Cedar Road / South Green Road Intersection, RSA Study

South Euclid and University Heights, Ohio

January 2012

Prepared By

NOACA
Planning For Greater Cleveland
noaca.org
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- Administer the area clearinghouse function, which includes providing local government with the opportunity to review a wide variety of local or state applications for federal funds.
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Road Safety Audit

Cedar Road and South Green Road Intersection
Cities of South Euclid and University Heights, Ohio

January 2012

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This study report is for a Road Safety Audit conducted for the intersection of Cedar Road and S. Green Road in the Cities of South Euclid and University Heights. The purpose of the audit is to examine the existing conditions and suggest short-term, low-cost safety improvement opportunities.

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Executive Summary
The Road Safety Audit (RSA) for the intersection of Cedar Road and S. Green Road in the Cities of South Euclid and University Heights is one of several audits conducted by Northeast Ohio Areawide Coordinating Agency (NOACA) as part of NOACA’s safety studies program for Fiscal Year (FY) 2012. The Cedar Road and S. Green Road intersection was identified as a high-crash location based on NOACA’s 2009 Crash Report titled: Accident Characteristics & Intersection Accident Analysis. The purpose of the RSA is to have an independent audit team examine the location and suggest short term, low cost safety improvements.

The RSA team recommended low-cost, short-term; low-cost, medium-term; and medium-cost longer term improvements to improve the level of safety at the intersection. The main recommendations are:

- Consider improving the timing of the traffic control signals at Cedar Road/S. Green Road, Cedar Road/Langerdale Boulevard/Kerwin Road and S. Green Road/Heinen’s Driveway regarding the following modifications:
  - Review the need to operate South Green on pedestrian recall and/or vehicular max recall for weekdays.
  - Maintain signal appurtenances (push buttons and loops) to restore actuation for side street demand.
  - South Green pedestrian walk indication could be reduced in the interests of returning more green time to Cedar.
  - Improve the signal timing and coordination along Cedar Road for the intersections of Cedar Road/S. Green Road and Cedar Road/Langerdale Boulevard-Kerwin Road.
  - Improve the signal timing and coordination along S. Green Road for the intersections of Cedar Road/S. Green Road and S. Green Road/Heinen’s Driveway.
  - Actuate the traffic control signal at the intersection of S. Green Road and Heinen’s Driveway such that it will provide a separate phase upon demand for traffic exiting the driveways opposite the Heinen’s Driveway.

- Add an exclusive Left-Turn bay on Cedar Road at the westbound approach of the intersection of Cedar Road and Langerdale Boulevard-Kerwin Road.
- Improve the pavement sub-grade and surface condition.
- Improve pavement markings.
- Offset the stop lines on the Cedar Road eastbound approach. Set back the stop line for left turn bay, and set forward the stop line for the through and right turn lanes.
- Relocate the RTA bus stop on the Cedar Road eastbound approach from its present location in front of the Speedway gas station to a location between the two CVS driveways.
- Improve the curvatures of the driveways for smoother ingress and egress movements, reduce their edge heights relative to the surface of the pavement to minimize the unevenness, make the driveways and their curb cuts more defined.
- Explore access management techniques to manage the driveways of the gas stations near the intersection.
Background and Location of the Intersection

The intersection is located within the political boundaries of two cities. The southbound approach (S. Green Road, north of Cedar Road) is within the borders of the City of South Euclid. The northbound approach (S. Green Road, south of Cedar Road) is within the City of University Heights. The center line of Cedar Road divides the roadway between the City of South Euclid in the north and the City of University Heights in the south. The controller box of the traffic control signal is located within the City of University Heights. Figure 1 shows the location of the intersection and surrounding communities.

Based on NOACA’s 2007-2009 Crash Report titled “Accident Characteristics & Intersection Accident Analysis,” this intersection ranked high among the top 100 high crash locations in the NOACA region. The ranking is based on a composite index derived from crash data obtained from the Ohio Department of Public Safety. The methodology NOACA used to rank the intersections is described in Appendix B.
**Team Members**

The team for this audit included members from the cities of South Euclid and University Heights, NOACA, and the Ohio Department of Transportation (ODOT) District-12 office.

