

Asheville Road Safety Audit 2 Report Patton Avenue



October 28-29, 2015

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Introduction

Background

The City of Asheville lies in the Blue Ridge Mountains and is the largest city in western North Carolina. The city has a population of 83,393 with 424,858 people in the four-county metropolitan area according to the 2010 census. It is a popular tourist destination because of the many attractions in and around the city limits, including the Biltmore Estate, The Blue Ridge Parkway, numerous hiking trails, and many acclaimed restaurants and breweries.

The objective of this effort is to identify potential strategies to improve the pedestrian environment in Asheville, NC. The initial task included conducting a review of pedestrian and bicycle crashes in the City of Asheville to identify contributing factors, trends, and patterns from the ten most recent years of available crash data. Based on this review of crash data along with additional input from a Steering Committee comprised of NCDOT and City representatives, thirteen locations were selected as candidate locations for more detailed study. The Steering Committee further refined the list down to three specific corridors identified for a pedestrian and bicycle-focused road safety audit (RSA) by an independent, multi-disciplinary RSA team. This report summarizes the findings of the second RSA conducted, which included a safety review of US 19 (Patton Avenue), from NC 63 (New Leicester Highway) to Regent Park Boulevard.

The purpose of this Road Safety Audit (RSA) is to improve pedestrian and bicyclist safety along this segment of Patton Avenue, and identify issues and potential countermeasures that could be applied to similar facilities in the city.

RSA Site Location

In light of the frequency of severe pedestrian and bicyclist crashes, Patton Avenue was selected as the focus of this effort. As shown in Figure 1 and Figure 2, the segment between New Leicester Highway and Regent Park Boulevard was examined as part of this RSA.



Figure 1. Location of RSA 2.

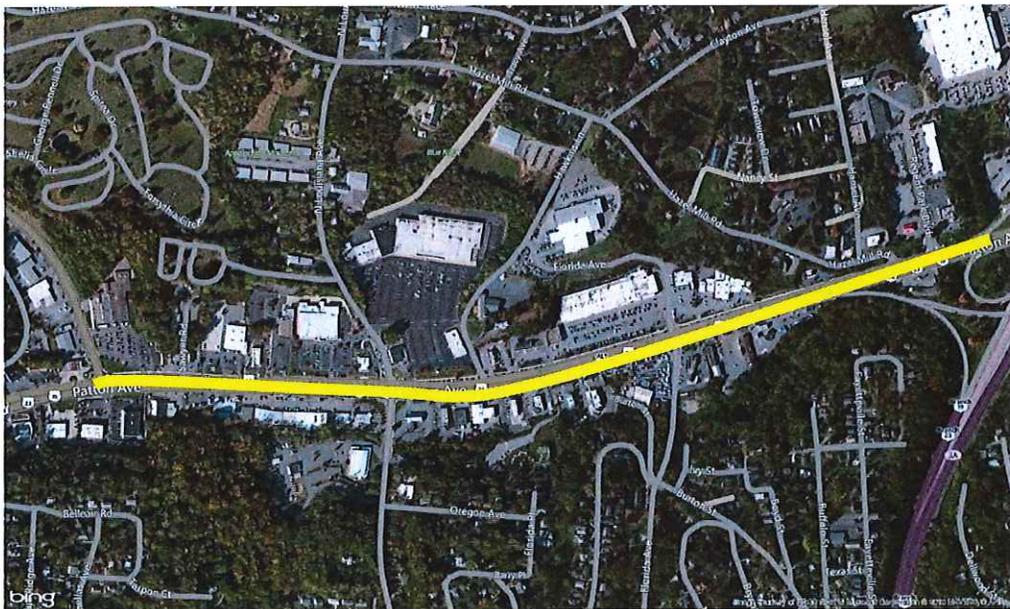


Figure 2. Map of the RSA corridor.

Geometric and Traffic Conditions

Patton Avenue (US 19), between Regent Park Boulevard and New Leicester Highway, is a six-lane divided roadway. This segment is 5,000 ft long and has a posted speed limit of 45 mph. The 2014 annual average daily traffic (AADT) in the eastern section of the corridor, between Regent Park Boulevard and N. Louisiana Avenue, is 47,000 vehicles per day. In the western section, between N. Louisiana Avenue and New Leicester Highway, the AADT is 44,000 vehicles per day.

This section of Patton Avenue is vital to moving vehicles from outside of Asheville (primarily from New Leicester Highway) into the city. This produces a large amount of commuter traffic in the AM and PM peak hours.

There are also many businesses along the corridor, including restaurants, automotive services, strip malls, gas stations, and supermarkets. Because of the high density of businesses along Patton Avenue, the corridor is filled with driveways to provide access to these businesses. Behind all of the commercial development lies residential areas, which makes Patton Avenue a desirable destination for vehicles and pedestrians with the available amenities (e.g., restaurants, shops, banks) along the corridor. There are four signalized intersections along the corridor, which are located at (1) New Leicester Highway, (2) N. Louisiana Avenue, (3) Florida Avenue, and (4) Regent Park Boulevard.

