

**ATTACHMENT A**

**A RESOLUTION RECEIVING AN UPDATE ON PEDESTRIAN SAFETY ON  
NORTH GREENSBORO STREET  
Resolution No. 159/2009-10**

WHEREAS, at the February 16, 2010, Board of Aldermen meeting, the Board discussed pedestrian safety on North Greensboro Street and directed the Transportation Advisory Board and Police Department to report back on their efforts regarding this topic; and,

WHEREAS, the Transportation Advisory Board has discussed pedestrian safety on N. Greensboro St. at several recent meetings and gathered information on pedestrian safety in general and pedestrian activity along this roadway segment; and,

WHEREAS, the Police Department has recently conducted enforcement activities along this and other segments;

NOW, THEREFORE BE IT RESOLVED by the Carrboro Board of Aldermen that the Board of Aldermen receives the update on pedestrian safety on N. Greensboro St.



## TOWN OF CARRBORO

NORTH CAROLINA

## MEMORANDUM

DELIVERED VIA:  HAND  MAIL  FAX  EMAIL

**DATE:** May 26, 2010

**TO:** Steven Stewart, Town Manager  
Mayor and Board of Aldermen

**CC:** Patricia McGuire, Planning Administrator  
Roy Williford, Planning Director  
George Seiz, Public Works Director

**FROM:** Jeff Brubaker, Transportation Planner  
Carolyn Hutchison, Police Chief

**RE:** Update on Pedestrian Safety on North Greensboro Street

The purpose of this memo is to provide a background on pedestrian safety issues on N. Greensboro St., especially the downtown segment between Shelton St. and Weaver St., and an update on recent activity by the Carrboro Transportation Advisory Board (TAB), Town staff, and others to address these issues.

At the February 16, 2010, Board of Aldermen meeting, two citizens spoke about concerns they had with pedestrian safety along this segment. The concerns focused on crosswalks, infrastructure improvements, and enforcement. The Board adopted a resolution asking for a report from the TAB and Police Department. Minutes from this meeting are available here:

[http://townofcarrboro.org/BoA/Minutes/2010/02\\_16\\_2010.pdf](http://townofcarrboro.org/BoA/Minutes/2010/02_16_2010.pdf)

This update follows up on the Board's request. A full report is not yet available, since, as stated below, an NCDOT study is still in progress.

### Background

Greensboro St. is a state-maintained road identified as an arterial in Carrboro Land Use Ordinance Sec. 15-210(b)(6). The Weaver-Shelton segment sees about 14,000 vehicles per day.<sup>1</sup> Daily two-way vehicle capacity is 18,300, indicating a level of service in the C to D range.<sup>2</sup>

<sup>1</sup> NCDOT AADT counts for 2005 and 2007. From 1997-2007 (odd years), traffic has remained relatively consistent, averaging 14,700 ADT with a high of 16,000 in 2003. Town traffic counts on April 14-16, 2010, were roughly in the 13,000 – 14,000 range.

<sup>2</sup> 2005 Mobility Report Card. <http://townofcarrboro.org/PZI/PDFs/2005MobilityReportCard.pdf>

Posted speed limit on N. Greensboro is 35 MPH from Hillsborough Rd. to Estes Dr., 30 MPH from Estes to just north of Shelton, and 20 MPH from just north of Shelton to Main St. (Speed limits are set in Town Code, Chapter 6:

<http://townofcarrboro.org/TC/PDFs/TownCode/TownCodeCh06.pdf>.) However, 85<sup>th</sup> percentile speed for the segment just north of Weaver was measured as between 29<sup>3</sup> and 32<sup>4</sup> MPH, significantly above the posted speed limit. Eighty-fifth percentile speed between Shelton and Pleasant Dr. was measured at 36 MPH.<sup>5</sup>

There are sidewalks on both sides of the road and bike lanes from Hillsborough Rd. to Parker St. Twelve-hour pedestrian counts (7am to 7pm) conducted in 2003 and 2005 as part of the Mobility Report Card are shown in Table 1 below.<sup>6</sup> None of the count locations from the Report Card were exactly in the Weaver-Shelton segment, but they are close. It should be kept in mind that these figures are snapshots taken from one day of counting.

Location	2003	2005
Greensboro St b/t Main St and Weaver St	1,936	1,304
Greensboro St b/t Estes Dr and Oak Ave	189	449
Weaver St b/t Greensboro St and E Main St	1,206	833
Main St b/t Greensboro St and Weaver St	1,245	1,577

**Table 1. 12-hour pedestrian volumes along selected roadway segments. Source: 2005 Mobility Report Card.**

The *Carrboro Comprehensive Bicycle Transportation Plan* identifies the Estes-Weaver segment of N. Greensboro as a high-crash corridor for bicycles.<sup>7</sup> A bus stop for the Chapel Hill Transit F bus is located mid-block between Short St. and Poplar Ave. (See map in Attachment B-2). The Harris Teeter (northbound) bus stop had an average of 17 daily boardings plus alightings in 2008-09 and the Fitch (southbound) stop had an average of 14.<sup>8</sup>

## HSRC report

A recent pedestrian safety study by the Highway Safety Research Center at UNC

Town of Chapel Hill. 2009. *Transportation Impact Analysis: Update for the Carolina North Development*. Available here: <http://www.ci.chapel-hill.nc.us/index.aspx?page=1387>

<sup>3</sup> Town traffic count, April 14-16, 2010, between Short St. and Poplar Ave.

<sup>4</sup> University of North Carolina Highway Safety Research Center (HSRC). 2009. *Identifying Locations for Pedestrian and Bicyclist Safety Improvements in Chapel Hill and Carrboro, North Carolina*. Final Report to North Carolina Department of Transportation, Traffic Engineering and Safety Systems Branch, p. 105

<sup>5</sup> Town traffic monitoring, April 14-16, 2010.

<sup>6</sup> 2005 Mobility Report Card.

<sup>7</sup> The plan is available online at: <http://townofcarrboro.org/PZI/Indusergs.htm>. See pp. 2-6 and 2-7 and Map 2.2.

