



Town of Biltmore Forest

TRAFFIC CALMING STUDY

2018



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1 | TRAFFIC CALMING

What is Traffic Calming?

History

Traffic calming is founded on the idea that streets are a means of connecting people to their communities, offering critical functionalities that help to create and preserve a sense of place. They provide a service to the community as a whole and should adequately and safely serve multiple users such as walkers, shoppers, tourists, cyclists, runners, children and families, as well as motorized vehicle passengers and mass transit riders.

Traffic calming uses techniques designed to lessen the impact of motor vehicle traffic by slowing it down, or literally “calming” it. This helps build human-scale, walkable, bikable and livable communities where motor vehicles are intended to be one form of transportation but not the sole form of transportation.

Traffic calming began in the Netherlands in the 1960s with the design of “woonerven”, or “living yards”. The Woonerven in The Netherlands is a street or road where pedestrians and cyclists have legal priority over motorists. Using a variety of traffic calming techniques, woonervens were intended to improve pedestrian, bicycle and motor vehicle safety.

Traffic Calming: *The combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter the behavior of drivers, and improve conditions for non-motorized street users.*

- Institute of Transportation Engineers (ITE)

In the late 1970s, Germany began working in this area using the term “Verkehrsberuhigung” which would eventually be translated as “traffic calming”. A number of communities in the United States began applying the principles of traffic calming in the late 1970s, at the same time that it was spreading to other European countries, Canada, and Australia. However, it has taken many years for traffic calming to gain popularity in America. As a result, many of the initial

studies on the effects of traffic calming have taken place abroad, where its application has reportedly lowered crash and injury rates anywhere from 20 to 80 percent.

In the United States, traffic calming measures are rarely combined to the extent that they are in Europe. Although it has been much more common to see the installation of individual measures, an increasing number of jurisdictions have begun combining measures with good success.

Purpose

The concept of traffic calming is based on the premise that roadways are meant for all users and modes of transportation including vehicles, pedestrians, bicyclists, and mass transit. High vehicular speeds can create an atmosphere in which non-motorists are intimidated, or even endangered, by motorized traffic. In addition, the most serious (and fatal) collisions are caused by high speeds. Traffic calming creates a set of checks and balances that compel those at the wheel to drive slowly and carefully, making streets safer for both drivers and pedestrians. By addressing high speeds, traffic calming can increase both the real and perceived safety of pedestrians and bicyclists, and improve the quality of life within the neighborhood.

As such, if a roadway can effectively slow or calm vehicular traffic, it is more likely to be used safely and comfortably by pedestrians and bicyclists. The basic principle behind traffic calming is that reducing the speed of motorized vehicles will decrease the likelihood that pedestrians or cyclists will be hit; and even if a collision does occur, the impact is reduced and the injuries are not as severe. Statistically, collisions that occur at lower speeds are less likely to kill or seriously injure.

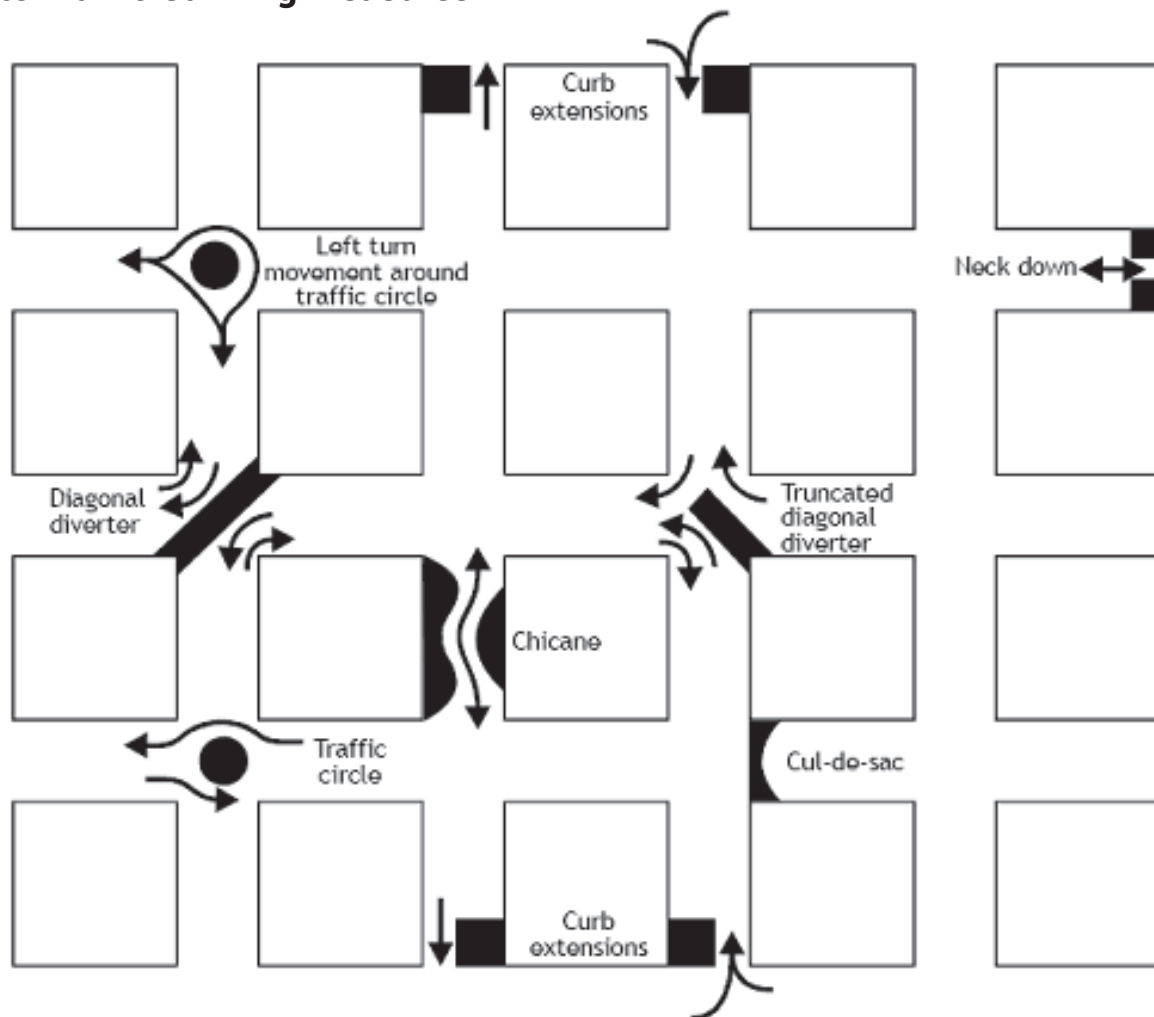
Traffic calming measures are typically limited for use on local streets. However, they have been incorporated on collector streets with predominantly residential land uses and, less frequently, on streets through downtown business districts. Because traffic calming measures are designed to slow traffic and reduce cut-through volumes, they are generally not appropriate for use on arterial streets which are intended to accommodate higher speeds and larger traffic volumes.

Communities may wish to control vehicular speeds and traffic volumes to achieve a variety of objectives. Those objectives might include: reducing accidents, collisions, noise, vibration, pollution, and crime. Some communities are also exploring how providing safe conduits for pedestrians and bikers can provide for healthier lifestyles.

According to the U.S. Department of Transportation, general objectives of traffic calming include:

- To encourage citizen involvement in the traffic calming process by incorporating the preferences and requirements of the citizens
- To reduce vehicular speeds
- To promote safe and pleasant conditions for motorists, bicyclists, pedestrians, and residents
- To improve the environment and livability of neighborhood streets
- To improve real and perceived safety for non-motorized users of the streets
- To discourage use of residential streets for cut-through vehicular traffic.

