Research Report
KTC-06-14/PTS01--06-1F

KENTUCKY TRANSPORTATION CENTER

# COOPER DRIVE PEDESTRIAN STUDY

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College of Engineering

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**Research Report**
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# COOPER DRIVE PEDESTRIAN STUDY

(Final Report)


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## Introduction

The purpose of this report is to summarize the findings of the pedestrian study conducted for Cooper Drive from Nicholasville Road to Sports Center Drive on the University of Kentucky Campus in Lexington, KY. This study was initiated by the University of Kentucky Parking and Transportation Services in response to high pedestrian crossing volumes on Cooper Drive. Cooper Drive is crossed daily by a large number of pedestrians to access the main campus from the stadium parking lot and Bluegrass Community and Technical College (BCTC). This study examines several roadway alternatives that have potential to improve these pedestrian movements in a safe and efficient manner.

## Existing Conditions

Cooper Drive serves as an extension of Waller Avenue. It is an east-west roadway that connects Nicholashville Road with Tates Creek Road. Cooper Drive splits South campus between Nicholasville Road and Sports Center Drive bounded by Commonwealth stadium and Bluegrass Community and Technical College (BCTC) to the south, and Main Campus to the north. **Figure 1** shows Cooper Drive and the surrounding area. Cooper Drive is a 5-lane facility between Nicholasville Road and University Drive and is reduced to a two-lane section east of University Drive through Sports Center Drive.

In addition to the major signalized intersections at Nicholasville Road, University Drive and Sports Center Drive, several unsignalized access points exist that provide access to parking facilities. These are shown in Figure 1.

A high volume of pedestrians cross Cooper Dr. to access the various parking facilities in this area, to access BCTC, the agricultural engineering complex and the Greg Page apartments Pedestrian activity is largely contained to four primary crossings: 1) Cooper Drive and University Drive intersection, 2) an unmarked mid-block crossing between Plant Sciences and Agricultural Engineering buildings 3) the Veterans Drive tunnel under Cooper Drive and 4) directly in front of the BCTC Moloney Building and the "Red Lot" parking facilities. These areas are denoted on Figure 1.

## Data Collection

Traffic data was collected in the form of manual turning movement counts at all signalized and unsignalized intersections and pedestrian counts were conducted at the mid-block crossings on the corridor. Data was collected December 4-6, 2005, during the fall semester. Turning movement counts were conducted during the AM and PM peak periods between 7:30 – 9:30 a.m. and 4:00- 6:00 p.m. Pedestrian counts were also conducted during these times, as well as during the mid-day peak period between 11:00 a.m. and 1:00 p.m. **Figure 2** summarizes the traffic data collected during this period.

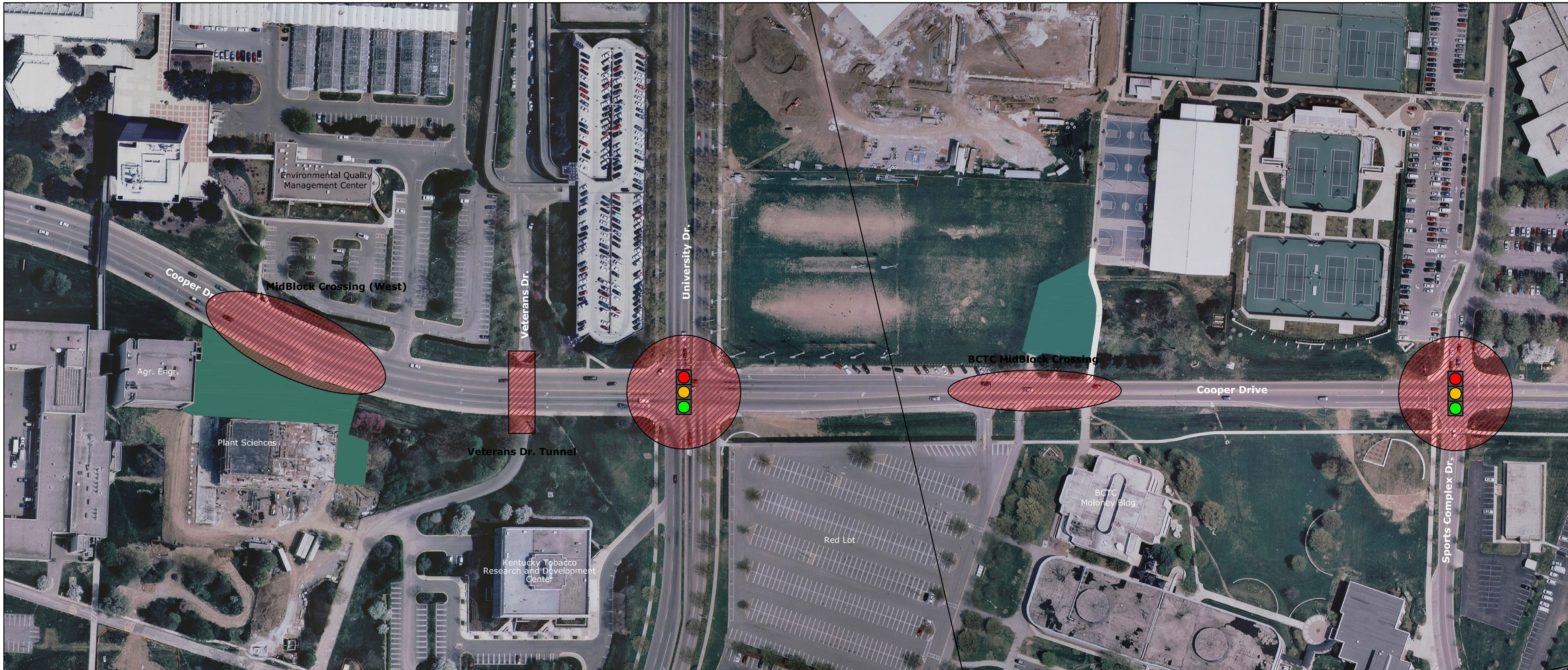
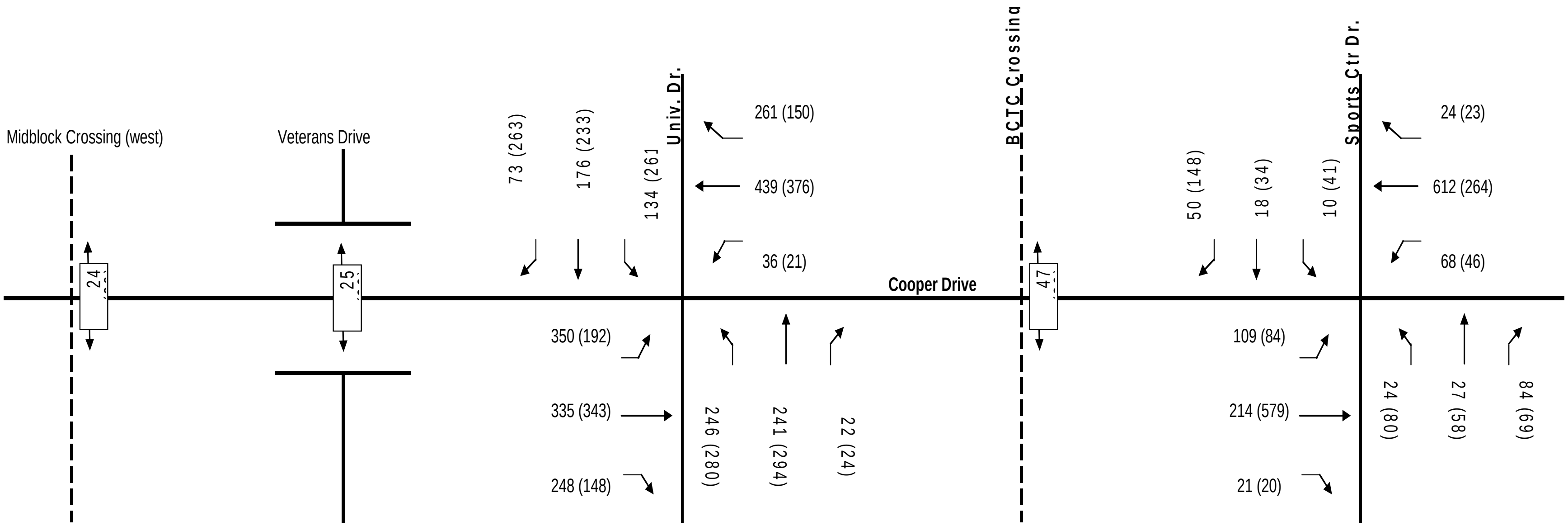


