

Crash Analysis Studio

Session 20: Boone, North Carolina

Held on August 16, 2024

Session Participants:

- **Donald Kostelec**, Transportation planning expert with specialization in Complete Streets, Safe Systems design, and ADA¹ compliance; host of The Planning Commission Podcast; writer and news site contributor; Master of Urban Planning and policy from University of Illinois at Chicago
- **Laura Buck**, Boone Resident; Alumna of Appalachian State University (ASU); Food security advocate; Concerned community members and traffic safety enthusiast
- **Jonah Bird**, Transportation planner with the Knoxville Regional Transportation Planning Organization (TPO); ASU Alumnus; Former resident of Boone; Traffic safety enthusiast
- **Edward Erfurt**, Director of Community Action at Strong Towns
- **Tony Harris** (moderator), Community Engagement Coordinator at Strong Towns

Summary of Crash Event

- The crash occurred at 12:49 p.m. (ET) on August 21, 2023 in the southbound lane of Depot Street at its intersection with Howard Street.
- The westbound motorist was turning left at the intersection to go south on Depot Street when he struck Diana Reyes Angeles, who was walking eastbound across Depot Street at a designated crossing.
 - The motorist stated he could not see Angeles over the hood of his truck; he stated he was not aware of her presence until he had already struck her.
 - Witnesses to the crash stated that the motorist did not appear to look for pedestrians or other non-motorists before beginning to turn onto Depot Street.
- Upon impact, Angeles was thrown to the ground; the pair of headphones she was wearing helped break her fall.
 - Angeles was transported to Watauga Medical Center, where professionals stated that she had a concussion.
- East of this intersection, Howard Street features one eastbound and one westbound lane; west of the intersection, Howard turns into a one-way street for westbound traffic with the eastbound lane designated for non-motorist usage.

¹ The Americans With Disabilities Act

- Depot Street features one northbound and one southbound lane, with parking lanes alternating from one side to the other² block by block.
- The speed limit on both Howard Street and Depot Street is 20 miles per hour (mph).
- There are stop signs at all legs of the unsignalized intersection, minus the west side of Howard where no eastbound traffic is permitted.
- Weather reports from the day of the collision indicate it was partially cloudy in Boone.

Primary Contributing Factors

There are people walking along Howard Street and Depot Street even though the infrastructure along these roadways is dangerous for them. The design of Depot Street, Howard Street, and their intersection demonstrates inadequate concern for the safety of non-motorists—including pedestrians and cyclists—that travel outside of privately owned and operated automobiles. This intersection is designed and built in a way that makes it dangerous—even for careful drivers.

Depot Street is historically known³ for its use as a roadway that transports goods and people throughout the downtown Boone transportation network. The Town of Boone has maintained Depot Street's upkeep and improvements as a local urban roadway for many decades. The growth of Appalachian State University, development of additional neighborhoods, and pedestrianization of downtown Boone has occurred near Depot Street—and north and south of Howard Street—without recent major physical changes to the built environment in the surrounding area.

Roadway designers and transportation professionals acknowledge the existence of non-motorists—including people traveling on foot, using mobility aids, and cyclists—at this location by constructing sidewalks, designating crossings, and including a temporary bike-way. Pedestrian traffic is high throughout the school year due to proximity to the Appalachian State University campus and adjacent housing.

These same professional parties have elected to use design standards near the crash location that cater to existing traffic traveling at speeds higher than the posted limit. Depot Street's excessively wide travel lanes for through traffic are a prime example of a roadway characteristic that poorly communicates behavioral expectations to motorists. This street also lacks infrastructure to protect pedestrians and cyclists. These design elements create an environment where motorists may be likely to ignore stop signs, surpass the posted speed limit, or otherwise disregard non-motorists moving through the area.

² This is also referred to as chicane parking.

³ [Report and Recommendation for the Designation of the Downtown Boone Local Historic District Boone, North Carolina](#), Dr. Eric W. Plaag, April 13, 2021.

