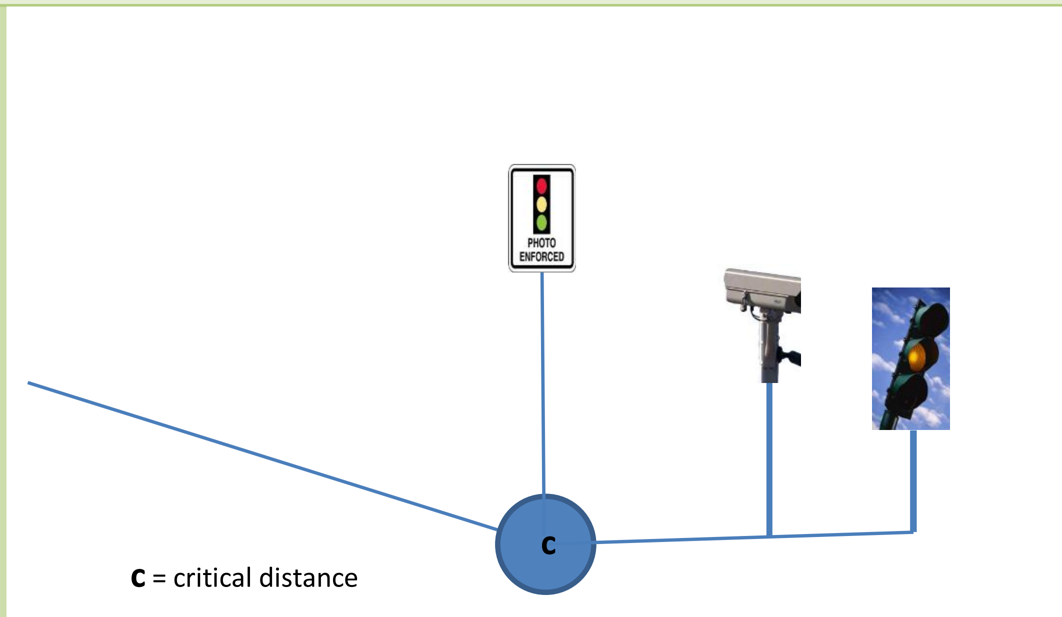
INTERSECTION ANALYSIS

Intersection

Capital Blvd (NB) at New Hope Church Rd.
Raleigh, North Carolina

Google Street View

Illustration



Test Time

Friday, November 23, 2012 3:44 PM

Testers

Brian Ceccarelli, Brian Appleby

Approach Speed & Grade

mph	Actual[1]	Signal Plan[2]
Speed	~55	45

degrees	Actual[3]	Signal Plan
Grade	+0.7%	+2.0%

Yellow Change Interval

seconds	Actual[4]	Signal Plan	ACS[5]	NCDOT Min Requirement	Physics[6]
Straight	4.3	4.3	4.3	5.2	8.7
Left Turn	3.0	3.0		3.0	8.7

Signal Plan

December 2006, Richard Mullinax

Red Light Camera

Straight-thru. I do not think there is left turn camera.

There is a separate Gatso, not an ACS, device facing the left turn lane or the westbound New Hope traffic. I do think the Gatso device is speed radar. It does not have a clear lens.

Description

The camera is on Capital Blvd facing northbound toward the traffic signal at New Hope Church Rd. The Capital Blvd approach has 6 northbound lanes. 2 of the 6 lanes are left

	turn lanes. A full left-most left turn lane begins at about 300 feet from the stop bar. A taper precedes it. The rightmost left turn lane begins farther back at about 558 feet from the stop bar. There is no dedicated right-turn lane. The critical distance is exactly at the trough of two hills. This coincidence turns the intersection into a red light camera gold mine and a safety hazard. As cars travel north on Capital Blvd., cars first descend a long -4% decline (over 800 feet). Gravity accelerates the freely-flowing cars to around 55 mph. Cars arrive at the bottom of the hill only to immediately ascend a hill which arrives at the intersection 283 feet later. At the trough of the hills is the exact location of the critical distance (283 feet) for a 45 mph +2% grade road. 45 mph and +2% are the numbers which Richard Mullinax used on the signal plan for the yellow light duration. There is a photo-enforced sign at the critical distance. Mullinax wrote +2% grade on the signal plan, but the grades of each lane are not +2%. Upon inspection each lane has a different grade. +2% is the *maximum* grade of the 6 lanes. The minimum grade, that for the right lane, is just about level. This segment of Capital Blvd runs along the bottom of a hill whose summit is somewhere to the northwest of the intersection. The left lanes have a steeper incline than the right lanes. We measured the grade of the right lane at +0.7%. But Mullinax applied +2% to the yellow time. He shortened the yellow by 0.2 seconds to 4.3 seconds. 4.3 seconds undercuts the yellow the NCDOT requires for right lanes. 150 feet from the stop bar is the entrance to CVS Pharmacy. This nearby business entrance resides inside the critical distance. Drivers turn right into this business. There are actuators under the road in all lanes at 283 feet from the stop bar. But the actuators are too close to the intersection because the 85^{th} percentile approach speed (55 mph, 0%) put the critical distance at 412 feet from the stop bar.
Conclusion	Mullinax undercut the yellow change interval at this intersection by 0.9 seconds by NCDOT's own minimum specifications. Had Mullinax considered the almost-level right lane, had Mullinax knew to how to measure the 85^{th} percentile v_0 and measure it at the critical distance as physics requires, Mullinax would have set the yellow duration to 5.2 seconds. 5.2 seconds is the NCDOT minimum yellow change interval. Physics demands that the yellow time must be 8.7 seconds. Unlike physics, NCDOT does not foresee drivers decelerating within the critical distance before entering the intersection. Aside from turning movements, Capital Blvd at New Hope Church Rd. has several reasons why drivers must decelerate just before entering the intersection. We enumerate these in the next section.
Failures	1. The yellow light duration does not take in account the 85^{th} percentile approach speed v_0 due to the hill. The critical distance[7] for a 45 mph +2% road is 283 feet.