Crash History

The vehicle crash analysis period for this RSA spanned five years, from September 1, 2010 to August 31, 2015. The pedestrian and bicyclist crash analysis period for this RSA spanned 10 years, from 2005 to 2014. Crash data were provided by NCDOT's Traffic Safety Systems Section. The North Carolina Crash Report Form (DMV-349) utilizes the following crash severities:

- Killed.
- A type injury (disabling).
- B type injury (evident).
- C type injury (possible).
- Property damage only.
- Unknown.

Pedestrian and Bicyclist Crash History

In the past 10 years (2005–2014), 32 pedestrian crashes and 5 bicycle crashes have occurred on Patton Avenue and the surrounding area. One fatality has occurred, along with four A-injuries, fourteen B-injuries, sixteen C-injuries, and two property damage only crashes. Fourteen of the crashes (38 percent) occurred while it was dark, and eight crashes (22 percent) occurred when the road was wet. The fatality in 2012 occurred at nighttime.

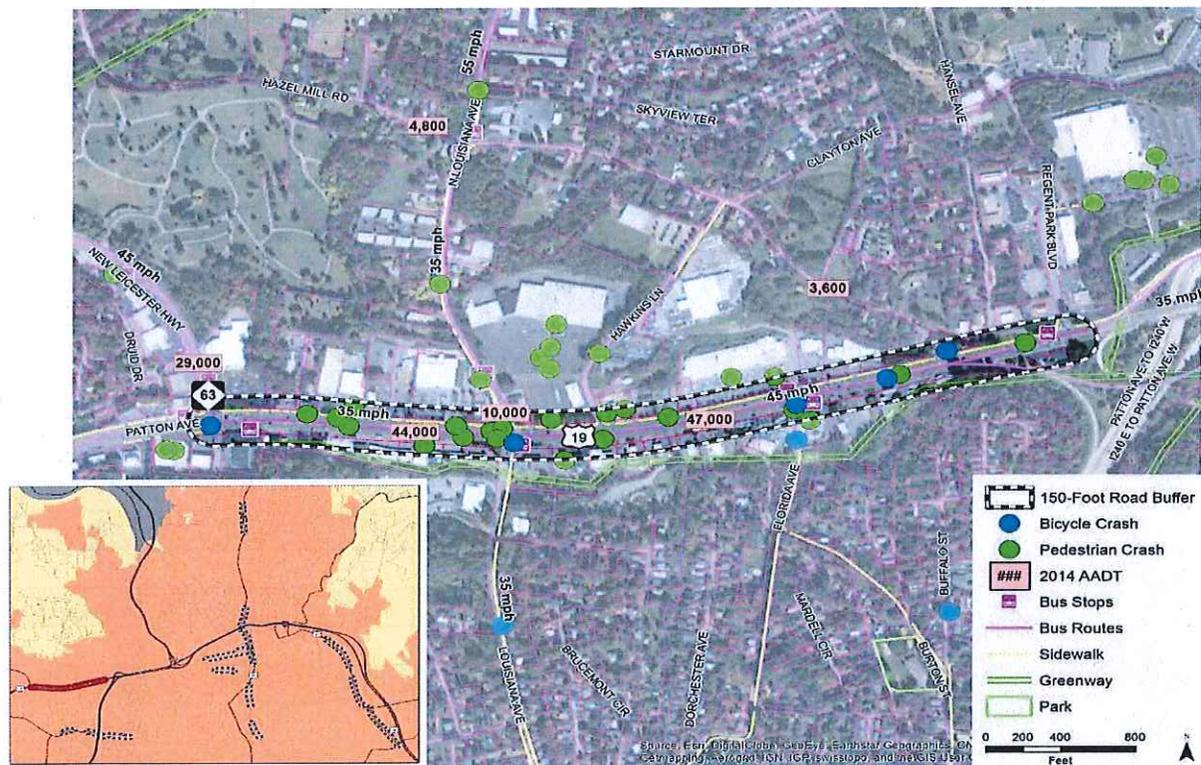


Figure 3. Location of pedestrian and bicyclist crashes along Patton Avenue.

Additional details relating to these crashes are contained in the RSA Team packet provided in the Appendix.

Vehicle Crash Summary

During the five-year analysis period (9/1/10 to 8/31/15), there were 749 crashes within the study area of Patton Avenue (MP 10.72 - 11.62). Crash data reveal that rear end crashes are the most common crash type at 66 percent of the total crashes, followed by angle crashes at 13 percent, and sideswipe (same direction) at 11 percent. Table 1 shows the severity and crash type of all collisions in the five-year study period. Rear end and angle crashes account for 80 percent of the total number of crashes.

Table 1. Patton Avenue Crash Summary (Sept. 2010 – Aug. 2015).

