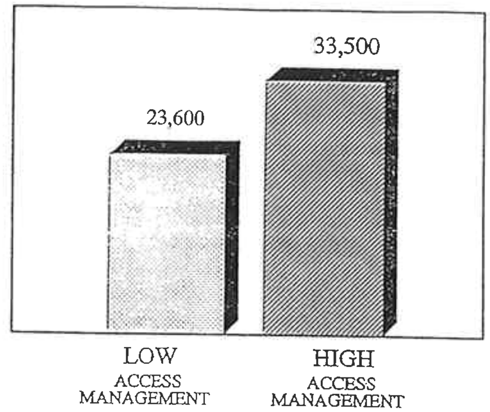

FIGURE 9 Capacity increases attributable to access management.

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6. Squires, C.A., and P.S. Parsonson, Accident Comparison of Raised Median and Two-Way Left-Turn Lane Median Treatments. *Record 1239*, TRB, National Research Council, Washington, D.C., 1989 pp. 30–40.
7. Benac, J.D., Accident Analysis of Geometric Operational Designs. Unpublished data, Traffic and Safety Division, Michigan Department of Transportation, Lansing, December 8, 1988.
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9. Florida Department of Transportation and 1985 Highway Capacity Manual.

GENERAL CONSIDERATIONS IN ESTABLISHING SPACING AND NUMBER OF DRIVEWAYS

Access spacing preserves the functional integrity of highways, while affording appropriate and reasonable access to abutting property. Effective access management must address both the spacing and the number of driveways that are permitted.

HIGHWAY PERSPECTIVE

Spacing provisions apply to highway connections involving private driveways, private streets, and public streets. All must be properly located and designed to ensure safe and efficient highway operations. Provisions concerning the number and spacing of driveways and streets should reflect the following general considerations (F.J. Koepke and H.S. Levinson, NCHRP Report 328, *Access Management Guidelines for Activity Centers*, TRB, 1992):

1. Spacing should be keyed to the roadway function or access class, operating speed, and development density. Spacing should be more restrictive along higher-type roads, such as strategic and principal arterials.
2. Spacing provisions should apply to new developments and to significant changes in existing developments.
3. The spacing provisions do not have to be consistent with existing access practices (i.e. in general, problems with existing access practices often mandate the need for new, clearer, and more explicit standards and enforcement provisions).
4. The provisions should cover (1) interchanges, (2) signalized streets and driveways, (3) unsignalized streets and driveways, (4) median openings, and (5) corner clearances.
5. The provisions should minimize the need for variances while simultaneously protecting traffic flow. Access to land parcels that does not conform to spacing criteria may be needed where there is no reasonable alternative access.
6. Allowable clearances for deviations from the desired spacing provisions should be specified for each class of road. They will be greater for collectors and minor arterials than for primary or strategic arterials.
7. Access driveways for major activity centers should be considered as intersecting high-volume roads, rather than as curb cuts.
8. Traffic signal spacing should be related to the operating speed. Signal spacing criteria should take precedence over unsignalized spacing standards in situations where future signalization is likely. This also applies to openings in median islands.
9. Grade separation may be needed where major roads intersect, or as a means of providing direct access to major traffic generators.
10. Reasonable access to property must be available. However, this may involve side-street access where direct access is denied to or from the main arterial.

The impacts of restricting access should be carefully assessed. Alternate routings for cars, trucks, buses, emergency vehicles, and pedestrians must be available to ensure that reasonable access is provided.

SITE PERSPECTIVE

Provisions concerning the spacing and number of driveways should reflect the following general considerations from a site perspective:

1. Provide access from more than one roadway where beneficial.
2. Encourage direct access to roadways of lower function or access class.
3. The number of site driveways should be based on need. For small developments where access to a lower function or access class is not available, limit site access to one driveway. For large developments, it may be necessary to provide two access points from a specific, high-volume approach direction.
4. Consider site access designs that simplify signal phasing by separating left-turns in and left-turns out for large developments.
5. Design features of a driveway or intersection, including lane width, medial treatment, turning radius, sight distance, etc. should reflect the access or functional class of the highway on which it will be located.
6. On-site circulation should be designed and sufficient storage space should be provided to preclude any spill back of traffic from site connectors onto the roadway system.

CONSIDERATIONS IN ESTABLISHING SPACING STANDARDS

The spacing of driveways and streets needs to reflect sound traffic engineering principles, driver behavior, and vehicle dynamics. Spacing should consider influences such as:

1. Highway function.
2. Access class and speed.
3. Locations of upstream and downstream streets and driveways.
4. Volume of trucks.
5. Expectancy of drivers.
6. Separation of conflict areas.
7. The number of conflict points within each conflict area.

Conflict separation is essential to achieve improvements in travel times, capacity, and safety. Separation of conflict points, such as driveways and streets, should focus on the element of time and its relationship to the driving task, which includes perception, reaction, navigation, and execution of the necessary maneuver. Vehicle dynamics and driver behavior are important determinants of access spacing.

FUNCTIONAL CLASSIFICATION

Access spacing should recognize that access and mobility are competing functions. This recognition is fundamental to the design of roadway systems that preserve public investments, contribute to traffic safety, reduce fuel consumption and vehicular emissions, and do not become functionally obsolete. Suitable functional design of the roadway system also preserves the private investment in residential and commercial development.

The 1994 AASHTO "Green Book" (page 3) recognizes that a functionally designed circulation system provides for distinct travel stages. It also indicates that each stage should be handled by a separate facility and that: "The failure to recognize and accommodate by suitable design each of the different stages of the movement hierarchy is a prominent cause of highway obsolescence". The AASHTO policy also indicates that the same principles of design should be applied to access drives and comparable street intersections.

A typical trip on an urban street system can be described as occurring in identifiable steps or stages as illustrated in Figure 1. These stages can be sorted into a definite hierarchy with respect to how the competing functions of mobility and access are satisfied. At the low end of the hierarchy are highway facilities that provide good access to abutting properties, but provide limited opportunity for through movement. Vehicles entering or exiting a roadway typically perform the ingress or egress maneuver at a very low speed, momentarily blocking through traffic and impeding the movement of traffic on the roadway. At the high end of the hierarchy are facilities that provide good mobility by limiting and controlling access to the roadway, thereby reducing conflicts that slow the flow of through traffic.

A transition occurs each time that a vehicle passes from one roadway to another and should be accommodated by a facility specifically designed to handle the movement. Even the area of transition between a driveway and a local street should be considered as an intersection and be treated accordingly (*A Policy on Geometric Design of Highways and Streets*, American Association of State Highway and Transportation Officials, 1994). However, design of these intersections poses few problems since speeds and volumes are low. Many urban circulation systems use the entire range of facilities in the order presented here, but it is not always necessary or desirable that they do so.

Highway specialization simply means using each individual street facility to perform the desired mix of the functions of access or movement. This is accomplished by classifying highways with respect to the amount of access or mobility they are to provide and then identifying and using the most effective facility to perform that function.

The functional system of classification divides streets into three basic classes identified as arterials, collectors, and locals as illustrated in Figure 2.

The function of an arterial is to provide for mobility of through traffic. Access to an arterial is controlled to reduce interferences and facilitate through movement. Collector streets provide a mix for the functions of mobility and access and, therefore, accomplish neither well. The predominate purpose of local streets is to provide good access. As noted in the 1994 AASHTO "Green Book" (page 793), driveways create intersections with the street system.

Each class of roadway has its own geometric, traffic control, and spacing requirements. The general types of facilities and their characteristics are summarized in Table 1. This table provides a broad guide in setting access spacing standards that are keyed to functional classes of roadways.

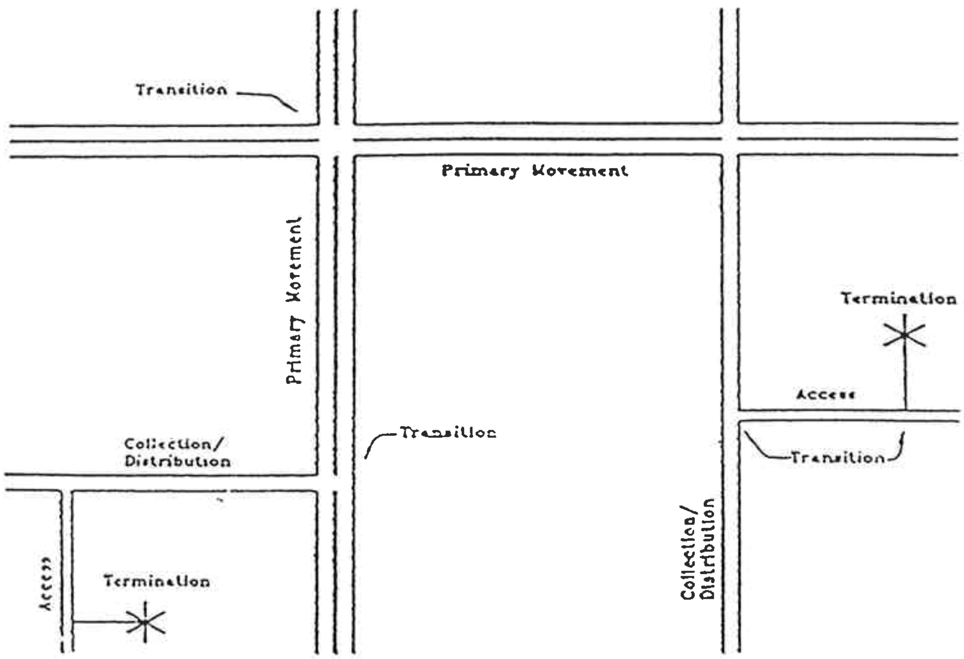


FIGURE 1 Trip stages.

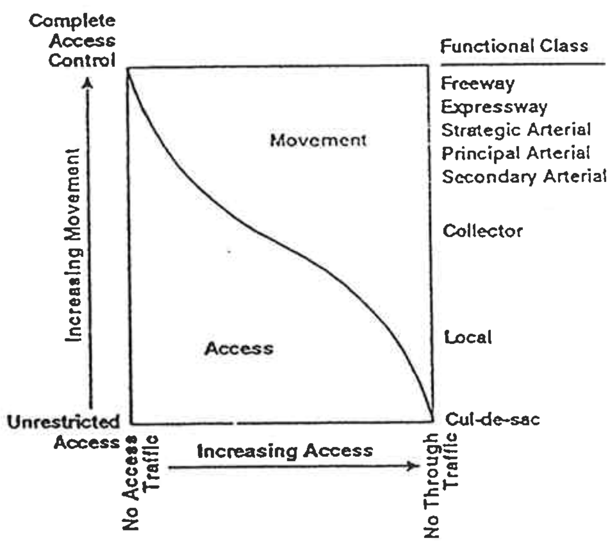


FIGURE 2 Basic functional classes.

SIGNALIZED INTERSECTION SPACING

Most traffic delays along roadways result from stops at traffic signals. Various studies have shown that the number of traffic signals per mile has a greater influence on travel speeds than the traffic volume per lane or the volume-to-capacity ratio. Therefore, selecting a long and uniform signalized intersection spacing is the first essential element in establishing access spacing standards.

The variables involved in the planning, design and operation of signalized arterial streets are reflected in the relationship between speeds, cycle lengths and signal spacings which yield maximum progression band widths in both travel directions. This relationship is shown in Figure 3 and Table 2. Examples of this relationship may be gleaned from a review of Figure 3. For a 100-second cycle length, a signal spacing of 1/4-mile equates to an 18-mph (29 km/h) progression speed, whereas a signal spacing of 1/3-mile equates to a 24-mph (38 km/h) progression speed, a nearly 35 percent increase.

Traffic signal timing coordination plans should allow for efficient traffic flow at different travel speeds. Signal timing plans should be able to operate efficiently over a range of cycle lengths (although the offset patterns may sometimes change).

