IN THE GENERAL COURT OF JUSTICE
SUPERIOR COURT DIVISION
WAKE COUNTY, NORTH CAROLINA

CECCARELLI et al, Case Number: 10-CVS-019930

Plaintiff,

v.

THE TOWN OF CARY,

Defendant.

AFFIDAVIT OF DAREN E. MARCEAU

STATE OF NORTH CAROLINA)
) SS:
COUNTY OF WAKE)

I, Daren E. Marceau, being first duly sworn according to law, depose and state:

1. I have personal knowledge of the matters set forth herein and am competent to testify to the facts in this Affidavit.

2. I am a licensed professional engineer (licensed in NC, VA, SC, GA, and FL), hold a Bachelor of Science in Civil Engineering and a Master of Science in Civil Engineering from North Carolina State University, and have many years experience designing transportation facilities such as traffic signals. Prior to becoming an engineer I was a police officer, and I served in the City of Raleigh, NC. My law enforcement duties involved investigating traffic crashes. After leaving the police department and finishing my masters degree program I was employed by a transportation engineering design and forensics firm in Cary, NC, and worked on projects across the U.S. In addition to my engineering practice that includes the design and analysis of traffic control devices I have also managed a forensic engineering practice for many years. My experience includes investigating and reconstructing traffic crashes as well as teaching classes for law enforcement officers, engineers, and attorneys in the areas of traffic crash investigation and reconstruction and transportation engineering with a focus on traffic control devices and their role in traffic crashes and roadway defects. I am a nationally-recognized author and instructor on the subject of reconstructing crashes at traffic signal intersections.

3. I have been retained by counsel for The Town of Cary, the defendant, in the above-captioned civil case. On October 31, 2012 my deposition was taken by the plaintiffs in this case. During my deposition counsel for the defendant, Mr. Paul Stam, requested that should

I change or add to my opinions that were presented at my deposition I should advise him of same. This affidavit is in response to his request as I have several opinions in this case that are in addition to those stated at my deposition. The following are opinions that I did not discuss at my deposition, and I have broken them into three general areas: 1) opinions concerning the lawful operation of the red light cameras at intersection which are the subject of this civil case, 2) opinions concerning the calculation and use of yellow change interval times in North Carolina, and 3) opinions related to the claims of plaintiffs Ceccarelli and Millette that they were unable to safely stop when they received yellow lights at the time and place when they were cited for running red lights.

4. Opinions related to the lawful operation of red light cameras at intersections in the Town of Cary:

   a. I am familiar with the following intersections located within the Town of Cary, and each of these intersections as well as the traffic signal at each of the intersections is owned by the state of North Carolina:

      i. Maynard Road at Kildaire Farm Road;
      ii. Kildaire Farm Road at Cary Parkway;
      iii. High House Road at Cary Parkway;
      iv. Walnut Street at Meeting Street

   b. I have reviewed and am familiar with the official NCDOT signal plans of record in use for the time period August 1, 2010 to August 18, 2012 for the above intersections on which the yellow change interval times are shown. I have also reviewed and I am familiar with the yellow and red interval calculations (clearance time sheet) used by the licensed professional engineers to calculate the yellow change interval times shown on the official NCDOT signal plans of record.

   c. Additionally, I am familiar with the intersection of Cary Town Boulevard at Convention Drive (formally known as Western Boulevard Ext. at Convention Drive/Principal Lane), which is located within the Town of Cary, but is owned by the state of North Carolina. The traffic signal at this same intersection is also owned by NCDOT. I have reviewed and am familiar with the official NCDOT signal plans of record in use for the time period December 2, 2009 to March 19, 2010 for the intersection of Cary Town Boulevard at Convention Drive on which the yellow change interval times are shown. I have also reviewed and I am familiar with the yellow and red interval calculations (clearance time sheet) used by the licensed professional engineer to calculate the yellow interval times shown on the official NCDOT signal plan of record.

   d. Additionally, I am familiar with the contents and use of the NCDOT Traffic Management & Signal Systems Unit Design Manual ("Design Manual"), first issued in 1999, and with periodic updates to the same Design Manual.

e. I am also very familiar with the federal Manual on Uniform Traffic Control Devices ("MUTCD") as well as the NCDOT Supplement to the MUTCD. I am familiar with the standards, guidance, and options in these manuals with respect to yellow change interval times.

f. I am also very familiar with the Institute of Transportation Engineers ("ITE") and their various publications specifically ITE's Traffic Engineering Handbook, and the calculations presented in this handbook for engineers to use when calculating yellow change interval times for traffic signals.

