SECTION 03000
STREETS

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# 03010 GENERAL

The latest revision of the NCDOT "Standard Specifications for Roads and Structures" shall apply unless otherwise specified herein. The following substitutions shall be read into the aforementioned specifications:

- "State" or "Commission" shall be replaced by "Town of Cary".
- "Resident Engineer" shall be replaced by "Engineering Director" or their authorized representative.
- "Sampling and testing by Commission" shall be replaced by the words "sampling and testing by the Town or its duly authorized testing agent".
- "Inspection by Commission" shall be replaced by "Inspection by Town or its duly authorized representative".
- All streets (private and public) shall be designed and constructed to Town Standards unless NCDOT Standards are applicable. NCDOT Standards shall be applicable on all existing state roads, extensions of existing state roads, or roads expected to be maintained by the state. Private streets will be permitted only for commercial and multi-family uses.

# 03020 DESIGN CONTROLS AND CRITERIA

## A. STREET CLASSIFICATIONS

Streets are classified according to the nature of the land uses they serve and the mode of travel (non-motorized and motorized) they accommodate. Streets are networked to provide a balance between access and mobility.

All streets shall conform to the Town of Cary Comprehensive Transportation Plan when applicable or shall be designed and located in proper relation to existing streets and the surrounding and environment. Street design should be consistent with topography and preserve developed properties and community values.

All streets shall be networked to provide safe and efficient access to all properties. No properties shall be landlocked or excessively removed from the street facilities.

1. Local Streets

Local streets provide the highest degree of access and the least mobility. They are generally associated with residential areas and permit direct access to abutting land. Local streets shall be designed to discourage high speed traffic and minimize excessive cuts, and fills. Local streets also constitute the backbone of neighborhood pedestrian and bicycle networks.

a. Minor Local Streets

- Alleys

Alleys are permitted only in the Town Center and within Planned Development District designs. The purpose of an alley is to provide utility and vehicular access to new residential developments that cannot be adequately served by existing streets. All alleys are to be privately maintained with measures to ensure the travelway is not obstructed in any manner, including parking. A pavement design shall be submitted to and approved by the Town Engineer for all alleys. Alleys shall be in tangent only. The Town shall not be responsible for damage to the pavement structure due to its use of the alley in providing public services.

- Cul-de-sacs

Cul-de-sacs serve either abutting residential or non-residential land uses and terminate in a turnaround. The standard maximum length for a cul-de-sac shall be 900 feet. The length may be varied by the Town Council depending upon the density within the subdivision. The recommendation for a variance shall consider the development density, land configuration, as well as all safety concerns. The length of a cul-de-sac shall be measured from the last point of alternate access.
No median shall be allowed in a 45 foot radius cul-de-sac. A median may be permitted where the cul-de-sac radius is increased and it can be demonstrated that all emergency vehicles can be readily accommodated.

Hammerheads shall not be allowed for any new construction. This applies to private streets, public streets, and temporary dead-end streets.

- Loop Street

Loop streets serve abutting residential land uses, terminate on the same street from which they originate, and shall not exceed

1500 feet in length. Short residential cul-de-sac streets may intersect onto this street.

b. Major Local Streets

- Residential Local Street

This is a street whose primary function is to serve an abutting residential land use. Motorists using such streets generally include only residents and their visitors. Use of such streets by large trucks and heavy vehicles is rare, except for occasional use by maintenance and delivery vehicles. Primary design concerns focus on fostering a safe and pleasant environment for the residential community, with convenience to the motorist secondary. Residential streets in new developments may incorporate traffic calming into the initial design. Traffic calming may include curvilinear streets and/or devices such as median islands, chokers, chicanes, roundabouts, etc.

- Access Street

These streets serve a dual function of providing access to adjacent property as well as providing through or connecting services between other local roads.

2. Collector Streets

Collector Streets provide a balance between land access and mobility within residential, office neighborhoods and commercial areas. These are streets which penetrate various land use classifications. They typically serve as a link between local streets and arterial streets.

a. Minor Collector Street (Residential)

A minor collector street shall be provided when traffic volumes, access volume conditions, or intersecting street linkages dictate.

Traffic conditions apply when the roadway, under immediate or ultimate buildout conditions, collects traffic from more than 150 dwelling units, or accounts for traffic volumes in excess of 1500 ADT.

Access conditions apply when the extent of a development so isolates the remote units of that development from a arterial street, that access by emergency or service vehicles can be deemed unsafe or uneconomic or the ability for residents to reach community travel destinations by means other than access to a arterial street can be achieved. Ideally, no

residential location is more than one-half mile from a collector street. Access conditions shall also apply where it is deemed reasonable and feasible to interconnect abutting neighborhoods.

b. Major Collector Street (Non-Residential)

A major collector street shall be provided when either traffic or access conditions dictate. Traffic conditions apply when the roadway, under immediate or ultimate buildout conditions, collects traffic volumes in excess of 3000 ADT. Access conditions apply when the extent of a development so isolates the remote units of that development from an arterial street that access by emergency or service vehicles can be deemed unsafe or uneconomic. Access conditions shall also apply where it is deemed reasonable and feasible to interconnect abutting development.

3. Arterial Streets

Arterial streets provide a high degree of mobility and limited access.

Any streets designated in the Comprehensive Transportation Thoroughfare Map or in the local municipal planning organization Thoroughfare Plan as a Thoroughfare or minor thoroughfare shall be considered an arterial street and must meet the design criteria set forth in AASHTO's "A Policy on the Geometric Design of Highways and Streets."

## B. DESIGN SPEED

Design speed is the maximum safe speed that can be obtained on a street when conditions are favorable enough for the design features of the street to control. The design speed chosen for a street should be logical with respect to topography, the adjacent land use, and the classification of the street.

