

Appropriate Countermeasures for Hazardous Site: Glenwood Ave and Peace St., Raleigh, North Carolina

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Abstract

Concerns are had for the safety of traversing vehicles at the intersection of Glenwood Ave and Peace St. in Raleigh, North Carolina. Though improvements were made four to five years prior to this study, an investigation into the last three years of collision data shows over forty collisions. The results of a field review warranted a Conflict Study and a Volume / Turning Movement Study, which provided data for two cost effective countermeasures recommended for installation: a median device installation on eastbound Peace St and a permitted-only left turning signal on eastbound Peace St. Further analysis may find other countermeasures to be helpful.

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Appropriate Countermeasures for Hazardous Site: Glenwood Ave and Peace St., Raleigh, North Carolina

Initial Research

Collision Data / Diagram

Collision data was requested for a three year period of reported collisions between the dates of January 4, 2008 and December 30, 2010. A collision diagram depicting this information can be seen in Appendix A. Intelligible reports and reports too far from the center of the intersection (outside scope of study) were removed, resulting in a diagram showing forty three collisions.

Patterns can be seen of driveway collisions and left turn collisions on eastbound Peace St, angle collisions on westbound Peace St, and illegal left turn collisions on northbound Glenwood Ave.

Field Review and Condition Diagram

After conducting this collision research and deeming the location hazardous and worthy of further investigation, a Field Review of the location was scheduled. Most reported collisions occurred during the day, so observations were made over a one hour period from 12pm-1pm on March 23, 2011. A night review of the location is not deemed necessary and outside the scope of this analysis.

All approaches were driven and walked, pictures were taken, and a condition diagram was created which can be seen in Appendix B. A copy of the field observation report can be seen in Appendix C.

These observations revealed high risk left turns onto Glenwood Ave from eastbound Peace St. There is inadequate sight distance of westbound movements caused by a steep, 16.6% grade due to a rail overpass further east. Also, long queues that build up on westbound Peace St encourage vehicles to try to increase their speed at yellow lights. However, the steep grade prevents vehicles from reaching the speed required resulting in westbound red-light runs.

The two “No Left Turn” signs at both westbound Peace St and northbound Glenwood Ave are not obeyed; a few illegal left turns were noticed, but none that caused immediate danger. These could be caused by unfamiliarity, lack of signage, or blatant disobedience. Bottom line: the signs do not command the level of respect required.

Erratic movements and near-collisions were sighted by the driveways to the Mellow Mushroom restaurant and Starbucks Coffee on eastbound Peace St, an area with a noticeable collision pattern on the Collision Diagram. Eastbound vehicles turning north onto Glenwood Ave enter this lane very early, nearly as far back as the previous intersection, and proceed through the shared median lane at faster than the recommended 35mph in order to catch a protected left-arrow phase. This is probably because of lengthy eastbound queues combined with a long and uninterrupted median turn lane.

Interviews with local businesses shared two common themes: concerns for driveway-related collisions in the median turn lane of eastbound Peace St, and truck collisions with the low clearance railroad overpass on westbound Peace St. No truck problems were personally observed.

The following studies were recommended for further data:

- **Driveway Related Collisions:** Conflict Study
- **Left-turn Head-on Collisions & Angle Collisions:** Conflict Study, Volume / Turning Movement Study

Studies

Conflict Study

A one hour Conflict Study was conducted on March 31, 2011 from 12pm-1pm. The results can be seen in Appendix D.

Conflicts were common on eastbound Peace St for eastbound business driveways and left turns onto Glenwood Ave. These two problems were ultimately chosen for countermeasure investigation due to the significant correlation between reported collisions and observed conflicts.

Volume / Turning Movement Study

A one hour Volume / Turning Movement Study was conducted on March 31, 2011 from 6pm to 7pm using TurnCount, an iOS application for iPhone. The results can be seen in Appendix E on a map or application print out. Buses were counted as trucks, no trucks were observed. Timestamped data is available upon request. AADT volume data seen on the Condition Diagram (Appendix B) was retrieved from NCDOT.