g. I have reviewed the yellow change interval times that are set forth on the signal plans of record described above and all the yellow change interval times shown on these signal plans are in full conformance with the requirements of the MUTCD.

h. The use of either the ITE change period formula ("ITE formula") (the change period is the yellow change interval plus the red clearance interval, and while the yellow and red interval times are often calculated together as the total change period they are often presented as separate yellow and red values) and the NCDOT change period formula which is a variant of the ITE formula shown in the various versions of the Design Manual, is a generally accepted engineering practice used by North Carolina professional engineers and meets the standard of practice for professional engineers in North Carolina. In addition, the use of the ITE formula is a generally accepted engineering practice and meets the standard of practice for professional engineers across the U.S.

i. Integral to the use of a formula for calculating the yellow and red intervals for a traffic signal is the use of an approach speed for the vehicles approaching the intersection and traffic signal. When calculating yellow and red interval times for left turns the use of a speed lower than the speed for the through travel lanes is a generally accepted engineering practice used by North Carolina professional engineers and meets the standard of practice for professional engineers in North Carolina and across the U.S.

j. Furthermore the use of 20 miles per hour or some other similar lower speed as the design speed for left turns in the formula for calculating yellow and red intervals is a generally accepted engineering practice used by North Carolina professional engineers and meets the standard of practice for professional engineers in North Carolina and across the country.

k. The red light cameras in operation in conjunction with the traffic signals at the intersections in the Town of Cary noted above were, in the time frames referenced, in compliance with North Carolina General Statutes.

5. Opinions concerning the calculation and use of yellow change interval times in North Carolina:

a. As defined in the MUTCD the sole purpose of the yellow signal light is to warn drivers that the green signal they just had is about to be given to another direction of travel, and that a red signal is about to start for their direction of travel.

b. Traffic engineers understand that drivers well in advance of a yellow light will almost always slow and stop. Their driver training and experience has taught them this. And, in the same manner drivers closer to the intersection will almost always continue when they receive a yellow light. Again, this is a learned driver behavior. Somewhere between these areas of decision lies an area of uncertainty for some drivers. We call this the "dilemma zone". After many thousands of observations of drivers and their response to yellow lights over many decades of research we understand where these three areas lie in advance of an intersection.

c. Traffic engineers use a yellow light distance (not time, but distance) in advance of the intersection so as to accommodate both the continuing and the stopping drivers. We calculate the stopping distance a driver will need for their given approach speed to see, perceive, and react to the yellow light by applying their brakes and slowing to a stop at a comfortable and easy deceleration rate. This distance corresponds to the area where drivers may have trouble deciding if they should stop or go – the dilemma zone. We now have a stopping distance in front of the intersection, and from that distance, whatever it may be, we calculate the time it will take the continuing driver to cover that same distance. This method of calculating yellow interval times thus accommodates both the *stopping driver* with the distance needed to stop and the *continuing driver* with the time needed to continue to the intersection before the signal turns red. The ITE formula as well as the NCDOT variant commonly used accounts for both the stopping driver and the continuing driver. Most roadway users never learn or understand all this as there is no need for them to know what goes on behind the scenes.

d. Contrary to common belief the yellow interval time is not nor was it ever intended to provide the time for a driver to slow to a stop before the signal turns to red. Unfortunately this belief is held by most drivers, police officers, and even by some traffic engineers. I've even told my student engineers and police officers this myth as sometimes it is just easier to not try to convince non-believers that the world is round, and to focus on more important issues. The reality is that the yellow interval is intended to provide the distance needed by the driver who decides to slow and stop in response to a yellow light. The key understanding here is that the time to stop and the distance to stop are not the same. When a driver applies their brakes and stops in response to a yellow light it is almost certain that the driver will stop well after the signal turns red. Most drivers never realize this until they are asked to watch signals the next time they drive, and to note what color the signal really is when they come to a stop at an intersection – it will usually be red. We traffic engineers understand that it takes more time to stop than what the yellow interval provides. And, that is alright as it is immaterial what color the signal is once the driver makes a decision to stop, and comes to a stop. This reasoning is beyond the scope of what drivers need to know to safely operate a vehicle and it is beyond what police officers need to know to issue citations or investigate crashes, and thus the myth that yellow lights should provide the total stopping time seems to be a common legend. And, it is just that – a myth and a legend, and nothing more.