Highest Injury Severity	Crash Type	No. of Crashes	Percent of Total
Highest Injury Severity	Killed	2	0.3
	Class A (Disabling injury)	1	0.1
	Class B (Evident injury)	37	4.9
	Class C (Possible injury)	285	38.1
	PDO	424	56.6
	TOTAL	749	100.0
Crash Type			
Crash Type	Rear end, slow or stop	498	66.5
	Angle	101	13.5
	Sideswipe, same direction	80	10.7
	Right turn, same roadway	12	1.6
	Pedestrian	8	1.1
	Right turn, different roadways	8	1.1
	Other non-collision	6	0.8
	Ran off road – right	6	0.8
	Backing up	5	0.7
	Left turn. Same roadway	5	0.7
	Other collision with vehicle	5	0.7
	Left turn, different roadways	3	0.4
	Ran off road - left	3	0.4
	Fixed object	2	0.3
	Sideswipe, opposite direction	2	0.3
	Head on	1	0.1
	Overturn/Rollover	1	0.1
	Pedalcyclist	1	0.1
	Read end, turn	1	0.1
	Unknown	1	0.1
TOTAL	749	100.0	

Figure 4 depicts the distribution of crashes along the study area by 1/100th of a mile (52.8 ft) beginning at mile post 10.72 (just west of New Leicester Highway) and ending at mile post 11.62 (just east of Regent Park Boulevard). The key intersections are labeled in Figure 4, which shows that 438 crashes (58 percent) occurred within the functional area (0.03 mile or 158 ft.) of the four signalized intersections (New Leicester, Louisiana, Florida, and Regent Park); however, collisions occurred between the signalized intersections as well.

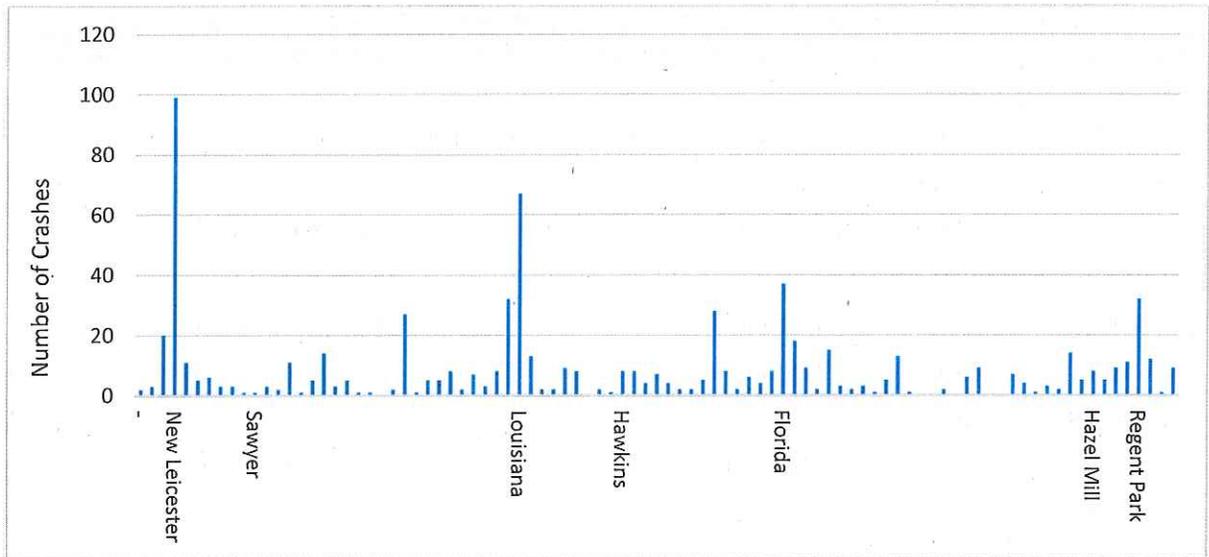


Figure 4. Histogram of 5-year vehicular crashes along Patton Avenue (2010-2015).

RSA Team

The success of a comprehensive RSA hinges on the strength of the team. The members of the RSA team were chosen to represent the wide array of transportation professionals. Each person offers a unique perspective based on their line of work and experience. Table 2 includes the names and contact information of the RSA team members.

Table 2. RSA team members and stakeholders.

Name	Organization	Email Address
NCDOT Division Staff		
Monty Ward	NCDOT Division 14 Assistant Division Traffic Engineer	dmward@ncdot.gov
NCDOT Regional Staff		
Pate Butler	NCDOT Metrolina Regional Traffic Engineer	mpbutler@ncdot.gov
NCDOT Signals Staff		
Zach Little	NCDOT – Signal Design Section	zmlittle@ncdot.gov
Tim Williams	NCDOT – Signal Design Section	tjwilliams@ncdot.gov
NCDOT Safety Staff		
Susie James	NCDOT – Traffic Safety Unit	sjjames@ncdot.gov
City Staff		
Mark Young	City of Morganton City Engineer	myoung@ci.morganton.nc.us
Asheville Police Department		
Scott Fry	Asheville Police Department	sfry@ashevillenc.gov
VHB		
Andrew Topp	VHB Senior Project Manager	atopp@vhb.com
Frank Gross	VHB Highway Safety Engineer	fgross@vhb.com
Matt Albee	VHB Transportation Analyst	malbee@vhb.com

Assessment Findings

The team conducted the RSA on Wednesday, October 28, 2015 and Thursday, October 29, 2015. The team visited the corridor on three different occasions to observe the PM peak, nighttime operations, and the AM peak. The RSA team noted both positive features and potential safety concerns found throughout the study locations; both are detailed in the following sections.

