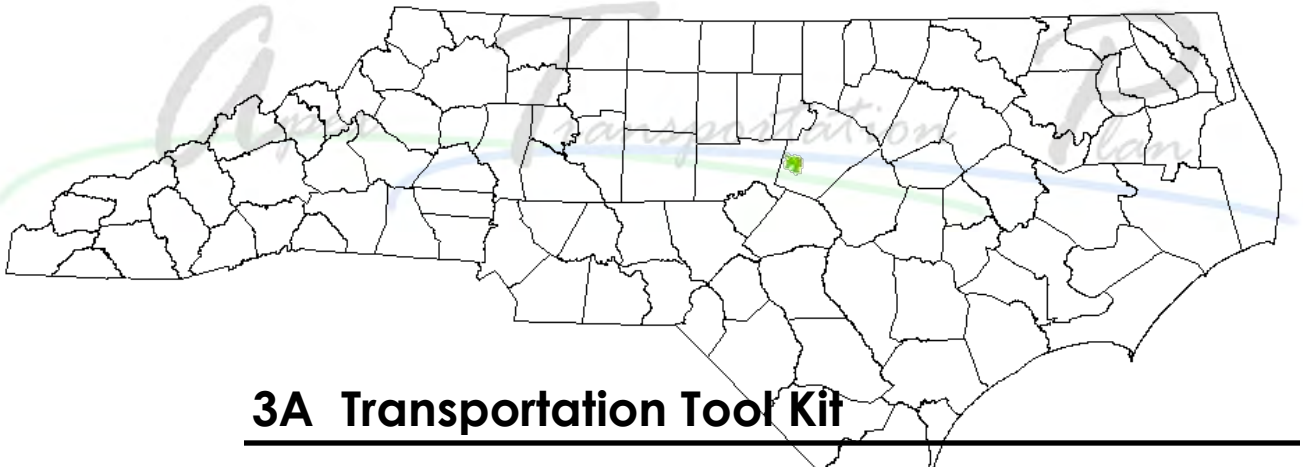


3A Transportation Tool Kit

3A.1 Walkability/Bikeability Audits

Walking and biking audits can be useful tools for evaluating existing conditions within an area and can help identify gaps in the current transportation network. These checklists ask questions such as "Was it easy to cross streets?" or "How was the surface that you rode on?" that allow the auditor to look for all factors that make a place walkable or bikable.

For a good walkability audit, visit:
http://www.walkinginfo.org/library/details.cfm?id=12

For a good bikability audit, visit:
http://www.bicyclinginfo.org/pdf/bikabilitychecklist.pdf

3A.2 Pedestrian Facilities

3A.2.1 Sidewalks

Sidewalks in Apex are typically 5-feet wide and constructed of concrete. In areas where high levels of pedestrian activity are anticipated, wider sidewalks should be considered. Sidewalks are required on one side of all new residential streets and both sides of all new collector and thoroughfare streets. Capital projects are underway to add sidewalks to existing streets that lack them. **Table 5.1** provides a list of capital improvement projects to be completed in the future. Existing and future sidewalks in Apex are shown on the Bicycle, Pedestrian, and Equestrian Plan map in **Appendix A**.

Sidewalks provide a comfortable place for people to walk and socialize.

3A.2.2 Verges

Adequate verge (the grass strip between the curb and sidewalk) widths are important in creating a desirable pedestrian space at the roadside. The minimum preferred width for verges is 5 feet.

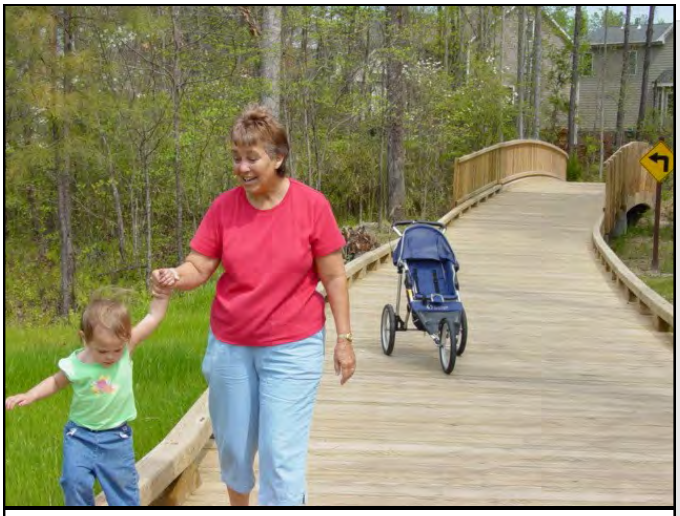
A verge is essential because it provides spaces for grass, utilities, fire hydrants, newspaper boxes, mailboxes, and numerous other necessary amenities that otherwise block and effectively narrow a sidewalk. Along roads with high volumes of motor vehicle traffic, a wider verge is preferable to create a more comfortable distance between the sidewalk and the roadway.

The grass verge along Tingen Road provides ample separation between the sidewalk and the road.

Specific verge widths for the different roadway types are shown on the roadway typical sections in **Section 3C**.

3A.2.3 Greenways

Greenways are paths designed for multiple nonmotorized users through open space. Essentially, greenways are natural, linear parks that provide a path for pedestrians and cyclists to travel both to a destination or for recreation. According to the Town of Apex Parks, Recreation, Greenways, and Open Space Master Plan, adopted in 2001, greenways in Apex have a minimum path width of 10 feet and an ideal path width of 12 feet. Greenways paths are typically constructed of asphalt, concrete, or wood (for boardwalk designs).



Greenways provide a place for pedestrians completely removed from motor-vehicle traffic.

3A.2.4 Multi-use paths

Similar to greenways, multi-use paths provide transportation and recreation access for nonmotorized users along a 10-foot-wide paved path. Unlike greenways, multi-use paths are located within the public right-of-way and adjacent to the roadway. Multi-use paths act as wide sidewalks while also providing room for bicyclists.

3A.2.5 Grade–separated crossings

While pedestrians are an important aspect of a healthy urban environment and are a welcome user of the street network, not all roadways are safe for (or accessible to) pedestrians. These facilities include freeways, highways, and roadways with many wide lanes. Grade-separated crossings of these unwelcoming facilities, such as pedestrian bridges and underpasses, are useful tools for maintaining pedestrian mobility despite these suburban barriers.

A tunnel under US 64 allows users of the American Tobacco Trail access across the highway.

3A.3 Bicycle Facilities

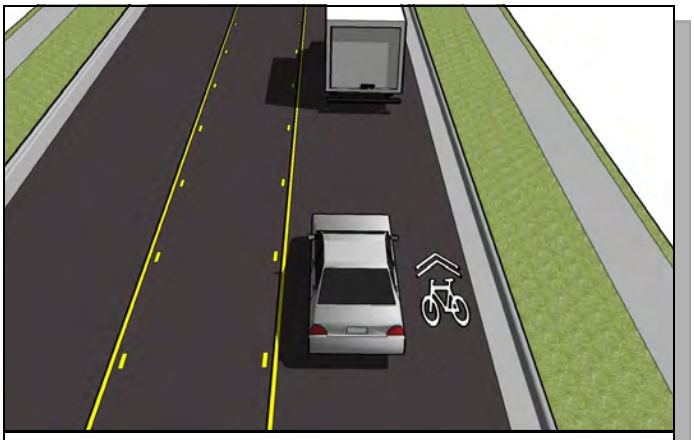
3A.3.1 Bicycle lanes

The American Association of State Highway Transportation Officials (AASHTO) notes that bicycle lanes can help provide roadway space for the preferential use by bicyclists. By creating extra space for bicyclists, these lanes help produce more predictable movements by both cyclists and motor vehicles, allowing for potentially safer interaction between the two groups.

According to the 1999 AASHTO report, "Guide for the Development of Bicycle Facilities," bike lanes should be delineated from other travel lanes with a 6-inch solid white line. Bike lanes should be a minimum of 5 feet in width, as measured from the face of curb to this line. On rural roads without curb and gutter, bike lanes should be a minimum of 4 feet in width.

3A.3.2 Shared roadway markings

Where bike lanes are not feasible, shared roadway markings, or "sharrows," can be used to demarcate a travel lane as a lane shared by multiple users. Sharrows are currently considered experimental by the National Committee on Uniform Traffic Control Devices (NCUTCD) but have been recommended for inclusion in the updated Manual on Uniform Traffic Control Devices (MUTCD).



This sketch shows what a sharrow would look like on a typical Apex street.