Figure 1 - Federal Highway Administration (FHWA)'s Visual Guide to Traffic Calming Measures



As is clearly shown here, traffic calming is inherently about altering motorists' behavior through access control and either vertical or horizontal deflection. Drivers must lower their speed to safely maneuver those measures.

Effectiveness

Enhanced safety is one of the most fundamental benefits of traffic calming and one of the primary reasons that programs are created. By reducing speed and decreasing traffic volume, the number and severity of vehicle crashes are significantly reduced.

According to a report by the Insurance Corporation of British Columbia, which examined 43 international studies, collision frequencies in areas with traffic calming measures declined between 8-100%. The report also revealed that there were no increases in collision frequencies where traffic calming measures had been employed.

A more recent study conducted found that children living near traffic calming devices were 50% less likely to be hit and injured by an automobile in their neighborhood.

Reducing vehicle speed creates a more walkable environment and significantly reduces the likelihood of serious injury or fatality of pedestrians. In fact, speed of the vehicle is by far the most significant factor contributing to pedestrian fatalities. According to data from the National Accident Sampling System, the rate of severe injury for people involved in crashes at impact speeds of 21-30 mph is 11.1; this rate increases to 27.9 at impact speeds of 31-40 mph and to 54.3 at speeds of 50 mph or more. Any collision with a pedestrian taking place at more than 50 mph is almost certain to result in a fatality.

Traffic calming strategies typically include a combination of education, enforcement and engineering, each of which are covered more comprehensive below. Each of these, dependent on the municipality's overall goal or objectives, varies in effectiveness when used independently of one another; often effectiveness is improved when one or more of these strategies is utilized:

Educational/outreach programs can be fairly cost-effective, but are most effective when used in combination with enforcement and engineered alterations.

Highly visible, long-term law enforcement can be very effective though such techniques can be disruptive on high volume streets and provide only short-term results. Enforcement strategies may be more effective in conjunction with an educational campaign that makes residents more aware of the potential consequences of their driving practices.

Engineered traffic calming measures are most often implemented to reduce traffic volume and speed and include a variety of options. The role of physical measures in traffic calming has been emphasized because they are "self-policing". This means that traffic calming measures, such as speed humps and traffic circles, have the ability to slow motor vehicles in the absence of enforcement.

Engineered traffic calming measures have proven far more effective in preventing child pedestrian injuries than basic road safety education, which has been unsuccessful in changing the behavior of children.

Traffic control devices (signs, signals, pavement markings, and other devices placed along roadways to guide and regulate the action of motorists on public roads) are vital for the success of infrastructure and must be used in conjunction.

Figure 2 -Effects of Traffic Calming Measures

	Volume Reduction	Speed Reduction	Conflict Reduction	Emergency Response
Horizontal Deflection				
Bulb-out / curb extension	☐	☑	☑	☐
Chicane	☑	☑	☐	☑
Gateway	☐	☑	☐	☐
On-street parking	☐	☑	☐	☑
Raised median island / pedestrian refuge	☐	☑	☑	☐
Traffic circle	☑	☑	■	■
Vertical Deflection				
Speed hump	☑	■	☑	■
Speed Cushion	☑	■	☑	☐
Raised crosswalk	☑	■	☑	■
Raised intersection	☐	☑	☑	■
Physical Obstruction				
Semi-diverter	■	☑	☑	☑
Diagonal diverter	■	☑	☑	☑
Right-in / right-out island	☑	☐	☑	☑
Raised median through intersection	■	☐	☑	■
Street closure	■	☑	■	■
Signing and Pavement Markings				
Speed limit signing	☐	☑	☐	☐
Multi-way stop control	☐	☑	☑	☑
Turn prohibitions	☑	☐	☑	☐
One-way streets	■	☐	☑	☑
Commercial vehicle prohibitions	☑	☑	☐	☐
Roadway narrowing with edge lines	☐	☑	☐	☐
Transverse markings	☐	☑	☐	☐

☐	Minimal or no effect
☑	Moderate effect
■	Significant effect

Different traffic calming measures have different effects. Choosing the right measures involves identifying the ultimate goals and figuring out how to use a combination of measures to achieve those goals.

Context

Study Area and Parameters

This project was brought about by the need to alleviate traffic concerns related to volumes and speed in a predominately residential area with regular pedestrian traffic and bicyclists in the roadway along with children playing near the roadway.

The Town of Biltmore Forest has received complaints from residents about vehicular speeding issues on Vanderbilt Road between Cedarcliff Road and Busbee Road as well as along Stuyvesant Road near the Holly Hill Road intersection. As a result, the Town has recognized the need to address speeding within the Town limits, but specifically in the areas mentioned above.

Residents have also expressed concerns about the cut-through traffic that occurs along Hilltop Road and Ridgefield Place. Concerns from residents have also been expressed about the traffic changes that will occur as a result of the traffic signal installation at the intersection of Eastwood Road and Hendersonville Road.

Biltmore Forest approached JMTE with a request to perform a traffic calming study along with the collection of speed and volume traffic data at key locations within the Town. The study was to also include recommendations for traffic



There are speed humps and a speed table crosswalk near the Biltmore Forest Country Club, which helps foster a safer environment for slow-moving golf carts and people on foot to cross safely.

mitigation along Hilltop Road and Ridgefield place due to the current as well as future traffic concerns. The Town also requested that recommendations be provided to increase pedestrian safety.

Installations of traffic calming devices have been present for a number of years, such as the speed humps and speed table crosswalk near the Country Club and the speed humps near the playground at Greenwood Road. These are designed to slow vehicular traffic at key locations - namely those that experience a higher level of pedestrian crossings and the presence of golf carts

However, the Town of Biltmore Forest is concerned about the widespread use of these traffic calming devices. The roadway characteristics are changed drastically with their installation which make them unsuitable for certain uses. As will be discussed in Chapter 3, there are many different approaches and strategies to traffic calming.

Housing

Biltmore Forest consists of mostly low density single-family homes, with some townhomes. Most houses sit on large properties (relative to the City of Asheville) with long driveways that separate residents from the streets, but some neighborhoods have parcels that are closer together and closer to the street. There are approximately 1,400 residents currently living in Biltmore Forest in a total area of just about 3 square miles.

Walkability

The Town of Biltmore Forest, though often hilly, is inherently walkable. The temperature in summer is noticeably cooler under the shady mature tree canopy that blankets the entire town. A stroll around the neighborhood streets feels almost like a walk in the woods. It is quiet and safe and most streets accommodate all users as equal. Biltmore Forest is a very active community and residents are often seen walking, jogging, and riding bicycles through the neighborhood. The community's wholly residential makeup serves the neighborhood well and makes most of the Town's streets ideal pathways for children learning to ride bikes, elderly couples out for a stroll, fitness enthusiasts, and dog walkers.

Figure 3 - Existing Countermeasures (North)

The northern section of Vanderbilt Road features several traffic calming measures, which are isolated and do not comprise a cohesive system:

- Rumble strips on Cedarcliff Road at the Vanderbilt Road intersection.
- Landscaped median on Vanderbilt Road between Busbee Road and Lone Pine Road.
- Speed humps, a speed table (with pedestrian crossing), and rumble strips on Stuyvesant at the Biltmore Forest Country Club [see Figure X - Existing Countermeasures (South)].