Recommended Cost Effective Countermeasures

Driveway-Related Collisions

The driveways on eastbound Peace St. that provide access to Starbucks and Mellow Mushroom contributed to a large number of reported collisions and a large number of conflicts seen during the conflict study. These collisions mostly involve left-turning vehicles and right turning vehicles entering the eastbound left turn lane.

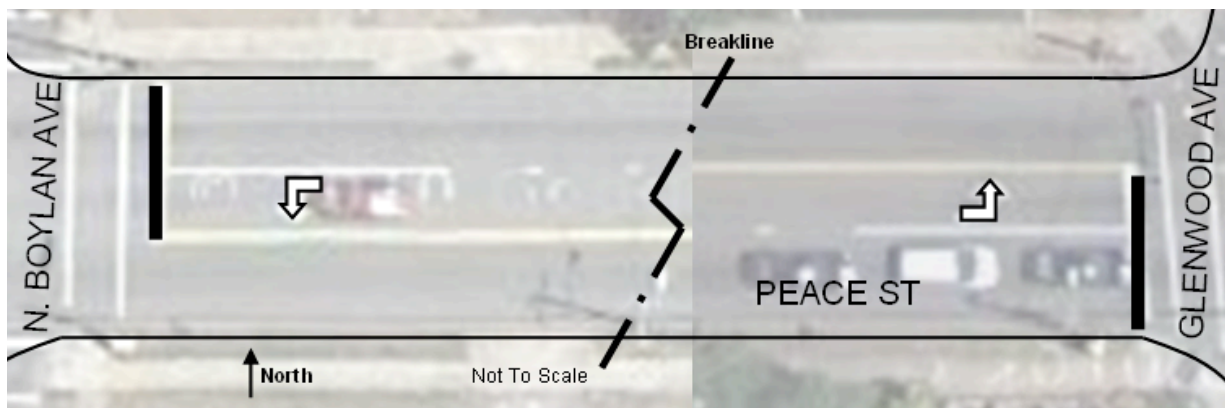


Figure 1: Existing Conditions

In the *Highway Safety Engineering Studies Procedural Guide* (1991), Parker recommends a median device installation to thwart collisions caused by left-turning vehicles. Upon observation of this site, I recommend this countermeasure for installation which can be seen in Figure 2. This will effectively provide a right-in-right-out solution, possibly to the chagrin of the Starbucks and Mellow Mushroom business owners and customers, but ultimately in the interests of driver safety.

