UC Berkeley SafeTREC

Identifying Planning Challenges in Pedestrian and Bicycle Safety Infrastructure in Rural and Urban Communities: A Sonoma County Case Study

Kora Robinson

Summer 2026

Abstract

This research brief examines pedestrian/bicycle crash and infrastructure differences in rural versus urban communities. Using Sonoma County rural communities as a case study, the brief identifies key differences in pedestrian/bicycle crash characteristics, severities, and locations. It examines differences in the nature of active travel, demographics, and current pedestrian/bicycle infrastructure and future investments. Interviews with three planners working in the county are included to identify key community and infrastructure challenges and areas for opportunities in rural versus urban communities. The brief concludes with recommendations for more collaboration between the state and local agencies for conducting safety improvements in rural communities and urges planners to consider crash characteristics and differences in the nature of active travel when implementing said improvements.

Introduction

Pedestrian/Bicyclist Demographics and Trip Characteristics in Rural Communities

There are fundamental differences in the nature of pedestrian/bicyclist trips and demographics in rural communities compared to urban areas. As defined by The Federal Highway Administration (FHWA) and Census Bureau, rural communities include all areas not included within an urban area. To be considered urban, the census designated area must have a population greater than 5,000 (FHWA Census Urban Areas and MPO/TMA Designation). In rural communities, women and youth are more likely to bike and retirement/recreation counties saw higher rates of biking. Retirement counties are defined as places with a significant population of retired individuals and recreation counties are defined as places with high levels of recreation-focused employment and income. (McAndrews, Okuyama, and Litt, 2017). In high-density urban areas, walking is more utilitarian for transportation purposes. In contrast, pedestrians who live in rural communities often cite walking for leisure. Walking for transportation purposes is associated with the surrounding built environments such as destinations to walk to, transit stops, and pedestrian infrastructure. Urban communities often have more infrastructure that supports walking for that transportation purpose (Carlson et. al, 2018). Bicycling prevalence is similar in urban and rural communities but trip purposes are again different for rural residents, with bicycling for exercise being the most cited trip purpose. Prevalence of bicyclist commuting and bike share programs was small in rural communities, suggesting that different factors should be considered when designing bicyclist infrastructure (Tribby and Tharp, 2019).

Pedestrian/Bicyclist Safety Issues in Rural Communities

Rural communities face many challenges that make implementation of pedestrian/bicyclist infrastructure difficult. Low population densities, lack of transportation options, high speed limits,

environmental characteristics (winding roads and hills), and large distances between destinations make walking and biking for physical activity difficult in rural communities. Rural communities often have inefficient infrastructure for walking and biking such as uneven or unpaved roads, cracked or no sidewalks, no shoulders or buffers separating road users from vehicle traffic, lack of crosswalks and bike lanes, poor street lighting, and fewer close destinations to travel to. Complete streets infrastructure for these communities will look different than urban environments and may include widening of shoulder widths for walking and biking, maintaining footpaths along the roadway, or the implementation of more urban pedestrian and bicyclist infrastructure improvements in denser downtown areas (Hansen et. al, 2015). Moreover, state roads often run right through rural communities and lack mid-block crossings that could help pedestrians and bicyclists cross these large roads. High speeds are a major issue of concern for rural residents and act as a large deterrent factor for walking and biking trips (Villwock-Witte, 2024).

Rural communities share a large proportion of all fatal crashes, with 45% of all U.S. fatal crashes occurring on rural roads between 2016-2020 even though only 19% of the population lives in these areas (Raymond, 2022). Pedestrian crashes are defined as collisions involving a motor vehicle and another individual on foot. Bicycle crashes are defined as collisions involving one or more individuals who are bicyclists and can occur with another cyclist or motor vehicle. There are important differences in pedestrian and bicyclist crash characteristics between rural and urban communities that must be considered to address these higher fatality rates. Rural bicycle collisions were often associated with dark lighting, higher speeds, riding with traffic on the road, and lack of infrastructure (Stewart et. al, 2025). Common bicycle crash types include bicyclists turning or merging into vehicle traffic or vehicles overtaking bicyclists (U.S. Department of Transportation: Federal Highway Administration, 2026). Rural and urban communities have similar common pedestrian crash types such as pedestrians walking in the roadway, and pedestrians failing to yield midblock. However, the most common places where rural pedestrian crashes occur are at midblock segments whereas the most common places where urban pedestrian crashes occur are at intersections. Rural two-lane roads see the largest rate of crashes and have the strongest need for safety improvements (U.S. Department of Transportation: Federal Highway Administration, 2026).