On roadways where on-street parking is permitted sharrows should be placed a minimum of 11 feet from the

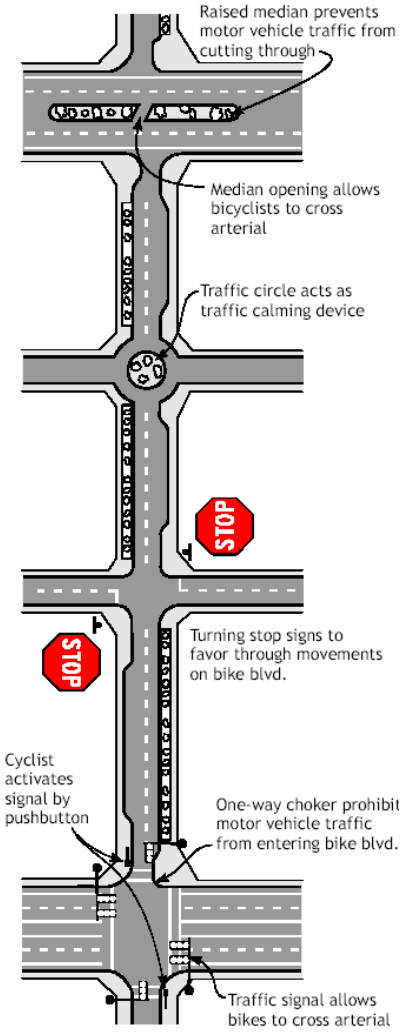
curb. This distance allows bicyclists to remain a safe distance from the parked cars, outside of the door zone. On roadways where on-street parking is prohibited and there is insufficient room for bicycle lanes sharrows should be placed 3 feet from the curb.

Wide lanes along Hunter Street provide enough room for both cars and cyclists.

3A.3.3 Wide outside lanes

Wide outside lanes are travel lanes that are wider than standard lanes in order to provide additional space between cyclists and motor vehicles. Typically these lanes are 14 feet wide on multilane roadways and 15 feet wide on single-lane roadways.

This facility is most appropriate on travel routes with moderate traffic volumes and is suitable for cyclists who are comfortable riding with the flow of regular traffic. While basic cyclists can ride these routes, they are most often preferred by advanced cyclists. In order to limit the effective width of motor-vehicle travel lanes, wide outside lanes should be used in conjunction with shared roadway markings.



Wide outside lanes will be included on all proposed and improved thoroughfares as well as all proposed collector streets.

3A.3.4 Signed routes

The North Carolina Department of Transportation has established a cross-state network of signed bicycle routes called "Bicycling Highways." In addition local bicycle traffic can be served on local signed routes that provide wayfinding guidance to citizens and visitors.

3.3.5 Bike boulevards

Like signed routes, bike boulevards provide wayfinding for cyclists desiring to ride on a roadway with light motor vehicle traffic. Bike boulevards often use local neighborhood streets with preferential design to bicycles such as limited numbers of stop-controlled intersections, partial roadway diverters, and neighborhood traffic circles.

3A.3.6 Off-road facilities

In addition to on-road facilities, off-road facilities can serve bicycle travel needs. Unlike many on-road facilities, these off road paths are often more attractive to younger or less-experienced cyclists. Such facilities include greenways and multi-use paths described previously.

Construction of a boardwalk along Beckett's Crossing Greenway created an off-road connection between Olive Chapel Road and the Beaver Creek Commons shopping center.

Opposite: A diagram shows treatments along a street to convert it to a bicycle boulevard.
Source: Turner-Fairbank Highway Research Center (http://www.tfhrc.gov/safety/pedbike/pubs/05085/chapt14.htm)

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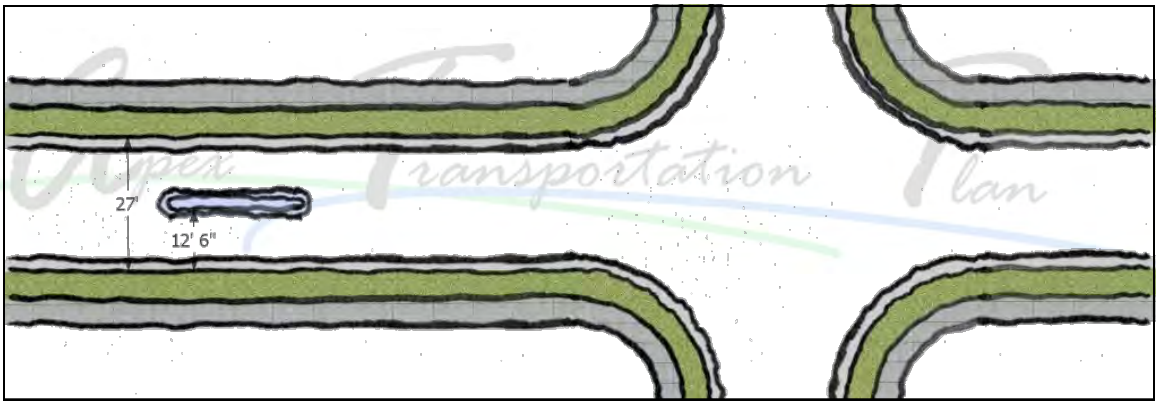


3B Traffic Calming

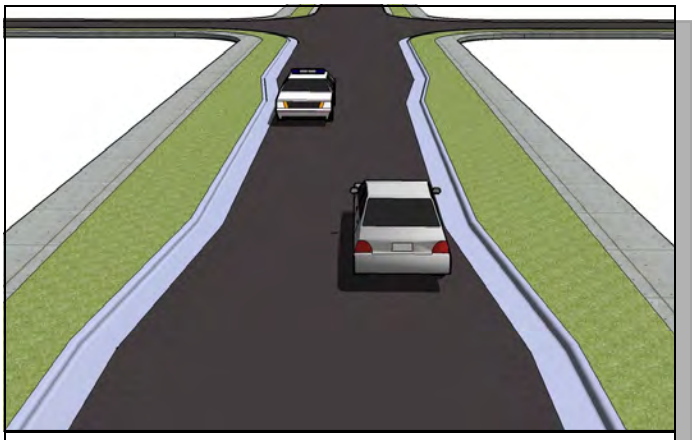
3B.1 Roadway Design

3B.1.1 Narrow lanes

The street typical sections for Apex include standard lane widths ranging from 11 feet to 15 feet. In areas with a need for traffic calming, lane width can be narrowed to 10 feet in order to slow motor vehicle traffic.

3B.1.2 On-street parking

Parallel on-street parking can help calm traffic by creating friction for vehicles in the travel lanes adjacent to the parking. Also, as people pull into and out of the spaces, the through traffic must slow down. Along roadways where on-street parking is permitted but not utilized, striping the parking areas may result in a similar reduction in speed.



Neckdowns can encourage motorists to slow down as they decrease the overall roadway width.

3B.1.3 Neckdowns

Neckdowns provide a narrowing of the roadway for a small section of the road by reducing the distance between the curbs. These treatments can be provided at specific points along a roadway to reduce lane width and slow speeds.

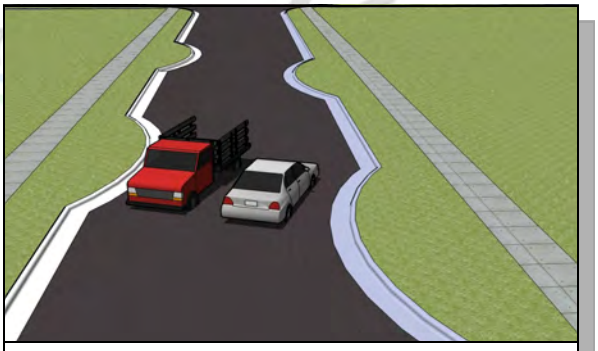
3B.1.4 Median slow points

Like neckdowns, median slow points narrow the roadway for a small section of the road. Instead of narrowing the road at the curb, a median is installed in the middle of the road to effectively narrow the travel lanes.

3B.2 Horizontal Deflections

3B.2.1 Diverters

For streets that have too much traffic traveling along them, diverters can prohibit vehicles from entering them at certain points. Diverters can be concrete islands or medians that prohibit specific movements at an intersection.



Chicanes force vehicles to make small turns in order to travel along a roadway.

3B.2.2 Chicanes

Chicanes channelize the travel lanes in order to slow traffic. This treatment turns a straight roadway into a serpentine street through a series of back-to-back curves.

3B.3 Vertical Deflections

3B.3.1 Speed humps

These treatments are raised areas along the road that are 3 inches high and 14 feet long.

A speed hump calms traffic along a residential street in Apex.

3B.3.2 Raised crosswalks

Like speeds humps, raised crosswalks are raised areas along the road. This treatment, however, provides a 10 foot wide plateau for a crosswalk. Raised crosswalks are 3 inches high and 22 feet long.

3B.4 Intersection Treatments

3B.4.1 Roundabouts

These free-flowing intersection treatments force vehicles to slow down when travelling through the intersection by using median deflectors and a center island to force vehicles around a circle.