Figure 1
Study Area

Figure 2: Turning Movement and Pedestrian Counts



# Pedestrian Issues

## Mid-Block Crossing (West)

The crossing between Plant Sciences and the parking lot at the Environmental Quality Management Center (EQMC) is an unmarked midblock crossing. Sidewalks are present on Cooper Drive; however, there is no direct connection for pedestrians who wish to cross Cooper towards the Agricultural Complex on the south side. The need for such a crossing is apparent from the well worn path that has been "created" from the high volume of pedestrians that use this crossing (**Figure 3**). The problem here is that pedestrians will not walk to the University/Cooper intersection to cross and then walk back to the Agricultural Complex. A sidewalk is present on the north side of Cooper Drive which connects to the EQMC and other area buildings.

Figure 3: Worn path to Plant Sciences /Agricultural Engineering

Moderate volumes of pedestrians cross at this location throughout the entire day. Approximately 50 pedestrians per hour were observed crossing here during the AM period and approximately 30 pedestrians per hour during the Midday and PM periods.

This crossing creates an unsafe environment for pedestrians for several reasons. Traffic on Cooper Drive between University and Nicholashville is heavy and typically travels at higher speeds. In addition, this crossing occurs at the same place where vehicles negotiate a reverse horizontal curvature and several vehicles are changing lanes in anticipation of the turning movements at the downstream intersections. The five-lane cross section also increases the exposure for pedestrians as they must cross over 60 feet of high speed traffic. (See **Figure 4**)

Figure 4: Cooper Drive looking North at Midblock Crossing (West)

## Veterans Drive Tunnel

Directly east of the EQMC parking lot unmarked crossing, Veterans Drive passes under Cooper Drive through a tunnel. Veterans Drive is one-way (southbound only) between Parking Structure 1 and the Plant Sciences parking lot. The tunnel serves a high volume of pedestrian and vehicular traffic crossing Cooper Drive. Counts conducted at this location documented over 650 vehicles per day and between 30 to 40 pedestrians per hour during the AM, Midday and PM peak periods at this location.

Figure 5: Veterans Drive Tunnel; looking south

Veterans drive is approximately 18-20 foot wide on both sides of the tunnel; however, no sidewalk or pedestrian facilities are provided. Through the tunnel Veterans Drive is 14.5 feet wide with a 5-foot sidewalk on the west side. (See **Figures 5**).

Problems with this location are the absence of any sidewalks connecting to the existing sidewalk in the tunnel and the sight obstructions at the south tunnel exit. Pedestrians typically walk on the east side of Veterans Drive, away from on-street parking, out of