<sup>8</sup> Data provided by Chapel Hill Transit.

identified no reported pedestrian collisions over its study period (2001-2005).<sup>9</sup> (Note that unreported collisions may still have occurred.) However, several factors were cited by the study authors that affect the need for pedestrian safety enhancements. First, the study noted that the Town has received several complaints from residents regarding pedestrian safety. Second, the study identified N. Greensboro as ranging between “medium high and medium low” perception of risk by pedestrians. This may be influenced by a relatively high perception of risk just to the south, at Weaver and Main. Two collisions were reported during the HSRC study period for the Greensboro-Main intersection. Although collisions and perception of risk were higher at Greensboro-Main than Greensboro-Shelton, the HSRC study ranks both intersections the same in terms of Intersection Safety Index (ISI), which takes into account traffic speed and volume, the number of lanes being crossed, surrounding land use, and the type of control (or lack thereof) at an intersection.<sup>10</sup>

Given the high 85<sup>th</sup> percentile speeds in the 20 MPH speed zone, the HSRC reported:

With speeds this high, motorists may not be willing to yield at the uncontrolled crosswalks that have been added to this section, and bicyclists may have difficulty riding in the traffic stream...The mix of numerous driveways, several of them busy commercial driveways, and higher speeds of traffic entering town, and a lack of signalized crossings may make for difficulty in crossing N Greensboro as well as crossing at driveways...<sup>11</sup>

### **Crash data, 2005-2010**

Crash data provided by the Police Department from 1/1/2005 to 5/19/2010 show two reported pedestrian-vehicle collisions in the Weaver-Shelton segment, both at the Greensboro-Shelton intersection. One collision involved a northbound vehicle turning left from Greensboro onto Shelton and striking the pedestrian walking southbound on the west side of Greensboro, crossing Shelton. Another collision was a hit-and-run in the marked crosswalk across Greensboro. The motorist, estimated to be going 35 MPH, skidded but failed to stop completely and hit the pedestrian at an estimated 3 MPH in the middle of the crosswalk.

Town-wide, there were 39 reports of crashes involving pedestrians over this 4.5-year period, involving 40 pedestrians. Once again, these are only crashes that were *reported*.

### **State law and motorist compliance**

According to an NCDOT guide,

Pedestrians have the right-of-way at marked and unmarked crosswalks in residential and business areas except where there is a traffic or pedestrian signal... Also, whenever any vehicle is stopped at an intersection crosswalk to

<sup>9</sup> HSRC 2009, p. 105

<sup>10</sup> HSRC 2009, pp. 105-106, 182

<sup>11</sup> HSRC 2009, p. 106

permit a pedestrian to cross, any other motorist or bicyclist approaching from the rear is not permitted to overtake and pass the stopped vehicle.<sup>12</sup>

However, marked crosswalks with only pedestrian crossing warning signs typically do not lead to very high motor vehicle yielding compliance. A study in Boulder, CO, found compliance to be only 34% – lower for multi-lane roadways.<sup>13</sup> A study in St. Petersburg, FL, found compliance at crosswalks with only high-visibility signs to be 17%.<sup>14</sup>

**Police Department enforcement efforts**

Community Services Division officers, with assistance from Patrol Division officers, conduct crosswalk safety operations at marked crosswalks throughout Town (as time and resources allow). The purpose of the operations is to educate the public, enforce violations, and reduce the number of incidents between pedestrians and vehicles in crosswalks.

Officers place a cone along the roadway at a pre-determined distance from the crosswalk. The distance from the cone to the crosswalk should allow for a safe stopping distance for a motor vehicle traveling at 10 MPH above the posted speed limit. The pedestrian officer enters the crosswalk when an approaching motor vehicle’s front bumper reaches the cone. Officers stop vehicles that fail to stop for the pedestrian in the crosswalk.

To date, officers have conducted crosswalk safety operations at the following marked crosswalks: N. Greensboro Street at E. Poplar Avenue; S. Greensboro Street at Carr Street; W. Main Street at Hillsborough Road; and Hillsborough Road at James Street. During the most recent crosswalk safety campaign (5/10-14/2010), the pedestrian officer entered the marked crosswalks 138 times. Officers wrote 47 citations for failing to yield the right-of-way to a pedestrian in the crosswalk. Approximately 34% of drivers clearly violated the law.

Drivers (and one bicyclist) offered the following excuses for their violations: did not see the pedestrian; saw the pedestrian but did not think he was in danger (so did not think they had to stop); did not know they were supposed to stop for pedestrians in a marked crosswalk; did not notice the crosswalk; was distracted; and must have been absent-minded.

The majority of the drivers who were stopped were cooperative and understanding. A few were apologetic. Several were argumentative with the officers.

**TAB efforts**

<sup>12</sup> NCDOT. 2004. A Guide to North Carolina Bicycle and Pedestrian Laws: Part 2. [http://www.ncdot.gov/bikeped/download/bikeped\\_laws\\_Guidebook-Part-2.pdf](http://www.ncdot.gov/bikeped/download/bikeped_laws_Guidebook-Part-2.pdf). Relevant statutes are: §20-155(c) and §20-173(a)

<sup>13</sup> City of Boulder Crosswalk Compliance Studies & Treatment Implementation. ITE Pedestrian Project Award Submittal. Copy available from Transportation Planner.

<sup>14</sup> Van Houten, Ron and J.E. Louis Malenfant. (undated). An Analysis of the Efficacy of Rectangular-shaped Rapid-Flash LED Beacons to Increase Yielding to Pedestrians Using Crosswalks on Multilane Roadways in the City of St. Petersburg, FL. [http://mutcd.fhwa.dot.gov/resources/interim\\_approval/ia11/stpetersburgrpt/index.htm](http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/stpetersburgrpt/index.htm)

Over the past year, the TAB has focused on pedestrian safety in the Weaver-Shelton segment. In the summer of 2009, the TAB took video clips of pedestrian activity at the Short and Poplar crosswalks. The video clips showed various pedestrian-vehicle interactions, including motorist noncompliance with crosswalks and pedestrians not crossing at marked crosswalks.

TAB member Austin Brown has conducted research on a relatively new crosswalk treatment known as the Rectangular Rapid-Flashing Beacon (RRFB) (Attachment C-3). The RRFB is a flashing LED light mounted to the crosswalk sign that is activated by a pedestrian wishing to cross. The report documents motorist yielding compliance improvements from the 20-30% range to the 80-90% range in St. Petersburg, FL, which installed several RRFBs as a pilot project. The RRFB has "interim approval" in the *Manual on Uniform Traffic Control Devices*, which means municipalities have the ability to request approval from the Federal Highway Administration (FHWA) to install them.