During off-peak conditions, a major suburban arterial should operate at speeds of between 45 and 55 mph (72 to 88 km/h). Cycle lengths of about 60 to 80 seconds are commonly employed, except where multi-phase operations require longer cycle lengths. Longer cycle lengths are used during the high-volume, peak periods to minimize the "lost time" that occurs each time the signal indication is changed. This includes the start-up delay when the traffic signal turns green.

TABLE 1 FUNCTIONAL ROUTE CLASSIFICATION

	Classification	Function	Typical Percent of Surface Street System Mileage	Continuity	Spacing (miles)	Typical Percent of Surface Street System Vehicle-Miles Carried	Direct Land Access	Minimum Roadway Intersection Spacing	Speed Limit (mph)	Parking	Comments
	Freeway and Expressway	Traffic movement	NA*	Continuous	4	NA	None	1 mile	45–55	Prohibited	Supplements capacity of arterial street system and provides high speed mobility
Arterial	Primary Arterial	Intercommunity and intrametro area Primary—traffic movement Secondary—land access	5–10	Continuous	1–2	40–65	Limited—major generators only	1/2 mile	35–45 in fully developed areas	Prohibited	
Arterial	Secondary Arterial	Primary—intercommunity, intrametro area, traffic movement Secondary—land access	10–20	Continuous	1/2–1	25–40	Restricted—some movements may be prohibited; number and spacing of driveways controlled	1/4 mile	30–35	Generally prohibited	Backbone of street system
	Collector	Primary—collect/distribute traffic between local streets and arterial system Secondary—land access Tertiary—interneighborhood traffic movement	5–10	Not necessarily continuous; should not extend across arterials	1/2 or less	5–10	Safety controls; limited regulation	300 feet	25–30	Limited	Through traffic should be discouraged
	Local	Land access	60–80	None	As needed	10–30	Safety controls only	300 feet	25	Permitted	Through traffic should be discouraged

Progression at reasonable speeds can be achieved at short signal spacings such as at 1/4 mile (0.402 km) only so long as the traffic volumes are very low and short cycles (65 seconds or less) are used. A 60-second cycle results in a 30-mph (48 km/h) progressive speed when signals are uniformly spaced ¼-mile apart. For a 70-second cycle, the speed drops to 26 mph (42 km/h).

As arterial and cross-street traffic volumes increase, longer cycle lengths must be used in order to increase capacity by minimizing lost time, especially when there are more than two signal phases. Therefore, cycle lengths of 80 to 120 seconds are commonly used on major urban arterials during peak periods in developed urban areas. A 90-second cycle and a 1/4 mile (0.402 km) spacing would result in a progression speed of only 20 mph (32 km/h); with a 120-second cycle, the progression speed drops to less than 15 mph (24 km/h), without any loss in through band width. In practice, timing patterns maintain speeds in both directions by reducing band width. During saturated flow conditions this is sometimes counter-productive.

A long uniform spacing of traffic signals may achieve an efficient signal progression at speeds of 35 mph (56 km/h) to 45 mph (72 km/h) along major suburban arterials. At these speeds, maximum flow rates are achieved and fuel consumption and emissions are kept to a minimum level.

A ½ mile (0.804 km) spacing along major suburban arterials is consistent with land subdivision patterns in many states. It allows changes in cycle lengths to adjust speeds to reflect peak and off-peak travel demands without any loss in through band efficiency.

Inspection of Figure 3 shows that a ½-mile (0.804 km) spacing is needed to provide efficient progression at 30 mph (48 km/h) with the 120-second cycle commonly used in many developed urban and suburban areas during peak hours.

A ½ mile (0.804 km) spacing also enables the implementation of timing plans that will result in appropriate off-peak progression speeds at cycle lengths that are appropriate for use with off-peak traffic volumes. A 65-second cycle will provide progression at

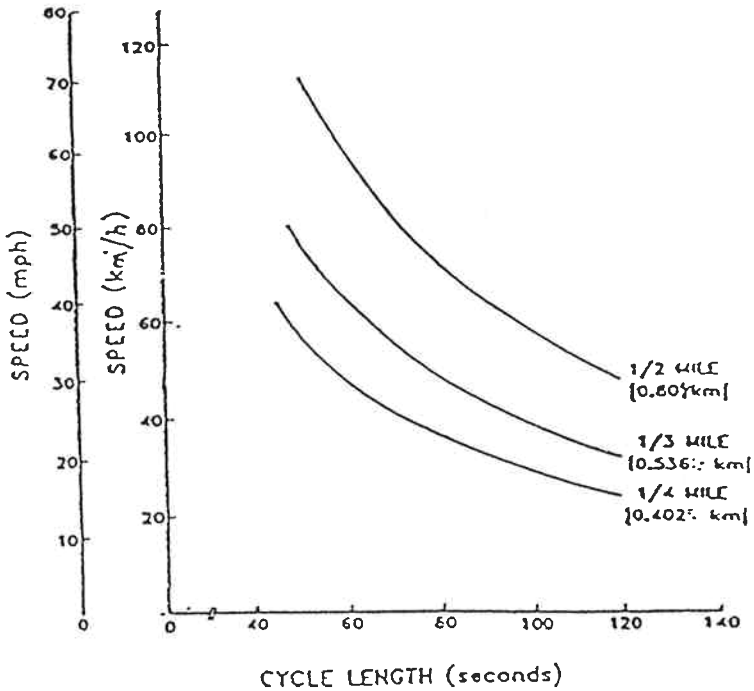


FIGURE 3 Optimum signal spacing as a function of speed and cycle length.

TABLE 2 OPTIMUM SIGNALIZED INTERSECTION SPACINGS (IN FEET) NEEDED TO ACHIEVE EFFICIENT TRAFFIC PROGRESSION AT VARIOUS SPEEDS AND CYCLE LENGTHS

Cycle Length (sec)	Speed (mph)						
	25	30	35	40	45	50	55
	Distance in Feet						
60	1,100	1,320	1,540	1,760	1,980	2,200	2,430
70	1,280	1,540	1,800	2,050	2,310	2,500	2,820
80	1,470	1,760	2,050	2,350	2,640	2,930	3,220
90	1,630	1,980	2,310	2,640	2,970	3,300	3,630
120	2,200	2,640	3,080	3,520	3,960	4,400	4,840
150*	2,750	3,300	3,850	4,400	4,950	5,500	6,050

* Represents maximum cycle length for actuated signal if all phases are fully used.

One mph = 1.609 km/h; one foot = 0.3048 meters

a speed of 55 mph (88 km/h), whereas an 80-second cycle provides a progression speed of 45 mph (72 km/h), without any loss in the "capacity" or efficiency of the progressive "through" band.

Obtaining long uniform signalized intersection spacing is much more difficult where: (1) there are severe topographical constraints, (2) land ownership patterns were laid out by metes and bounds or by Spanish land grant, and (3) the street pattern is irregular.

In many developed areas, signal spacing has already been established by the locations of intersecting streets.

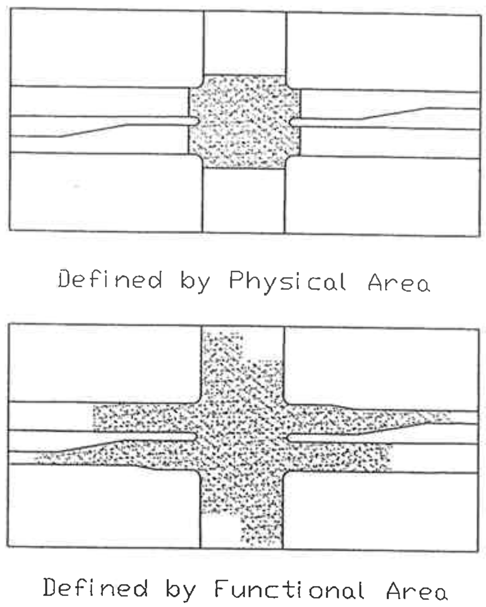


FIGURE 4 Boundary of intersection.

Existing operating speeds may be preserved by introducing signals for land development only where they fit into the time-space pattern and do not reduce significantly the through band width.

FUNCTIONAL INTERSECTION AREA

Corner clearances upstream and downstream of an intersection should be governed by the functional area of an intersection. AASHTO ("Green Book", page 793) specifically states that: "Driveways should not be situated within the functional boundary of at-grade intersections. This boundary would include the longitudinal limits of auxiliary lanes". While AASHTO does not present guidelines as to the size of this functional area, logic indicates that it must be much larger than the physical area (see Figure 4). It extends both upstream and downstream of the intersection and increases as the percentage of trucks increases.

Need for Turn Lanes

Research has found that accident rates increase exponentially as the speed differential in the traffic stream increases (V.G. Stover and F.J. Koepke, *Transportation and Land Development*, ITE, 1988). While the actual accident rates may change over time and by location, the ratio of the accident rates is expected to provide a good indication of the relative

TABLE 3 RELATIVE ACCIDENT POTENTIAL ON AT-GRADE ARTERIALS

Speed Differential	-10	-20	-30	-35
Relative Accident Potential	1	3.3	23	90

accident potential at different speed differentials. The relative accident potential values in Table 3 were obtained by dividing the accident rate at each speed differential by the accident rate of vehicle(s) traveling about 10 mph slower than other traffic. This indicates, for example, that a vehicle traveling 35 mph slower (a 35 mph speed differential) than other traffic is 90 times more likely to become involved in an accident than a vehicle traveling only 10 mph slower. A vehicle traveling 20 mph slower than the traffic stream has 3.3 times the likelihood of being involved in an accident as one going 10 mph slower than the other traffic.

Although the relative accident ratios may vary somewhat, they clearly show that the likelihood of accidents increases dramatically as the difference in the speed of vehicles in a traffic stream increases. This underscores the need to separate through traffic from vehicles that are turning right or left.

Figure 5 shows the observed speed profiles of right-turning vehicles on the approach to a driveway. As indicated in the figure, a variety of driveway throat widths and curb return radii result in very similar speeds. The driveways ranged from a 30-foot width and 30-foot radius (a total curb opening of 90 feet) to a width of 20 feet and zero radius (a "dropped" curb or "dustpan" design) having a total opening of 20 feet. The speed profiles for a variety of throat widths and curb return radii fell between these limits and were surprisingly similar. The forward speed for when the right-turning vehicles cleared the through traffic lane ranged from about 9 to 14 mph (14 to 22 km/h). Clearance was considered to have occurred when a following vehicle could pass without encroaching upon the adjacent traffic lane. Thus, the turning vehicle had not cleared the curb line. Very high speed differentials between the turning vehicles and through traffic will be generated which, in turn, produce a high accident potential. Thus, auxiliary left-turn and right-turn lanes (bays) are needed at intersections and driveways on major roadways.