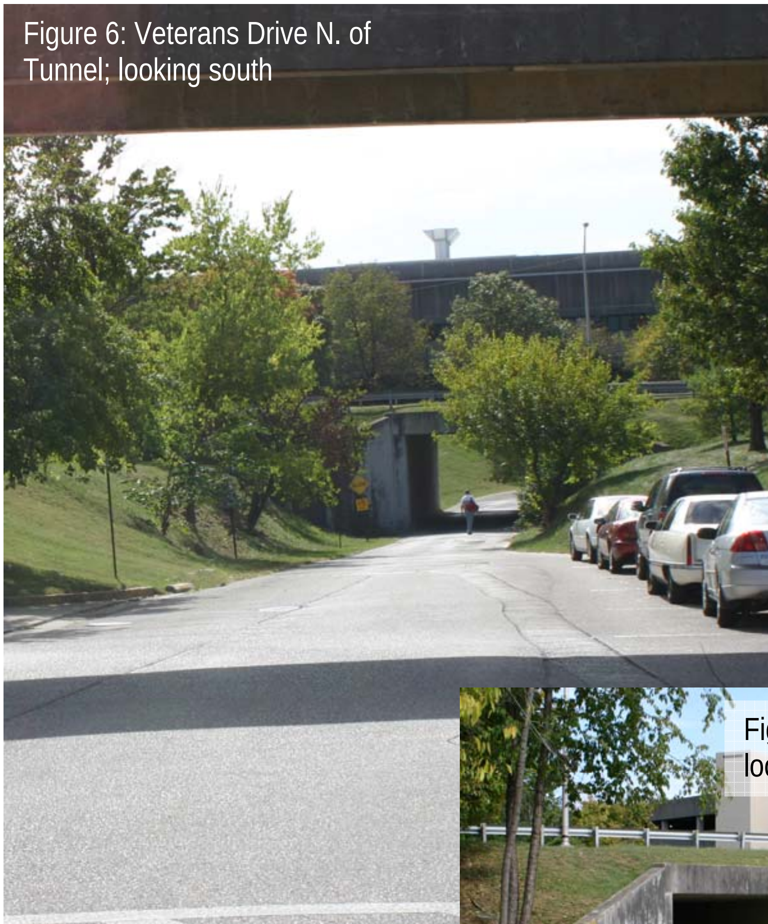


Figure 6: Veterans Drive N. of Tunnel; looking south

the way of traffic. To enter the tunnel, pedestrians must cross the street to access the sidewalk through the tunnel (see **Figure 6)**. South of the tunnel, most pedestrians again walk on the east side of street, due to the restricted sight distance caused by the embankment (see **Figure 7**). A footpath also exists in the form of steps up the steep slope on the southeast side of the tunnel; however, there is no clear origin or destination at the top of this path. (See **Figure 8**).

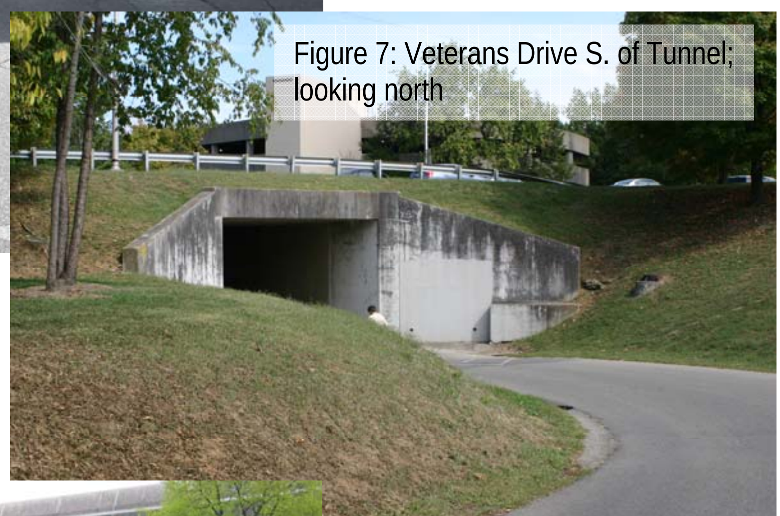


Figure 7: Veterans Drive S. of Tunnel; looking north

Figure 8: Worn Steps up steep slope

## University Drive and Cooper Drive

The signalized intersection of University Drive and Cooper Drive serves the heaviest volume of pedestrian and bicycle traffic. Pedestrian traffic primarily originates on the south from parking at Commonwealth Stadium and the Greg Page Apartments; and on the north from the main campus and the recreation facilities directly across Cooper Drive.

The traffic signal at this location is an actuated signal with protected left turn movements in all directions, which operates a long (100 second) cycle length. The presence of the protected left turn phases results in reduced available pedestrian crossing time, which in turn increases the delay for pedestrian as well as encourages crossing at times other than when the WALK indication is present. The long cycle length increases pedestrian and vehicular delays. Pedestrians were observed to frequently cross against the signal, especially during the protected left turn phases. The high delays at the intersection experienced by both pedestrians and motorists lead to a competition for the same space which can create a hazardous situation for the pedestrian. In addition, pedestrians must cross five or six lanes of traffic on each leg of the intersection, without any protection or refuge from traffic. (See **Figure 9**)

Figure 9: Crossing University Drive at Cooper Drive

## BCTC Mid-Block Crossing (East)


Figure 10: Aerial view of BCTC Mid-block Crossing

The eastern mid-block crossing connects the northern entrance of the BCTC Moloney Building on the south with the recreational fields and blue courts to the north. This crossing is shown in **Figure 10**. A hedge on the north side of the Red Lot restricts pedestrian activity and redirects it to this general area. However several breaks in the hedge currently exist along this area, creating several crossing points. (See **Figure 11**)In addition, the northern gate to the Red Lot obstructs the pedestrian path to the designated crossing, as seen in Figure 12. This obstruction can force pedestrians to use the main vehicular gate to cross Cooper Drive. Another unsafe situation for pedestrians is the presence of turning vehicles in and out from the Red Lot, which often create conflict points and could become hazardous. There is also a vehicular access drive approximately 40 feet east of the Red Lot that provides opportunity for pedestrians to cross even though it is restricted to motor traffic,.

Figure 11: Pedestrians crossing at various points at Mid-block Crossing (East)


Figure 12: Obstructions along pedestrian path (Red Lot Gate)

## Sports Center Drive and Cooper Drive

The signalized intersection of Sports Center Drive and Cooper Drive also provides a pedestrian crossing connecting the BCTC campus with the recreational facilities and campus residential areas to the north. Crosswalks are only provided at this location on the south and west legs due to the absence of sidewalks on the northeast corner of the intersection. The crosswalk across the south leg of the intersection crosses approximately 10 feet behind the existing stop bar, putting pedestrian traffic behind, and in conflict with vehicular traffic at the signal. Due to the long cycle length (125 seconds) at this intersection, pedestrians and motorists delays can be high as well. The long delays may also encourage pedestrians to cross at inappropriate times and thus create a safety hazard.