**April 19 TAB meeting with NCDOT**

On April 19, 2010, the TAB held a special call meeting that included two traffic engineers from NCDOT Division 7; Town staff from the Police and Planning Departments; the Carrboro Planning Board chair; and a representative of the DCHC-MPO. The meeting included a site visit and walk along the Weaver-Shelton segment followed by a presentation and discussion back at Town Hall. The approved minutes for this meeting are in Attachment C-1.


At the meeting, NCDOT representatives suggested that Town staff send a letter to the Division 7 office requesting a study of the feasibility of several potential safety enhancements discussed by the TAB. The TAB then adopted a formal recommendation to this effect. Town staff sent a letter dated April 30 and received a response dated May 7 affirming that NCDOT would go ahead with the study. Note that the request is not to install any improvements but to determine their feasibility based on criteria employed by NCDOT.

The TAB recommendation and subsequent letters between the Town and Division 7 are attached (C-2, D-1, D-2).

**Next steps**

The next steps are to receive the study from NCDOT. After that is completed, NCDOT would determine what, if any, funding is available for any recommended enhancements. Town staff will continue to monitor potential funding sources. More information will be available after these next steps have been completed.






**TOWN OF CARRBORO**  
 301 W. Main St.  
 Carrboro, NC 27510  
 Created April 19, 2010

NC State Plane Coordinate System (NAD83)  
 THIS MAP IS NOT A CERTIFIED SURVEY  
 NO RELIANCE MAY BE PLACED IN ITS ACCURACY  
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 The date of modification does not constitute such a warranty.

### North Greensboro St., Carrboro

#### Legend

-  Bus Stops
-  Sidewalks



**TOWN OF CARRBORO**  
**TRANSPORTATION ADVISORY BOARD**  
**RECOMMENDATION**

**April 19, 2010**

SUBJECT: Pedestrian activity on N. Greensboro St.

MOTION: The Transportation Advisory Board (TAB) recommends that Town staff request that the NCDOT investigate possible solutions to improve yielding compliance at the pedestrian crosswalks along North Greensboro Street between Weaver and Shelton Streets. These crosswalks were examined as part of the TAB meeting attended by NCDOT staff on Monday April 19, 2010.

In particular, these solutions include:

1. A reduction of the speed limit between Estes and Shelton on Greensboro Street
2. A relocation of the speed limit signs on Greensboro Street near the crosswalk at Shelton Street
3. Better markings at the crosswalks including the use of inroad signs
4. Possible relocation of crosswalks on Greensboro Street, in particular the crosswalk at Short Street
5. Use of the LED, Rectangular Rapid Flashing amber Beacons, (*RRFB*) (see Figures 1 and 2) at select marked crosswalks at uncontrolled locations
6. Possible narrowing of roadways to reduce speeds along Greensboro Street

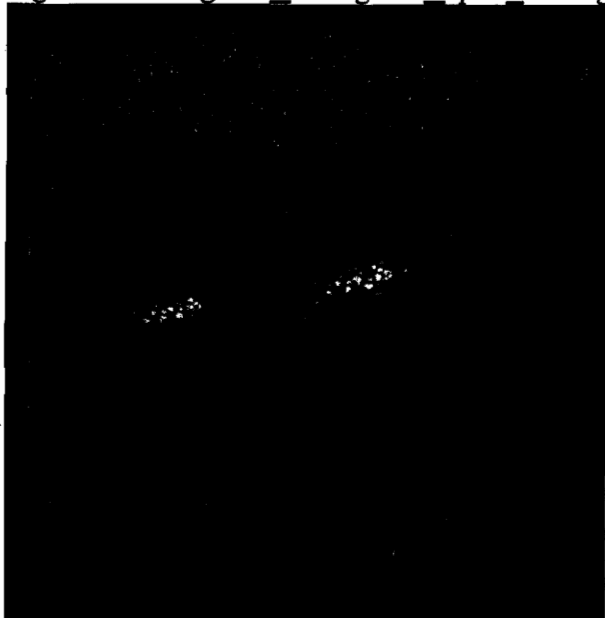
Carrboro is a vibrant compact town full of wonderful shops, restaurants, art galleries and businesses. The close proximity of many of these establishments to one another allows numerous residents and visitors to walk for part or all of their town trips. Carrboro has several mid-block or uncontrolled crosswalks located near or along the routes connecting these pedestrian generators and attractors. Recently several citizens shared their concerns with the Board of Alderman about motorists not yielding to pedestrians at crosswalks.<sup>1</sup>

While no systematic evaluation has been conducted to quantify the prevalence of motorists failing to yield to pedestrians in crosswalks, several TAB members have repeatedly observed or personally experienced this driving behavior. TAB members also have video footage showing motorists failing to yield to pedestrians at uncontrolled crosswalks along the segments of North Greensboro Street.

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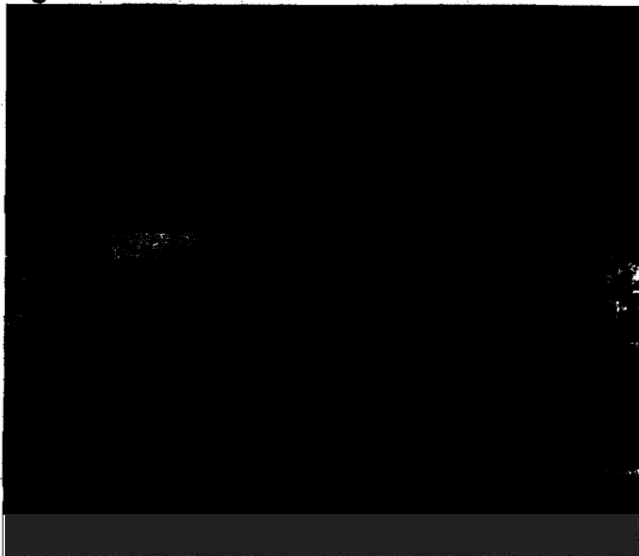
<sup>1</sup> Town of Carrboro, Board of Alderman meeting minutes from February 16, 2010  
[http://townofcarrboro.org/BoA/Minutes/2010/02\\_16\\_2010.pdf](http://townofcarrboro.org/BoA/Minutes/2010/02_16_2010.pdf)

Figure 1 Rectangular Rectangular Rapid Flashing amber Beacons



The LED flashers beacons of the Rectangular-shaped Rapid Flash used in the study were six (6) inches wide, 2.5 inches high, and placed nine (9) inches apart. Each unit was dual indicated (LEDs on front and back). These beacons were mounted under pedestrian crosswalks signage (Figure 2). Each side of the LED beacon flashed a yellow light in a wig-wag flashing sequence (left light on, then right); the two LEDs in combination flashed 190 times in the wig-wag flashing sequence during a 30 second cycle. The stutter flash pattern is similar to that used on emergency vehicles.

