Wayne Avenue
Safety Improvement Study

Safety Study
Prepared for: ODOT District 7
January 2025

OHIO DEPARTMENT OF TRANSPORTATION

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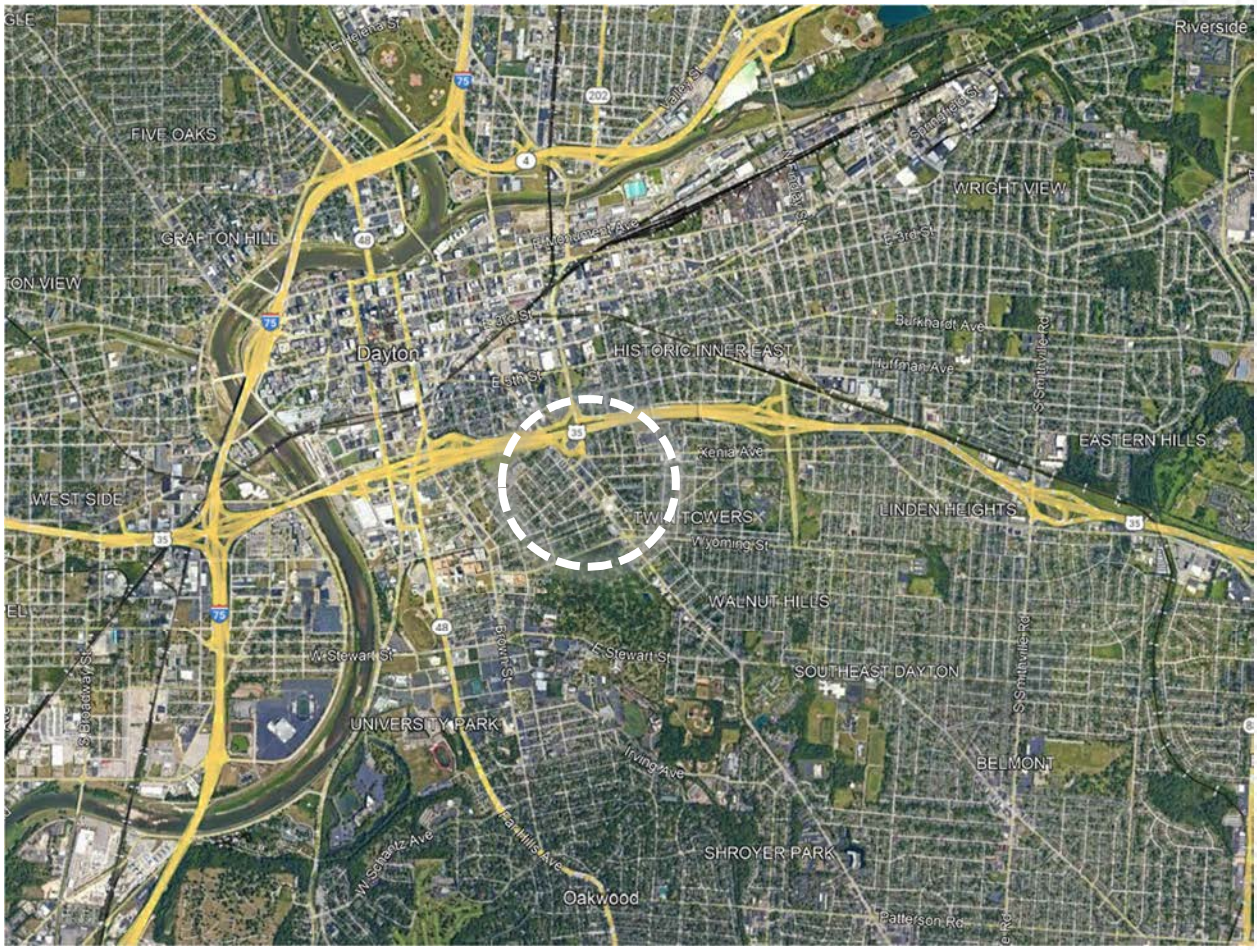
Ohio Department of Transportation District 7
Dayton, Montgomery County
Segment: Wayne Avenue between Wyoming Street and US 35
Study Completion Date: January 2025
Consultant: Environmental Design Group

LOCATION MAP



II. EXECUTIVE SUMMARY

A. Project Background

The City of Dayton is interested in a safety study and funding application to improve the safety and mobility of all road users along Wayne Avenue from Wyoming Street to US 35. This five-lane roadway has an ADT of approximately 18,000 vehicles per day, with limited pedestrian facilities, several bus stop locations, and a history of high crash frequencies and severities. A five-year crash analysis shows 219 crashes occurred on the corridor in the years 2019 – 2023, with 28.8% causing injury, three (3) fatalities, and five (5) severe injuries. Nine (9) crashes involved pedestrians and three (3) involved bicycle riders. The study proposes targeted safety improvements that address high-speed risks, enhance pedestrian crossings and other facilities, and improve the overall safety infrastructure of the segment of Wayne Avenue from Wyoming Street to Buckeye Street. The proposed safety improvements are multi-faceted, incorporating traffic calming measures, pedestrian and bike infrastructure enhancements, lighting, strategic signal adjustments, and other modifications to foster a safer, more accessible environment for all road users on this corridor.

B. Overview of Possible Causes

The analysis of Wayne Avenue has identified several key factors contributing to the high crash frequency and safety challenges within the corridor:

Challenging and Complex Signalized Intersections: The intersections at Wyoming Street and Clover Street exhibit complicated layouts with multiple lanes, unclear signage, and insufficient pedestrian facilities. These design elements create confusion for drivers and pedestrians, often leading to unsafe decision-making. Factors like skewed intersections, inadequate sight lines, and poorly defined lanes further contribute to an elevated risk of crashes, including rear-end collisions and red-light running incidents. Improvements to lane markings, signage, signal visibility, and intersection geometry are critical to enhance safety at these locations.

Multilane Roadway Configuration: Wayne Avenue's multilane setup, with multiple travel lanes and a center turn lane, increases the number of conflict points where crashes can occur. The wide roadway encourages higher speeds, which reduces reaction times and increases crash severity. This complex environment, combined with high traffic volumes, can overwhelm drivers and create hazardous conditions for pedestrians and cyclists attempting to cross. Implementing traffic calming measures like raised medians, speed tables, and protected crossings can help manage these risks.

Lack of Pedestrian and Bike Infrastructure: The absence of adequate pedestrian and bicycle facilities along Wayne Avenue is a significant safety concern, with multiple crashes involving vulnerable road users reported in the area. The narrow

sidewalks, limited crosswalks, and lack of bike lanes make it difficult for pedestrians and cyclists to navigate safely. Creating safer crossings, improving sidewalk conditions, and integrating bike lanes are essential steps to enhance mobility for nonmotorized users, particularly near intersections and public transit stops.

These factors highlight the need for a comprehensive approach to redesign Wayne Avenue's infrastructure to prioritize safety for all road users, including implementing traffic calming, enhanced signage, and improved pedestrian and bicycle facilities.

C. Recommended Countermeasures

Upon identifying the probable causes that negatively affect roadway safety on Wayne Avenue, the following countermeasures have been recommended for the study area.

New Pavement Markings: New pavement markings, including stop bars, high-visibility crosswalks, and lane arrows, should be applied throughout the studied corridor of Wayne Avenue and at the approaches of intersecting roadways.

ADA Compliance: New ADA-compliant curb ramps should be installed at each pedestrian crossing. Additionally, any repairs to the existing sidewalk should be addressed to maintain accessibility.

Signal Improvements: There are three signalized intersections within the study area, each with low-visibility signal heads. Signal improvements should be utilized at each of these intersections, including new LED signal heads, reflective backplates, mast-arms, and Dilemma Zone Protection (DZP) systems. Signal phasing should be optimized for the appropriate volume of traffic and should include leading pedestrian intervals (LPIs) or exclusive pedestrian phasing.

Pedestrian Hybrid Beacon: A raised two-stage pedestrian hybrid beacon (PHB) should be installed near the intersection of Wayne Avenue and Pierce Street / Park Drive to facilitate safe mid-block crossings for pedestrians and to influence slower vehicle speeds in an area frequently trafficked by pedestrians. This crossing should be installed in conjunction with two adjacent medians, creating a two-stage crossing with a pedestrian refuge island.

Raised Intersection at Clover Street: The intersection of Wayne Avenue and Clover Street should become a raised intersection, enhancing pedestrian visibility in crosswalks and influencing slower vehicle speeds. This intersection should also utilize bollards on the perimeter of each corner, protecting pedestrians from errant vehicles.

Improved Bus Stop Amenities: To meet the needs of the public as expressed through the public input survey, bus stop amenities should be installed throughout the corridor. Bus shelters are recommended to be installed at Keowee Street and Wyoming Street. Benches are recommended to be installed at Hickory Street, Bradford Street, Clover Street, and Oak Street.

Street Trees: The existing street trees should be evaluated and replaced if the tree has grown too large, as large trees become a danger to run-off-road vehicles and negatively disrupt adjacent sidewalk. All street trees should have new grates and boxes to improve the aesthetics of the corridor and create an inviting environment for all road users.

Utility and Lighting Improvements: The existing overhead utilities create distracting visual clutter for motorists, likely drawing their focus from more valuable items: signage, signals, and other road users. This should be addressed by burying the utilities underground, if feasible. New lighting should be installed throughout the corridor to enhance safety for all road users during non-daylight hours.

Road Diet: A road diet should be implemented north of Keowee Street / Adams Street where the AADT of Wayne Avenue lessens. This includes the removal of two travel lanes, moving the curb inward, and adding sidewalk or green space to improve pedestrian facilities. Traffic calming within this road diet can also be enhanced with the addition of a median containing shrubs and trees.

Gateway Treatments: Decorative gateway treatments should be installed at both the north and south ends of the project limits. These treatments are likely to enhance traffic calming as driver awareness of the surrounding neighborhood is heightened. The treatments also improve aesthetics and can create residential pride in this Dayton neighborhood.

Other repairs: Upon completion of the above countermeasures, any necessary curb repairs and/or drainage replacements should also be addressed.

III. PURPOSE AND NEED

The purpose of this study is to evaluate the existing safety conditions and to identify potential countermeasures along the 0.5-mile corridor of Wayne Avenue. The study limits span from Wyoming Street to the US 35 overpass, just north of Buckeye Street. The study area contains ten intersections, three of which are signalized.

The studied crash history of Wayne Avenue depicts high crash rates for motorized and nonmotorized users alike. As a result, this study recommends improvements to enhance safety for all road users. However, it is pertinent that additional improvements be made specifically for nonmotorized users. Vehicles, especially

newer models, are designed to protect those inside with safety features such as seatbelts, airbags, automatic breaking, and steering assistance. Pedestrians and cyclists have much greater exposure to, and much lower resilience during a collision. For this reason, nonmotorized travelers are often referred to as vulnerable road users, or VRUs.

In the years 2019 – 2023, the corridor hosted twelve VRU crashes: nine pedestrian crashes and three cyclist crashes. All but one of these crashes resulted in injury. In December 2022, a fatal pedestrian crash occurred when a driver failed to maintain control of their vehicle, striking a pedestrian who was standing in the sidewalk at the Clover Street intersection. Since the start of this safety study, another VRU crash occurred at this same intersection, which resulted in serious injury. In July 2024, a driver struck a young girl on her bicycle, as well as two other pedestrians, before dragging the girl and her bicycle for nearly half a mile.

It is evident to the City of Dayton that transformative changes must be implemented throughout this corridor. This safety study identifies and recommends countermeasures for the City to utilize in hopes of decreasing crash rates and creating a safe, equitable, and welcoming transportation network for all road users.

IV. EXISTING CONDITIONS

A. Background

The 0.5-mile roadway segment of Wayne Avenue between Wyoming Street and US 35 is a north-south principal arterial located just southeast of downtown Dayton. This segment contains ten intersections, three of which are signalized. The roadway is five lanes wide, with two northbound lanes, two southbound lanes, and a center turn lane. The posted speed is 35 mph.

The corridor provides access to an array of land uses including restaurants, businesses, residential units, and a gas station. It also hosts a number of bus stops for the Dayton RTA.

B. Conditions Diagrams

Environmental Design Group staff visited the project site on Wednesday, July 10, 2024. The investigation followed the GORE (Geometry, Operations, Roadway Users/Human Factors, and Environment) Model as described in the ODOT Regional Road Safety Audit Implementation Guide. The field-gathered information is supplemented with other sources of information from Ohio Geographically Referenced Information Program (OGRIP) Data Downloads and Google Street View imaging. The observations, traffic controls, and current conditions are described below and visually articulated in Figure 1 – Figure 4. Full sheets are available in Appendix A.

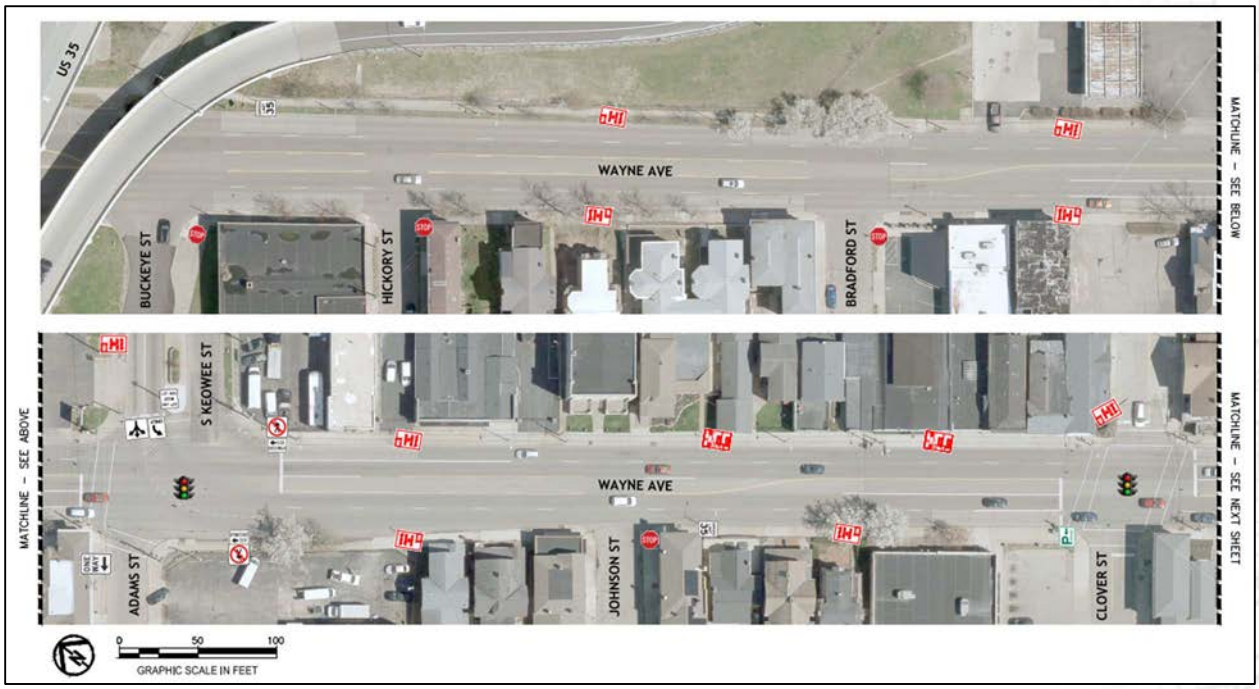


Figure 1. Existing Traffic Control (1) Buckeye Street to Clover Street

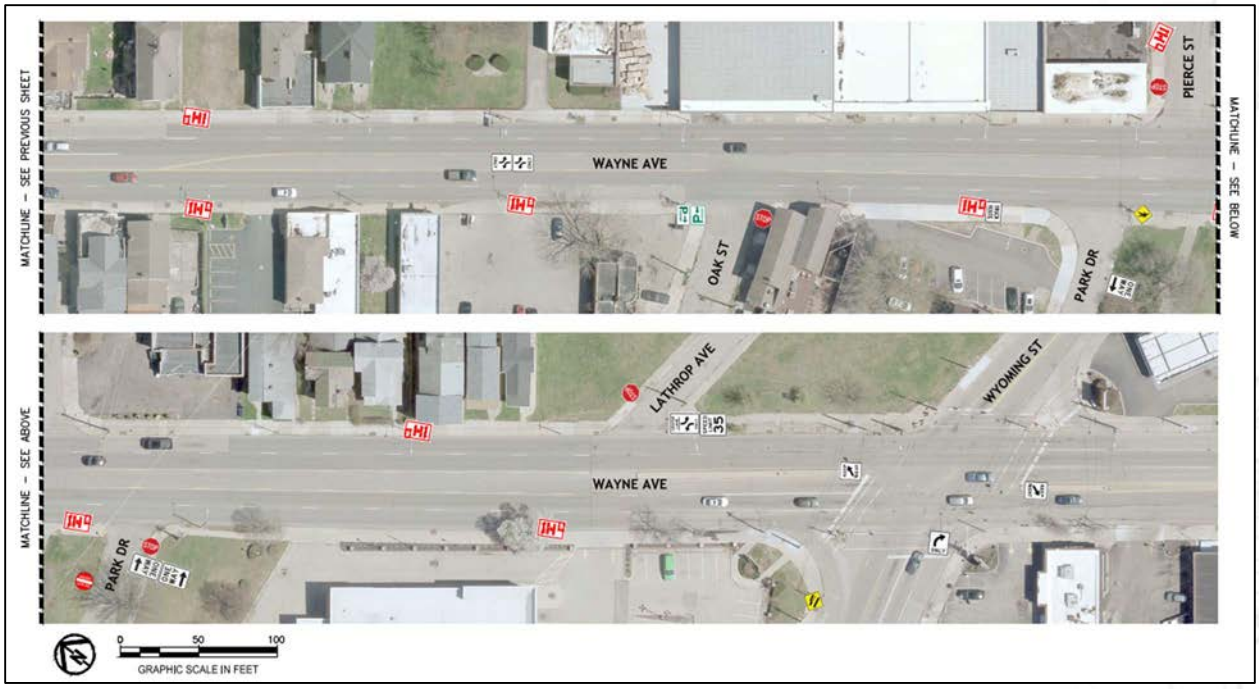


Figure 2. Existing Traffic Control (2) Clover Street to Wyoming Street

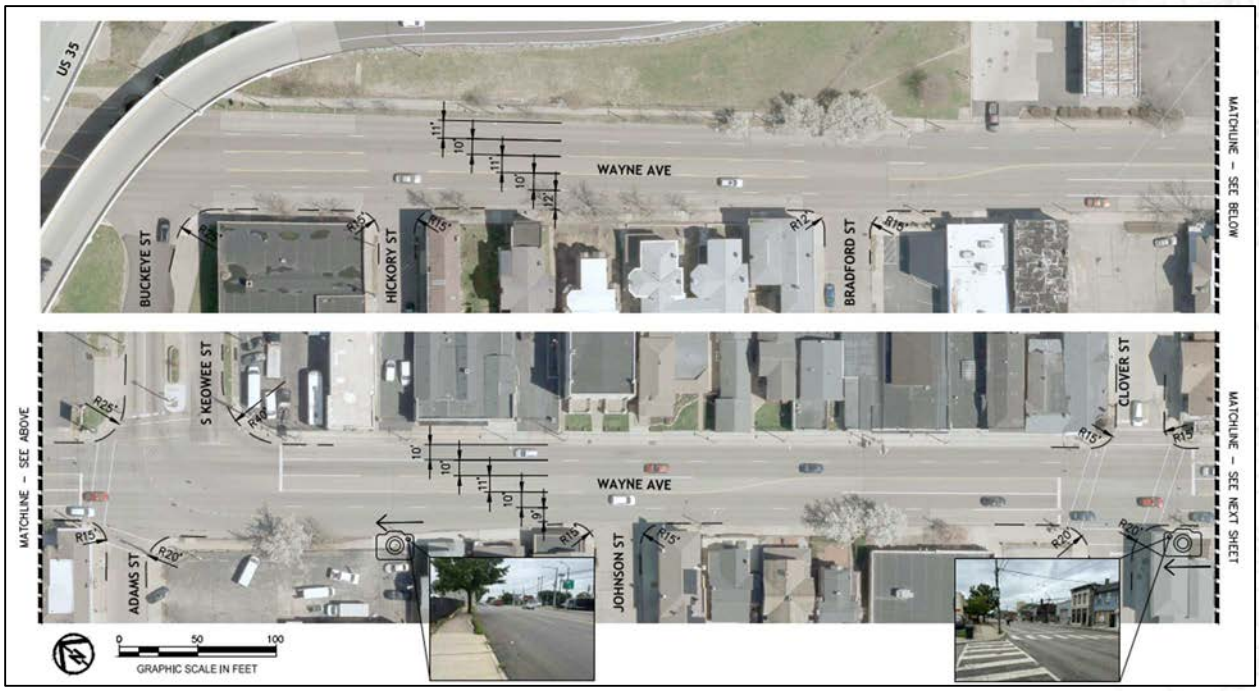


Figure 3. Existing Conditions (1) Buckeye Street to Clover Street

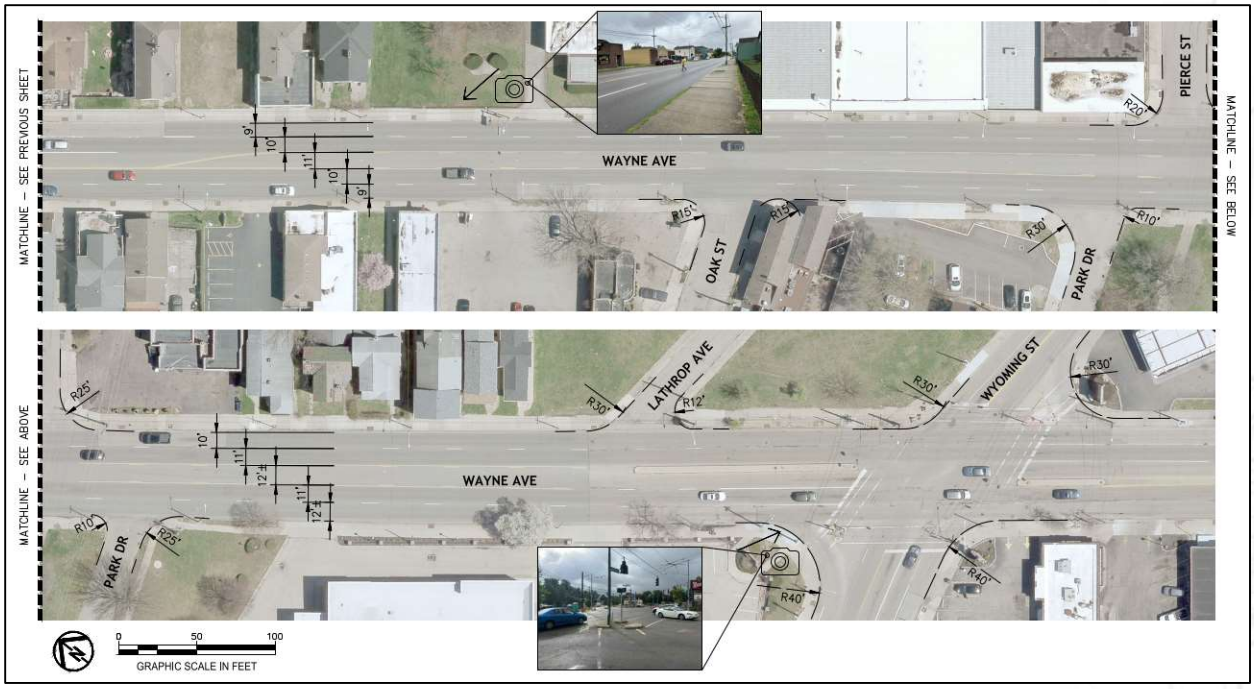


Figure 4. Existing Conditions (2) Clover Street to Wyoming Street

C. Physical Conditions

This section will describe each portion of the study area separately, incorporating the four elements of the GORE Model. Each of these elements are defined below:

Geometry is roadway elements such as curves, gradient, sight distance, and clear zones.

Operations describes how the road is utilized and how effective current operational practices are at preventing or mitigating crashes.

Roadway Users/Human Factors are the various modes present along the roadway and the potential conflicts that may exist.