Figure 4 - Existing Countermeasures (South)

This section of Stuyvesant Road features several traffic calming measures, which represent a concerted effort to slow vehicles near the Country Club and Greenwood Park. Measures include:

- Series of four speed humps and one speed table (with pedestrian crossing) near the Biltmore Forest Country Club.
- Rumble strips on Stuyvesant to indicate proximity of the speed table.
- Two speed humps near Greenwood Park and the rear entrance to Carolina Day School.

2 | STRATEGIES to CALM TRAFFIC

Traffic calming can be addressed in a number of ways and usually includes a combination of three strategies: education, enforcement and engineering. Using this three-tiered approach can provide municipalities with greater flexibility and help identify specific traffic calming measures to be implemented while prioritizing projects accordingly.

Different traffic calming methods have varied levels of effectiveness based on the overall goal or objective. For example, some methods are more effective in reducing the speed of motorized vehicles while others are intended to decrease congestion or overall amount of traffic. Although education and enforcement may offer more cost-effective solutions to traffic calming, municipalities do often find that engineering strategies are required especially when a community is trying to reduce “cut through” traffic, traffic that utilizes local streets rather than the arterial roadway network that circumvents the community.

Education & Outreach

Municipalities can help calm traffic and reduce high speeds on local streets through an outreach campaign that addresses the consequences of speeding and reckless driving.

Public education can be an effective tool in changing the attitude and behavior of drivers. Educational efforts focus on the consequences of unsafe driving practices as well as educating inattentive, aggressive drivers that modifications of their own driving behavior may help solve the problem of unsafe roadways.

Communities with educational programs seek to remind speeding drivers of the negative effects of their actions, often by stressing that the community's children are the most at risk. Educational campaigns may use brochures or neighborhood newsletters to spread this message. Newsletters could contain information on speeding fines (particularly in school zones), pedestrian and bicycle safety tips, and information on average speeds in the neighborhood.

Some approaches to education and outreach include:

- **Neighborhood Meeting** – Organize a meeting with the affected neighborhood to discuss the specific traffic issues for that neighborhood and recommend ways for residents to personally reduce speeds and increase safety in their neighborhood.

- **Traffic Safety Newsletter** - Preparation of a newsletter designed for a specific neighborhood describing the traffic concerns and recommendations. The newsletter may provide information on volumes and speeds in the area, as well as reminders of traffic laws and traffic safety tips.
- **Speed Trailer** – Use of a portable trailer equipped with a radar unit, which detects the speed of passing vehicles and displays it on a reader board. The trailer shows drivers their actual speed versus the posted speed limit and encourages compliance. The device also helps by-standers to gauge how fast the posted speed limit looks as drivers pass by.
- **Neighborhood Pledge or “Pace” Cars** – A pledge form may be distributed through the neighborhood to encourage neighbors to commit to driving the speed limit. The municipality may also provide a bumper sticker or decal for residents committed to driving the speed limit. The drivers of these “pace” cars will lead by example through their neighborhood and others.
- **Signing** – The posting of appropriate regulatory or warning signs to remind drivers of the traffic laws. Examples of signing that could be used to educate drivers of traffic laws include: speed limit, no outlet, pedestrian crossing, or school warning signs.
- **Turn restrictions** – Full or part-time turn restrictions may be used where a specific movement is creating a safety problem or where cut-through in a neighborhood is an issue. This could also apply to “No Right on Red” designations. Installing this type of sign requires police enforcement. Turning movement restrictions are considered regulation and can only be implemented through an official and enforceable municipal ordinance.

Enforcement

Enforcement strategies can be very useful in addressing traffic calming issues in a community. Increasing enforcement in targeted areas where speeding is an issue may encourage motorists to drive at the posted speed or risk some form of punishment by local law enforcement. However, enforcement strategies may require a consistent and continual presence of law enforcement to be most effective. Many communities may find that this is cost prohibitive since rarely do the fines collected cover the full cost of the enforcement. However, consistent visible enforcement does lead to respect of the speed limit by motorists. Enforcement strategies are often coupled with education measures that can help address specific safety issues in a community and educate the public on why increased enforcement is needed.

Several enforcement methods to help lower vehicular traffic speeds include:

- **Neighborhood Speed Watch Program** - A speed-monitoring program in which residents of a neighborhood measure vehicle speeds with a radar unit and record license plate numbers of those exceeding the speed limit. The registered owners are sent letters explaining the safety concerns in the neighborhood and asking them to reduce their speeds.
- **Targeted Police Enforcement** - Increased police enforcement of traffic regulations within a designated area.

Engineering

Engineered measures include structural modifications as well as signs and pavement markings. Different traffic calming methods have varied levels of effectiveness based on the overall goal or objective.

Horizontal Deflection

There are two types of horizontal deflection devices used in traffic calming. Although horizontal deflection measures are mainly used to address speed concerns, applications that narrow the travel lane at intersections can improve pedestrian safety by reducing the width of the crossing. Horizontal deflection measures may also have the secondary effect of reducing volumes; however, the effects will typically be minor.

The first type hinders the driver's ability to drive in a straight line by creating a horizontal shift in the roadway. This shift forces drivers to slow their vehicles in order to safely navigate the roadway.

The second type of horizontal deflection measure is designed to narrow the width of the travel lane. Doing so reduces the usable surface of the roadway causing drivers to slow their vehicles to maintain an acceptable level of comfort.

Examples of horizontal deflection measures include:

- **Curb extension / bulb-out / neckdown** - areas of expanded curbing that extend across a parking lane and may narrow a travel lane.
- **Chicane** - series of 3 bulb-outs, staggered at mid-block locations on alternating sides of the street.
- **Gateway** - entrance treatment, typically using physical and textural changes, that provides identity to an area.
- **On-street parking** - provision of on-street parking that reduces roadway width.

- **Raised median island / pedestrian refuge** - narrow islands, at mid-block or intersections, between travel lanes with breaks in landscaping and curbing for pedestrians.
- **Traffic circle** - raised island in the center of an intersection that requires vehicles to travel counterclockwise around the circle.

Vertical Deflection

These are traffic calming measures that create a change in the height of the roadway. When designed properly, vehicles must slow down over these measures in order to avoid an unpleasant abrupt vertical motion. As with horizontal deflection measures, vertical deflection measures are mainly used to reduce vehicle speeds, with only minor effects on traffic volumes. Vertical deflection measures can also be used to improve the safety of pedestrian crossings.

- **Textured crosswalk** - use of pavers or other materials to demarcate crosswalks and alert motorists that they are entering a pedestrian-friendly area.
- **Speed hump** - raised humps in the roadway, typically 3 inches high with a 12 or 22-foot travel length.
- **Raised crosswalk** - marked pedestrian crossings elevated 3 to 6 inches above street grade at intersections or mid-block.
- **Raised intersection** - intersections, including crosswalks, raised 3 to 6 inches above street grade.

Horizontal Narrowing or Road Diet

A road “diet” is the removal of travel lanes from a roadway, converting that space for other uses such as bike lanes, parking, and landscaping. Narrowing traffic lanes differs from other road treatments by making slower speeds seem more natural to drivers and less of an artificial imposition, as opposed to most other treatments used that physically force lower speeds or restrict route choice. Biltmore Forest does not have any roads with more than two lanes, so a road diet is not applicable for this study. There are no opportunities for removing travel lanes.

Signs and Pavement Markings

Signs and markings can be used as traffic calming measures that regulate traffic movements in lieu of physical changes to the roadway. In certain applications, these measures may produce the same effect as the physical traffic calming

measures. However, police enforcement is often required to ensure motorist compliance.