Once selected, all pertinent features of a street, such as width, curvature, sight distance, access points and parking should be related to the design speed.

## C. TRAFFIC COMPOSITION

1. General

The physical characteristics and performance of different users have a direct impact on geometric design. Although the dimensions and performance of motorized vehicles typically dictate the components of

street design, consideration of the characteristics of non-motorized vehicles and pedestrians should be taken into account.

2. Vehicles

Streets shall be designed such that the traveling paths of these vehicles do not conflict with the physical constraints of the street or hinder the other users of the street. The applicable category of design vehicle is based upon the classification of the street.

Local streets can be subject to both passenger cars and trucks. In particular, minor local streets are to be designed for passenger cars and major local streets shall accommodate single-unit trucks.

Collector streets are to be designed to accommodate single-unit trucks, or in the case of a non-residential setting, the streets shall accommodate the type of vehicle prevalent to their access purpose.

Arterial streets shall meet the design needs of vehicles specified by NCDOT.

3. Pedestrians

The trip purpose and ability of a pedestrian are important factors affecting the design of streets and pedestrian facilities. The purpose and frequency of pedestrian trips, as well as the variability in the abilities of the pedestrians themselves, are heavily dependent upon the adjacent land uses. Measures should be employed to facilitate the pedestrians use of a roadway and help to reduce pedestrian-vehicular conflicts. More information on pedestrian characteristics and facilities can be found in FHWA's "Pedestrian Facilities Users Guide.

4. Bicycles

The physical dimensions and abilities of a bicyclist are important factors affecting the design of streets and bicycle facilities. While the physical dimensions are relatively consistent, the skills, confidence, and preference of bicyclists vary dramatically. The design of bicycle facilities will vary with user type, roadway characteristics/conditions. Measures should be employed to facilitate the bicyclist's use of a roadway, help to promote bicyclist use of a roadway and help promote bicyclist/motor vehicle safety and operation. More information on bicyclist characteristics and bike facilities can be found in AASHTO's "Guide for Development of Bicycle Facilities".

## D. ACCESS MANAGEMENT

1. Driveways

The number of street and driveway connections permitted serving a single property frontage or commercial development shall be the minimum deemed necessary by the Town Engineer for reasonable service to the property without undue impairment of safety, convenience, and utility of the roadway. Normally, not more than two driveways shall be permitted for any single property frontage.

The arrangement of driveways should be related to adjacent driveways and nearby street intersections. Driveways accessing local or collector type streets shall be at least 100 feet from the point of tangency of the radius curvature of the next intersecting street. Driveways serving traffic volumes in excess of 300 ADT or accessing thoroughfares shall be located a minimum of 250 feet from the point of tangency of the radius of curvature of the intersecting street.

Where two driveways are proposed along a single property frontage to facilitate operations, the minimum distance between the centerlines of the drives shall be 200 feet. The minimum distance between the centerlines of driveways into shopping centers or facilities generating in excess of 300 ADT shall be a minimum of 400 feet. Full access driveways open to signalization should be 1000' apart. Driveways which access thoroughfares and serve more than 1500 ADT shall provide deceleration lanes in approach to the driveway.

Residential drives shall be located a minimum of 10 feet from the point of tangency of curb radii of street intersections.

2. Streets

There shall be a minimum of 200 feet between centerlines of street jogs on collectors and arterials. Local streets shall not be offset less than 125 feet from their centerline.

Median breaks shall be provided to allow safe and efficient movement of traffic. The desirable spacing of median breaks shall be at 1000' intervals, with the minimum allowable spacing to be at 500' intervals.

Intersections of roadways controlled by a traffic signal should be spaced along roadways at the following intervals:

| | |
|---|---|
| Arterial Streets | 1/2 -1 mile |
| Collector Streets | 1/4 mile |

| | |
|---|---|
| Local Streets | 1000’ |

Four legged intersections not controlled by a traffic signal should be spaced along roadways at the following intervals:

| | |
|---|---|
| Arterial Streets | 1000’ |
| Collector Streets | 750’ |
| Local Streets | 300’ |

Three legged intersections not controlled by a traffic signal should be spaced along roadways at the following intervals:

| | |
|---|---|
| Arterial Streets | 800’ |
| Collector Streets | 500’ |
| Local Streets | 200’ |

TABLE 3.1
STREET CLASSIFICATIONS

| CLASSIFICATION | LAND USE | SUB-CLASS | STREET SUFFIX(S) | DRIVEWAY CUTS | ON STREET PARKING | DESIGN VEHICLE |
|---|---|---|---|---|---|---|
| | | | | | | |
| Minor Local | Residential | Cul-de-Sac, Alley, Loop | CT, LN, LP | Yes | Yes | PC |
| Major Local | Either | Street | ST | Yes | Yes | SU |
| Minor Collector | Residential | Road | RD | Yes | Yes | SU |
| Major Collector | Non-Residential | Avenue | AVE | Limited | No | Designated |

# 03030 TYPICAL CROSS SECTION ELEMENTS

The elements which compose the cross section of a street should take into account the classification, design speed, traffic volume, traffic composition, and terrain of that street. The elements of the cross section include the roadway (curbs, shoulders, traveled way, bike lanes and parking Lane), and roadside (utility strips, sidewalks, and multi-use paths) and median area. All of these elements lend themselves together into determining the required right-of-way width.

## A. ROADWAY

1. Pavement Design

A pavement design will be required for all collector streets and arterials. A pavement design shall also be required for all streets located within areas with Triassic soils (as shown on Figure 3). The pavement design shall be in accordance with these specifications.