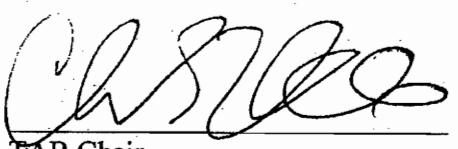
Figure 2 Photo of an activated RRFB in St. Petersburg FL



Moved: Brown

Second: Perry

VOTE: Ayes (6): Hileman, Brown, Perry, LaJeunesse, Michler, Pergolotti. Nays (0).  
Abstain (0). Absent (1): Krasnov.

  
\_\_\_\_\_  
TAB Chair

5 / 3 /10  
DATE

**The use of Rectangular Rapid Flashing amber Beacons, (*RRFB*)  
as a potential for increasing motorist yielding compliance  
at select mid-block crosswalks in Carrboro**

April 19, 2010

Prepared by Austin Brown, Carrboro Transportation Advisory Board Member

Carrboro is a vibrant compact town full of wonderful shops, restaurants, art galleries and businesses. The close proximity of many of these establishments to one another allows numerous residents and visitors to walk for part or all of their town trips. Carrboro has several mid-block or uncontrolled crosswalks located near or along the routes connecting these pedestrian generators and attractors. Recently several citizens shared their concerns with the Board of Alderman about motorists not yielding to pedestrians at crosswalks.<sup>1</sup>

While no systematic evaluation has been conducted to quantify the prevalence of motorists failing to yield to pedestrians in crosswalks, several Transportation Advisory Board (TAB) members have repeatedly observed or personally experienced this driving behavior. TAB member also have video footage showing numerous motorists failing to yield to pedestrians at uncontrolled crosswalks along a segments of North Greensboro Street near downtown and on Main Street.

Town Staff and TAB members have a meeting on Monday April 19, 2010 with representatives from the NCDOT to discuss infrastructure countermeasures that can be installed to help increase yielding compliance. When discussing available and appropriate options, the TAB would like NCDOT to consider, if warranted, use of the LED, Rectangular Rapid Flashing amber Beacons, (RRFB) (see Figures 1 and 2) at select marked crosswalks at uncontrolled locations. For warrant criteria please see Appendix A.

The RRFB is being used in several U.S cities and has shown significant success. The results from an evaluation of the RRFB installed at 18 crosswalk locations in St. Petersburg, Florida indicate that the device increased yielding levels from single digit in some locations, and 20% to 30% in other locations to levels between 80% and 90% at most test sites. Additionally, these yielding levels persisted for up to two years and did not decline over time.<sup>2</sup> In Mundelein, IL, near Chicago, the RRFB were installed at two locations. Prior to the installation of these devices, the average motorist yielding compliance at these locations was 13%. Observational measurements at seven and thirty days post installation saw 67% and 65% of motorist yielding respectively. Similarly, in Washington DC the RRFB was installed at one location. Prior to installation 26% of motorist yielding to pedestrians in the crosswalk. At seven and thirty days after the installation, the yielding percentages grew to 62% and 74% respectively.<sup>3</sup>

<sup>1</sup> Town of Carrboro, Board of Alderman meeting minutes from February 16, 2010  
[http://townofcarrboro.org/BoA/Minutes/2010/02\\_16\\_2010.pdf](http://townofcarrboro.org/BoA/Minutes/2010/02_16_2010.pdf)

<sup>2</sup> Ron Van Houten & J.E. Louis Malenfant, An Analysis of the Efficacy of Rectangular-shaped Rapid-Flash LED Beacons to Increase Yielding to Pedestrians Using Crosswalks on Multilane Roadways in the City of St. Petersburg, FL. Federal Highway Administration. Available at  
[http://mutcd.fhwa.dot.gov/resources/interim\\_approval/ial1/stpetersburgprt/index.htm](http://mutcd.fhwa.dot.gov/resources/interim_approval/ial1/stpetersburgprt/index.htm)  
Accessed February 1, 2010.

<sup>3</sup> Analysis of Effects of LED Rectangular Rapid-Flash Beacons on Yielding to Pedestrians in Multilane Crosswalks. Jim Shurbutt, Ron Van Houten, Shawn Turner, and Brad Huitema Transportation Research Record: Journal of the Transportation Research Board, No. 2140, Transportation Research Board of the National Academies, Washington, D.C., 2009, pp. 85-95.

Based on the successful results from St. Petersburg and several other U.S. Cities, the RRFB earned Interim Approval from Federal Highway Administration (FHWA) for inclusion in the MUTCD in 2008<sup>4</sup> and the Interim Approval remained valid under the 2009 MUTCD.<sup>5</sup>

The RRFB is relatively inexpensive. According to FHWA, the per-unit product and installation cost was \$15,000 for a safety study in Miami, Florida.<sup>6</sup> For specific product and pricing information contact Stop Experts Inc, the vendor of the RRFB.  
(<http://www.spotdevices.com/system-rrfb.html>)

According to information from FHWA, there are no significant utility or environmental issues of using the RRFB. Installation is not problematic because the device relies upon radio frequency communication to link the devices, there is no need to install wiring under the roadway. Additionally, because the device can be solar powered there is no need to connect power to the unit. From a maintenance perspective, these devices seem very reliable. The primary maintenance issue would be the repair or replacement of a unit if a vehicle strikes it.<sup>7</sup>

NCDOT has a history of agreeing to pedestrian treatments that have interim approval in the MUTCD. A local example from Chapel Hill is the installation of flashing yellow arrows for permissive left turns on NC-54 at Hamilton Rd. and other intersections. Additionally, according to Stop Experts Inc, efforts are currently underway in Wilmington, NC, to have the RRFB installed.