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization</th>
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<tbody>
<tr>
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<td>City Engineer</td>
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**Pre-Audit and Post-Audit Meetings**

Pre-audit and post-audit meetings among team members including representatives from the cities of South Euclid and University Heights were held on November 21 and 22, 2011 at South Euclid City Hall. The team shared their experiences and knowledge about the intersection of Cedar Road/S. Green Road and adjacent intersections Cedar Road/Langerdale Road-Kerwin Road to the west, and S. Green Road/Heinen’s Driveway to the south. Lead members in the Audit Team presented information about crash data, graphs, and a collision diagram. A description of the crash information presented at the pre-audit meeting is shown in the next section titled “Crash History”. The field audit for the intersection was conducted in the interim between the two meetings and is presented in detail in the following section titled “The Audit”. The field work was conducted for the mid-day and the evening peak periods. After dark, field review was also made to observe low traffic volume conditions and determine whether the present lighting appeared adequate, and whether there were any visibility issues that might be contributing factors in the occurrence of crashes. The team returned the following day to make observations of the operation of the intersection for the morning peak traffic patterns compared with the patterns observed for other peak periods. The team convened a post audit meeting to share and discuss its findings and observations in preparation for writing a draft report.
Crash History

A review of the most recent three-year crash history at and within a 300-foot radius of the intersection was conducted to establish a profile for the types and patterns of crashes at this intersection. Crash records for years 2008, 2009, and 2010 were obtained from the Ohio Department of Transportation and studied to determine, among other things, the types, approximate locations, and severity of crashes at this intersection. The records show there were 134 crashes at and near the intersection in the three-year period, and the predominant types of crashes are rear end and angle collisions. The diagrams presented below show the various types of crashes, severity, month of year, day of week, and time of day of their occurrence, pavement conditions at the time of their occurrence, and crash contributing factors. Presented also is a collision diagram that shows the type and approximate location of each crash in the three-year period.

Angle collisions and rear end collisions are the predominant types of crashes at this intersection. Those two types of crashes indicate that there is a great deal of interference with the paths of travelling vehicles. The presence of a significant number of sideswipe passing collisions supports the notion that interference in the stream of traffic causes these collisions as sideswipe passing collisions often occur when drivers attempt to avoid such interferences. Chart 1 below, ‘Frequency of Crashes By Type of Crash’, shows the various types and number of crashes at this intersection.

![Frequency of Crashes by Type of Crash]

**Chart 1**
Chart 2 below, ‘Frequency of Crashes by Contributing Factor’, provides a glimpse of the type of citations issued to drivers deemed at fault in a crash. These citations relate to the type of crash that occurs. ‘Failure to Yield’ is a citation often associated with angle collisions. ‘Following Too Closely’ is a type of citation given to drivers deemed at fault in rear end collisions. Rear end crashes are typical in congestion conditions. The high frequency of ‘Failure to Yield’ shown in the diagram corresponds to the high number of angle collisions involving vehicles with conflicting movements. These factors are not necessarily the causes of the crashes but are indicative of the involvement of other conditions.

![Frequency of Crashes by Contributing Factor for Veh. 1](chart2.png)
Chart 3, ‘Frequency of Crashes by Action of Vehicle 1’, shows that most of the crashes involve vehicles travelling straight or turning left. The reference to “Veh.1” is the reference to the vehicle deemed at fault and issued the citation. This is indicative of interference with the paths of travel. Interferences could come from traffic movements from the adjacent points of ingress and egress, blockage to line of sight, or some malfunction in the traffic control devices at the subject location.
Chart 4 for ‘Frequency of Crashes by Hour’ shows that the frequency of crashes increases in the period between about noon to about 5 pm. Heavy traffic movements on Cedar Road begin at about 8 am for the morning commute, increase during the mid-day peak, and begin to decline towards the end of the pm peak commute period of 4-5 pm.