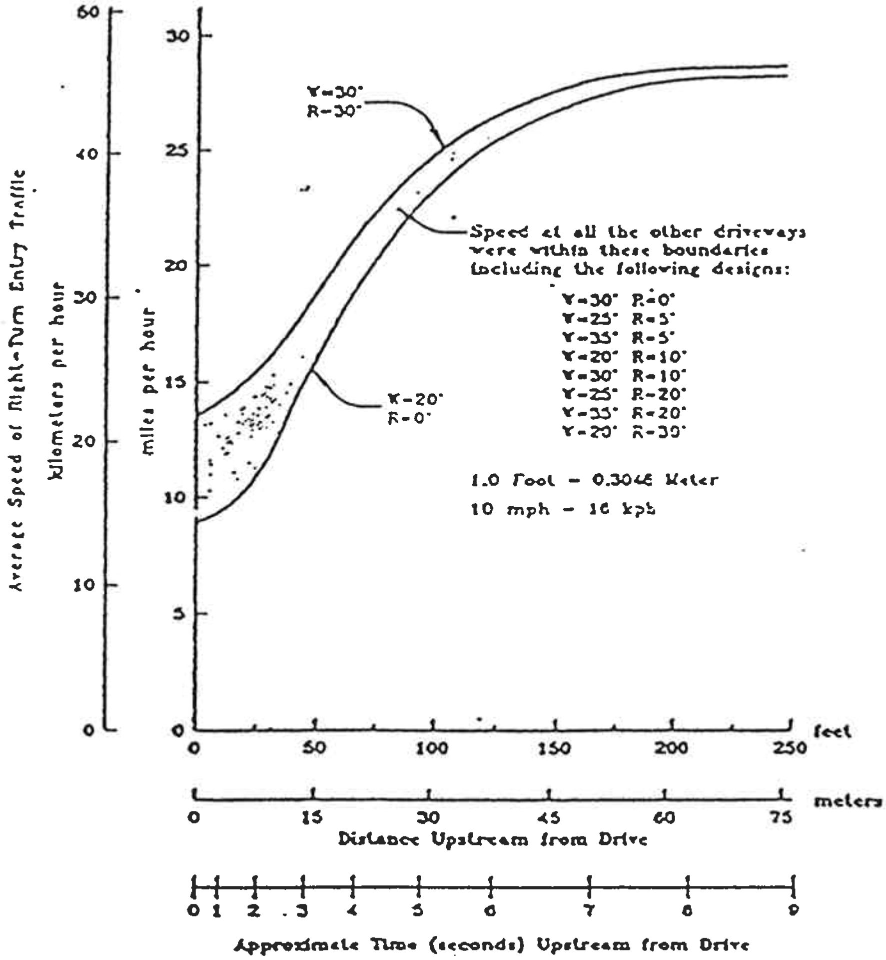


FIGURE 5 Speed profile of driveway traffic.

The fact that excessive speed differentials are created a considerable distance upstream from the point at which the driveway maneuver is made probably results in an under-reporting of driveway related accident reports. It also shows that turn lanes are needed to achieve acceptable speed differentials between driveway traffic and through vehicles on arterial streets.

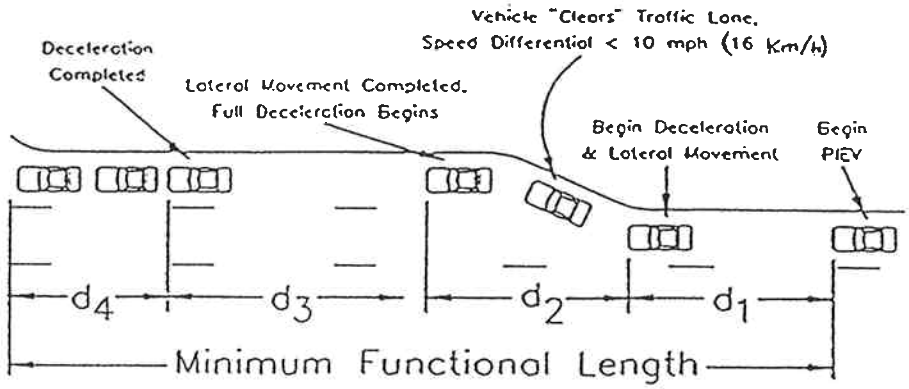
Use of a taper on the upstream side of the driveway does not significantly influence the speed of the vehicle making the driveway maneuver. However, the taper results in a reduction in exposure time (the time which the turning vehicle is blocking the through traffic lane).

Upstream Dimensions

The elements that define the upstream functional area of an intersection are shown in Figure 6. They include the following:

d_1 — The perception-reaction time required by the driver. For motorists who frequently use the street, this may be as little as one second or less. However, strangers may not be in the proper lane to execute the desired maneuver and may require several seconds.

d_2 — Braking while moving laterally is a more complex maneuver than braking alone — perhaps one-half the deceleration rate used in d_3. Lateral movement is commonly assumed to be 4 feet per second (1.2 meters per second) under urban conditions and 3 feet per second (0.9 meters per second) for rural conditions. At low deceleration rates, the driver will have shifted laterally so that a following vehicle can pass without encroaching on the adjacent lane before a 10 mph (16 km/h) speed differential occurs. At deceleration rates greater than about 4 fps^2 (1.2 mps^2), the speed differential will exceed 10 mph (16 km/h) before the turning vehicle "clears" the through traffic lane. Clearance is considered to have occurred when a



d_1 = distance traveled during perception–reaction time

d_2 = distance traveled while driver decelerates and maneuvers laterally

d_3 = distance traveled during full deceleration and coming to a stop or to a speed at which the turn can be comfortably executed

d_4 = storage length

Note: The maneuver elements (i.e., d_1, d_2, d_3, and d_4) apply equally to left turns and right turns.

FIGURE 6 Determinants of the intersection maneuver distance.

TABLE 4 FUNCTIONAL INTERSECTION AREA, EXCLUDING STORAGE

Minimum Maneuver Distance[1] in Feet (Metres)

Speed		Desirable Conditions[2]				Limiting Conditions[3]			
		Deceleration[5]		Total[6]		Deceleration		Total[6]	
km/hr[4]	(mph)	metres[4]	(feet)	metres[4]	(feet)	metres[4]	(feet)	metres[4]	(feet)
50	(30)	70	(225)	100	(325)	50	(170)	65	(215)
55	(35)	90	(295)	130	(425)	65	(220)	80	(270)
65	(40)	115	(375)	160	(525)	85	(275)	70	(335)
70	(45)	140	(465)	190	(630)	105	(340)	125	(405)
80	(50)	170	(565)	230	(750)	125	(410)	145	(480)
90	(55)	205	(675)	265	(875)	150	(495)	170	(565)
95	(60)	240	(785)	305	(1005)	170	(565)	200	(655)

(1) All values rounded to nearest 5 metres (5 feet).

(2) 2.5 second perception-reaction time; 1.1 mps^2 (3.5 fps^2) average deceleration while moving laterally into turn bay and an average 1.8 mps^2 (6 fps^2) deceleration thereafter, 16 kph (10 mph) speed differential.

(3) 1.0 second perception-reaction time; 4.5 fps^2 (1.4 mps^2) deceleration while moving laterally into turn bay and an average 9.0 fps^2 (2.7 mps^2) deceleration thereafter, 10 mph (16 kph) speed differential.

(4) Nearest 5 kph for design.

(5) Distance to decelerate from speed to a stop while maneuvering laterally into a left or right-turn bay.

(6) Deceleration distance plus distance traveled in perception-reaction time.

following vehicle can pass without physically encroaching on the adjacent lane.

d_3 — Deceleration after moving laterally into the turn bay should be at a rate that will be used by most drivers. Studies have found that most drivers (85%) will utilize a deceleration rate of 6 fps^2 (1.8 mps^2) or more; only about 50% can be expected to accept a rate of 9 fps^2 (2.7 mps^2) or greater (M.S. Chang, C.J. Messer, and J. Santiago, "Timing Traffic Signal Change Intervals Based on Driver Behavior," TRB, 1985), the rate used by AASHTO in establishing safe stopping sight distances.

d_4 — Length required to store all turning vehicles.

Functional upstream intersection areas for different speeds, excluding queue storage, are given in Table 4. In calculating the deceleration distances, full deceleration rates of 6 fps^2 (1.8 mps^2) and 9 fps^2 (2.7 mps^2) were used. The 6 fps^2 (1.8 mps^2 deceleration is accepted by 85% of drivers. This value is used for a "desirable condition" since it will be used, or accepted, by most drivers. Since only 50% of drivers accept an acceleration of 9 fps^2 (2.7 mps^2), this value is used as a limiting condition or upper limit for design. Maneuvering from the through lane into a right-turn or left-turn lane while decelerating is a more demanding driving task than decelerating only. Therefore, a lower deceleration rate was used in calculating distance d_2 than d_3.

The difference in the maneuver distance required for peak and off-peak speeds will provide some storage. This difference will generally be sufficient to provide the necessary right-turn storage on arterial approaches at intersections with collector streets. At high-volume intersections, the functional limits are commonly controlled by peak-period conditions since peak period maneuver distance plus storage for queuing is longer than the maneuver and storage distances needed in the off-peak. Thus, the functional area is comprised of the distance shown in the "Total" column in Table 4 plus the queue storage distance.

Downstream Dimensions

The downstream functional area of an intersection extends some distance downstream from the crosswalk location. It recognizes the need for guidance and tracking after a vehicle passes through an intersection. Although guidelines are needed for both upstream and downstream of an intersection, they are not as well developed for the downstream distances.

Various approaches may be considered in deriving the downstream distance in which no driveways should be located. These approaches include the following:

- Length of an acceleration lane,

TABLE 5 MINIMUM STOPPING SIGHT DISTANCES

		Calculated Stopping Distance (ft)	
Speed (mph)	AASHTO Stopping Distance(1) (ft)	9 fps^2 Deceleration(2)	6 fps^2 Deceleration(3)
20	125	120	145
25	150	165	205
30	200	220	275
35	250	275	350
40	325	340	435
45	400	410	530
50	475	485	640
55	550	565	750
60	650	655	870

One mph = 1.609 km/h; one foot = 0.3048 meters.

(1) Source: Reference (1) Table III-1, page 120, 1990. AASHTO "Green Book"; distances rounded to 25 feet for design.

(2) Average deceleration acceptable to about 50% of drivers; 2.5 sec. perception-reaction time; rounded to 5 feet.

(3) Average deceleration acceptable to about 85% of drivers; 2.5 sec. perception-reaction time; rounded to 5 feet.

- Stopping sight distance,
- Right-turn conflict overlap, and
- The left-turn driving task.

Length of an Acceleration Lane

A driveway or approach connection should not be placed within the length of an acceleration lane. In addition, there should be some separation distance between the end of the acceleration lane and the first downstream driveway. However, since acceleration lanes are rarely used on at-grade arterials, this criterion will seldom apply.

Stopping Sight Distance

Ideally, a vehicle should clear a major intersection before the driver is required to respond to vehicles entering, leaving or crossing the arterial. This simplifies the driving task and minimizes driver mistakes and collisions.

AASHTO stopping sight distances provide a possible criterion that enables drivers to clear an intersection before having to decelerate in response to a downstream conflict. AASHTO uses a 2.5 second perception-reaction time and coefficients of friction that are acceptable to about 50 percent of drivers. These distances — which are based on a deceleration rate of about 9 feet per second per second — are shown in Table 5. The table also shows stopping sight distances for a rate of 6 feet per second per second that is acceptable to 85% of the drivers.

Right-Turn Conflict Overlap

Minimizing the number of access points that a driver must monitor simultaneously simplifies the driving task. Drivers need to be alert for turning vehicles at one driveway at a time. This criterion — referred to in the literature as the "Right-Turn Conflict Overlap" — calls for adequate separation of conflict points.

Two conflict points between a through vehicle and a driveway vehicle are created where the driver of the through vehicle must be alert for a right-turning vehicle entering the roadway, from one drive at a time, or for a vehicle making a right-turn into a driveway. In both cases, through vehicles must decelerate to avoid a collision. This will create a shock wave in the through traffic stream. Moreover, a driver executing a right-turn or left-turn from the traffic stream will seriously disrupt the platoon flow. This has a negative impact on capacity and traffic operations as well as jeopardizing the public safety.

TABLE 6 MINIMUM DISTANCES TO REDUCE COLLISION POTENTIAL DUE TO RIGHT-TURN CONFLICT OVERLAP

Speed (mph)	Separation (ft.)
30	100
35	150
40	200
45	300

One mph = 1.609 km/h; one foot = 0.3048 meters.

(1) Measured from rear edge-to-rear edge of intersections as defined by curb returns. Assumes 1.0 second perception reaction time, 6.0 fps^2 average deceleration by through vehicle, vehicle entering the roadway accelerated at an average of 2.1 fps^2 to 3.1 fps^2.