Rural vs. Urban Communities in Sonoma County

While aggregate data highlights the unique safety risks in rural regions, these findings are often dismissed because the vast differences of size and population characteristics between jurisdictions make direct comparisons difficult. This brief presents a case study of three distinct sites within Sonoma County including Santa Rosa, Guerneville, and El Verano, providing findings of differences between pedestrian and bicycle crash characteristics, infrastructure, and implementation challenges identified by planners working in the county. By examining these sites within a single county framework, we can better understand the dynamics of pedestrian and bicycle infrastructure, safety considerations, and investment differences under the same governing institutions in urban versus rural communities.

Santa Rosa serves as the urban community for Sonoma County in this brief as it has the largest population with 485,375 residents as of 2024 and highest density of 4,173 people per square mile (American Community Survey, 2024 5-Year Estimate). Two communities with populations less than 5,000 were chosen to represent rural communities. These two communities were identified based on population size and identification in the high injury network map published by the Sonoma County Transportation

Authority, included below. The two rural communities of Guerneville (Figure 1) and El Verano (Figure 2) represent the high injury networks identified in both western and eastern rural communities in the county, respectively.

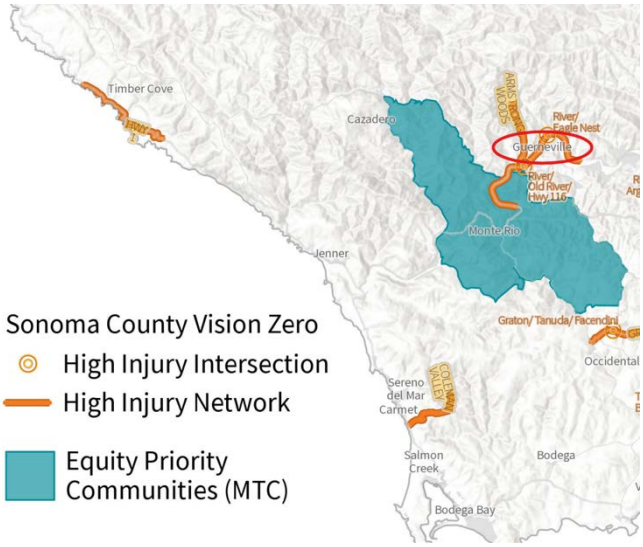


Figure 1: Guerneville

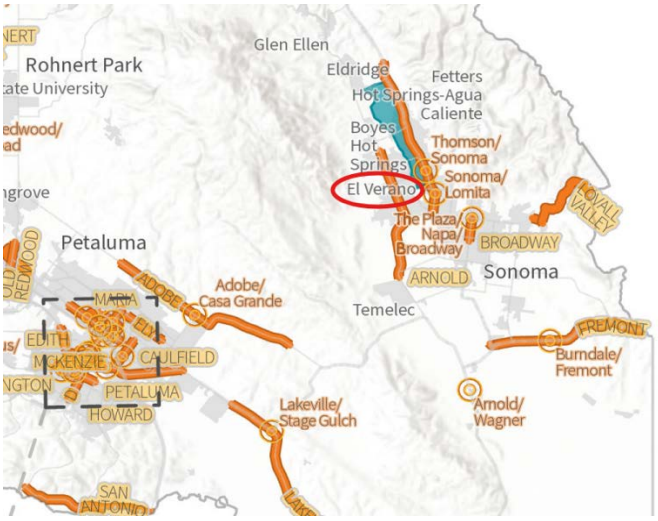


Figure 2: El Verano

Demographics

There are some notable demographic differences between urban and rural areas in Sonoma County. However, most of the rural areas have low American Community Survey (ACS) response rates, leading to high variation in data. Results should be assessed within that context. Santa Rosa has the largest population in the county with the highest population density. This is an outlier for the county as a whole, as the population density for the county altogether is considerably lower, with an average population density of 308 people per square mile. Demographics like age, race, commute times, and