Environmental is the performance of a roadway under various environmental conditions such as differing weather patterns and lighting scenarios.

1. Geometry
   Roadway elements such as curves, gradient, sight distance, clear zones.

   ### Buckeye Street to Keowee Street

   The segment of Wayne Avenue between Buckeye Street and Keowee Street is approximately 700 feet long. The urban segment has multiple

access drives and intersections at Hickory Street and Bradford Street. The section slopes downward to the south at approximately 2%.

There are four lanes and one two-way left-turn lane, varying from approximately 10-12 feet wide. There are no shoulders. Sidewalks are present on both sides of the street, varying from approximately 7-foot to 9-foot wide. However, there are no marked crossings at either of the intersections.

There are items in the clear zone, notably green utility poles for Dayton RTA. The adjacent land to this segment is used for residential and commercial purposes, including coffee shops, apartments, and a gas station.

The Intersection of Wayne Avenue and Keowee Street/Adams Street

This is an urban intersection with businesses on each quadrant and approach. The east leg of the intersection is Keowee Street and the west leg is Adams Street. The south and west legs are nearly flat, the north leg slopes down into the intersection at approximately 2%, and the east leg slopes down into the intersection at approximately 1%.

The north and south legs of the intersection (Wayne Avenue) both have two approach lanes and a left turn lane. Adams Street has no approach lanes, as this is a one-way street in the westbound direction. Keowee Street has two approach lanes approximately 11 feet wide, and a center median approximately 14 feet wide. None of the approaches have shoulders. For left-turning westbound traffic, the outermost receiving lane is widened to accommodate larger vehicles, such as large trucks.

There are crosswalks present at three approaches, although they are not high-visibility. The northwest corner of the intersection has a storefront that extends to the sidewalk, impacting the sight distance for eastbound drivers on Adams Street and southbound drivers on Wayne Avenue. Other factors in the clear zone are utility poles and a fence. Figure 5 depicts the northbound approach to this intersection from a pedestrian's point of view.

Keowee Street to Clover Street

The segment of Wayne Avenue between Keowee Street and Clover Street is approximately 500 feet long. This urban segment has a few access drives and an intersection at Johnson Street. The segment is nearly flat.

There are four lanes and one two-way left-turn lane, varying from approximately 9-11 feet wide. There are no shoulders. Sidewalks are

present on both sides of the street, varying from approximately 6-11 feet wide. There are no crosswalks at the intersection with Johnson Street.

The clear zone contains utility poles and a large sign for US 35 (see Figure 6). Trees also reside in the clear zone and have become overgrown with branches in the traveled way. The adjacent land is used for residential and commercial purposes, including homes, restaurants, a Family Dollar, and other various storefronts.

The Intersection of Wayne Avenue and Clover Street

This is an urban intersection with businesses on three quadrants and a home on the fourth. Each of the four legs are nearly flat.

The north and south legs of the intersection (Wayne Avenue) both have two approach lanes and a left turn lane. The east leg (Clover Street) has two approach lanes, varying from approximately 10-11 feet wide. The west leg (Clover Street) has one approach lane, approximately 12 feet wide. None of the approaches have shoulders. During the site visit, it was noted that the radii of the curb return appear to be small.

Three of the quadrants contain buildings that sit close to the roadway, impacting the sight distance for northbound, southbound, and eastbound drivers. There are also poles in the clear zone at each approach and corner that worsen sight distance.

There are high-visibility crosswalks at this intersection. These markings appear to be new, as recent satellite imagery shows crosswalks that are not high-visibility. These crosswalks are shown in Figure 7.

Clover Street to Wyoming Street

The segment of Wayne Avenue between Clover Street and Wyoming Street is approximately 1,300 feet (0.25 miles) long. This urban section has multiple access drives and intersections at Oak Street, Park Drive, Pierce Street, and Lathrop Avenue. Note that the City plans to remove access to Lathrop Avenue and repurpose the land for a new school. A southbound view of this segment is shown in Figure 8.

There are four lanes and one two-way left-turn lane, varying from approximately 9-12 feet wide. There are no shoulders. Sidewalks are present on both sides of the street, varying from approximately 4-foot to 12-foot wide.

There are no crosswalks at any of the intersections within this segment. Additionally, the intersections of Wayne Avenue with Oak Street, Park Drive, and Lathrop Avenue are skewed at various angles. The clear zone contains utility poles and buildings. The adjacent land to this segment contains a mix of homes and various storefronts.

The Intersection of Wayne Avenue and Wyoming Street

This is an urban intersection with businesses on three quadrants and along the north and south legs (Wayne Avenue). The east and west legs (Wyoming Street) are residential and are populated by homes. The east leg is skewed at approximately 44 degrees. The west leg is skewed at approximately 24 degrees. This intersection is depicted in Figure 9.

The north and south legs of the intersection both have two approach lanes and a left turn lane. Additionally, the rightmost lane in the north and south legs have slip lanes to turn right onto Wyoming Street. The east leg has two approach lanes, varying from approximately 9-10 feet wide. The west leg has three approach lanes, varying from approximately 11-13 feet wide. None of the approaches have shoulders.

The buildings present on each quadrant are set back from the roadway and do not disturb sight distance, but other factors such as poles, business signs, and shrubs populate the clear zone.

2. Operations

How the road is utilized and how effective current operational practices are at preventing or mitigating crashes.

Buckeye Street to Keowee Street

There are five lanes for traffic in this section: two for northbound traffic, two for southbound traffic, and one two-way left-turn lane that transitions into a left turn lane for southbound traffic near the Keowee Street intersection.

The Intersection of Wayne Avenue and Keowee Street

Since Adams Street is a westbound one-way street, it is aligned with the westbound lanes on Keowee Street, allowing through traffic from Keowee Street to follow a straight path. However, this alignment causes left-turning northbound traffic to travel an extended distance, far past the stop bar, to reach Adams Street. This lengthens the time that these cars must be in the intersection, increasing the chances of a crash.

The westbound approach is the only approach to have protected left turns (since there is no eastbound approach on Adams Street). Traffic appeared to be speeding on the southbound approach. Speeding drivers must abruptly hit their brakes once the traffic signal switches to yellow or risk running the red light. Drivers were observed turning left during the red phase on the southbound approach.

Keowee Street to Clover Street

There are five lanes for traffic in this section: two for northbound traffic, two for southbound traffic, and one left turn lane which is used for both the Keowee Street and Clover Street intersections. Southbound traffic was observed to speed through this section.

The Intersection of Wayne Avenue and Clover Street

On the south leg (Wayne Avenue), the far east lane is concrete and utilized as a bus stop. Each approach has two 3-spot signal heads, which appear to be relatively small and may be less noticeable to motorists. There is a signal actuator present in the eastbound approach. There are no protected left turns at this intersection but there are left-turn lanes on both the northbound and southbound approaches. The east and west legs are slightly misaligned, creating a diagonal path for eastbound and westbound through traffic. Due to the diagonal nature of the intersection, eastbound and westbound traffic may experience more difficulty in crossing safely.

There are high-visibility crosswalks on each approach at the intersection. Additionally, there are pedestrian signal heads, push buttons, and phase countdowns. At the site visit, southbound drivers were observed to be speeding.

Clover Street to Wyoming Street

There are five lanes for traffic in this section: two for northbound traffic, two for southbound traffic, and a two-way left-turn lane. At the approach of the Wyoming Street intersection, the two-way left-turn lane transitions into a left turn lane for southbound traffic, being separated by northbound traffic with a concrete median approximately 4 feet wide.

Along this segment, the curb is missing or damaged, signaling a pattern of vehicles hitting the curb or driving off the road. There are some curb cuts present in this segment which may be unused, possibly allowing for their removal.

The Intersection of Wayne Avenue and Wyoming Street

On the west leg (Wyoming Street), the roadway splits into two lanes without signifying if one lane is to act as a left turn lane. On the east leg, the two receiving lanes appear to merge back into one lane, further added to the confusion of whether both approaches on the west leg can continue straight. There are two crosswalk islands located at northwest and southeast corners with right turn slip lanes as previously discussed.

There was significant damage on the concrete median on the north leg of the intersection, signifying possible U-turns, drivers hitting the median, cars scraping the side of it, or crashes that heavily impacted the appearance of the median. Similarly, the concrete pedestrian islands exhibit damage from past stray vehicles.

At the time of the field review, this intersection was under construction for lane upgrades. Traffic was temporarily maintained with construction barrels for most of the corridor between Clover Street and Wyoming Street.

3. Roadway Users/Human Factors
   The various modes present along the roadway and the potential conflicts that may exist.

Buckeye Street to Keowee Street

Pedestrians were observed along this segment. Pedestrians utilize the sidewalks to access local businesses. Vehicles were traveling at normal speeds for this section of the roadway.

The Intersection of Wayne Avenue and Keowee Street

Road users observed at this intersection include pedestrians, bikes, trolleys, trucks, and street cleaners. One cyclist was seen riding on the sidewalk along the westbound approach.

Keowee Street to Clover Street

Due to the geometry of this intersection, westbound traffic turning left onto Wayne Avenue is received by a wider right lane to accommodate constraints of larger vehicles. This wider right lane may influence drivers to pursue higher speeds as they move southbound on Wayne Avenue.

The Intersection of Wayne Avenue and Clover Street

Road users observed at this intersection include pedestrians, buses, bikes, and skateboarders. There are bus stops on both the northbound and

southbound approaches. There is also a bike rack located in the southwest quadrant.

Pedestrians and cyclists were seen crossing Wayne Avenue despite northbound and southbound traffic having a green light. Several pedestrians were observed not utilizing the crosswalks located at the intersection. With Family Dollar located in the northwest quadrant, pedestrians choose to take the shortest and fastest path to reach the business. Rather than using the crosswalks, the pedestrians cross the street where a pathway connects to the sidewalk. Those who did use the crosswalks showed urgency to cross as fast as possible, which may indicate that there is a concern that vehicular traffic moving too fast or may not be paying attention to crossing pedestrians. Figure 10 and Figure 11 depict both a pedestrian and a cyclist cross the north leg of the intersection outside of the marked crosswalk. A cyclist on the northbound approach was observed to be riding on the sidewalk.

Clover Street to Wyoming Street

Road users observed along this segment include pedestrians and cyclists. Many pedestrians were observed walking outside of crosswalks to local businesses. One example is shown in Figure 12. In this segment, there were few pedestrian facilities that allowed pedestrians to cross safely to access local businesses and parks.

At the Pierce Street intersection, westbound drivers stopped at the stop sign have a challenged sight distance due to buildings. It was observed that drivers on Pierce Street come to a stop closer to the intersection to gain better sight distance before turning. This limited sight distance is depicted in Figure 13. Additionally, there are businesses located along both sides of the roadway for most of this segment.

The Intersection of Wayne Avenue and Wyoming Street

Road users observed at this intersection include scooters and cyclists. These users did not utilize the intersection or crosswalks to reach the bike lane present on Wyoming Street. Additionally, the building in the northwest quadrant is utilized by AARP, signaling a likely increased presence of older drivers. This parking lot has speed bumps at the entrance/exit, as seen in Figure 14.

There is a pole located on the sidewalk in the northeast quadrant, reducing the sidewalk width and preventing the use of wheelchairs. This pole is depicted in Figure 15. There appears to be damage to the concrete pedestrian island in the southeast quadrant, signifying that pedestrians

may not be safe utilizing this facility. This damage can also be seen in Figure 9. Additionally, it was noted that, although outside of the limits of this study, pedestrians often cross Wayne Avenue between the Walgreens and Kroger just south of this intersection. This crossing behavior has led to pedestrian crashes in the past and also supports a common theme that pedestrians are not crossing Wayne Avenue at the marked crosswalks.

4. Environment
   Performance of a roadway under various environmental conditions such as differing weather patterns and lighting scenarios.

   Buckeye Street to Keowee Street
   There is lighting present throughout the east side of the segment but none on the west side.

   The Intersection of Wayne Avenue and Keowee Street
   There are two lights present at the intersection: one at the southeast quadrant and one at the southwest quadrant. Due to the alignment of Adams Street and Keowee Street, this lighting placement might not be sufficient for the entire extent of the intersection.

   Keowee Street to Clover Street
   There is lighting present throughout the east side of the segment. There is only one light on the west side, near the intersection of Wayne Avenue and Johnson Street.

   The Intersection of Wayne Avenue and Clover Street
   There is one light present at the intersection, placed on the northeast corner.

   Clover Street to Wyoming Street
   There is lighting present throughout the east side of the segment with four additional lights throughout the west side of the segment.

   It was noted that there may be a drainage problem within this segment. Rusted poles and overgrown weeds indicated improper drainage, as seen in Figure 16. Additionally, ponding was observed at multiple locations, primarily at curb returns where curb ramps are located. This can also be found at the Pierce Street intersection shown in Figure 13.

   The Intersection of Wayne Avenue and Wyoming Street
   The northbound approach has a downgrade which could become dangerous under snow or ice conditions.

5. Field Observations
   Other gathered information not covered in the GORE model.

   ### Buckeye Street to Keowee Street
   No other observations were made in the field.

   ### The Intersection of Wayne Avenue and Keowee Street
   Pedestrians primarily cross using the crosswalk at this intersection to access the gas station at the northeast quadrant of the intersection.

   ### Keowee Street to Clover Street
   No other observations were made in the field.

   ### The Intersection of Wayne Avenue and Clover Street
   A gas meter was relocated in front of the Ghostlight Coffee shop. It was noted that if a driver hits this meter, there could be an explosion.

   Locals also stated that they are uncomfortable walking on the sidewalks due to the presence of cyclists on the sidewalks.

   ### Clover Street to Wyoming Street
   No other observations were made in the field.

   ### The Intersection of Wayne Avenue and Wyoming Street
   The lack of pavement markings, combined with the presence of lane merges, makes this intersection confusing for users and difficult to navigate. Pedestrian facilities are dated and present a safety concern.

See **Figure 5** - **Figure 16** for photos of the site, which are referenced in the above discussion.

Figure 5. Approaching Keowee Street from the south

Figure 6. Visual and physical clutter: utilities and US 35 signage

Figure 7. Eastbound view at the intersection with Clover Street


Figure 8. Southbound view near the intersections with Lathrop Street and Wyoming Street

Figure 9. Wyoming Street intersection from its northwest quadrant

Figure 10. A cyclist crosses Wayne Avenue near Clover Street outside of the marked crosswalk

Figure 11. A pedestrian runs across Wayne Avenue near Clover Street outside of the marked crosswalk

Figure 12. A pedestrian crosses Wayne Avenue mid-block between Clover Street and Oak Street

Figure 13. Limited sight distance when traveling westbound on Pierce Street


Figure 14. Speed bumps at the entrance of an AARP health center

Figure 15. A pole blocks wheelchair access near Wyoming Street

Figure 16. Weed growth, indicating poor drainage

V. PUBLIC ENGAGEMENT

A. Gathering Public Input

Gathering public input was an integral part of this study. Crash data can provide decisionmakers with precise data about what has already happened, but it cannot provide the necessary information about how and why people are making their transportation decisions. Furthermore, the public can recall near misses or other common trends that the crash data cannot show. Therefore, public engagement is an important and complementary part of the safety planning process.

An online survey went live on July 23, 2024 and was open for two weeks. The survey was advertised through the local news outlet and collected 425 unique responses.

On July 22, 2024, the day before the survey link was posted, a tragic crash occurred at Wayne Avenue and Clover Street. A driver in an SUV failed to yield to pedestrians in the crosswalk, causing severe injuries to at least one child. The news article about this crash provided the link to the survey, informed the public about this safety study, and briefly mentioned potential countermeasures such as a road diet. This event, along with the news coverage and its mention of the survey, likely contributed to the substantial volume and engagement of responses received.

Common Concerns:

- Unsafe vehicle speeds
- Pedestrian and cyclist safety
- Sidewalk proximity to high-speed vehicles
- A lack of adequate crosswalks
- Limited sight distance at intersections

The survey questions and responses are shown below in Figure 17 through Figure 23.

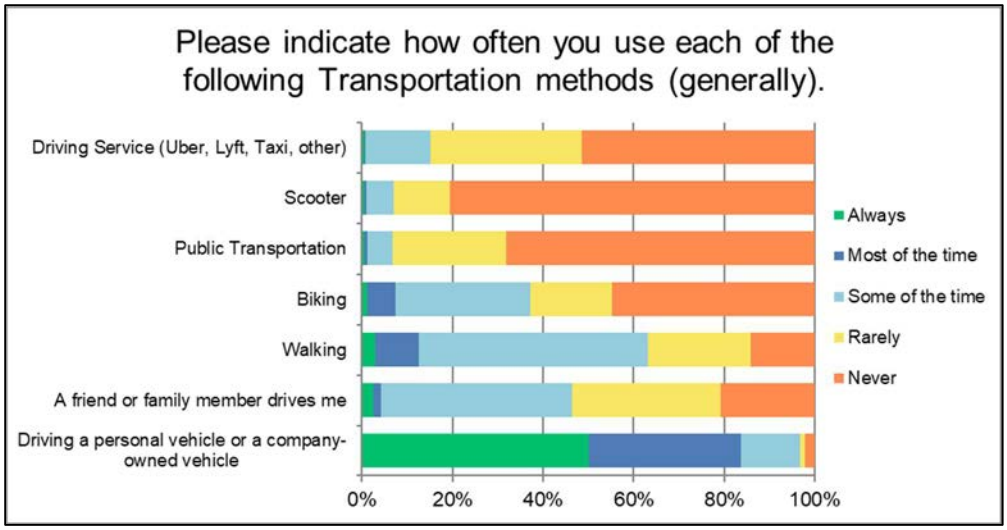


Figure 17. Survey responses to "Please indicate how often you use each of the following Transportation methods (generally)."

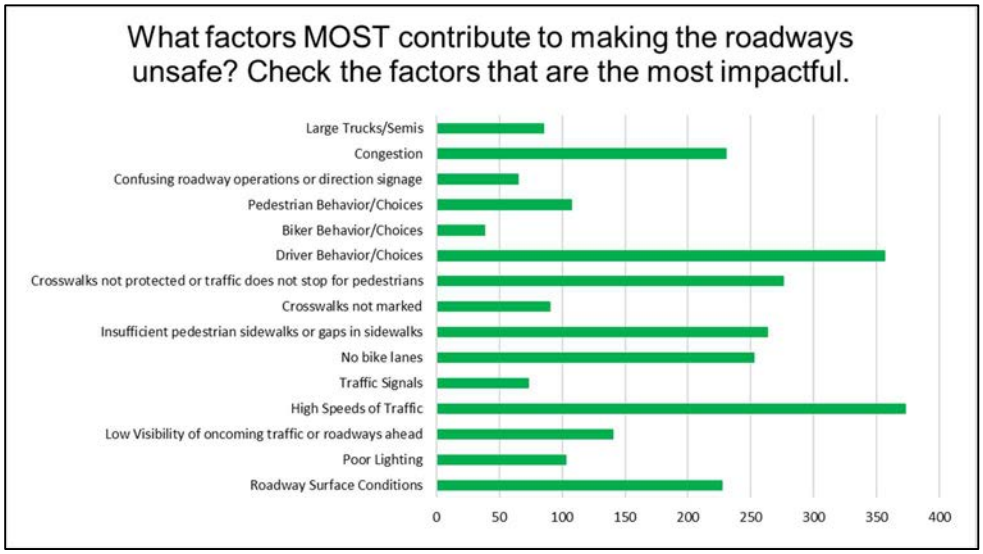


Figure 18. Survey responses to "What factors MOST contribute to making the roadways unsafe? Check the factors that are the most impactful."

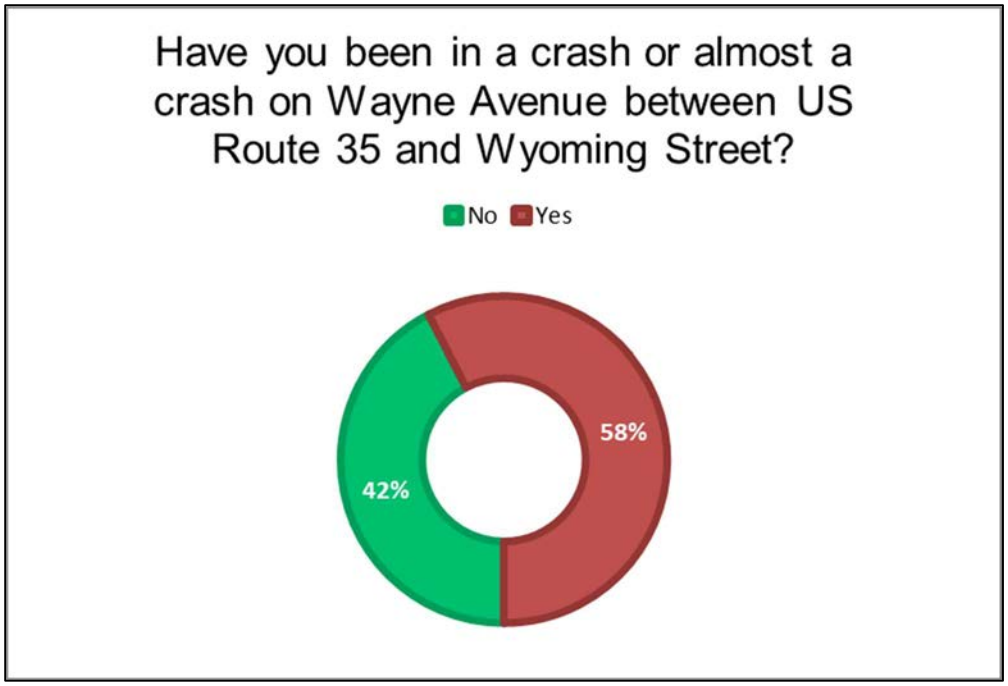


Figure 19. Survey responses to "Have you been in a crash or almost a crash on Wayne Avenue between US Route 35 and Wyoming Street?"

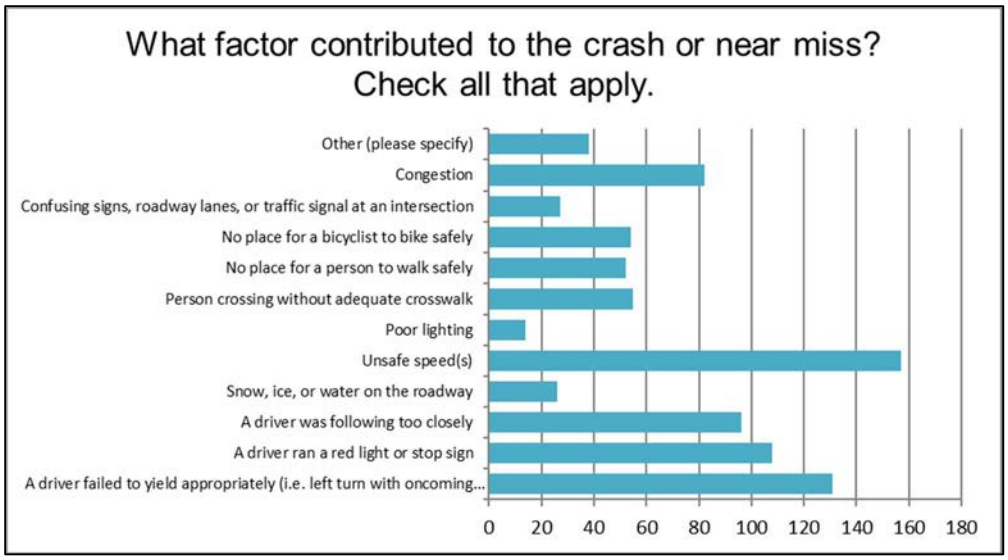


Figure 20. Survey responses to "What factor contributed to the crash or near miss? Check all that apply."