The remainder of this document summarizes or directly borrows from the extensive evaluation of the use of the RRFB at 18 multilane road locations in St. Petersburg, Florida. The full report of the evaluation of RRFB in St. Petersburg is titled: An Analysis of the Efficacy of Rectangular-shaped Rapid-Flash LED Beacons to Increase Yielding to Pedestrians Using Crosswalks on Multilane Roadways in the City of St. Petersburg, FL and is available online at [http://mutcd.fhwa.dot.gov/resources/interim\\_approval/ial1/stpetersburgrpt/index.htm](http://mutcd.fhwa.dot.gov/resources/interim_approval/ial1/stpetersburgrpt/index.htm). The report provides details about the study design, crosswalk locations, importance of advanced yield lines and other pertinent engineering considerations.

<sup>4</sup> Interim approval for optional use of rectangular rapid flashing beacons (IA-11) FHWA Policy Memorandum, Manual on Uniform Traffic Control Devices. Available:

[http://mutcd.fhwa.dot.gov/resources/interim\\_approval/ial1/fhwamemo.htm](http://mutcd.fhwa.dot.gov/resources/interim_approval/ial1/fhwamemo.htm) Accessed: March 1, 2010

<sup>5</sup> Interim Approval Valid Under the 2009 MUTCD Available [http://mutcd.fhwa.dot.gov/res-interim\\_approvals.htm](http://mutcd.fhwa.dot.gov/res-interim_approvals.htm) Accessed: March 17, 2010.

<sup>6</sup> Federal Highway Administration, August 25, 2008 Miami-Dade Pedestrian Safety Project: Phase II Final Implementation Report and Executive Summary. Available

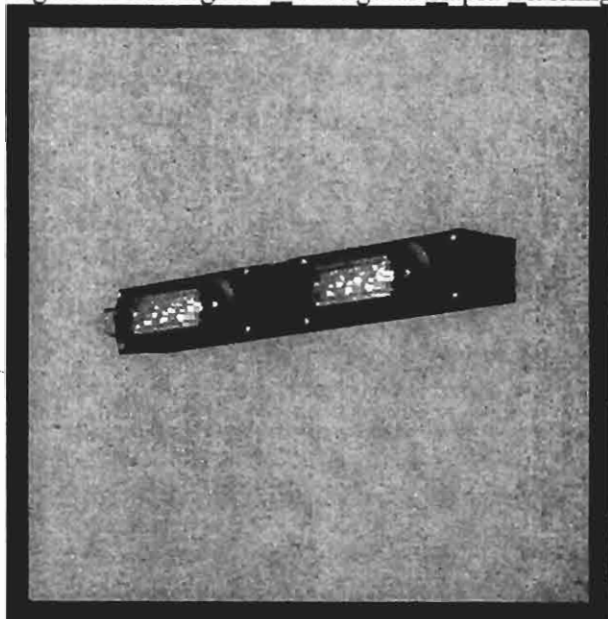
[http://safety.fhwa.dot.gov/ped\\_bike/tools\\_solve/ped\\_scdproj/miami/ch3.cfm](http://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_scdproj/miami/ch3.cfm)

Accessed: March 1, 2010.

<sup>7</sup> Federal Highway Administration, August 25, 2008 Miami-Dade Pedestrian Safety Project: Phase II Final Implementation Report and Executive Summary. Available

[http://safety.fhwa.dot.gov/ped\\_bike/tools\\_solve/ped\\_scdproj/miami/ch3.cfm](http://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_scdproj/miami/ch3.cfm)

Figure 1 Rectangular Rectangular Rapid Flashing amber Beacons



The LED flashers beacons of the Rectangular-shaped Rapid Flash used in the study were six (6) inches wide, 2.5 inches high, and placed nine (9) inches apart. Each unit was dual indicated (LED's on front and back). These beacons were mounted under mounted under pedestrian crosswalks signage (Figure 2.) Each side of the LED beacon flashed a yellow light in a wig-wag flashing sequence (left light on, then right) - the two LED's in combination flashed 190 times in the wig-wag flashing sequence during a 30 second cycle. The stutter flash pattern is similar to that used on emergency vehicles.

Figure 2 Photo of an activated RRFB in St. Petersburg FL



### History

In 2003, St. Petersburg, Florida had a pedestrian injury rate higher than the state average and felt that improving their rate of motorist yielding to pedestrians in crosswalks, which was less than two percent, could help reduce their pedestrian injuries.<sup>8</sup> The City found it imperative to take action to increase yielding compliance.

In an effort to increase yielding rates the City identified 81 crosswalks and enhanced each of these locations with various signs and pavement markings listed in the MUTCD. Through permission to experiment from FHWA No. 4-305(E), the City installed the Rectangular Rectangular Rapid Flashing amber Beacons, (RRFB) mounted under pedestrian crosswalks at 18 locations identified as uncontrolled crosswalks located at established pedestrian generators and attractors that had adequate crossing demand.

Working with the City, Drs. Ron Van Houten and J.E. Louis Malenfant evaluated the RRFB's effectiveness to attract a motorist's attention to the presence of a pedestrian in a crosswalk and actually induce compliance, in accordance with Section 316.130(7), Florida Statutes. The RRFB were used in conjunction with advance yield markings during daytime and nighttime operation with and without a median island or pedestrian refuge island. The evaluation also compared the RRFB to over-head and side-mounted round flashing amber beacons. If the RRFB treatments produced results equal to or better than the standard overhead or side mounted round flashing beacon or in-roadway beacons and produced clear safety benefits, the RRFB could be a viable alternative to use instead of these treatments.