Positive Existing Features

Based on its review of existing site conditions, the RSA team identified the following positive characteristics of the roadway:

- The **raised median** prevents left turns in and out of driveways.
- The **signal timing** appears to be efficient and clears most queues (particularly on Patton Avenue).
- The presence and spacing of the **roadway lighting** on both sides of the road enhances nighttime visibility.
- **Sidewalks are well lit** along most of the corridor.
- The **bus stops were well lit**. Since buses generate pedestrian activity, a well-lit bus stop is important to improve pedestrian visibility.
- The presence of **wide sidewalks** on the north side of Patton Avenue (new within five years) provide a separate facility for pedestrians and enhance pedestrian safety. While it is not an ideal situation, cyclists are also using the sidewalks to avoid riding in the road.
- The **prevailing speeds** during the day are at or below the posted speed limit.
- The **pedestrian countdown signal** and **pushbuttons** on N. Louisiana Avenue.
 - The pushbuttons have a latching mode and an audible push button
 - Locator tones and rapid tick is more desirable rather than audible "walk"
 - Maintenance is much easier for locator tones and rapid tick



Identified Safety Issues and Suggestions for Improvement

Upon completing the data analyses and field observations, the RSA team identified a number of overarching issues and related suggestions that are summarized in Table 3. For each issue identified, the team proposed corresponding countermeasures to address the issue, which are also included in Table 3. The issues are organized at the corridor-level, then by each intersection. The RSA team found that the intersection of New Leicester Highway had the most issues, which are further grouped by category. The suggestions have been categorized as near-term, intermediate, and long-term. Near-term improvements can typically be implemented through maintenance forces, while intermediate and long-term improvements often require additional planning, design, and funding.

Table 3. Noted overarching safety issues and suggestions for improvement.

1. Corridor-wide	
Issue Description	Suggested Action
<ul style="list-style-type: none"> Multiple parcels have several driveways in close proximity, which may be consolidated Pedestrians crossing midblock  <ul style="list-style-type: none"> Lack of sidewalks and connectivity on the south side of Patton Tow truck rotation (rotation-based response instead of proximity-based). This results in long delays, particularly during rush hour East end of corridor is relatively dark (from Acton Chiropractic to Regent Park Boulevard). There are unlit bulbs and trees obstructing lights. The unlit lights are as follows: <ul style="list-style-type: none"> - Double-sided light in median - Two other unlit bulbs (one on each side of Patton near Regent Park) Lighting in parking lots is dark in spots where pedestrians are walking on south side of Patton Shelters are not provided at all bus stop locations 	<p>Near Term</p> <ul style="list-style-type: none"> Pass information along to City and District to identify driveways for relocation, closing, or consolidation (support their review of upcoming driveway permits and redevelopment plans) Opportunity to revise tow truck rotation practice to call nearest available unit Replace unit bulbs Reorient curb ramps as opportunities arise for sidewalk improvements Trim trees to improve visibility of signs and clearance for pedestrians  <p>Intermediate</p> <ul style="list-style-type: none"> Consider installing positive barrier to discourage midblock pedestrian crossings. The impacts for emergency response should be considered for this countermeasure Install sidewalks on the south side of Patton

- Curb ramps direct pedestrians into the center of the intersection rather than along the sidewalk/crosswalk



- Trees obstruct signing and hang low creating obstruction for pedestrians
- Sidewalks stop at most driveways rather than continuing sidewalks across driveways, which sends a message of priority to the driver rather than the pedestrian



- Opportunities to partner among DOT, City, and property owners
 - DOT installs crosswalks and pedestrian signals at signalized intersections
 - City installs sidewalks on south side of Patton (conditional on driveway consolidation)
 - Property owners agree to narrow and consolidate/eliminate driveways
 - There may be examples of previously closed driveways along the south side with redevelopment (old curb cuts with no driveways)
 - If sidewalks are installed, conduct a sign review for height of signs (with respect to pedestrians)
- Consider adding bus shelters where none currently exist

Long Term

- Enhance sidewalk network as redevelopment occurs (i.e., sidewalks should continue across driveways rather than driveways continuing across sidewalks)

2. Intersection of New Leicester Highway	
Issue Description	Suggested Action
<ul style="list-style-type: none"> • Lack of access management <ul style="list-style-type: none"> - Driveways near intersection with left-turns across conflicting traffic <ul style="list-style-type: none"> ▪ Katie Check Cashing ▪ Ingles (on New Leicester) 	<p>Near Term</p> <ul style="list-style-type: none"> • If Katie Check Cashing is closed, there is an opportunity to adjust driveway permit during new ownership • Consider installing a monolithic raised median or tubular delineators along New Leicester to prohibit left-turns in and out of Ingles near the signalized intersection <p>Intermediate/Long Term</p> <ul style="list-style-type: none"> • Consider relocating, consolidating, and closing driveways along the north side of



- Several driveways on north side create conflicts with pedestrians, and those within the westbound dual-right turn lane create a weaving movement to enter westbound through lane or U-turn at Leicester.
- Access to Little Caesar's is steep, which is an ADA issue



The steep grade in front of Little Caesar's.