283 feet back from the intersection stop line places the point of measurement of v_0 at the bottom of the hill. Using a radar gun we measured the speed at 55 mph. When one plugs 55 mph into the critical distance formula, the critical distance is 412 feet. 412 feet lands directly on the -4% hill. The speed of cars on the hill is still 55 mph. The NCDOT shorts the yellow time 0.7 seconds just by measuring the speed incorrectly.

The previous intersection is Greywood Dr. Greywood Drive is over 1000 feet distant. That means we were able to measure freely flowing traffic. (Traffic approaching New Hope Church was not hampered by the Greywood Drive signal.) The speeds we measured were of traffic approaching New Hope Church, traffic that was not impeded by traffic density or other traffic conditions.

2. There are actuators under Capital Blvd at 283 feet. While the actuators can be used to keep or turn the light green for a driver who enters the critical distance for a 45 mph +2% grade road, the actuators do not help the drivers at the real critical distance (412 feet, 0% grade). The actuators are 412 – 283 = 129 feet too close to the intersection.

3. Richard Mullinax used the grade of the lane with the maximum slope, not the grade of the lane with the minimum slope. The maximum grade is the left lanes. That makes the yellow light too short for right lanes. The maximum grade is +2%. But the minimum grade is that of the right lane: +0.7%. It is not even 1%. The right lane is almost level. Therefore Richard Mullinax creates type 1 dilemma zones for cars in the right lanes. Mullinax shorted the yellow for the right lanes by 0.2 seconds. Shorting a yellow by 0.2 seconds is enough to increase light runners by 150%. (Shorting a yellow by 0.5 seconds increased red light runners by 400% in Cary.)

4. ITE Yellow Change Interval Formula fails to provide fair warning for drivers who tap their brakes while inside the critical distance. The Formula always induces a type 1 dilemma zone when a driver decelerates just before entering the intersection. There are conditions at this intersection which force a driver to slow down just before entering. Systematic slowing down begins at about 200 feet.

   a. Capital Blvd has a lot of northbound traffic at this location. The density of the traffic inside the intersection can become too great to make drivers comfortable to go the speed limit. And so drivers slow down just before entering the intersection.

   b. Drivers are beginning to shift lanes for the upcoming US1/US401 split. Drivers are jockeying for position. The lane shifting causes drivers to slow down before entering the intersection.

   c. There is traffic turning right into CVS Pharmacy which causes drivers behind the turning drivers to involuntarily slow down. Drivers are too close to the intersection to stop but their slower speed now conflicts with the never-slow-down mandate of the NCDOT. We almost saw a crash occur because of this

	problem. There were two drivers in the right lane. One turned in CVS. The other, an African-American woman had to slow down for the CVS customer, but continued straight. The signal turned yellow. She was too close to stop but too far to proceed at the slower speed she was going. She slammed on her brakes. She skidded into the middle of the intersection. She entered the intersection almost 2 seconds into the red. All that because of a driver previously entered CVS Pharmacy and the NCDOT yellow change interval formula does not accommodate common traffic scenarios. This is how crashes occur. d. The slight incline itself may cause some cars to decelerate slightly before entering the intersection. 5. This intersection's left turn yellow duration (3.0 seconds) is wrong. It complies with the NCDOT's false assumption that all drivers who intend to turn left travel at a maximum of 22.9 mph 100 feet from the stop bar. This assumption always forces drivers travelling legally at 23 mph up to the speed limit to run red lights.
NCDOT Min Requirement	The approach speed is about 55 mph. The grade of the rightmost lane is for all practical purposes a level lane. Using the AASHTO values, the ITE Formula yields the yellow change interval = 5.2 s.

Footnotes

For definitions of approach speed, critical distance the yellow change interval formula and for an explanation of the various types of problems, refer to *Misapplied Physics in the International Standards that Set Yellow Light Durations Forces Drivers to Run Red Lights*.

1. I measured the approach speed of vehicles at the critical distance using a Bushnell Speedster III Radar Gun. The accuracy of this model is +/- 1 mph. I did not take into account the cosine law, so the actual approach speed is greater than that shown here. The difference is insignificant.

2. The approach speed in the signal plan is that the traffic engineer plugged into the yellow change interval formula.

3. I measured the grade of the road using an iPad clinometer app.

4. I measured the yellow time using a Dakota Compass Stop watch. I take several measurements and then average them. So far my measurements have matched the signal plan by +/- 0.10 seconds.

5. Affiliated Computer Services (ACS) stamps a red light camera citation with the camera system's measured yellow time. The system measures the yellow time using passive magnetic inductance. The system senses a change in the intersection's yellow light circuit by sensing a magnetic field induced by its initiating electric current. It may take several tenths of a second before the yellow circuit completely closes and the yellow light bulbs illuminate. The ACS yellow interval is usually longer than the yellow duration the driver actually sees.

6. Any duration less than the laws of physics forces certain drivers to run red lights. Physics dictates the necessary yellow change interval such that both drivers progressing at a constant approach speed and drivers progressing but decelerating toward the intersection can stop or go safely without running a red light.

7. I computed the critical distance, **C**, by plugging the signal plan's speed limit and grade into the critical distance formula. I located the critical distance point using a Rolatape measuring wheel, measuring out the critical distance from the intersection's stop line.