e. Also part of the engineer's job in calculating yellow and red intervals, together called the change period as described in the MUTCD and by ITE, is accounting for the speed of the approaching vehicles. Common sense tells us that a faster car will take more distance to stop than will a slower car. And the calculation of red and yellow intervals needs to consider the approach speed. Without doing prohibitively expensive formal speed studies on a regularly schedules basis for every approach to every traffic signal at several different times on different days of the week to gather speed data it is standard engineering practice across the U.S. and in North Carolina to use the posted speed limit as the approach speed used for calculating yellow and red intervals.

f. And, common sense also tells us that a driver making a left turn in an intersection will be driving slower as they approach the intersection and as they travel through the intersection than will a driver who is in a through lane traveling at the posted speed limit. As noted above it is standard engineering practice to use a reduced speed when calculating yellow change interval times for left turns, and the speed of 20 mph is used in North Carolina. At face value this 20 mph calculation value might seem arbitrary and might not seem to accommodate all drivers. For example, the plaintiff in this case alleges that 20 mph doesn't account for the driver approaching the intersection at 45 mph. I agree – it doesn't. And, the yellow interval time calculated at 20 mph wasn't intended to accommodate drivers approaching a left turn signal at 45 mph because we don't have such a situation in real life.

g. If we lay out before us all the possible scenarios under which a driver could arrive at a traffic signal in preparation for making a left turn, and we combine this exercise with an understanding of how protected (green arrow) and permitted (green ball) left turn signals operate it becomes very clear that a 45 mph driver is simply not going to have the opportunity to arrive on a green light over an unoccupied turn lane (thus allowing the driver to approach at a higher average speed without crashing into queued cars ahead of the driver) and then make a left turn at that signal while that signal is giving the driver a yellow light calculated for 20 mph. Allow me to explain why in the next few paragraphs.

h. What is not commonly know by drivers is that traffic signals "rest in green" for the main street through lanes until another car pulls up, stops on a detection area, and requests a green light. We engineers design signals like this to promote free-flowing traffic along the main street under lower traffic volume periods like at night. The signal will just rest in green for the main street all day and all night until someone pulls up and needs a green light on a conflicting approach. And, while the main street through signal lights rest in green all other signals for all other lanes at this intersection will rest in red. This includes protected left turns (green arrow) on the main street and the side streets as well as the side street through lanes. Understanding that signals operate like this let's examine a few possibilities of how a left turning driver might arrive at an intersection, and let's assume this is late at night without traffic queued in the left turn lane as such traffic would naturally cause the approaching driver to reduce their speed to avoid a collision. In other words, we are creating the perfect conditions for a driver to come into a left turn at the posted speed limit:

i. If this intersection did not have protected left turns and only had green "ball" signals, or permitted left turns, then the main street left turn lane would have a green signal when the late night driver approached at 45 mph with no traffic queued in front of them. And, this green signal would be a ball signal not a protected left turn arrow. If by race chance some other driver approached the intersection at the same time from another direction and the signal changed to yellow for the left turning driver the yellow would be timed for the through movement at the 45 mph speed not at a reduced 20 mph since it is in fact the main street permitted phase that is being terminated, not a dedicated/protected left turn phase. And, even if a reckless turning driver hadn't reduced their speed in preparation for turning as we hope they would have done they would still have the full-speed protection in the yellow light they received.

ii. Protected left turns typically rest in red all day and all night unless a vehicle arrives on red, and requests a green light. If this intersection had a protected left turn arrow for the main street drivers it would be red in the absence of queued cars in the left turn lane, and the turning driver would have to slow and stop for a red light, and they never would see a yellow light.

iii. Keeping in mind that reduced speeds for yellow interval calculations apply only to protected left turns and thus permissive left turns will be timed to match the adjacent through lanes at the posted speed limit we can continue to go through every possible scenario of drivers arriving at a protected green arrow signal when there are cars queued up waiting to receive a red light (approaching driver has to slow to much less than the posted speed to avoid collision) or when the queued cars have just received a green light and are pulling forward slowly at first (again, the approaching driver has to slow to avoid crashing) as examples, and we will find that there are no situations where the approaching driver is being short-changed with a short yellow that is not commensurate with their actual speed.

iv. After holding the yellow light timing, as calculated by North Carolina engineers, at arm's length, and understanding the context in which yellow light interval times are used for left turns, and how permitted and protected left turns actually time their yellow intervals differently, it becomes obvious that plaintiff's concerns are truly a moot point, and that drivers are not exposed, unless by careless high-speed driving, to yellow lights, that when timed with a reduced speed, are short-changing the left turning drivers with inadequate distance to stop or time to proceed.