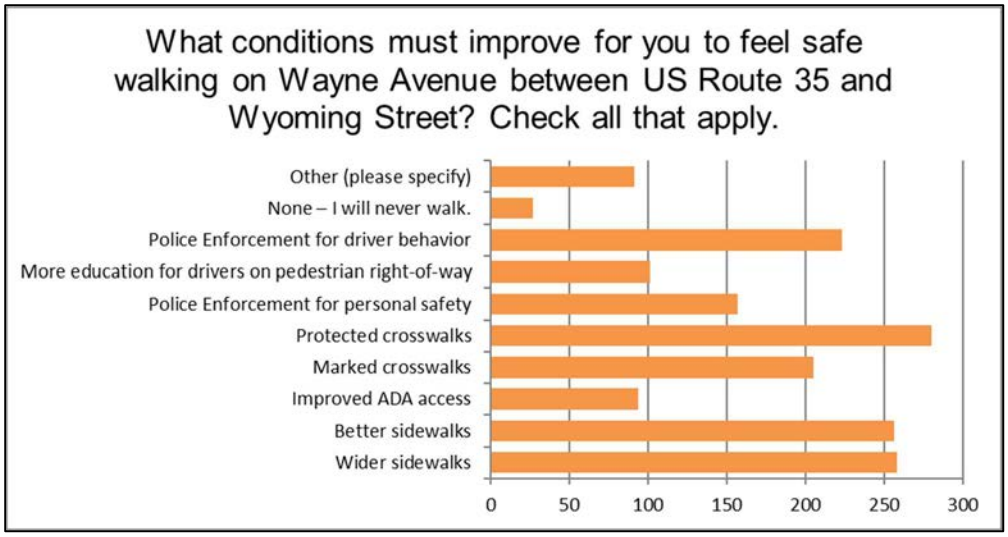


Figure 21. Survey responses to "What conditions must improve for you to feel safe walking on Wayne Avenue between US Route 35 and Wyoming Street? Check all that apply."

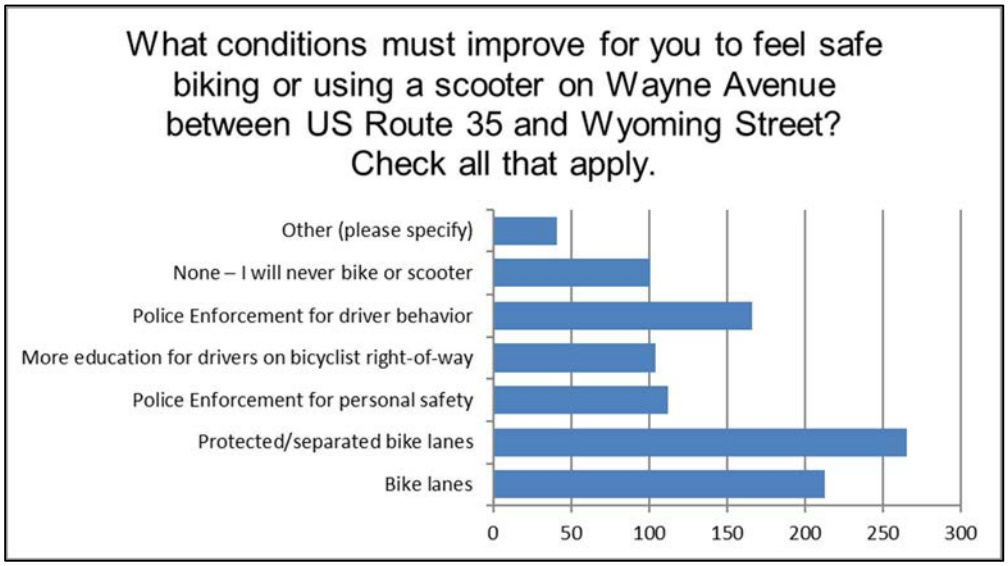


Figure 22. Survey responses to "What conditions must improve for you to feel safe biking or using a scooter on Wayne Avenue between US Route 35 and Wyoming Street? Check all that apply."

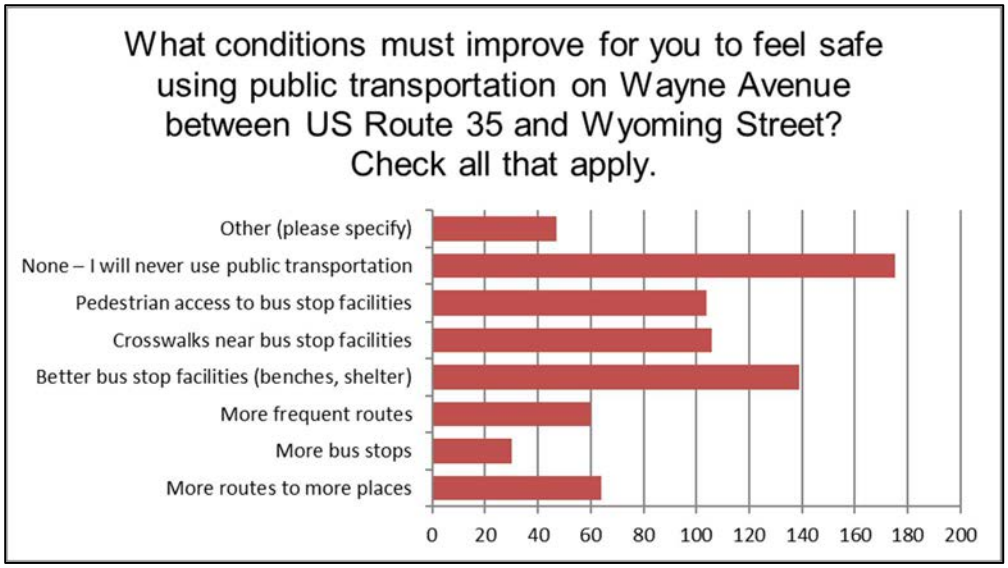


Figure 23. Survey responses to "What conditions must improve for you to feel safe using public transportation on Wayne Avenue between US Route 35 and Wyoming Street? Check all that apply."

As represented through the survey responses, locals are eager to see change along Wayne Avenue. Many respondents reported feeling unsafe due to high speeds, other drivers' behavior, and a lack of safe pedestrian and bicycle infrastructure. Over half of the respondents indicated that they have, or almost have, experienced a crash within the corridor, many of which were due to high speeds. Respondents indicated that they would feel safer walking on Wayne Avenue with the addition of protected crosswalks, better and wider sidewalks, and police enforcement of driver behavior. Similarly, many respondents indicated that they would feel safe biking on Wayne Avenue if bike lanes were constructed. To feel safe using public transportation on Wayne Avenue, responses show a desire for better bus stop facilities. The results of this public survey helped vocalize the needs of the community, equipping the project team with focus areas and goals which the proposed countermeasures aim to address.

VI. CRASH DATA AND ANALYSIS

A. Available Traffic Data

Turning movement counts were obtained along Wayne Avenue at the three signalized intersections within the study limits: Keowee Street, Clover Street, and Wyoming Street. Counts were taken on Tuesday August 20, 2024 between 7:00 AM and 7:00 PM. All locations shared an AM peak hour of 7:30-8:30 and a midday peak hour of 12:15-1:15. The intersections at Clover Street and at Wyoming Street had a PM peak hour of 3:45-4:45, while Keowee Street had a PM peak hour of 4:00-5:00. Complete turning movement count data is provided in Appendix B.

See Figure 24 - Figure 27 for the turning movement counts at Keowee Street.

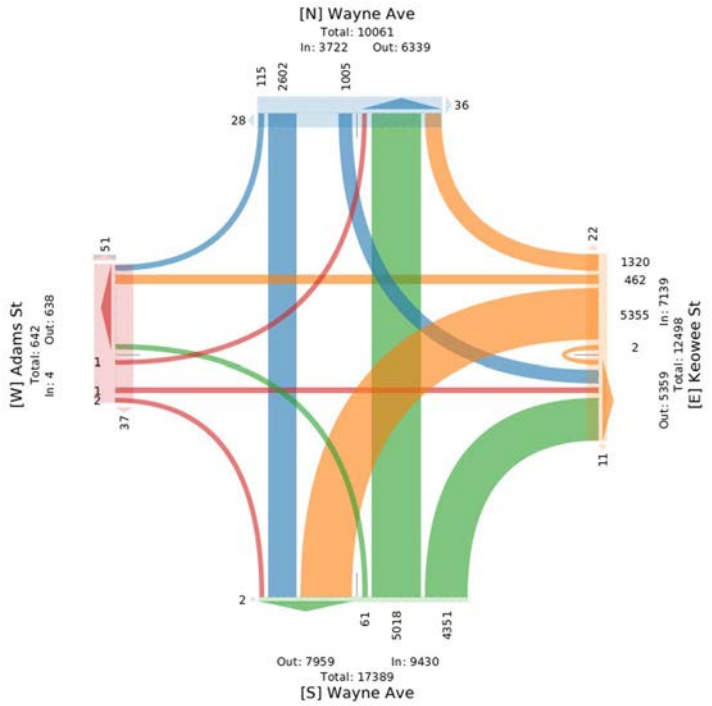


Figure 24. Turning Movement Counts at Keowee Street, 7:00 AM - 7:00 PM

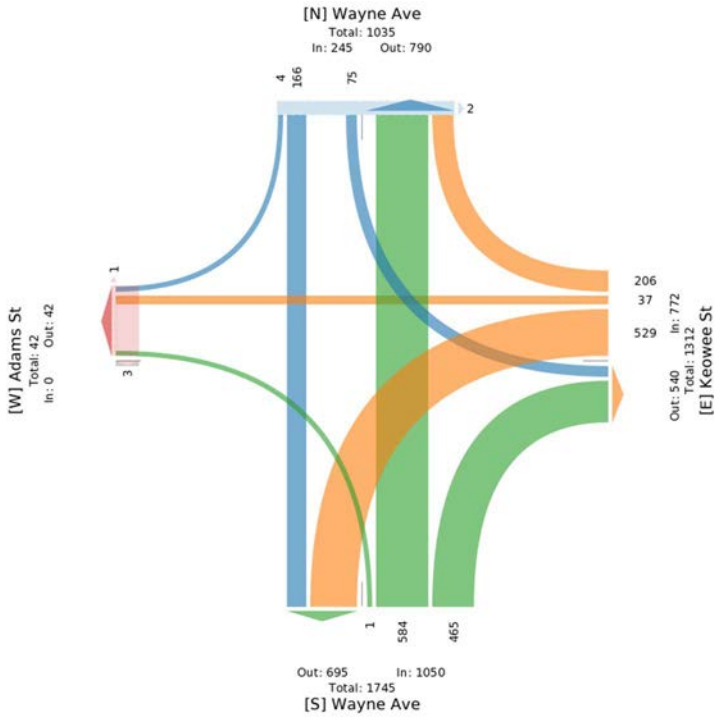


Figure 25. Turning Movement Counts at Keowee Street, 7:30 AM - 8:30 AM

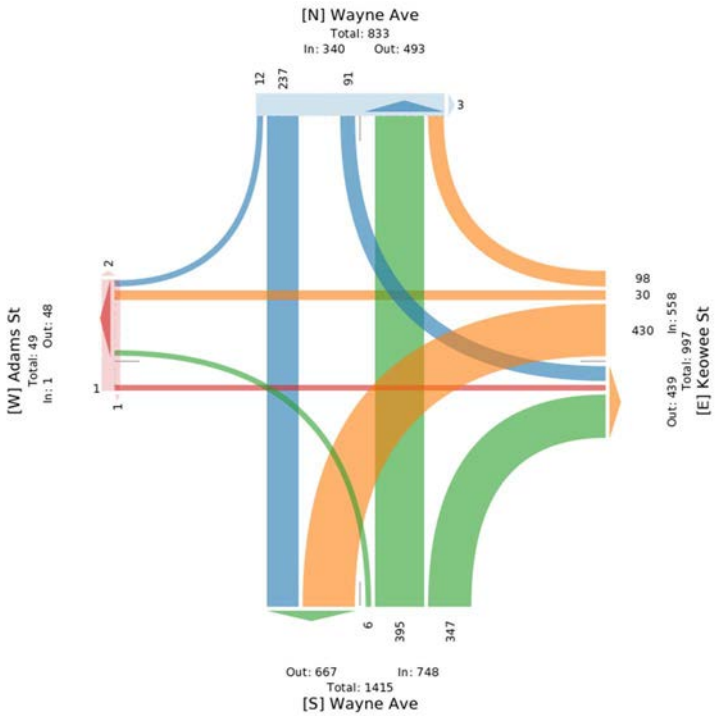


Figure 26. Turning Movement Counts at Keowee Street, 12:15 PM - 1:15 PM

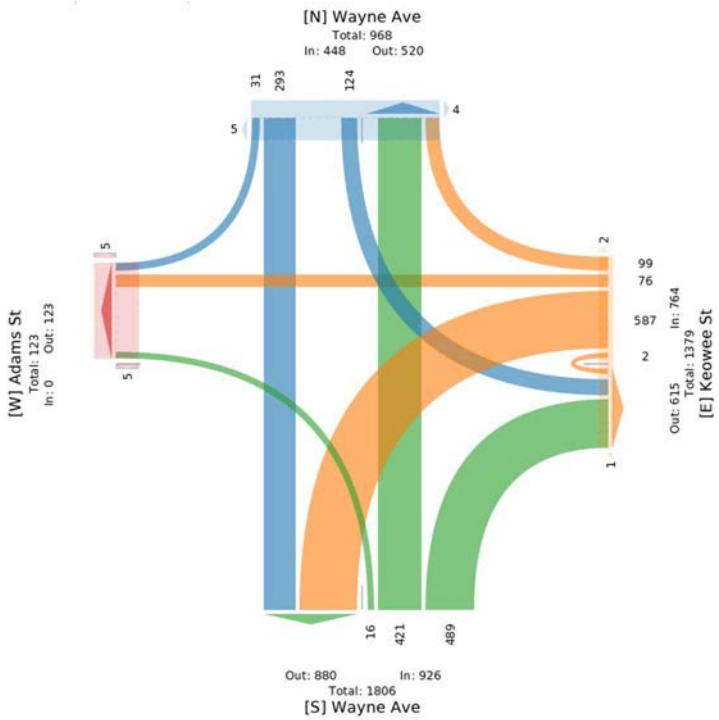


Figure 27. Turning Movement Counts at Keowee Street, 4:00 PM - 5:00 PM

See Figure 28 - Figure 31 for the turning movement counts at Clover Street.

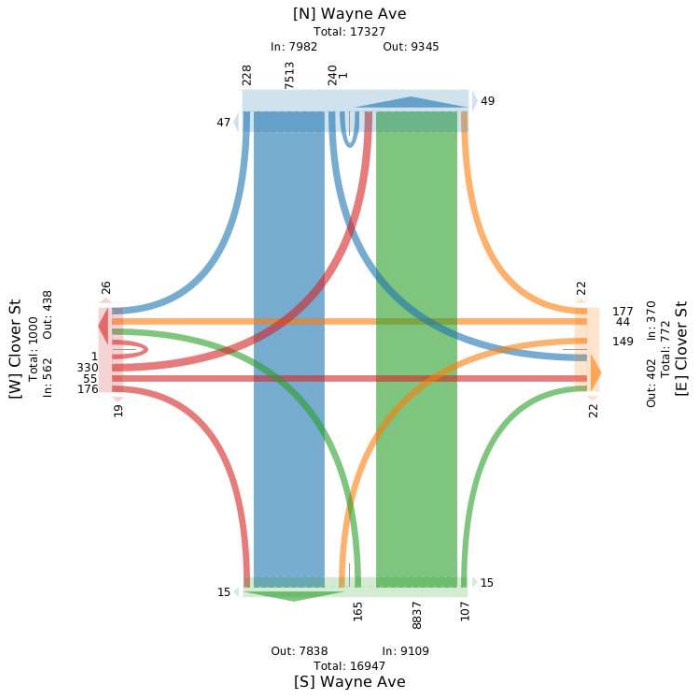


Figure 28. Turning Movement Counts at Clover Street, 7:00 AM - 7:00 PM

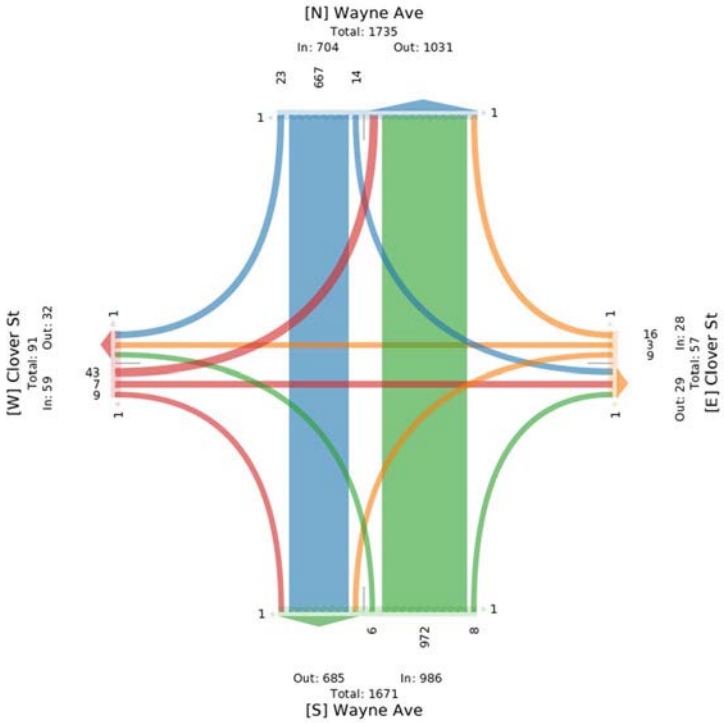


Figure 29. Turning Movement Counts at Clover Street, 7:30 AM - 8:30 AM

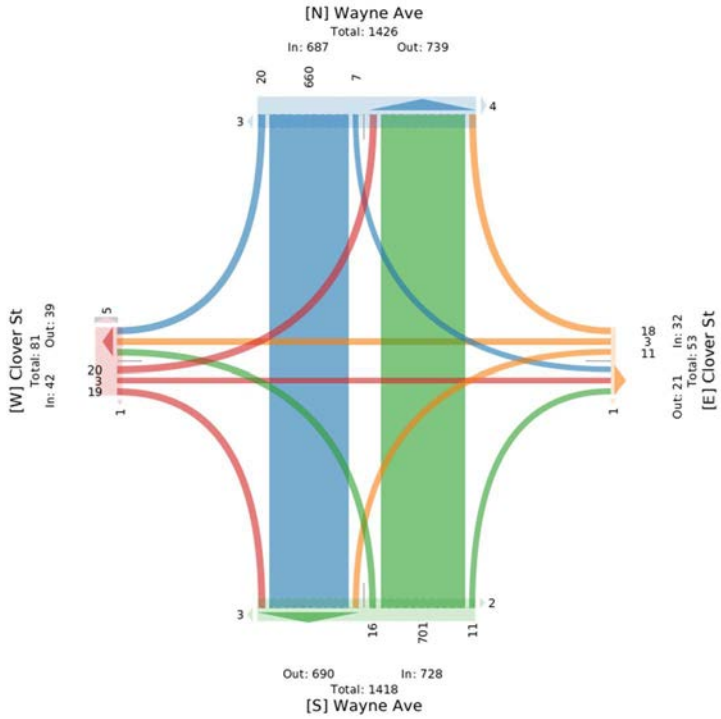


Figure 30. Turning Movement Counts at Clover Street, 12:15 PM - 1:15 PM

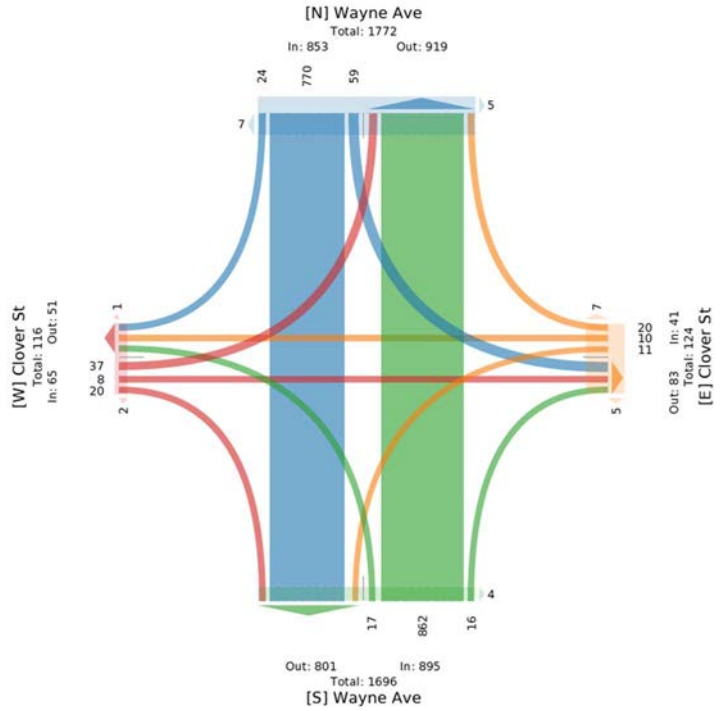


Figure 31. Turning Movement Counts at Clover Street, 3:45 PM - 4:45 PM

See Figure 32 - Figure 35 for the turning movement counts at Wyoming Street.