Seagrove's Farm (left) and Beaver Creek Crossings both have existing, functioning roundabouts in Apex.

3B.4.2 Mini-circles

Like roundabouts, mini-circles force vehicles to slow down to travel around a circle. This treatment uses a smaller center circle intended for intersections with lower traffic volumes.

Curb extensions reduce turning speeds and shorten pedestrian crossing distance in Venice, California.

3B.4.3 Intersection bulb-outs

This treatment involves curb extensions at intersections to narrow the travel lane. In addition to the traffic calming benefits, bulb-outs shorten crossing distances for pedestrians.

3B.4.4 Raised intersections

Similar to speed humps and raised crosswalks, raised intersections calm traffic through vertical deflection. This treatment raises the roadway within the intersection and improves visibility of vehicles within the intersection.

3B.4.5 Reduced turning radius

In areas where vehicles are turning too quickly at an intersection, smaller turning radii can help reduce vehicle speeds.

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3C Streets

3C.1 Median Treatments

Two types of medians are typically constructed on roadways:

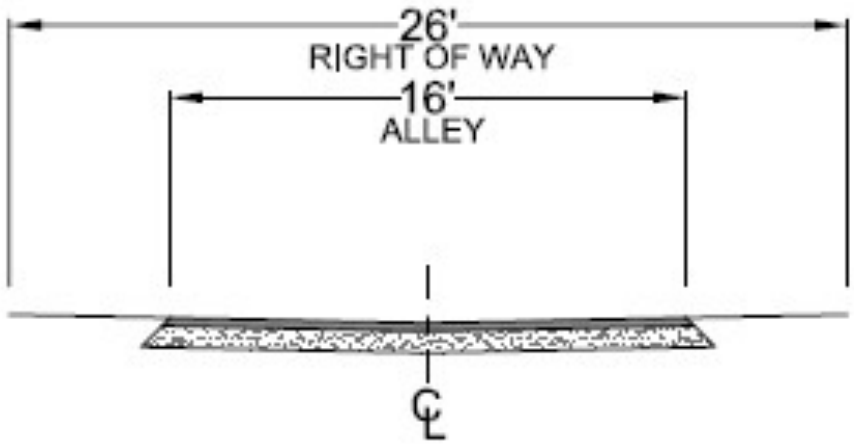
- Two-way left-turn lanes (TWLTL)
- Raised curbs and other non-traversable medians

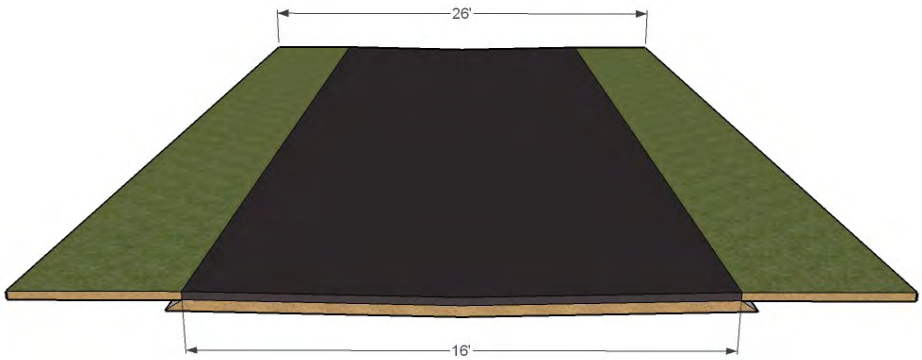
TWLTLs and medians improve traffic operations and safety by removing left-turning vehicles from through travel lanes. TWLTLs provide less access control, greater operational flexibility, and require minimal additional right-of-way. Raised curb medians provide greater travel safety through access control, physically separate opposing traffic, limit conflicts, allow for vegetation in the median, and provide better pedestrian refuge, but require a wider right-of-way. Because they shorten the crossing distance for pedestrians, provide a refuge for crossing, and generally improve the aesthetics of the roadway, non-traversable medians should be encouraged over two-way left-turn lanes where possible.

Two-way left-turn lanes (TWLTLs) and non-traversable medians provide different asthetics and access control for a roadway. Olive Chapel Road, left, has a TWLTL near Pearson Farms while the Apex Peakway near Old Mill Village has a planted median in the center.

3C.2.1 Alley

Alleys are minor streets located behind buildings that act as a shared driveway for the buildings they serve. Alleys reduce the need for driveways directly onto the main street and reduce conflicts between motor vehicles and pedestrians.



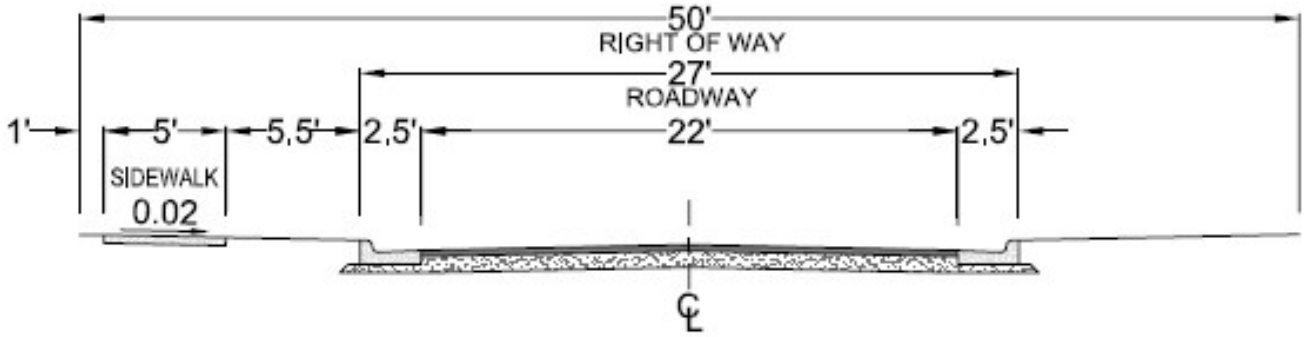


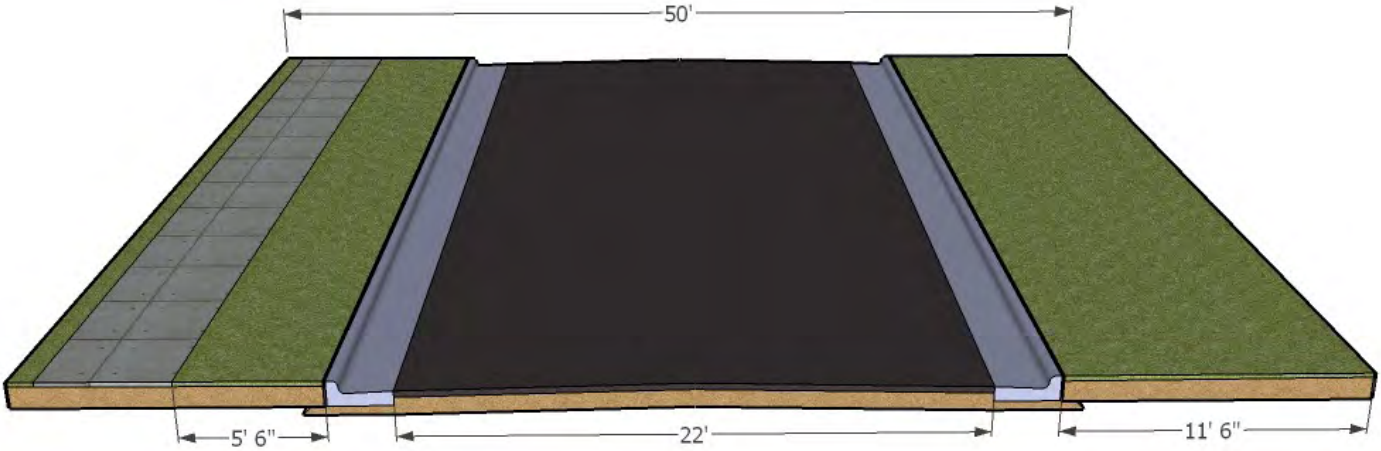
This 16-foot-wide alley in Carpenter Village in Cary is similar to Apex's new alley standard.

Design Speed	<20 mph
Design ADT	<1,000
Max Grade	10 percent
Min Centerline Radius	50 feet
Land Use/Access	All Full access

3C.2.2 Minor Residential Street

Minor residential streets use the smallest principal street standard for Apex. These streets are intended for low volume, low speed motor vehicle traffic and moderate pedestrian and bicycle traffic.