modes are highly variable due to small sample sizes in rural areas. In comparison with Santa Rosa and the county as a whole, rural areas lean older (50+), are predominantly white, and have higher work-from-home populations (American Community Survey, 2024 5-Year Estimate Table B01001 Population by age range and Table B08006 Sex of Workers by Means of Transportation to Work). Countywide, a majority of commute trips are made by vehicle drivers regardless of other characteristics like density, indicating low biking and walking as a commuting mode in all of Sonoma County (American Community Survey, 2024 5-Year Estimate Table B08006 Sex of Workers by Means of Transportation to Work). This could indicate that biking and walking is not a viable way to commute in the county and may be higher in recreational contexts.

Pedestrian/Bicycle Crash Characteristics

Unincorporated Sonoma County was used as a proxy for rural areas when examining pedestrian and bicycle crashes. The two rural communities identified above (Guerneville and El Verano) and other rural communities in the county are classified as unincorporated Sonoma County. When using the Transportation Injury Mapping System (TIMS) Statewide Integrated Traffic Records System (SWITRS) Query and Map tool, Guerneville and El Verano are not included as communities for selection and are rather grouped into the unincorporated Sonoma County category. To identify pedestrian and bicycle crashes for these rural communities, the unincorporated Sonoma County option was selected.

Table 1: Pedestrian/Bicycle Crash Summary Rural versus Urban Sonoma County

	Total Crashes	Percentage State Highway	Percentage Ped Involved	Percentage Bike Involved
Santa Rosa	564	9.0%	54.1%	46.6%
Unincorporated Sonoma County	392	21.4%	38.0%	62.2%

Notes: Santa Rosa N= 564 crashes, Rural N= 392 crashes. Rural in this context included crashes within unincorporated Sonoma County. Crashes were filtered for the time frame Jan. 2017-Dec. 2023 and included all bicycle and pedestrian crashes.

Figure 3: Santa Rosa Crashes by Crash Severity

Notes: Santa Rosa N= 564 crashes. Crashes were filtered for the time frame Jan. 2017-Dec. 2023 and included all bicycle and pedestrian crashes.

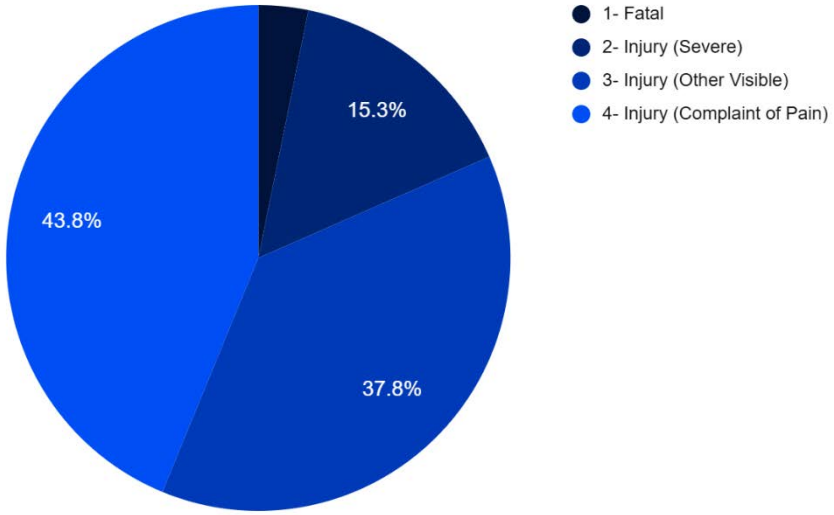
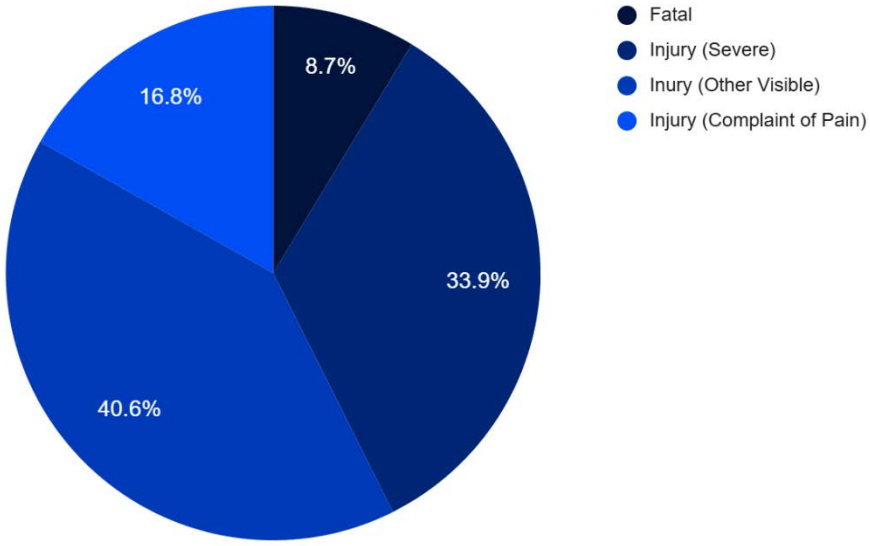