Pavement markings are less dependent on enforcement, inexpensive when compared to some forms of traffic calming and do not require physical roadway changes. Markings come in a variety of shapes, sizes and colors. Considerations for the addition or removal of pavement markings in the use of traffic calming are based on roadway characteristics, local driver familiarity, and local preference.

Some attributes of pavement markings that affect traffic calming are:

- Color
- Size (width, length & height, if they have texture)
- Angle
- Proximity to other traffic calming devices
- Location within the roadway
- Quantity

Physical Obstruction

Physical obstruction refers to measures that prevent particular vehicle movements, thereby discouraging or eliminating cut-through traffic. The overall traffic volume reduction depends upon the nature of the traffic calming measure and the number of movements obstructed. These measures include:

- **Semi-diverter** - directional closure created by blocking half the street.
- **Diagonal diverter** - physical barrier placed diagonally across a four-way intersection to create two unconnected intersections.
- **Right-in / right-out island** - the use of raised islands to prevent left turns and through movements, to and from side streets, at intersections.
- **Raised median through intersection** - median barrier through an intersection that discourages through-traffic in a residential area by restricting movements.
- **Street closure** - the use of a cul-de-sac to close a roadway by extending a physical barrier across the entire width, obstructing all traffic movements.

3 | DATA COLLECTION

Process & Methods

Prior to studying potential traffic calming measures on local streets, traffic conditions were investigated to determine if operational deficiencies were contributing to the identified traffic concerns. In addition, where the use of traffic calming measures may divert large volumes of traffic from local streets, the effects on adjacent roadways were addressed.

Roadway conditions were documented during several site visits. The roadway was photographed, measured, and observed. Signs were located and documented, and pavement markings were identified.

Existing volume and speed data was collected using pneumatic tube counters and video cameras. Traffic patterns and speed data was interpreted to verify existing issues and analyzed to determine appropriate recommendations.

The 85th percentile total speeds at each tube location are used to compare current traffic speeds to the posted speed limits. Figure 5 shows these speed limit comparisons along with the 85th percentile speed, mean speed, and the percentage above the speed limit.

NOTE: The 85th percentile speed is the speed at or below which 85 percent of the motorists on a street are traveling. This speed is often used as a measure of the upper limit of reasonable speeds for prevailing conditions. Only 15 percent of vehicles go faster than this speed, and 85 percent go at or below this speed.

NOTE: Volume data should not be collected when (1) school is out of session, (2) holidays impact travel, (3) severe weather impacts travel, (4) accidents or construction change travel patterns, and (5) special events abnormally increase or decrease travel patterns.

Figure 5 - Tube Counter Locations & Findings

LOCATION	DATES	SPEED LIMIT	85th PER-CENTILE	MEAN SPEED	% ABOVE the SPEED LIMIT
331 Vanderbilt Road	1/22/18 - 1/28/18	35 mph	43.8 mph	38.4 mph	25%
390 Vanderbilt Road	1/22/18 - 1/28/18	25 mph	37.1 mph	31.5 mph	48%
16 Stuyvesant Road	1/22/18 - 1/28/18	25 mph	35.4 mph	30 mph	42%
125 Stuyvesant Road	1/22/18 - 1/28/18	25 mph	35.9 mph	30.2 mph	44%

Figure 6 - Locations of Tube Counters & Cameras (North)

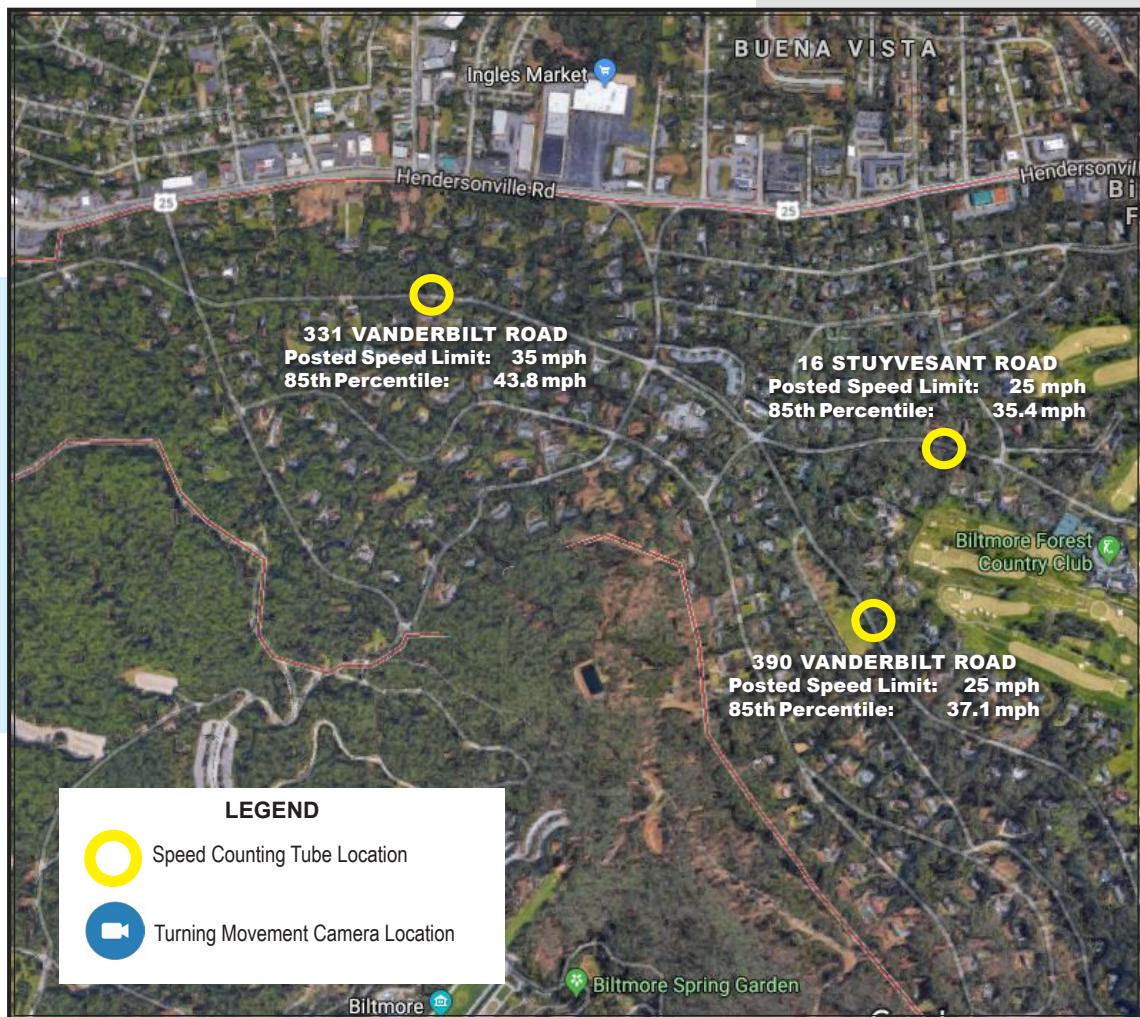


Figure 7 - Locations of Tube Counters & Cameras (South)



4 | RECOMMENDATIONS

The recommendations below have been identified as immediate and secondary action steps. Other considerations have also been made which include long-term actions and recommendations for steps involved in a traffic calming policy.

Immediate Action Steps

The recommended steps are based on considerations of roadway characteristics, installation costs, community acceptance and speeds in excess of the posted speed limits in the study area.