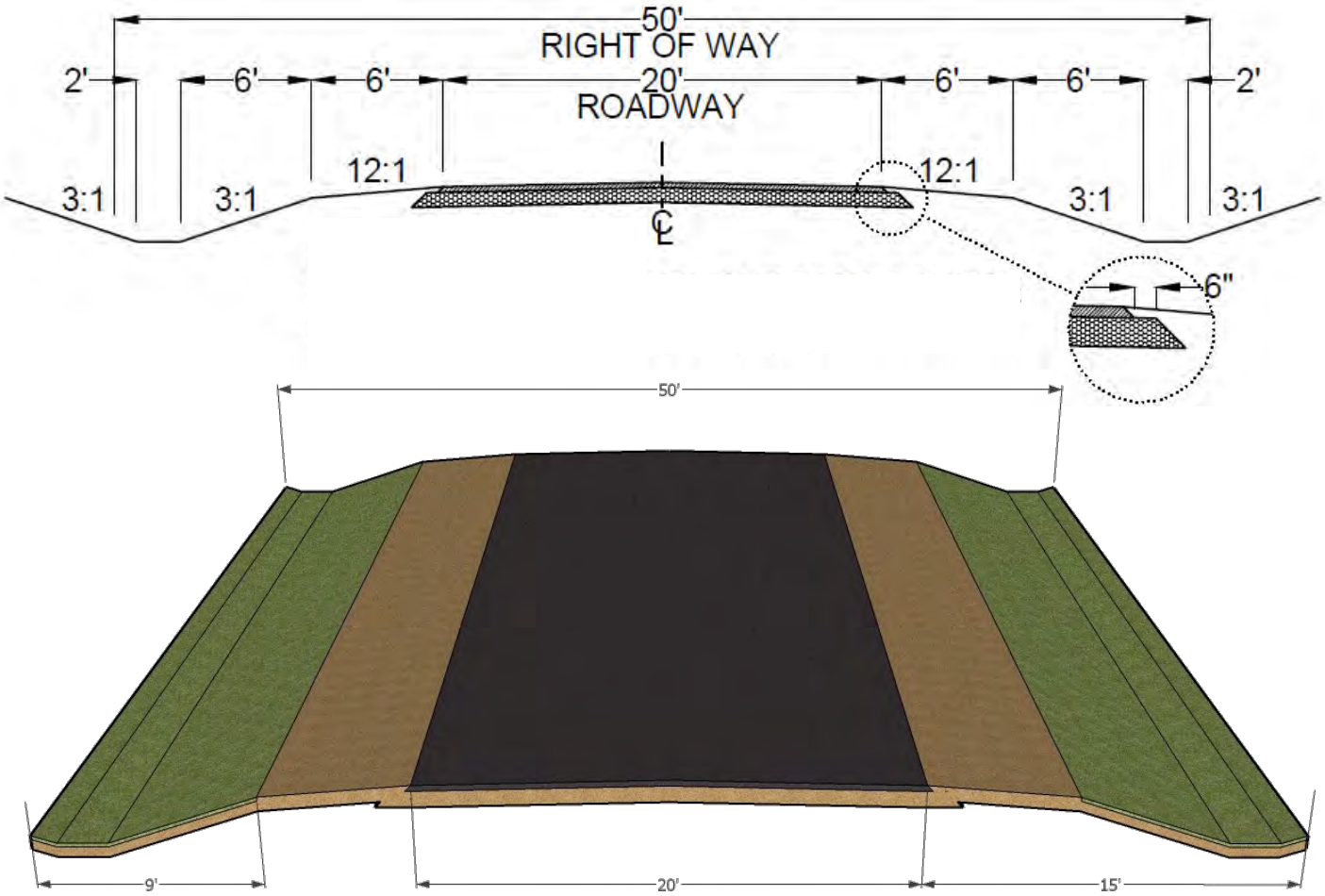


Most local streets in Apex are minor residential streets, like Vatersay Drive in Cameron Park.

Design Speed	25-30 mph
Design ADT	2,000
Max Grade	10 percent
Min Centerline Radius	150 feet
Land Use/Access	Residential Full access

3C.2.3 Rural Residential Street

Rural residential streets are minor streets that serve rural, low-density, residential development. These streets serve rural subdivisions that have a maximum density of one unit per acre. Due to the low density of the development, no separate bicycle or pedestrian facilities are provided.

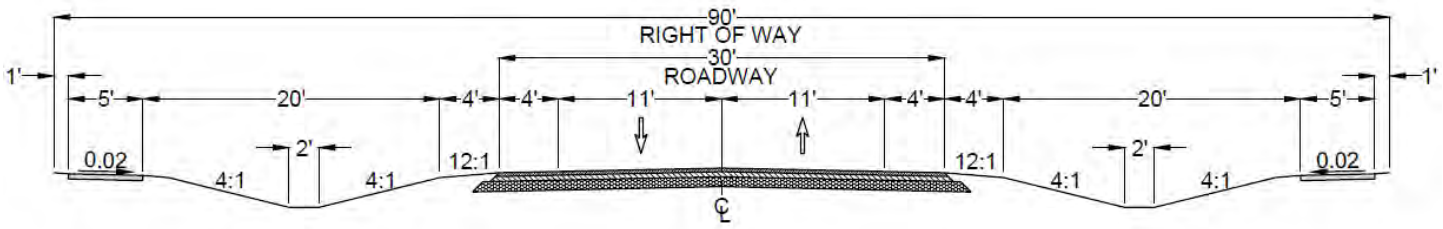


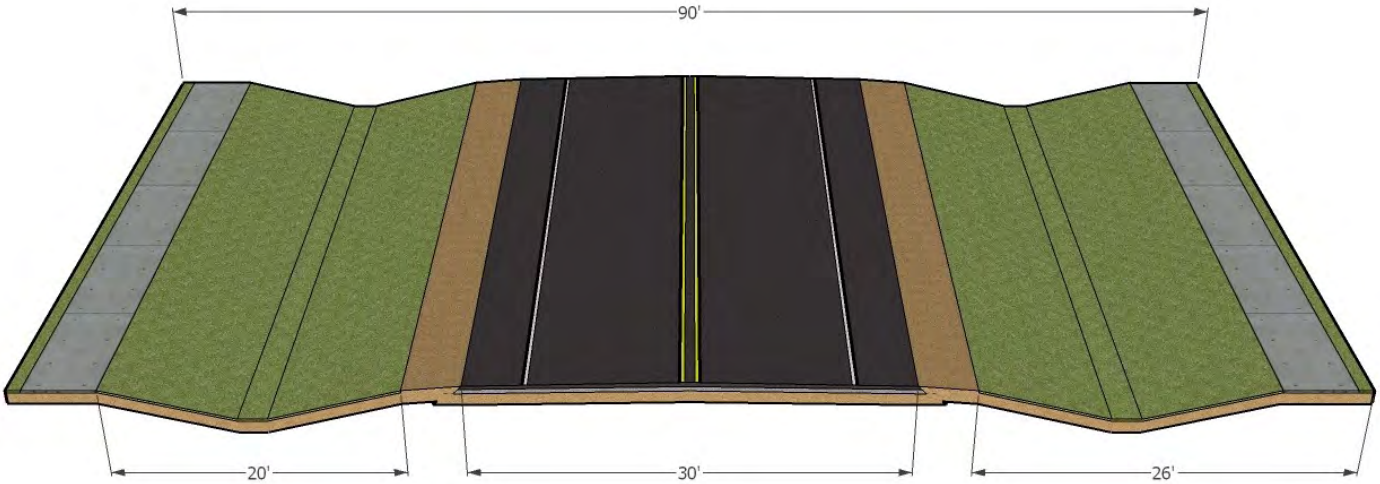
Colby Chase Drive is a rural residential street near Smith Road to the southeast of Apex.

Design Speed	25-30 mph
Design ADT	2,000
Max Grade	10 percent
Min Centerline Radius	150 feet
Land Use/Access	Residential Full access

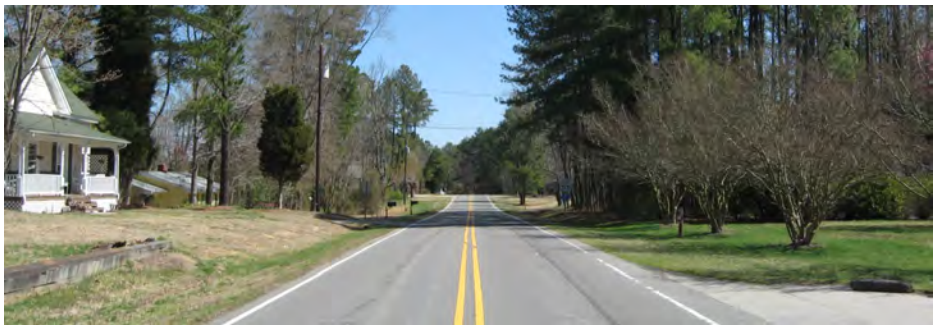
3C.2.4 Rural Collector Street/2-Lane Rural Thoroughfare

Rural collector streets and 2-lane rural thoroughfares provide the basic transportation framework in the areas outside of the urbanized portions of Apex. These streets are intended for low-moderate volume, moderate speed motor vehicle traffic and low pedestrian and bicycle traffic.