## Pedestrian Solutions

The preceding section identified that there are three major issues with pedestrian crossings along Cooper Drive. These include: 1. street width; 2 traffic speeds; and 3. unmarked crossings. There are several means that could alleviate these problems aiming to improve the safety of both pedestrians and drivers. In the following a brief description and the applicability of such means is presented.

### Street widths

Crossing wide streets create a safety hazard for pedestrians and require a careful consideration of the potential options for reducing the number of lanes. Even though pedestrian safety is a priority, the narrowing of the street at the potential crossing should not negatively impact the traffic and thus create problems for other system users. A typical solution to such an approach is the careful evaluation of the needs for traffic and the provision of raised islands and medians to facilitate pedestrian crossings. Medians where pedestrians can take refuge are also part of such solutions in order to break the street crossing in two segments and thus minimize the need for longer openings of traffic on busy streets. This approach could be utilized here, since the existing volumes indicate that there are more lanes than actually needed, especially between intersections.

### Traffic speeds

High traffic speeds often pose a problem to pedestrians crossing a street because they create an unsafe environment due tot eh potential underestimation of the traffic speed. Means to reduce speeds have focused on both remedial and strong ways. Simple remedial means include the reduction of speed limits and increase in enforcement. However, past experience indicate that speed limit signs have very little effect on reducing speeds and enforcement creates only temporal effects, i.e. once is gone the speeds increase again. More physical means seem to have a better effect on reducing speeds. Such means include introduction of curvature on straight segments, reduction of number of lanes, and raised crosswalks and intersections. The presence of physical, vertical obstacles on the road have the greatest impact since they require for vehicles to slow down while at the same time make the pedestrians more visible by placing them higher than the street level. This measure is probably the most likely means to be used here along with the reduction of number of lanes.

### Unmarked crossings

There is a belief that pedestrians will cross a street wherever it seems reasonable to them. However, the presence of crosswalks at predetermined locations creates a safer environment and reduces the number of random crossings. Therefore, crosswalks should be placed at reasonable locations, where pedestrians are expected to use them and there seems to be a demand for them. Crosswalks should provide a feeling of safety to pedestrians by providing refuge areas, if needed, and physical separation from the traffic. Moreover, crosswalks should be clearly visible to motorists. Slight vertical deflections at crosswalks for the traffic are often applied to both reduce speeds and make the crossing more obvious along with in-lane pedestrian crossing signs at the crossings (**Figure 13**). Raised crosswalks have also shown better visibility than on pavement crossings because the raise the pedestrian and place them drivers' eye height (especially for larger vehicles). Such devices will be utilized in this study aiming to improve pedestrian visibility and safety.

Figure 13: In-lane Pedestrian Crossing Sign

## Capacity Analysis

As discussed above the primary issues for pedestrians are street widths and traffic speeds. These problems require the reduction of the number of the lanes on Cooper Drive and major cross-streets and the installation of central median to provide a pedestrian refuge area. Based upon these principles, several lane configuration and traffic control alternatives were developed. All alternatives considered are presented and discussed below.

**Existing Conditions**: Provides baseline conditions for comparison of alternatives.

**Alternative 1:**

- Reduce Cooper Drive to one through lane per direction with a center median between the pedestrian bridge and University Drive. (This will eliminate left turns from EQMC parking lot)
- Eliminate the shared through-right turn lane on both approaches of University Drive.
- Provide a median refuge on Cooper Drive at the University Drive intersection.
- Eliminate protected left-turn signal phases at University Drive and Cooper Drive; except for the eastbound left turn movements. *(The detection loop on for the eastbound left turn movement should be moved back from the stop bar 75-100 feet to reduce the number of calls to this exclusive left turn phase, reducing the delays at the intersection).*
- Provide center median at BCTC mid block crossing.
- No Change at Sports Center Drive.

**Alternative 2:**

- Same as Alternative 1, except two-way stop control at Sports Center Drive.

**Alternative 3:**

- Same as Alternative 1, except roundabout at Sports Center Drive.

**Alternative 4:**

- Provide Roundabout at University Drive.
- Reduce Cooper Drive to 2 lanes with center median between Pedestrian Bridge and University Drive.
- Provide center median at BCTC mid block crossing.
- No Change at Sports Center Drive.

**Alternative 5**

- Same as Alternative 4 with Roundabout at Sports Center Drive.

**Alternative 6**

- Same as Alternative 4 except two-way stop control at Sports Center Drive.

In addition to the geometric improvements, revised signal timing plans were developed for all signalized intersections. The revised timing plans aimed to develop a phasing and timing plan for the intersections to reduce delays and queues. The new timing plans require a reduced cycle length at these intersections; this is critical in improving operations along the corridor. **Appendix A** contains the revised signal timing plans for each alternative.

Traffic operations analysis was conducted for the signalized and unsignalized intersections along the corridor for each of the proposed alternatives to ensure that the proposed alternatives do not negatively affect the operation of Cooper Drive corridor. Analysis was conducted for both the AM and PM peak periods using TSIS microsimulation model. Results of this analysis are reported in terms of average delay (seconds per vehicle) for each approach and for the intersection as a whole. **Table 1** summarizes the intersection analysis.

In addition to intersection analysis, corridor level statistics were calculated for each alternative. Corridor level analysis was conducted for both the eastbound and westbound through movements from Nicholasville Road to Sports Center Drive. Statistics for the corridor level analysis include average travel time, total delay, average speed and total stops, to provide an estimate of the level of progression through the corridor. The results of this analysis are presented in **Table 2**.