Chart 5, ‘Frequency of Crashes by Day of Week’, shows the distribution of crashes by day of the week.
Chart 6, ‘Frequency of Crashes by Month’, shows no remarkable or unusual variation in crash frequency by month of year. The slight variations from month to month are most likely random. They were not due to any recognizable reason.

Chart 7, ‘Frequency of Crashes by Year’, shows that the distribution of crashes over the three-year period is rather balanced. The slight variation in frequency for year 2010 compared with years 2009 and 2008 is negligible.
Chart 8, ‘Frequency of Crashes by Year and Severity’ shows that the percent of injury crashes decreased from about 48 percent of the total in 2008 to 20 percent of the total in 2010.
Chart 9, ‘Frequency of Crashes by Severity’ shows an average percent of injury crashes to property damage crashes to be approximately 25 percent. No fatal crashes in the three year period studied were reported at this intersection.

Chart 10, ‘Frequency of Crashes by Light Condition’ shows that during the analysis period 83 percent of the crashes occurred during daylight. Environmental conditions such as light conditions and road surface conditions are important elements in the occurrence of crashes. An examination of lighting conditions during non-daylight hours was made in order to ascertain whether adequate lighting conditions exist. It was determined that lighting conditions were adequate as street lights and other lighting sources from adjacent businesses provided adequate illumination.

Chart 11 below ‘Frequency of Crashes by Road Condition’ shows that thirty-two percent of the crashes occurred on adverse pavement conditions. The condition of the road surface is noticeably
questionable. Bad road surfaces exacerbate the potential occurrence of crashes on wet, snow-covered, or icy pavement conditions.

Alcohol related and alcohol suspected crashes represent about 10 percent of the crashes in the three year period studied. About 9 percent of the crashes involved individuals who had been drinking (HBD) but their ability was unknown. Approximately 1 percent involved individuals who had been drinking (HBD) and their ability was impaired as shown in chart 12.
The collision diagram, Figure 2 below, shows the types, severity and approximate locations of the reported crashes. The diagram indicates that most of the angle crashes are driveway related. It also shows that most of the crashes occurred on Cedar Road.
The Audit

The Road Safety Audit (RSA) for this intersection was conducted on November 21 and 22, 2011. It is part of the Northeast Ohio Areawide Coordinating Agency’s (NOACA’s) safety studies program for FY 2012.

A Road Safety Audit (RSA) is a formal examination of safety performance of an existing or future road or intersection by an independent audit team. The RSA team usually considers the safety of all road users, qualitatively estimates and reports on road safety issues, and makes suggestions and recommendations regarding safety improvements. The steps for a road safety audit¹ are:

1. Identify the project or the road-in-service to be audited.
2. Select the RSA team.
3. Conduct pre-audit and post audit meetings.
4. Perform field observations under various conditions.
5. Conduct an audit analysis.
6. Present the audit findings to the project owner/design team.
7. Project owner/design team prepares a formal response.
8. Incorporate findings within the project when appropriate.

The above-stated steps were followed in conducting this road safety audit.

¹ FHWA Road Safety Audit Guidelines, FHWA-SA-06-06
Figure 3, below, shows an aerial view of the intersection, its existing lane configuration and assignments, year 2007 Average Daily Traffic (ADT), and adjacent intersections in the area of influence that affect the operation of the primary intersection that is subject to this road safety audit.
The main characteristics of this intersection are:

- Cedar Road is classified as a principal urban arterial and S. Green Road is classified as a minor urban arterial.
- Based on a 2006 vehicle count data, S. Green Road services about 16,000 vehicles per day (VPD) north of Cedar Road and about 13,000 VPD south of Cedar Road.
- Based on a 2006 vehicle count data, Cedar Road services about 25,300 vehicles per day (VPD) east of S. Green Road and about 20,200 VPD west of S. Green Road.
- The Northbound and Southbound approaches of the intersection are skewed. The Northbound approach meets Cedar Road at an angle, whereas the southbound approach meets Cedar Road at approximately a right angle.
- S. Green Road has a slight vertical curve, enough to create some visibility problems;
- The traffic control signal at the intersection uses a four-phase setting that consists of protected left turn movements and through movements with permissive left-turns for the four approaches.
- While all traffic movements on all approaches are heavy, traffic movements on Cedar Road are heaviest.
- There were no fatal crashes. About 25 percent of all crashes are injury crashes, and the rest are property damage only.