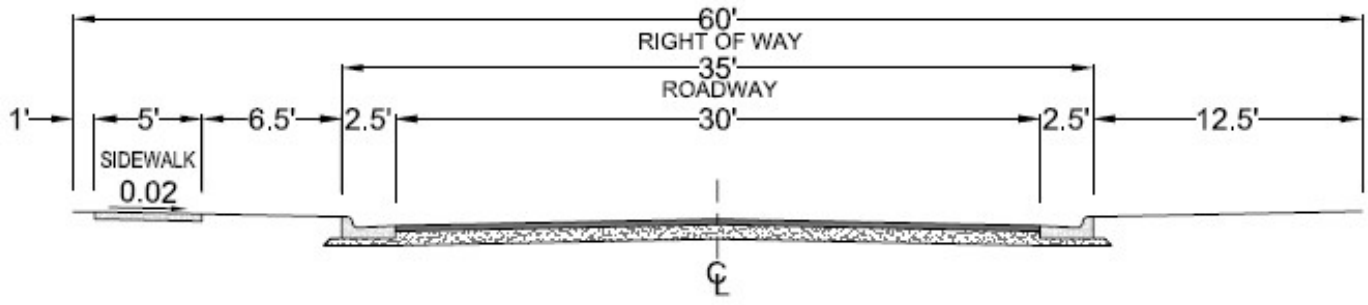
Old US 1 in New Hill is one of many 2-lane rural thoroughfares in and around Apex.

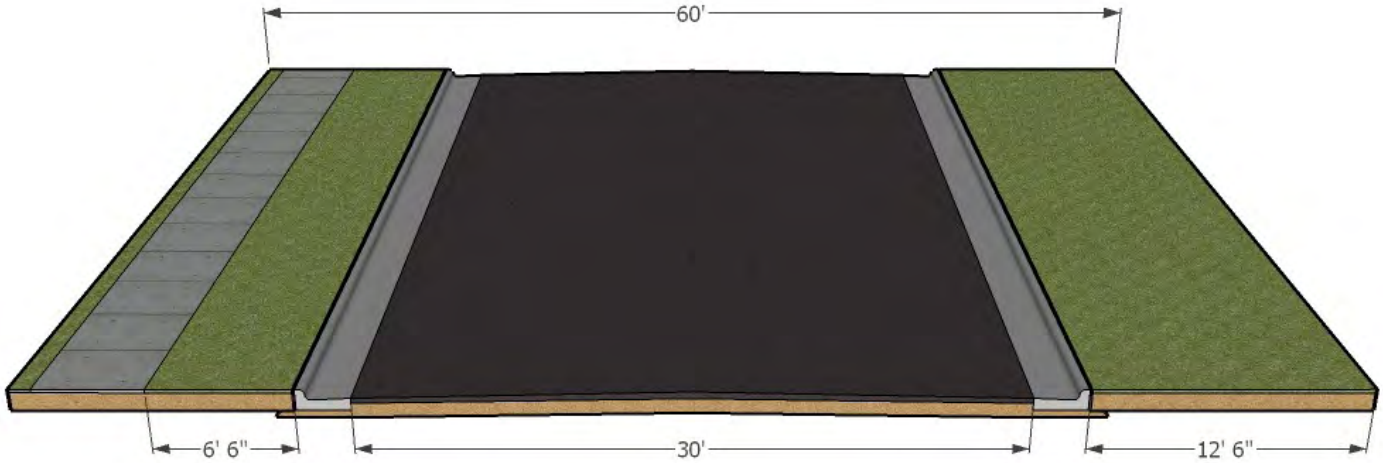


Design Speed	30-50 mph
Design ADT	15,000
Max Grade	7 percent
Min Centerline Radius	550 feet
Land Use/Access	All Full access

3C.2.5 Major Residential Street

Major residential streets are used for major streets running through residential subdivisions or for sections of a minor residential street at the entrance to the subdivision.



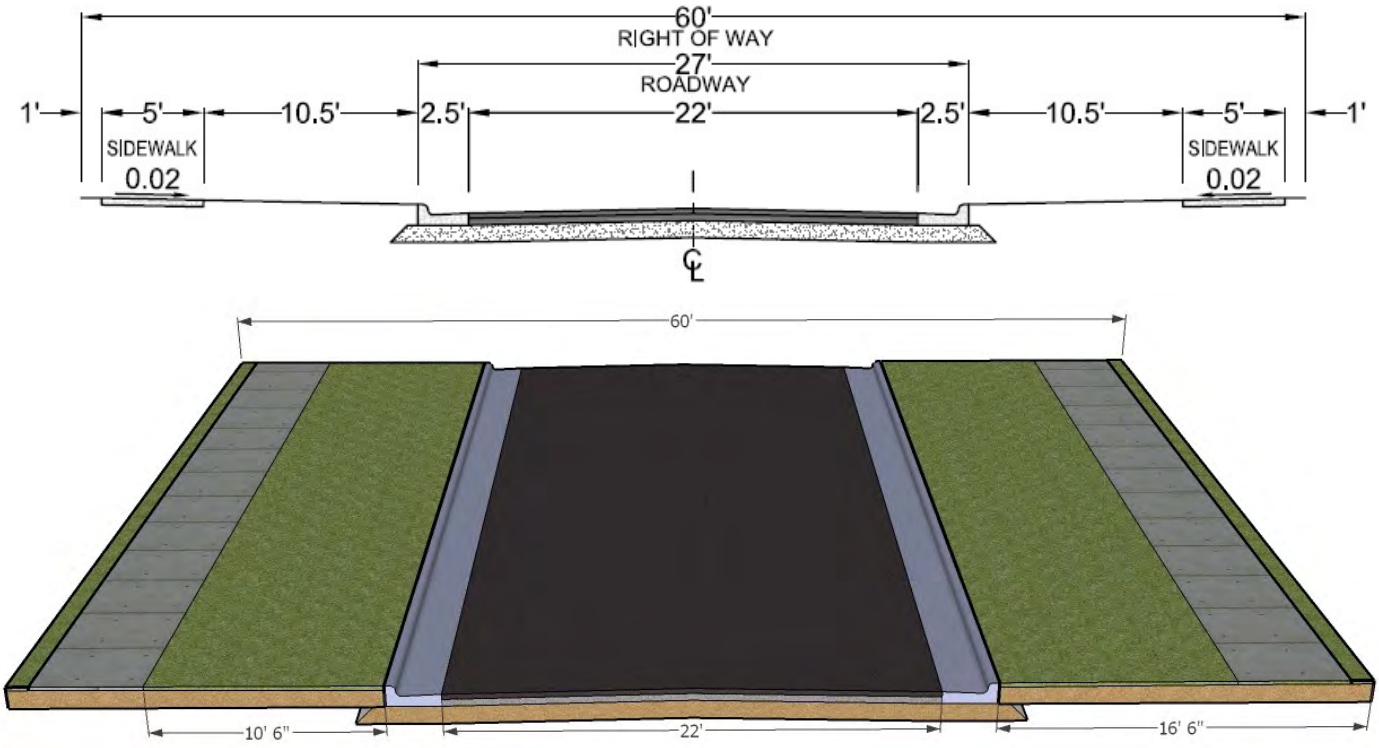


White Dogwood Road is a major residential street with a median treatment at its intersection with Olive Chapel Road.

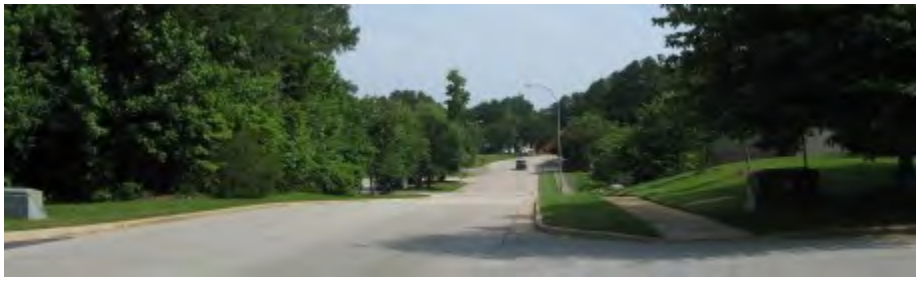
Design Speed	25-30 mph
Design ADT	3,000
Max Grade	10 percent
Min Centerline Radius	150 feet
Land Use/Access	Residential Limited access

3C.2.6 Minor Collector Street

Minor collector streets have the same roadway layout as minor residential streets, but are located on a wider right-of-way with sidewalks on both sides of the street. These streets are intended for low-moderate volume, low speed motor vehicle traffic and moderate pedestrian and bicycle traffic.