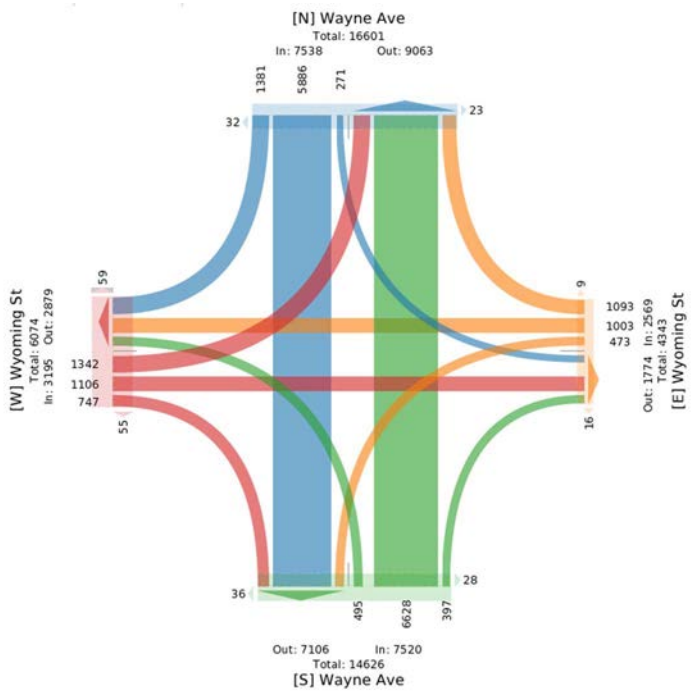


Figure 32. Turning Movement Counts at Wyoming Street, 7:00 AM - 7:00 PM

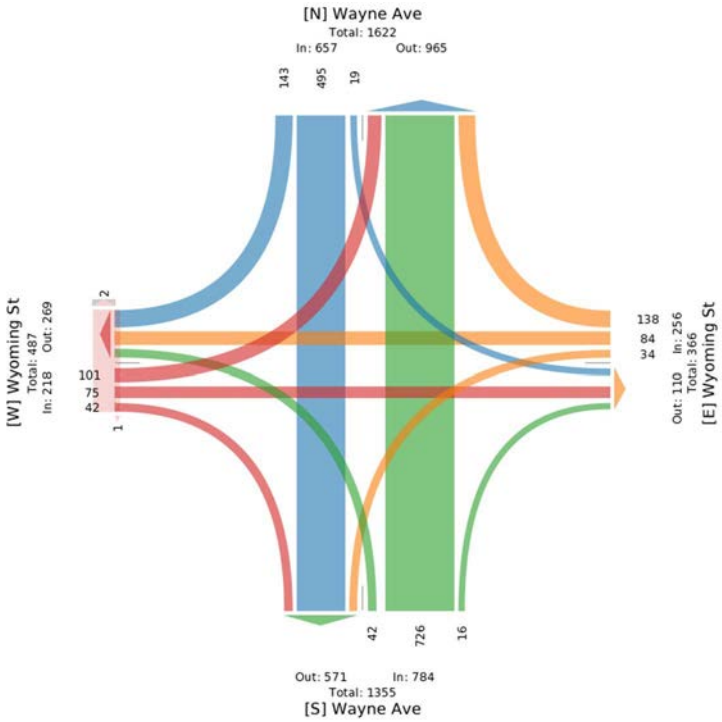


Figure 33. Turning Movement Counts at Wyoming Street, 7:30 AM - 8:30 AM

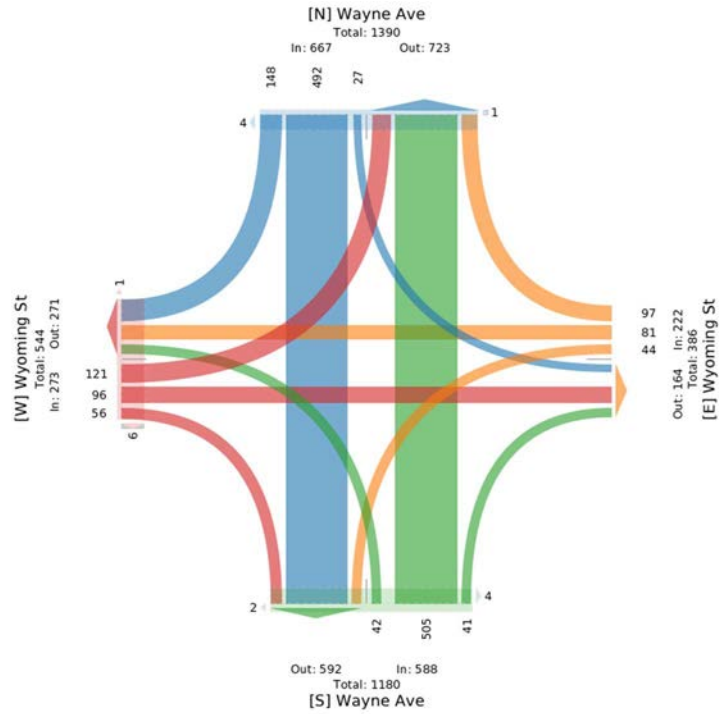


Figure 34. Turning Movement Counts at Wyoming Street, 12:15 PM - 1:15 PM

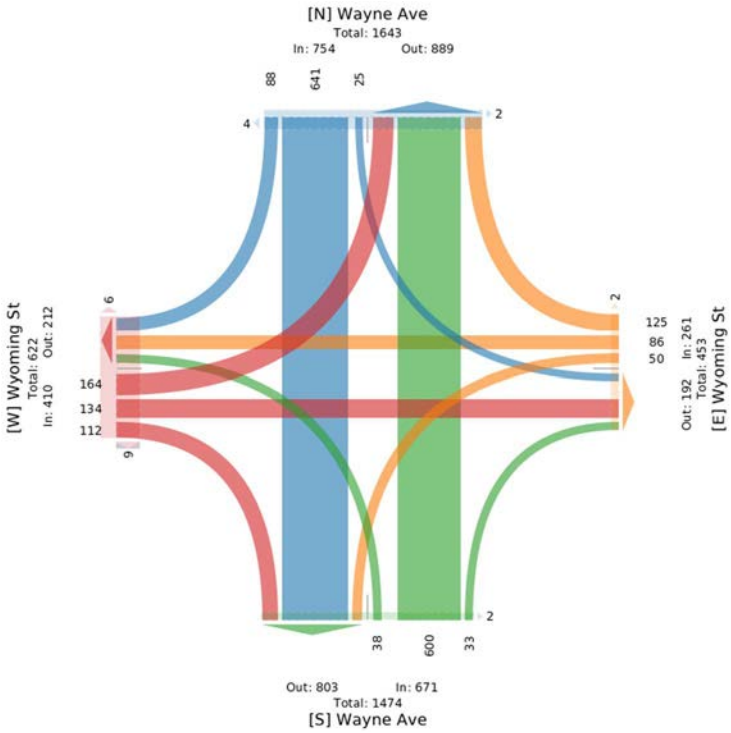


Figure 35. Turning Movement Counts at Wyoming Street, 3:45 PM - 4:45 PM

B. Crash Data Summaries

Crash data was collected from the five year period of 2019-2023 for the studied corridor of Wayne Avenue between Buckeye Street and Wyoming Street. This data was reported by the Ohio Department of Public Safety and obtained through the ODOT Transportation Information Mapping System (TIMS) website. Each crash from the data set is reviewed with particular attention to critical elements of the crash, such as type of crashes, locations, contributing factors, driver actions and reactions, and severity of injuries. Some crashes are removed from the data set as they occurred outside project limits, are animal related, or contain other reasons rendering the crash non-applicable. Any necessary corrections are made to the crash data before further processing.

Once the refined collection of crash data is modified, the ODOT Crash Analysis Module (CAM) tool is used to organize the crash data into tables and charts. Information is tabulated in various categories based on significant crash characteristics such as the previously noted critical elements as well as date, time of day, weather conditions, road conditions, and other relevant aspects. The complete crash information tables are provided in Appendix C of this report.

The data shows a gradual decrease in crash frequency each year, beginning with 57 crashes in 2019 and ending with 26 crashes in 2023. However, the sudden decrease in crash frequency between 2022 and 2023 is likely attributed to the crash reporting policy by Dayton police. In 2023, the officers began to only fill out crash reports for injury-related crashes. Though there are some PDO crash reports available in TIMS, the data likely does not accurately represent the true number of PDO crashes during that year. This should be kept in mind when reviewing the following crash data.

Despite the decrease in overall crash frequency, the frequency of fatal and serious injury (FSI) crashes has fluctuated over the years. There were four FSI crashes in 2022, two FSI crashes in 2020, and one FSI crash in 2021 and in 2023. There were no FSI crashes reported in 2019. See Table 1 for a summary of yearly crash frequencies compared to percent injury. Note that percent injury includes fatal and all injury crashes, not just FSI crashes.

Table 1. Crash Frequency vs. Percent Injury

Year	Total Crashes	Percent Injury
2019	57	26.3%
2020	48	27.1%
2021	45	33.3%
2022	43	30.2%
2023	26	26.9%

The most common crash types were rear end crashes and angle crashes, each with 47 crashes (21.5% each). The third most common crash type was sideswipe-passing crashes (18.7%). See Table 2 for a summary of annual crash data by crash type.

Table 2. Crash Data by Crash Type

Crash Type	Crashes	%
Rear End	47	21.46%
Angle	47	21.46%
Sideswipe - Passing	41	18.72%
Left Turn	29	13.24%
Fixed Object	19	8.68%
Right Turn	12	5.48%
Pedestrian	9	4.11%
Backing	5	2.28%
Head On	4	1.83%
Pedalcycles	3	1.37%
Parked Vehicle	2	0.91%
Other Object	1	0.46%
Grand Total	219	100.00%

The top five most common crash types listed above are further analyzed below in Figure 36. This figure displays the proportion of crash severity that resulted from each of these five crash types. Note that, while leading in number of crashes, the rear end crash type was the only type of the five to not result in any FSI crashes.

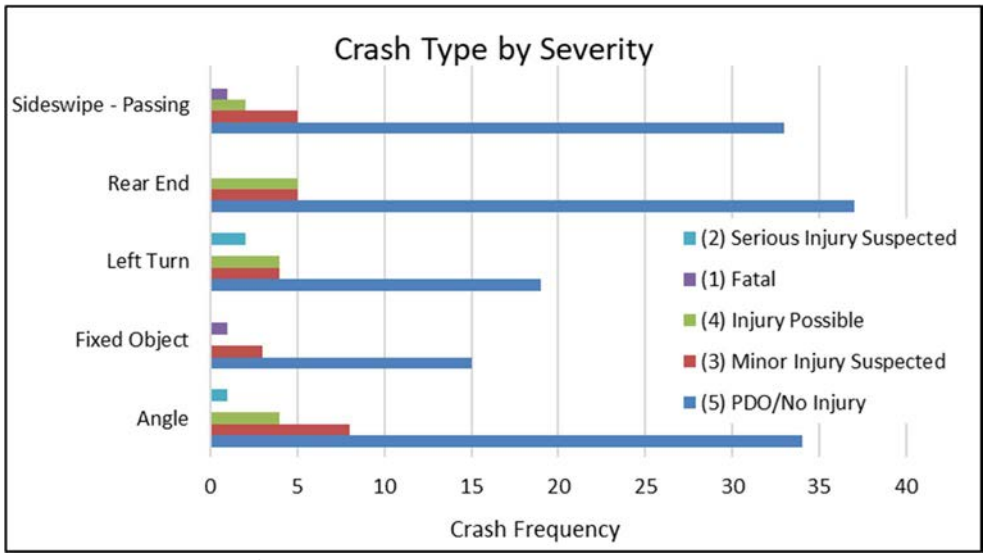


Figure 36. Severity of Common Crash Types

The most frequently reported contributing factor was Failure to Yield, with 50 of the 219 total crashes (22.8%). The second most common contributing factor was Following Too Closely / ACDA (20.6%). Other Improper Action and Ran Red Light

contributed to 13.2% and 12.3% of crashes, respectively. Additional information regarding contributing factors is provided below in Table 3.

Table 3. Summary of Contributing Factors

Unit 1 Contributing Factor	Crashes	%
Failure to Yield	50	22.83%
Following Too Closely/ACDA	45	20.55%
Other Improper Action	29	13.24%
Ran Red Light	27	12.33%
Improper Lane Change	20	9.13%
None	13	5.94%
Not Discernible	10	4.57%
Improper Turn	8	3.65%
Unsafe Speed	5	2.28%
Improper Backing	4	1.83%
Drove off Road	3	1.37%
Improper Passing	2	0.91%
Wrong Way	1	0.46%
Improper Crossing	1	0.46%
Left of Center	1	0.46%
Grand Total	219	100.00%

Crash frequency was highest in the month of August, with 25 total crashes over the five year period. Similarly, October experienced 22 crashes, January experienced 21, and December experienced 20. See Table 4 for a summary of crash data by month.

Table 4. Total Crashes by Month

Month	Total Crashes
January	21
February	13
March	16
April	18
May	19
June	17
July	13
August	25
September	19
October	22
November	16
December	20
Grand Total	219

The most common day for a crash to occur was Tuesday, hosting 41 of the 219 crashes. This was followed by Wednesday (36 crashes) and Friday (31 crashes). The

least common day for a crash to occur was Sunday, with 27 total crashes over the study period. See Figure 37 for a summary of this data.

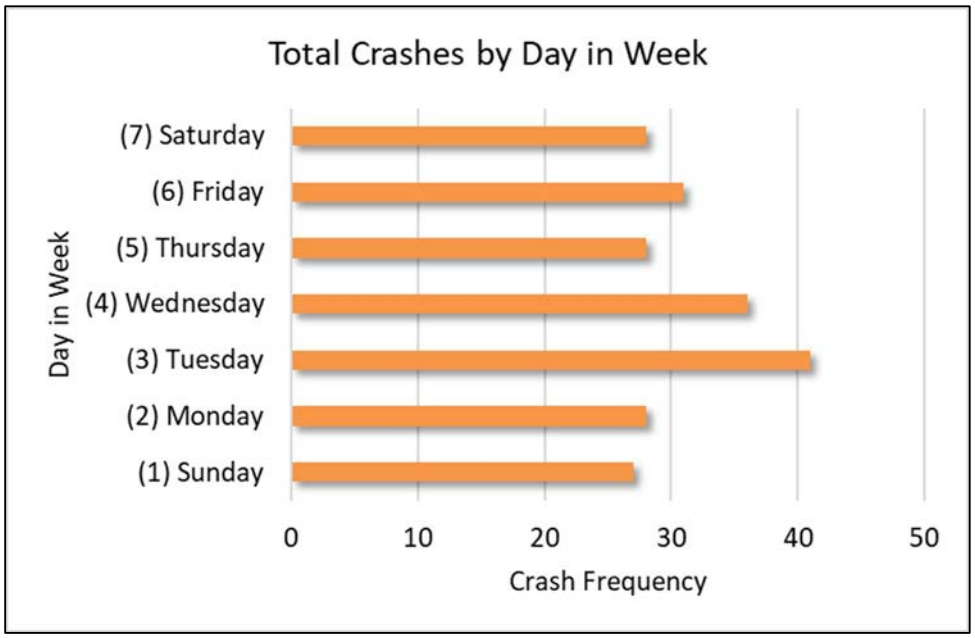


Figure 37. Total Crashes by Day

Similarly, crash frequency peaked around 3:00 PM with 22 total crashes. The hours of 2:00 PM and 5:00 PM each totaled 20 crashes. Crash frequency generally fluctuated steadily throughout the day, with the largest peak in these afternoon hours. See Figure 38 for a summary of crash data by hour of day.

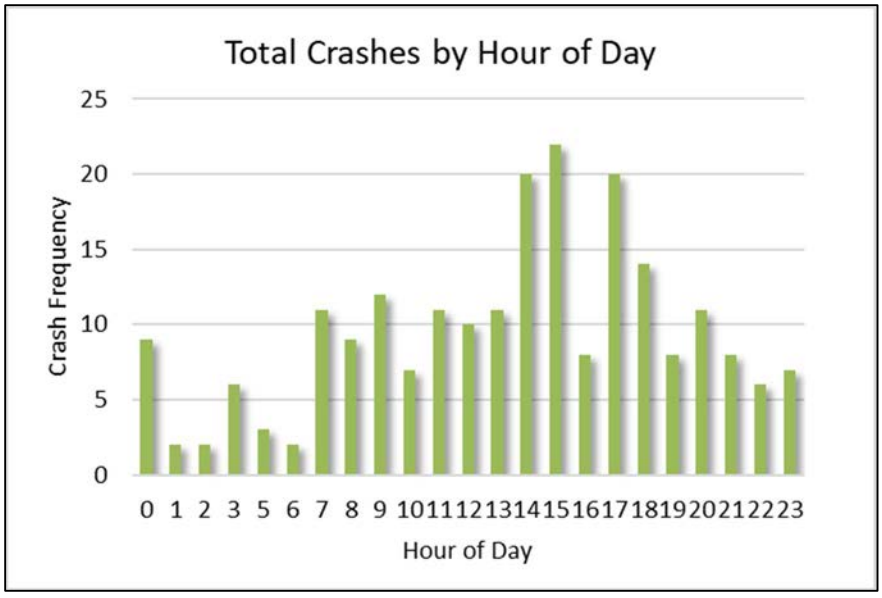


Figure 38. Total Crashes by Hour

Approximately 66% of crashes were reported to have occurred during daylight hours. The remaining 34% of crashes occurred during dark, dawn, or dusk hours when natural lighting becomes insufficient, and drivers rely on street lighting or vehicle headlights. Nearly 29% of total crashes (85% of non-daylight crashes) occurred under Dark – Lighted Roadway conditions. There are streetlights placed consistently throughout the corridor, however these streetlights may be too dim, or the lightbulbs may have burnt out over the years and need replaced. Figure 39 below shows a breakdown of these statistics.

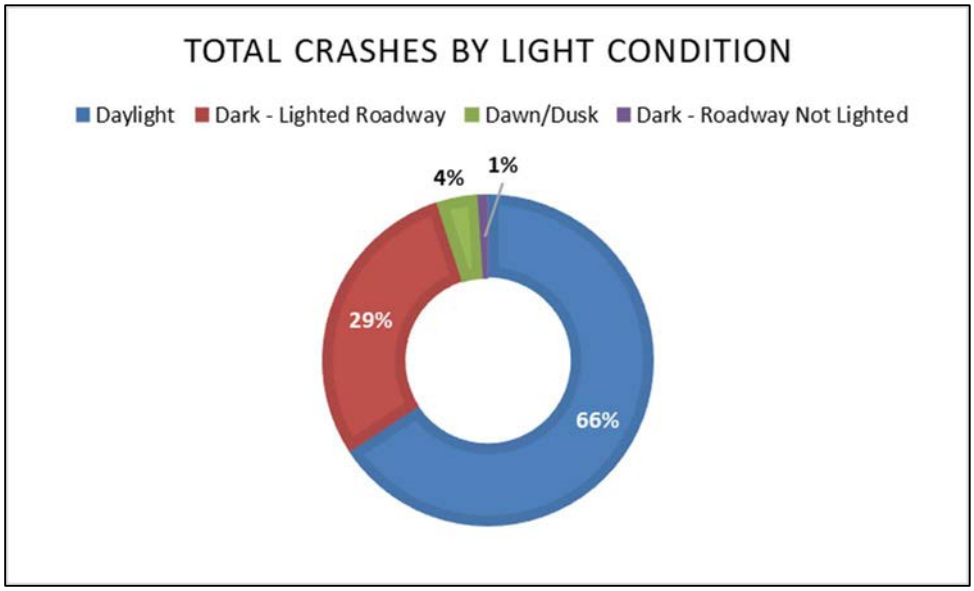


Figure 39. Total Crashes by Light Condition

C. Crash Graphs and Tables

Crash graphs and tables from the ODOT CAM tool are provided in Appendix C. The most relevant graphs pertaining to the crash analysis are discussed above.

D. Crash Diagrams

Crash diagrams showing the 219 analyzed crashes can provided below in Figure 40 – Figure 45. These diagrams are also available in Appendix D.