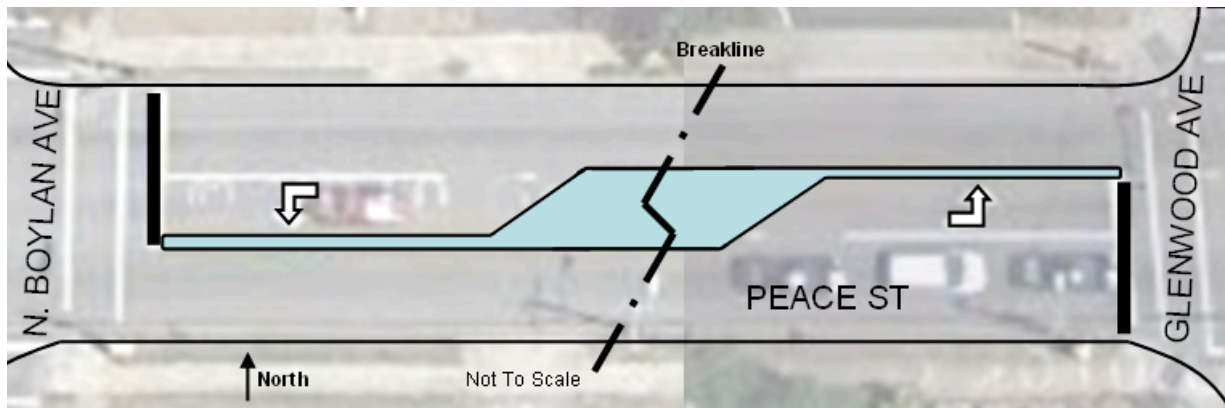


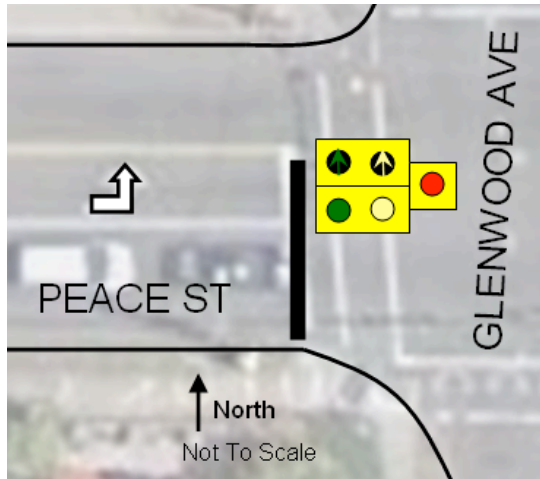
Figure 2: Recommendation: Median Device Installation

Left Turn Collisions

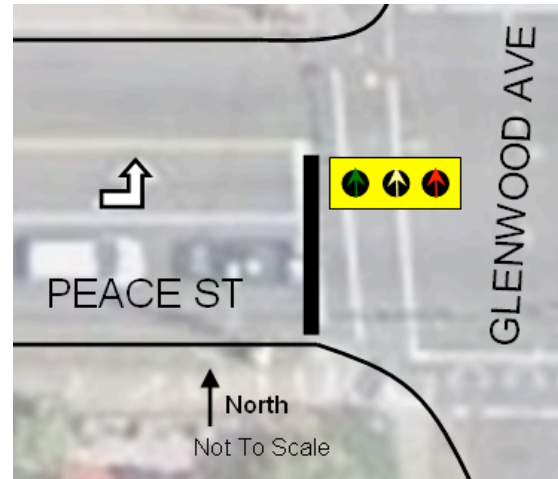
For solutions to eastbound left turn collisions, recommendations by Parker were not helpful. The Crash Modification Factors Clearinghouse on the web was used as a source for more studies and information.

A study titled *Accident Modification Factors for Traffic Engineering and ITS Improvements* by Harkey et. al. (2008) found that by changing the traffic control of left turns at urban intersections from protected-permitted to solely protected turns could reduce collisions by 99%, a crash modification of factor of .01. This study was rated five stars by the CMF Clearinghouse as highest and most reliable.

I am recommending this countermeasure for installation, see Figure 4. By only altering one signal at the interchange, this countermeasure is highly cost effective and provides a solution to risky left-turns caused by the limited sight distance of the oncoming traffic on westbound Peace St.



**Figure 3: Existing Conditions:
Protected/Permitted Left-turn Phasing**



**Figure 4: Recommendation: Protected-ONLY
Left-turn Phasing**

If installed in conjunction with the median device installation, one worry is that a lengthy queue may build in the eastbound Peace St left turn lane. Based upon the data collected in the Volume Study, this should not be a problem. Further analysis is recommended by conducting a Capacity Study, a study outside the scope of this analysis.

Further Analysis

Driveway-Related Collisions

The eastbound Peace St. driveways for Mellow Mushroom and Starbucks could benefit from consolidation, but the incurred construction costs as well as inconvenience to the businesses do not necessarily justify added costs solely for consolidation. A more cost-effective solution would be to allow one driveway to act as “right-in” and the other to act as “right-out”. ***This would effectively cut diverging and converging conflict points in half and possibly reduce conflicts and collisions.*** Added costs for this improvement would be minimal, but would reduce available parking spaces for the businesses. Further study may merit this countermeasure helpful.

Truck Clearance

While locals reported truck problems, there does not seem to be a lack of signage representing the hazard caused by the railroad overpass. Further investigation may find that a truck detour may be helpful.