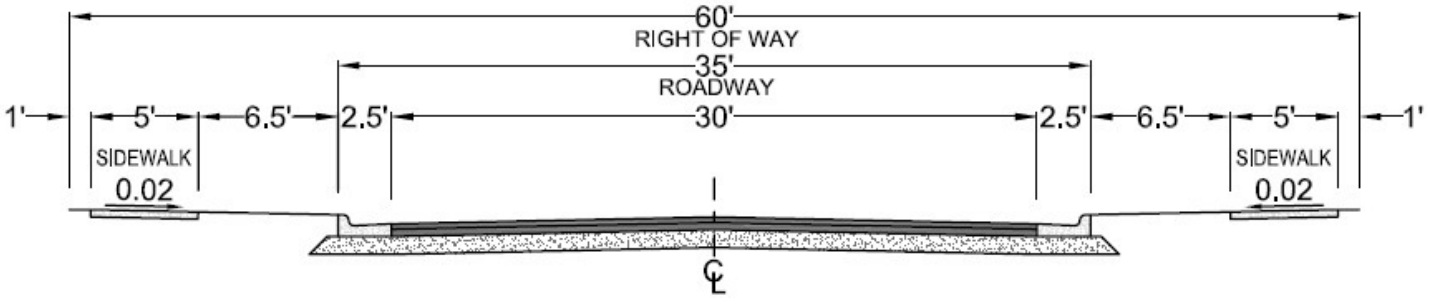
Minor collector streets, such as Reliance Avenue shown here, have a similar footprint as minor residential streets, but are designed for slightly more traffic.

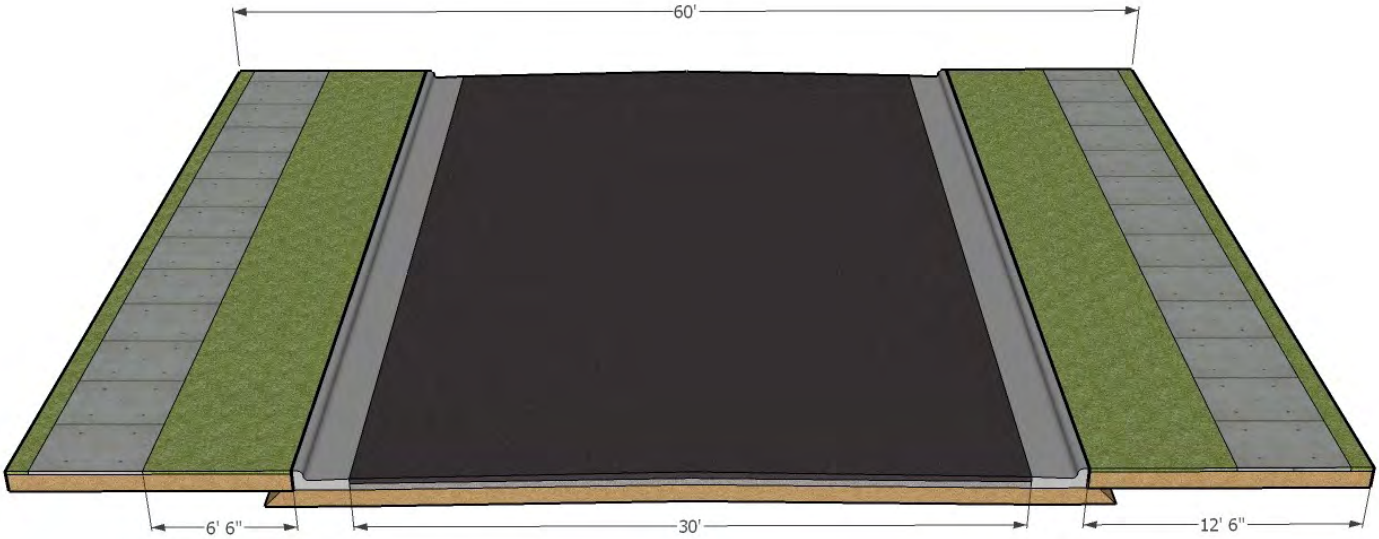


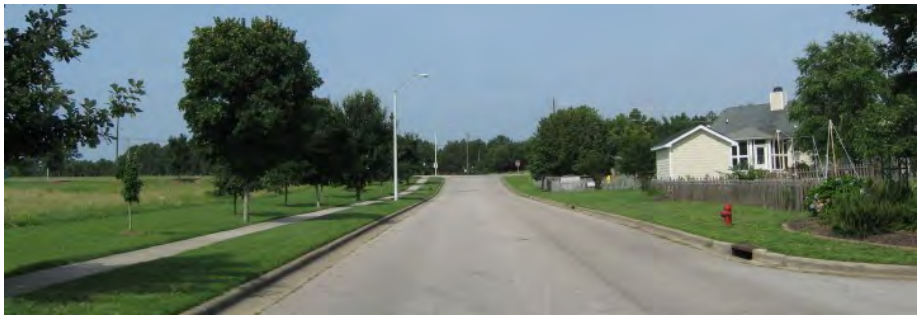
Design Speed	30-40 mph
Design ADT	5,000
Max Grade	7 percent
Min Centerline Radius	550 feet
Land Use/Access	All Full access

3C.2.7 Major Collector Street

Major collector streets have 8 additional feet of roadway width than the minor collector streets. These streets are intended for moderate volume, moderate speed motor vehicle traffic and moderate pedestrian and bicycle traffic. Major collectors prohibit direct access by residential driveways.





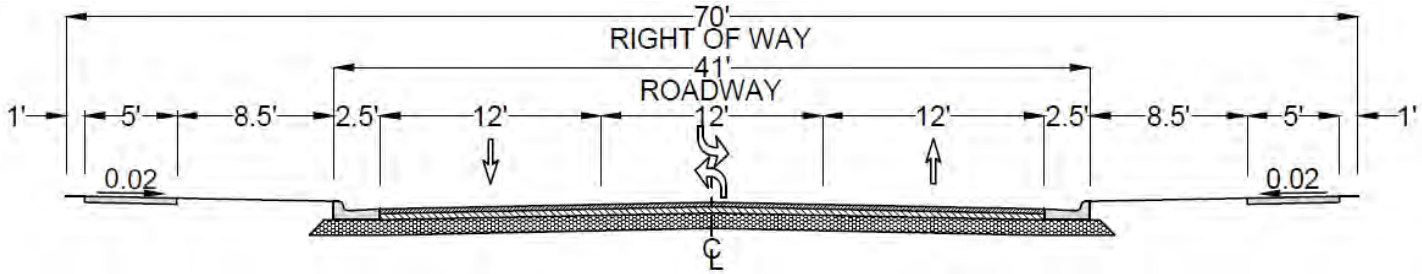


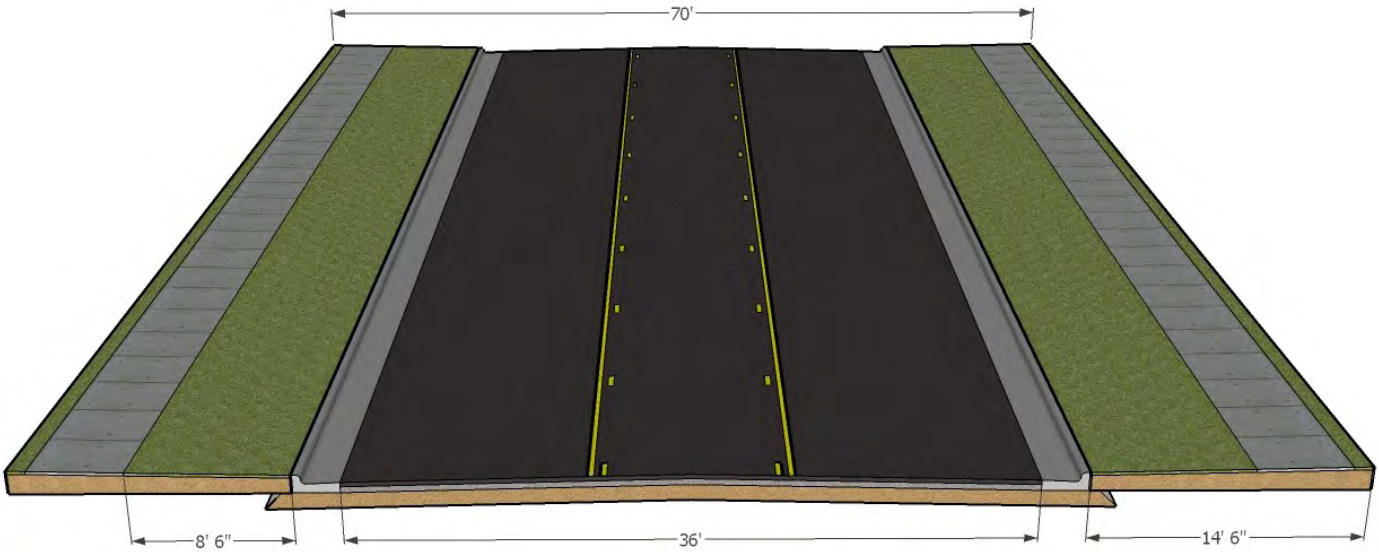
Perry Road is one of Apex's existing major collector streets.