Figure 40. Crash Diagram (1) Wayne Ave from US 35 to Hickory St

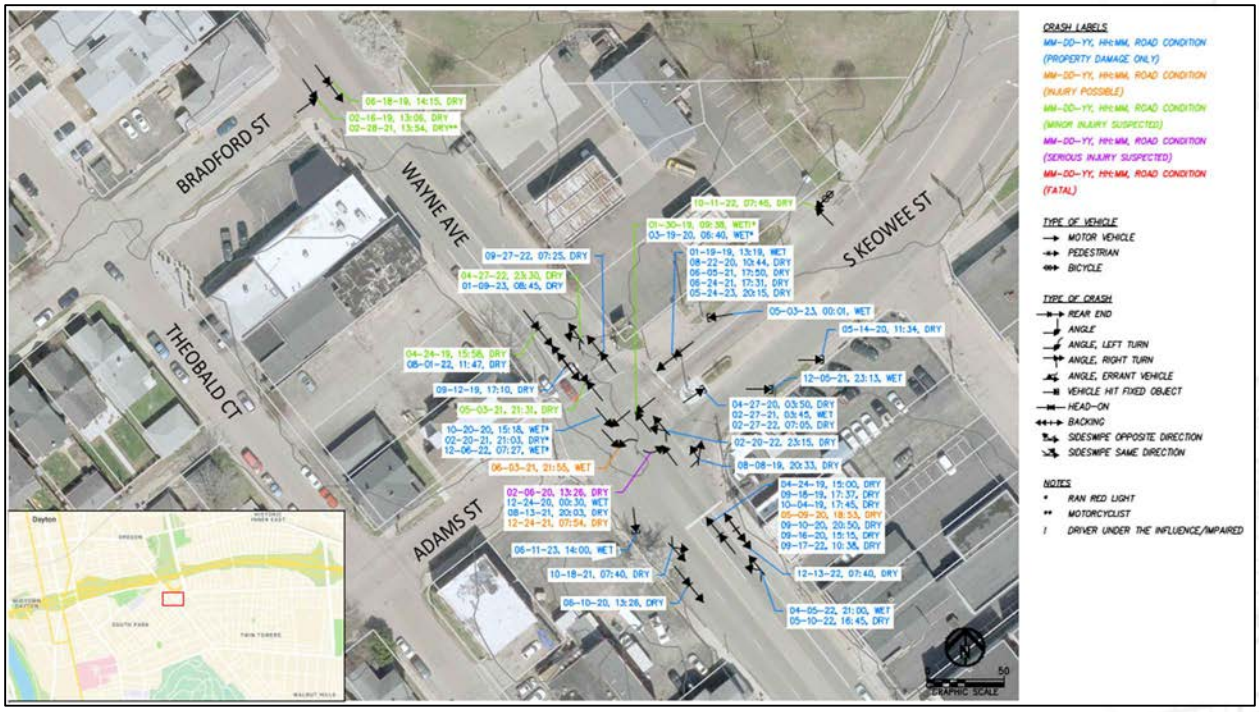


Figure 41. Crash Diagram (2) Wayne Ave from Bradford St to Keowee St

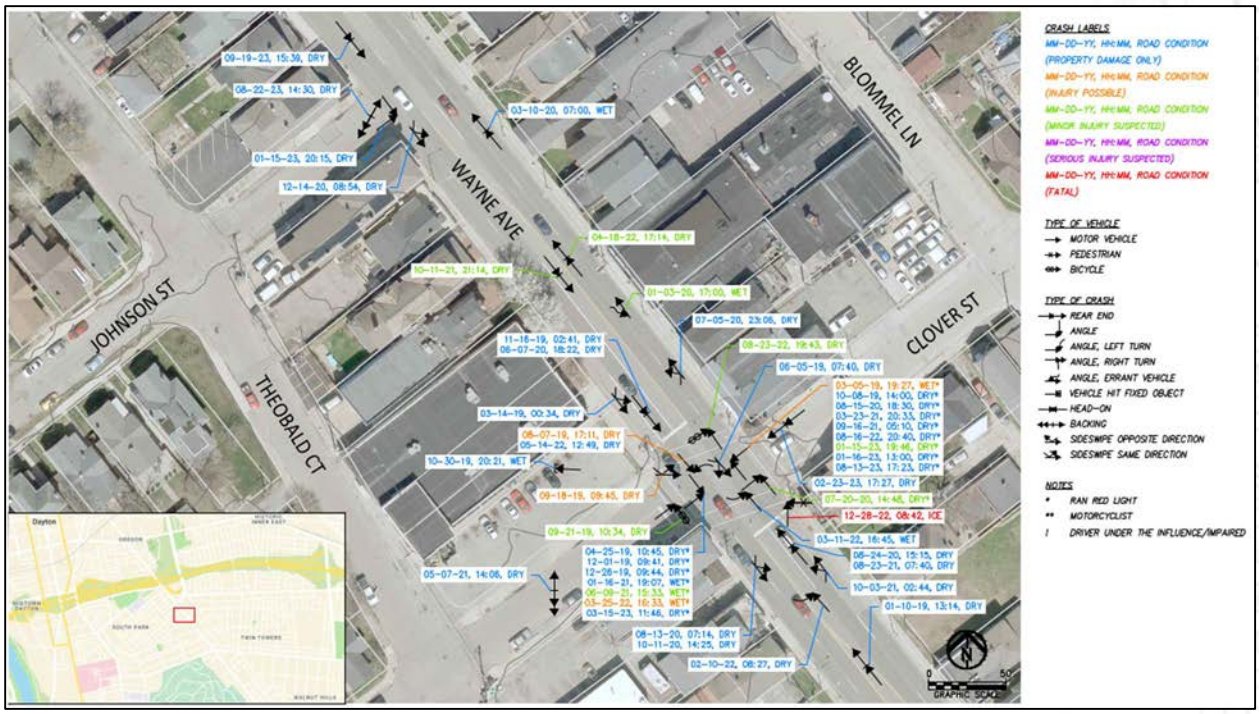


Figure 42. Crash Diagram (3) Wayne Ave from Johnson St to Clover St

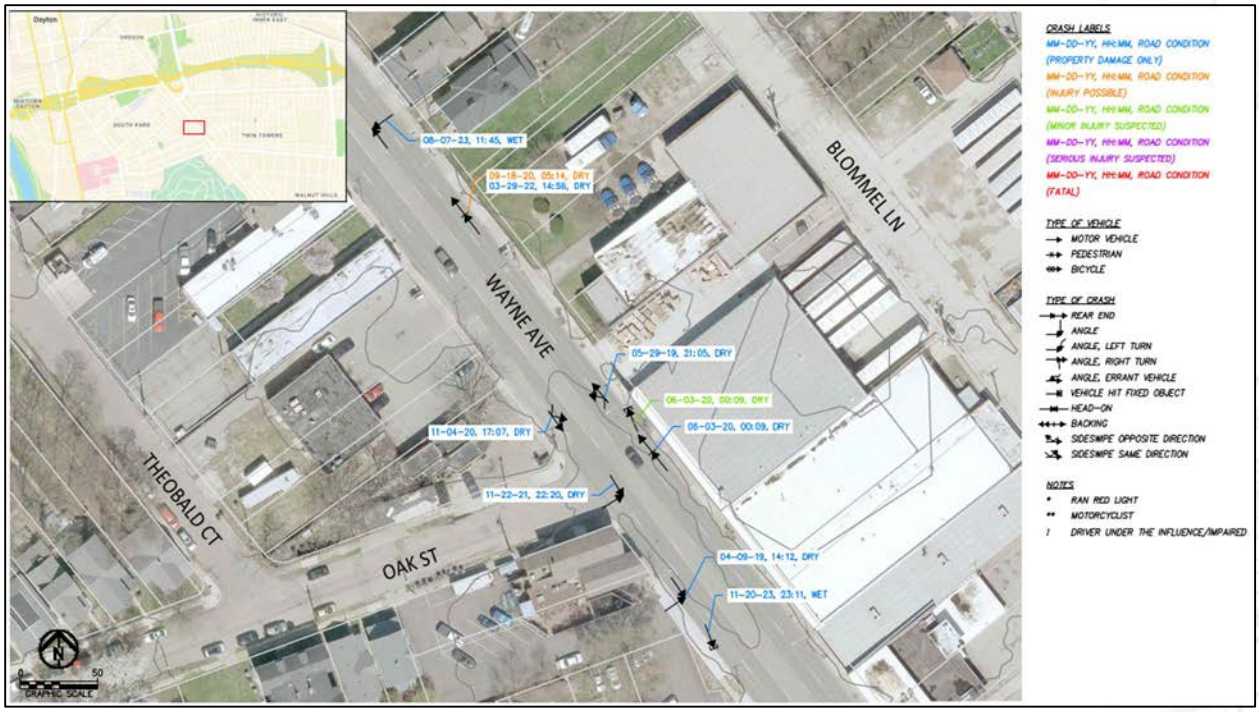


Figure 43. Crash Diagram (4) Wayne Ave from Clover St to Oak St

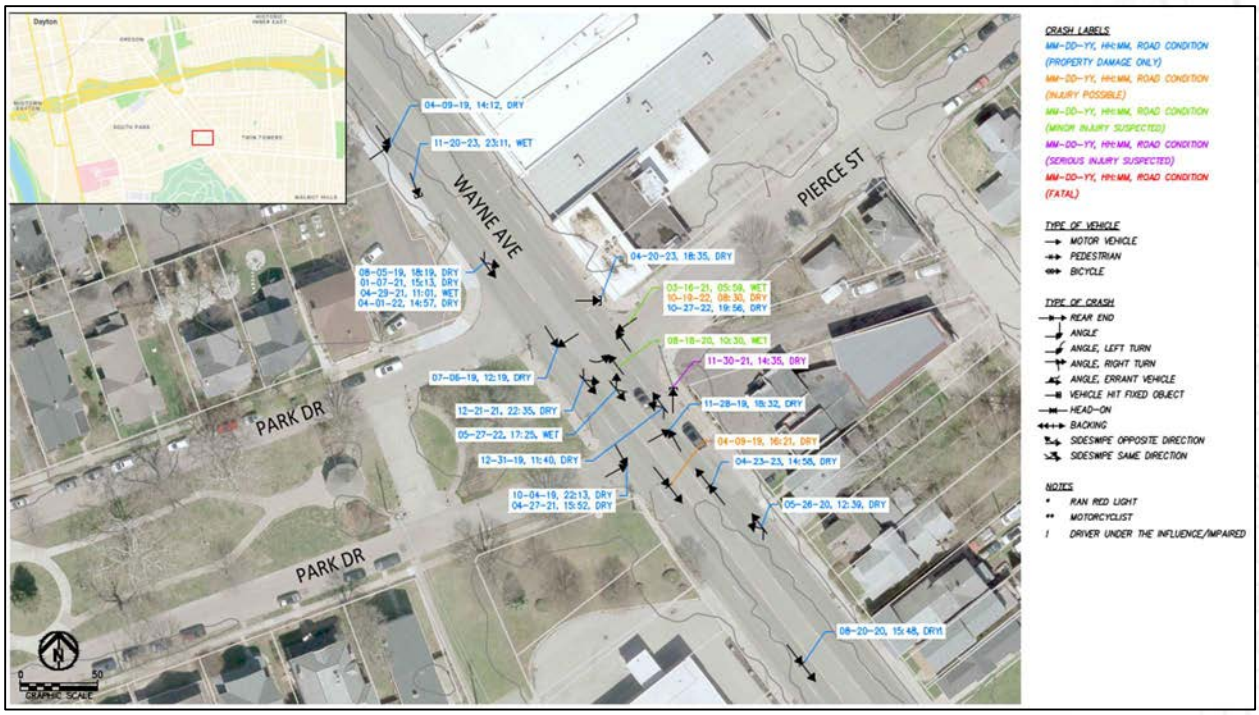


Figure 44. Crash Diagram (5) Wayne Ave at Park Dr and Pierce St

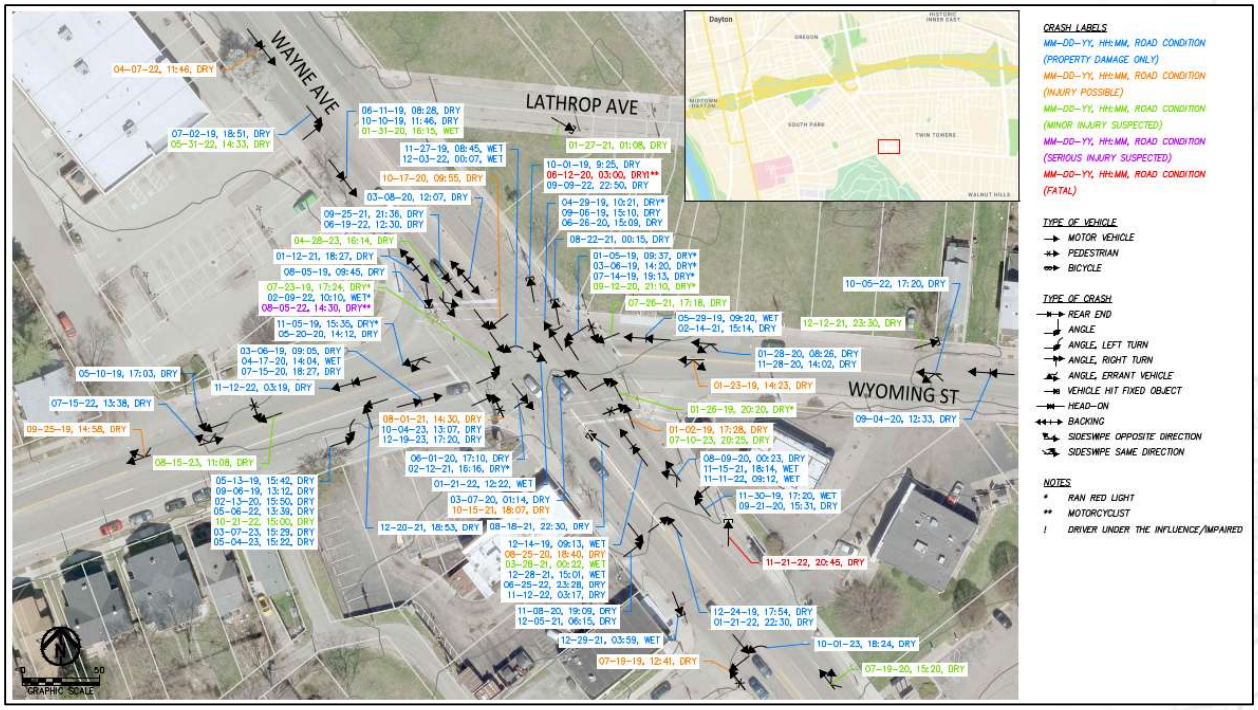


Figure 45. Crash Diagram (6) Wayne Ave at Lathrop Ave and Wyoming St

E. Crash Analyses

The traffic safety conditions of the study area are further evaluated by conducting a safety performance analysis based on the criteria and methodologies prescribed in the Highway Safety Manual (HSM). The HSM provides an analytical and statistical model for predicting frequency of crashes based on key features such as roadway type, roadway conditions, intersection geometry, and traffic data. The HSM model provides a way to quantitively evaluate the safety aspect of a particular segment of roadway and/or a particular intersection by comparing them to similar segments and intersections.

To facilitate the safety performance analysis, the ODOT Economic Crash Analysis Tool (ECAT) is used. This tool is a spreadsheet that can process the given crash data and, using the HSM crash predictive model, estimate the "predicted" and "expected" frequency of crashes along the subject corridor or at the subject intersection. These conditions are further described as follows:

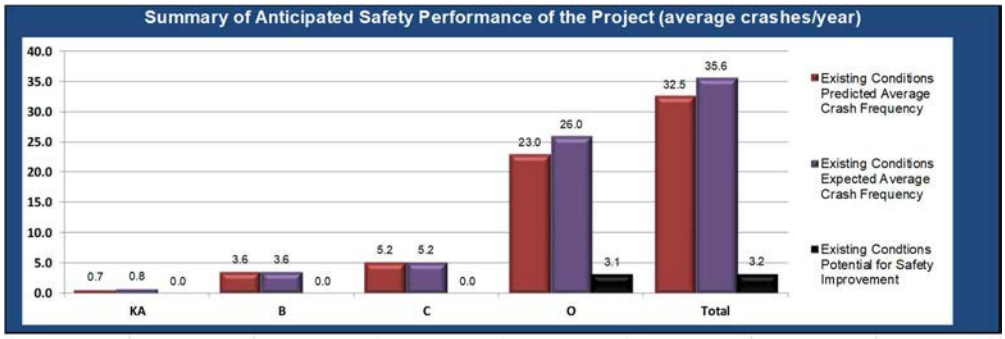
Predicted Average Crash Frequency (crashes per year): Estimated average crash frequency for a site using the predictive HSM model adjusted for a given set of geometric conditions and traffic volumes. This reflects how the site is "predicted" to perform in comparison to peer sites.

Expected Average Crash Frequency (crashes per year): Estimated average crash frequency for a site with a given set of geometric conditions, traffic volume, and a

known crash history. This reflects how the site is "expected" to perform in comparison to peer sites while taking actual historical crash performance into consideration.

If the Expected Average Crash Frequency is greater than the Predicted Average Crash Frequency, then the roadway segment or intersection being studied is indicated to be experiencing more crashes than anticipated for the given roadway conditions and traffic volumes. Thus, the segment or intersection is believed to have potential for safety improvements.

For the studied corridor of Wayne Avenue, the model provides an estimated Predicted Average Crash Frequency of 32.5 crashes per year and an estimated Expected Average Crash Frequency of 35.6 crashes per year. These values show that the studied segment of Wayne Avenue experiences a higher crash frequency than what the HSM model predicts. Therefore, the calculated potential for safety improvements (predicted frequency minus expected frequency) is a positive value of 3.2 crashes per year. This data is shown below in Figure 46.



Project Summary Results (Without Animal Crashes)					
	KA	B	C	O	Total
$N_{predicted}$ - Existing Conditions	0.7399	3.5911	5.1630	22.9745	32.4685
$N_{expected}$ - Existing Conditions	0.7510	3.6289	5.2066	26.0369	35.6234
$N_{potential\ for\ improvement}$ - Existing Conditions	0.0111	0.0378	0.0436	3.0624	3.1549

Figure 46. ECAT summary of potential safety improvements for the studied Corridor

The results from the ECAT analysis also provide the potential safety improvements of each segment and intersection. Not shown, but notably, the two highest ranking intersections were Wyoming Avenue and Clover Street, scoring 3.68 and 0.97 in total potential for improvement, respectively.

F. Probable Causes and Identification of Potential Countermeasures

The crash patterns throughout the study area point to several issues along Wayne Avenue and its intersections that negatively impact the area's crash frequency. The most likely and significant probable causes are:

1. Challenging and Complex Signalized Intersections

   As discussed above, the ECAT analysis shows that the intersections at Wyoming Street and Clover Street experienced an unusually high crash frequency over the study period. Each intersection presents its own challenges to motorists and nonmotorists alike:

   - Wyoming Street: The north, south, and west legs of this intersection each have five marked lanes, and the east leg has three marked lanes. The north and south approaches also have short right-turn slip lanes which are delineated by small pedestrian refuge islands. Despite this complexity in lanes and unmarked travel paths, there are no pavement markings denoting right- or left-turn lanes. Similarly, there are no lane designation signs when approaching the intersection from any direction. There are also no yield signs at the N/S slip lanes to signify that drivers must merge into the E/W traffic who may be traveling through the intersection at the same time. Finally, there are two signals for each approach: one three-ball signal head and one five-ball signal head (right-turn for E/W, left-turn for N/S). It is likely that drivers may be confused when entering this intersection by the quantities of lanes and signal configurations. A wrong assumption may cause a driver to incorrectly assume another vehicle's intended path. This confusion and discomfort are likely amplified for pedestrians who must cross multiple lanes with extra diligence for vehicles from each approach. This intersection is also heavily skewed, which impacts sight lines, may lead to drivers' incorrect assessment of approach speeds for other vehicles, and may cause misperceptions of true gap spacing for making turning movements.
   - Clover Street: This misaligned intersection hosts similar problems to Wyoming Street. The north and south legs each have five marked lanes, the east leg has three marked lanes, and the west leg has two marked lanes. Each approach has two three-ball signal heads. None of the approaches have pavement markings or lane-designation signs that signify to drivers which lane they must be in. Furthermore, the adjacent buildings reside within nearly five feet of three of the four corners, greatly affecting drivers' sight distance of both motorists and nonmotorists. Notably, one pedestrian lost their life at this intersection in 2022. As denoted on Crash Diagram (3) above (Figure 42), many of the angle crashes that occurred at this intersection resulted from a ran red light. This could indicate a large dilemma zone – the area on the approach to an intersection where, when experiencing a phase change from green to yellow, a driver may not be able to stop comfortably before the stop bar but also may not be through the intersection prior to the phase

change to red. Some drivers apply the brakes sharply and some proceed through the intersection. These choices in the dilemma zone are often the root cause of rear ends and run red light crashes.

The third signalized intersection located at Keowee Street/Adams Street did not score as high during the ECAT analysis, but it faces similar challenges as the other two intersections. This intersection also lacks proper lane markings and lane control signage. There have also been numerous ran-red-light crashes during the study period.

Additional pavement markings, appropriate signage, signal visibility upgrades, reduced dilemma zones, signal phasing revisions, geometric realignment, and lane assignments/reconfigurations can make these intersections safer for all road users.

2. Multilane Roadway Configuration

Wayne Avenue is a multilane roadway consisting of four travel lanes with a center turn lane, with medians and an additional turn lane near Wyoming Street. There are many reasons why this configuration can have negative effects on roadway safety, including:

- Conflict points: The Federal Highway Administration (FHWA) defines a conflict point as "any location where road users' paths coincide, categorized as either crossing, merging, diverging, or nonmotorized." With additional lanes comes additional conflict points, increasing the likelihood of crash types such as sideswipes, rear ends, or left-turn angle crashes
- Higher speeds: When drivers are presented with a wide roadway, they are more likely to falsely perceive the safety of driving at high speeds since there's more space available for recovery in the case of a crash. However, higher speeds lead to more distance covered during reaction times, increased crash severity, and a greater potential for crashes for all modes of travel.
- Higher traffic volumes: Drivers often perceive the presence of additional lanes to be an opportunity to support additional traffic. However, an increase in traffic can lead to vehicles driving in closer proximity, further worsening the chance of collisions.
- Complex environment: Multilane roadways present a complex environment for all road users. Drivers are presented with more visual information, such as signs and other vehicles, which can become overwhelming and lead to error in decision making. Similarly, the complexity of multilane roadways affects pedestrians and cyclists since the presence of multiple lanes is more difficult to

cross, both due to the physical distance of the crossing and the volume of traffic which must be avoided when crossing. If a pedestrian or cyclist has an error in judgement, the stakes are much higher, as these road users are much more susceptible to experiencing a higher severity of crashes than their vehicular counterparts.

The various negative effects of multilane roadways can be mitigated through the implementation of traffic calming measures, such as adding raised medians and vertical elements, speed tables, protected crossings, and incorporating other pedestrian and bicycle infrastructure.

3. Lack of Pedestrian and Bike Infrastructure

During the crash analysis, twelve crashes involving vulnerable road users were analyzed: nine pedestrian crashes and three bicyclist crashes. Of the twelve, only one crash did not result in any suspected injury. One of the twelve resulted in a fatality: a pedestrian standing on the corner of Wayne Avenue and Clover Street. Vehicles, especially newer models, are built to protect those inside with safety features such as seatbelts, airbags, automatic breaking, lane assist, and many more new features. However, pedestrians and cyclists have much greater exposure and much lower resilience to crashes. For this reason, nonmotorized travelers are often referred to as "vulnerable road users" or VRUs. All but one of the reported pedestrian and bicycle crashes occurred at an intersection, indicating an elevated level of concern for facilities and intersection configurations within the study limits. These crashes did not only occur when an individual needed to cross Wayne Avenue, but also when crossing a side street, moving parallel to traffic. This is likely one reason why many pedestrians choose to cross Wayne Avenue outside of marked crosswalks. Often, pedestrians perceive crossing mid-block without a crosswalk to be safer. This is because they can find their own gap in northbound traffic, then wait for a gap in southbound traffic, and complete the crossing. This results in potential conflicts with only one lane at a time (as they cross) and from one direction of travel. Conversely, at a signalized intersection, after waiting for the appropriate time for pedestrian crossing, they must proceed along their intended path while watching for many lanes of traffic approaching from all directions including run red light traffic on the lanes crossing, right on red traffic, and left turning traffic.

Sidewalks are relatively narrow – especially near the intersection of Clover Street – with overgrown street trees and utilities as obstacles.

There are many reasons to cross Wayne Avenue such as to reach the park between Park Drive lanes, residents, and businesses. There are few signs and appurtenances leading drivers to anticipate pedestrians along the corridor.

There is no bike infrastructure on Wayne Avenue, however, there are bike lanes connecting to Wayne Avenue on the east leg of Wyoming Avenue, a bikeable park connecting to Wayne Avenue and several in the near vicinity, and several residential homes and businesses which many people may need to access without the use of a vehicle.

Therefore, it is pertinent to build infrastructure that allows nonmotorized road users to travel as safely as their motorized counterparts, especially near intersections.

Pedestrians and cyclists can choose nonmotorized travel for a variety of reasons. Firstly, these individuals may not have access to a vehicle because they cannot afford one. Reaching one's destination should be safe regardless of one's financial status. Creating an equitable transportation system can ensure that anyone can arrive to the grocery store, a doctor's appointment, school, or any other destination without worrying for their health and safety. Similarly, these individuals may be utilizing the Dayton RTA bus system, which has numerous stops throughout the study area. As a result, these locations should be prioritized when installing new pedestrian and bicycle infrastructure.

Another reason that active transportation may be utilized is due to a traveler's age or mobility. Specifically, elderly individuals often feel unsafe driving due to declining sight and hearing abilities and slower reaction times, among other factors. These individuals are more likely to utilize Dayton RTA to safely arrive at their destination. However, the existing pedestrian infrastructure is not conducive to a safe transportation network, likely deterring many users who would choose to walk if it were safer. Without proper pedestrian facilities, elderly and other disabled residents aren't provided with a safe mode of transportation. This can prevent them from making medical appointments, going to the store, visiting family, or completing a variety of necessary or desired trips. If they still choose to travel without proper pedestrian infrastructure, they must place themselves in an unsafe environment, risking their health, and ultimately, their lives.

Finally, active transportation can be used recreationally to improve one's health. Active transportation not only increases physical activity and improves physical health, but when utilized instead of driving, it can also

lead to a decrease in car emissions, improving air quality and public health. People of all ages may choose to walk, run, or bike to improve their health. Without the safe facilities to do so, nearby residents are likely to feel discouraged from doing so along or across Wayne Avenue. Dayton residents may also choose to improve their health by utilizing the Miami Valley Bike Trails. These trails can be found in Montgomery, Miami, Clark, and Greene counties. One trail, the Dayton-Kettering Connector, runs nearly parallel to Wayne Avenue, just a few blocks to the west. Streets such as Wyoming Street, Oak Street, Adams Street, and Buckeye Street serve as a direct connection between the Dayton-Kettering Connector and Wayne Avenue.

Pedestrian and bicycle facilities can be incorporated into an improved design of Wayne Avenue to create transportation equity for road users despite financial status, age, mobility, and mode of travel.

G. Evaluation of Countermeasures and Alternatives

The potential countermeasures to address the aforementioned probable causes are described below.

1. Designing Safer Intersections

   The first way to improve the safety of both the Wyoming Street and the Clover Street intersections is to clearly mark each approach lane with edge lines and turning arrows, if necessary. To prepare drivers to decide which lane they must be in, lane designation signs can be installed at an appropriate distance prior to reaching the intersection. An example of this signage is shown in Figure 47. The R3-H8bj sign provided below would be appropriate for the westbound approach at the Wyoming Street intersection.

Figure 47. ODOT R3-H8bj Signage

Similarly, yield signage, as shown in Figure 48, would be appropriate to install at the right-turn slip lanes for N/S traffic at the Wyoming Street intersection.

Figure 48. Federal YIELD Signage

Improvements can also be made to the signals at these intersections. Each approach lane should have its own signal head, either multiple three-ball signal heads or a combination of three- and five-ball signal heads, to properly direct the incoming traffic. To increase visibility, particularly during dark hours, reflective backplates can be added to each signal. This reflective backing is shown below in Figure 49.

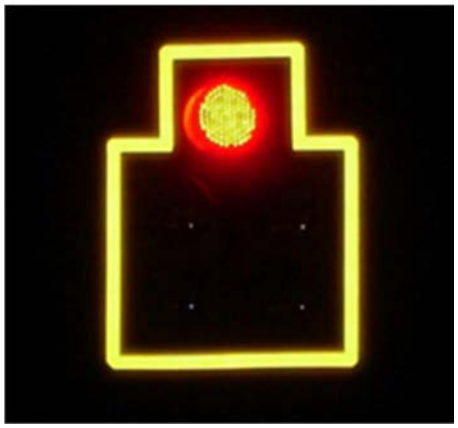


Figure 49. Reflective signal backplate at night

Signals at these intersections can also be improved through the installation of a dilemma zone protection (DZP) system. The FHWA defines the dilemma zone as "an area in which a driver cannot stop gently before the stop line or clear the intersection safely before the red phase." When in the dilemma zone, drivers must either risk running a red light, or they must come to an uncomfortable and abrupt stop. Both decisions can result in a crash. Continuing through the intersection can cause angle crashes, while stopping abruptly can cause rear-end crashes. Recall from the Crash Data

Summaries section that these two crash types tied for the most common crash type, each attributing for 47 crashes. By installing a DZP system, radars can detect when a vehicle is approaching the intersection at a higher speed, determining that the scheduled signal timing would place them in the dilemma zone. Once detected, the system can protect these vehicles from potential dilemma zone conflicts by extending the green interval to its maximum green length. This dynamic system is likely to reduce the number of rear-end and angle crashes at each of the three signalized intersections within the study limits.

To prevent additional pedestrian fatalities at Clover Street, there must be a great effort to redesign the intersection with a focus on traffic calming and pedestrian infrastructure, each of which will be discussed in further detail throughout the next two sections.

2. Traffic Calming on a Multilane Roadway

As previously discussed, the intersection at Clover Street must incorporate traffic calming and pedestrian infrastructure for the safety of all travelers in the future. One method of traffic calming which can be applied to the intersection is by creating a raised intersection. The FHWA states:

> A raised intersection is a flat, raised area covering an entire intersection with ramps on all approaches… A typical installation is at a signal-controlled or all-way stop-controlled intersection with a large volume of street-crossing pedestrians. A raised intersection reinforces the need for a motorist to drive cautiously and be wary of crossing pedestrians.

Raised intersections typically rise to meet the height of the sidewalk. By raising an intersection, vehicles are more likely to decrease their speed, creating a traffic calming effect at each approach. Furthermore, the additional height raises crossing pedestrians, enhancing their visibility to approaching vehicles. An image of a raised intersection is provided below in Figure 50.