Figure 4: Rural Crashes by Crash Severity

Notes: Rural N= 392 crashes. Rural in this context included crashes within unincorporated Sonoma County. Crashes were filtered for the time frame Jan. 2017-Dec. 2023 and included all bicycle and pedestrian crashes.



Source: UC Berkeley SafeTREC Transportation Injury Mapping System (TIMS) SWITRS Crash Summary and Map.

From January 2017 to December 2023, the proportion of fatal and severe injury crashes was higher in rural areas, with 42.6% of crashes in rural Sonoma County in the fatal and severe crash severity categories compared to 18.5% in Santa Rosa. This higher concentration of fatal and severe injury crashes in rural Sonoma County can potentially be explained when looking at the percentage of crashes that took place on state highways in Santa Rosa versus rural Sonoma County. From January 2017 to December 2023, only 9% of crashes in Santa Rosa occurred on state highways compared to 21.4% of crashes in rural Sonoma County. These state highways like CA-116 and CA-12 run right through the historic downtowns of rural communities like Guerneville and El Verano. The higher speed limits on these rural highways are deadly to pedestrians/bicyclists as higher impact speeds strongly predict injury risk and severity as demonstrated by past studies (Monfort and Mueller, 2025). The difficulty of getting drivers to slow down when entering the boundaries of smaller rural communities on these roads could lead to higher crash severities for vulnerable road users, defined as individuals outside of vehicles who are unprotected. In rural Sonoma County out of all motor vehicle crashes, only 38.0% of crashes involved pedestrians compared to 54.1% of crashes in Santa Rosa. Conversely, rural Sonoma County had a higher percentage of crashes involving bicyclists, with 62.2% of all motor vehicle crashes involving them compared to 46.6% in Santa Rosa. This could mean that in rural communities like Guerneville and El Verano, pedestrians are less likely to use state highways for walking but that a larger share of residents use these roads for recreational cycling.

Active Transportation Infrastructure

Santa Rosa has the largest concentration of crash clusters when compared to rural crash clusters in the county. It also has the largest existing bicycle infrastructure network. There are rural crash clusters near the towns of Guerneville, El Verano, Lytton, and Occidental. All state rural highways with high crash clusters in historical downtowns like Guerneville and El Verano contained no existing bicycle infrastructure including State Route 116 and State Route 12. Other rural roads with high crash clusters had either class II bike lanes or no current bicycle infrastructure on that road but had intersecting or adjacent roads with class II bike lanes. The Bikeways and Pedestrian Active Transportation Map provided by the Sonoma County Transportation Authority (SCTA) contained active transportation project points that included areas where planned crosswalk or other pedestrian improvements are set to be completed. No data was found for current existing pedestrian infrastructure across Sonoma County, only proposed pedestrian infrastructure improvements were found. The Sonoma County Transportation Authority's Active Transportation Plan notes areas for proposed bicycle and pedestrian infrastructure improvement projects with a majority of the proposed plans for rural roads/highways identified being the same as the areas with high crash clusters found through mapping of crash data. Santa Rosa contained the most existing bicycle infrastructure with a majority of existing infrastructure being Class I-IIB infrastructure including shared-use paths, bicycle lanes, and buffered bicycle lanes. The Sonoma County Transportation Authority recognizes that unincorporated parts of the county that contain rural highways and roadways have the most room for bicycle infrastructure improvements. Most of the proposed bicycle infrastructure improvements near rural crash clusters included adding Class I-IIB bicycle lanes where there is currently no infrastructure present (Countywide Active Transportation Plan for Sonoma County, Sonoma County Transportation Authority, 2025).