Session participants identified the following primary factors that contributed to this crash:

1. **The motorist failed to yield or stop for Diana Reyes Angeles who was crossing the street in a marked crosswalk.**
 - a. The motorist was turning left at the intersection and it was documented in the police report that the motorist stated he could not see Angeles over the hood of his truck; he stated he was not aware of her presence until he had already struck her.
 - b. Local experts noted that multiple cars did not come to a complete stop during a speed study conducted for this analysis; failure to stop at this crosswalk is not a unique event.

2. **The design speed of Depot Street and its regulation of traffic flow through an all-way stop is incompatible with non-motorist traffic; the documented travel speeds pose related incompatibilities even though these speeds largely fall under the posted limit.**
 - a. The speed limit on Depot Street—and on Howard Street—is 20 mph.
 - i. Designers may have chosen this speed limit to try and accommodate the dense foot traffic of downtown Boone, especially since this foot traffic increases when classes at Appalachian State University are in session.
 - b. Some drivers exceed the posted speed limit.
 - i. Local expert Laura Buck and colleague Alex Armistead conducted a speed study on the evening of May 27th over a period of 2 hours.
 - ii. Of the 167 cars tracked during this window, 6% of them were found to be traveling over the speed limit.
 - iii. Only one driver was found to be traveling at a rate of 10 mph or more over the posted speed limit.
 - iv. 85% of drivers were calculated to be traveling at or below the 20 mph limit.
 - c. Many drivers traveling between 15 and 20 mph do not come to complete stops at the intersection.
 - i. Research conducted by the IIHS revealed that stop sign violations [account for close to 70% of all crashes at stop-controlled intersections](#), with up to one-third of those collisions resulting in injuries to the involved parties.
 - ii. Drivers that disobey stop signs logically decrease the amount of available time to check for pedestrians or other vehicles; in an environment with high pedestrian traffic and left-turn conflicts, this disregard is even more likely to heighten the chance of a collision.
 - iii. The motorist in this crash may have completely stopped, as Diana Angeles' injuries are consistent with expectations for a 15 to 20 mph impact.
 - iv. Failure to obey stop signs at this intersection increases the risk of crashes and severe injury.

- d. Vehicle travel speeds and driver disregard for stop signs at the Depot Street and Howard Street intersection subject non-motorist users—including pedestrians, cyclists, and potential transit riders—to substantive danger.
- 3. The design and size of vehicles traveling through this intersection decrease the visibility of—and heighten risk of serious injury to—pedestrians and non-motorists traveling through the area.**
- a. The motorist involved in this crash was driving a lifted pickup truck—specifically a Chevrolet Avalanche—with tinted windows.
 - b. The height of the Avalanche’s hood made it difficult for the motorist to see Diana Angeles, who is approximately five feet tall; the tinted windows further reduced his sightlines during his left hand turn onto south Depot street.
 - i. Lifted, taller vehicles are more likely to hit pedestrians in vital organs during crashes; one peer-reviewed study⁴ indicates a ten centimeter increase in front-end hood height translates to a 22% increase in the likelihood of a pedestrian fatality during a crash.
 - ii. The Insurance Institute for Highway Safety (IIHS) also notes⁵ that vehicles with a hood height of more than 40 inches are nearly 45% more likely to cause fatalities in pedestrian crashes than vehicles with a hood height of 30 inches or less.
 - c. The visibility of children, people using wheelchairs or mobility aides, and shorter pedestrians crossing this intersection may be substantially reduced for motorists driving larger vehicles or trucks.
- 4. Lane widths and stop signs at the intersection produce mismatched expectations for motorist behavior as they navigate west on Howard Street and either north or south on Depot Street.**
- a. The placement of 13.5 foot wide through traffic lanes for northbound and southbound travel along Depot Street does not maintain desired safety impacts organizations like NACTO⁶ typically [associate with narrower lanes](#).
 - i. The Federal Highway Administration (FHA) and the American Association of State Highway and Transportation Officials (AASHTO) indicate that neighborhood streets—like the ones found in downtown Boone—should adhere to [standard lane widths](#) between nine and twelve feet.
 - b. The Depot Street and Howard Street intersection was converted to an all-way stop in 2017⁷ without additional temporary or permanent modifications to the built environment for reducing speed.

⁴ [“The effect of front-end vehicle height on pedestrian death risk”](#), Justin Tyndall, *Economics of Transportation*, Volume 37, 2024.

