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NSTSCE

National Surface Transportation Safety Center for Excellence

Equity in Transportation Safety

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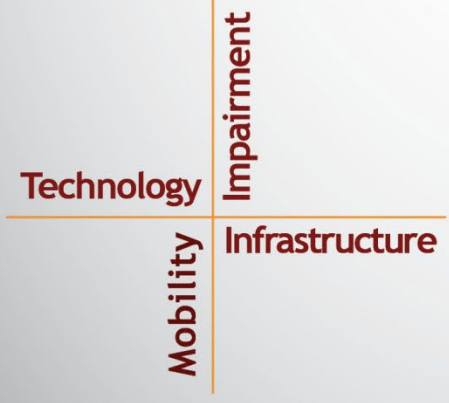

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EXECUTIVE SUMMARY

Equity in transportation is a key issue for the Federal Highway Administration (FHWA) as well as state departments of transportation. Equitable transportation ensures safety for all road users across all modes of transportation for all communities. Access and safety should not be based on "income, race and ethnicity, languages, ages, abilities, and housing status" (U.S. Department of Transportation, 2022a). Quality and safety of travel should not differ across travel modes or be prohibitive based on cost, location, or social factors (Stacy et al., 2020).

FHWA recommends the adoption and equitable application of a safe system approach to achieve Vision Zero objectives to eliminate traffic fatalities and severe injuries (U.S. Department of Transportation, 2023e). A safe system fundamentally recognizes human error and accounts for it when designing systems and operations (U.S. Department of Transportation, 2023j). The incorporation of equity into Vision Zero Action Plans, Highway Safety Improvement Plans, and State Highway Improvement Plans has enabled research and implementation efforts aiming to reduce inequities in transportation systems (U.S. Department of Transportation, 2023a).

Incorporating equity into roadway safety data is critical for conducting data-driven safety analysis. FHWA recommends collaboration with underserved communities through a process of collecting and analyzing data, engaging community representatives, implementing improvements, and evaluating impacts (U.S. Department of Transportation, 2023e). Ensuring robust and accurate data is critical. For example, crash injury and fatality tribal data is underreported in the Fatality Analysis Reporting System, leading to underrepresentation in crash frequency prediction models (Gottsacker, 2019).

State programs have worked to incorporate a wide variety of data into their crash models. Social and demographic data such as race, ethnicity, gender, age, education, employment status, income level, disability status, among many other variables, have been evaluated and demonstrated to be factors in the frequency of crashes. States have published mapping tools to visualize data trends and identify locations for targeted implementation efforts in conjunction with scoring metrics for evaluating proposed solutions.

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LIST OF ABBREVIATIONS AND SYMBOLS

ACS	American Community Survey
AIAN	American Indian and Alaskan Native
APANO	Asian Pacific American Network of Oregon
BIPOC	Black, Indigenous, or People of Color
DOT	U.S. Department of Transportation
FHWA	Federal Highway Administration
HISN	High Injury Street Network
HOI	Health Opportunity Index
HSIP	Highway Safety Improvement Program
MnDOT	Minnesota Department of Transportation
PAWS	Priority Areas for Walking
PBOT	Portland Bureau of Transportation
RITI	Rural, Isolated, Tribal, and Indigenous
RRTPO	Richmond Regional Transportation Planning Organization
SHSP	Strategic Highway Safety Plans
SPACE	Suitability of Pedestrian and Cyclist Environment
STEPP	Student Transportation Equity for Priority Populations
SWITRS	Statewide Integrated Traffic Records System
VDOT	Virginia Department of Transportation
WDOT	Washington Department of Transportation

CHAPTER 1. INTRODUCTION

Social inequities in crashes, road injuries, and fatalities have been identified within and between countries (World Health Organization, 2009; Gervais & Concha, 2008; Lu et al., 2005). The World Health Organization notes that "over 90% of the world's fatalities on the roads occur in low-income and middle-income countries, which have only 48% of the world's registered vehicles." These inequities have been found to disproportionally affect racial or ethnic minorities, as well as children and older adults. Additionally, findings demonstrate a higher prevalence of injury in economically depressed regions when compared to similar affluent regions (Gervais & Concha, 2008; Lu et al., 2005; Morency et al., 2012; Ernst, 2011).

Consideration for equity in transportation has been identified as a critical priority for project planning and implementation by multiple government and safety organizations (World Health Organization, 2009; Ernst, 2011; Alexander Litman & Todd Litman, 2022; U.S. Department of Transportation, 2017). In 2017, the U.S. Department of Transportation (U.S. DOT) published "Beyond Traffic 2045," providing a full review of current and future conditions as well as stating, "Our transportation system does not have to be a force that exacerbates social divisions and income inequality" (U.S. Department of Transportation, 2017). Furthermore, equity in transportation was among the top six goals outlined by the Secretary of Transportation in the U.S. DOT's Strategic Plan for FY 2022–2026 (U.S. Department of Transportation, 2022d).