Pictures 1 through 4 show each approach of the intersection of Cedar Road and S. Green Road.
Issues Identified
The audit team made observations regarding many elements of the intersection including traffic movement, signal operation, pedestrian movement, lighting conditions, road surface condition, adjacent points of ingress and egress (access), and roadway alignment. The team made recommendations based on its observations for measures to improve the overall safety conditions at this intersection. The safety issues identified are listed under the following categories: traffic control signals, Geometry and Alignment, pavement condition and marking, access management and pedestrian movement. The recommendations, summarized in the tables below, were paired with cost category, implementation time, and potential benefit of each suggested recommendation with regards to reducing the frequency of crashes at and near this intersection.

Findings and issues identified in this road safety audit are presented as follows in this section:

Traffic Control Signals

Timing and phasing

- The phase for S. Green Road is 50 seconds for the left and through movements with a pedestrian recall and vehicular maximum recall phase for all periods observed. The phasing can be improved if it is actuated without a pedestrian recall phase in order to give extra green time to Cedar Road.
- During the evening peak hour, the southbound left-turn movement is heavy and the queue does not always clear the intersection during the green interval.
- The clearance time appears to be extremely short considering the large expanse of the intersection. The yellow interval for the through movement, measured in the field, was 2.43 seconds and the all red was 2 seconds.
- Cedar Road westbound coordination has a 19-second offset.
- Eastbound coordination of the Cedar Road/Green Road intersections with Cedar Road/Langerdale/Kerwin, shown in Figure 3, is needed to permit better traffic flow.
- The northbound phase at the intersection of Cedar Road/Kerwin Road operates on recall. Unneeded recall disrupts progression on Cedar Road. It is best if it is actuated and made to operate on demand.
- Westbound traffic arrives in platoons. The queue of the through traffic movement blocks left-turning traffic from getting to the left-turn bay.
- There is no coordination on S. Green between the traffic control signal for Cedar Road/S. Green Road and the traffic control signal for S. Green Road and the Heinen’s Driveway, which appears to operate independently.
- The traffic control signal at the Heinen’s Driveway was observed to operate on flashing mode during the morning peak period with flashing yellow for the main road and flashing red for the driveway. Crashes at this location have an impact on the overall safe operation of the intersection of Cedar Road and S. Green Road. Furthermore, the traffic control
signal at S. Green Road and Heinen’s Driveway simultaneously controls two other separate driveways on the opposite side of the Heinen’s Driveway, creating conflicting traffic movements with equal right-of-way. Those driveways that serve businesses in the small shopping plaza opposite the Heinen’s Driveway should be controlled by a separate phase upon traffic demand.

**Hardware**

- The present traffic control signal is equipped with a type 170-controller.
- Currently, the traffic control signal heads do not have back-plates. It would be advisable to retrofit the existing traffic control signal heads with back-plates for better visibility and to minimize potential glare.
- It is preferable to install a single traffic control signal head per lane (3-3-5).
- The pre-emption system did not seem to function. Some EMS vehicles were observed to traverse the intersection without activating the preemption system. It was turned off in the City of South Euclid for S. Green Road. As for Cedar Road, the system is controlled by the City of Cleveland Heights.
Geometry/Alignment

- Traffic backup on Cedar during the evening peak is caused by westbound left-turning traffic from Cedar Road at Kerwin Road intersection. Add a short left-turn bay on Cedar. The pavement width at the approach is approximately 53 feet.
- The crosswalk on the west leg of the intersection is slanted.
- The skew of the intersection of S. Green Road with Cedar Road and the slight vertical curve (upward grade) interfere with the safe movement of through southbound traffic and northbound left-turning traffic on the permissive left-turn phase. The sight distance for the left-turn movement during a permissive left-turn phase is obstructed by queued traffic on the opposite approach left-turn lane due to the oblique alignment of S. Green Road.