- The pavement design and traffic analysis shall be signed and sealed by a NCPE, and shall be submitted for approval prior to placement of curb and gutter or pavement material. All streets maintained by the NCDOT must receive approval of the pavement design from the NCDOT prior to the placement of curb and gutter or pavement material.
- Approved pavement design methods include those most current as proposed by NCDOT, AASHTO and the Asphalt Institute MS 1 document. Other design methods will not be accepted.

    + The AASHTO method will require use of a terminal serviceability index of 2.0 for collectors and 2.5 for thoroughfares, $S_o$ = 0.49 for flexible pavement or $S_o$ = 0.39 for rigid pavements, and a reliability of 98 percent for thoroughfares and 95 percent for collectors.

    + Rigid pavement design shall follow the most current AASHTO Method or the Portland Cement Association Method.

- Pavement design shall be based on subgrade conditions, a 20 year design life and projected traffic loading.
- Subgrade conditions shall be based upon corrected soaked CBR values at 0.1 inch penetration per ASTM D1883.
- Soil samples used for these CBR tests shall be obtained at intervals not greater than 500 feet Typically, a subdivision will require 2 to 3 soil samples as a part of the pavement design.

Larger subdivisions, greater than 100 lots, may require additional soil samples at the discretion of the Town Engineer.

- Boring logs and scaled drawings designating boring locations with CBR tests and other pertinent data shall accompany the pavement design.

2. Lane Widths & Cross Slope

All major collectors and thoroughfares shall be marked in accordance with the latest revisions of the MUTCD unless otherwise approved by the Town Engineer. This shall be noted on roadway and subdivision plans as a requirement of the Developer and shall be completed prior to issuance of a Certificate of Occupancy for the development or final acceptance of the roadway by the Town.

The Town of Cary considers bicycle traffic an important mode of transportation. Bike lanes shall be incorporated into thoroughfare and collector street design as required per the Town's Comprehensive Transportation Plan.

Normal crown for the pavement section shall be 0.02' per foot. Superelevation should never exceed 0.04' per foot.

## B. ROADSIDE

1. Utility Strips

Utility strips shall be sufficient to permit the adequate installation and maintenance of sidewalks and utilities, as well as provide sufficient clear distance as defined by NCDOT.

Shoulder sections without sidewalk shall be 10 feet wide on all streets that have a cross section of 35 feet or greater.

2. Drainage Channels and Side Slopes

Streets designed without curb and gutter must meet all of the following requirements and be approved by the Town Council:

a. 50 feet of right of way;
b. 5% maximum and 0.5% minimum vertical grade;
c. Swales shall carry the 10 year storm in a non-erosive manner;
d. Driveway pipes shall pass the 10 year storm;
e. Driveway pipes shall have flared end sections or headwalls on both ends.

3. Curb and Gutter

Curb and gutter shall be required on all streets with the following exceptions:

- Residential cul-de-sacs in a Planned Unit Development;
- Residential loop streets with low traffic volumes in a Planned Unit Development;
- Streets within the Reservoir Watershed Protection District.

On all public streets, median curb shall be standard 18 inch mountable curb, and all other curb and gutter shall be standard 30 inch. No valley curb shall be used on public streets.

A minimum 5 foot section of curb and gutter shall remain when removing curb for the installation of a driveway, street turnout or repair of curb and gutter. When less than 5 feet of the curb remains, the curb shall be removed to the next joint.

4. Sidewalk

Sidewalks shall be constructed within the street right of way or within a dedicated sidewalk easement in accordance with Town Standards and Town policy. Sidewalks shall be installed at the time of roadway construction or widening unless otherwise approved by the Town Council. Sidewalk shall be required as follows:

- Thoroughfares, all collector streets and non-residential cul-de-sacs: sidewalk on both sides.
- Residential and non-residential local: Sidewalk on one side.
- Loop, and residential Cul-de-sac streets: No sidewalk unless either street is within one-half mile linear traverse of a greenway, park, shopping area, or the street is within 1.5 mile linear traverse of a school, in which case sidewalk on one side will be required.

The minimum thickness of a sidewalk shall be 4 inches. A 6 inch depth is required at locations where a driveway crosses a sidewalk, at street intersections (along the length of radius curb returns), and in the handicap ramps. Sidewalks shall have a uniform slope toward the

roadway of 0.02' per foot. The utility strip between the sidewalk and the back of curb shall slope at ¼" to ½" toward the roadway.

Sidewalks shall typically be a minimum distance of five (5) feet off of the back of curb with a minimum width of five (5) feet.

Where sidewalks and/or greenways intersect any section of curb and gutter, a wheelchair ramp shall be installed.

5. Multi-use Paths

Location of paths shall be in keeping with the Greenways Master Plan, however in those situations where greenways are proposed to run parallel with roadways, they shall serve as multi-use paths. Width, offset and pavement design are indicated on the standard detail.

6. Shoulder Sections

Shoulder sections are only allowed on streets where curb and gutter is not required. Shoulder sections must be a minimum of 5 feet wide.

### C. MEDIAN SECTIONS

Raised median sections shall be a minimum of 16 feet wide measured from the back of curb to the back of curb to provide 12 feet for left-turning vehicles and 4 feet for the placement of signs and separation of traffic at median openings. It is desirable to have continuous median sections on thoroughfare roadways. In no case shall plantings within a median obstruct required sight distance.

Medians shall have sufficient crown (0.04' per foot) to promote drainage off the median, but shall never be to a cross slope in which sight distance is obstructed.

# 03040 GENERAL DESIGN ELEMENTS

### A. HORIZONTAL ALIGNMENT CONTROLS

1. Superelevation

Superelevation should not be used on local streets. Generally it should be noted that a superelevation rate of 0.04 is applicable to urban design. The rate of superelevation is controlled by several factors:

- climate (amount of snow and rain)
- terrain (rolling or level)
- location (urban or rural)
- traffic composition (i.e. slow moving traffic)

Given these factors it is concluded that no single maximum superelevation rate is universally applicable.