- Congestion on southbound approach
 - Dual left-turns have significant queueing
 - Utilization of left-turn lanes are inefficient (queue spreads)
 - Drivers use southbound two-way left-turn lane (TWLTL) to bypass queue
 - Drivers wait through multiple cycles during morning peak and other periods

Patton with priority to closing those within the functional area of the intersection

- Redesign Little Caesar's driveway for ADA compliant cross-slope

Near Term

- Consider using outside lane as a shared thru/right/left to facilitate dual or triple left turn
- Continue ongoing enforcement of driver's use of the TWLTL on New Leicester to bypass queue

Intermediate

- Consider restriping TWLTL on New Leicester as a left-turn lane back to Druid Drive or just south of that, which will combat inefficient southbound left-turn lane utilization (queue spread)



Vehicles queuing to turn left from Leicester onto Patton Avenue

- Increase capacity with triple left on southbound approach and dual left on eastbound approach
- Increase capacity with triple left on southbound approach and dual left on eastbound approach
 - Could take a westbound receiving lane to add space for an eastbound dual left (minimize ROW costs)
 - Another option is to reduce lane and median widths to find space for eastbound dual lefts

- Pedestrian Facilities
 - Lack of crosswalks and pedestrian signals
 - While there are plans for future crossings on 3 approaches, the RSA team noted the following concerns:
 - North crosswalk is conflicting with dual right-turn movement. Specific concerns include the high-speed turning movement and observed red-light-running
 - Lack of planned crossing on east leg
Limited access to bus stop on southeast corner
 - Lack of sidewalk along New Leicester



lack of crosswalks and pedestrian signals despite the curb ramp and truncated domes

Intermediate

- Install sidewalk on New Leicester to Ingles
- Install crosswalks and pedestrian signals pending installation of sidewalk around intersection
- Consider use of blank-out signs and red right-turn arrow on the westbound approach, along with placement of crosswalk on north approach, to ensure visibility of pedestrians and mitigate concerns with the conflicting right-turn movement
- Eliminate eastbound receiving lane to install pedestrian refuge and allow multi-stage crossing on the east leg
 - Any improvement should maintain corridor signal coordination and not exacerbate queue/congestion on the southbound approach

Long Term

- Install sidewalk on New Leicester that leads to Ingles

- Bus Stop
 - No access to bus stop on the south side from the north side of Patton Avenue
 - No shelter on the south side and north side

Intermediate

- Install bus shelter on the south side of Patton
- Install crosswalk from north side of Patton to south side. Also install a sidewalk along south side of Patton Avenue to access bus stop and other properties



Pedestrians waiting at the bus stop on south side of Patton.

- Signing and Marking
 - Right-turn trap lane on Patton Avenue (east of New Leicester)
 - Shared right-through lane upstream
 - Lack of signing to indicate transition from through to right-turn only
 - Two through lanes westbound and three receiving lanes (poor lane alignment)
 - Tree obstructs signing for US 19, NC 63, etc. on northeast corner

- Behavior
 - Red light running and rolling stops for westbound right-turn movement
 - Eastbound left turns were sneaking through on yellow and early red interval
 - Pedestrians crossing and standing in the median



Pedestrian waiting next to the median while crossing Patton despite the lack of pedestrian facilities

Near Term

- Install advance signing [Right Turn Must Turn Right] to indicate transition from through to right-turn only lane
- Trim vegetation to improve visibility of signs

Intermediate/Long Term

- Opportunity to use extra space (i.e., concrete median and extra receiving lane) on west leg of the intersection for dual lefts in the eastbound direction

Near Term

- Consider installing mini skip marks instead of solid white lines to delineate westbound dual right turn movement and discourage free-flow behavior during the red phase
- Enforce westbound right-turn red light runners
- Enforce eastbound left-turn red light runners

Intermediate

- Consider flashing right-turn arrows to designate permitted phase, and solid red right-turn arrows to allow a protected pedestrian movement if a future crosswalk is installed on the north leg
- Consider crosswalk locations and facilitate crossings on all approaches. See earlier discussion in the Crossings section for more details

3. Intersection of N. Louisiana Avenue

Issue Description

- No crosswalks or pedestrian signals on the west side. Note that the eastbound bus stop is on east side and has access to existing crosswalk.
 - Westbound bus stop is located on west side of the intersection (where crosswalk is missing)
 - Pedestrians observed crossing Patton Avenue on west side (without crosswalk)



- Pedestrian pushbutton pedestal is loose on NE corner (farthest north)
- Bus shelter on north side is obstructing guide signs
- Southbound bus on Louisiana made left turn and immediately stopped on Patton (southeast side)
 - Creates potential to trap vehicles (following bus) in the intersection
- Missing skip marks for southbound dual left turns
- No sidewalks along northeast side of Louisiana
 - No sidewalks through parking lot to K-Mart
 - 5 pedestrians crashes occurred in K-Mart parking lot in 10-year study period
- Hill in front of K-Mart is washing out and nearby driveway has washout

Suggested Action

Near Term

- Install skip marks for southbound dual lefts
- Relocate signs that are obstructed by bus shelter