Picture 7: Cedar Road at S. Green Road eastbound approach, looking east

Picture 8: S. Green Road northbound approach, looking north

Picture 9: S. Green Road northbound approach, looking north
**Pavement Condition and Markings**

**Pavement Condition**
- Pavement condition within the intersection is bad. It is rutted, cracked, uneven, and in some places crumbling.

![Picture 10: Pavement condition](image1)

![Picture 11: Pavement condition](image2)

![Picture 12: Pavement condition](image3)

![Picture 13: Pavement condition](image4)
Pavement rutting is excessive, particularly on Cedar Road east of S. Green Road as can be seen in picture 18.

**Pavement Markings**

- Pavement lane lines, centerlines, and crosswalk markings are faded, jagged and at times unclear due to the unevenness of the surface of the pavement as the line markings follow the uneven surface of the pavement due to its rutting condition.
- There are no dotted lane line extensions within the intersection to help drivers stay within their respective lanes so as not to encroach on the right of way paths of other vehicles.
Access Management

- The westbound approach for the S. Green Road/Heinen’s Driveway traffic control signal is shared by two driveways creating conflicting turning movements. Assign a separate phase for each driveway using demand adaptive traffic control signals while giving priority to the main road (S. Green Road).
- There are numerous driveways and points of access on both sides along Cedar Road and on both sides along S. Green Road. Consolidate these driveways as much as possible. The driveways for the businesses at and near the intersection may be candidates for consolidation.
- The driveways of Speedway gas station, Huntington Bank, Bruegger’s Bagels, and Shell gas station have high numbers of right-angle crashes (See Collision Diagram, Figure 2) due to left-turning traffic out of and into those driveways. Restricting left-turns into and out of these businesses is advisable.
- The RTA bus stop, on the Cedar Road eastbound approach, blocks the access points for CVS and Speedway. The location of the bus stop also prevents or impedes right-turns on red. The bus stop should be relocated between the two CVS driveways and fitted with a concrete bus stop pad.
• The movement into and out of the plaza on the north side of Cedar Road is significant. There are two driveways for this plaza from which traffic attempts to cross over to businesses on the other side of Cedar Road or attempts to cross two lanes of traffic to turn left to go eastbound, thereby interfering with oncoming westbound traffic on Cedar Road.

• Traffic from businesses on the south side of Cedar Road also attempts to cross four lanes of traffic to enter the plaza on the north side of Cedar Road, or cross three lanes of traffic to turn left to go west as shown in picture 23.

• The plaza on the north side of Cedar Road sits a little higher than the grade of the roadways, therefore its driveways are significantly above grade causing entering and exiting traffic to be slow when negotiating these ingress and egress points.

Picture 23: Turning movement across three lanes of traffic
**Pedestrian Movement**

- The pedestrian signal operates on recall during the whole week. The recalls on Saturdays are requested by the local residents.
- Pedestrian movements were light. On Saturdays, however, pedestrian movements are a little heavier and the pedestrian crossing phase is set on recall. Thermal detection equipment may be employed for pedestrian walk phase activation.
- Pedestrian crossing push buttons are available at all approaches.

**Adjacent or Nearby Signalized Intersections**

Two nearby signalized intersections appear to have a negative effect on the occurrence of crashes near the Cedar Road/S. Green Road intersection. The intersection of Cedar Road at Langerdale Road is controlled by a traffic control signal that is coordinated in the westbound direction for all time periods. The intersection of S. Green Road at the Heinen’s Driveway operates independently from the main intersection of Cedar Road and S. Green Road. They cause further congestion and delays which produce driver frustration and impede the flow of uninterrupted traffic through the two corridors.

The nearby intersection of Cedar Road/Langerdale Boulevard-Kerwin Road is less than 500 feet to the east from the main intersection of Cedar Road and S. Green Road. The absence of a left-turn bay at the westbound approach of this intersection compounds the problem as when a vehicle attempts to turn left, it blocks one of the two heavily travelled through lanes on Cedar Road and halts platoons of vehicles. Drivers behind the left-turning vehicle attempt to move around it causing interference with the flow of through traffic in the adjacent lane.