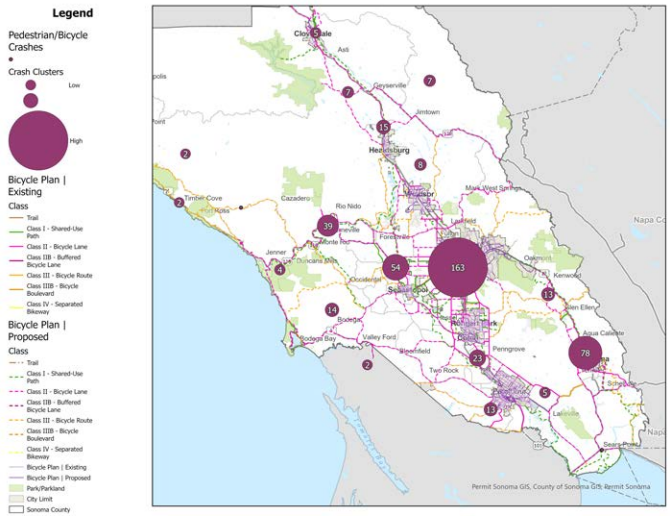


Figure 5: Crash Clusters, Existing Bike Infrastructure, and Proposed Bicycle Infrastructure

Notes: Crashes were filtered for the January 2017-December 2023 timeframe and included all bicycle and pedestrian crashes. The crashes' x,y locations were inputted into ArcGIS Pro and clustered based on the number of crashes in the given area with anything more than two crashes considered a cluster.

Source: Bicycle Plans Existing and Proposed in the [Bikeways and Pedestrian Active Transportation Map] available on ArcGIS online.

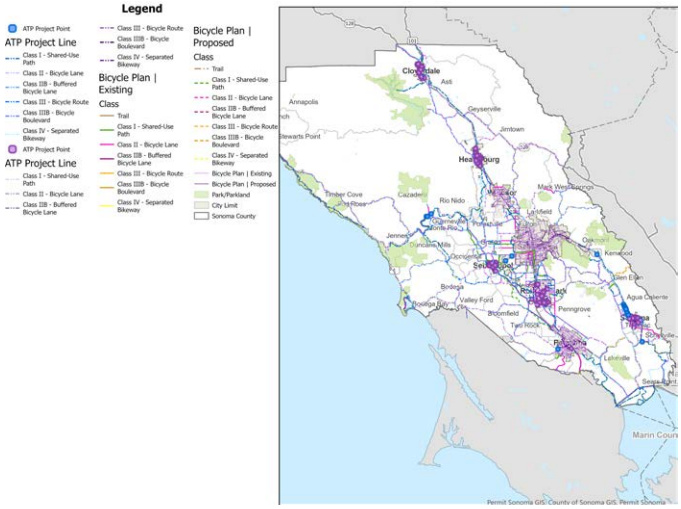


Figure 6: Sonoma County Transportation Authority Active Transportation Projects, Existing Bike Infrastructure, and Proposed Bicycle Infrastructure

Source: SCTA Active Transportation Plan, Bicycle Plans Existing and Proposed in the [Bikeways and Pedestrian Active Transportation Map] available on ArcGIS online.