2. Tangent Lengths

a. Collector Streets

Tangent sections shall be of sufficient length to accommodate minimum superelevation runoff lengths as noted in the latest edition of AASHTO's, "A Policy on Geometric Design of Highways and Streets". The minimum tangent length on the stop approach to an intersection of a higher classification shall be 100 feet.

b. Local Streets

Tangent sections shall not exceed 300 feet for minor local streets and 500 feet for major local streets. The minimum tangent length approaching an intersection is 30 feet.

3. Curves

Curves are to be designed to establish the proper relation between design speed and superelevation. The minimum radius of curvature is limited by a given design speed and superelevation rate. The maximum and minimum radii of curves for each roadway class is specified in Figure 1.

Horizontal and vertical curves should be designed concurrently so as to encourage uniform speed, and accent or preserve the significant natural features of the land.

Whereas, the maximum radius of curvature is limited by the posted speed ($85^{th}$ percentile) and the associated expectations of pedestrians and motorists for the adjacent land use.

## B. VERTICAL ALIGNMENT CONTROLS

1. Grades

Street grades shall be established such that drivers can negotiate in adverse weather.

The minimum grade allowed on any street shall be one-half of one percent (1/2%).

The maximum grade allowed when approaching an intersection is five percent (5%) for the last 100 feet of pavement before the intersection. The maximum grades allowed per street type classification are listed in Figure 1.

2. Curves

Vertical curves affect the gradual change between grades of a vertical alignment. The curves should produce a design which provides adequate sight distance adequate for drainage and rider comfort. To meet these criteria, the vertical curves are designed to curve at rates specified in Figure 1. The product of the curvature rates and the algebraic difference in adjoining grades is the basis for the minimum length of curves, but should never be less than the minimum lengths provided in Figure 1.

a. Crest Vertical Curves

The design of crest vertical curves should focus on providing sufficient sight distance. Crest vertical curves which are too abrupt in their curvature can impede the line of sight to drivers and thereby limit sight distance.

b. Sag Vertical Curves

The design of sag vertical curves should focus on rider comfort and drainage. Sag vertical curves which are too abrupt in their curvature can magnify the effects of the gravitational and vertical centrifugal forces acting on a rider. Sag curves which are too gradual can create substandard drainage conditions within the curve. The rate of vertical curvature is to insure that a minimum grade of 0.003 ft./ft. is obtained within a 50’ distance from the level point. In addition, sag vertical curves in cut situations should be avoided to prevent potential problems associated with the ponding of water.

The Town Engineer may approve street lighting which exceeds the standard Town requirements for residential streets so as to

reduce the length of sag vertical curves, provided the street lights are operational prior to the issuance of any Certificate of Occupancy on such street. The minimum allowable length of sag vertical curves, where a street light is in the sag, shall be 20A for residential local streets, and 15A for cul-de-sacs and loop roads.

## C. STOPPING SIGHT DISTANCE

1. General

Sight distance shall mean the length of roadway visible to the driver traveling along the roadway. Sight distance provides motorists the opportunity, traveling at design speeds, to prevent their vehicles in various situations from striking unexpected objects.

Stopping sight distance is the distance required of a driver to perceive, react, brake, and stop before reaching a conflicting object in its path. The required stopping sight distance is dependent upon the reaction time of the driver, the design speed of the vehicle, and the grade of the roadway. Stopping sight distances for both level and graded situations are listed in the latest version of AASHTO's Policy on Geometric Design of Highways and Streets.

Stopping sight distance is measured in the horizontal (plan) and vertical (profile) planes. In both planes, a driver must be offered an unobstructed line of sight to the roadway in front of them.

The horizontal stopping sight distance is measured along the middle of the travel lane from the driver to the object. The horizontal line of sight (Figure 4) is a straight line connecting the driver's eye, which is located in the middle of the travelway, with the object, which is also located in the middle of the travelway. If this line of sight is impeded by any obstructions, either the obstruction should be moved or the alignment adjusted.

The vertical stopping sight distance is measured along the middle of the travel lane from the driver to the object. The vertical line of sight (Figure 5) is a straight line connecting the driver's eye, which is located 3.5 feet above the roadway surface, with the object, which is located 0.5 feet above the roadway surface. If this line of sight is impeded by any obstructions, either the obstruction should be moved or the alignment adjusted.

## D. TRAFFIC CONTROL

1. Traffic Signs, Pavement Markings, and Street Name Signs

All streets require traffic signs. All collectors and arterials require traffic signs and pavement markings. Traffic signs and pavement markings shall be marked in accordance with the latest revision of the MUTCD unless otherwise approved by the Town Engineer. A pavement marking plan showing description and placement of traffic signs, pavement markings, and specialty signs shall be submitted with all roadway and subdivision plans as a requirement of the Developer, and shall be done prior to issuance of a Certificate of Occupancy for the development or final acceptance of the roadway by the Town. The pavement markings for all streets, both public and private, shall be thermoplastic in accordance with NCDOT standards. Exception of the use of thermoplastic is granted in the case of private parking stalls.

Traffic Control and Street Name Signs within subdivisions which will be maintained by the Town shall be consistent with the MUTCD. All specialty traffic control and street name signs and posts must comply with Policy Statement Number 85 including all amendments as approved by the Town Council. Requests for specialty signs shall be submitted to and approved by the Engineering Department.