The other nearby intersection of S. Green Road and the Heinen’s Driveway is a little over 500 feet to the south from the main intersection of Cedar Road and S. Green Road. It is not coordinated with the main intersection, operates on flash mode during the am peak period, and controls other driveways located on the opposite side of the Heinen’s Driveway.
## IMPROVEMENT MEASURES AND CRASH REDUCTION FACTORS

<table>
<thead>
<tr>
<th>Intersection Operation Recommendations:</th>
<th>Cost Category(^1)</th>
<th>Time(^2)</th>
<th>CRF(^3)</th>
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<tr>
<td><strong>Signal Timing</strong></td>
<td></td>
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</tr>
<tr>
<td>➢ Full actuation of the signal using the existing hardware</td>
<td>Low</td>
<td>Short term</td>
<td>80% reduction in left turn crashes</td>
</tr>
<tr>
<td>➢ Increase clearance interval;</td>
<td>Low</td>
<td>Short term</td>
<td>15% reduction in all types of crashes</td>
</tr>
<tr>
<td>➢ Improve the coordination along Cedar Road between S. Green Road and Langerdale Road;</td>
<td>Low</td>
<td>Short term</td>
<td>15% reduction in all types of crashes</td>
</tr>
<tr>
<td>➢ Coordinate traffic flow along S. Green Road between Cedar Road and Heinen’s access;</td>
<td>Low</td>
<td>Short term</td>
<td>15% reduction in all types of crashes</td>
</tr>
<tr>
<td>➢ Install backplates to improve the visibility of the signals;</td>
<td>Low</td>
<td>Short term</td>
<td>20% reduction in right angle crashes</td>
</tr>
<tr>
<td>➢ Consider reactivating the emergency vehicles pre-emption system.</td>
<td>Low</td>
<td>Short term</td>
<td>70% reduction in emergency vehicle crashes</td>
</tr>
<tr>
<td><strong>Pedestrian Signals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Upgrade pedestrian crossings to countdown signals or,</td>
<td>Low</td>
<td>Medium term</td>
<td>25% reduction in pedestrian crashes</td>
</tr>
<tr>
<td>➢ Use activation by thermal detection.</td>
<td>Low</td>
<td>Medium term</td>
<td>Unavailable</td>
</tr>
</tbody>
</table>

---

1 ODOT classification (Appendix D)
2 Implementation Time
3 Crash Reduction Factor: The percentage of crash reduction expected after implementing the recommended countermeasure. U.S. Department of Transportation, FHWA-SA-08-011
<table>
<thead>
<tr>
<th>Vehicular Movement Recommendations:</th>
<th>Cost Category(^1)</th>
<th>Time(^2)</th>
<th>CRF(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intersection Geometry and Visibility:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Consider improving the alignment of S. Green Road;</td>
<td>High</td>
<td>Long term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Add a left-turn bay on the westbound approach of Cedar Road/Langerdale Road.</td>
<td>Medium</td>
<td>Medium term</td>
<td>10% reduction in all types of crashes</td>
</tr>
<tr>
<td><strong>Pavement Condition and Pavement Marking:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Add dotted lane-extension guidelines through the intersection to guide S. Green Road traffic movements;</td>
<td>Low</td>
<td>Short term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Move the stop lines back and stagger for each lane assignment;</td>
<td>Low</td>
<td>Short term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Improve pavement markings;</td>
<td>Low</td>
<td>Short term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Resurface pavement and build bus concrete pads.</td>
<td>Low to Medium</td>
<td>Medium term</td>
<td>33% reduction in all types of crashes</td>
</tr>
<tr>
<td><strong>Access Management:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Restrict turning movement to Right-in/Right-out on Cedar Road within 300 feet of the intersection.</td>
<td>Low</td>
<td>Short term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Install raised islands at access points to enforce the Right-in/Right-out movements; or</td>
<td>Low</td>
<td>Short term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Install pylons along the center line of Cedar Road to prevent vehicle cross-over, although this might increase the use of the corner access points unless they are closed off;</td>
<td>Low</td>
<td>Short term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Consolidate driveways;</td>
<td>Medium</td>
<td>Medium term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Reshape the driveway curb cuts for better visibility and ease of access;</td>
<td>Low</td>
<td>Short term</td>
<td>Unavailable</td>
</tr>
<tr>
<td>➢ Relocate the RTA bus stop and provide a bus stop concrete pad;</td>
<td>Low</td>
<td>Short term</td>
<td>Unavailable</td>
</tr>
</tbody>
</table>