The minimum distances that are required to avoid this conflict overlap for one-driveway at a time are shown in Table 6. These distances can be used to determine the minimum spacings when drivers monitor multiple driveways at a time. This is accomplished by dividing the distances shown by the number of driveways to be monitored simultaneously. Thus, half of these distances are needed where drivers are required to monitor two access points at a time. For example, using 300 feet (92 meters) for 45 mph (70 km/h), a separation of 150 feet (45 meters) will require drivers in the through traffic to monitor two driveways simultaneously.

The single and double right-turn conflicts are illustrated in Figure 7.

A comparison of stopping sight distances (Table 5) and conflict overlap (Table 6) shows that the latter are shorter distances than the stopping sight distances (i.e., 100ft -vs- 200ft at 30mph and 300ft -vs- 400ft at 45mph). This is because the through vehicles do not come to a complete stop. The resulting high speed differentials in the through traffic lanes poses a potential collision problem on high speed, high volume streets and roads.

Left-Turn Driving Task

The left turn maneuver at intersections is difficult and critical. Drivers making left turns should have at least 2.0 seconds before they encounter vehicles entering or leaving the roadway. This calls for a downstream distance of 45 to 60 feet (13m to 18m).

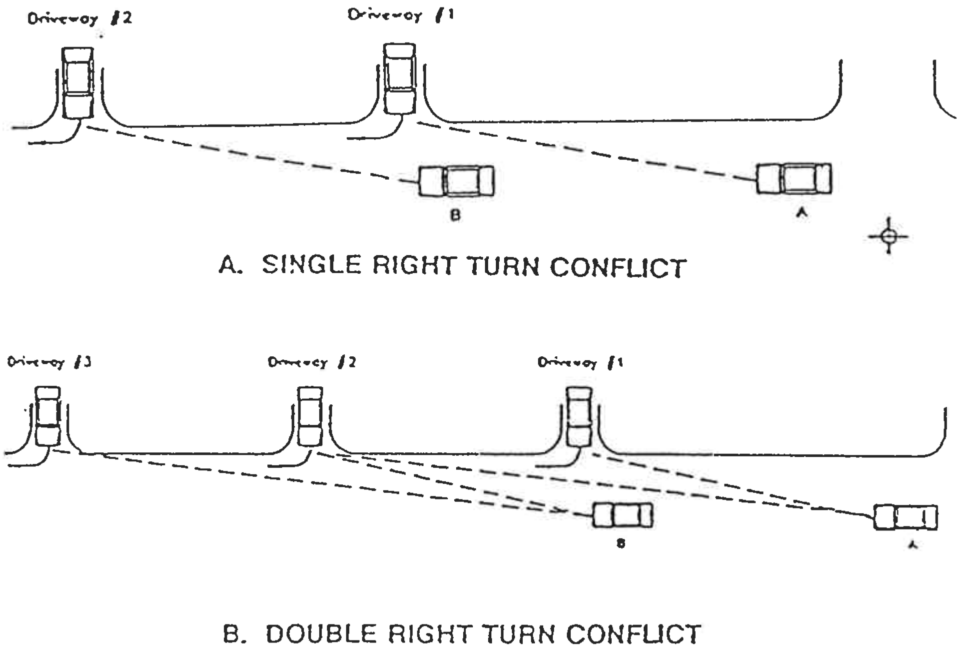
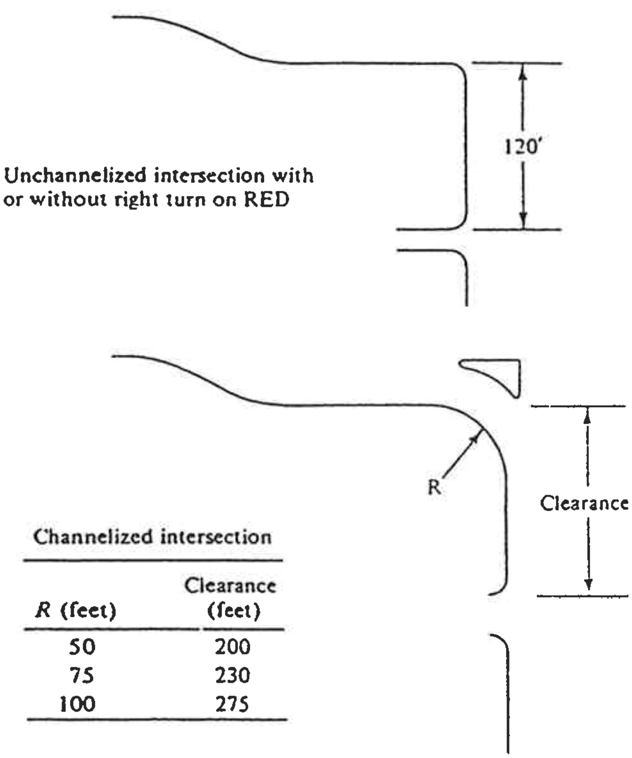


FIGURE 7 Right-turn conflict overlap.



Channelized intersection

R (feet)	Clearance (feet)
50	200
75	230
100	275

FIGURE 8 Right-turn downstream corner clearances.

Right-Turn Downstream Clearance Distances

Suggested corner clearances downstream from a major intersection are illustrated in Figure 8.

Where a right-turn deceleration lane of sufficient length is provided downstream from a major intersection, a distance of 35 to 40 ft (10m to 12m) between the end of the curb return and the beginning of the right-turn lane bay taper is desirable.

UNSIGNALIZED INTERSECTION SPACING

Jurisdictions that have adopted access management regulations have used different approaches for selecting standards for unsignalized access spacing. Theories that might be considered in selecting driveway spacing standards include:

- Stopping sight distance,
- Intersection sight distance,
- Length of turn lanes,
- Right-turn conflict overlap, and
- Egress capacity.

TABLE 7 AASHTO PASSENGER VEHICLE SIGHT DISTANCES FOR LEFT AND RIGHT TURNS

Design Speed (mph)	AASHTO Left and Right Turns
20	230
25	300
30	375
40	460
45	575
50	700
55	850
60	1,000
	1,500

One mph = 1.609 km/h; one foot = 0.3048 meters.

Examples of the actual practice are presented in the next section.

Stopping Sight Distance

Stopping sight distance must be provided at all intersections including driveways. AASHTO uses coefficients of friction that result in braking rates that are acceptable to about 50% of the drivers. The high deceleration rates suggest that minimum stopping sight distances suitable for access design may be longer than the recommended AASHTO values. Moreover, AASHTO does not address the problem of severe braking on a horizontal curve where locked wheel braking will cause a driver to lose control of the vehicle. Additionally, the higher height of eye in trucks does not offset the longer stopping distance required by trucks.

Intersection Sight Distance

Unobstructed sight distance must be provided on all approaches to an intersection. Any object within the sight triangle that is high enough above the elevation of the adjacent roadway to constitute a sight obstruction should be removed or lowered. Such objects include buildings, signs, cut slopes, hedges, trees, bushes, and tall crops. Curb parking within the sight triangle should also be prohibited.

AASHTO assumes a perception-reaction time of 2.0 seconds as being adequate for left turns, right turns, and crossing maneuvers. However, logic and experience indicate that need drivers making a left turn or crossing maneuver require more time than drivers turning right and only looking left.

For divided highways where the median is wider than the length of the design vehicle plus front and rear clearance, the maneuver can be performed as two operations. The stopped vehicle must first have adequate sight distance to depart from a stopped position and cross traffic approaching from the left. The crossing vehicle may then stop in the median before performing the second operation. The second move requires the necessary sight distance for vehicles to depart from the median to turn left into the cross road and to then accelerate without being overtaken by vehicles approaching from the right.

The AASHTO intersection sight distances assume that the stopped vehicle makes the turn and accelerates to 85% of the speed of traffic on the major roadway. This requires that on-coming traffic on the major roadway decreases speed by about 15%. Such an assumption is probably suitable for rural conditions; however, it may be a questionable assumption for high volume urban situations with coordinated traffic signal timing where traffic flow occurs in platoons. This is because: (1) drivers in the through traffic lanes will have limited opportunity to change lanes even under moderate volumes; and (2) forcing vehicles in the through traffic lanes to decelerate 15% will produce a speed differential "shock wave" in the traffic lane.

The sight distances shown in Table 7 suggest that the AASHTO values may be low for major urban arterials, especially for the left turn maneuver. However, the left-turn sight distance can be increased to account for a larger perception-reaction time by multiplying the through traffic speed in feet or meters per second by the number of seconds the perception-reaction time is to be increased.

The sight distances given in Table 8 suggest that the AASHTO intersection sight distance curves appear low for the crossing maneuver as compared to the calculated sight distances shown.

Length of Turn Lanes

The AASHTO "Green Book" (page 793) makes the statement that "Driveway terminals are in effect at-grade intersections . . . and . . . Driveways should not be situated within the functional boundary of at-grade intersections. This boundary would include the longitudinal limits of the auxiliary [left-turn and right-turn] lanes." Under this criteria, minimum driveway

TABLE 8 COMPARISON OF SIGHT DISTANCES FOR A PASSENGER VEHICLE CROSSING A TWO-LANE ROADWAY

Speed (mph)	Crossing Sight Distance (feet)			
	1990 AASHTO	Calculated(1) (2)		
		2-lane(3)	4-lane undivided(3)	6-lane undivided(3)
20	195	205	235	260
25	240	255	295	325
30	290	310	350	390
35	340	360	410	450
40	390	410	470	515
45	440	465	530	580
50	480	515	590	645
55	525	565	645	710
60	570	615	705	775
65	620	670	765	840
70	650	720	825	905

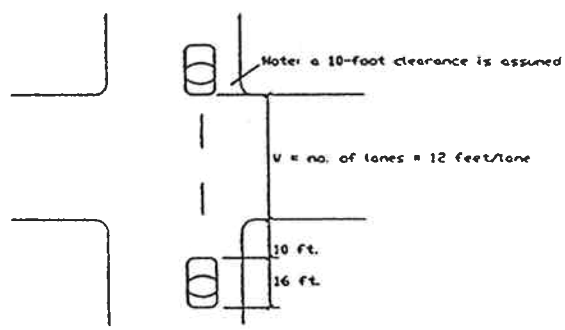
(1) 2.0 second perception-reaction. All values rounded to 5-foot increment.

(2) Acceleration times for crossing vehicles to clear roadway from Figure IX-33, Pg. 705, 1994 AASHTO "Green Book".

All distances rounded to 25 feet.

(3) 30 ft back-of-curb to back-of-curb; 8.2 second crossing time

Conditions:



One mph = 1.609 km/h; one foot = 0.3048 meters.

spacing would exceed the dimensions given earlier in Table 4.

Right-Turn Conflict Overlap

Minimum distances required to avoid the right-turn conflict overlap where shown earlier in Table 6. These distances would result in a speed differential substantially in excess of 10 mph. Thus, the conflict overlap criteria results in considerably shorter distances than the criteria of a 10 mph speed differential between a turning vehicle and through traffic.

If the right-turn conflict is to be limited to one driveway at a time and vehicles in the through traffic lanes are not required to reduce speed more than some accepted amount (such as a speed reduction of 0 mph, 10 mph, or 15% below design speed), the minimum driveway spacing is the intersection sight distance. Thus, it should be realized that the minimum spacings in Table 6 represent conditions where the access spacing has a significant impact on the through traffic. The potential magnitude of this impact is suggested by the speed differential that may be precipitated in the traffic stream.