Previous work by Turner and colleagues evaluated multiple treatments in an effort to increase motorist yielding to pedestrians at uncontrolled crosswalk locations. The Turner study included 11 separate treatments at sites across the country. The treatments included red signal devices (e.g., mid-block signals), active when present devices (e.g., pedestrian crossing flags, in-roadway warning lights and overhead flashing yellow beacon both with push button activation), and enhanced and/or high-visibility devices (e.g., in-street crossing signs, high-visibility signs and median refuge islands). Turner et al. found the most effective treatment for increasing yielding were the red signal devices. The treatment type that was second best, that did not include a red beacon, were the in-street crossing signs (87% compliance). It should be noted however that these devices were evaluated on smaller two-lane roadways and would not perform as well on larger arterial roadways. The least effect devices were the high visibility signs (17%).<sup>9</sup>

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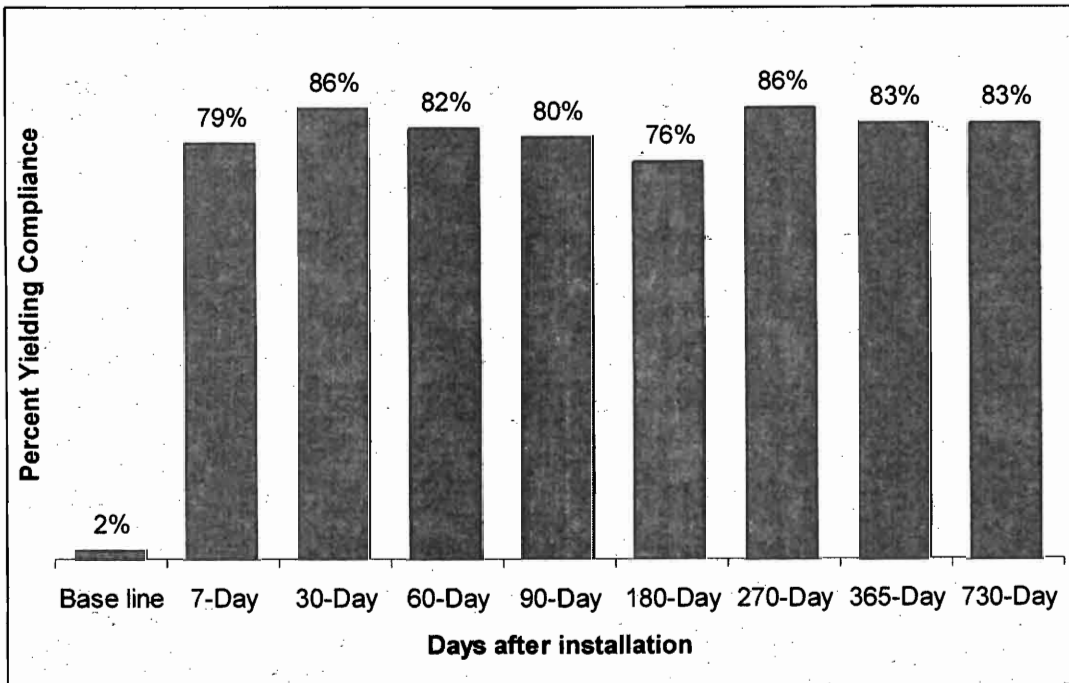
<sup>8</sup> Michael J. Frederick & Ron Van Houten Increasing Motorist Yielding Compliance at Pedestrian Crosswalks from under 2% to as high as 94% using Rectangular Rapid Flashing Beacons - Earning it "Interim Approval" from Federal Highway Administration. Available: [http://www.stpete.org/pdf/ite\\_paper\\_07.pdf](http://www.stpete.org/pdf/ite_paper_07.pdf). Accessed: February 28, 2010

<sup>9</sup> Turner, S., Fitzpatrick, K., Brewer, M., and Park, E.S. Motorist yielding to pedestrians at unsignalized intersections: Findings from a national study on improving pedestrian safety. Transportation Research Record, 1982. Transportation Research Board, Washington, D.C., 2006, pp. 1-12.

### Results

The results indicated that the RRFB devices dramatically increased yielding levels from single digits at several locations and 20% to 30% at other locations to 80% to 90% at most sites. No other device without a red indication, such as a traffic signal, has produced similar yielding data. Figure 3 illustrates the average percent of motorist yielding compliance over time for all 18 sites where the RRFB were installed. The RRFB produced sustained yielding behavior. It should be noted that because all 18 devices were not installed simultaneously not all data point represent the average data for all 18 sites. The baseline, 7 day, 30 day, 60 day and 90 day data represent data for all 18 sites. The 180 day data only represents data for 17 sites, while the 270 day data represent data for 15 sites, and the 360 day data only represent data for 10 sites. The 730 day data point is only based on the first site to be installed.

**Figure 3.** Average Yielding Compliance over time for all 18 sites that received the Rectangular-shaped Rapid Flashing (RRFB) LED Beacons



The results of this study indicate that the use of the *RRFB* increased motorist yielding rates significantly. These results showed clear safety benefits associated with the introduction of the pedestrian-activated device. One reason why this device is so effective may be related to the salience of the rapid flash sequence. Another reason may be related to the direct correlation between the pedestrians sign and the flashing device. The flashing device likely produces driver orientation to the pedestrian sign and making it stand out from the clutter.

### Location Specific Information

Several location-specific results from St. Petersburg are listed below. Each of the sites is on roads carrying two-way traffic. Each site also had a "Yield Here to Pedestrian" advance yielding sign approximately 30 ft. in advance of the crosswalk along with the in-roadway advance yield markings. For more information than what is listed here, please refer to the full report by Drs. Van Houten and J.E. Louis Malenfant.

#### 62<sup>nd</sup> Avenue South at 21<sup>st</sup> Street

This crosswalk traversed two lanes, was in front of a middle school and had a posted speed limit of 15 mph in the school zone and 35 mph outside the school zone.

The introduction of the rapid-flash beacon at this site produced a large increases in drivers yielding right-of-way to pedestrians. At baseline yielding compliance was of 0%. At 30 and 60 days after installation, yielding increased to 76% and 77% respectively over baseline. At 180 days, 1 year and 2 years post installation the yielding compliance percentages were 78%, 84% and 79% above baseline.<sup>10</sup>

#### 1st Street at 37th Avenue

The crosswalk at 1st Street traversed four lanes, had a posted speed limit of 35MPH, and an ADT (Average Daily Traffic Count) of 8,596. This location provided a crossing between two bus stops and included a pedestrian refuge island in the middle of the crosswalk.

The introduction of the rapid-flash beacon at this site produced a marked increase in drivers yielding right-of-way to pedestrians from a baseline level of 18% to averages of 86% and 90% for the two- and four-beacon treatments, respectively. Data collected 14 months later was associated with yielding of 100% with the beacon and 27% without the beacon.

#### 58th St. N s/of 3rd Avenue

The 58th St. crosswalk traversed four lanes, had a posted speed limit of 35 MPH, and an ADT of 19,192. It also had a refuge island and provided a crossing for the residents of a near-by retirement center.