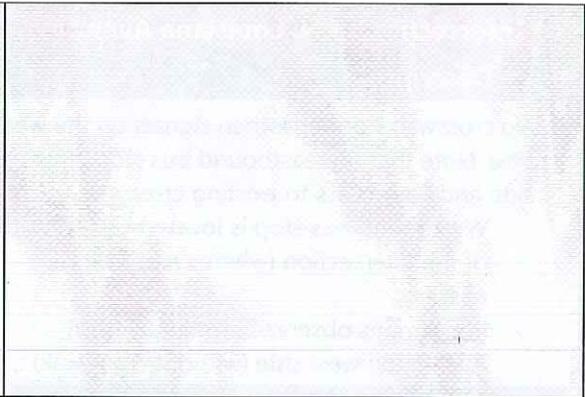
Intermediate

- Consider installation of crosswalk and pedestrian signal on the west approach
- Consider eliminating right-turn lane (or narrowing all lanes) on Louisiana to gain room for sidewalk. Note that it will be difficult to install sidewalk from Patton Avenue to K-Mart due to grade and existing buildings with limited offset to road
- Consider taking a lane of parking stalls in parking lot to install wide (or designated pedestrian area) sidewalk through the parking lot to K-Mart
- Consider moving bus stop on southeast corner further east to eliminate the potential to trap vehicles in the intersection that are following the bus
- Consider installing retaining walk and filling in hole in front of K-Mart
- Reconstruct sidewalk and drainage on the northwest corner





- Northwest corner of Louisiana, the drainage along Patton Avenue cuts into sidewalk



4. Intersection of Hawkins Lane

Issue Description

- Lack of wrong way or one-way signs to indicate presence of median
- Queue from Louisiana extends to Hawkins
- Sidewalk in front of Taco Bell narrows to 3 ft
- Curb ramps are angled into intersection, see corridor level for details



Lack of wrong way/one-way signs

- Multiple driveways per property in close proximity to intersection
 - Three driveways for Taco Bell (two on Patton Avenue, one shared with Bank of America)
 - Bank of America driveway has two driveways on Patton Avenue

Suggested Action

Near Term

- Install wrong way or one-way signage

Intermediate

- Widen sidewalk to be consistent with remainder of corridor

Long Term

- Potential for elimination or consolidation of Taco Bell driveways
- Potential to close western Bank of America driveway, which would add parking spaces
- Another option is to separate the Bank of America driveways

- The large width of the shared driveway of Taco Bell and Bank of America allows vehicles to enter at a high speed and the absence of pavement markings allows for inappropriate vehicle positioning when entering or exiting



The shared driveway of Taco Bell and Bank of America

5. Intersection of Florida Avenue

Issue Description

- No crosswalks or pedestrian signals; note that pedestrian and bicyclist activity is apparent and there is a residential area south of the corridor
- Short section of sidewalk on southeast corner lacks connectivity with the sidewalk network
- Rear end crash occurred during observations
- Vegetation obstructs sidewalk on Florida on the southeast corner



- Tree branches hanging over sidewalk on north side of Patton Avenue, see corridor level for details

Suggested Action

Intermediate

- Install crosswalks and pedestrian signals (all approaches if feasible; otherwise on north, south, and west legs in the intermediate without moving stop bar and median island)
- Trim branches hanging over sidewalk

Long Term

- Consider extending sidewalk on Florida back to residential neighborhood
- Consolidate three drives on northeast corner to one or none and use access at signal for Florida
- Consolidate three driveways at Shell (southeast corner)



- Multiple driveways on the northeast and southeast corner, see corridor level for more details

6. Intersection of Hazel Mill Road

Issue Description

- The driveway at Acton Chiropractor is wide and parking space is marked in the driveway. The business also has two driveways
- Hazel Mill is a wide intersection (officer reported crashes resulting from dual right turn movement (unofficial use of wide side road)
- Debris in road formed shape of pork chop island



Debris in the roadway and the faded "Do Not Enter" sign

- Large wheel rut on Hazel Mill where debris was washed from
- Inappropriate "Do Not Enter" sign, which was also faded

Suggested Action

Near Term

- Clear rocks
- Fill in wheel rut
- Opportunity to install pork chop island to narrow opening
- Install right-turn only sign in pork chop or pavement marking
- Consider paving inside of curve to facilitate off-tracking
- Remove unnecessary sign and possibly replace with Wrong Way and/or One-Way signs
- Reorient curb ramps, see corridor level for more details
- Replace worm truncated domes at curb ramps
- Trim vegetation, see corridor level for more details

- Lack of one-way signs and wrong way signs
- Truncated domes are in poor condition (formed in concrete and worn down)



- Obstructed wayfinding sign (by the tree) and offset far from travel way
- 25 rear end crashes on Patton near Hazel Mill



- Consider extending pork chop island or other channelization to prevent drivers from making high-speed turn movements

Intermediate

- Narrow west driveway of Acton Chiropractor to define/extend parking (work with business)
- Consider installing short right-turn lane on Patton Avenue (westbound) to get turning vehicles out of through lane. The RSA team noted that this may facilitate higher speeds entering Hazel Mill due to alignment. See the near-term suggestions for an opportunity to mitigate this concern (i.e., extending pork chop island/channelization)

7. Intersection of Regent Park Boulevard

Issue Description

- No crosswalks or pedestrian signals



- Positive: pedestrian refuge islands
 - Issue with height of refuge islands and number of traffic paths pedestrians must cross
- Wide crossing (120 ft or more from curb to curb)
- STOP bar is placed beyond refuge islands
 - Drivers block pedestrians

Suggested Action

Near Term

- Install truncated domes within refuge islands
- Move stop bar back
- Replace grate covers with ADA-compliant grates
- Fix yield sign and add saw tooth pavement markings for yield control