Sonoma County Planner Interviews

To identify challenges faced by planners when implementing infrastructure in both urban and rural settings, three planners were interviewed. This allowed for real-world accounts of barriers to infrastructure implementation and community engagement that can help inform how safety practitioners and advocates move forward. Interviewees were given the option of participating in a Zoom interview or providing responses via email. Three interviewees were recruited, two were interviewed via Zoom and one provided interview responses via email. All interviewees were told they would not be personally identified in research findings. Interviewees were asked 12 questions about their background, community challenges in getting citizens on board with proposed pedestrian and bicycle infrastructure changes, and infrastructure challenges during implementation in both urban and rural environments. The two planners interviewed via Zoom worked for the City of Santa Rosa and the interviewee who responded via email worked for the Sonoma County Transportation Authority. This allowed perspectives to be given at the local city and county level around community and infrastructure challenges in both urban and rural places.

Challenges Identifies by Planners

Removal of parking for businesses was one of the main challenges that planners faced when implementing new bicycle or pedestrian infrastructure. Planners approached this issue differently, with all acknowledging that concerns over parking are valid for small businesses. Directing the conversation towards new business traffic via other modes of transportation seemed to curtail some fears but not all. In more rural towns, local neighbors were the opposition group most encountered who banded together to oppose new bicycle or pedestrian infrastructure due to concerns over more congestion for vehicle drivers. For implementing rural bicycle or pedestrian

infrastructure, there were different barriers mentioned like drainage ditches, wildlife protections, and right-of-way issues, that made implementing improvements more difficult. On rural roadways, speed was cited as a major concern by planners since many of these collisions occur on state highways with higher speeds. Implementing infrastructure for lower speed limits can be difficult due to local residents' concerns of increased congestion. Lack of traffic enforcement and underreporting of crashes is another challenge in rural towns as well as lack of funding for safety improvements.

Moments of Success Identified by Planners

Adoption of safety messaging helped planners gain community support across a wide range of groups and residents. Framing bicycle/pedestrian infrastructure improvements as improving safety for everyone, including drivers by lowering speeds, was crucial in getting opponents on board with the infrastructure changes. The support of local groups was identified as key to gaining community support and excitement towards new bicycle or pedestrian infrastructure improvements. Groups such as Sonoma County Bicycle Coalition, Bikeable Santa Rosa, Safe Routes to School, Santa Rosa YIMBY, and the Bicycle and Pedestrian Advisory Board were mentioned. Bikeable Santa Rosa conducts “Tip o’ the Hat Rides” which bring the community together to celebrate new bicycle infrastructure improvements through community rides where bicyclists decorate their helmets and wear hats to ride the new infrastructure. The City of Santa Rosa takes the approach of adding bicycle or pedestrian infrastructure improvements when scheduled pavement maintenance is already taking place to finish both pavement and safety improvements all at once. Support from the state government and improvements to engineering guidelines around speed limit setting was mentioned as a key factor in the ability to improve safety for both urban roadways. Assembly Bill No. 43 (AB43), passed in 2021, allows more flexibility for local jurisdictions when setting speed limits, allowing considerations of safety, land uses, and pedestrian and bicyclist volumes when establishing new roadway speed limits. These changes in speed limit setting have allowed urban local jurisdictions in Sonoma County the ability to set speed limits based on safety of all road users, rather than the previous focus on vehicle travel only.

Opportunities Identified by Planners

The need for bicycle and pedestrian safety improvements on rural highway sections in Sonoma County, such as State Route 12 (SR-12) in Sonoma and State Route 116 (SR-116) near Guerneville, were identified as key areas for improvement by all planners interviewed. These rural roadways were cited as being challenging for implementing safety improvements due to their isolation, lack of funding support, and terrain. For preferred safety improvements, planners mentioned implementation of multi-use paths with separation from motor vehicle traffic, paving of creek paths, addition of lighting and beautification of creek paths, separated bike lanes, features for traffic calming with a focus on beautifying such as bioretention, and class I and class IV bike lanes with physical bollards and barriers. As currently little to none of the rural state routes mentioned by planners have any bicycle or pedestrian infrastructure, proposing plans to community members and local agencies was the focus in these areas. All planners identified Santa Rosa as making incredible improvements in recent years towards implementation of bicycle and pedestrian safety improvements and cited the rural roadways in the county as a challenging area with opportunities for improvements to be made.