At this site, the average yielding compliance during baseline recording was 10.9%. The activation of the over-head standard beacon produced an average yielding compliance of 15.5%. This is an average increase of only 4.6% above baseline. The introduction of a two-beacon, rapid-flash, system produced an increase in yielding to 78.3%. A four-beacon system followed giving 88% yielding compliance. Reversal back to two beacons yielded 84.6% compliance followed by 89.3% yielding for the second four-beacon system treatment. The average yielding percentage for a two-beacon system was 81.5%. The average yielding compliance for the four-beacon system was 88.7%. With the introduction of a two- and four-beacon system came

<sup>10</sup> The crosswalk information and yielding rates for 62nd Avenue South at 21st Street was not specifically addressed in the report by Drs. Van Houten and J.E. Louis Malenfant. The data for this crosswalk was provide by Michael J. Frederick, Manager Transportation, City of St. Petersburg, FL.

increases of 70.6% and 77.8% increases over baseline, respectively, and increases of 66% and 73.2% over the standard-beacon efficacy.

**22nd Avenue N. at the 5th St**

The 22nd Avenue North crosswalk traversed four lanes, had a posted speed limit of 35 MPH, and an ADT of 18,367. It is equipped with a refuge island and provided crossing for neighborhood residents to and from a large dog park.

At this site the introduction of the rapid-flash beacon produced a marked increase in drivers yielding right-of-way to pedestrians from a baseline level of 28% to a two-beacon treatment level average of 84% and an average of 93% for the four-beacon treatment. Crossing 14 months latter with the beacon was associated with yielding of between 97 and 100% while crossing 14 months latter without the beacon lead to yielding of 23%.

**31<sup>st</sup> Street north 54<sup>th</sup> Avenue South**

The 31st St. crossing traversed three lanes at the crossing itself, had a posted speed limit of 35 MPH, and an ADT of 9,600. It had a refuge island and provided crossing between an over-flow parking lot and a large community sports complex.

At this site the introduction of the rapid-flash beacon produced a marked increase in drivers yielding right-of-way to pedestrians from a baseline level 15% to 73% and 80% for the two and four beacons treatments respectively. Data collected 14 months later with the beacon was associated with 93% yielding.

**4th St. & 18th Avenue**

This location was equipped with a side-mounted system. This roadway traversed four lanes, has an ADT of 9,600, and a posted speed of 35 MPH.

Baseline data at this site showed a 0.0% yielding compliance. Activating the side-mounted standard beacon produced a 12.2% yielding compliance after seven days. A 30-day analysis of the standard side-mounted system yielded 17% compliance. The RRFB produced 63.4% yielding compliance after 7 days and the 30-day analysis showed 72% yielding. The rapid-flash percentages are representative a two-beacon system only. The average yielding percentage for each of the two-beacon analysis is 67.7%. This number is 55.5% more yielding over the 12.2% observed during the standard beacon treatment.

**Results of RRFB in other cities**

The motorist yielding compliance increase resulting from the RRFB are not unique to St. Petersburg. In Miami, FL yielding rates at baseline were as low as those in St. Petersburg. After the installation of the rectangular stutter flash system at select intersections in Miami, yielding compliance rates were similar to those achieved in St. Petersburg. Research is currently underway to replicate these findings at other U.S sites including Washington DC., Mundelein, Illinois and Los Cruses New Mexico.<sup>11</sup> The effectiveness of the RRFB at locations in

<sup>11</sup> Michael J. Frederick & Ron Van Houten Increasing Motorist Yielding Compliance at Pedestrian Crosswalks

Mundelein, IL and Washington DC are similar to those achieved in St. Petersburg. For more details including a location by location display of motorist yielding rates at baseline and post RRFB installation please see the Transportation Research Record article titled, "*Analysis of Effects of LED Rectangular Rapid-Flash Beacons on Yielding to Pedestrians in Multilane Crosswalks,*" in Appendix E of this document.

#### **Use of enforcement in conjunction with RRFB**

The report by Van Houten and Malenfant did not specifically mention the use of law enforcement concurrently with the sites they evaluated. However, according to Michael Frederick, in Neighborhood Transportation with the City of St. Petersburg, FL, In addition to the use the RRFB, a system wide enforcement program was introduced with weekly operations by the Police Department at marked crosswalks. The enforcement activities ran at all locations starting with warnings, between 05/08/06 to 02/28/07 and citations between 02/28/07 to 09/30/08.<sup>10,12</sup>

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from under 2% to as high as 94% using Rectangular Rapid Flashing Beacons - Earning it "Interim Approval" from Federal Highway Administration. Available: [http://www.stpete.org/pdf/ite\\_paper\\_07.pdf](http://www.stpete.org/pdf/ite_paper_07.pdf) Accessed: February 28, 2010

<sup>12</sup> Personal communication (email) with Michael Frederick 3/1/2010.

## Appendices

### Appendix A: Enhancement Installation Criteria

Information below came from "Enhancement Installation Criteria" section at [http://mutcd.fhwa.dot.gov/resources/interim\\_approval/ia11/stpetersburgprt/app1.htm](http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/stpetersburgprt/app1.htm)

Warrant Worksheet for Installation of an Intelligent Transportation System at a Crosswalk at an Uncontrolled Location.

If any two of the following questions are answered yes the Intelligent Transportation System Crosswalk Installation is warranted. The data and questions are ordered in terms of ease of data collection.

Number of lanes carrying through traffic in each direction.

First direction \_\_\_\_\_

Second direction (not relevant if one-way) \_\_\_\_\_

1. Does the pedestrian need to cross more than two lanes of traffic?

Yes \_\_\_ No \_\_\_

Daytime ADT (between 8:00 AM and 6: PM)

2. Does the hourly daytime two way traffic volume exceed 400 vehicles per hour?

Yes \_\_\_ No \_\_\_

Mode vehicle speed \_\_\_\_\_

3. Is the mode vehicle speed greater than 35 mph?

Yes \_\_\_ No \_\_\_

Percentage of pedestrians that are involved in a motor vehicle-pedestrian conflict per 100 crossings with vehicles present that involved an evasive action by the driver, the pedestrian or both. \_\_\_\_\_

Percentage of pedestrians crossing while vehicles were present who were trapped in the center of the roadway for more than 6 seconds. \_\_\_\_\_

4. Is the percentage of motor vehicle pedestrians conflicts greater than 2.5%?

Yes \_\_\_ No \_\_\_

Is the percentage of pedestrians trapped in the roadway greater than 5%?