- Install three (3) speed humps along Hilltop Road at approx. 500' spacing. [COST ESTIMATE: \$12,000].
- Install rumble strips on Vanderbilt and Stuyvesant at approaches to intersections that are not stop controlled. Specifically, on both approaches to the following intersections [COST ESTIMATE: \$9,000]:
 - Vanderbilt Road @ Cedarcliff Road.
 - Stuyvesant Road @ Browntown Road.
 - Stuyvesant Road @ Holly Hill Road.

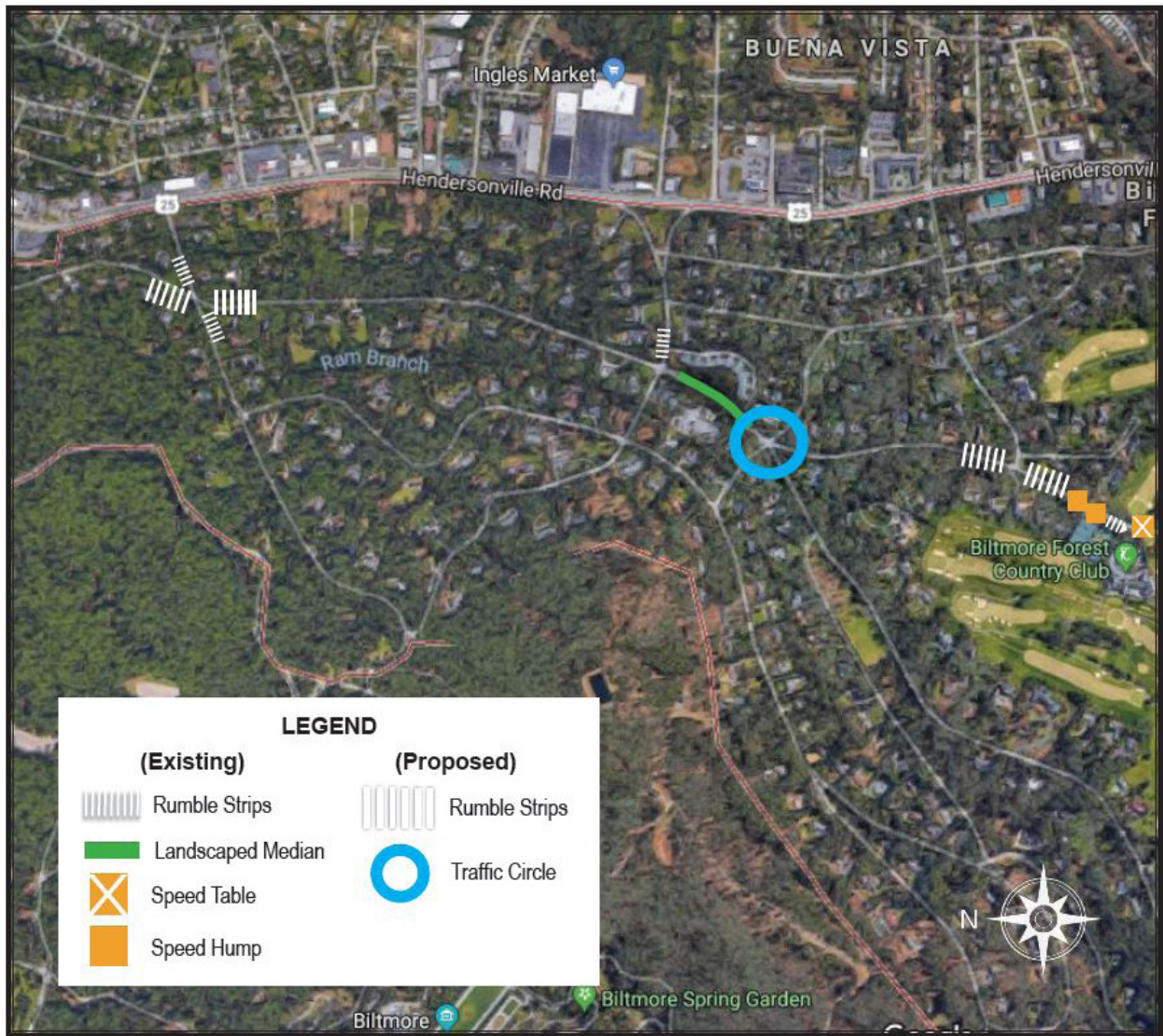


The rumble strips on Cedarcliff Road are a successful safety measure to alert drivers that they are approaching a stop sign at the intersection with Vanderbilt Road.

- Install an additional speed hump on the southbound approach of Stuyvesant Rd at Green Road. Currently there are 2 speed humps, but an additional speed hump on the down grade approach would be more effective. [COST ESTIMATE: \$4,000].



Greenwood Park is located at the bottom of a hill on Stuyvesant Road, where it would be easy to drive recklessly fast. Two speed humps prevent the worst instances of speeding, but warrant additional traffic calming -- specifically, one more speed hump in the series to make clear to motorists that this area is designated as a slow zone where children are expected to be playing and crossing the street.

Figure 8 - Proposed Countermeasures (North)

- Additional rumble strips at key intersections.
- The five-point intersection of Vanderbilt Road, Stuyvesant Road, and Lone Pine Road is confusing. There is poor communication to indicate who has the right-of-way and there are sight distance and turn radius incongruities. JMTE recommends that the Town consider installing a traffic circle or roundabout to simplify the turning movements of vehicles, clarify the right-of-way, limit conflict points, and allow for traffic to flow more freely from each entry point.

Figure 9 - Proposed Countermeasures (South)



- Additional rumble strips at key intersections.
- Additional speed hump on the downhill approach to Green Road.
- Three speed humps along Hilltop Road.
- JMTE recommends the Town explore the option of closing Ridgefield Place to through traffic. This effort is to encourage use of Eastwood Road and the planned signalized intersection at Hendersonville Road.

- Restripe Vanderbilt Road and Stuyvesant Road - eliminate the yellow center lines and increase the white edge lines from 4" to 6".