Intermediate

- Install crosswalk for pedestrians crossing Regent Park
- Consider eliminating westbound right-turn slip lane from Patton Avenue to Regent Park
- Consider narrowing the width of Regent Park approach, eliminating the southbound right-turn slip lane or bringing the

- Left turn drivers block right turn visibility



- Drainage grates have wide spacing of crossbars the run parallel to the travel lane, which are not ADA compliant and present an issue for bicyclists
- Yield sign at southbound approach is bent away from drivers' view
- Short, discontinuous segment of sidewalk along Regent Park

southbound right-turn movement under signal control and adding right turn arrow to coincide with the protected lefts from eastbound Patton Avenue

- Keeping the wide approach may be necessary to accommodate truck movements and if it remains, consider installing more formal pedestrian refuge islands on north leg
- Extend sidewalk along Regent Park to access businesses

8. From I-240

Issue Description

- Mopeds on interstate
- Pedestrians crossing interstate

Suggested Action

Near Term

- The current law states that mopeds are not allowed on the interstate
- If tickets won't hold up in court, then consider a minimum posted speed limit sign (40 mph) to help with enforcement

Patton Avenue and New Leicester Highway Capacity Analysis

A peak period turning movement count was conducted on January 14, 2016 at the Patton Avenue at New Leicester Highway intersection for the purpose of conducting a capacity analysis of three alternatives that could potentially improve intersection operations. The alternatives are as follows:

- A. Southbound triple left-turn lane
 - a. Build one additional left-turn lane or allow a shared left/through/right-turn lane
- B. Eastbound dual left-turn lane
 - a. Build one additional left-turn lane
- C. Westbound triple right-turn lane
 - a. Build one additional right-turn lane

An analysis was performed to determine the Level of Service and delay of these alternatives. The results are presented in Table 4 and Table 5. Any of these improvements can be constructed in tandem for even better operations. The RSA team discussed eliminating the northbound approach and its phase to improve operations; however, the team agreed it would not be feasible.

Based on the results of this analysis, the addition of a third southbound left-turn lane and second eastbound left-turn lane appear to have the most benefit to operations and congestion-related collisions. The addition of a third southbound left-turn lane (Alternative A) drops the overall intersection delay by 13-14 seconds in each peak. The benefit to queuing is substantial in the AM peak where left-turn volumes exceed 1,300 vehicles per hour. The Synchro 95th percentile queue is cut in half from approximately 1,000 feet to 500 feet. The second eastbound left-turn results in a substantial intersection delay reduction in the PM peak, as the overall intersection delay drops by 19.3 seconds, improving intersections operations into the LOS D range. The Synchro queue distances for the eastbound left-turn are cut in half with this improvement. Also, the reallocation of green time from the eastbound left-turn phase to other phases results in delay reductions for other approaches as well. Both of these improvements appear to be feasible given the right-of-way and constructability constraints. For both improvements, the additional receiving lane already exists, so any widening would be on the main approach itself.

The third improvement tested, an additional westbound right-turn lane, does not improve AM operations as the existing lanes have plenty of capacity for the current volume. The third westbound right-turn does, however, benefit overall operations in the PM, dropping overall intersection delay by 2 seconds. Since only two receiving lanes exist along New Leicester

Highway, additional widening will be required along that approach as well. The eastbound left-turn and southbound left-turn lane are recommended due to the substantial operational benefit these lanes provide. Both of these improvements should result in better queue accommodation, which help minimize rear end collisions between through and left-turning vehicles along the same roadway. The third westbound right-turn lane improvement provides only marginal operational benefit, but could be incorporated into the design improvement plans, if sufficient funding exists.

Table 4. Level of Service and Delay of Alternatives at Patton and New Leicester.

Intersection and Approach	Existing		Alternative A		Alternative B		Alternative C	
	AM	PM	AM	PM	AM	PM	AM	PM
Patton Ave at New Leicester Hwy	D (43.4)	E (71.1)	C (29.5)	E (58.1)	D (39.0)	D (51.8)	D (43.4)	E (69.1)
Eastbound	D-54.2	E-56.2	C-33.2	D-46.7	D-49.5	D-49.0	D-54.2	E-56.2
Westbound	D-47.8	E-65.8	C-32.5	D-51.1	D-37.0	D-40.2	D-47.8	E-61.3
Northbound	C-25.4	F-97.7	B-17.2	E-76.5	C-25.4	E-72.2	C-25.4	F-97.7
Southbound	C-32.3	F-102.4	C-24.8	F-90.3	C-32.5	E-79.7	C-32.3	F-102.4

Table 5. Queue Comparison of Alternatives at Patton and New Leicester.