Table 1: Intersection Traffic Analysis Results

| AM Peak Hour Analysis | *Existing* | *Alt 1* | *Alt 2* | *Alt 3* | *Alt 4* | *Alt 5* | *Alt 6* |
|---|---|---|---|---|---|---|---|
| **Limestone @ Cooper** | **37.33** | **38.34** | **38.59** | **39.48** | **53.06** | **38.69** | **45.79** |
| Eastbound | 57.90 | 57.40 | 60.60 | 57.40 | 89.20 | 58.00 | 71.40 |
| Westbound | 47.80 | 46.10 | 47.00 | 50.60 | 48.60 | 47.10 | 46.70 |
| Northbound | 28.70 | 31.30 | 29.60 | 31.20 | 42.40 | 40.00 | 37.30 |
| Southbounf | 36.50 | 36.60 | 39.30 | 39.40 | 60.00 | 30.70 | 48.30 |
| **Cooper @ Parking Lot West** | **2.90** | **3.79** | **3.85** | **3.93** | **66.68** | **13.87** | **58.47** |
| Eastbound | 2.90 | 4.10 | 4.20 | 4.50 | 116.20 | 21.70 | 97.60 |
| Westbound | 2.80 | 3.40 | 3.40 | 3.20 | 2.50 | 2.40 | 2.60 |
| Southbounf | 9.40 | 5.70 | 7.00 | 6.80 | 6.60 | 4.50 | 5.00 |
| **Cooper @ University** | **26.24** | **20.52** | **21.20** | **26.35** | **76.57** | **66.02** | **73.85** |
| Eastbound | 21.80 | 17.10 | 18.50 | 39.00 | 72.70 | 47.80 | 65.30 |
| Westbound | 22.90 | 14.10 | 15.40 | 11.30 | 130.90 | 147.40 | 133.50 |
| Northbound | 29.70 | 30.10 | 29.50 | 27.70 | 35.90 | 24.00 | 35.40 |
| Southbounf | 36.10 | 26.20 | 26.50 | 23.90 | 7.00 | 7.40 | 6.60 |
| **Cooper @ Parking Lot East** | **3.05** | **3.42** | **2.51** | **2.80** | **61.38** | **85.90** | **56.61** |
| Eastbound | 2.50 | 2.60 | 2.70 | 2.70 | 1.80 | 1.80 | 1.80 |
| Westbound | 3.30 | 3.80 | 2.20 | 3.45 | 97.50 | 146.40 | 92.40 |
| Northbound | 5.20 | 6.40 | 6.40 | 4.20 | 6.80 | 9.60 | 8.10 |
| **Cooper @ Sports Complex** | **16.04** | **11.57** | **5.19** | **2.47** | **25.91** | **25.66** | **27.45** |
| Eastbound | 12.20 | 11.20 | 3.60 | 3.63 | 9.90 | 5.60 | 3.10 |
| Westbound | 10.00 | 12.00 | 1.10 | 2.00 | 35.20 | 24.70 | 14.70 |
| Northbound | 52.10 | 12.20 | 25.10 | 2.90 | 26.70 | 2.40 | 136.60 |
| Southbounf | 32.40 | 8.80 | 17.10 | 6.00 | 26.30 | 339.60 | 173.60 |

Table 1: Intersection Traffic Analysis Results (continued)

| PM Peak Hour Analysis | *Existing* | *Alt 1* | *Alt 2* | *Alt 3* | *Alt 4* | *Alt 5* | *Alt 6* |
|---|---|---|---|---|---|---|---|
| **Limestone @ Cooper** | **49.81** | **51.00** | **51.76** | **51.82** | **50.61** | **50.65** | **52.88** |
| Eastbound | 59.10 | 67.90 | 68.40 | 66.90 | 71.10 | 58.20 | 72.30 |
| Westbound | 51.30 | 49.50 | 50.20 | 52.30 | 49.60 | 49.30 | 50.90 |
| Northbound | 41.10 | 43.40 | 41.40 | 43.10 | 43.70 | 52.10 | 41.50 |
| Southbounf | 49.00 | 48.60 | 50.60 | 49.40 | 46.50 | 42.20 | 51.30 |
| **Cooper @ Parking Lot West** | **2.90** | **4.51** | **4.32** | **4.96** | **4.99** | **4.68** | **4.72** |
| Eastbound | 2.40 | 4.90 | 4.80 | 4.80 | 5.70 | 5.30 | 5.30 |
| Westbound | 1.90 | 2.70 | 2.70 | 2.60 | 1.80 | 1.90 | 1.80 |
| Southbounf | 11.10 | 13.40 | 11.80 | 19.80 | 19.60 | 17.80 | 19.00 |
| **Cooper @ University** | **21.62** | **27.49** | **22.38** | **20.32** | **32.58** | **32.25** | **36.37** |
| Eastbound | 18.00 | 19.40 | 21.20 | 19.20 | 29.60 | 24.10 | 26.30 |
| Westbound | 18.00 | 16.80 | 14.10 | 13.00 | 10.30 | 10.70 | 9.60 |
| Northbound | 22.20 | 50.90 | 35.40 | 28.80 | 35.30 | 33.30 | 35.60 |
| Southbounf | 27.30 | 21.00 | 17.30 | 19.40 | 49.30 | 56.70 | 67.10 |
| **Cooper @ Parking Lot East** | **2.45** | **2.72** | **2.48** | **2.45** | **2.43** | **2.20** | **2.04** |
| Eastbound | 2.30 | 2.60 | 2.70 | 2.60 | 1.80 | 1.80 | 1.80 |
| Westbound | 2.20 | 2.60 | 1.90 | 2.00 | 2.70 | 2.10 | 1.80 |
| Northbound | 8.50 | 6.30 | 6.80 | 6.60 | 9.20 | 10.40 | 9.20 |
| **Cooper @ Sports Complex** | **20.29** | **11.06** | **4.39** | **6.53** | **12.09** | **4.22** | **4.53** |
| Eastbound | 12.90 | 13.30 | 2.90 | 10.80 | 14.90 | 6.90 | 2.00 |
| Westbound | 12.80 | 10.50 | 1.00 | 0.60 | 12.20 | 0.60 | 1.40 |
| Northbound | 41.40 | 9.40 | 8.90 | 4.10 | 9.60 | 5.40 | 10.80 |
| Southbounf | 34.00 | 7.50 | 9.30 | 5.17 | 6.60 | 1.30 | 10.40 |