2. Traffic Signals

The design, installation and construction of traffic signals shall meet the specifications put forth by NCDOT's Traffic Engineering Branch in the latest version of their manual "Traffic Signal Specifications". Special attention shall be given to the areas of these specifications regarding metal poles and preemption control. All control equipment shall be programmed.

a. Metal Poles

Metal poles with mast arms shall be employed at intersections where utilities are underground. All other locations will be decided on a case by case basis. Where applicable, consideration should be given to standard designs of metal poles and mast arms and footings as approved by NCDOT.

b. Preemption Control

Emergency vehicle-initiated preemption of traffic signals on the State Highway System must be approved by NCDOT. Official first response emergency vehicles that utilize sirens and red flashing lights to provide services to the public which prevent loss of life and property are the only eligible vehicles. "Official"

vehicles are fire-fighting and emergency medical services vehicles owned, operated and maintained by the emergency response agency or authority.

Police vehicles may have access to the preemption system on state maintained roadways only after approval by NCDOT. All preemption equipment must be on the Traffic Signal Equipment Qualified Products List (QPL). The Traffic Engineering and Safety Systems Branch manages this QPL and is responsible for assuring the equipment is reliable, cost effective and compatible with NCDOT and agency requirements.

3. Traffic Calming

All traffic calming devices must be shown and approved as a part of a site plan prior to installation and must be in conformance with the Specifications. The traffic control devices and all related signs and pavement markings shall be maintained by the Owner. Traffic control devices may include rumble strips, raised pavement markers or pavement undulations (speed humps) or other devices, listed in the Traffic Calming Handbook or approved by the Town Engineer.

a. Rumble Strip

An irregular surface established to draw the attention of motorists and alert them of potential hazards or conflicts. The material used as a part of a rumble strip may be cobblestone, stamped concrete, brick or rough surface asphalt. A rumble strip may not vary more than one (1) inch in height from the pavement elevation. All rumble strips must be located outside any public right of way.

b. Raised Pavement Markers

Raised pavement markers may be used to create an irregular surface to draw the attention of motorists and to alert them of potential hazards or conflicts. The markers must be made of a flexible and durable solid material designed to support vehicular traffic. The placement of markers may be staggered in a manner as approved by the Town Engineer. All raised pavement markers shall have a maximum height of 1 inch above the pavement surface. The minimum size of the marker shall be 4 inches by 4 inches. The markers must be located outside any public right of way. All raised pavement markers shall have cube-corner microprism reflectors visible from either direction of travel.

c. Pavement Undulation (Speed Hump)

A pavement undulation is a gradual raised pavement surface which transverses the travelway. The surface material for a pavement undulation shall be the same as the adjacent travelway, typically asphalt.

A pavement undulation shall be parabolic with a maximum height of 3 inches. The undulation shall be tapered to the edge of the pavement or gutter line for the last 12 inches along each side. The minimum length of the pavement undulation shall be 12 feet.

All pavement undulations shall be clearly marked with pavement markings or warning signs for each direction of travel (see Detail No. 3000.18). Pavement undulations must be located a minimum distance of 500 feet from a signalized intersection. The Town and/or NCDOT may require the removal of any speed undulation which causes traffic to back up onto a public street.

d. Pedestrian Crosswalks

All locations which are designated for pedestrian traffic crossings shall be designated as a crosswalk with pavement markings and signage. The type and placement of signage and markings shall be consistent with MUTCD. The implementation and location of pedestrian crosswalks shall adhere to Policy Statement 128.

4. Lane Configuration

Tapers shall be used as necessary in street design. Approach tapers are used to shift lanes laterally. The following equations shall be used as applicable:

L = WS for posted speeds of 45 mph and greater;
L = $WS^2/60$ for posted speeds of 40 mph or less;
Where : L = Length in feet
S = Speed in miles per hour
W = Lateral offsets in feet.

# 03050 SPECIFIC DESIGN ELEMENTS

## A. INTERSECTIONS

1. Alignment

Streets shall intersect each other at right angles whenever possible. The minimum desirable intersection angle is 80 degrees. At no time shall a street intersect any other street at less than 75 degrees.

2. Layout Configuration

Curb radii shall be designed to satisfy the turning radius of the predominant design vehicle using the roadway. Minimum radii are listed in Figure 1. Turn bay tapers shall be straight line at a ratio of 15:1 for posted speeds of 45 miles per hour and more. The minimum turn bay taper allowed is 8:1 for posted speeds below 40 miles per hour. Symmetrical reverse curve tapers are recommended for non-thoroughfare streets as shown in the details. Storage lengths for the turn bays shall be calculated using an acceptable method.

Streets with medians shall be designated to allow for proper turning movements for a SU (single unit truck) design vehicle. AASHTO guidelines should be followed for the actual median design and median opening dimension.

3. Intersection Sight Distance

Unlike stopping sight distance, intersection sight distance is only applicable at the intersection of two streets or the intersection of a street and driveway. At all intersections, there is a minor street or movement (whose approach is controlled by some device like a sign), and a major street or movement (whose approach may not be controlled). Intersection sight distance is the distance required of a driver on the minor street to react and safely cross or join the major street traffic, while not requiring the major street traffic to reduce its speed or alter its path. The Town shall review all proposed development plans and landscaping planting plans for compliance with the latest version of AASHTO's Policy on Geometric Design of Highways and Streets sight distance requirements. All new development within the Town's ETJ shall meet these requirements.

Some objects located within sight distance areas may not significantly obstruct the required visibility of the driver. The driver may be able to see over, under or around some objects within sight distance areas. Objects that may be required within sight distance areas include fire hydrants, utility poles and traffic control devices which are located to

minimize visual obstruction. Other objects 12 inches in diameter and smaller, such as tree trunks and sign posts, may be allowed within sight distance areas if located so as to not substantially restrict the driver's view. The Town Engineer shall determine what objects, if any, may be located within sight distance areas. Trees greater than 12 inches in diameter and located in the right of way shall be evaluated in accordance with other applicable Town policies and requirements.