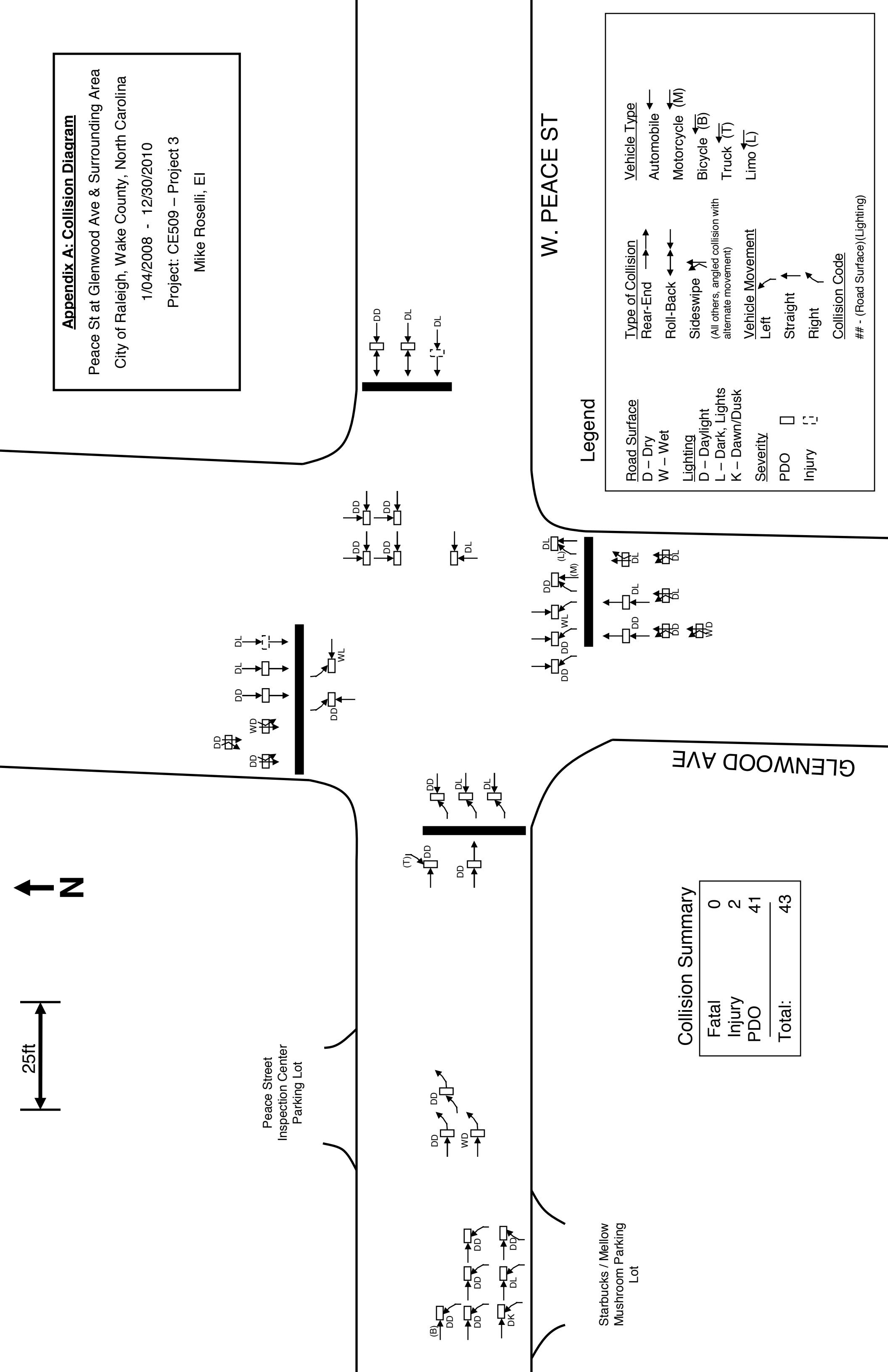
Illegal Left Turns

Illegal left turns were seen, but did not immediately cause observed conflicts in the conflict study. Further investigation may find better signage or police enforcement to be helpful.