Figure 10 - Pavement Marking Cross-Section for Vanderbilt Road & Stuyvesant Road

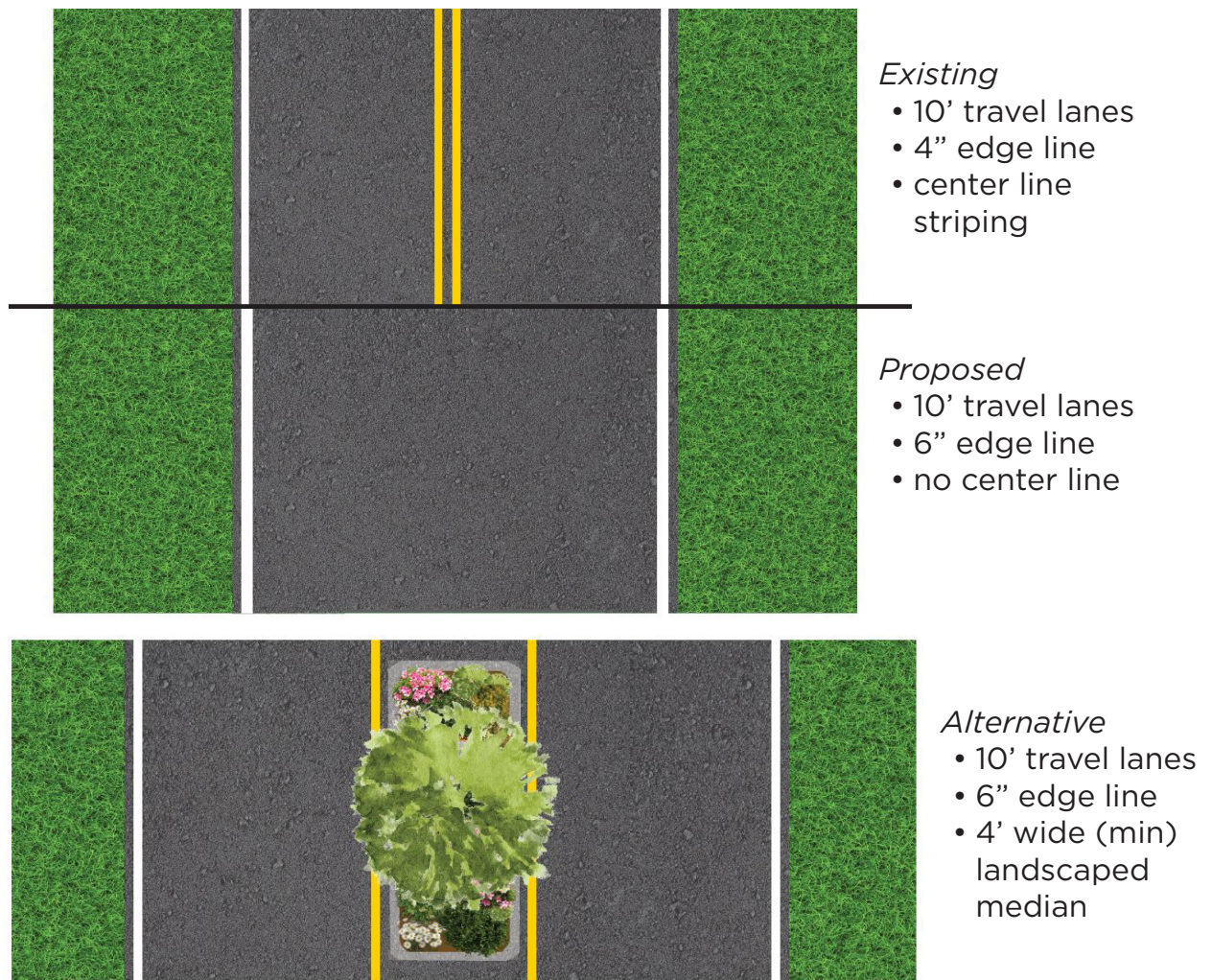
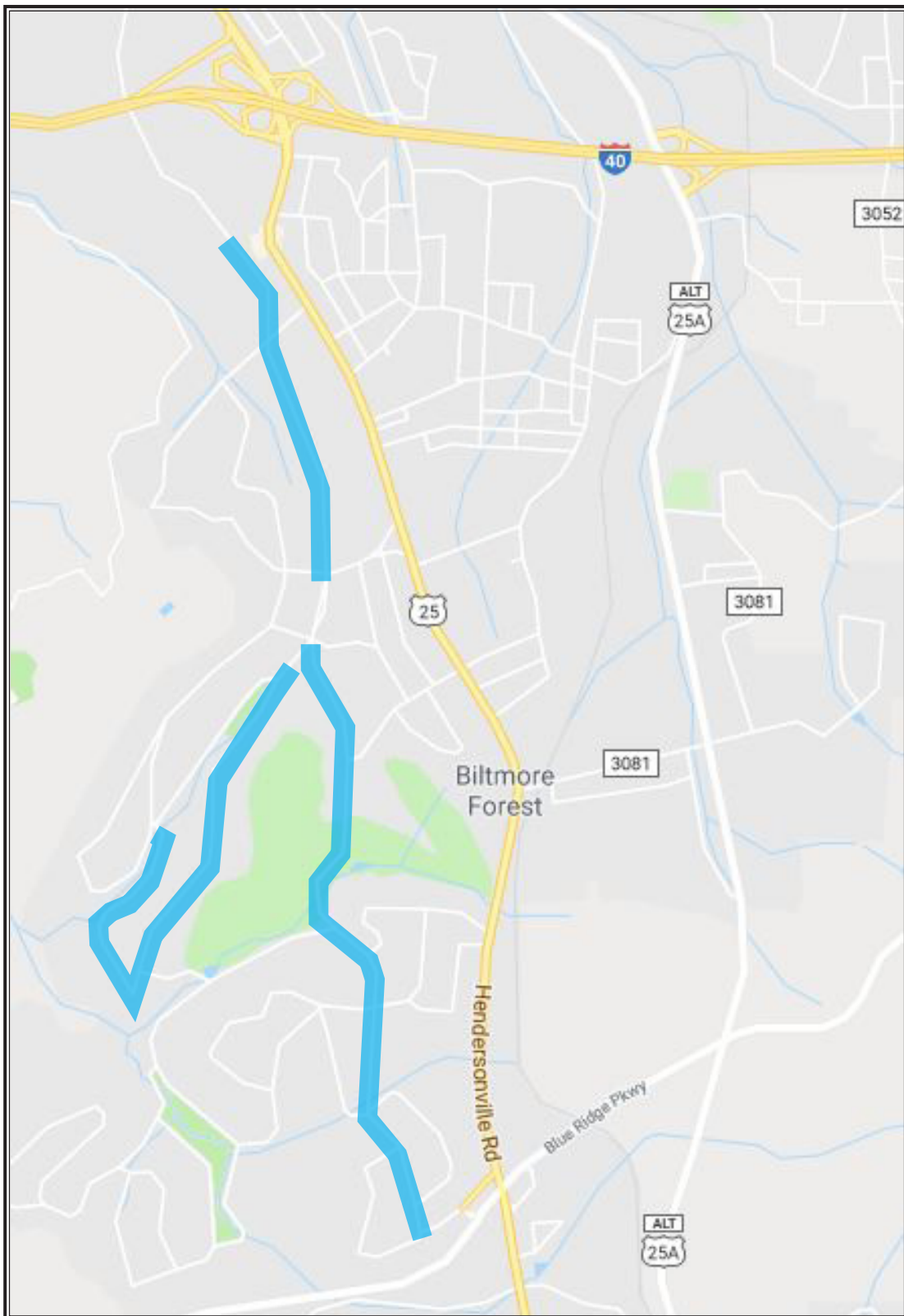


Figure 11 - Map of Roadway Sections for Restriping



Secondary Action Steps

- Installing/relocating signage – a **full sign assessment**.
- Utilize **speed sensor signs** which display vehicle speed at key locations such as speed limit changes, intersection approaches, straightaways, and on Vanderbilt Rd north of Cedarcliff Road. Locations would depend on existing sign location and spacing and would be determined through a full sign assessment in the Town of Biltmore Forest. For streets with speed problems that are either (a) ineligible for physical speed control devices, or (b) have constructability constraints, apply permanently mounted speed sensor signs to reduce speeds. The busiest streets entering Biltmore Forest would be the best use of this speed reduction tool.



Speed sensor signs that indicate a driver's current speed are highly effective at reminding people that they are indeed driving faster than the posted speed limit. They also indicate that local law enforcement is aware of a speeding problem and focused on enforcement in the area.