Design Speed	30-40 mph
Design ADT	5,000
Max Grade	7 percent
Min Centerline Radius	550 feet
Land Use/Access	All No residential access

3C.2.8 3-Lane Thoroughfare

3-lane thoroughfares are typically minor roads that have a high volume of turning movements. These streets separate turning movements from through movements to improve motor vehicle flow.



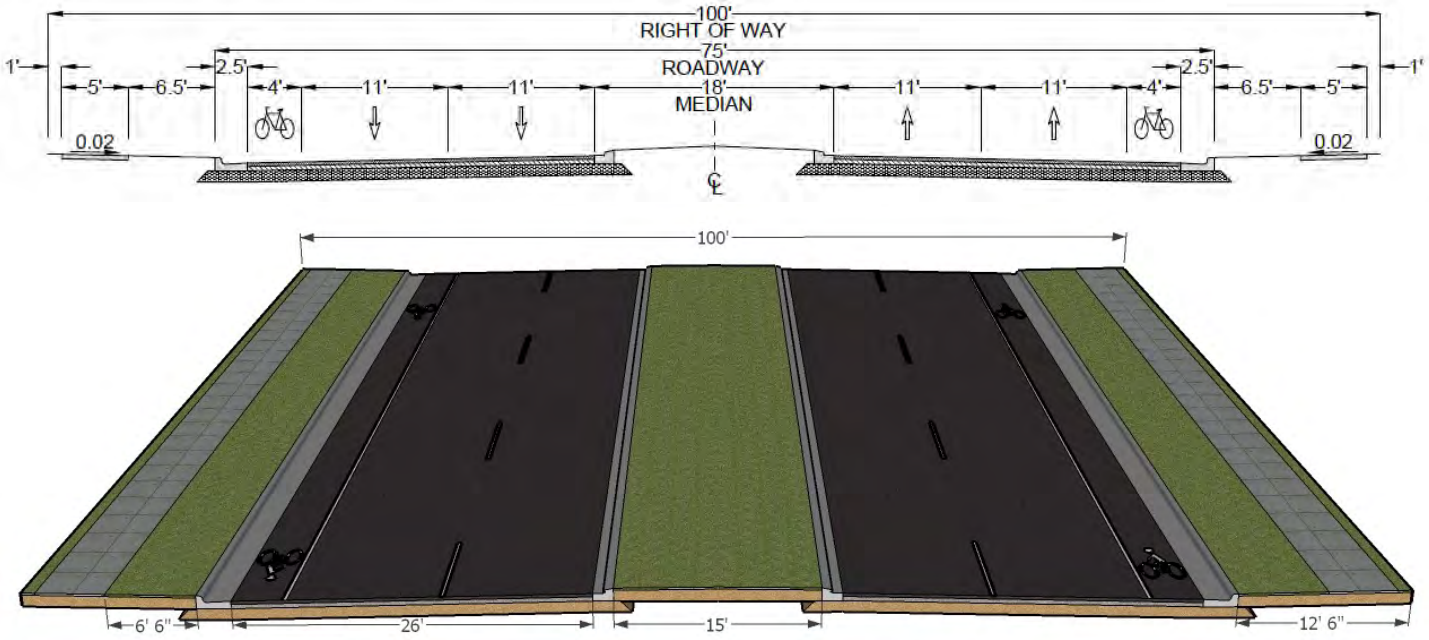


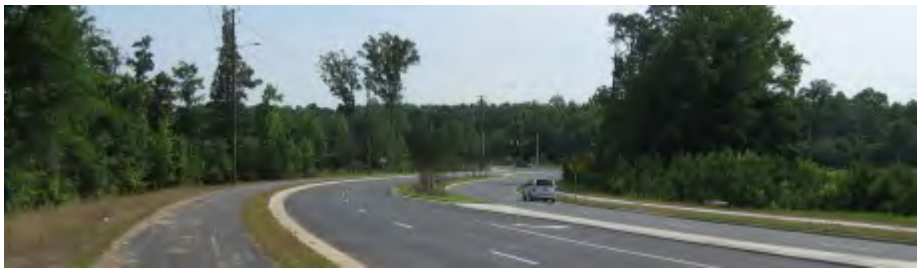
NC 55 near Apex Middle School is a 3-lane thoroughfare in town.

Design Speed	35-50 mph
Design ADT	15,000
Max Grade	7 percent
Min Centerline Radius	550 feet
Land Use/Access	All Full access

3C.2.9 4-Lane Median-Divided Thoroughfare

4-lane median-divided thoroughfares accommodate the highest degree of motor vehicle mobility. These streets separate turning movements from through movements to improve motor vehicle flow. Despite the high mobility of motor vehicle traffic, these streets provide for low-moderate pedestrian and bicycle traffic.



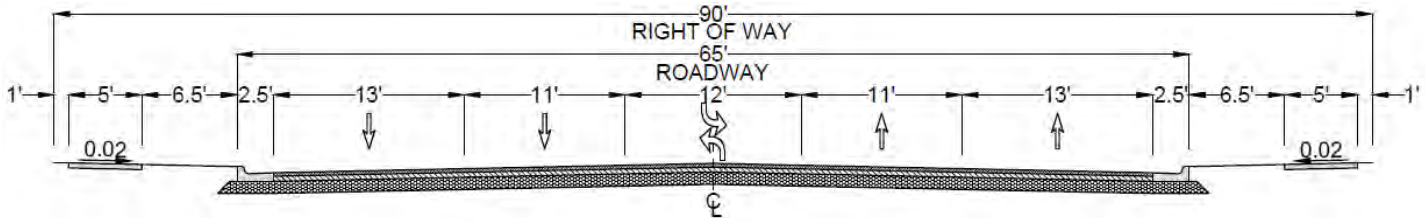


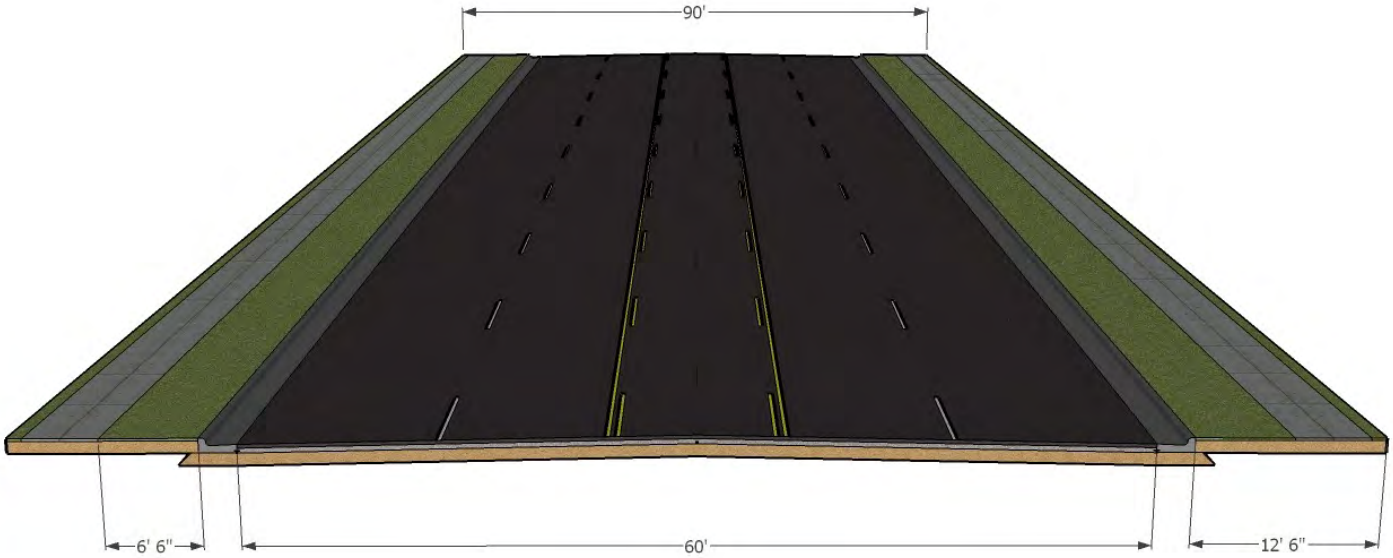
The section of the Apex Peakway near Broadstone Station is a 4-lane median -divided roadway.