References

1. Parker, M. Highway Safety Engineering Studies Procedural Guide, USDOT FHWA, 1991
2. Harkey, D., et al., Accident Modification Factors for Traffic Engineering and ITS Improvements, NCHRP Report 617, TRB, 2008

Appendix A: Collision Diagram

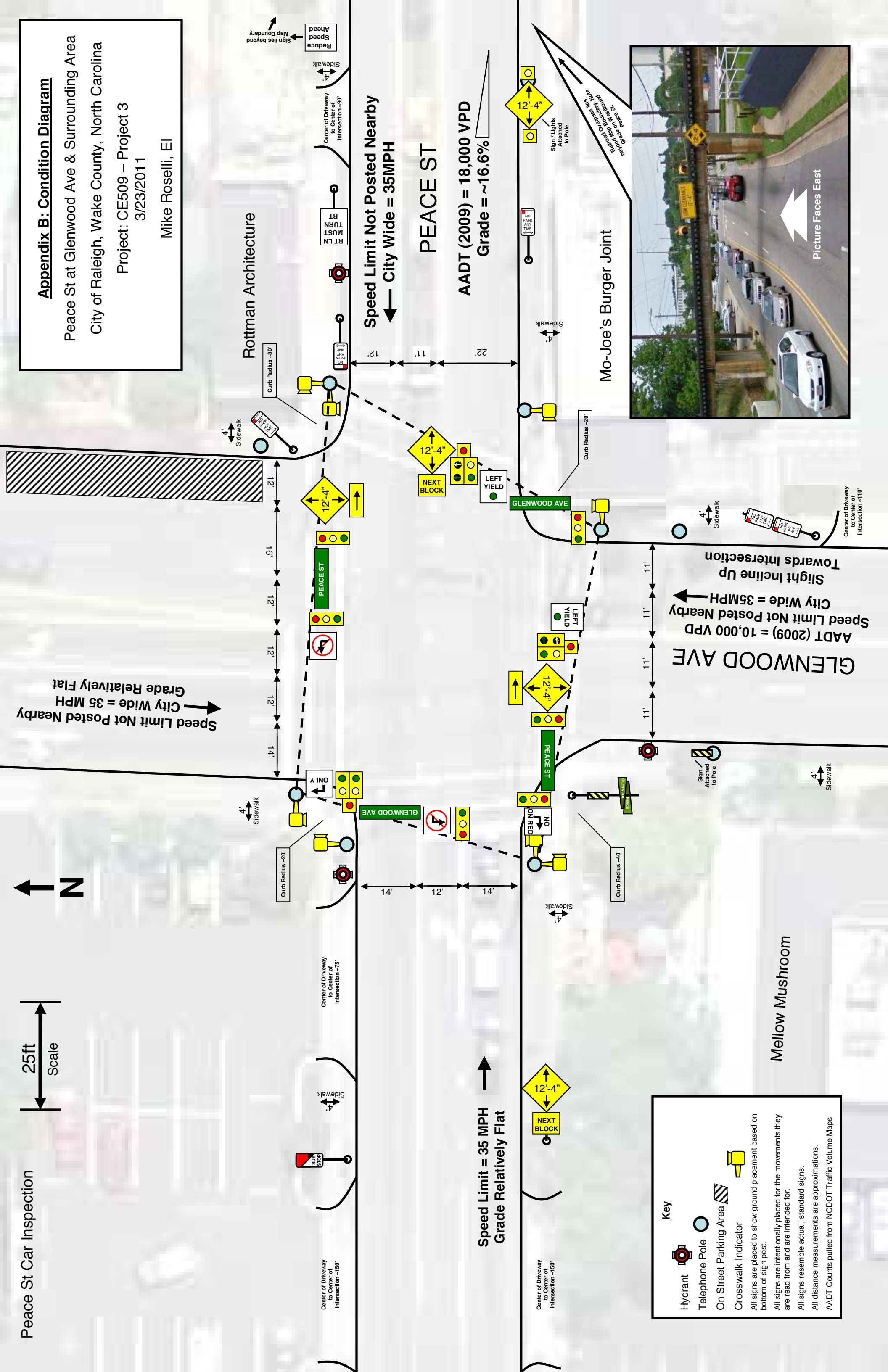


Appendix B: Condition Diagram

← Z

Peace St at Glenwood Ave & Surrounding Area
City of Raleigh, Wake County, North Carolina