Table 2: Corridor Level Analysis Results

| | | *Existing* | *Alt 1* | *Alt 2* | *Alt 3* | *Alt 4* | *Alt 5* | *Alt 6:* |
|---|---|---|---|---|---|---|---|---|
| AM PEAK HOUR | | | | | | | | |
| Eastbound | Travel Time (min) | 2.83 | 2.80 | 2.73 | 2.75 | 6.13 | 3.65 | 5.35 |
| | Total Delay (min) | 1.65 | 1.58 | 1.52 | 1.82 | 4.90 | 2.43 | 4.12 |
| | Speed (mph) | 12.83 | 13.38 | 13.54 | 10.42 | 5.41 | 9.61 | 6.05 |
| | Stops | 1108 | 1188 | 957 | 982 | 1910 | 1691 | 2000 |
| Westbound | Travel Time (min) | 2.67 | 2.59 | 2.41 | 2.10 | 6.79 | 7.99 | 6.30 |
| | Total Delay (min) | 1.48 | 1.35 | 1.19 | 1.17 | 5.55 | 6.76 | 5.06 |
| | Speed (mph) | 13.63 | 14.60 | 15.65 | 13.56 | 5.27 | 4.55 | 5.74 |
| | Stops | 1247 | 1291 | 970 | 1048 | 2790 | 3433 | 1665 |
| PM PEAK HOUR | | | | | | | | |
| Eastbound | Travel Time (min) | 2.79 | 3.04 | 2.89 | 3.01 | 3.39 | 2.99 | 2.79 |
| | Total Delay (min) | 1.60 | 1.82 | 1.67 | 1.80 | 2.14 | 1.76 | 1.84 |
| | Speed (mph) | 12.63 | 11.78 | 12.28 | 11.83 | 11.29 | 12.38 | 10.43 |
| | Stops | 1060 | 1142 | 838 | 1049 | 1325 | 1189 | 898 |
| Westbound | Travel Time (min) | 2.65 | 2.62 | 2.41 | 2.44 | 2.74 | 2.57 | 2.56 |
| | Total Delay (min) | 1.46 | 1.40 | 1.19 | 1.24 | 1.49 | 1.34 | 1.31 |
| | Speed (mph) | 12.77 | 13.03 | 13.55 | 13.37 | 12.68 | 12.93 | 12.96 |
| | Stops | 1153 | 1242 | 1078 | 1133 | 1948 | 9295 | 1817 |

As can be seen from the above tables, all alternatives examined provide an acceptable level of service and do not create undue delays. However, it is evident that those alternatives where a roundabout at University Drive is proposed (Alternatives 4, 5 and 6) provide higher delays at that intersection than any of the other alternatives considered. This is primarily due to the high turning traffic volumes on Cooper Drive, which does not provide adequate gaps for the heavy turning movements exiting University Drive. These alternatives were removed from further consideration.

Alternatives 1, 2 and 3 which incorporated signal timing and phasing improvements, along with alternative traffic control strategies at Sports Center Drive, were shown to provide vehicular operations similar or better than the existing conditions. It should be noted here that all these alternatives apply a reduction in the number of lanes at University Drive, which validates the original assumption that there are more lanes than needed in this section of the roadway. Alternatives 2 and 3 were also shown to provide significantly lower delay at Sports Center Drive by removing the traffic signal, and providing an alternative form of traffic control.

Based upon the analysis presented here, Alternatives 2 and 3 are shown to provide the best vehicular operations, while also provide extensive improvements for pedestrian movements along the corridor. Due to the more extensive improvements associated with Alternative 3, through the construction of a roundabout at the intersection of Cooper Drive and Sports Center Drive, this alternative could be viewed as the long range alternative for the corridor; and Alternative 2, could be then considered as an interim solution to immediately accommodate pedestrian and vehicular traffic.

# Recommendations

## *Short-Term Solution*

To immediately address the pedestrian issues and concerns along Cooper Drive, Alternative 2 is proposed as the preferred alternative. These improvements include the following:

- Reduce Cooper Drive to one through lane per direction with a center median between the pedestrian bridge and University Drive. (This will eliminate left turns from EQMC parking lot)
- Eliminate exclusive right turn lane on northbound leg and southbound curb lane of University Drive
- Provide median refuge on Cooper Drive at the University Drive intersection.
- Eliminate protected left-turn signal phases at University Drive and Cooper Drive; except for the eastbound left turn movements. *(The detection loop on for the eastbound left turn movement should be moved back from the stop bar 75-100 feet to reduce the number of calls to this exclusive left turn phase, reducing the delays at the intersection).*
- Provide center median at BCTC mid block crossing.
- Same as Alternative 1, except two-way stop control at Sports Center Drive.

In addition to these improvements, additional miscellaneous improvements are also possible due to the proposed lane reconfiguration. These include:

- Reducing the number of through lanes on University Drive from 4 to 2, to provide additional on-street parking (north leg only) and a bicycle lane in each direction (both legs).

- Providing a bicycle facility on Cooper Drive between Nicholasville Road and University Drive.

All short term improvements proposed under Alternative 2 are shown in **Figure A1**.

## *Long-term Solution*

Alternative 3 is proposed as the long term solution. This alternative includes a roundabout at the Sports Center Drive intersection along with all changes noted in the short-term solution. It is proposed that when long term improvements are made on the corridor, additional improvements along Cooper Drive also should be incorporated to further enhance and improve pedestrian and vehicular safety. These include:

- Widening Cooper Drive to a 46 foot cross section, between University Drive and Sports Center Drive, to accommodate 12 foot lanes in each direction, a 12 foot raised median and 5 foot bicycle lanes in each direction.

- Providing sidewalks on Cooper Drive between University Drive and Sports Center Drive.

- Paving the existing “unofficial” off street shoulder parking areas along Cooper Drive and convert them to back-in parking only. This will eliminate the hazardous condition when vehicles are backing out of parking spaces onto the street, often with visibility obstructed by adjacent parked vehicles. Providing adjacent sidewalks will also remove the pedestrian traffic from Cooper Drive that is generated by this parking area.

All long term improvements proposed under Alternative 3 are shown in **Figure A2**.