Yes \_\_\_ No \_\_\_

**Appendix B** MUTCD approval Memo

**Appendix C** Ron Van Houten & J.E. Louis Malenfant, An Analysis of the Efficacy of Rectangular-shaped Rapid-Flash LED Beacons to Increase Yielding to Pedestrians Using Crosswalks on Multilane Roadways in the City of St. Petersburg, FL. Federal Highway Administration. Available at [http://mutcd.fhwa.dot.gov/resources/interim\\_approval/ia11/stpetersburgrpt/index.htm](http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/stpetersburgrpt/index.htm) Accessed February 1, 2010.

**Appendix D**

Analysis of Effects of LED Rectangular Rapid-Flash Beacons on Yielding to Pedestrians in Multilane Crosswalks. Jim Shurbutt, Ron Van Houten, Shawn Turner, and Brad Huitema Transportation Research Record: Journal of the Transportation Research Board, No. 2140, Transportation Research Board of the National Academies, Washington, D.C., 2009, pp. 85-95



**TOWN OF CARRBORO**  
NORTH CAROLINA

April 30, 2010

Mike Mills, PE  
Division Engineer  
Division of Highways – NCDOT  
P.O. Box 14996  
1584 Yanceyville Street  
Greensboro, NC 27415-4996

Dear Mr. Mills:

The purpose of this letter is to request that the Division conduct a study to determine the feasibility of pedestrian safety improvements in the N. Greensboro St. corridor, from Estes Dr. to Weaver St., in Carrboro.

The request arose out of a meeting of the Carrboro Transportation Advisory Board (TAB) on Monday, April 19<sup>th</sup>, 2010, regarding pedestrian safety along the segment in question. In addition to TAB members, the meeting was attended by Planning Board Chair Damon Seils, Chief Carolyn Hutchinson and Captain Joel Booker from the Police Department, Dale McKeel from DCHC-MPO, and NCDOT engineers Kelvin Jordan and Chuck Edwards. The TAB has set aside considerable time at recent meetings to discuss pedestrian safety issues along this segment<sup>1</sup>, and at the April 19<sup>th</sup> meeting, TAB members and Town staff expressed gratitude for the time Kelvin and Chuck devoted to listening to their concerns. My own perspective is that the meeting was very constructive.

Specifically, the study should focus on the feasibility of at least the following potential engineering solutions for increasing motorist yielding compliance at crosswalks within the Estes-to-Weaver segment:

1. A reduction of the speed limit between Estes Dr. and Shelton St. on Greensboro St.
2. A relocation of the speed limit signs on Greensboro St. near the crosswalk at Shelton St.
3. Better markings at the crosswalks, including the use of in-road signs
4. Possible relocation of crosswalks on Greensboro St., in particular the crosswalk at Short St.
5. Use of the LED, Rectangular Rapid Flashing amber Beacons (RRFB) at select marked crosswalks at uncontrolled locations
6. Possible narrowing of vehicle travel lanes to reduce speeds along Greensboro St.

<sup>1</sup> The issue was also discussed at length at the Carrboro Board of Aldermen meeting on February 16, 2010  
[http://townofcarrboro.org/BoA/Minutes/2010/02\\_16\\_2010.pdf](http://townofcarrboro.org/BoA/Minutes/2010/02_16_2010.pdf)



# TOWN OF CARRBORO

NORTH CAROLINA

On the enforcement side, the Carrboro Police Department has been active in ticketing noncompliant motorists at crosswalks along N. Greensboro St., as resources allow. However, the Police Department's obligation to provide comprehensive law enforcement in its jurisdiction means that frequent enforcement of traffic violations along one roadway segment is not possible at this time.

In a recent report by the UNC Highway Safety Research Center, the N. Greensboro St. segment in question was identified as having a "complex mix of conflict areas" between motor vehicles, bicyclists, and pedestrians.

The mix of numerous driveways, several of them busy commercial driveways, and higher speeds of traffic entering town, and a lack of signalized crossings may make for difficulty in crossing N Greensboro as well as crossing at driveways...<sup>2</sup>

I am attaching the TAB's recommendation from the April 19<sup>th</sup> meeting, which includes additional research on the RRFB, and an aerial photo map of the segment in question. The TAB provided Kelvin and Chuck with additional informational materials at the meeting.

Thank you for your consideration of this request, and please let me know if you need any more information or have any questions.

Sincerely,

Jeff Brubaker  
Transportation Planner

- cc: Patricia McGuire, Planning Administrator
- Steven Stewart, Town Manager
- Carolyn Hutchinson, Police Chief
- George Seiz, Public Works Director
- Charlie Hileman, TAB Chair, and TAB members
- Damon Seils, Planning Board Chair, and Planning Board members
- Dale McKeel, DCHC-MPO Bicycle and Pedestrian Coordinator (file)

(attachments)

<sup>2</sup> University of North Carolina Highway Safety Research Center. 2009. *Identifying Locations for Pedestrian and Bicyclist Safety Improvements in Chapel Hill and Carrboro, North Carolina*. Final Report to North Carolina Department of Transportation, Traffic Engineering and Safety Systems Branch, pp. 105, 106



STATE OF NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION

Beverly Eaves Perdue  
GOVERNOR

Eugene A. Conti, Jr.  
SECRETARY

May 7, 2010

Mr. Jeff Brubaker  
Transportation Planner  
Town of Carrboro  
301 W. Main Street  
Carrboro, NC 27510

Dear Jeff:

Thank you for your letter, and the list of recommendations from the Town of Carrboro Transportation Advisory Board, regarding the pedestrian safety improvements in the North Greensboro Street corridor, between Estes Drive and Weaver Street, in Carrboro.

I appreciate you, and the Transportation Advisory Board, bringing this issue to our attention, and we will be glad to investigate these possible solutions listed as a way to enhance the pedestrian safety along this particular corridor.

We will begin this investigation immediately, and provide you with the results of our investigation as soon as possible.

If you have any questions, please do not hesitate to contact this office.

Sincerely,

A handwritten signature in black ink, appearing to read "J. M. Mills".

J. M. Mills, P.E.  
Division Engineer

JMM/jm

Cc: Mike Fox  
Pat Wilson  
Kelvin Jordan  
Chuck Edwards