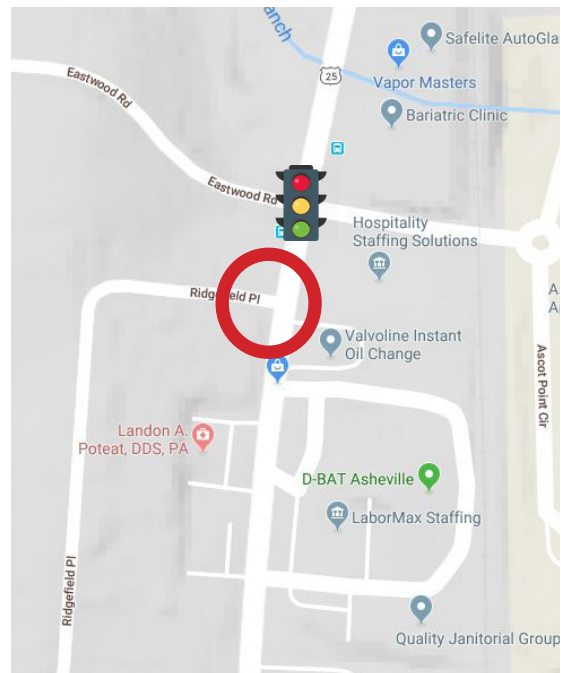
Other Considerations

- Explore **closing access to Ridgefield Place** from Hendersonville Road.



JMTE recommends installing temporary barricades or other devices (planters, bollards, traffic cones, etc.) to test the closure before it is permanently installed. Road closures can be seen as detrimental to residents because they limiting their ability to choose how to use the street on which they live. A temporary installation can demonstrate its effectiveness.

A full street closure would result in a cul-de-sac at the end of Ridgefield Place. *[Pedestrians should still have access from the cul-de-sac to Hendersonville Road].*

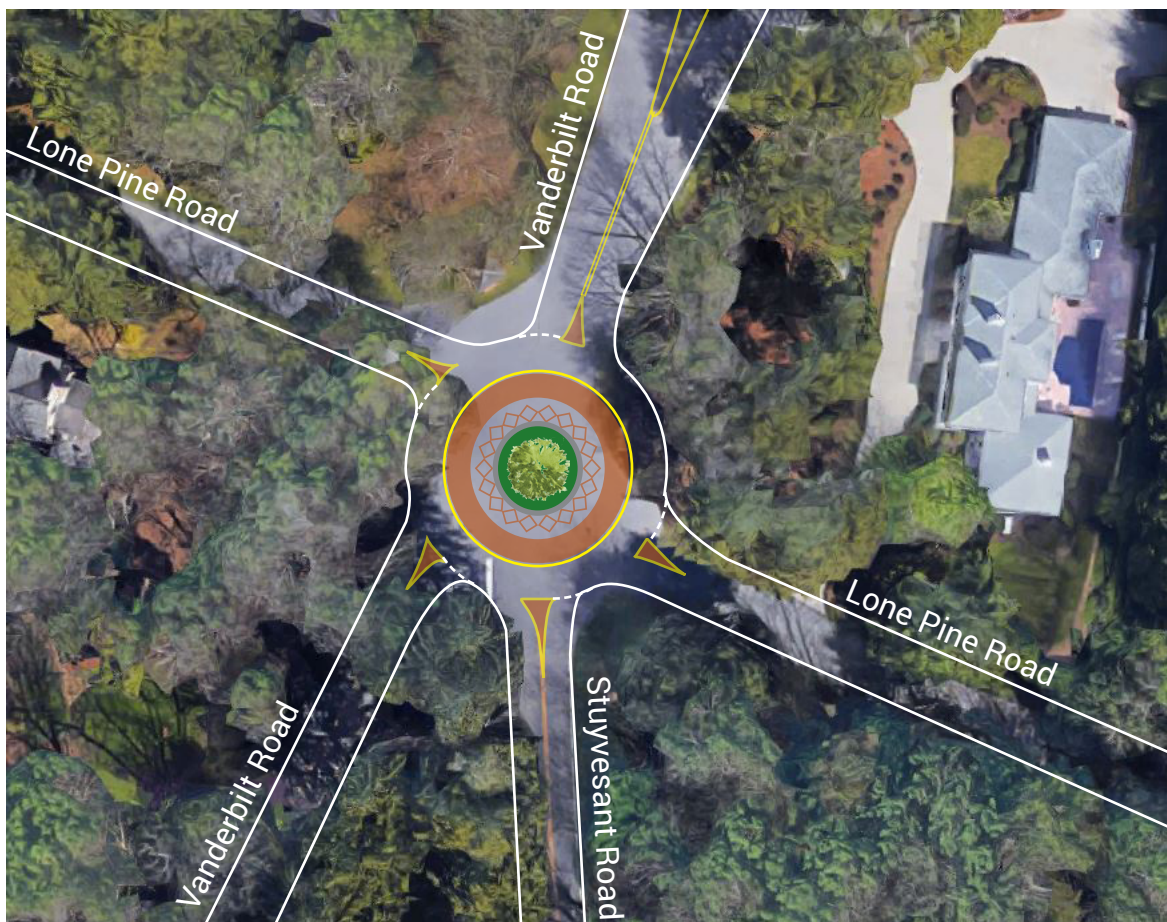


The intersection of Eastwood Road and Hendersonville Road is slated for a new traffic signal.

- Consider installing a **traffic circle/roundabout** at the Vanderbilt Rd @ Lone Pine Rd @ Stuyvesant Rd intersection

Any discussion about traffic calming stems from a desire to make an area safer. Speeding problems are only a problem because of the safety repercussions that arise from aggressive driving and excessive speed for a specific built environment. This intersection is inherently dangerous -- it allows vehicles to travel at 30mph along Vanderbilt Road, but also enables cars to make a slight left onto Stuyvesant. This means that people approaching the intersection are often unsure how other drivers will behave. Additionally, there are some poor sight distance problems and larger-than-necessary turning radii.

A traffic circle here would simplify everyone's turning movements, make sure everyone understands who has the right-of-way, and enable vehicles to turn around effectively. Pedestrians will be safer, having to look for oncoming traffic from one direction only, and it can ultimately be used as an attractive gateway for the Town of Biltmore Forest, with a large tree or monument at its center.



- Consider widening the roadway to **install a landscaped median** along Vanderbilt Road between Busbee Road and Cedarcliff Road.



The wide, landscaped median in front of the Town administration building limits turning movements (access management) and slows traffic by altering the perception of roadway width with verticle delineators.

- Create **standard operating procedures** that quantify speed and volume problems prior to installation of future traffic calming devices. Perceptions of speeding and dangerous behavior may not align with actual vehicular traffic data. The Town should identify criteria for initiating the process to implement various traffic calming measures. For instance, when the 85th percentile vehicular speeds are 10 miles per hour above the posted speed limit, that section of roadway qualifies for additional traffic calming ideas.
- Follow up with **data collection** to quantify speed and volume of traffic at least six months after new traffic calming devices are installed. Hire a consultant or use Town staff to collect vehicular speed data at or near a traffic calming implementation site within one year. Before and after speed data will indicate how successful that particular measure has been and whether it warrants removal or additional traffic calming in the area. This information can be presented to the residents of Biltmore Forest as demonstrative of the Town's efforts to address speeding concerns.

- Consider designating and establishing a **“Traffic Calming District”** encompassing most of the primary corridor through town, adding an additional \$200 fine to existing speeding fines. JMTE recommends this district be approximately 2 miles from Cedarcliff Road/Vanderbilt Road to Stuyvesant Road/Stuyvesant Crescent.