As previously indicated, the distances for driveway spacing and downstream corner clearance given in

TABLE 9 MINIMUM ACCESS SPACING TO PROVIDE MAXIMUM EGRESS CAPACITY

Speed (mph)	Spacing (feet)[1]
20	120
25	190
30	320
35	450
40	620
45	860
50	1,125
55	1,500
60	1,875

(1) 1.5 times the distance required for a passenger car on level terrain to accelerate from zero to through traffic speed based on acceleration information from NCHRP Report 270 as contained in the 1990 AASHTO Green Book, Reference (1), Figure IX-34, p. 749

One mph = 1.609 km/h; one foot = 0.3048 meters.

TABLE 10 SUMMARY OF MINIMUM UNSIGNALIZED ACCESS SPACING (IN FEET) BY SPEED FOR VARIOUS CRITERIA

Criteria		Posted Speed (mph)								
		20	25	30	35	40	45	50	55	60
1.	Stopping Sight Distance	120	165	220	275	340	410	485	565	655
2.	Length of Turn Lane: Turning Traffic To Leave Through Lane With A Speed Differential Of:									
a)	≤ 10 mph					490	590	700	820	950
b)	≤ 15 mph				390	390	490	590	700	820
c)	≤ 20 mph			320	320	320	390	490	590	700
3.	Minimize Right Turn Conflict Overlap			100	150	200	300			
4.	Intersection Sight Distance Through Traffic Reduces Speed by 15%	230	300	375	460	575	700	850	1,000	1,150
5.	Maximum Egress Capacity	120	190	320	450	620	860	1,125	1,500	1,875

One mph = 1.609 km/h; one foot = 0.3048 meters

Table 6 may be used to determine minimum spacings requiring the driver to monitor multiple driveways by simply dividing the distance by the number of drives to be monitored simultaneously.

Egress Capacity

Driveways spaced at distances greater than 1.5 times the distance required to accelerate from zero to the speed of through traffic will reduce delay to vehicles entering the traffic stream and will improve the traffic absorption characteristics of the traffic stream (I.T. Major and D.J. Buckley, "Entry to a Traffic Stream, *Proceedings* of the Australian Road Research Board, 1962). Spacings based on accelera tion distances for passenger cars on level grades are given in Table 9.

At desirable peak-period speeds (about 35 mph, 55 km/h), the minimum spacing is 450 feet (137 meters). This suggests that more than five right-turn in and right-turn out driveways between signals at ½-mile (0.805 km) spacings will result in a reduction in the number of vehicles that can enter through the roadway from adjacent properties and will actually be detrimental to the businesses located on the arterial. At an off-peak speed, of say 50 mph (80 km/h), no more than one right-turn access drive can be provided without having a negative effect on capacity. The actual capacity effects will depend on the driveway volumes involved.

Summary

Table 10 summarizes the unsignalized access spacing guidelines for the various criteria that have been described. Spacing standards within the ranges shown should be selected whenever possible to ensure safe traffic operations. However, their application may require adjustments in developed areas, where land subdivision has often limited property frontage and the desired spacings may not always be achievable. To address these situations, procedures should be established to deal with exceptions to the adopted access standards.

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7. Adapted from AASHTO "Green Book."
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10. Adapted from Access Management, Location and Design, NHI Course No. 25255 Participant notebook, FHWA, 1992.

REGULATIONS, POLICIES, AND STANDARDS FOR STATE HIGHWAY SYSTEMS

This section discusses the spacing standards for states that have, or are considering access codes. These states include Colorado, Florida, and New Jersey where comprehensive codes are in effect, and Oregon where standards have been drafted. It also discusses pertinent standards that are contained in NCHRP Report 348 "Access Management Guidelines for Activity Centers." It contains standards for interchanges, signalized intersections/driveways, unsignalized intersections/driveways, and median breaks.

INTERCHANGES

Interchanges are normally provided along freeways and expressways. They also may be appropriate where major arterials cross, or in special situations such as providing access to major generators. Table 1 presents the interchange spacing standards for Florida, New Jersey, Oregon, and those suggested in NCHRP Report 348.

The minimum interchange spacing in urban/suburban areas generally ranges from one to two miles.

TABLE 1 REPORTED INTERCHANGE SPACING STANDARDS BY MILES (KILOMETERS) AND AREA TYPE

Miles (Km)

Area Type

	URBAN/SUBURBAN						RURAL ALL	
	1-CBD and Fringe for Cities in Urbanizing Areas		2-Existing Urbanized Areas Other Than Type 1		3-Transitioning Urbanized Areas and Urban Areas Other Than Type 2			
Colorado[1]	1	(1.6)	2	(3.2)	2	(3.2)	2	(3.2)
Florida[2]	1	(1.6)	2	(3.2)	3	(5)	6	(10)
New Jersey[3]	1	(1.6)	1	(1.6)	1	(1.6)	2	(3.2)
Oregon (Draft) [4]	2-3	(3.2-4.8)	2-3	(3.2-4.8)	2-3	(3.2-4.8)	3-8	(4.8-12.8)
AASHTO[5]	1	(1.6)	1	(1.6)	1	(1.6)	2	(3.2)
NCHRP 348[6]								
Freeway	1	(1.6)	1	(1.6)	1	(1.6)	3	(4.8)
Expressway	1	(1.6)	1	(1.6)	1	(1.6)	2	(3.2)

Sources:

(1) Colorado State Highway Access Code
(2) Florida DOT Access Management Standards (Rule 14-97).
(3) New Jersey State Highway Access Management Code.
(4) Huntington, D. and McSwain, R., "Access Management Facility Planning in Oregon" in Proceedings - First National Access Management Conference.
(5) A Policy on Geometric Design of Highways and Streets, AASHTO, 1990.
(6) Koepke, F.J. and Levinson H.S., NCHRP Report 348, Access Management Guidelines for Activity Centers.

TABLE 2 MINIMUM ACCEPTABLE THROUGH BANDWIDTH CRITERIA TO DETERMINE SIGNAL LOCATION — NEW JERSEY

	Minimum Acceptable Through Band Width
Urban	
Accessible Principal Arterial	50%
Minor Arterial	40%
Collector and Local	30%
Rural	
Accessible Principal Arterial	50%
Minor Arterial	40%
Major Collector	35%
Minor Collector/Local	30%

Note: Minimum cross street green time should be sufficient for pedestrians to cross highway.

TABLE 3 NEW JERSEY DOT SPACING OF SIGNALIZED INTERSECTIONS

Cycle Length (sec.)	Speed (mph) 25	30	35	40	45	50	55
	Distances in Feet						
60	1,100	1,320	1,540	1,760	1,980	2,200	2,430
70	1,280	1,540	1,800	2,050	2,310	2,500	2,640
80	1,470	1,760	2,050	2,350	2,640	2,640	2,640
90	1,630	1,980	2,310	2,640	2,640	2,640	2,640
120	2,200	2,640	2,640	2,640	2,640	2,640	2,640
150*	2,640	2,640	2,640	2,640	2,640	2,640	2,640

*Represents maximum cycle length for actuated signal if all phases are fully used.

Spacing in rural areas ranges from two to eight miles. Spacing, however, may be closer where access is provided to or from collector distributor roads.

SIGNALIZED INTERSECTION/DRIVEWAY SPACING

The spacing of signalized intersections should allow efficient signal progression at the prevailing speeds and cycle lengths. This normally requires relatively uniform spacings between signals, and sufficient distances between them.

Two basic approaches are used by the states:

1. Colorado and New Jersey (and suggested in NCHRP Report 348) specify minimum through band widths for various highway classes. Table 2 shows the minimum acceptable through band widths for New Jersey. Table 3 presents the optimum signal spacing applied in New Jersey for various progression speeds and cycle lengths. Table 4 presents the ranges in acceptable through band widths suggested in NCHRP Report 348.

TABLE 4 RANGES IN MINIMUM ACCEPTABLE THROUGH BANDWIDTH FOR EVALUATING SIGNAL LOCATIONS

ACCESS LEVEL/ CATEGORY	URBAN		SUBURBAN		RURAL	
	Speed mph	Min. Band Width(%)	Speed mph	Min. Band Width (%)	Speed mph	Min. Band Width (%)
1 Freeway	55	a	55	a	55	a
2 Expressway	40 - 45	45 - 50 b	45 - 50	45 - 50 b	50 - 55	45 - 50 b
3 Strategic Arterial	30 - 35	45 - 50 c	35 - 40	45 - 50 c	50 - 55	45 - 50 c
4 Principal Arterial	30 - 35	40 - 45	35 - 40	40 - 45	45 - 50	40 - 45
5 Minor Arterial	30 - 35	35 - 40	35 - 40	35 - 40	45 - 50	35 - 40
6 Collector	30 - 35	30 - 35	35 - 40	30 - 35	40 - 45	30 - 35
7 Local/ Frontage Rd	25 - 30	d	30 - 35	d	40 - 45	d

a = Not applicable.
b = Applies to signalized public streets only, since direct access to driveways is prohibited.
c = Generally applies to signalized public streets only, since direct access to driveways is generally prohibited.
d = Not specified.

Thus, a principal arterial would require the following minimum through band widths.

	Speed (mph)	*Minimum Bandwidth (%)*
Urban	30-35	40-45
Suburban	35-40	40-45
Rural	45-50	40-45

2. Spacing standards can be specified for each class of road. This approach is followed in Colorado and Florida. Both states require ½-mile spacing along high type roads (Tables 5 and 6). Oregon is proposing ½ to 2-mile signal spacing along expressways (Table 7).

These criteria are designed to limit signals (especially for access drives) to locations where the progressive flow of traffic will not be impaired significantly, and there is no loss to through band width for the prevailing travel speed. However, spacing requirements can be relaxed when signals are provided in only one direction of travel and there is no loss in through band width.

UNSIGNALIZED INTERSECTION/DRIVEWAY SPACING

There is a general consensus that standards for unsignalized intersections are needed to promote safety, ensure adequate sight distances, and minimize delays to through traffic. There is, however, a wide diversity of opinion and practice regarding the specific spacing criteria: some agencies base standards on safe stopping sight distances; operating speeds; or overlapping right turn requirements. A few base standards on the size and type of generator. Some use a rule of thumb that spaces driveways at five times the driveway width.

TABLE 5 COLORADO DOT ACCESS STANDARDS

ACCESS CATEGORIES	ROADWAY TYPE	DIRECT LAND ACCESS	ROADWAY INTERSECTION SPACING	INTERSECTION TREATMENT	POSTED SPEED	SIGNAL PRO-GRESSION[1]	MINIMUM BAND WIDTH[1]
1	Freeway	None	N/A	Grade separation	55 mph	N/A	N/A
2	Expressway	Generally prohibited. Right turns permitted if no other reasonable access exists.	1 mile desired (½ mile min.)	Signals or grade separation of heavy cross traffic volumes	55 mph	45 mph	50%
3	Arterial	Preferably prohibited. Right turns permitted if no other reasonable access exists.	½ Mile ± 200 ft.	Signals	45-55 mph	45 mph	40% desirable (30% min. if existing band is below 30%)
4	Arterial/ Collector	Permitted	½ Mile ± 200 ft.	Signals	35 mph	35 mph	30% desirable (20% min. if existing band is below 20%)
5	Frontage/Service Roads	Permitted	Based on posted speed	Signals	Existing posted speed	N/A	N/A

Source: The State Highway Access Code, Amended by the Colorado State Highway Commission, August 15, 1985.

Note: [1] 90-120 second cycle.