Recommendations

Rural Pedestrian/Bicycle Infrastructure Improvements

Ample opportunities exist in rural towns in Western and Eastern Sonoma County for bicycle/pedestrian infrastructure improvements. Towns like Guerneville and Sonoma both have rural state highways running through their historical downtowns (SR-116 in Guerneville and SR-12 in Sonoma). There is opportunity in both places to consider adding pedestrian and bicycle infrastructure and speed management measures along these state routes in the historical downtowns. There is high pedestrian and bicycle traffic in both of these historical downtowns, and for both residents and tourists it would be beneficial for Guerneville and Sonoma to invest in the safety of their downtown areas. Outside of these areas, there are other opportunities for implementation of bicycle and pedestrian infrastructure such as shared-use paths with separation from motor vehicle traffic, improvements to lighting, and the addition of native plants along paths to provide further natural protection from motor vehicle traffic (Small Town and Rural Multimodal Networks, 2016). Many of the plans laid out in the Sonoma County Transportation Authority's Active Transportation Plan include plans for these types of infrastructure improvements in rural towns in Sonoma County. With plans in place, executing them in a timely manner is key to improving the safety of pedestrians and bicyclists in rural Sonoma County.

Future Studies

Implementation of infrastructure improvements in rural towns in Sonoma County provides a good natural starting point for measuring the outcomes of pedestrian and bicycle safety improvements for both collision rates and for levels of traffic stress. There are still unknowns around what types of infrastructure improvements are applicable in rural towns given the focus on recreational travel for pedestrians and bicyclists. Conducting a pre and post study measuring collision rates and level of bicycle and pedestrian traffic stress, and surveying residents before and after the implementation of a pedestrian or bicycle infrastructure improvement, would be valuable in determining the effects of these proposed improvements. It would be worth the time of city and county planners in Sonoma County to implement pilot projects and surveys before building permanent safety infrastructure to ensure they address the concerns of all residents and business owners, by making adjustments to the planned project before it is finalized. Extensive community outreach both before and after the implementation of pilot projects is necessary to fully consider the needs and concerns of the community who will use this infrastructure and understand the impacts it will have on all modes of travel.

For the implementation of infrastructure improvements on sections of rural highways that cross through historical downtowns, collaboration with Caltrans is necessary as they have ownership over these roads. Rural towns like Guerneville and El Verano will need the support of the Sonoma County Transportation Authority to advocate for placemaking and reduction of speeds on the rural highways that pass through their downtown areas. Legislation like AB43 is useful for urban local roads, however it cannot be applied to rural highways due to Caltrans ownership over these roads. A next step in implementing the safety infrastructure improvements in rural communities as outlined by SCTA will involve direct collaboration with Caltrans which could further delay projects. Better collaboration and communication between Caltrans and local rural communities is needed for the successful implementation of safety infrastructure improvements.

Conclusion

Overall, pedestrian and bicycle safety improvements are not one-size-fits-all solutions. Considerations for the differences in the nature of active travel in rural environments has important implications for the infrastructure needed. According to the American Community Survey, 2024 5-Year Estimate, rural communities currently don't and most likely will not continue to commute to work via walking or biking. Planners should consider safety improvements for these communities. Collision data shows that these communities have ever-increasing pedestrian and bicyclist fatalities due to a lack of infrastructure and high speeds. In Sonoma County, major safety improvements are needed in rural communities to help make walking and biking safer for people of all ages and abilities. Considerable efforts have been made by the Sonoma County Transportation Authority to recognize the safety needs of these communities, but more work is needed to reach the execution phase of these projects. Right-of-way challenges and lack of project funding are key challenges for implementation of these proposed projects as noted by planners working in the county. Rural communities are in need of these infrastructure improvements just as much if not more than urban communities. Working through challenges in implementation is worthwhile for all planners in Sonoma County to help improve the safety of the entire region.

About the Program

This research brief was developed as part of the Community Pedestrian and Bicycle Safety Program (CPBSP). The aim of the CPBSP is to reduce pedestrian and bicyclist fatalities and serious injuries in California. We partner with communities across California to discuss, plan, and implement safety improvements and projects. The CPBSP prioritizes working in communities that are disproportionately at risk for road traffic injuries and addressing the safety needs of people who are underserved by traditional transportation resources and planning.