Some conditions may exist that prevent the attainment of desirable sight distance. In such cases, the maximum practical sight distance shall be obtained. In addition, where desirable sight distance is not attained, additional measures such as warning signs, reduced speed zones and other traffic controls may be imposed. In all cases, unless otherwise provided by Code or granted an exemption from the Engineering Director, the minimum provision of adequate stopping sight distance shall be required.

The Town shall remove sight distance obstructions located within Town right of way. The Town will notify the NCDOT of sight distance obstructions located within their right of way. The Town shall provide written notification to the owner(s) of private property on which a sight distance obstruction exists. The property owner(s) shall be responsible for the prompt removal of the obstruction on their property, and may be liable for any damage resulting from their failure to remove the obstruction.

In addition, intersection sight distance is based on conflicts with opposing vehicles rather than with objects located in the roadway. Intersection sight distance is measured in the horizontal (plan) and vertical (profile) planes. In both situations, a driver must be offered an unobstructed line of sight to the roadway they wish to cross or join. The horizontal intersection sight distance is measured along the centerline of the major street between the drivers of the two opposing vehicles.

The horizontal line of sight is a visual line connecting the driver’s eye and the approaching vehicle, both of which are in the center of the travelway. If this line of sight is impeded by any obstructions, either the obstruction should be moved or the alignment adjusted. The vertical intersection sight distance is measured along the centerline of the major street between the drivers of the two opposing vehicles. The vertical line of sight is a visual line connecting the driver’s eye, which is located 3.5 feet above the roadway surface, with the approaching vehicle, which is located 4.25 feet above the roadway surface. If this line of sight is impeded by any obstructions, either the obstruction should be moved or the alignment adjusted.

The amount of sight distance required at an intersection depends on the type of traffic control at the intersection and the speeds of the vehicles.

a. Yield Sign Control

This type of design requires that the side street be posted with yield signs. The sight distance for the driver on the side street (minor movement) must be sufficient for the driver to observe a vehicle on the through street (major movement) approaching from either the left or the right and bring his/her vehicle to a stop prior to reaching the intersection as shown in Figure 8.

Where proper sight distance cannot be achieved for the driver on the side street, it may be necessary to have a posted speed reduction on the approach or to replace the yield sign with a stop sign. Adequate sight distance shall also be provided for safe departure from a stopped condition.

b. Stop Sign Control

Where traffic is required to stop, the driver of the stopped vehicle shall have adequate sight distance to cross or join the approaching traffic flow without adversely affecting the travel speed of the approaching traffic. There are three basic maneuvers that occur at stop controlled intersections:

I. To travel across the intersecting roadway by clearing traffic on both the left and the right of the crossing vehicle;

II. To turn left into the crossing roadway by first clearing the traffic on the left and then entering the traffic stream with vehicles from the right (this maneuver is similar in nature to that made by the median left turns off the through street); and

III. To turn right into the intersecting roadway by entering the traffic stream with vehicles from the left.

Where the through street is undivided, or divided with a median narrower than 20 feet, maneuvers I and II are treated as a single operation. Where the median can provide storage for the design vehicle (20 feet wide for a passenger car), maneuvers I and II may be considered in two separate phases of operation.

The measurement method for determining the sight line for left, right, and through movements from the side street is based on values listed and illustrated in Figure 9.

The measurement method for determining the sight line for left turns from the median lane of the through street is based on values listed in AASHTO and is illustrated in Figure 7.

## B. DRIVEWAYS

1. Non-Residential Driveways

Standard concrete driveway aprons shall be used when the ADT for the driveway is less than 300 vehicles.

Street type turnouts shall be used when the driveway ADT is greater than the above listed conditions or when access by larger trucks must be accommodated. A minimum radius of 30 feet shall be used on all streets. Lesser radii may be used for street type turnouts with deceleration lanes. The maximum grade allowed when approaching an intersection is five percent (5%) for the last 30' before the edge of the intersection.

Non-residential driveways that are unpaved shall have a minimum 20 foot paved surface strip measured from the back of the driveway apron.

All driveways shall have a minimum width travel lane of 23 feet. Any curb and gutter used will be in addition to the 23 foot minimum width.

Non-residential driveways with islands shall have a 16 foot entrance lane. A 16 foot exit lane shall be required when one exit lane is used, and a 24 foot exit shall be used for 2 exit lanes. The 16 foot and 24 foot dimensions shall be measured from face-of-curb to face-of-curb.

2. Residential Driveways

Residential drives shall be 12 to 18 feet wide, conform to the Standard Detail for concrete driveway aprons and be located a minimum of 10' from the point of tangency of curb radii of street intersections.

Where driveway aprons are in sag locations, installation of a trench drain in the gutter line may be acceptable as a means to alleviate drainage problems. The Town shall not be responsible for the maintenance of residential driveways.

## C. PARKING LOTS

Parking lots shall be designed to provide safe maneuverability of vehicles. A minimum parking stall dimension of 9 feet by 18 feet shall be provided. Handicap parking spaces shall be a minimum of 8 feet wide with a 5 foot lane adjacent to the space properly marked with signage in accordance with the N.C. Building Code. All parking facilities shall have dimensions as outlined on Figure 2 and the Town Parking Ordinance. The measurement of said dimensions shall be to the face of curb, unless a curb stop is employed, in which case that will serve as the end of measurement.

At locations where sidewalk abuts a parking bay which is 18 feet deep, the sidewalk shall be a minimum width of 6 feet.

A minimum pavement structure consisting of 8 inches of ABC stone and 2.5 inches of S 9.5B asphalt shall be used in the travel aisles on parking facilities for multi-family (excluding duplex and triplex) developments, and non-residential developments. Access drives for these facilities shall also meet this minimum pavement standard. A minimum of 6 inches of ABC stone shall be required for parking stalls.

All paved parking facilities shall be striped with 4 inch white lines.