⁵ [Vehicles with higher, more vertical front ends pose greater risk to pedestrians](#), The Insurance Institute for Highway Safety, November 14, 2023.

⁶ National Association of City Transportation Officials

⁷ [“Depot/Howard Street Intersection Now All-Way Stop”](#), High Country Press, August 9, 2017.

- i. Footage of the intersection also illustrates telephone poles may obstruct motorists from seeing the stop signs altogether, especially if they are not locals or residents familiar with the intersection.
 - c. These conflicting design elements provide motorists with an environment that is tempting to speed through, while also demanding they stop at the intersection.
- 5. The wider transportation network of downtown Boone simultaneously funnels cars and pedestrians toward the Howard Street, Depot Street, and their intersection in an incompatible manner that compromises the safety of all road users.**
 - a. King Street and River Street are primary collector roads located one block north and south of Howard Street; King and River funnel most automobile traffic through downtown Boone.
 - b. Traffic flow between King Street and River Street fluctuates due to levels of tourism and events at Appalachian State University; the more visitors there are in town, the more likely there will be congestion along and around these two streets.
 - c. On one hand, Howard Street is a predominantly pedestrian area surrounded by multiple residential neighborhoods and student housing communities; on the other hand, Howard Street places pedestrians at heightened risk because it is sandwiched within the traffic generated by King and River Streets.
 - i. Multiple parking lots and driveway cuts along the east side of Howard Street generate additional traffic that further increases this risk.
- 6. Howard Street has been subjected to a series of incomplete redevelopment activities and safety measures over many years; this pattern of partial implementation has created inconsistencies in pedestrian safety and driver expectations that heighten risk at the Howard and Depot Street intersection.**
 - a. The Town of Boone implemented a one-way westbound route⁸ on Howard Street in 2010 and 2011 with a promise to install safety bollards that were never fully realized; bollards that were installed vanished within two years and were never replaced.
 - b. An all-way stop was instituted at the Howard and Depot intersection in 2017—partially due to the need to resurface Depot Street—in advance of final Howard Street improvement plans.
 - c. Experimental directional signs⁹ were also installed at the intersection's crosswalks during the early days of the pandemic to alleviate congestion caused by foot traffic; these signs were neither maintained at Howard Street and Depot Street, nor installed at other downtown intersections.

⁸ [Boone Town Council To Discuss One-Way Howard & Appalachian Streets in Downtown](#), High Country Press, April 14, 2015.

⁹ [Town of Boone Public Works Department put Experimental Directional Signs on Crosswalks in Downtown Boone Friday Morning](#), High Country Press, June 19, 2020.

- d. The application of minor, short-lived changes to an intersection and two roads that need more direct redesign efforts does more to confuse drivers than it does to constructively modify their behavior.

Recommendations

The Depot and Howard Street intersection functions as a downtown urban intersection near a bustling university campus, commercial destinations, and multiple neighborhoods where residents and visitors routinely shop, walk, and bike. Recent sidewalk improvements on Depot Street embrace this, but these improvements stop short of the intersection. Non-motorists are encouraged to use Howard Street as a primary connection between the campus and the town has completed lane closures to accommodate a “Pedestrian Walkway” which stops prior to this intersection.

The current roadway design was a major contributing factor for this crash. Depot Street features excessively wide through travel lanes that may communicate to drivers that the intersection is designed to prioritize them and their usage. Howard Street is in the midst of a transition from a utilitarian rear alley into a partially implemented “Pedestrian Walkway” communicating to walkers and cyclists that the street is designed to prioritize their usage. The intersection of Depot and Howard Streets is a convergence of several incomplete roadway projects and conflicting objectives. Howard Street’s heavy levels of pedestrian foot traffic, and the street conditions require both drivers and non-vehicular users to make many complex and risky decisions which could result in serious injury or death.

Boone municipal leadership, technical staff, and community members should all agree upon the desired user behavior along Depot and Howard Streets –particularly at their intersection—as the first step toward improving safety at the collision location for all road users. The Town of Boone will benefit from adopting a formal resolution that declares safety as a top priority at the intersection of Howard and Depot Streets; this resolution should guide future traffic management and infrastructure decisions to ensure pedestrian and cyclist safety.