Intersection and Approach	Queue Variable	Existing		Alternative A		Alternative B		Alternative C	
		AM	PM	AM	PM	AM	PM	AM	PM
Eastbound Left-Turn	Synchro 95th	#316'	#626'	194'	#602'	129'	#282'	#316'	#626'
	SimTraffic Max	275'	451'	217'	504'	159'	305'	299'	600'
Westbound Through	Synchro 95th	#422'	#770'	#328'	#717'	#422'	#693'	#422'	#770'
	SimTraffic Max	306'	1502'	259'	480'	283'	471'	375'	873'
Westbound Right-Turn	Synchro 95th	8'	373'	11'	382'	8'	226'	6'	211'
	SimTraffic Max	152'	1494'	172'	321'	152'	218'	137'	261'
Southbound Left-Turn	Synchro 95th	#1,010'	#681'	#502'	#423'	#1,010'	#642'	#1,010'	#681'
	SimTraffic Max	552'	484'	332'	365'	546'	328'	454'	516'

Note: "#" indicates that volume exceeds capacity

Note: the **bold** text indicates the values corresponding to the approach that will be altered in each alternative

Improvements Suggested for Consideration

Corridor-Wide

- Replace unlit bulbs
 - East end of corridor is relatively dark (from Acton Chiropractic to Regent Park Boulevard).
 - Double-sided light in median
 - Two other unlit bulbs (one on each side of Patton near Regent Park)
- Trim trees and vegetation to improve visibility of signs and clearance for pedestrians
- Install sidewalks on the south side of Patton Avenue
- Consider adding bus shelters where none currently exist
- Enhance sidewalk network as redevelopment occurs (i.e., sidewalks should continue across driveways rather than driveways continuing across sidewalks)

Intersection of New Leicester Highway

- Consider redesigning Little Caesar's driveway for ADA-compliant cross-slope if redevelopment occurs
- Intersection operation improvements through geometry
 - Consider eastbound dual left-turn lane
 - Consider installing triple left-turn lane for southbound approach
- Consider restriping TWLTL on New Leicester Highway as a left-turn lane back to or just south of Druid Lane if deemed feasible
- Consider use of blank-out signs and red right-turn arrow on the westbound approach, along with placement of crosswalk on north approach, to ensure visibility of pedestrians and mitigate concerns with the conflicting right-turn movement
- Install bus shelter on the south side of Patton
- Install crosswalk from north side of Patton to south side. Also install a sidewalk along south side of Patton Avenue to access bus stop and other properties
- Install advance signing [Right Turn Must Turn Right] to indicate transition from through to right-turn only lane
- Trim vegetation to improve visibility of signs

Intersection of N. Louisiana Avenue

- Install skip marks for southbound dual lefts
- Add a crosswalk and pedestrian signals to western approach
- Relocate signs that are obstructed by bus shelter on northwest corner

- Consider taking a lane of parking stalls in parking lot to install wide (or designated pedestrian area) sidewalk through the parking lot to K-Mart because 5 pedestrian crashes occurred in the K-Mart parking lot during the study period (2005-2014)
- Consider moving bus stop on southeast corner further east to eliminate the potential to trap vehicles in the intersection that are following the bus

Intersection of Hawkins Lane

- Install wrong way or one-way signage
- Consider consolidation of driveways when redevelopment occurs.
 - Potential for elimination or consolidation of Taco Bell driveways
 - Potential to close western Bank of America driveway, which would add parking spaces
 - Another option is to separate the Bank of America driveways

Intersection of Florida Avenue

- Install crosswalks and pedestrian signals (all approaches if feasible; otherwise on north, south, and west legs in the intermediate without moving stop bar and median island)
- Trim branches hanging over sidewalk

Intersection of Hazel Mill Road

- Clear rocks
- Fill in wheel rut
- Opportunity to install pork chop island to narrow opening and to prevent drivers from making high-speed turn movements
- Consider paving inside of curve to facilitate off-tracking
- Remove unnecessary "Do Not Enter" sign and possibly replace with "Wrong Way" and/or "One-Way" signs
- Trim vegetation

Intersection of Regent Park Boulevard

- Install truncated domes within refuge islands
- Move stop bar back
- Replace grate covers with ADA-compliant grates
- Fix yield sign and consider adding saw tooth pavement markings for yield control
- Install crosswalk for pedestrians crossing Regent Park

Conclusions

Patton Avenue is a 6-lane, divided roadway in an area with many businesses and pedestrian traffic. There have been 32 pedestrian crashes and 5 bicycle crashes in the past 10 years (2005 – 2014). There were 749 reported vehicle crashes in the past 5 years, with rear end crashes and angle crashes as the most common crash types. More than half of the crashes in the five-year study period occurred at the four signalized intersections, but crashes are also taking place between intersections. The number, location, spacing, and design of driveways is a primary contributing factor of midblock crashes throughout the corridor. Specifically, the number of driveways increases exposure and potential conflict points, which increase the chance of a collision (vehicle-vehicle, vehicle-pedestrian, and vehicle-bicycle).

The RSA organizers composed a multidisciplinary team with various backgrounds and experiences within the transportation field, including law enforcement. After reviewing the data and making observations at Patton Avenue, the RSA team identified a list of safety issues, and then developed targeted countermeasures to address these issues. To address the complex nature of traffic safety issues, the countermeasures include engineering, enforcement, and education strategies to enhance vehicle, pedestrian, and bicycle safety. The recommendations made for Patton Avenue could be used at corridors that share similar characteristics, such as AADT, cross-section, and crash patterns. Some general measures suggested by the RSA team include the following:

- Enhance pedestrian facilities, including the continuity and connectivity of the network
 - Add crosswalks and pedestrian signals to intersections without these facilities
 - Add a consistent and complete sidewalk network on the south side of the street
- Focus on improving the intersection of New Leicester Highway
- Close, consolidate, and redesign driveways as redevelopment occurs