---

1 ODOT classification (Appendix D)
2 Implementation Time
3 Crash Reduction Factor: The percentage of crash reduction expected after implementing the recommended countermeasure. U.S. Department of Transportation, FHWA-SA-08-011
Conclusion and Recommendations

The recommendations in this report are mostly low-cost, short-term measures to increase the level of safety at this intersection. The main recommendations are summarized and illustrated below:

- Perform capacity analysis and evaluate the operation of the intersection to improve the signal timing to allow for better traffic flow through all intersections and for better lane utilization, considering the following modifications:
  - Limiting the pedestrian recall phases to Saturdays only.
  - Limiting vehicular recall on S. Green Road phases.
  - Increasing green time for the through traffic on Cedar Road.
  - Increasing the yellow and all-red clearance intervals.
  - Reevaluate coordination offsets for mid-day and PM peak periods.

- Add an exclusive left turn bay on the westbound approach of Cedar Road at the intersection of Langerdale Boulevard to remove left-turning vehicles from the stream of the through traffic to allow for a continuous movement of traffic through the intersections of Cedar Road/S. Green Road and Cedar Road/Langerdale Boulevard. Left turning vehicles in the through traffic stream impede the flow of traffic, causes interference, and contribute to the occurrence of crashes. The length of the present left turn bay on the eastbound approach is about 175 feet. There is about 200 feet available in the opposite direction of the existing left-turn lane. A left-turn bay of about 175 feet may be accommodated, and the remaining 25 feet can be used as a buffer area to separate the two left-turn bays, as shown in diagram1 below.
• Improve the traffic control signal operation at the S. Green Road and the Heinen’s Driveway by providing separate phases for the driveways on the opposite side of the Heinen’s Driveway and coordinating this traffic control signal with the operation of the traffic control signal for the main intersection of Cedar Road and S. Green Road. The present operation exacerbates the occurrence of crashes as it creates traffic movement conflicts at the driveways, impedes the flow of traffic, and interferes with the continuous movement of the traffic platoons from the upstream intersection of Cedar Road and S. Green Road (see diagram 2, below).

• Improve the pavement condition and pavement markings.
• Offset the stop lines on the eastbound approach of Cedar Road by bringing the shared through and right turn stop line forward to enable safer right turns on red.
• Improve the curbs and curvatures of the driveways to enable easier ingress and egress movements and to help define these points of ingress and egress more clearly.
• Make the lane markings on S. Green Road northbound and southbound approaches follow the curvature of the roadway instead of the present straight line markings, and provide dashed or broken lines within the intersection to guide vehicular movements to guide vehicles through the intersection.
- Relocate the bus stop presently in front of the Speedway gas station to another location preferably before the driveways of the Speedway gas station and in front of CVS between its two driveways.
- Close driveways closest to the intersection, and/or convert some of them to Right-in/Right-out only.
- Setback the Speedway gas station sign as it blocks the line of sight of drivers exiting the Speedway gas station and the line of sight of drivers of eastbound vehicles from seeing vehicles attempting to exit the Speedway gas station.
- The present roadway and sidewalks do not provide for safe bicycle traffic; sidewalks need repair and pedestrian crossings need improvement.
- Provide traffic control signal back-plates.
- Provide one signal head per lane if possible. This is preferable, but not required.

These recommendations are sent to the cities of South Euclid and University Heights for their review, comments, and consideration as deemed appropriate. The cities are asked to comment on all recommendations, and provide their responses in order to incorporate them in this report.