Mike Roselli, El



Appendix C: Field Observation Report

FIELD OBSERVATION REPORT

Location FRONT OF STARBUCKS, GLENWOOD & PEACE ST

Date 3/23/2011
Time 12:12 PM

Observer MIKE ROSELLI

PART I - PHYSICAL CHECKLIST

	No	Yes	Comments
1. Are there sight distance obstructions to:			
a. Traffic control devices?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>RIGHT LANE BLOCKS LEFT E.B. PEACE</u>
b. Intersections and driveways?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>CANT SEE W.B. PEACE</u>
c. Turning or oncoming vehicles?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>ON COMING FROM E.B. PEACE LEFTS.</u>
2. Does parking affect:			
a. Sight distance?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
b. Through or turning vehicle paths?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
3. Is horizontal alignment inadequate?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
4. Is vertical alignment inadequate?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>PERHAPS W.B. PEACE</u>
5. Is pavement width or the number of lanes inadequate?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
6. Are intersection or driveway radii too short?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
7. Are there problems with driveways such as:			
a. Inadequate design?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>MAYBE</u>
b. Location near major intersection?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
c. Too many driveways?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
8. Is channelization inadequate for:			
a. Reducing conflict points?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
b. Separating traffic flows or defining movements?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
9. Should pedestrian crosswalks be:			
a. Added?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
b. Relocated or repainted?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
10. Are there problems with traffic signs such as:			
a. Inadequate or improper message?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>MAYBE</u>
b. Too many signs?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>NO LEFTS NOT OBEYED</u>
c. Placement or size?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
11. Are there problems with traffic signals such as:			
a. Timing?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>MAYBE ALL RED TOO SHORT</u>
b. Number of signal heads?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>TOO MANY SIGNAL HEADS?</u>
c. Placement or size?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
12. Are there problems with pavement markings such as:			
a. Vehicle paths not clearly marked?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>DONT KNOW?</u>
b. Location of the markings?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
13. Do posted speed limits appear to be too high or too low for conditions?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
14. Does the pavement condition (potholes, irregular surface, etc.) appear to contribute to safety problems?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
15. Is roadway lighting inadequate?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<u>DONT KNOW</u>
16. Are there tire skid marks on the pavement?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
17. Is there evidence of vehicle accidents such as scar marks on trees, utility poles, embankments, or other objects?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
18. Is there an abundance of vehicle accident debris such as small pieces of crushed glass, plastic, etc., along the shoulder or in the median area?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

Figure 7. Field review checklists.

FIELD OBSERVATION REPORT (CONTINUED)

PART II - OPERATIONAL CHECKLIST

	No	Yes	Comments
1. Do obstructions block the driver's view of opposing or conflicting vehicles?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	HILL WB PEACE
2. Do drivers have trouble finding the correct path through the location?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	WB PEACE STRAIGHT MOVEMENTS
3. Is there any indication of driver confusion about routes, street names, or other guidance information?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	SEE ABOVE
4. Do steep grades create large speed differences?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	SOMEWHAT, SEE ABOVE
5. Are pavement surface conditions creating erratic driver movements?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
6. Does the presence of existing driveways contribute to erratic driver movements?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	WELLOW PWSH.
7. Is excessive vehicle delay creating unsafe risk taking by motorists?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
8. Are there large speed differences between vehicles:			
a. Traveling through the location?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
b. Turning at driveways or intersections?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
9. Do drivers respond incorrectly to:			
a. Signals?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	LEFTS
b. Signs or other traffic control devices?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
c. Turning lanes?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
10. Are problems being caused by the volume of:			
a. Through traffic?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
b. Turning traffic?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
11. Do pedestrian movements create conflicts?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	NONE SEEN
12. Do bicycle movements create conflicts?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	11
13. Is there considerable weaving or lane changing by drivers at the location?	<input type="checkbox"/>	<input type="checkbox"/>	
14. Are there violations of parking at the location?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	NONE SEEN
15. Are there violations of other traffic control devices or regulations such as:			
a. Running red light?	<input type="checkbox"/>	<input type="checkbox"/>	
b. Failing to stop or yield the right-of-way?	<input type="checkbox"/>	<input type="checkbox"/>	
c. Speed limits?	<input type="checkbox"/>	<input type="checkbox"/>	
d. Right-turn-on-red?	<input type="checkbox"/>	<input type="checkbox"/>	
e. Other?	<input type="checkbox"/>	<input type="checkbox"/>	SPEEDING UP HILL ON WELLOWS
16. Are there traffic flow problems or traffic conflict patterns associated with turning vehicles?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
17. Are there any other unusual traffic flow problems or traffic conflict patterns?	<input type="checkbox"/>	<input type="checkbox"/>	
18. Does inadequate lighting cause drivers to slow down or create erratic maneuvers?	<input type="checkbox"/>	<input type="checkbox"/>	DONT KNOW

Figure 7. Field review checklists (Continued).