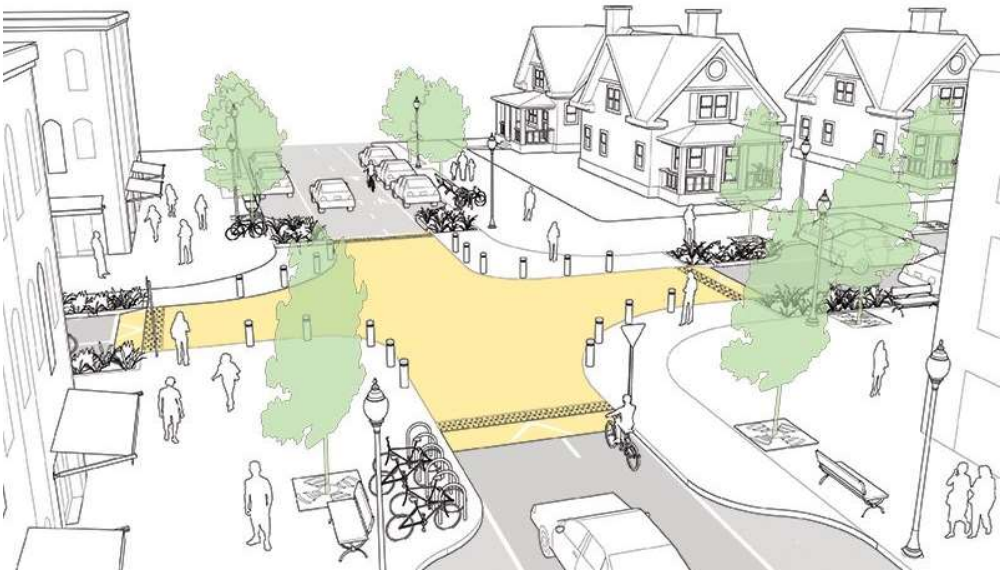


Figure 50. Configuration of a raised intersection

Additionally, traffic calming and pedestrian protection can be created at the Clover Street intersection by installing bollards at each corner, slowing turning traffic and protecting pedestrians in the sidewalk. Figure 50 above also depicts the application of this countermeasure.

One of the most common ways to achieve traffic calming is by implementing a road diet. The term "road diet" refers to the process of reducing the number of travel lanes within a road or decreasing the width of the lanes. By removing lanes, the volume of traffic may decrease as drivers are more likely to perceive fewer lanes as having a smaller capacity for vehicles. Additionally, seeing a narrower roadway ahead increases the chances that drivers will reduce their speed due to the discomfort of a tight space. Removing lanes can further lead to reduced speeds as drivers are limited to the speed of the driver ahead of them. Other tools can be used to create this same feeling of discomfort for drivers, such as adding center medians or vertical elements like trees and shrubs. Drivers recognize that they cannot drive as quickly through tighter spaces without risking a crash with a limited amount of recovery space. Decreasing the number of lanes in the configuration of Wayne Avenue would decrease the number of conflict points, likely leading to a decrease in sideswipe, left-turn angle, and rear end crashes.

Some roadways may not be good candidates for road diets due traffic volume and capacity needs. If a roadway has a high AADT (average annual daily traffic), removing lanes can lead to unwanted delays and an increase in crashes. State agencies and researchers often disagree on the maximum traffic volume for a roadway to be fit for a road diet. The Federal Highway

Administration (FHWA) suggests in the Road Diet Informational Guide that roadways with an ADT of 20,000 vehicles per day (vpd) or less may be good candidates and should be evaluated for feasibility. The Road Diet Informational Guide also states that other researchers have documented road diets with ADTs ranging from 8,500 to 24,000 vpd. Recall that traffic counts were obtained on August 20, 2024, from 7:00 AM to 7:00 PM. The maximum recorded volume of daily traffic on Wayne Avenue is shown above in Figure 24 at 17,389 vehicles. The exact effectiveness of a road diet on Wayne Avenue cannot be determined, as it poses the likelihood of both positive and negative outcomes.

However, the AADT of Wayne Avenue appears to decrease north of the Keowee Street intersection. Figure 24 also shows that this region experienced about 10,000 vehicles during the 7:00 AM to 7:00 PM count. Therefore, implementation of a road diet on Wayne Avenue north of Keowee Street is likely to produce positive traffic calming effects with a lower chance of increasing crash frequency or motorist delays. It must be noted that this study only contains approximately 700 feet of roadway north of Keowee Street. If implemented, this road diet should continue north, past US 35, to increase the likelihood that vehicles traveling into and out of the study limits will exemplify slower speeds.

To encourage slower speeds throughout the entire study area, medians can be installed to populate the roadway with vertical elements. Medians are one method of creating a narrower—or the illusion of a narrower—roadway. Narrow roadways are uncomfortable for drivers to traverse at high speeds, commonly resulting in a reduction in speed. Flush medians (painted medians on the pavement) are less likely to have this effect, as raised medians create a small vertical barrier that drivers fear to strike. The presence of vertical objects, such as shrubs or trees, further creates the feeling of a narrow roadway. Street trees and shrubs can be placed within the median to create the feel of a constricted roadway, likely resulting in slower speeds and fewer or less-severe crashes. Though medians are a useful tool in enhancing traffic calming, they can also be difficult to properly maintain.

Similarly, trees and shrubs can be placed on the roadside to create traffic calming effects. There are many street trees along Wayne Avenue, though many have become overgrown, reducing walking space and lifting sidewalk pavement. Additional trees can be planted to both fill empty gaps and to replace the overgrown trees. Planting shrubs along the edge of the sidewalk could also create the continuous presence of short, vertical elements, both calming traffic and creating a buffer between vehicles and

pedestrians on the sidewalk. However, this may not be feasible throughout the entire project limits as minimum sidewalk and buffer widths must adhere to those outlined in ODOT's Multimodal Design Guide (MMGD).

Often, infrastructure designed for the safety of nonmotorized users inherently creates traffic calming effects. This is because many pedestrian- and bike- focused countermeasures often encourage vehicles to slow down or prepare them to yield to pedestrians and cyclists. Planting shrubs to create a buffer between motorized and nonmotorized traffic is an example of how traffic calming can be intertwined with pedestrian infrastructure. Pedestrian infrastructure is discussed in more detail in the following section.

On the north end of this corridor, the application of gateway treatment would also contribute to traffic calming. Common features include signage, roadway narrowing, decorative paving, landscaping, and vertical elements like archways or pillars, all of which work together to create a well-defined entry point into the new zone. Gateway treatments are a traffic calming technique designed to alert drivers that they are entering a different area where lower speeds or increased caution is required, such as residential neighborhoods, pedestrian-activity zones, or school areas. These treatments work by providing visual cues that encourage drivers to slow down and proceed with greater caution.

By incorporating elements like signs, road markings, or structural changes, gateway treatments create a psychological effect that makes the roadway appear narrower or more constrained, prompting drivers to reduce their speed naturally. Physical modifications are also a key component of gateway treatments. Raised medians, islands, or slight bends in the road (chicanes) require drivers to maneuver more carefully, further reducing their speed. Additionally, changes in road texture or color, such as using brick or colored asphalt, create a sensory change that heightens driver awareness. These features often come with prominent signage reminding drivers of reduced speed limits or increased pedestrian activity, emphasizing that they are entering a new zone that requires modified driving behavior.

The use of aesthetic elements like landscaping, public art, or community branding in gateway treatments also creates a distinct sense of place, reinforcing the idea that this area is meant for slower, more careful driving. See Figure 51 and Figure 52 for examples of gateway treatments.

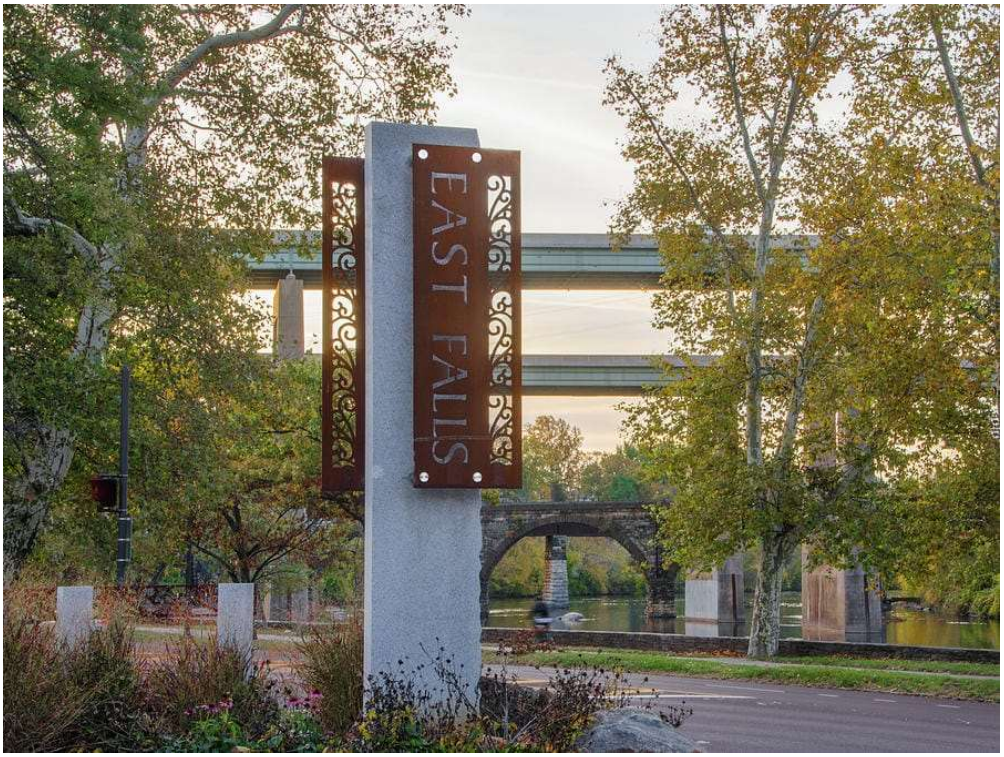


Figure 51. Community branding through roadside signage

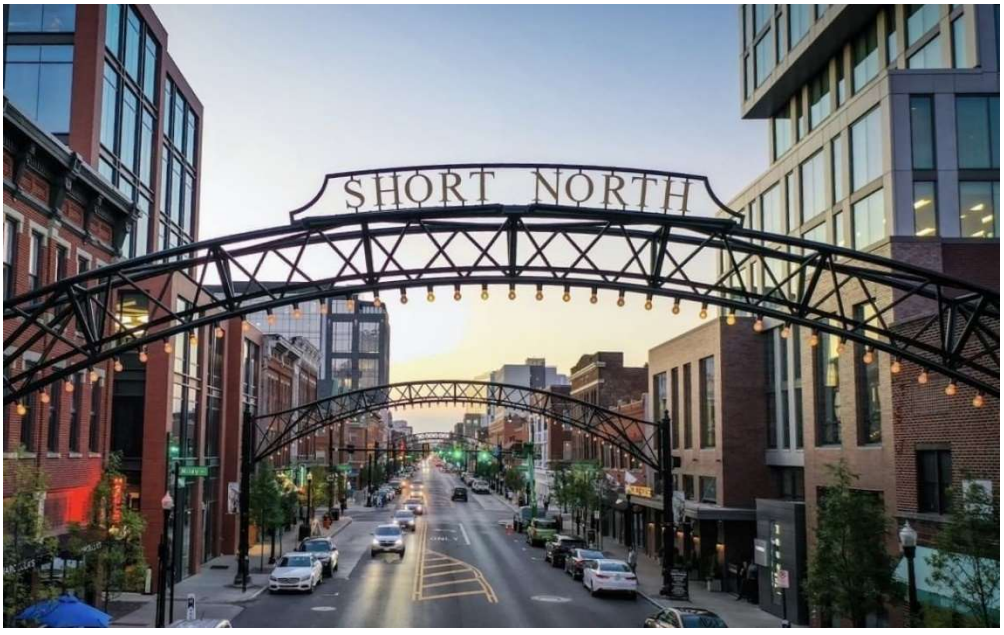


Figure 52. Community branding through overhead signage

These traffic calming treatments are effective because they rely on visual and physical cues to influence driver behavior rather than depending solely on enforcement methods like speed cameras or police presence. By creating a self-enforcing environment, gateway treatments and traffic

calming help reduce instances of aggressive driving and make roads safer for all users.

For these visual and physical cues to remain effective, drivers must not become overwhelmed by excessive visual clutter such as signs, utilities, or other distracting roadside elements. Once drivers become overwhelmed by roadside visual clutter, they are more likely to ignore the roadside altogether to maintain their focus on the road. This can lead to an increase in danger as drivers become less likely to notice elements such as pedestrian crossing signs or posted speed limits.

One way to reduce visual clutter is to remove the overhead utilities present along Wayne Avenue and place them underground. Though this is not an affordable task, it can create positive effects on both the safety and the aesthetics of the area. Clearing this overhead space can also increase the feasibility of overhead gateway treatments, such as the example depicted in Figure 52. Similarly, light poles can be removed from the roadside and placed in the center median, offering both functional and aesthetic benefits. Figure 53 shows an example of how lighting can be placed in a center median to reduce roadside visual clutter and enhance the aesthetics and traffic calming effects of the median.

Figure 53. Functional roadway lighting used for aesthetics and traffic calming

3. Install Additional Pedestrian and Bicycle Infrastructure

Pedestrian Infrastructure:

New pedestrian infrastructure can be installed throughout the study area to decrease the likelihood of future pedestrian crashes and to create a safer transportation system for all road users. Pedestrian infrastructure such as sidewalks and high-visibility crosswalks can be simple yet valuable assets in ensuring pedestrian safety. Presently, sidewalks exist on both sides of Wayne Avenue throughout the study limits. Many regions of this sidewalk have become damaged or non-compliant to ADA requirements. To address this, a sidewalk survey can be conducted to determine which sidewalks must be replaced.

Pedestrians utilizing the sidewalk on Wayne Avenue must walk to one of the three signalized intersections to utilize a marked crosswalk. Often, pedestrians cross mid-block to avoid walking the extra distance, whether to save time, because they lack the mobility to travel long distances, or due to the perception of safety. Regardless, when they reach these intersections, pedestrians are faced with limited pedestrian facilities, offering little reward for walking an additional distance. To facilitate safe crossings on Wayne Avenue, new high-visibility crosswalks and ADA-compliant curb ramps can be added at each intersection.

The following images depict the effects of high-visibility crosswalks. Figure 54 shows crosswalk marking styles: "standard" low-visibility crosswalks and "continental" high-visibility crosswalks. The standard markings in the left image do not grab drivers' attention, lessening the likelihood that drivers perceive the possible presence of a crossing pedestrian. Also, as cars drive over these markings, the paint fades quickly, lessening their effectiveness over time. The four high-visibility crosswalks in the right image not only grab drivers' attention but can also be designed to align with tire paths, preventing the paint from being worn away as quickly as the standard design. Note that the left image in Figure 54 uses one curb ramp at each quadrant of the intersection, while the right image has two curb ramps at each quadrant. Often, having one curb ramp on each corner prevents the ramps from properly aligning with the direction of the crosswalk, creating great and dangerous confusion for individuals who are visually impaired.

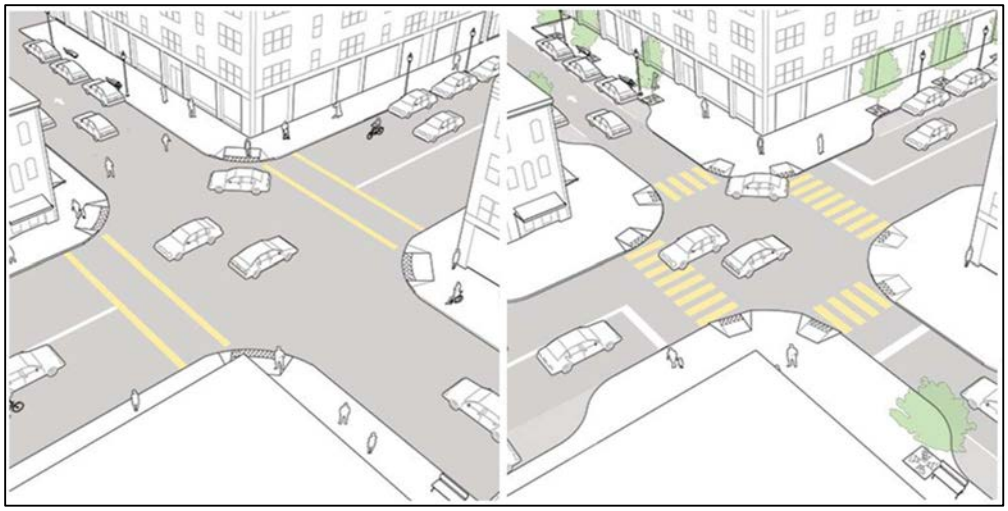
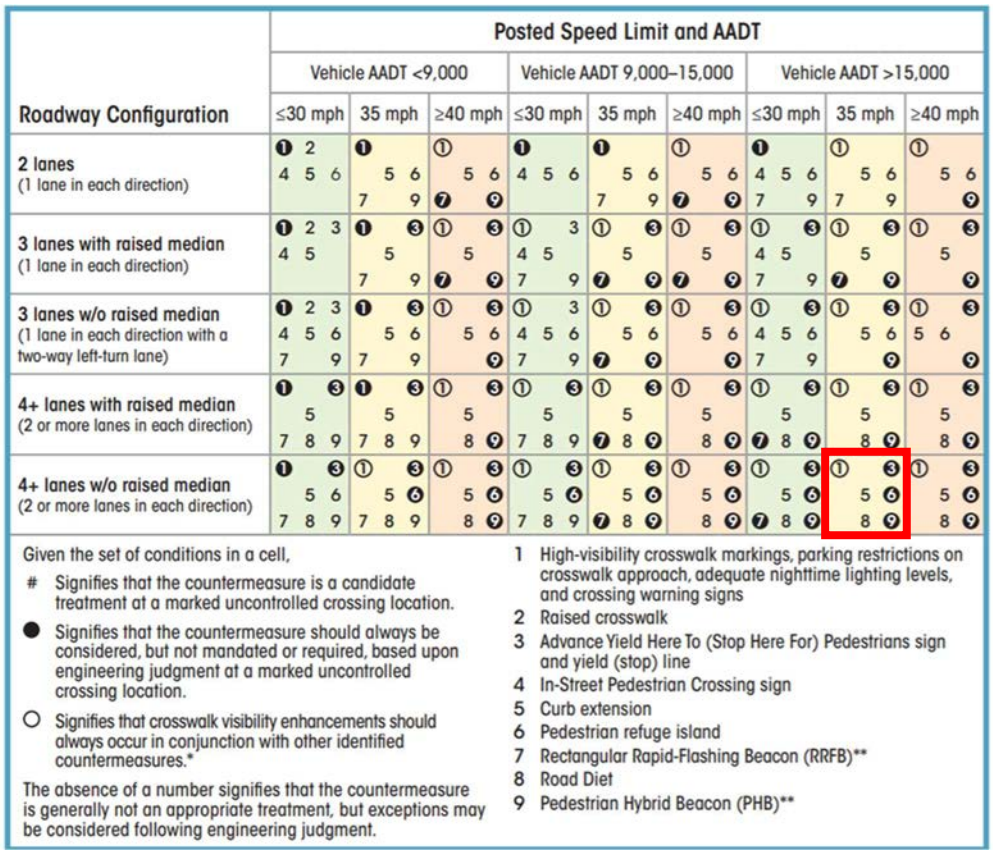


Figure 54. Comparison of traditional vs. high-visibility crosswalk markings

As discussed above, pedestrians may be less likely to walk to the next signalized intersection to cross Wayne Avenue. Intermediate crossing locations can be created by using recommended crossing treatments that are appropriate for the characteristics of Wayne Avenue. ODOT's Multimodal Design Guide (MMDG) provides guidelines for the application of pedestrian treatments based on roadway speed, volume, and configuration. These guidelines are shown in Figure 55. This chart provides countermeasures that would be appropriate to apply along Wayne Avenue. To determine possible pedestrian countermeasures, the *4+ lanes without raised median* configuration, *35 mph* posted speed limit, and *Vehicle AADT>15,000* volume are to be used in this study.



Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	● 2 4 5 6	● 5 6 7 9	○ 5 6 ● ●	● 4 5 6	● 5 6 7 9	○ 5 6 ● ●	● 4 5 6 7 9	○ 5 6 7 ●	○ 5 6 ●
3 lanes with raised median (1 lane in each direction)	● 2 3 4 5	● ● 5 7 9	○ ● 5 ● ●	○ 3 4 5 7 9	○ ● 5 ● ●	○ ● 5 ● ●	○ ● 4 5 7 9	○ ● 5 ● ●	○ ● 5 ●
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	● 2 3 4 5 6 7 9	● ● 5 6 7 9	○ ● 5 6 ●	○ 3 4 5 6 7 9	○ ● 5 6 ● ●	○ ● 5 6 ●	○ ● 4 5 6 7 9	○ ● 5 6 ●	○ ● 5 6
4+ lanes with raised median (2 or more lanes in each direction)	● ● 5 7 8 9	● ● 5 7 8 9	○ ● 5 8 ●	○ ● 5 7 8 9	○ ● 5 ● 8 ●	○ ● 5 8 ●	○ ● 5 ● 8 ●	○ ● 5 8 ●	○ ● 5 8 ●
4+ lanes w/o raised median (2 or more lanes in each direction)	● ● 5 6 7 8 9	○ ● 5 6 7 8 9	○ ● 5 6 8 ●	○ ● 5 6 7 8 9	○ ● 5 6 ● 8 ●	○ ● 5 6 8 ●	○ ● 5 6 ● 8 ●	○ ● 5 6 8 ●	○ ● 5 6 8 ●

Given the set of conditions in a cell,

\# Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.

● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.

○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
2 Raised crosswalk
3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4 In-Street Pedestrian Crossing sign
5 Curb extension
6 Pedestrian refuge island
7 Rectangular Rapid-Flashing Beacon (RRFB)**
8 Road Diet
9 Pedestrian Hybrid Beacon (PHB)**

Figure 55. Application of Pedestrian Crash Countermeasures by Roadway Speed, Volume, and Configuration

By utilizing these categories, the MMDG recommends the application of the following countermeasures:

(1) High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs

(3) Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line

(5) Curb extension

(6) Pedestrian refuge island

(8) Road diet

(9) Pedestrian Hybrid Beacon (PHB)

Countermeasure (1) and Countermeasure (8) have been previously discussed in detail above. The installation of Countermeasure (5) *curb extension* is not recommended, as there are no lanes which would be feasible to restrict access at an intersection. If a road diet were recommended to be implemented, then curb extensions would become a more feasible countermeasure.

Countermeasure (9) *Pedestrian Hybrid Beacon (PHB)* can be utilized to facilitate safe crossings on Wayne Avenue in intermediate mid-block locations. A Pedestrian Hybrid Beacon (PHB) is a signalized mid-block crossing which directs vehicles to stop when a pedestrian activates the push button, allowing them to safely cross Wayne Avenue despite having trouble finding a sufficient gap in traffic. The FHWA suggests that PHBs are most effectively utilized at locations where three or more lanes will be crossed, traffic volumes exceed 9,000 AADT, and speed limits exceed 35 mph. When a pedestrian needs to cross, they can activate the push button, and the signal will display the necessary sequence. This sequence is detailed below in Figure 56. When the signal is not activated by a crossing pedestrian, vehicles may travel through the crosswalk without interruption.

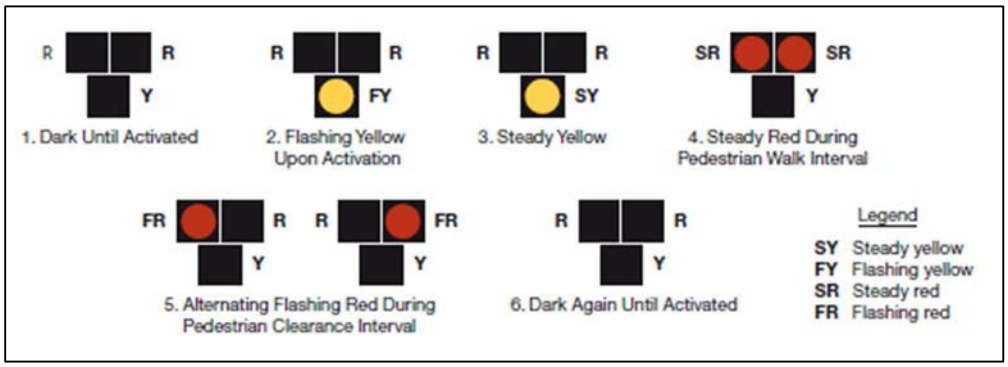


Figure 56. Signal head display sequence of a Pedestrian Hybrid Beacon (PHB)

The remaining recommended countermeasures – (3) A*dvance Stop Here For sign and stop bar* and (6) *pedestrian refuge island* – can be combined with a PHB to form a two-stage mid-block pedestrian crossing. PHBs are often installed with the use of Advance Stop Here For signage and stop bars, further signifying to vehicles that they must come to a stop prior to traveling through the activated crosswalk. By adding a pedestrian refuge island, pedestrians can cross one direction of traffic at a time before activating the crosswalk again. This design is called a two-stage crossing, since pedestrians must only cross one direction at a time. This also means that one direction of traffic must stop at a time, further limiting delay as vehicles don't need to wait for a pedestrian to cross the entire roadway. The two-stage crossing design also supports elderly pedestrians and those with limited mobility, as the refuge island can create a much-needed break in walking for these individuals. Figure 57 shows an example of the two-stage crossing design.