## *Location Specific Recommendations*

### Mid-Block Crossing (West)

The problems associated with this crossing are the roadway width and the speed of the traffic. The reduction of the total number of travel lanes on Cooper Drive and the provision of a median to allow pedestrian refuge will address these issues. Reducing the number of lanes will significantly improve safety for both pedestrians and vehicles. The exposure of pedestrians while crossing will be reduced, while at the same time the demands for lane choice and change decisions will be eliminated. The central median proposed at this location should be raised to provide a physical separation of pedestrian and vehicular traffic and improved channelization to vehicles. The crosswalk should be raised to allow for smooth crossing and better pedestrian visibility. As an interim solution, a wide flush median with transverse markings could be used.

It is also critical to increase the visibility of the crossing, alerting motorists to the potential presence of pedestrians. At a minimum advance pedestrian crossing signs should be installed on both approaches. A raised crosswalk at this location is also recommended to increase the visibility of pedestrians and reduce speeds through this congested area.

A sidewalk on the south side of Cooper Drive should be constructed providing access to the Plant Sciences/Agricultural Engineering buildings, as the existing footpath indicates.

### Veterans Drive Tunnel

It is recommended that a pedestrian facility be provided throughout this entire section of Veterans Drive to separate pedestrian and vehicular traffic. The preferred placement of this facility would be on the east side of the street. Placing the sidewalk on this side will not interfere with the existing parking. AT the same time, it will extend the existing sidewalk at Parking Structure 1 to the north and continue the sidewalk to the south, along well worn paths surrounding the Tobacco Research and Development Center. In order to reduce costs an extruded curb could be used, in conjunction with bollards to separate the pedestrian facility from the travel way. This alternative would require the removal of the existing sidewalk through the tunnel.

A similar facility could be constructed on the west side of the tunnel, in order to avoid demolition and reconstruction costs associated with removal of the tunnel sidewalk. However, drainage problems on this side of the roadway may complicate placement of an extruded curb, requiring a raised sidewalk. Sight distance around the embankment on the south side of the tunnel is an additional concern if the sidewalk is placed on this side. Therefore, it is recommended that the embankment be cut back, by flattening the slope in order to provide improved sight distance around the embankment. Cutting back this embankment would also allow for improved drainage through this area.

Regardless of the side that the sidewalk will be placed, it is recommended that a narrower lane width (10-11 ft) be maintained to encourage traffic to slow down and provide additional room for the pedestrian facility. In addition, the profile of the speed bumps should be increased to make them more effective at reducing speeds.

## University Drive and Cooper Drive

As recommended above, the total number of lanes to be crossed should be reduced at this intersection, and a sufficient central median should be provided to allow for reduced exposure and a pedestrian refuge area, similar to that currently provided on the north leg of the intersection as shown in **Figure 14**.

Figure 14: Proposed Median Design

Providing raised pedestrian crossings at the intersection will also provide additional traffic calming measures, and increased visibility of pedestrians. It is therefore recommended that a raised intersection be provided at this location to both provide better pedestrian visibility and reduce travel speeds through the intersection and along Cooper Drive.

Due to the high volume of bicycle traffic observed at the intersection, bicycle lanes should be provide to separate bicycle traffic from either motorized or pedestrian areas.

## BCTC Mid-Block Crossing (East)

It is recommended that the pedestrian paths be revised to direct all pedestrian crossing activities to a single location. This will allow for pedestrian crossing treatments, as well as lessening the confusion to motorists due to the numerous pedestrian crossing points. The following improvements are proposed enhance channelization.

1) Relocate the entrance gate to the red lot closer approximately 6 feet closer to the Cooper Drive so that the gate arm is in line with the existing hedge, providing a more direct path for pedestrians.

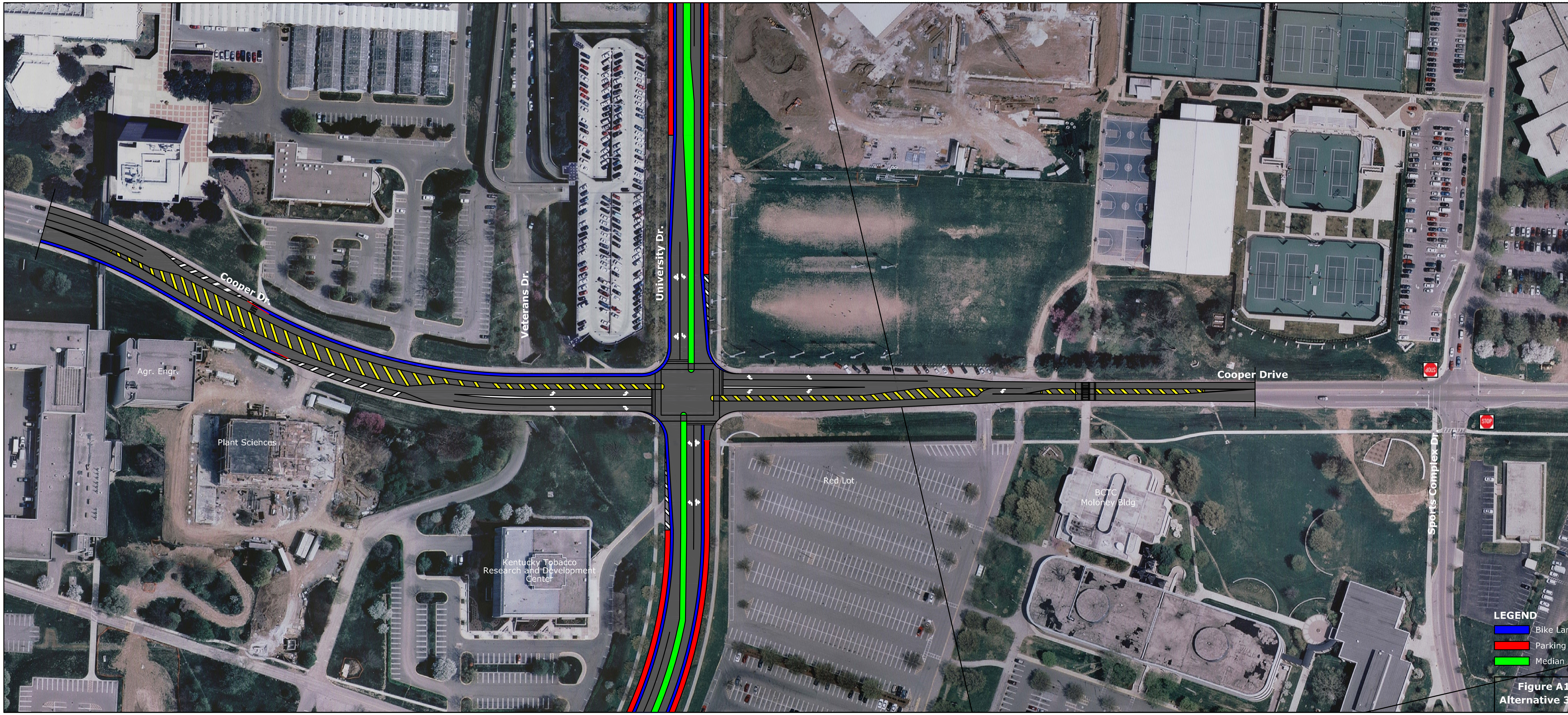
2) Remove the existing vehicular access drive east of the Red Lot gate and continue the existing hedge line to the main sidewalk in front of BCTC.