TABLE 6 FLORIDA DOT ACCESS MANAGEMENT STANDARDS (RULE 14-97)

ARTERIAL CLASSIFICATIONS & STANDARDS

Access Class	Medians "Restrictive" physically prevent vehicle crossing "Non-Restrictive" allow turns accross at any point	Connection Spacing (feet)		Median Opening Spacing		Signal Spacing (feet)	Connection Spacing (meters)		Median Opening Spacing		Signal Spacing (meters)
		>45mph	<45mph	Directional	Full		>75kph	<75kph	Directional	Full	
2	Restrictive w/ Service Roads	1320	660	1320	2640	2640	400	200	400	800	800
3	Restrictive	660	440	1320	2640	2640	200	130	400	800	800
4	Non-Restrictive	660	440			2640	200	130			800
5	Restrictive	440	245	660	2640/ 1320	2640/ 1320	130	75	200	800/ 400	800/ 400
6	Non-Restrictive	440	245			1320	130	75			400
7	Both Median Types	125		330	660	1320	40		100	200	400

The key factors that influence spacing include: (1) the access class of road, (2) the design and operating speed of the roadway, and (3) the size of the traffic generator involved. But there appear to be few, if any, generally accepted models for how they should be inter-related.

Individual state practices vary. (1) Florida and Oregon specify allowable distances by the type or access class of road (Tables 6 and 4-7), (2) Colorado uses safe stopping sight distance as the criteria for roads where direct access is permitted, (3) New Jersey adopted the same distances as derived from overlapping right turn criteria. All three states have a system by which variances may be issued where the standards cannot be met.

Along a highway in an established urban area with a mix of long and short frontage lots, New Jersey has adopted standards for average driveway spacing based on posted speed limit rather than a required minimum spacing standard between adjacent driveways. New Jersey applies a formula for "non-conforming" lots to limit the allowable traffic generation based on the lot frontage, acreage, and posted speed limit.

Figure 1 presents a hypothetical development scenario for purposes of comparing the spacing practices

TABLE 7 DRAFT OREGON DOT ACCESS MANAGEMENT CLASSIFICATION SYSTEM

Category	Access Treatment	LOI (1)	Urban / Rural	Intersection				Signal Spacing (4)	Median Control
				Public Road		Private Drive (3)			
				Type (2)	Spacing	Type	Spacing		
1	Full Control (Freeway)	Interstate/ Statewide	U	Interchange	2-3 Mi·	None	NA	None	Full
			R	Interchange	3-8 Mi	None	NA	None	Full
2	Full Control (Expressway)	Statewide	U	At Grade/Intch	1/2-2 Mi	None	NA	1/2-2 Mi	Full
			R	At Grade/Intch	1-5 Mi	None	NA	None (5)	Full
3	Limited Control (Expressway)	Statewide	U	At Grade/Intch	1/2 - 1 Mi	Rt Turn	800 '	1/2-1 Mi	Partial
			R	At Grade/Intch	1-3 Mi	Rt Turn	1200 '	None (5)	Partial (6)
4	Limited Control	Statewide / Regional	U	At Grade/Intch	1/4 Mi	Lt/Rt Turn	500 '	1/2 Mi	Partial/None (7)
			R	At Grade/Intch	1 Mi	Lt/Rt Turn	1200 '	None (5)	Partial/None (7)
5	Partial Control	Regional District	U	At Grade	1/4 Mi	Lt/Rt Turn	300 '	1/4 Mi	None
			R	At Grade	1/2 Mi	Lt/Rt Turn	500 '	1/2 Mi	None
6	Partial Control	District	U	At grade	500 '	Lt/Rt Turn	150'	1/4 Mi	None
			R	At grade	1/4 Mi	Lt/Rt Turn	300 '	1/2 Mi	None

of Colorado, Florida, and New Jersey. Table 8 provides more details concerning how access would be accommodated for each of the lots in this scenario.

Current practices by cities and states, obtained from the NCHRP Report 348 survey, are shown in Table 9. These general guidelines are not necessarily consistent with those based upon speed, right turn conflict or sight distance criteria. NCHRP Report 348 also developed a series of spacing standards that are keyed to travel speed, access classification, and size of generator.

MEDIAN OPENINGS

Median openings generally should relate to the street or block spacing. Thus, where streets are placed every mile, ½ mile, ¼ mile and so on, these modules will influence median spacing. In addition, *full* median openings should be consistent with signal spacing criteria, or otherwise be susceptible to closure.

Florida has six classes of arterial roadways. Three of these require restrictive (physical) medians. Directional (left turn in) spacing ranges from 660 to 1320 feet. Full median *and* signal spacing range from 1320 to 1640 feet. NCHRP Report 348 suggests unsignalized median spacings of 330 to 660 feet for urban settings, 660 feet for suburban settings, and 1320 feet for rural settings. However, a full median applies only to "other arterial" and collector roads; for higher classes, medians are limited to street intersections or to left turn entrances only.

In general, access on both sides of the road should be aligned on undivided highways. Where this is not possible, sufficient left-turn storage should be provided in establishing the minimum offset distance. In general, driveways should be offset by at least 200 feet when two low-volume traffic generators are involved, the higher of 200 feet or the established spacing standard when one major traffic generator is involved, and at least two times the established spacing standard when two major traffic generators are involved.

TABLE REFERENCES (Only Those Cited)

2. New Jersey Department of Transportation.

3. Appendix D of New Jersey Access Code.

4,9. Koepke, F.J. and H.S. Levinson, Access Management Guidelines for Activity Centers. NCHRP *Report 348*. TRB, National Research Council, Washington, D.C., 1992.

7. Huntington, D. and R. McSwain, *Access Management and Facility Planning in Oregon*, 1993 Conference Proceedings, Vail, Colorado.

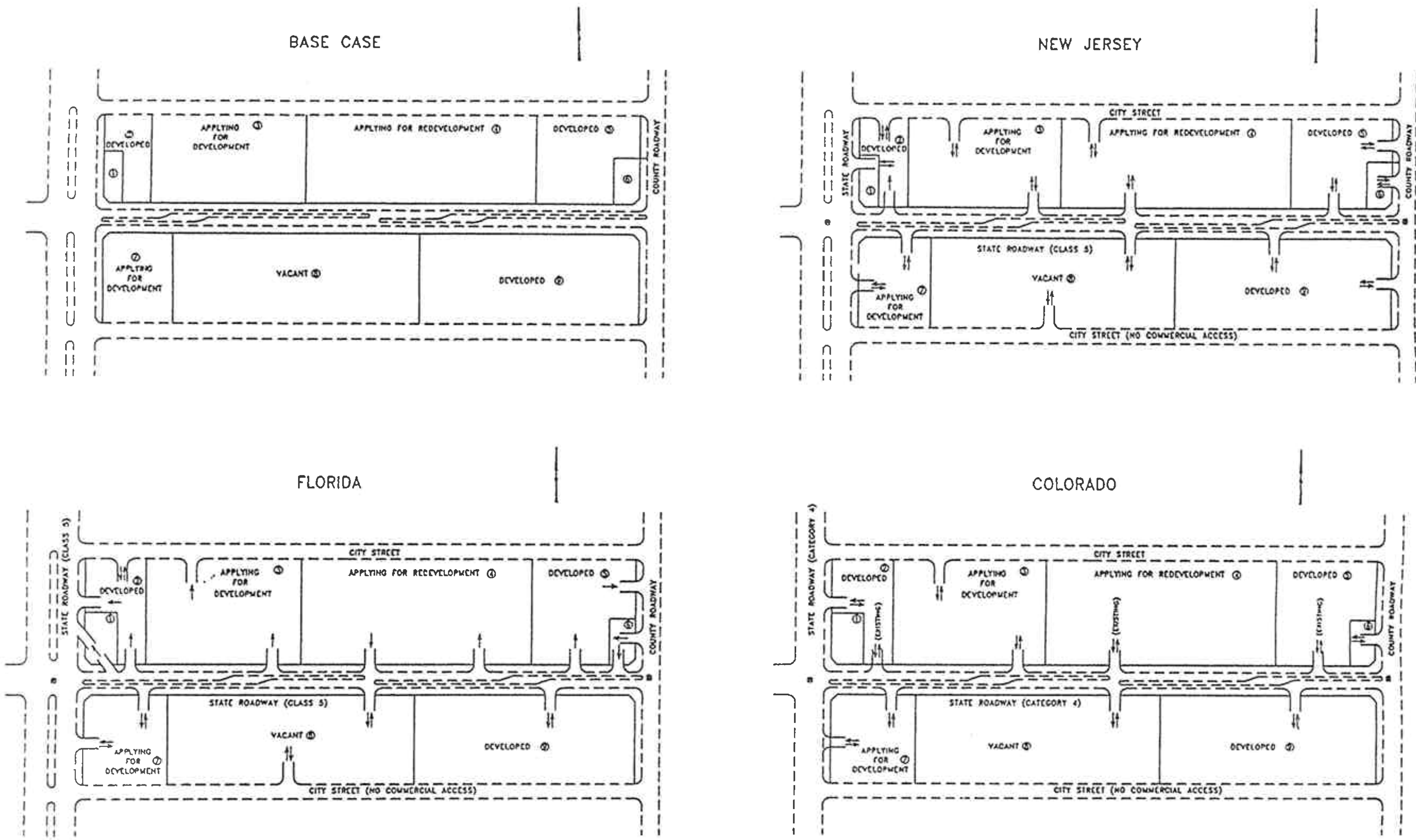

FIGURE 1 Comparison of hypothetical application of Colorado, Florida, and New Jersey standards.

TABLE 8 HYPOTHETICAL APPLICATION OF SPACING STANDARDS: COMPARISON OF COLORADO, FLORIDA, AND NEW JERSEY

LOT NUMBER AND STATUS	COMMENT BY LOT		
	COLORADO	FLORIDA	NEW JERSEY
1 Developed or Undeveloped	One-way access (entrance) to east-west and north-south (entrance) state hwys acceptable for lot redevelopment. Two-way access to north-south state hwy for proposed development.	One-way access to east-west (entrance) and north-south (exit) hwys with 75' and 100' corner clearances respectively.	One-way access (entrance) to east-west state hwy conditional to waiver approval. Two-way access to north-south state hwy preferable.
2 Developed	Two-way access to east-west and north-south state hwys acceptable.	One-way access (entrance) to east-west and north-south state hwys preferable for significant change to site.	Access to city street preferred to north-south hwy. One-way access (entrance) to east-west state hwy acceptable. Access to north-south state hwy objectionable.
3 Applying for development	Access to east-west state hwy acceptable. Alternative access to city street desirable.	One-way access (entrance or exit) to east-west state hwy and city street (exit or entrance) desirable. Required clearance of 440' from driveway for lot #4.	Access to east-west state hwy required east of left turn pocket. Alternative access to city street desirable.
4 Applying for redevelopment	Access to east-west state hwy acceptable. Additional access conditional to meeting variance requirements.	One-way access to east-west hwy acceptable. Additional access, 440' clearance and variance application required.	Operational evaluation and queuing analysis required on east-west state hwy. Alternative access to city street desirable.
5 Developed	Two-way access to east-west state hwy acceptable. Shift driveway away from intersection.	One-way access to east-west state hwy modification recommended. Additional access not specified (county road).	Access to east-west state hwy acceptable. Additional access to county road desirable.
6 Undeveloped	Access to county road preferred over east-west state hwy.	One-way access (exit) to east-west state hwy acceptable. Additional access required on county road.	Access to county road acceptable, access denied on state hwy.
7 Applying for development	Two-way access to east-west and north-south state hwys acceptable.	Two-way access to east-west and north-south state hwys acceptable.	Access to east-west or (and) north-south state hwy conditional to corner clearance (evaluation of benefits).
8 Vacant	Access to east-west state hwy acceptable. Additional access conditional to meeting variance requirements.	Access determined by location of driveways for adjacent lots.	Operational evaluation and queuing analysis required on east-west state hwy. Alternative access to city street desirable.
9 Developed	Access to east-west state hwy acceptable.	Two-way or two one-way access to east-west state hwy acceptable.	Proposed access to east-west hwy acceptable. Alternative access to city street or county road desirable.
COMMENTS	Hwys assumed as urban hwys (cat 4).	Speed limit assumed at 45 mph. East-west hwy assumed to be divided.	Speed limit assumed at 45 mph. East-west hwy assumed to be divided.