- Establish a proactive **traffic monitoring program** either through the Police or Public Works Department to monitor speeding on high priority streets (Vanderbilt and Stuyvesant) and develop a neighborhood **Traffic Advisory Committee (TAC)** that meets quarterly to discuss transportation-related issues in or near the Town of Biltmore Forest. Use these resources to become aware of and respond to resident concerns. The TAC can also help develop parade routes, trick-or-treating safety ideas, and community bike rides or charity races.
- Develop an **education and enforcement program** for speeding to address resident concerns on streets that may not warrant engineering solutions for traffic calming but do contain isolated problems (sight



distance issues, high pedestrian volumes, an adjacent park) in which these strategies will help. Strategies could include neighborhood yard signs and should emphasize and reinforce cultural norms, reminding people that they are driving through a residential area, instead of highlighting laws or fear campaigns. People who violate speed limits may not necessarily do so because they are ignorant or misinformed about the possible ramifications of their behaviour, or make a conscious decision to put the pedal to the metal, but a gentle reminder that people are using the streets as well could be helpful. The “Most of Us Wear Seat Belts” campaign is an example of a program that targets changes in underlying social norms, which may shift public perceptions regarding acceptable driving behaviors.

- Establish a **traffic calming capital improvement plan (CIP) line item** in the Town’s budget that funds speeding device installation and maintenance for priority locations in the Town.
- Examine property owner acceptance of using the existing right-of-way along specific sections of Vanderbilt Road and Stuyvesant Road to accommodate **landscaped medians between travel lanes.**



Traffic calming infrastructure can be more effective when paired with community educational campaigns. Signs in front yards can quickly send a message that residents have a cultural expectation that motorists slow down when driving through their neighborhood.



- Once the **traffic circle or roundabout** at Vanderbilt Rd/Lone Pine Rd/Stuyvesant Rd has been installed, hire a consultant to further examine resident support and feasibility for **gateway monuments and small traffic circles** at several other key intersections:
 - Stuyvesant Rd/Greenwood Rd/Stuyvesant Crescent
 - Stuyvesant Rd/Southwood Rd
 - Stuyvesant Rd/Browntown Rd
 - Vanderbilt Rd/Busbee Rd
 - Vanderbilt Rd/Cedarcliff Rd



Small traffic circles, with clear pavement markings and visible signs, are often effective at slowing traffic at intersections, limiting conflict points (thus reducing crash rates), and engendering a safer intersection for people walking.

- Develop a **natural surface trail system** throughout the study area as an alternative to building a curb-and-gutter sidewalk. Ultimately, the best way to create a safe transportation system for all users is to separate pedestrians from vehicular traffic. JMTE anticipates strong support for and wide use of a trail system that enables residents to walk from Biltmore Village to the Blue Ridge Parkway, using Town-owned parcels and existing right-of-way to connect most streets in Biltmore Forest for pedestrian use. Consider also partnering with business property owners along Hendersonville Road to create links into the broader South Asheville community and make walking to businesses along Hendersonville Road a safe option for Town residents.



Some residential neighborhoods have complete sidewalk systems that use a natural surface instead of concrete. While this does little to ensure full accessibility for those with mobility challenges, it does provide a safe pedestrian path that is fully separated from the roadway. Biltmore Forest should consider funding a study to determine the feasibility of implementing a similar network for its residents within the existing right-of-way. With a trail system, JMTE recommends striped crosswalks at all roadway crossings, trailheads with comprehensive maps, and standard roadway informational signs.

Pedestrian Safety & Traffic Calming

Streetscape safety is most effectively achieved by separating modes of different speeds and vulnerabilities to the extent possible by both space and time (bicyclists from pedestrians and pedestrians from vehicles), informing ALL users of the presence and mix of travel modes (walk, bike, drive) and establishing provisions for adequate sight distance.



To improve safety for all users of the roadway in Biltmore Forest, the ideal countermeasure is the development of a complete sidewalk system or natural surface trail along both Stuyvesant Road and Vanderbilt Road, with marked crosswalks at each intersection. However, this action would take significant effort and would depend on Town and community support. Indeed, part of the charm of Biltmore Forest comes from its shared use of streets – dog walkers and morning commuters comfortably navigate the residential neighborhoods with respect and courteousness. Driver behavior is affected by the regular presence of pedestrians and the fairly narrow, winding streets.

Pedestrians age 65 and older are more likely to be injured or killed at intersections (approximately 59 percent of total pedestrian crashes) compared to non-intersections (approximately 41 percent), since older people tend to cross at intersections more often than younger ones. Even though Biltmore Forest does not have a sidewalk system, people still need to cross at intersections. Because there are no traffic signals and no crosswalks, this can be dangerous if motorists fail to prepare (i.e. slow down) for an intersection. By installing rumble strips at key intersections through town the collective benefit will be felt -- everyone will be slightly more aware of their surroundings and, whether they slow down or not, should be conscious of people walking in the intersection and vehicular turning movements at the intersection.

Crash involvement rates are the highest for 5- to 9-year-old males, who tend to dart out into the street. Approximately 65 percent of crashes involving pedestrians occur at non-intersections. This is particularly true for pedestrians under age 9. The Town has already demonstrated support for safety in the area of Carolina Day School -- there are currently two speed humps at this location. By adding an additional speed hump the calming effects will be more effective.

Restriping Vanderbilt Road and Stuyvesant Road is a relatively simple and uncontroversial strategy to alter motorists' perception of width. Speeding is often exacerbated when motorists feel confident in the width of a travel lane; knowing how much room they have to maneuver enables a sense of comfort and confidence. Most streets in Biltmore Forest do not have pavement markings, which creates a sense of "shared space" along the roadway network

It is recommended that a full sign assessment be performed in order to determine the number and spacing of signs that would be needed along the study corridor to contribute to vehicle speed reduction. All existing and proposed traffic calming devices should be signed according to the MUTCD. JMTE documented and located all the signs along Vanderbilt and Stuyvesant and will provide a map showing existing signs.

Traffic Mitigation

Exploring a road closure is an effort to address resident concerns about through traffic in the neighborhood. JMTE recommends that the Town develop a survey to ascertain whether residents on Hilltop and Ridgefield would support limiting access to and from this neighborhood. JMTE recommends working in alignment with NCDOT to identify the best method for preventing motorists from entering Ridgefield from Hendersonville Road and/ or preventing motorists from entering Hendersonville Road from Ridgefield Place. Limiting ingress and egress from Ridgefield would make it a cul-de-sac (accessed only from Hilltop Rd) or at least more of a residential street (limiting the ability of through-traffic to use Ridgefield as a connector).

Giving residents a voice in the decision-making process is vital to making sure that this traffic calming measure is not met with acrimony - and allowing the people who live on these streets (or own property on these streets) to make suggestions about the different options for closing the access will help the community find the right solution. Street closures should be installed only with strong community support.

Installing speed humps along Hilltop Road will discourage through traffic. A relatively high density of residential dwellings (for Biltmore Forest) warrants a more concerted effort to redirecting some traffic. While JMTE did not discern any abnormal turning movements in the area, residents have expressed a desire for traffic calming measures to influence driver behavior. Since speed humps are most effective when spaced 250-600 feet apart, the recommended approach is to install a 3 along the section of Hilltop Road from Stuyvesant Rd to Eastwood Rd (approximately 1,600 ft).

This project might receive resistance from residents on Eastwood Road, since traffic may be diverted there. However, the houses on Eastwood are set back further from the road; the effect of high volumes and speeding is worse along Hilltop, where some houses are quite close to the road and driveways are closer together.

Design & Implementation

As the Town of Biltmore Forest approves and prioritizes these recommendations JMTE can provide detailed designs and implementation strategies to ensure a smooth and efficient installation process. Updated cost estimates can be provided based on implementation schedules.