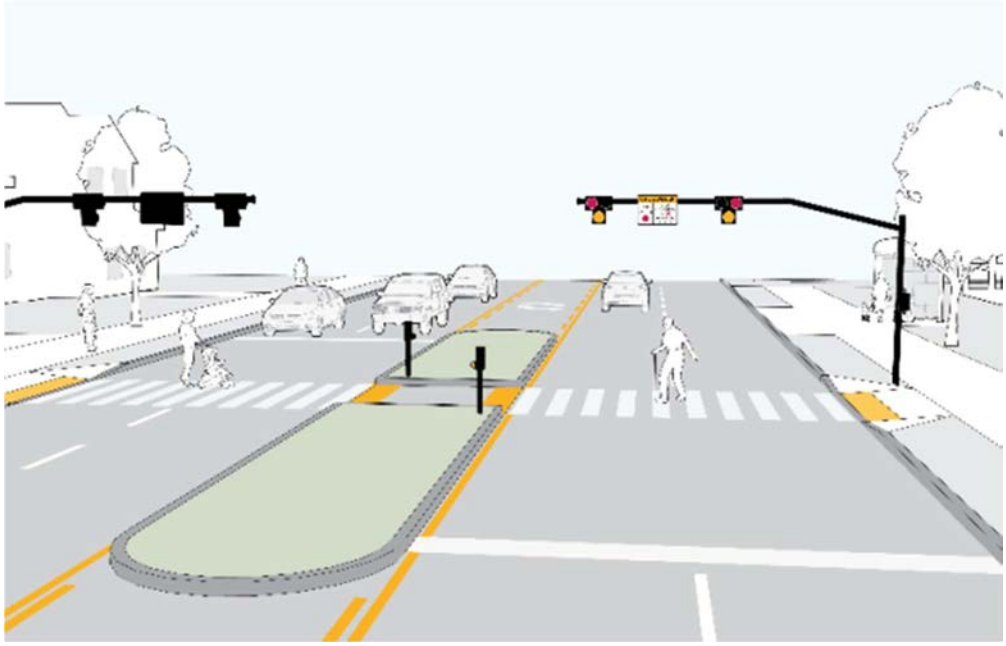


Figure 57. Two-stage Pedestrian Hybrid Beacon

Determining a proper location for this two-stage PHB crossing requires many considerations. Firstly, it needs to be placed in a region where medians can exist without interfering with necessary movements. Secondly, it should be placed in accordance with frequent pedestrian routes and near known pedestrian destinations. One location which may benefit from the installation of a PHB is the intersection of Park Drive and Pierce Street. Pedestrians may travel to this intersection to reach the adjacent park or to continue north or south on Wayne Avenue. This location is also about halfway between the next two adjacent marked crossing locations: the intersections at Wyoming Street and Clover Street. However, the configuration and misalignment of Pierce Street and Park Drive can cause confusion for motorists and non-motorists alike. Three possible PHB configurations are shown in Figure 58 below. If placed within the intersection, as shown in the cyan Alternative 2, this intersection and crossing can be raised to form a second raised intersection. Like at Clover Street, raising this area can further contribute to traffic calming and can enhance the visibility of pedestrians using the crosswalk. The exact placement of the PHB and the raising of this misaligned intersection are likely to require additional feasibility research prior to design and implementation.

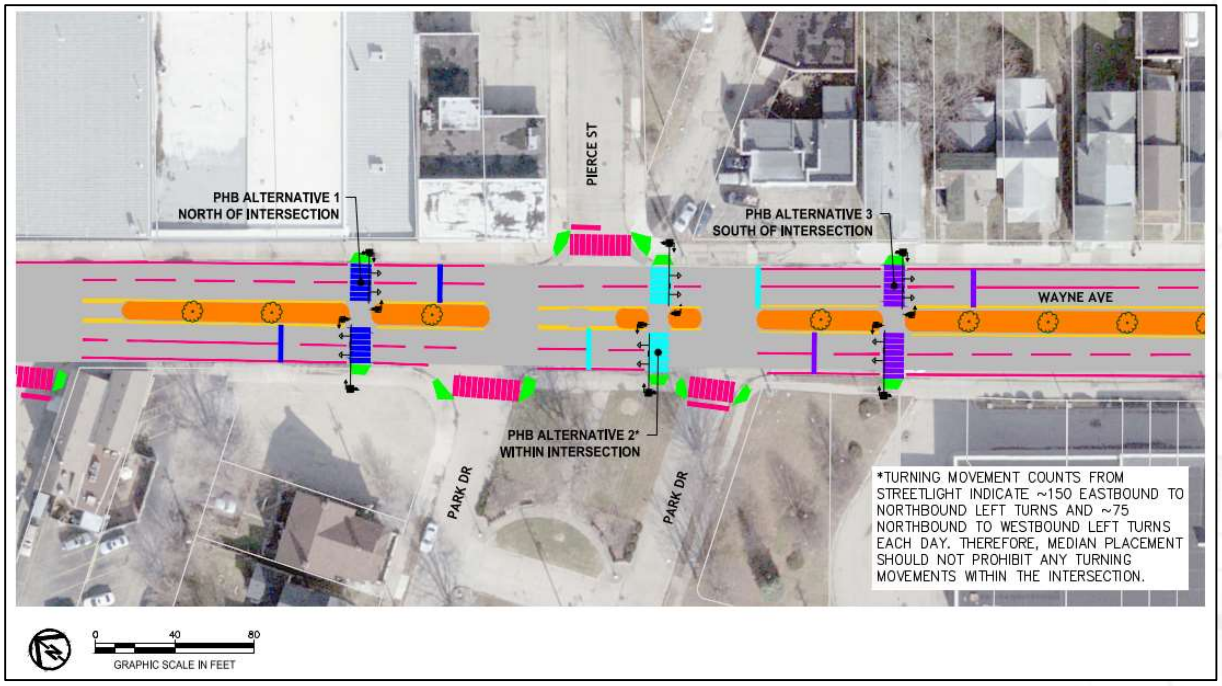


Figure 58. Alternative configurations of the two-stage PHB crossing

Ultimately, the project team favors the Alternative 2 location due to the proximity of the park and the likelihood that this route would best serve pedestrians. Utilizing this location raises concerns for turning movements at this unique intersection. Park Drive eastbound and westbound lanes are separated with the park in between. Turns from Wayne Avenue onto Park Drive occur at the north part of the intersection. Turns from Park Drive onto Wayne Avenue occur at the south part of the intersection. For the proposed configuration, it is recommended that this PHB placement be implemented in conjunction with the extension of the proposed median along Wayne Avenue, blocking Park Drive and preventing these left turn movements. Eastbound drivers on Park Drive would retain their ability to turn right onto Wayne Avenue. Eastbound drivers on Park Drive wishing to turn left at Wayne Avenue can instead utilize the connecting roadway within the park to make a U-turn onto westbound Park Drive, then navigate to Cross Street and Oak Street to reach Wayne Avenue.

Pedestrian refuge islands can also be placed at signalized intersections. For example, there are two existing refuge islands at the Wyoming Street intersection, allowing pedestrians to cross the right-turn slip lanes before they must cross the other travel lanes. However, these existing islands, as well as the median on the southbound approach, are visibly damaged, signifying that vehicles commonly hit these structures and are likely to harm a pedestrian who is waiting to cross. To improve the existing layout, larger refuge islands can be installed at intersection corners (outside of slip

lanes), and the existing median can be replaced. By clearly designating the lanes with improved markings, as discussed above, the eastbound and westbound legs can be reduced to only one receiving lane, allowing an increase in island size. By increasing the size of the pedestrian refuge islands, the crosswalks become shorter, lessening the exposure time of pedestrians when crossing the intersection.

The signalized intersections within the study area can better serve pedestrians by implementing new signal phasing. One way to improve signal timing for pedestrians is to utilize Leading Pedestrian Intervals (LPIs), which provide additional time at the start of each phase—typically three to six seconds—to allow pedestrians to begin crossing prior to vehicles entering the intersection. Though they cannot cross the entire roadway in this short amount of time, LPIs shorten exposure time in the crosswalk and place pedestrians further in drivers' line of sight when their light turns green, increasing visibility and decreasing the likelihood of a crash. Another countermeasure involving intersection signals is to create a pedestrian only phase. A pedestrian only phase, sometimes referred to as "exclusive pedestrian phasing" or as a "pedestrian scramble," separates pedestrians and vehicles in time, allowing pedestrians to cross any approach knowing that no vehicles should be entering the intersection at that time. This would be a valuable tool to utilize at the raised Clover Street intersection, further encouraging driver attention on pedestrians to prevent future injuries and fatalities.

In the studied corridor of Wayne Avenue, there are seven bus stops present: five southbound stops (Hickory Street, Keowee Street, Clover Street, Oak Street, and Wyoming Street) and two northbound stops (Bradford Street and Clover Street). As indicated in the public survey results, many respondents indicated that they would feel safer using public transportation on Wayne Avenue if better bus stop facilities were made available. To address these concerns, it is recommended that bus stop facilities, such as benches and shelters. Benches can be utilized at the following bus stop locations:

- Hickory Street (southbound)
- Bradford Street (northbound)
- Clover Street (northbound and southbound)
- Oak Street (southbound)

Similarly, it is recommended that bus shelters be constructed for the following bus stop locations:

- Keowee Street (southbound)
- Wyoming Street (southbound)

Bicycle Infrastructure:

There are many types of bicycle-oriented facilities.

- Bicycle Boulevard: Also called a shared roadway, bicycles and vehicles share the same travel lanes, which are designated with sharrow pavement markings.
- Bike Lane: An exclusive lane within the roadway for bicycles to travel separately from vehicles. Often, one bike lane is placed on each side of the roadway to facilitate bicycles and vehicles traveling in the same direction. Bike lanes may be buffered with additional edge lines or with vertical elements such as bollards.
- Cycle Track: A bidirectional set of bike lanes, placed on one side of the roadway instead of placing one direction on each side. Bicycle traffic is placed on the roadway but delineated from the bidirectional vehicle traffic.
- Shared Sidepath: A bidirectional path paved adjacent to the roadway where bicyclists, pedestrians, skaters, and other nonmotorized users can travel.

Each of these facility types, and many others, have advantages and disadvantages which restrict which type of roadway they are best suited for. Wayne Avenue is a five-lane roadway with sidewalks abutting the curb, and buildings set at the outer edge of the sidewalks. With the current traffic volume, projected capacity needs, a center turn lane, and available right of way, allocating space for bike lanes will be difficult and costly. As a result, additional bike facilities cannot be built unless lanes are removed from the roadway and redesigned for bicycle use. Though a bicycle boulevard would not require additional space, it would likely be unfavorable and unsafe to place cyclists in the same travel lanes as high-speed and high-volume traffic.

One possible method to create space for bike lanes in each direction is to remove the center turn lane throughout the study, which varies between approximately 11-12 feet, and creating 5 foot wide bike lanes on each side of the roadway. A visual representation of this roadway design is shown below in Figure 59 and Figure 60. This design may be problematic at the signalized intersections where left turn lanes would be eliminated, and no protected left turn phase could be provided. To avoid increased crashes due to failure to yield to oncoming traffic for left turns at these intersections, the northbound and southbound approaches can be limited to two lanes, but utilize separated or split signal phasing, preventing any through traffic from delaying or conflicting with the opposing left-turning vehicles. This would result in further delays for all intersection approaches if the cycle length is increased, or more delays for only the

northbound/southbound approaches if the green phase for each directional movement is halved. As shown in the capacity analyses later in this report, northbound/southbound delays are currently relatively low. An additional 30 seconds of delay for each northbound and southbound approach may be an acceptable trade for providing space for another mode of traffic. Therefore, it is possible to create bicycle infrastructure for the safety of cyclists which also contributes to traffic calming and improved safety for all road users but may result in additional delays for motorists.

Congestion and slower traffic may be frustrating at times, but slower speeds yield less severe crashes – especially for Vulnerable Road Users. Considering the public call for improving safety for people using this corridor, the slower speeds and delays may not be a significant drawback. However, losing access to a designated left-turn lane may prove to increase crash frequency – especially rear-end and left-turn angle crashes – at unsignalized intersections.

It should be noted that there are currently no bike lanes on Wayne Avenue immediately north and south of the studied corridor. If bike infrastructure is planned for these segments and this corridor could offer connectivity, installing bike lanes may be even more desirable.

Implementing bicycle infrastructure on Wayne Avenue presents many challenges, yet is also likely to produce numerous benefits. Figure 59 and Figure 60 depict a possible configuration of Wayne Avenue incorporating bike lanes with other previously mentioned countermeasures.

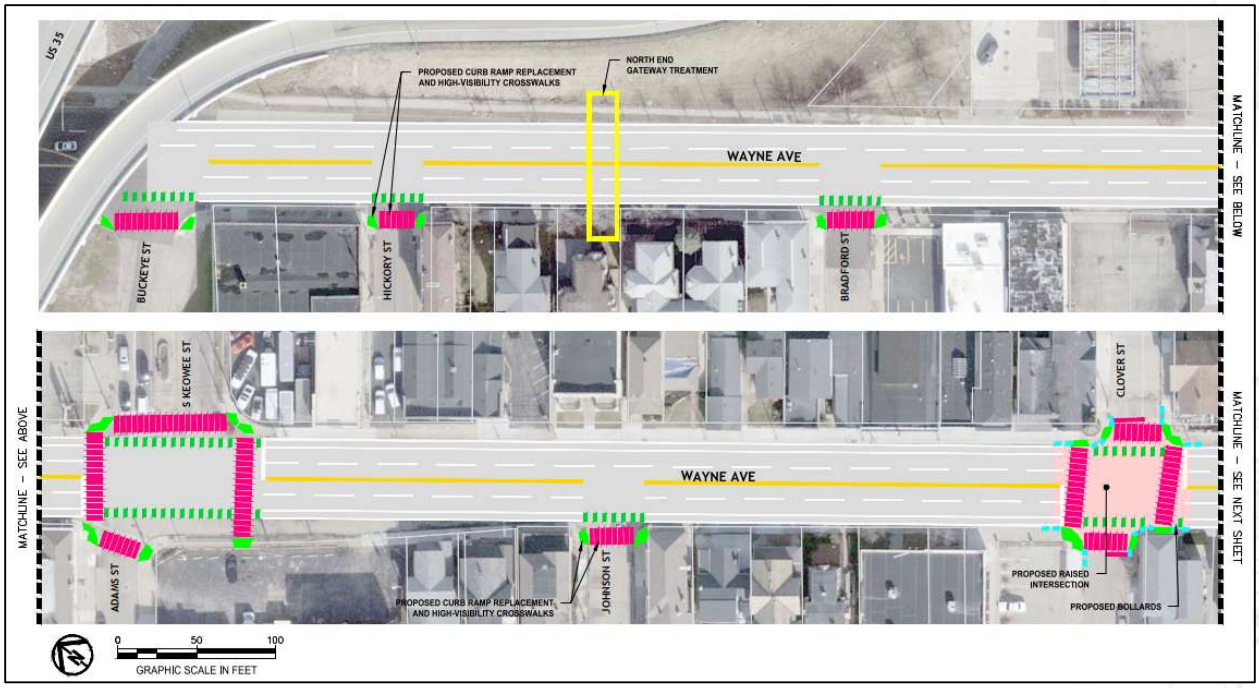


Figure 59. Possible roadway configuration providing bike lanes (1)

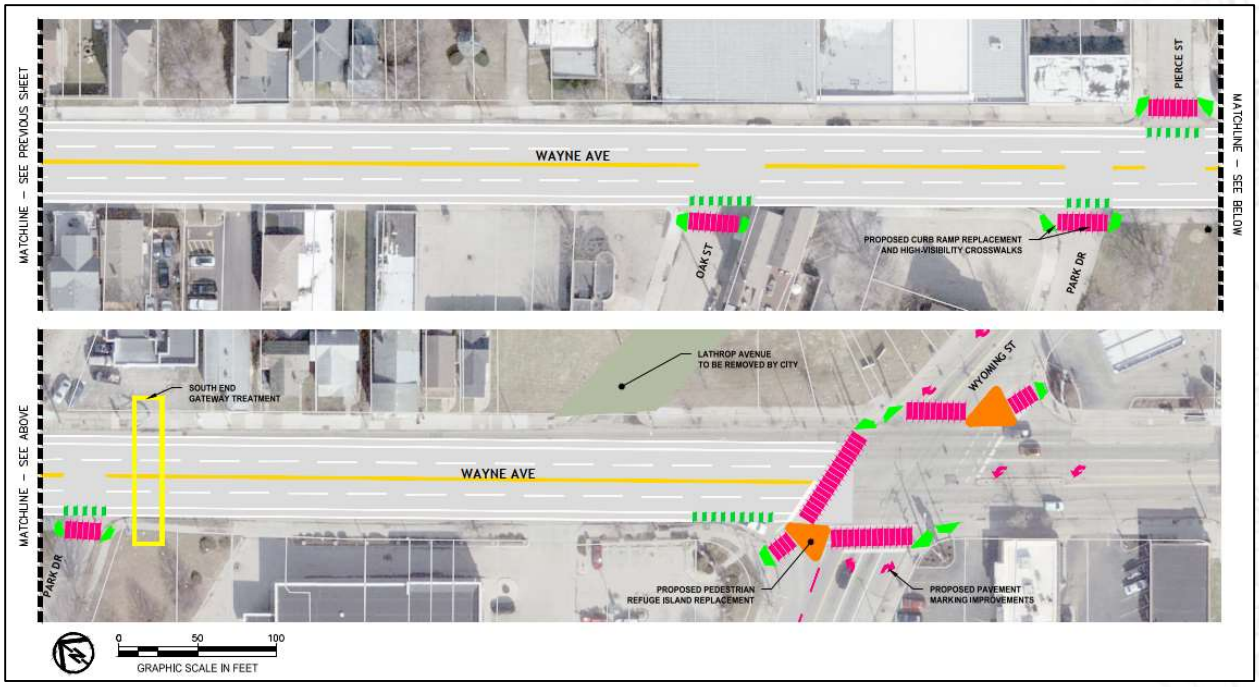


Figure 60. Possible roadway configuration providing bike lanes (2)

If bike lanes are not a feasible option for Wayne Avenue, bike infrastructure can still be considered for implementation throughout the surrounding area. One way to provide infrastructure for cyclists is to provide another

bicycle facility parallel and in very close proximity to Wayne Avenue. Theobald Court, which runs parallel to Wayne Avenue one block to the west, can be transformed into a bicycle boulevard. Converting Theobald Court into a low-stress shared roadway, elements such as sharrow pavement markings, signage, speed tables, painted curb extensions, and planters can be implemented. These elements signal to drivers that the roadway serves both motorized and nonmotorized traffic, raising awareness and increasing safety for nonmotorized users. This layout would reroute bicycle traffic away from Wayne Avenue while maintaining a close distance to amenities and destinations on Wayne Avenue. Theobald Court runs between Hickory Street and Oak Street, which leaves some discontinuity for a full parallel route that reaches Wyoming Avenue. Additional countermeasures can be installed to address this, as follows. A high-visibility crosswalk and signage can be installed where Theobald Court terminates at Oak Street. Cyclists can then cross Oak Street and utilize the existing widened sidewalk on Wayne Avenue between Oak Street and Park Drive. Park Drive consists of two one-way streets separated by a linear park. Cyclists can pass through the park at the short connecting roadway approximately 100 feet west of Wayne Avenue. Finally, a short 11 foot wide path can be constructed south of Park Drive, connecting the roadway within the park to Caleb Place, eventually reaching Wyoming Avenue. Upon reaching Wyoming Avenue, cyclists can continue towards their destination, possibly utilizing the existing bike lanes on Wyoming Street. Figure 61 displays the routing described above.

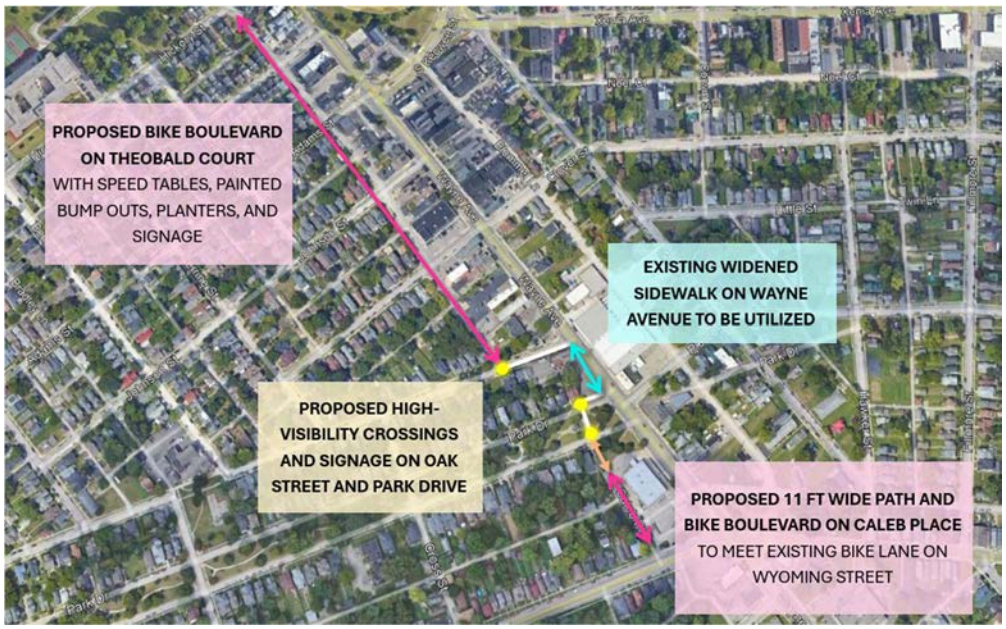


Figure 61. Suggested alternative bicycle routing outside of the project limits

The proposed bike boulevard can be installed in conjunction with marketing tools such as signage and wayfinding maps. Signage, like the example shown in Figure 62, can serve as a bridge between the new bike boulevard and the existing community. There are numerous parks in the Historic South Park neighborhood, which lies just west of Wayne Avenue. The neighborhood hosts Burns-Jackson park, Adams Park, Park Drive Park, and Blommel Park, which can be traveled to with the use of the bike boulevard. Figure 63 depicts marketing material that can be used to show the bike boulevard in relation to nearby parks, a school, and the existing bike lanes on Wyoming Street.