On all parking lot facilities, cut and fill slopes shall not begin immediately at the back of curb, instead a minimum 4’ shoulder is required behind the back of curb.

## D. FIRE LANE

Fire Lanes shall be installed and inspected in accordance with the public street requirements and the fire code. The Fire Official shall have the authority to designate fire lanes as deemed necessary for Fire Department access. The requirements for installation of a fire lane shall be subject to the fire code.

Fire lanes shall be a minimum width of 20 feet and shall be properly marked and signed to designate the access as a "FIRE LANE" as specified by the Fire Marshal. The surface of the fire lane shall be paved with a minimum of 8 inches of ABC stone and 2.5 inches of S 9.5B asphalt.

All fire lanes shall be marked in accordance with one of the following requirements:

- Continuously marked with thermoplastic yellow striping along the fire lane with "NO PARKING FIRE LANE" printed with minimum 8 inch high letters at 40 foot intervals or as directed by the Fire Marshal;

- Continuously marked with thermoplastic yellow curb with "NO PARKING - FIRE LANE" along the fire lane with "NO PARKING - FIRE LANE" printed with minimum 8 inch high letters at 40 foot intervals or as directed by the Fire Marshal:

- The installation of the MUTCD standard sign showing "No Parking - Fire Lane" placed at each end of the fire lane and at 50 foot intervals with arrows on the signs or a continuously painted yellow strip along the designated fire lane.

## 03060 MATERIALS

Portland cement concrete for curb and gutter, driveways, and sidewalks shall have a minimum 28 day compressive strength of 3000 psi, a non-vibrated slump between 2.5 and 4 inches, a minimum cement content of 564 pounds per cubic yards, an air entrainment of between 5 and 7%, and a maximum water-cement ratio of 0.532. (Also see Sec. 2.07 “Concrete”)

Joint filler shall be a non-extruding joint material conforming to ASTM C1751.

Concrete Curing Agents shall be free from any impurities which may be detrimental to the concrete and meet Section 1026 of the NCDOT Standard Specifications.

Aggregate for portland cement concrete shall meet the requirements for fine and course aggregate of Section 1014 of the NCDOT Standard Specifications.

Portland Cement and admixtures shall meet the requirements of Section 1000 of the NCDOT Standard Specifications.

Water for mixing or curing the concrete shall be free from injurious amounts of oil, salt acid, or other products injurious to the finished product.

Aggregate Base Course shall consist of coarse aggregate produced in accordance with Section 1010 of the NCDOT Standards for either Type A, B, or C aggregate.

Superpave – Asphalt Concrete Surface Course, Type S 4.75A, SF 9.5B, S 9.5A, S 9.5B, S 9.5C, S 12.5B, S 12.5C and S 12.5D, shall consist of a mixture of coarse and fine aggregates, asphalt cement, and shall meet the requirements in Sections 609 and 610 of the NCDOT Standard Specifications.

Superpave – Asphalt Concrete Intermediate Course, Type I 19.0B, I 19.0C and I 19.0D, shall conform to the general, material, and construction specifications of Section 609 and Section 610 of the NCDOT Standard Specifications.

Superpave – Asphalt Concrete Base Course, Type B 25.0B, B 25.0C and B 37.5C, shall conform to the general, material, and construction specifications of Section 609 and Section 610 of the NCDOT Standard Specifications.

Tack Coat shall be asphalt or asphalt cement and shall meet the general, material, and construction specifications of Section 605 of NCDOT Standard Specifications.

Concrete Pavement shall meet the general, material, and construction specifications of Section 700 of the NCDOT Standard Specifications.

Concrete Pavers may be used on privately maintained streets. The Town will not maintain decorative type paved street surfaces such as pavers or imprinted designs within public right of way.

Geotextile Fabric may be used to stabilize roadways, subgrades, slopes, and for other uses as necessary. The material must be approved by the Town Engineer prior to installation. Areas stabilized with fabric shall be indicated on "as-built" drawings with the manufacturer name and type fabric indicated.

# 03070 CONSTRUCTION AND INSPECTION

## A. STREETS

No base material shall be placed on a roadway until the storm sewer, subgrade, utilities, and all appurtenances have been inspected and approved by the Inspector.

The Inspector may require field density testing of the subgrade soils by a certified testing firm. The firm shall perform sufficient Proctors to evaluate the compaction characteristics of various soils used in the roadbed. The Inspector may also require field density testing of the ABC used and an asphalt mix formula before either is inspected or approved.

The subgrade shall be compacted as described in Section 02050 Earthwork. Inspection of the subgrade prior to placement of base course, and inspection of the base course prior to placement of asphalt shall be performed by proof rolling and/or field density testing at the direction of the Inspector.

## B. CURB AND GUTTER, AND SIDEWALKS

No concrete shall be placed until the forms and subgrades have been approved by the Inspector.

The surface of sidewalks shall be finished to grade and cross section with a float, trowelled smooth and finished with a broom. Sidewalks must be satisfactorily installed before issuance of CO.

- Subgrade shall be excavated to the required depth, and shaped to the proper cross-section. Where tree roots are encountered, they shall be removed to a depth of 1 foot for the full width of the excavation. The subgrade shall be stable and thoroughly compacted.

- Forms shall be set and maintained true to the required lines, grades, and dimensions. Forms shall be constructed with material of such strength and rigidity to prevent any appreciable deflection between supports. Straight forms shall be within a tolerance of 1/2 inch in 10 feet from a true line horizontally or vertically. Forms shall be thoroughly cleaned of all dirt, mortar and foreign material before being used. All inside form surfaces shall be thoroughly coated with commercial quality form oil.

- Grooved Contraction Joints shall be cut to a depth equal to at least 1/3 of the total slab thickness. The joint shall be no less than 1/8 inch in width and cut at intervals equal to the width of the sidewalk.