If the design intent of Depot Street is to prioritize safety, particularly for non-motorist users, elected officials must provide direction and guidance to technical staff that Depot Street should be an urban street that prioritizes safety above all other objectives. Particular attention should be directed toward safety elevation and increasing awareness of non-motorist users.

There are multiple ways to address these factors and minimize the likelihood of future collisions, fatalities, and traumatic injuries. At the intersection of Depot and Howard Streets and in the area surrounding the crash location, the following practices should be adopted.

Immediate:

1. Elected officials of Boone should provide direction and guidance to municipal staff that Depot and Howard Streets should be an urban street that prioritizes safety above all other objectives.

- a. Each elected body should prepare a resolution¹⁰ to this effect that states:
 - i. Safety for all users shall be the top design priority above all others for this location.
 - ii. All future planning and design efforts for these streets shall be contextual to a downtown urban character.
 - iii. Temporary safety measures should be implemented until more permanent measures are made.
2. Solicit representatives from both the Town of Boone and Appalachian State University to conduct a walk audit of the area around the crash location to observe the existing conditions.
 - a. Walk the length of Depot Street from King to River Street.
 - b. Walk the length of Howard Street from Burrell to the University.
 - c. Highlight the pedestrian experience and where complex decisions must be made and where there are conflicts between users.
 - d. Generate a list of short-term and long-term actions that can be achieved through existing maintenance programs and budgets; items such as signage, painting, and future repaving should be included and attended to as quickly as possible.
 - e. Conduct an additional walk audit when class is in session and more students are present in the area.
3. Implement temporary safety measures until more permanent measures are made. These measures should consist of temporary materials that can be deployed in a matter of hours or days. These features could include the following recommendations from the panel:
 - a. Install prefabricated barriers—like rubber bumps or flex posts—to harden the centerline of Depot Street, as a hardened centerline will prevent automobiles from cutting corners during turns and demand drivers pay closer attention during turning maneuvers.
 - b. Create temporary curb extensions that help narrow the roadway, increase motorist awareness, and reduce pedestrian exposure; utilize mountable curb ramps and aprons where necessary to address concerns about accessibility for large automobiles and emergency vehicles.
 - c. Place bollards in the middle of the Depot Street and Howard Street intersection to increase friction and demand drivers navigate the area more carefully; these bollards can be easily installed, quickly removed, and are likely already available in municipal inventories.
 - d. Narrow the width of each of Depot Street's lanes down to nine feet with paint and bollards.
 - e. Claim additional pavement that emerges from lane narrowing to widen existing sidewalks and increase the accommodations for pedestrian foot traffic.
 - f. Municipal staff should be empowered to implement and adjust these measures as necessary. Once installed, staff should study road user behavioral changes

¹⁰ These resolutions should be shared at the state level with the North Carolina Department of Transportation (NCDOT) and with the High Country Rural Planning Organization (RPO) that serves Watauga County.

over a one week period and adjust temporary interventions based on the desirability of observed outcomes.

4. Increase public engagement and awareness of street safety by inviting Appalachian State University students and other concerned community members to work alongside local transportation authorities, to initiate temporary safety interventions around the intersection. Equip these community members with paint, delineators, barriers, and other temporary, low-cost materials.
5. Add LED flashers around the existing stop signs at the intersection; outfit these flashers with pedestrian push buttons to draw more attention to the stop signs and increase pedestrian visibility.
6. Explore where there are opportunities to limit—or fully restrict access to—Howard Street entry and exit points into parking lots that feature alternate access points via King Street or River Street.
7. Install “Stop Ahead” signs and pavement markings around the intersection to alert motorists to the presence of the intersection.
8. Form an interdisciplinary team of staff from multiple departments to act as rapid responders¹¹ to automobile collisions. The members of this team should include representation from the Downtown Boone Development Association¹², the Town of Boone’s Public Works Department, and the Police Department.
 - a. This team should convene following a serious crash and be responsible for documenting factors that contribute to crashes as demonstrated in this Crash Analysis Studio. These findings should be shared with the elected leadership and the public.
 - b. Grant this team agency to immediately implement short term or temporary physical improvements to the street that respond to the contributing factors of the crash. These should be quick build projects undertaken with available resources that can be deployed in a matter of days. Charge the team with the authority to implement the immediate actions suggested in this report, as well as work toward near-term and long-term recommendations.
9. Review all local street standards and implementation practices that resulted in the current conditions at this intersection and standards that prioritize throughput over safety.