The cities of South Euclid and University Heights may use this report to request safety funding through the Ohio Department of Transportation (ODOT) Central Office to address some or all of the recommendations presented in this report.
Appendix A: Glossary

**An Actuated Traffic Control Signal:** A traffic control signal that operates based on actual, real time vehicular demand.

**Actuation:** Initiation of a change in or extension of a traffic signal phase through the operation of any type of detector.¹

**Adaptive Traffic Signal Control:** The process by which the timing of a traffic signal is continuously adjusted based on the changing arrival patterns of vehicles at an intersection, usually with the goal of optimizing a given measure of effectiveness. The characteristics of a traffic signal cycle are optimized at the conclusion of every phase based on the vehicle arrival times.

**Backplate:** A thin strip of material that extends outward from and parallel to a signal face on all sides of the signal housing to provide a background for improved visibility of the signal indications.¹

**Capacity:** Traffic-carrying ability of a facility over a range of defined operational conditions. Capacity analysis provides tools to assess facilities and to plan and design improved facilities.²

**Crash Reduction Factor:** The percentage of crash reduction expected after implementing the recommended countermeasure.

**Detector:** A device that detects the presence of a vehicle and actuates the demand for a green signal.

**Green Time:** The duration of the green indication for a given movement at a signalized intersection.

**Permitted Turn:** Left or right turn at a signalized intersection that is made against an opposing or conflicting vehicular or pedestrian flow.²

**Protected Turn:** The left or right turns at a signalized intersection that are made with no opposing or conflicting vehicular or pedestrian flow allowed.²

**Signal Phasing:** The way in which the right of way is allocated among conflicting traffic movements that seek to use the same space.

**Split Phasing:** A signal phasing where each two opposing traffic movements have a completely separate phase.

**Stop Line:** A solid white line extending across approach lanes to indicate the point behind which vehicles are required to stop.¹

¹ Manual on Uniform Traffic Control Devices
² Highway Capacity Manual
Appendix B:
Methodology for Ranking High-Crash Locations

Crash locations are ranked based on a composite index derived from the four different ranking aspects, described below. The Composite Index for a location is the sum of the four ranks the location has according to crash frequency, equivalent property damage only, average equivalent property damage only and crash rate.

1. **Frequency of Crashes**
   
   Rank 1 means the location has the highest crash frequency.

2. **Equivalent Property Damage Only Index (EPDO)**
   
   This index uses a formula to convert crashes of all severities to the equivalent of property damage-only crashes. It is calculated by weighing crashes as follows, where the cost of property damage only (PDO) crash is given a weight of 1:
   
   - The number of fatal crashes multiplied by 122.75 (the cost of a fatal crash is $1,199,558).
   - The number of injury crashes multiplied by 7.30 (the cost of an injury crash is $71,343).
   - The number of property damage only (PDO) crashes multiplied by 1.0 (the cost of a PDO crash is $9,772).

   
   
   
   EPDO = (# of fatal crashes x 122.75) + (# of injury crashes x 7.30) + property damage-only crashes

   Rank 1 means the location has the highest EPDO.

3. **The average Equivalent Property Damage Only (EPDO per crash)** is calculated for each intersection by taking the EPDO index calculated in step 2 above divided by the number of crashes occurring at the intersection.

   The highest EPDO per crash is ranked number 1.

4. **Crash Rate (Crashes per million entering vehicles):**

   Crash Rate = (# of crashes x 1,000,000) / [(years of data)*(365)*(daily traffic volume entering the intersection)]

   Rank 1 means the location has the highest crash rate

5. **Composite Index** = Frequency Rank + EPDO rank + EPDO per crash rank + Crash rate rank

   (Ranking of crash locations will be according to the value of the composite index in descending order: a location having the lowest composite index ranks at the top)
# Appendix C: ODOT Cost-Range Categories

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost Range in Dollars</th>
<th>Time Range in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Less than $100,000</td>
<td>One year or less</td>
</tr>
<tr>
<td>Medium</td>
<td>$100,000-$5,000,000</td>
<td>One year - 5 years</td>
</tr>
<tr>
<td>High</td>
<td>Greater than $5,000,000</td>
<td>More than 5 years</td>
</tr>
</tbody>
</table>