Design Speed	40-50 mph
Design ADT	30,000
Max Grade	7 percent
Min Centerline Radius	850 feet
Land Use/Access	All Limited access

3C.2.10 5-Lane Thoroughfare

5-lane thoroughfares provide two through lanes in each direction and a continuous two-way left turn lane in the middle to accommodate turning movements. Because of the high number of turning movements and the wide pavement width, these streets have low mobility for pedestrian and bicycle traffic. As a result, 5-lane thoroughfares should be discouraged except where absolutely necessary.





NC 55 south of US 1 is a standard 5-lane roadway in Apex.

Design Speed	40-50 mph
Design ADT	30,000
Max Grade	7 percent
Min Centerline Radius	700 feet
Land Use/Access	All Full access

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3D Intersections

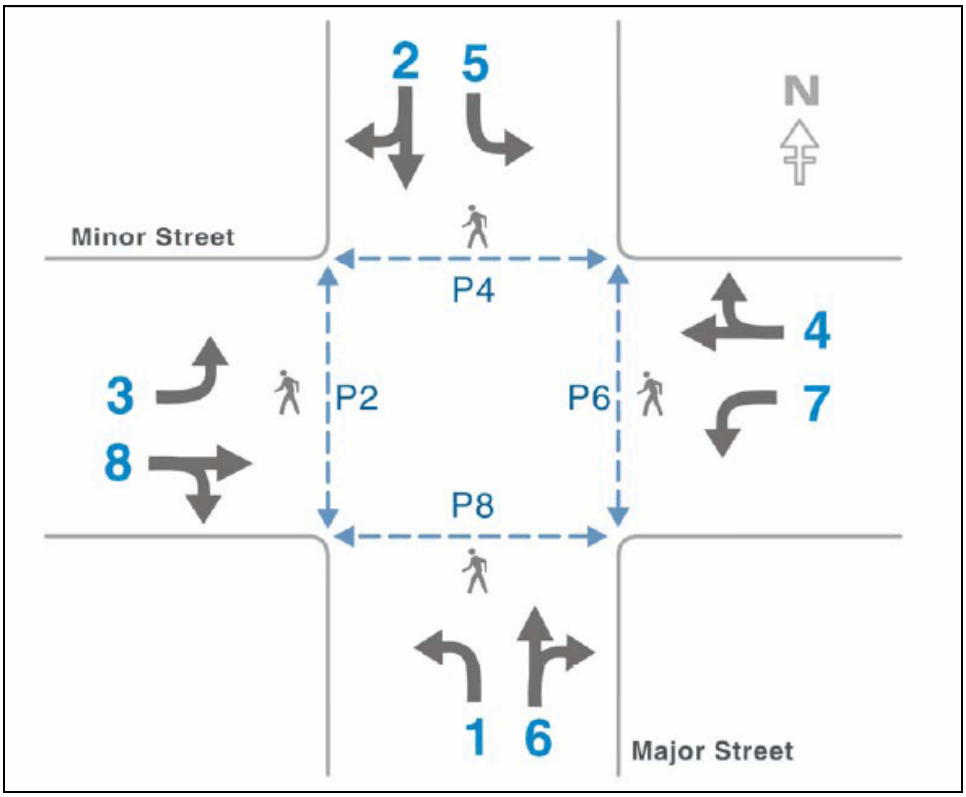
3D.1 At-grade Intersections

3D.1.1 Stop Control

A basic treatment for intersections with low daily traffic is stop control. In this treatment one or more of the intersection legs has a stop sign to determine which vehicles must yield the right-of-way.

3D.1.2 Signalized Intersection

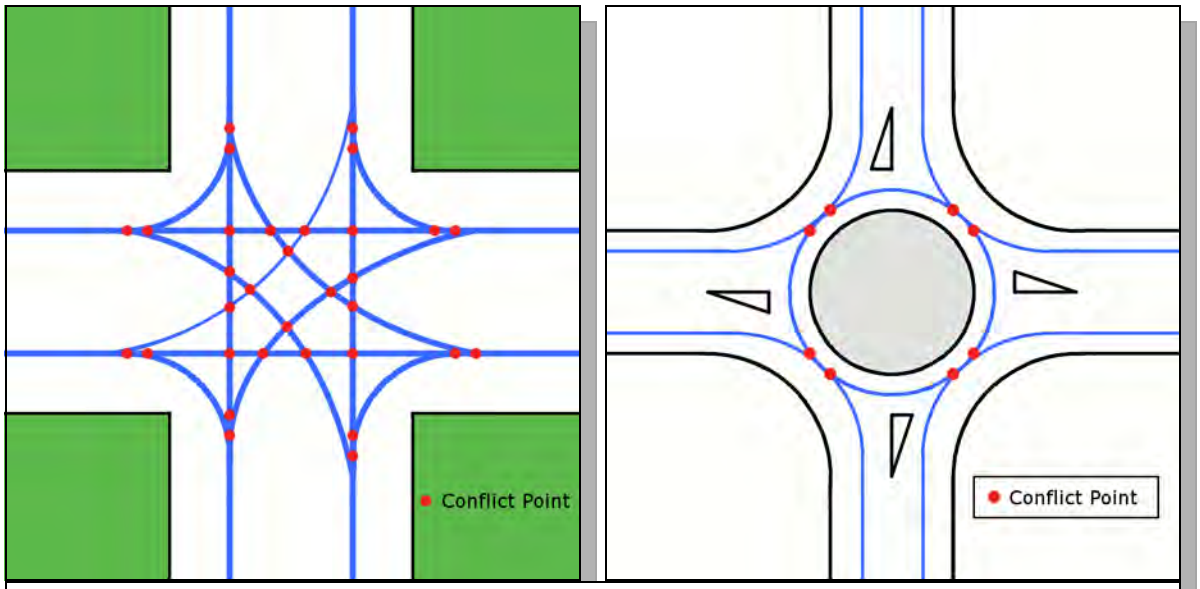
For intersections with greater traffic or heavier turning movements, a traffic signal may be necessary to improve safety and mobility. The benefits of these treatments are direct access for users in all directions and familiarity for drivers. Turning conflicts, however, can make these intersections unsafe for drivers and pedestrians, and the more permitted phases that are signalized, the greater the delay for other phases.



Signalized intersections often have 8 phases of permitted movements that can cause delay for other roadway users.

3D.1.3 Roundabout

Roundabouts and traffic circles are intersection treatments that keep traffic moving by providing yield-controlled access on the approach legs. Roundabouts can be single-lane or multi-lane. This intersection design has been shown to be safer and more efficient than a standard signalized intersection, namely by reducing the number of conflict points between vehicles and by reducing start-up times through free-flow movement. Roundabouts are also beneficial as they require pedestrians to cross only 1 direction of traffic at a time.



A standard 4-leg intersection has 32 vehicle conflict points while a 4-leg single lane roundabout has only 8 conflict points.

3D.1.4 Superstreet

This intersection treatment eliminates the left-turn and through movements from the side streets onto the main street. Instead of making a left-turn from the side street onto the mainline, a driver would turn right and then make a u-turn. Superstreets essentially convert a two-way street into parallel one-way streets and improve mobility along the mainline.

US 17 in Leland (left) and US 15-501 in Chapel Hill are two types of superstreet treatments in North Carolina.
Source: www.ncdot.org

There are numerous intersection designs that separate cross movements on different grades or levels. Below are three specific designs.

3D.2.1 Compact Diamond Interchange

Compact diamond interchanges are a standard interchange design with ramps on all four quadrants with an attempt to minimize the footprint of the facility. Crossing movements between the two roadways are physically separated with a bridge.

A compact diamond interchange is used at I-440 and Poole Road in east Raleigh.

3D.2.2 Single Point Urban Interchange

The single point urban interchange or SPUI is a compact interchange design that manages all turning movements on and off the ramps using one traffic signal instead of multiple signals. This design reduces the footprint of the interchange but the long crossing distances and frequency of turning movements creates a highly undesirable pedestrian environment.

The Fayetteville Road and I-40 interchange in Durham incorporates a single point design.

3D.2.3 Modern Roundabout Interchange

The modern roundabout interchange is another design that attempts to minimize the footprint of the interchange by combining the intersections for the ramps. Instead of signals at these intersections, however, there are roundabouts that intersect to create an elongated roundabout design. The minimal turning conflicts of this design make it safer and more appealing for pedestrians.

An artistic rendering shows the future design of a modern roundabout interchange along Keystone Parkway in Carmel, Indiana. Several of these interchange designs are currently under construction in Carmel.