Near Term (within the next 12 months):

10. Use evaluations of temporary curb extensions and lane narrowing activities to decide which measures to make more permanent.
 - a. Replace the most effective curb extensions with more durable structures.
 - b. Use thermoplastic or epoxy paint to permanently re-stripe new lane configurations.
 - c. Take appropriate steps to ensure these changes accommodate any local regulations, infrastructure requirements, and/or drainage needs.

¹¹ For more information on rapid response models, see [Pedestrian Safety Gets Big Boost From New Cincinnati Initiative](#) (January 2023).

¹² This may include Downtown Development Coordinator Lane Moody.

11. Implement a raised intersection—or at least raised crosswalks at the intersection—to slow down vehicles and heighten the visibility of pedestrians for motorists.
 - a. The Federal Highway Administration (FHA) reports that raised crosswalks can reduce pedestrian crashes by as much as 45%.
12. Identify utility poles that obstruct views and traffic signs, and explore moving overhead utility lines underground to reduce the visual clutter and distractions experienced by drivers at this intersection and its surrounding area.
13. Initiate a redesign process of Howard and Depot Streets into shared streets that prioritize cyclists and pedestrians by:
 - a. Establishing a target vehicle travel speed of 10-15 mph.
 - b. Introducing features like textured paving to signal that vehicles are guests—rather than primary users—in this space.
14. Proceed with consolidating or fully restricting access to Howard Street from parking lots where opportunities exist for alternate access points via King Street or River Street. This could occur through both redevelopment applications and through public-private partnerships.
15. Update and revise any identified local street standards and implementation practices that created the current conditions at this intersection.
16. Develop and adopt low cost, quick deployment street standards for implementing temporary safety measures when additional dangerous street conditions are identified.

Long Term and Systematic:

17. Study the potential of pedestrianizing Howard Street in its entirety; limit vehicle access by transforming eastbound Howard Street—after its intersection with Depot Street— into a one-way lane for through traffic.
 - a. A study may include short term closures to vehicular traffic to track how this change enhances the area's appeal; monitor economic activity on Howard Street as it becomes more fully integrated into downtown Boone's pedestrian friendly atmosphere.
18. Relocate or remove utility poles and underground utilities when these utilities need to be replaced or upgraded.

Concluding Statement

The series of design flaws present along Howard Street and at the crash location are dangerous for Boone residents, Appalachian State University students, and other community members. Design emphasis that prioritizes traffic flow over non-motorist safety, deviation from the designer's intent due to site conditions, and partially completed projects contribute to higher risk of injuries and deaths in communities across North Carolina and in locations throughout North America.

In Boone, local leaders and citizens need to lead by example by treating Howard Street as an urban street section rather than a road designed for high volumes of traffic; road user behavior and expectations will slowly change to help standardize this treatment as common practice. At

the time of this report's publication, the Howard Street redevelopment project had gone out to bid¹³. Highlights from the plans include:

- Transforming Howard Street into a one-way westbound street from Appalachian Street to Burrell Street.
- Installing an eastbound, one-way curb-protected bike lane along the south edge of Howard Street.
- Marking westbound traffic lanes with sharrows to benefit westbound cyclists.
- Hardscaping plans that make provisions for 110 steel bollards and 17 collapsible bollards.

By evaluating the numerous factors that contribute to a crash, we believe that designers, decision-makers, and the general public can move beyond the current approach, which seeks only to assign blame to involved parties, to a model that helps change the way these spaces are designed, developed, and cared for. Substantive changes to Howard Street and Depot Street should prioritize pedestrian safety alongside motorist usage. Further transformation of this intersection into a place treated and cared for like a local roadway stands to benefit Boone, its visitors, and its residents.

¹³ Additional information can be found in the following documents from Davis • Martin • Powell (DMP) Engineers & Surveyors: [Addendum 1](#), [Addendum 2](#), and [Addendum 3](#).