Once pedestrian traffic can be consolidated at this location, a raised mid-block crosswalk is proposed in conjunction with a raised median. Advance and in-lane pedestrian crossing signs should also be installed at this location.

## Sports Center Drive and Cooper Drive

Providing raised pedestrian crossings at the intersection will also provide additional traffic calming measures, and increased visibility of pedestrians. A central median should also be considered to allow for reduced exposure and a refuge area.

The use of a roundabout will also improve pedestrian and vehicular separation and improve flow for all users. Reducing the delay here will serve to reduce pedestrian and/or motorist frustration and subsequently reduce aggressive maneuvers from the roadway users.


Cooper Dr.
Agr. Engr.
Plant Sciences
Kentucky Tobacco Research and Development Center
Veterans Dr.
University Dr.
Red Lot
Cooper Drive
BCTC Moloney Bldg
Sports Complex Dr.
LEGEND
Bike Lane
Parking
Median
Figure A1
Alternative 3

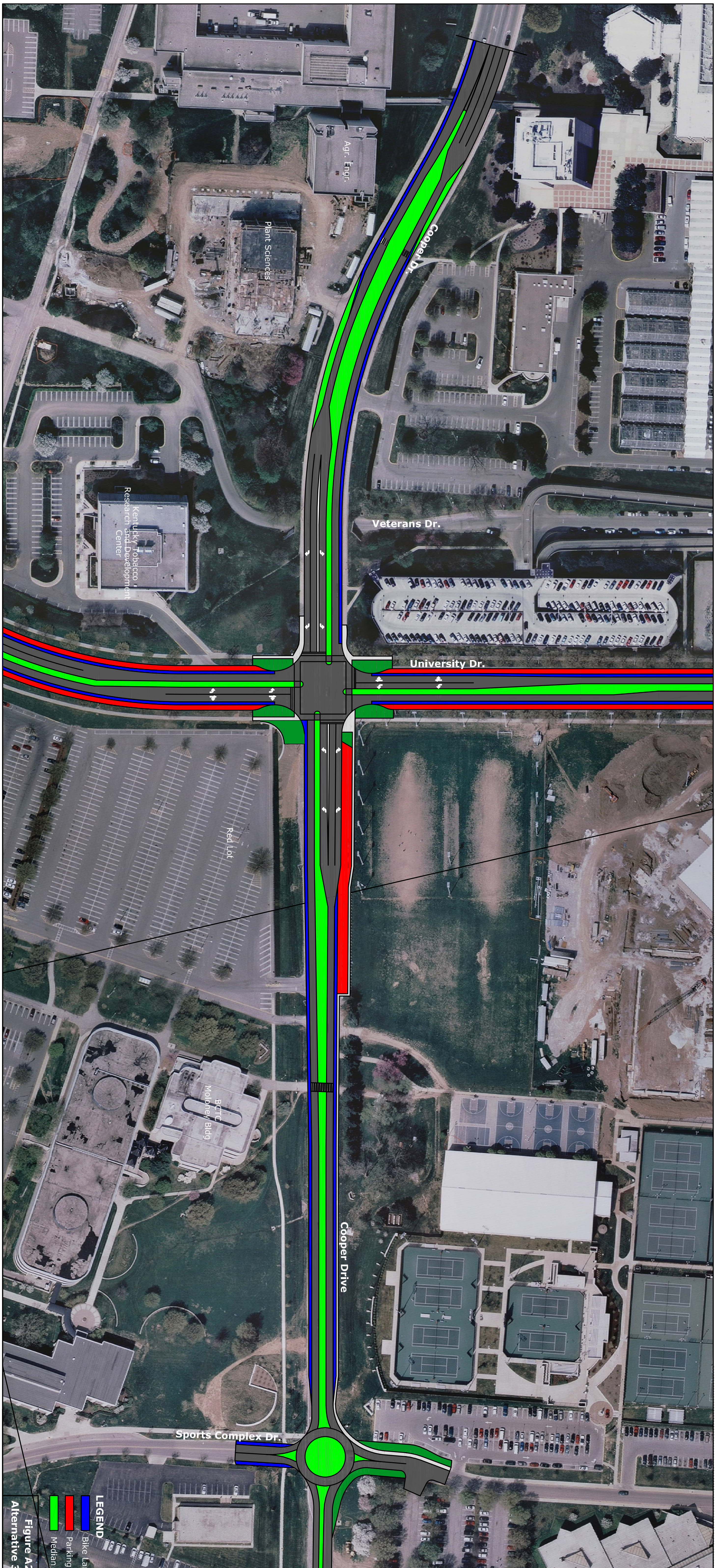



Figure A2
Alternative 3

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