FIELD OBSERVATION REPORT (CONTINUED)

PART III - SKETCH OF LOCATION

Instructions: In the space below, draw a free hand sketch of the location and identify areas with considerable vehicle accident debris and mark the paths of any obvious high-risk movements.

SEE CONDITION DIAGRAM.

Figure 7. Field review checklists (Continued).

Appendix D: Conflict Study Diagram

25ft



Appendix D: Conflict Study Diagram
& General Observations

Peace St at Glenwood Ave & Surrounding Area
City of Raleigh, Wake County, North Carolina
Conducted 3/31/2011, 12:00pm-1-pm
Project: CE509 – Project 3
Mike Roselli, EI

Observed: Vehicle could not see oncoming traffic, ran “yellow trap”. Conflict was near collision!

Observed: 3 Vehicles running intersection after the end of the yellow-arrow phase, in danger of oncoming traffic.

Observed: 2 Vehicles enter turn lane as far back as previous intersection, violate speed to get to the green arrow.

Observed: 2 Yellow-Light Speed-ups that became Red-light runs.

Observed: 3 Illegal Lefts



Observation Point

APPROACH



W. PEACE ST

GLENWOOD AVE

Legend

Conflicts

Denoted by: □

Vehicle Movement

Left

Straight

Right

Appendix E: Volume / Turn Movement Study

Turn count summary (15 minute bins)

Reference - Glenwood at Peace: 2011-03-31

Day of week: Thursday

Raleigh, NC, USA,

Analyst: Mike Roselli, Company Name: NC State University, Email Address: marosell@ncsu.edu

Total vehicle traffic

Interval starts	Southbound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
21:59	0	0	0	0	0	0	0	0	0	0	0	0	0
22:00	60	106	27	1	118	52	1	65	17	18	170	18	653
22:15	75	109	25	0	120	64	1	50	9	14	134	18	619
22:30	60	96	19	0	103	41	1	69	8	21	115	15	548
22:45	60	107	24	0	86	33	0	48	15	20	109	18	520
23:00	2	3	0	0	10	1	0	3	0	1	12	0	32

Truck traffic

[illegible]

Pedestrian volumes

[illegible]



ALL APPROACHES

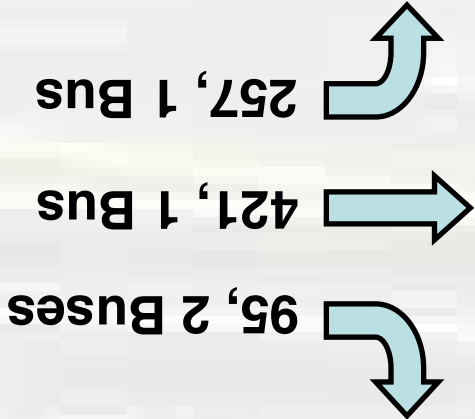


**Appendix E: Traffic Volume /
Turn Movement Study**

Peace St at Glenwood Ave & Surrounding Area
City of Raleigh, Wake County, North Carolina
Conducted 3/31/2011, 6:00pm-7:00pm

Project: CE509 – Project 3
Mike Roselli, EI

- First vehicle count INCLUDES the buses. No Trucks were observed from 6:00pm to 7:00pm.
- See attached Turn Count Summary. Time-stamped .csv available upon request.



2



2



74



528, 4 Buses



69

Total Entering Vehicles:
2372



191



437, 2 Buses



1



2



3



3



8



235, 2 Buses



3



69

W. PEACE ST

GLENWOOD AVE