TABLE 9 GENERALIZED GUIDELINES FOR UNSIGNALIZED ACCESS SPACING

Condition	Guideline	
• Operating Speed:	30 mph 100-200+ feet 45 mph 300-550+ feet	
• Type of Facility: - Spacing		
Major (principal) arterials	300-500 feet	
Minor arterials	100-300 feet	
Collectors	100-200 feet	
• Corner Clearance:	Upstream	Downstream
Major arterials	450 ft.	350 ft.
Minor arterials	400 ft.	350 ft.
Collectors	200 ft.	200 ft.
Major collectors (residential)	150 ft.	150 ft.
• Type of Generator: Projected Driveway Volume	Distance From Street	Distance From Driveway
‹ 500 ADT	5 - 50 ft.	5 - 60 ft.
500 - 1,500 ADT	50 - 100 ft.	100 - 400 ft.
› 1,500 ADT	100 - 800 ft.	300 - 800 ft.

REGULATIONS, POLICIES, AND STANDARDS FOR LOCAL HIGHWAY SYSTEMS

This section gives examples of spacing of unsignalized and signalized driveways and intersections for local highways and streets, including corner clearances and median treatments where they are employed. "Local" is defined as all jurisdictions other than states, including: cities, counties, Metropolitan Planning Organizations (MPO) and municipalities. The components of access management are frequently addressed in sections concerning subdivision/site plan regulations and are not usually part of access management programs. While there appears to be many local regulations including corner clearance and driveway spacing standards, the global impact of these tools on increasing safety and capacity is reduced when they are applied individually.

The need for spacing standards and concepts applies to local highway and street systems. Access management concepts are based on tested traffic engineering principles and applied to physical conditions that do not relate to the type of governmental jurisdiction involved. For example, in New Jersey, the state access code provides spacing standards that can be used in access manage ment programs for local highway systems.

As states increase access management on their state highway systems, regional, county and local roadway systems are receiving greater pressure to increase land access along their roadways. A key to providing this access and maintaining good local circulation will require careful and coordinated land use and local circulation planning. This may explain why an increasing number of local entities have established driveway spacing standards. Many local jurisdictions are turning to some form of access management plans in areas that are now or are expected to be intensely developed to maintain functional integrity while permitting site access.

In reviewing the various spacing standards it becomes apparent that no uniform policies or standards are used, although Tri-County MPO (Michigan) and New Jersey adopted the same spacing standards that were derived from overlapping right-turn criteria. Consideration of the local context, including local political issues, may be a key factor in the observed variation. Access management decisions at the local level may be more influenced by political issues, since the decision-makers often have limited transportation knowledge.

Another issue relates to the loss of functional integrity (operational viability). In many areas, there are a multitude of agencies responsible for permit issuance and roadway construction and improvement. In addition, it is rare that one agency makes all decisions for the various functional classifications of roads. It is important that these various agencies consult and coordinate their efforts to provide a "seamless", integrated and properly functioning roadway system that provides for both regional and local traffic mobility, and land access.

TABLE 1 SUMMARY OF DRIVEWAY SPACING CONTROLS FOR SELECTED CITY AND COUNTY GOVERNMENTS

Jurisdiction	Level of Government	Type of Regulation
Tri-County RPC, Lansing, MI	MPO	Ordinance
Ingham County, MI	County	Administrative Rule
Palm Beach County, FL	County	Administrative Rule
Austin, TX	City	Land Development Code/Transportation Criteria Manual
Lakewood, CO	City	Ordinance
Tallahassee, FL	City	Ordinance/ Regulatory Manual
Clarksville, TN	City	Ordinance

TABLE 2 TRI-COUNTY REGIONAL PLANNING COMMISSION UNOBSTRUCTED SIGHT DISTANCES FOR EXITING VEHICLES

Design Speed (mph)	Sight Distance (feet)
30	200
35	225
40	275
45	325
50	350

TABLE 3 DESIRABLE COMMERCIAL DRIVEWAY SPACING BETWEEN TWO-WAY DRIVEWAYS[1,2,3] IN INGHAM COUNTY, MICHIGAN

Posted Speed (mph)	Minimum Separation (feet)
25	105
30	125
35	150
40	185
45	230
50	275
55	330

1 Distances between adjacent one-way driveways with inbound drive upstream from outbound drive can be one-half the distances shown above.

2 Measured near edge to near edge of adjacent driveways.

3 Where a parcel lacks sufficient frontage to meet above requirements, owner may: 1) seek a variance, but in no case can the variance permit spacing less than the next lowest classification, or 2) agree to establish common driveway with adjacent owners; the driveway midpoint should be the property line between the two parcels.

Of critical importance to agencies responsible for good access management at the local level is the need to provide adequate sight distance. It is important on all roadways, but it is an especially important consideration on local roadways where land access is provided and there are numerous driveways. (See section 3, "Unsignalized Intersection Spacing" for more specific details on stopping sight distances.) Many of the local regulations reviewed here provided sight distance requirements that represent good practice as described in section 4.

A sampling of local regulations are reviewed in this section, as indicated in Table 1. The types of jurisdictions range from regional, such as MPOs to cities and counties.

TABLE 4 PROPERTY CLEARANCE REQUIREMENTS FOR INGHAM COUNTY, MICHIGAN

Classification	Property Clearance (feet)
Arterial	75
Collector	50
Local (nonresidential)	25
Local (residential)	10

* Minimum property clearance distance should ideally be one-half of the driveway spacing requirement (see Table 3) to ensure adequate spacing; where a property has insufficient frontage to provide this distance, joint access with adjacent property should be pursued.

METROPOLITAN PLANNING ORGANIZATIONS/ COUNCILS OF GOVERNMENT

Tri-County Regional Planning Commission — Lansing, Michigan

The spacing standards used by the Tri-County Regional Planning Commission are identical to those used by New Jersey (see section 4). A second set of standards addresses the placement of driveways by requiring unobstructed sight distance for exiting vehicles, as shown in Table 2. There are also requirements for corner clearance that call for a minimum of 40 feet from the perpendicular curb face of the signalized or stop-sign controlled intersection to the point of tangency of the driveway curb return radius closest to that intersection. The driveway radius is not permitted to compound with the intersection corner.

COUNTIES

Ingham County, Michigan

Rules adopted on December 1, 1994 by the Ingham County Road Commission include driveway spacing

TABLE 5 CORNER CLEARANCE REQUIREMENTS FOR INGHAM COUNTY, MICHIGAN

Roadway Classification	Intersecting with	Clearance (in feet)
Arterial	Arterial	250
	Collector	125
	Local	50
Collector	All	50
Local	All	50

* If property line is less than the distance from the corner than meets the minimum requirements, then the driveway must be located within 10 feet (3.05 meters) of the property line [farthest] away from the corner.

TABLE 6 ACCESS STANDARDS FOR PALM BEACH COUNTY, FLORIDA

Roadway Classification	Driveway Spacing	Signal Spacing	Corner Clearance (Minor Street)	Corner Clearance (Thoroughfare Plan Road)	Median Opening
80′ ROW – Collector	125′ *	.25 mile	50′	75′	N/A
106′ or Wider ROW – Arterial	245′ *	.5 mile	75′	125′	660′–830′

Note: All dimensions are minimums. [ROW = right-of-way.]
* Minimum spacing permitted between driveways.

standards as a function of posted speed limit, as outlined on Table 3. The standards are based on average vehicle acceleration and deceleration rates considered necessary to maintain safe traffic operations. The county also specifies Property Clearance standards for the distance between the property line of a parcel and the nearest edge of the nearest driveway as shown in Table 4. Corner clearance standards are also provided and were determined as a function of the type of streets which intersect as per Table 5.

Clear vision areas are required and govern intersections and railroad crossings where the Road Commission either controls the limited access right of way or has an easement for a clear vision area. Driveways are not permitted where the Commission controls the right of way. Where the Commission only has easements, driveways are not permitted if another reasonable point of access is available. Sight distance requirements are very specific according to the type of vehicle and type of roadway, and the turning movements involved. There are specific requirements for stopping sight distance when there are grade changes of more than 3%.

For commercial driveways, one driveway is permitted for each separately owned parcel having less than 100 feet of frontage, provided it can meet the other requirements (for driveway width, etc.). Additional driveways are permitted when there is more than 100 feet of frontage, provided that the sum of the driveway widths of additional driveways does not exceed 15 percent of the frontage in excess of the first 100 feet. The traffic volume, safety and operation considerations and the rules must also be met. The Commission can deny access when such driveway would result in a safety hazard. Driveway consolidation is encouraged but not required. One residential driveway is permitted per each platted lot or for unplatted property with less than 100 feet of frontage. Additional residential driveways

TABLE 7 DRIVEWAY DEFINITIONS FOR AUSTIN, TEXAS — TRANSPORTATION CRITERIA MANUAL

Type of Driveway	Access Definition
Type I	1 or 2-family residences
Type II	Any development other than in Type I
Type III	A temporary asphalt approach to parcels being used by any type of development, from a road not yet constructed or not having curb and gutter; must be reconstructed to Type I or Type II standards within 60 days after construction of the abutting street to permanent standards

are permitted when the frontage is greater than 100 feet, provided that the sum of the driveway widths of additional drives do not exceed 15 percent of the frontage in excess of the first 100 feet.

Palm Beach County, Florida

Palm Beach County established two classifications for county-maintained roadways - *undivided collector* roads having an 80-foot right-of-way, and *divided arterial* roads of 106 feet or wider. The 80-foot collectors typically consist of a 5-lane undivided section having a two-way left turning lane in the center. All divided roadways are classified in the 106-foot arterial category. The typical sections of these roadways include 6 or 8-lane sections with medians; left turns are accommodated in the medians. In both cases, where roadways have not been built to their ultimate sections, it is required to base driveway spacing on the ultimate design section of the roadway.

The driveway spacing standards differ for the 80-foot undivided and 106-foot divided roadway sections, as shown on Table 6. The county does not specify the number of driveways serving a site, and sites are evaluated on a case by case basis. However, the number of driveways should be kept to a minimum. Standards are provided for median openings on divided roads, and for corner clearances categorized by the type of road - minor or thoroughfare - which intersects the main county road, as well as by the county roadway classification.

TABLE 8 AUSTIN, TEXAS, DRIVEWAY SPACING REQUIREMENTS FOR ALL PERMANENT DRIVEWAYS EXCEPT THOSE AT 1- AND 2-FAMILY RESIDENCES

Local Street, Residential or Neighborhood Collector	50
Commercial or Industrial Collector	75
Primary Collector	100
Minor Arterial	150
Major Arterial, PRA	200
"Hill Country Roadway"	300

PRA = Principal Roadway Area — where zoning controls prohibit access to individual lots with less than 200 feet of roadway frontage along designated routes. Lots with less frontage may require joint access or alternative access agreements.

CITIES

Austin, Texas

The City of Austin uses two methods to manage access: a Transportation Criteria Manual (TCM) and a Land Development Code (LDC) that together provide a comprehensive approach to driveway spacing.

The December, 1991 *Transportation Criteria Manual* provides minimum design criteria intended to assure that access is provided to abutting property with a minimum of interference with the free and safe traffic movements, and prevents congestion in the area of the abutting property's entry/exit. *The right of the public to free and unhampered passage on public streets is considered paramount to other interests*. The manual also notes that, while regulated limitation of access is necessary for arterials to enhance their primary mobility function, providing access is the primary function of local roads and streets. The three types of driveways used in Austin are described in Table 7.

While the TCM provides a series of separate standards for one-way, two-way undivided and two-way divided roads, the spacing standards are identical for all three and are summarized in Table 8. The manual recognizes that, as a result of limited lot frontage or other constraining factors, existing physical conditions may not permit complete adherence to the standards. In such cases the TCM encourages, but does not require, alternative access options such as joint access driveways, access easements or access to intersecting streets.