i. Traffic signals are not an assembly of unconnected and independently working parts. They are in fact a system of very interrelated parts, strategies, and formulas that the engineer brings together in a pre-planned harmony in the interest of safety and efficiency. When one component is taken out of context and apart from the rest of the system, such as the yellow time provided by the ITE formula, that one part may seem to have problems. As an example, the stopping distance we use for yellow interval times defines a finite point in front of the intersection, and the dilemma zone previously described is not a finite point but is rather an area surrounding the stopping distance line. In other words there could be a driver who receives a yellow light when they are not exactly on the imaginary stopping distance point in front of the intersection, and they may not feel comfortable slowing or going.

j. To address the drivers who might be caught in the dilemma zone we traffic engineers do not rely upon the yellow interval time alone. We intentionally place signal detection devices, such as detection loop wires buried in the pavement or video detection camera zones, in advance of the dilemma zones so as to avoid giving drivers a yellow light when they are in an area of potential uncertainty. The signal controller receives an input signal from a car driving over the detection loop wire that is upstream of the dilemma zone, and the controller "extends" the green light for a few seconds before giving the same driver a yellow light. This places the driver much closer to the intersection when they eventually do receive a yellow light, and removes the possibility that they will have difficulty deciding if they should stop or go. And, we typically place the detection loop wire to accommodate drivers who may be traveling a bit slower than the posted speed. For example, in a 45 mph zone we usually place the detection loops to accommodate a 40 mph driver. Again, these are common and standard engineering practices that the motoring public does not know about, and doesn't need to know or understand to operate their cars.

k. Most drivers understand that while they approach an intersection on a green light and their signal changes to yellow the opposing drivers on conflicting approaches to the intersection have been facing a red signal. What is not usually understood by the same approaching drivers is that when their yellow light turns to red the other drivers' signals remain red for a short period. We call this the "all-red" period or interval. If an observer stands on a street corner positioned so they can see both the northbound and westbound signal faces for example they can easily see both signals with a concurrent red indication. The idea is to not give the waiting drivers a green light immediately after the stopping driver received a red light. It is lawful for a driver to proceed through the intersection if they enter it on yellow, and we want them to clear the intersection before giving conflicting drivers a green light. Engineers call this a "factor of safety", and it is intended to reduce the possibility of a crash. Engineers calculate the red clearance interval time by simply calculating the time for a driver at the speed limit to clear the intersection width. While the calculation of red intervals is not directly a part of this legal case the plaintiffs have alleged that yellow times in use in North Carolina are too short, and cause crashes. The point of this discussion of red intervals and all-red periods is to show that engineers, as a matter of standard engineering practice in North Carolina, intentionally build additional behind-the-scenes safety measures into traffic signal timing to prevent crashes.

l. After having investigated many traffic signal-related crashes over several decades, and after authoring a textbook on this subject, and after having taught many police officers, engineers, and attorneys how to use traffic signal timing to solve crash cases it is very apparent that, and most of my students have heard me say, "When we have a red light crash because someone ran a red light they did so by a big mistake, and not by a little mistake. When they got their yellow and red light they were nowhere near this intersection. They were in the next county!" Granted, that is an exaggeration, but it drives home the point that when a crash happens at a signalized intersection the offending driver is usually several football fields away from the intersection when they receive a yellow and red. They didn't just miss it by a few tenths of a second. There are other factors of safety that we engineers intentionally build into traffic signal timing, such as the delay from when the conflicting driver receives a green light and their wheels actually start to roll (about 2 seconds) and the time it actually takes the moving car to get out into the intersection to an area of potential conflict (several more seconds) after the wheels actually start rolling, and they all provide such a large margin of safety that even if an engineer missed the exact yellow time calculation by several tenths of a second, or if the speed limit changed and the signal timing was not upgraded to match the new and higher speed limit a light-running crash is still not going to happen unless a reckless driver really, really runs the light by a large margin.

m. Plaintiffs have based their case on what they believed to be an oversight by engineers all over the world especially in North Carolina that resulted in yellow lights being timed too short to provide the time for drivers to stop. And, plaintiffs have produced many experts to prove that the time provided by yellow lights does not allow drivers to stop. It is my opinion that they are correct: yellow lights do not provide the time to stop. They are not supposed to do so. Yellow lights are intended to, and do, as I have just demonstrated, provide the <u>distance to stop</u> and the <u>time to go</u>.

n. Plaintiffs contend that yellow interval timing does not accommodate drivers who may be in the dilemma zone and not exactly on the imaginary line defined by the calculated stopping distance in the ITE formula. As discussed above traffic engineers use strategically-placed detection areas to reduce the possibility of a driver being placed into such a situation by intentionally extending the green light a bit longer before giving the driver a yellow light when they are farther downstream and shouldn't have a problem with a stop-or-go decision.

o. Plaintiffs also contend that using a reduced speed of 20 mph for the calculation of left turn yellow interval times also short-changes drivers. Unless a driver is operating their car in a very wild, unreasonable, and dangerous manner with the intent of taking a street corner at high speed they will not be in a situation where they will likely ever encounter a yellow interval that is timed too short for their approach speed. Using 20 mph as the reduced approach speed for protected left turns is standard and accepted engineering practice in North Carolina.