Figure 62. Example of bike boulevard signage

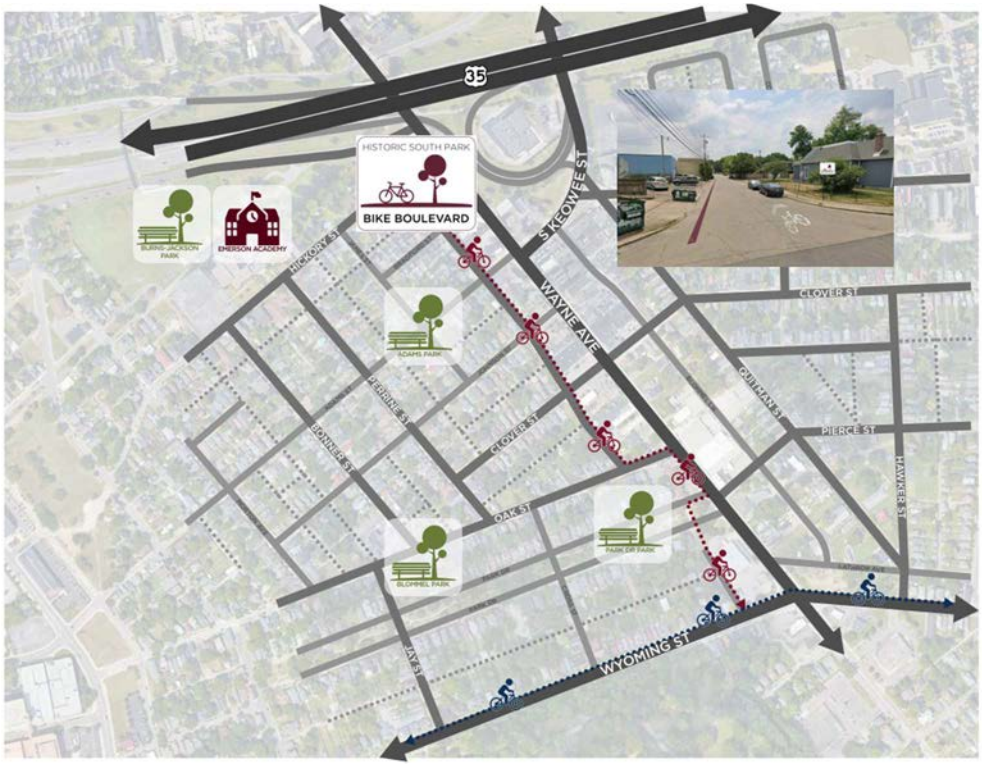


Figure 63. Map of cyclist amenities in the Historic South Park neighborhood

Another unique tool to draw attention to the suggested bicycle routing is to paint a colorful line on roadway pavement along the route. Utilizing a unique, intentionally colored line along the proposed bicycle routing, as well as future bicycle routes in the City of Dayton, can improve wayfinding for cyclists. Figure 64 depicts a rendering of Theobald Court with a colorful line, signage, and sharrow marking.

Figure 64. Rendering of Theobald Court with pavement markings and signage

Table 5 below provides an estimated cost of implementing these changes. This estimate includes a speed cushion and two sharrow markings in each block, as well as a painted bump out and planter at each corner of Theobald Court and Caleb Place. These quantities and costs are subject to change upon further feasibility study.

Table 5. Cost estimate for the suggested alternative bicycle routing

ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
Utility Work	1	LS	$5,000.00	$5,000.00
11' Wide Trail	105	FT	$78.00	$8,190.00
Speed Cushion	6	EA	$12,000.00	$72,000.00
Shared Lane Marking	12	EA	$350.00	$4,200.00
Crosswalk Line, Type 1 24"	70	FT	$30.00	$2,100.00
Bump Out Pavement Markings	4400	SF	$5.00	$22,000.00
Landscape Planter	22	EA	$2,000.00	$44,000.00
TOTAL				**$157,490.00**

It is pertinent that cyclists be supplied with safe routing that adequately provides access to popular destinations and maintains connectivity with

existing bike infrastructure. The project team believes that the routing suggested above can be a step towards reaching this goal.

Safe street design encompasses traffic calming, pedestrian safety, and clear visual cues for drivers. By combining each of these elements, Wayne Avenue can be transformed into a welcoming corridor for users of all modes to safely traverse. Each of the countermeasures discussed above are recommended for implementation by the project team. Figure 65 and Figure 66 illustrate these ideas below. These diagrams are also provided in Appendix E. Note that these diagrams do not display countermeasures such as signage or signal improvements, but the team continues to encourage their implementation. These diagrams incorporate the City's plans to remove Lathrop Avenue.

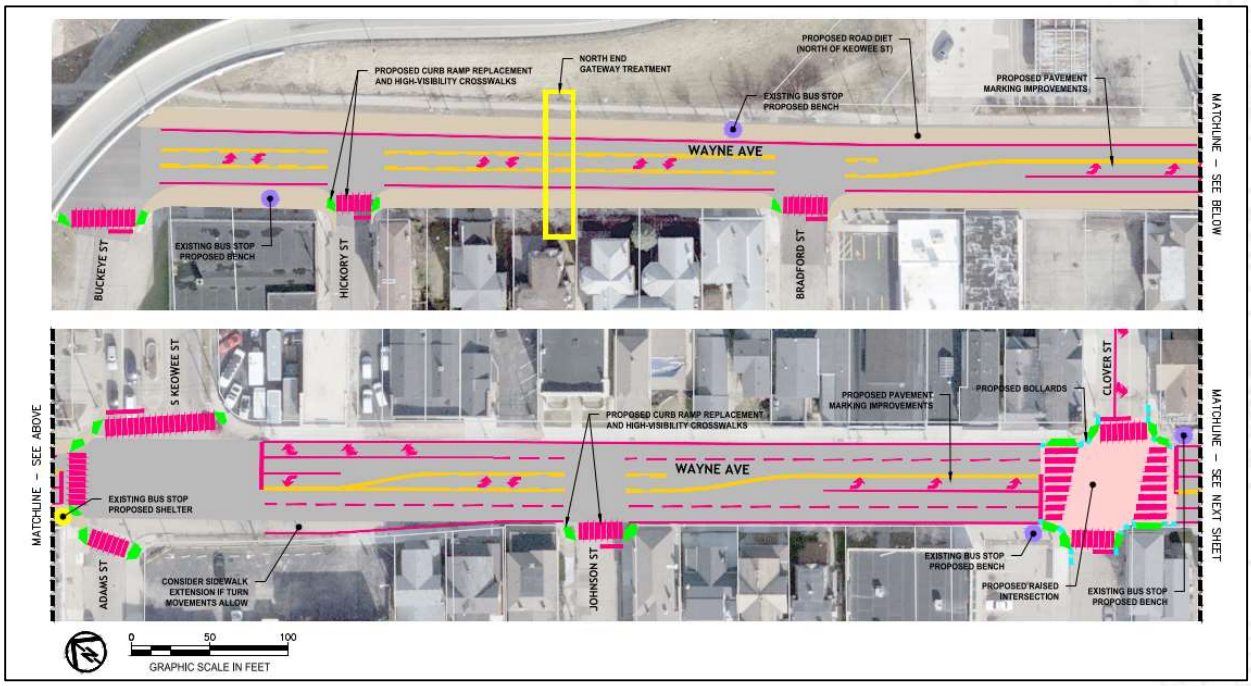


Figure 65. Proposed Conditions (1) Buckeye Street to Clover Street

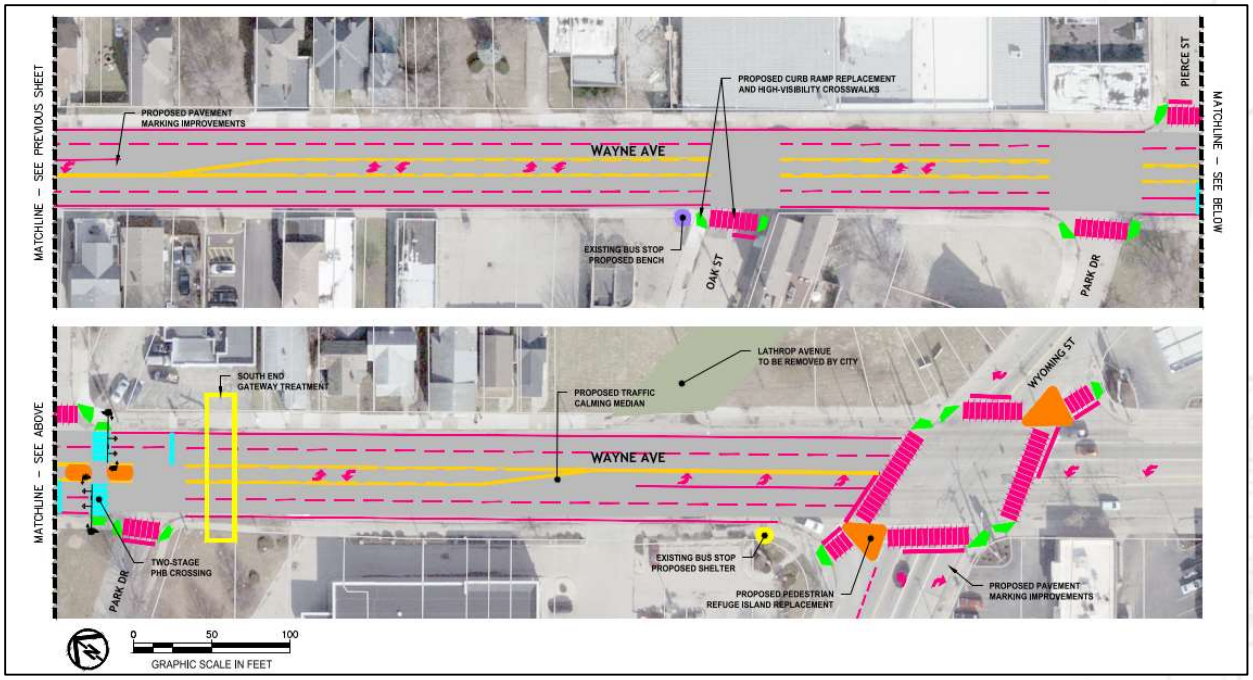


Figure 66. Proposed Conditions (2) Clover Street to Wyoming Street

It is important to note that Wayne Avenue is part of the National Highway System. As stated in Section 105.4 of the ODOT Location & Design Manual, Volume I:

"On National Highway System (NHS) roadways, local jurisdictions shall use the ODOT Location & Design Manual (L&D) and any appropriate AASHTO publications."

According to Figure 301-4 from the L&D, an arterial with posted speed below 50 mph is to be designed with 11 foot lane widths. Much of the studied region of Wayne Avenue is approximately 50 feet wide with five lanes, likely preventing future designs from adhering to this requirement. A design exception will be necessary to maintain the same level of service and number of lanes.

To better visualize the recommendations of this report, renderings are provided in Figure 67 - Figure 70. These renderings can also be found in Appendix F.

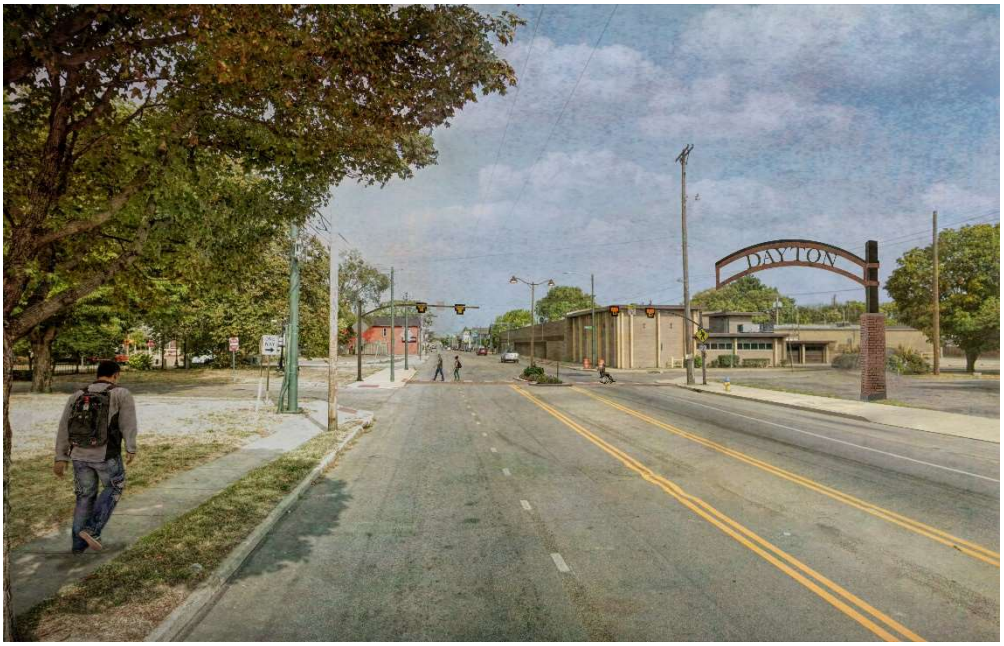


Figure 67. Rendering of the proposed Southern Gateway


Figure 68. Rendering of the proposed Pedestrian Hybrid Beacon (PHB)

Figure 69. Rendering of the proposed Raised Intersection at Clover Street

Figure 70. Rendering of the proposed Northern Gateway

VII. CAPACITY ANALYSIS

The capacity of the Wayne Avenue corridor was analyzed using Highway Capacity Software (HCS) version 2024. The traffic turning movement counts obtained for this study were used as raw data inputs. The analyses considered the three signalized intersections with Wayne Avenue – Wyoming Street, Clover Street, and Keowee Street – as the corridor. Existing Conditions and Proposed Conditions were

evaluated under the same traffic volumes. Note that the intersection of Wyoming Street and Wayne Avenue was under construction during the time of the turning movement collection. The volumes may not represent typical traffic along the corridor and especially not at Wyoming Street.

Left turn lane lengths were calculated based on existing traffic. In most cases, the determining factor of the left turn lane length was not the queue and turn lane design hourly volume, but the blockage due to the volume in the adjacent through lanes. To avoid this, the protected left turn phase can be set to occur after the through/right green phase, allowing the left turn queue to be generated without blockage. Therefore, and additional analysis was performed to show the Proposed Conditions with a lagging left turn phase.

The intersection signals are expected to be upgraded, allowing for 5-ball signal heads and protected left turn phasing for improved safety. All red time was included, as well as extra time for leading pedestrian intervals.

Predicted levels of service and delays are presented in Table 6 through Table 8. The full results of this analysis and the left turn lane calculations can be found in Appendix G.

Table 6 - HCS Analyses for the intersection of Keowee Street and Wayne Avenue

HCS 2024 Analyses	Keowee Street				Wayne Avenue				Intersection	
	Eastbound		Westbound		Northbound		Southbound			
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Existing	0.0		39.5	D	9.9	A	18.3	B	22.3	C
Proposed	0.0		40.8	D	30.2	C	23.1	C	32.5	C
Proposed, Lagging Left	0.0		37.9	D	26.7	C	27.0	C	30.8	C

Table 7 - HCS Analyses for the intersection of Clover Street and Wayne Avenue

HCS 2024 Analyses	Clover Street				Wayne Avenue				Intersection	
	Eastbound		Westbound		Northbound		Southbound			
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Existing	62.3	E	57.4	E	8.5	A	9.2	A	11.7	B
Proposed	62.2	E	58.1	E	9.2	A	15.3	B	15.0	B
Proposed, Lagging Left	62.1	E	58.1	E	6.8	A	10.0	A	11.3	B

Table 8 - HCS Analyses for the intersection of Wyoming Street and Wayne Avenue

HCS 2024 Analyses	Wyoming Street				Wayne Avenue				Intersection	
	Eastbound		Westbound		Northbound		Southbound			
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Existing	53.6	D	55.4	E	18.6	B	9.2	A	26.1	C
Proposed	101.4	F	44.9	D	13.2	B	6.3	A	31.1	C
Proposed, Lagging Left	43.0	D	36.6	D	16.7	B	9.9	A	21.5	C

Note that the proposed condition results depicted in Table 6 utilize the single through-lane configuration on Wayne Avenue north of Keowee Street. Despite the reduction of travel lanes, this southbound approach maintains an acceptable level of service (LOS) C in both proposed analyses. Upon considering the aforementioned daily traffic counts and the predicted level of service, this study supports the implementation of a road diet on Wayne Avenue north of Keowee Street.

VIII. SUMMARY OF PREVIOUS TRAFFIC STUDIES

A. Wayne Avenue Corridor Study

The *Wayne Avenue Corridor Study*, completed in August 2010, analyzed Wayne Avenue between Wyoming Street and Keowee Street. Utilizing crash data from 2007 – 2009, the study analyzed 117 crashes. The analysis determined an average crash frequency of 39.0 crashes per year, compared to the 2019 – 2023 average crash frequency of 43.8 crashes per year. These values depict a 12.3% increase in average annual crash frequency.

There were no fatalities during the 2007 – 2009 study period, though 35% of total crashes resulted in injury. There were three fatalities in 2019 – 2023, and the percent injury was found to be 28.8%, though this value may be skewed by revised documentation procedures by Dayton Police. Pedestrian crashes accounted for 9% of total crashes in 2007 – 2009 and 4.11% of total crashes in 2019 – 2023.

The capacity analyses, as presented in Table 9, show similar results to the analyses performed for this study.

Table 9. Wayne Avenue Corridor Capacity Analysis Results (2010)

Scenario	Peak Period	Approach/Movement LOS (Delay)				Overall
		EB	WB	NB	SB	
Wayne Avenue & Keowee Street	AM		D (41.9s)	A (5.1s)	A (6.8s)	B (16.5s)
	PM		D (37.6s)	B (12.7s)	B (13.3s)	C (20.6s)
Wayne Avenue & Clover Street	AM	D (41.0s)	D (40.7s)	A (6.6s)	A (3.4s)	A (6.0s)
	PM	D (42.0s)	D (40.9s)	A (4.1s)	A (2.6s)	A (4.7s)
Wayne Avenue & Wyoming Street	AM	D (42.1s)	D (35.4s)	A (9.6s)	C (21.3s)	B (18.6s)
	PM	D (38.1s)	C (29.0s)	B (13.5s)	C (24.8s)	C (24.2s)

The final recommendations from the 2010 report are listed below. A short summary is provided under each recommendation to discuss updates and considerations of implementation.

Short Term Recommended Countermeasures:

- Clearance interval modifications
    - *Clearance intervals were not modified, maintaining a City Standard timing of a four-second yellow phase and two-second all-red phase.*

- Consider the removal of traffic signal at the Clover Street intersection
    - *This intersection remained signalized to provide signalized pedestrian crossings and to facilitate safe navigation for vehicles leaving adjacent neighborhoods where buildings limit sight distance.*

- Investigate Pedestrian Pushbutton Operational Status at the Clover Street and Wyoming Street intersections
    - *Both intersections utilize actuated crossings of Wayne Avenue and non-actuated crossings of Clover Street/Wyoming Street. Push buttons have been reviewed to ensure proper operation.*

Medium Term Recommended Countermeasures:

- Install backplates on traffic signal heads
    - *Backplates have not been installed due to wind related maintenance issues, as overhead trolley wires prevent the tethering of backplates.*

- Upgrade pavement markings along the corridor, including lane arrows, stop bars, and crosswalks
    - *Existing pavement markings have been upgraded to thermoplastic during various resurfacing projects. However, additional markings, such as lane arrows, crosswalks, and stop bars have not been added.*

- Install additional traffic signal head for westbound traffic at the Keowee Street intersection on southeast signal pole
    - *This countermeasure was not discussed for implementation.*

- Upgrade traffic signal indications to LED at the Clover Street and Wyoming Street intersections
    - *Traffic signal indications have been updated accordingly.*

- Change the northbound and southbound left turn signal phasing to protected movements only at the Wyoming Street intersection
    - *This countermeasure was not implemented due to the lack of study on resulting traffic operations along Wayne Avenue.*

Long Term Recommended Countermeasures:

- Improve access management on the corridor as properties redevelop
    - *Access management has not been addressed as redevelopment has consisted of re-use of existing buildings and facilities.*

- Construct a traffic island on Wyoming Street west of the intersection
    - *This countermeasure was not favored due to concerns over maintaining access to the property in the southwest corner.*

IX. FINAL RECOMMENDATIONS

This study provides an in-depth investigation of the crash history, existing conditions, probable causes of crashes, and potential countermeasures to be applied throughout the Wayne Avenue corridor. The studied intersections and segments contain a combination of factors that lead to high crash frequency and severity. The following countermeasures are proposed for implementation with the goal of transforming the studied corridor of Wayne Avenue into a safe, equitable, and inviting roadway for motorized and nonmotorized users alike.

- New Pavement Markings: New pavement markings, including stop bars, high-visibility crosswalks, and lane arrows, should be applied throughout the studied corridor of Wayne Avenue and at the approaches of intersecting roadways.
- ADA Compliance: New ADA-compliant curb ramps should be installed at each pedestrian crossing. Additionally, any repairs to the existing sidewalk should be addressed to maintain accessibility.
- Signal Improvements: There are three signalized intersections within the study area, each with low-visibility signal heads. Signal improvements should be utilized at each of these intersections, including new LED signal heads, reflective backplates, mast-arms, and Dilemma Zone Protection (DZP) systems. Signal phasing should be optimized for the appropriate

volume of traffic and should include leading pedestrian intervals (LPIs) or exclusive pedestrian phasing.

- Pedestrian Hybrid Beacon: A raised* two-stage pedestrian hybrid beacon (PHB) should be installed near the intersection of Wayne Avenue and Pierce Street / Park Drive to facilitate safe mid-block crossings for pedestrians and to influence slower vehicle speeds in an area frequently trafficked by pedestrians. This crossing should be installed in conjunction with two adjacent medians, creating a two-stage crossing with a pedestrian refuge island.
- Raised Intersection at Clover Street: The intersection of Wayne Avenue and Clover Street should become a raised* intersection, enhancing pedestrian visibility in crosswalks and influencing slower vehicle speeds. This intersection should also utilize bollards on the perimeter of each corner, protecting pedestrians from errant vehicles.
- Improved Bus Stop Amenities: To meet the needs of the public as expressed through the public input survey, bus stop amenities should be installed throughout the corridor. Bus shelters are recommended to be installed at Keowee Street and Wyoming Street. Benches are recommended to be installed at Hickory Street, Bradford Street, Clover Street, and Oak Street.
- Street Trees: The existing street trees should be evaluated and replaced if the tree has grown too large, as large trees become a danger to run-off-road vehicles and negatively disrupt adjacent sidewalk. All street trees should have new grates and boxes to improve the aesthetics of the corridor and create an inviting environment for all road users.
- Utility and Lighting Improvements: The existing overhead utilities create distracting visual clutter for motorists, likely drawing their focus from more valuable items: signage, signals, and other road users. This should be addressed by burying the utilities underground, if feasible. New lighting should be installed throughout the corridor to enhance safety for all road users during non-daylight hours.
- Road Diet: A road diet should be implemented north of Keowee Street / Adams Street where the AADT of Wayne Avenue lessens. This includes the removal of two travel lanes, moving the curb inward, and adding sidewalk or green space to improve pedestrian facilities. Traffic calming within this road diet can also be enhanced with the addition of a median containing shrubs and trees.
- Gateway Treatments: Decorative gateway treatments should be installed at both the north and south ends of the project limits. These treatments are likely to enhance traffic calming as driver awareness of the surrounding neighborhood is heightened. The treatments also improve aesthetics and can create residential pride in this Dayton neighborhood.

APPENDIX A - EXISTING CONDITIONS DIAGRAMS

APPENDIX B - TURNING MOVEMENT COUNTS

APPENDIX C - CAM TOOL TABLES

APPENDIX D - CRASH DIAGRAMS 2019 - 2023

APPENDIX E - PROPOSED CONDITIONS

APPENDIX F - PROPOSED CONDITIONS RENDERINGS

APPENDIX G - HCS ANALYSES

APPENDIX H - COST OPINION

- Other repairs: Upon completion of the above countermeasures, any necessary curb repairs and/or drainage replacements should also be addressed.

*Raised pavement is to be installed using stamped and colored concrete, decreasing the likelihood of pavement rutting and creating visual and textural contrast to heighten driver awareness.
Implementing the countermeasures listed above is estimated to cost approximately $5,310,000. See Appendix H for the itemized cost opinion used in calculating this amount. Note that three items on this cost opinion have been marked with an asterisk: utility work, new lighting, and gateway treatments. The prices of these three tasks utilize high-level estimates that are likely to require more in-depth consideration prior to funding and implementation. As a result, these three items are less likely to accurately reflect their true price of implementation.

X. CONCLUSIONS

Upon reviewing the existing conditions of Wayne Avenue and analyzing the recent crash history, many concerns and trends have been identified, which can be addressed through future design projects. Both intersections and segments along the study area facilitate high speeds, which increases both the chances of a crash and the severity of a crash. Traffic calming countermeasures will likely produce slower speeds and engaged drivers, making the roadway safer for all users. Each of the suggested countermeasures is proposed due it the positive outcomes they are likely to produce, even with some impact on delay times. To prevent crashes, and notably, fatalities on Wayne Avenue, there must be great efforts to change the way vehicles travel through the corridor.