Table 9 provides the driveway offset requirements. Although alignment with opposing streets is permitted

TABLE 9 AUSTIN, TEXAS, REQUIREMENTS FOR DRIVEWAY LOCATION FOR TYPE II AND III DRIVEWAYS

Type of Roadway	Alignment	or	Offset (feet)
Undivided Arterial or Driveway	With Opposing Street		120
Undivided Collector or Driveway	With Opposing Street		80
Divided Roadways	With Median Breaks		100

TABLE 10 AUSTIN, TEXAS, REQUIREMENTS FOR CORNER CLEARANCE

Driveway Type	Minimum Spacing Requirement to Inter-tersecting Right-of-Way — the less of *
Type I	50 feet or no closer than 60% of parcel frontage
Type II and III	100 feet or no closer than 60% of parcel frontage

* Driveways cannot be constructed within the curb return of a street intersection.

for signalized intersections, this option is discouraged and requires the approval of the Director of Transportation and Public Services. If approved, the driveway may be subject to design specifications such as an increase in maximum driveway widths to provide a driveway width that is the same as the cross-section of the opposing street. Corner clearance standards are shown on Table 10.

The LDC defines a fourth type of driveway, Type IV, that serves as access from a Principal Roadway Area (PRA) to a lot used for any purpose other than 1-2 family residential. PRA is an area where particular zoning controls are applied that prohibit direct access to individual lots with less than 200 feet of roadway frontage along designated routes. Lots with less frontage may require joint access or alternative access agreements. If no alternative access measures can be applied and a property has an unconforming frontage, a maximum of one driveway will be allowed.

Access spacing requirements can be modified for properties that would be subject to right-of-way condemnation before their acquisition if so requested by either the condemning authority or property owner. Such a modification requires a finding that a deviation from the spacing standard would not create a public safety hazard or have an adverse effect on roadway operations.

Lakewood, Colorado

The City of Lakewood adopted an ordinance in 1985 that sets forth access controls and street classifications. The ordinance refers extensively to the Colorado State Highway Access Code. Spacing on state highways must meet the provisions of the state access code. For city streets, when lots are not large enough to allow accesses on opposite sides of the street to be aligned, the center of driveways should be offset by 150 feet on collector and commercial/multi-family local streets; or 300 feet on all arterials. It states that joint access must be considered for two adjacent developments when a new access will not meet the spacing requirements. The ordinance utilizes functional classification for the various spacing requirements, except for sight distance, which is governed by number of lanes, design speed and type of turning movement.

Access spacing requirements are shown in Tables 11 and 12. Table 11 sets forth spacing requirements by type of intersection. Table 12 defines additional requirements. Minimum sight distance requirements are specified for the same categories as in Ingham County, although the standards are more stringent here.

Tallahassee, Florida

In 1988, Tallahassee adopted an ordinance covering connections to the street system. The manual states that minimum standards for driveways are essentially the same as those included in the Florida Department of Transportation "Policy and Guidelines for Vehicular Connections to Roads on the State Highway Systems" from February, 1985. In the manual developed to

TABLE 11 SPACING REQUIREMENTS BY TYPE OF INTERSECTION FOR LAKEWOOD, COLORADO

Roadway Type	Signalized Intersections	Unsignalized Intersections
Arterials	Typically .5 mile intervals	Must be "T," spaced 600 feet apart; 4-way permitted if lefts onto and through movements across arterial are precluded.
Collectors	Typically .5 mile intervals; less when adequate signal progression can be maintained	4-way permitted, if spaced 600 feet apart
Commercial/Multi-Family Local Streets	4-way intersections spaced at least 600 ft. apart; for "T" intersections, center lines of streets not in alignment must typically be offset a minimum of 300 ft. from nearest 4-way intersection.	

TABLE 12 ADDITIONAL SPACING REQUIREMENTS FOR LAKEWOOD, COLORADO

Spacing Element	Arterial	Major Collector	Minor Collector	Commercial/ Multi-Family Local	Single-Family Local
Minimum Stopping Sight Distance	325	250	250	200	200
Minimum Unsignalized Intersection Spacing	600	600	600	300	300
"T" Intersection Spacing	600	300	300	150	150
Curb Cuts	300	150	150	150	15

TABLE 13 TALLAHASSEE, FLORIDA, CLASSIFICATION FOR DRIVEWAY AND STREET CONNECTIONS

Type of Connection		Driveway Use Definition
Class I	Non-Commercial	For access to single family dwelling; multi-family up to 4 units; agricultural land and field entrances; and all sidewalk and bikeway connections
Class II	Minor Commercial	Medium volume generator; access to property other than "nominal" residential and agricultural
Class III	Major Commercial	High volume generator; access to facilities generating high traffic volumes (approx. ADT greater than 1500 vpd); examples: shopping centers, industrial parks, office parks,.colleges, large residential complexes
Class IV	Public/Private Roads	New public or private roads or streets

TABLE 14 ROADWAY CLASSIFICATION AS A FUNCTION OF TRAFFIC GENERATION IN TALLAHASSEE, FLORIDA

(Will be adjusted when local rates become available)
(For additional rates see Trip Generation, Fourth Edition, ITE)

Connection Class	Traffic Generator Class	Land Use Type (Example Only)	Number of Weekday Trip End Generation	
			Average	Range
Class I (non-commercial)	Low	Small Farms; Single Family, Duplex & small apts. (4 units or less)	10.0/D.U.	4.3 to 21.9
Class II (minor commercial)	Medium (Approx. ADT <1500 vpd)	1. Apartments (5 or more units in a building)	(1) 6.6/D.U.	(1) 5.1 to 9.2/DU
		2. Auto Dealer	(2) 47.5/TSF	(2) 15.4 to 79.0/TSF
		3. Medical Office	(3) 54.6/TSF	(3) 38.0 to 99.0/TSF
		4. Motels	(4) 10.2/Occ. Room	(4) 4.7 to 14.6/Occ.Room
		5. Hotels	(5) 8.7/Room	(5) 5.3 to 9.5/Room
		6. Restaurants (sit down)	(6) 200.89/TSFGFA	(6) 112 to 345
		7. Office Buildings (less than 100,000 S.F.)	(7) 17.7/TSF	(7) 0.8 to 28.8/TSF
		8. Schools (Elem. & Jr. High)	(8) 1.02/student	(8) 0.5 to 1.0
		9. Service Stations	(9) 133/Pump	(9) 103 to 178/Pump
		10. Drug Stores	(10) 70.1/TSFGLA	(10) 25.5 to 106.9
		11. Libraries	(11) 41.0/TSF	(11) 20.8 to 75.4/TSF
		12. Convenience Stores (24HR)	(12) 625.2/TSF	(12) 422 to 839/TSF
Class III (major commercial)	High (Approx. ADT >1500 vpd)	1. Apartments(multi-buildings)	(1) 6.6/DU	(1) 5.1 - 9.2/DU
		2. Banks	(2) 192/TSF	(2) 160 - 220/TSF
		3. Colleges/Universities	(3) 2.41/student	(3) 0.94 to 3.89/student
		4. Factories	(4) 2.01/employee	(4) 0.60 to 6.66/employee
		5. High Schools	(5) 1.39/student	(5) 0.71 to 2.49/student
		6. Hospitals	(6) 11.4/bed	(6) 3.0 - 32.0/bed
		7. Office Buildings (100,000 S.F. or over)	(7) 14.3/TSF	(7) 3.6 - 23.6/TSF
		8. Shopping Centers	(8) 166.35/TSFGLA	(8) N/A
		9. Theatres, Auditoriums (places of assembly)	(9) 220/screen	(9) Weekday
			(9) 376/screen	(9) Weekend
		10. Restaurants (Drive in) weekday	(10) 632.1/TSFGFA	(10) 284.0 - 1359.5
		weekend	(10) 720.0/TSF	(10) 346.3 - 1686.0
		11. General Industrial	(11) 6.9/TSF	(11) 1.57 - 16.07
Class IV (Roads)	All private or new public streets or roads intersecting the public street system.			

Source: Trip Generation, 4th Edition, ITE
Legend: DU = Dwelling Unit
TSF = Thousand Square Feet
TSFGFA = Thousand Square Feet Gross Floor Area
TSFGLA = Thousand Square Feet Gross Leasable Area

implement the ordinance, there are four classes of driveway or street connections as shown in Table 13. The relationship between these connection classes, land use and estimated traffic generation is shown in Table 14.

Minimum spacing between driveways are shown in Table 15. For commercial/office subdivi sions the minimum is set at 275 feet, and can be no closer than *100 feet to the ROW line* of an intersecting street. Where the distances recommended are not feasible for Class III

TABLE 15 ROADWAY CONNECTION STANDARDS IN TALLAHASSEE, FLORIDA

Item	Roadway Type	Class I URBAN	Class I RURAL	Class II URBAN	Class II RURAL	Class III URBAN	Class III RURAL
Minimum Distance between Driveways	Local St. Minor collector	40'	40'	40'	40'	50'[2]	50'[2]
	Major Collector Arterial	100'	100'	175'	175'	250'[2]	250'[2]
Minimum Corner Clearance[3]	Local St. Minor Collector	0'	10'	0'	15'	50'	50'
	Major Collector Arterial	10'	25'	25'	25'	50'	50'

1 These are absolute minimums only and greater distances are desirable for Class II roadways.

2 These spacings are to be used whenever: volume is greater than 5000 vpd, speed is greater than 25 mph, there are 30-60 commercial driveways per mile or minimum driveway volumes are greater than 200 vph during peak periods. The standards state that theoretically, desirable driveway spacing along arterials are recommended to be:

Speed (mph)	Minimum Spacing (feet)
20	85
25	105
30	125
35	150
40	180
45	230
50	275

3 Where urban intersections are or will be signalized, Class I and II connections should provide a 50' minimum corner clearance.

roadways, lesser spacing distances between driveways may be approved, but not less than the absolute minimum spacing distances shown for Class II roadways. No more than two driveways to any single property are permitted unless roadway frontage is greater than 660 feet. Along arterials, more than one driveway is warranted only when the access volume would total more than 500 vpd even with the 660-foot frontage. Joint driveways are encouraged where several adjacent developments have limited frontage.

Specific sight distance requirements are provided in Appendix C of the Tallahassee ordinance. Tallahassee requires driveways to be located at a point where acceptable sight distance is provided. The regulations further stipulate that driveway access to other roads or facilities (alternative access) may be required where direct access may be unsafe or cause improper traffic operations. Direct driveway access can be denied or a driveway connection may require redesign of existing or proposed connections when traffic patterns, connection points, geometrics or traffic control devices are causing or are expected to cause undue disruption of traffic or create safety hazards.

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CONCLUSIONS

1. Access management is important for safety, capacity, travel times, and mobility.
2. Access management is a key component of congestion management.
3. Access spacing is an essential part of access management.
4. Criteria should cover both driveways and streets in non-developed and developed (i.e., retrofit) areas.
5. Criteria should reflect the type of highway, operational characteristics, and type of environment. They should separate conflict areas and minimize conflict points, considering driver behavior and vehicle dynamics.
6. Spacing criteria should be keyed to the functional classifications of the road system — with the more restrictive standards established for a higher type of road.
    - Signalized intersection spacing should maintain maximum band widths in each direction of travel at different travel speeds. This calls for regularly spaced intersections, a sufficient distance apart.
    - There is less consensus on unsignalized intersection spacing and corner clearance. Sight distance requirements and driver response times are key parameters.
    - A growing number of states, regions, and municipalities have established spacing standards that reflect good traffic engineering practice.
    - Continued research on unsignalized spacing and corner clearance criteria and their applicability in various urban, suburban and rural settings is essential.

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