6. Opinions related to the claims of plaintiffs Ceccarelli and Millette that they were unable to safely stop when they received yellow lights at the time and place when they were cited for running their respective red lights:

a. Both plaintiff Ceccarelli and plaintiff Millette testified that upon receiving a yellow light at the time and place where each was cited for running a red light they were unable to safely stop without entering the intersection when a red signal light was displayed. As part of my analysis of this case I examined their testimony, and found both to be untrue. Presented below is a summary of my analysis. And, attached to this Affidavit as Exhibit 1 are two pages of an Excel spreadsheet upon which the details of my analysis are presented.

b. At the time of his red light camera citation Mr. Ceccarelli was speeding on Cary Town Boulevard at its intersection with Convention Drive, and was recorded at 50 mph in a posted 45 mph zone. I examined his ability to have safely stopped on his approach to the signal upon having received a yellow signal light as he did on the night of his citation. I considered his stopping ability at both the posted speed of 45 mph and at his actual speed of 50 mph. I used the 4.0 second yellow interval time that was in use in the signal controller at the time of Mr. Ceccarelli's citation. I also reviewed the Redflex red light camera citation photos and the video taken with the photos, and used the times provided in these images to pinpoint Mr. Ceccarelli's arrival at the intersection with respect to when his red and yellow intervals started as he approached the intersection. My findings were as follows:

i. Had Mr. Ceccarelli been traveling at the legal speed limit on the night of his citation, and upon receiving his yellow light had he braked at a very easy deceleration rate he would have stopped about 5 feet before the intersection's stop line.

ii. Even at his higher speed of 50 mph had Mr. Ceccarelli braked upon receiving his yellow light he would have come to a complete stop in front of the stopline with a very easy and comfortable braking effort.

iii. I also examined drivers in general at this intersection who received a 4.0 second yellow light, and their ability to safely stop. And, my analysis shows that drivers traveling at 45 mph, the posted speed limit, will easily stop without entering the intersection with an easy braking effort.

iv. It is my conclusion that Mr. Ceccarelli simply failed to slow and stop when he received a yellow signal light. His testimony that he could not safely stop is unfounded.

c. At the time of her red light camera citation Ms. Millette was making a left turn from Kildaire Farm Road onto Cary Parkway, and was recorded at 23 mph. I examined her ability to have safely stopped on her approach to the signal upon having received a yellow signal light as she did on the day of her citation. I used the 3.0 second yellow interval time that was in use in the signal controller at the time of Ms. Millette's citation. I also reviewed the Redflex red light camera citation photos and the video taken with the photos, and used the times provided in these images to pinpoint Ms. Millette's arrival at the intersection with respect to when her red and yellow intervals started as she approached the intersection. My findings were as follows:

i. Ms. Millette testified that she slowed on her approach to the intersection in the left turn lane as there were other cars ahead of her. This is consistent with how we expect traffic to be on northbound Kildaire Farm Road in the evening rush hour at this intersection. Ms. Millette's car is seen in the Redflex video following other cars into the intersection, and this agrees with her testimony that there were other cars queued ahead of her in the turn lane. Common sense tells us that Ms. Millette would have reduced her original traveling speed simply to have avoided colliding with the cars queued ahead of her at this congested intersection, and her speed as she actually approached the intersection was low if not stop-and-go.

ii. In my analysis, and in an effort to favor the plaintiff, I ignored the fact that Ms. Millette was behind a queue of other cars, and I used an approach speed that was higher than the speed at which Ms. Millette was likely traveling. I used an average speed for the last half of her travel in the turn lane assuming that there were no other cars in the turn lane ahead of her, and that Ms. Millette would have been traveling an original speed of 45 mph and then eventually slowed to 23 mph, her clocked speed as she ran the red light. I found that Ms. Millette was about 201 feet from the intersection when she received her yellow light, she traveled another 75 feet during her perception/reaction time, and then still had 126 feet to slow and stop. This would have required a braking effort that was more leisurely/easy than what most engineers use for yellow interval timing with the ITE formula. And, Ms. Millette could have easily stopped before entering the intersection on a red light.