For more information, visit https://bit.ly/CPBSP or email us at safetrec@berkeley.edu

Rural Planning Resources

DOT Rural Transportation Resources

National Center for Rural Road Safety

National Center for Rural Road Safety: A Handbook with Tips and Tools for Developing A Local Road Safety Plan for Your Community

Rural Design Guide

Safe Routes to School Programs in Rural California: A Guide for Communities and Partners

Technical Guidance

DOT Rural/Urban Traffic Fatalities

Governors Highway Safety Association: America's Rural Roads: Beautiful and Deadly

Small Town and Rural Multimodal Networks, U.S. Department of Transportation Federal Highway Administration (2016)

Traffic Safety Countermeasures That Work in Rural Communities National Highway Traffic Safety Administration

Works Cited

Carlson, Susan A., Geoffrey P. Whitfield, Erin L. Peterson, Emily N. Ussery, Kathleen B. Watson, David Berrigan, and Janet E. Fulton. “Geographic and Urban–Rural Differences in Walking for Leisure and Transportation.” American Journal of Preventive Medicine 55, no. 6 (December 2018): 887–95. https://doi.org/10.1016/j.amepre.2018.07.008.

Charyk Stewart, Tanya, Allison Pellar, Moheem Halari, Kevin McClafferty, Pascal Verville, Michael Pickup, Douglas Fraser, Jason Gilliland, and Michael Shkrum. “Safe System Approach to Preventing Cyclist Fatalities: Safety by Design for Urban and Rural Environments.” Injury Epidemiology 12, no. S1 (October 24, 2025). https://doi.org/10.1186/s40621-025-00621-w.

Countywide Active Transportation Plan for Sonoma County, Sonoma County Transportation Authority, 2025 https://scta.ca.gov/wp-content/uploads/2025/06/SCTA_ATP_SCTA_Countywide_4.25.25small.pdf

Hansen, Anush Yousefian, M. Renée Umstattd Meyer, Jennifer D. Lenardson, and David Hartley. “Built Environments and Active Living in Rural and Remote Areas: A Review of the Literature.” Current Obesity Reports 4, no. 4 (September 12, 2015): 484–93. https://doi.org/10.1007/s13679-015-0180-9.

McAndrews, Carolyn, Kenta Okuyama, and Jill S. Litt. “The Reach of Bicycling in Rural, Small, and Low-Density Places.” Transportation Research Record: Journal of the Transportation Research Board 2662, no. 1 (January 2017): 134–42. https://doi.org/10.3141/2662-15.

Monfort, Samuel S., and Becky C. Mueller. “A Modern Injury Risk Curve for Pedestrian Injury in the United States: The Combined Effects of Impact Speed and Vehicle Front-End Height.” *Journal of Safety Research* 94 (September 2025): 235–41. https://doi.org/10.1016/j.jsr.2025.06.030.

Raymond, Paula. America's Rural Roads: Beautiful and Deadly. Washington, DC: Governors Highway Safety Association, September 2022. https://www.ghsa.org/sites/default/files/2025-04/rural_report.pdf.

Tribby, Calvin P., and Doug S. Tharp. “Examining Urban and Rural Bicycling in the United States: Early Findings from the 2017 National Household Travel Survey.” Journal of Transport & Health 13 (June 2019): 143–49. https://doi.org/10.1016/j.jth.2019.03.015.

U.S. Department of Transportation: Federal Highway Administration, Highway Safety Information System (HSIS). “Summary Report: Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways.” Highways DOT. Accessed March 9, 2026.

Villwock-Witte, Natalie M. “Characteristics and Reported Bicycle & Pedestrian Infrastructure for Communities of Less than 10,000 People in Maine, Minnesota, & New Hampshire.” Case Studies on Transport Policy 15 (March 2024): 101120. https://doi.org/10.1016/j.cstp.2023.101120.

Funding for this program was provided by a grant from the California Office of Traffic Safety, through the National Highway Traffic Safety Administration. This report was prepared in cooperation with the California Office of Traffic Safety (OTS). The opinions, findings, and conclusions expressed in this publication are those of the author(s) and not necessarily those of the OTS.

UC Berkeley SafeTREC OTS CALIFORNIA OFFICE OF TRAFFIC SAFETY