- Expansion Joints shall be a 1/2 inch joint filled with joint filler and placed between all rigid objects and placed no farther than 50 feet apart for sidewalks and curb and gutter, extending the full depth of the concrete with top of the filler 1/2 inch below the finished surface.

END OF SECTION 03000 Text

FIGURE 1

| | | | Horizontal Curve Controls | | | Vertical Curve Controls | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Street Classifications** | **Posted Speed** | **Design Speed (MPH)** | **Maximum Superelevation (ft/ft)** | **Radii (ft)** | **Curb Return Radius*** | **Maximum Grade** | **Length Crest** | **Length Sag** | **Minimum Length** |
| **Major Collector Streets** | 35 | 40-50 | 0.04 | 490-930 | 40’ | 9% | 55A | 55A | 120’ |
| **Minor Collector Streets** | 35 | 35-45 | 0.04 | 225-665 | 30’ | 9% | 28A | 35A | 120’ |
| **Major Local Streets** | 25 | 25-35 | Reverse crown | 140-375 | 20’ | 9% | 20A | 28A | 100’ |
| **Minor Local Streets** | 25 | 25-30 | Normal crown | 90-230 | 10’ | 10% | 18A | 18A | 75’ |

A – Algebraic difference in grades
* Intersections between different roadway classification shall use the curb radius required for the higher classification

FIGURE 2
PARKING LOT STALL DIMENSIONS

DIMENSIONS FOR 90-DEGREE PARKING

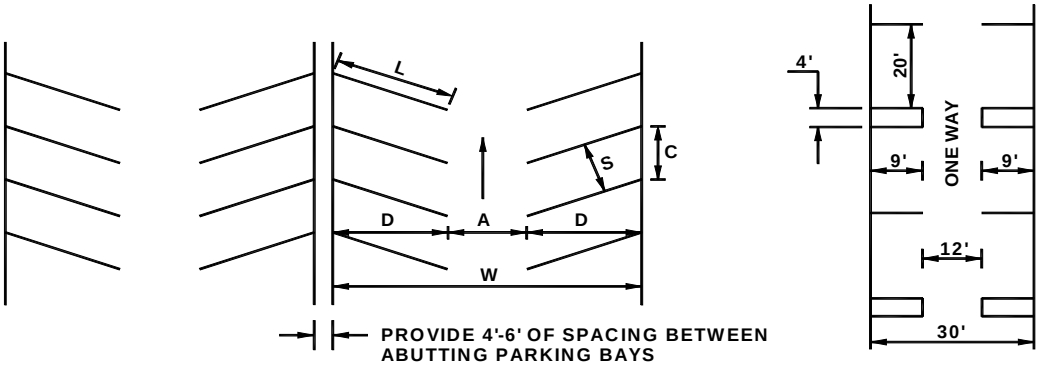
| APPLICATION | | (S) STALL WIDTH (feet) | (C) STALL LENGTH (feet) | (D) STALL DEPTH (feet) | (L) LINEAR DEPTH (feet) | (A) AISLE WIDTH (feet) | (W) MODULE WIDTH (feet) |
|---|---|---|---|---|---|---|---|
| CUSTOMER, high turnover | RECOMMENDED | 10 | 10 | 18 | 18 | 25 | 61 |
| | MINIMUM | 9.5 | 9.5 | 18 | 18 | 24 | 60 |
| CUSTOMER AND EMPLOYEE, low turnover | RECOMMENDED | 10 | 10 | 18 | 18 | 25 | 61 |
| | STANDARD | 9.5 | 9.5 | 18 | 18 | 24 | 60 |
| | MINIMUM | 9 | 9 | 18 | 18 | 23 | 59 |

DIMENSIONS FOR 60-DEGREE PARKING

| APPLICATION | | (S) STALL WIDTH (feet) | (C) STALL LENGTH (feet) | (D) STALL DEPTH (feet) | (L) LINEAR DEPTH (feet) | (A) AISLE WIDTH (feet) | (W) MODULE WIDTH (feet) |
|---|---|---|---|---|---|---|---|
| CUSTOMER, high turnover | RECOMMENDED | 10 | 11.5 | 15.6 | 18 | 23.8 | 55 |
| | MINIMUM | 9.5 | 11 | 15.6 | 18 | 22.8 | 54 |
| CUSTOMER AND EMPLOYEE, low turnover | RECOMMENDED | 10 | 11.5 | 15.6 | 18 | 22.8 | 54 |
| | STANDARD | 9.5 | 11 | 15.6 | 18 | 21.8 | 53 |
| | MINIMUM | 9 | 10.4 | 15.6 | 18 | 20.8 | 52 |

DIMENSIONS FOR 45-DEGREE PARKING

| APPLICATION | | (S) STALL WIDTH (feet) | (C) STALL LENGTH (feet) | (D) STALL DEPTH (feet) | (L) LINEAR DEPTH (feet) | (A) AISLE WIDTH (feet) | (W) MODULE WIDTH (feet) |
|---|---|---|---|---|---|---|---|
| CUSTOMER, high turnover | RECOMMENDED | 10 | 14.1 | 12.7 | 18 | 22.6 | 48 |
| | MINIMUM | 9.5 | 13.4 | 12.7 | 18 | 22.6 | 48 |
| CUSTOMER AND EMPLOYEE, low turnover | RECOMMENDED | 10 | 14.1 | 12.7 | 18 | 23.6 | 49 |
| | STANDARD | 9.5 | 13.4 | 12.7 | 18 | 22.6 | 48 |
| | MINIMUM | 9 | 12.7 | 12.7 | 18 | 21.6 | 47 |




NOTE: C= S FOR 90 DEGREE PARKING
D= L FOR 90 DEGREE PARKING