RESEARCH OBJECTIVES

The goal of this effort is to review approaches to addressing equity in transportation safety, including current practices, applicable policies, methodologies, performance measures, and tools, as well as consideration for barriers and limitations to those approaches. This report outlines background context and important concepts followed by a series of case studies providing insight into current practices and approaches for incorporating equity into safety analysis tools. Analysis was conducted using combined datasets illustrating the types of equity-relevant insights that can be obtained. A summary of outcomes includes recommendations, challenges, and a framework to consider when incorporating equity into safety analysis, policies, and action plans.

EQUITY

In 2021, the Executive Order on Advancing Racial Equity and Support of Underserved Communities Through the Federal Government defined equity as

> The consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer … persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.

The objectives include identifying methods to access equity, such as barriers for participation by eligible individuals, as well as conducting equity assessments in federal agencies to ensure the accessibility of funded programs. The order additionally instructs the federal government to

allocate resources to advance fairness and opportunity by increasing investments in underserved communities and engage with members of those communities. Lastly, the order established an Interagency Working Group on Equitable Data to address the lack of federal datasets disaggregated by "race, ethnicity, gender, disability, income, veteran status, or other key demographic variables." The data working group is charged with providing recommendations for identifying gaps in current data collection programs and policies, as well as strategies for resolving deficiencies. This working group's purpose is to support agency implementation efforts to increase data that can be used to "measure equity and capture the diversity of the American people" (The White House, 2021).

EQUITY IN TRANSPORTATION

The Federal Highway Administration (FHWA) highlighted noteworthy approaches to addressing equity utilized by jurisdictions including California, Minnesota, San Francisco, and Virginia. San Francisco echoes FHWA's principle that "a transportation system should be safe for all road users, for all modes of transportation, in all communities and for people of all incomes, races and ethnicities, languages, ages, abilities, and housing status" (U.S. Department of Transportation, 2022a, U.S. Department of Transportation, 2023e). Figure 1 provides a visual representation of the differing impact between equal versus equitable approaches. In this example, equality would be providing a uniform bike to individuals with differing cycling needs, while equity would be providing individuals with a bike suited to their specific cycling needs. An equitable approach ensures all individuals have access to cycling rather than requiring adaptation as a requirement for participation.

Figure 1. Illustration. Transportation equity in roadway safety (U.S. Department of Transportation, 2023e).

An equitable approach to roadway safety should include working with underserved communities to ensure their needs are considered and addressed. The FHWA recommends identifying "communities experiencing disparities in roadway fatalities and serious injuries" through collecting and analyzing data. Once identified, they recommend connecting and engaging with community representatives to "understand their transportation safety needs and build trust." This leads to proposed improvements and implementation efforts aimed at addressing the identified

disparities through “safety planning, funding, design, operations, and asset management processes” (U.S. Department of Transportation, 2023e).

VISION ZERO

Vision Zero was adopted by the Swedish Parliament in 1997 and is “an ethical stance stating that it is not acceptable for human mistakes to have fatal consequences.” The perspective aims to shift focus from the road user to the transportation system and its management entities as primarily responsible for road safety. Vision Zero operates under the assumption that there are no perfect humans, and therefore transportation systems should be designed to account for human mistakes. Using this approach, Sweden has installed central barriers and roundabouts to reduce collisions and has invested in designing urban environments with a focus on consideration for vulnerable road users.

Since the adoption of Vision Zero, the already low figure of seven fatalities caused by roadway collisions per 100,000 inhabitants has been reduced by more than half. Notably, during that same period, there was a reported increase in the volume of roadway traffic. In recent years, however, the reduction in traffic fatalities has slowed, requiring additional investment in solutions for continued progress (Government Offices of Sweden & World Health Organization, 2019).

In the U.S., nearly 50 cities have adopted Vision Zero actions plans (U.S. Department of Transportation, 2023i). The referenced action plans meet the Vision Zero Network criteria requiring:

> 1) a clear goal of eliminating traffic fatalities and severe injuries, 2) public and official commitment from the mayor, 3) the action plan is in place or set to be implemented, and 4) key departments are leading including public health and transportation offices (Vision Zero Network, 2023).

The FHWA has encouraged the adoption of a safe system approach to achieve the goals of Vision Zero, stating that “to reach zero deaths and serious injuries, the safe system approach should be applied equitably to address these disparities” (U.S. Department of Transportation, 2023e). Further, the agency states that the goal of eliminating traffic fatalities across travel modes “requires the implementation of a safe system approach” (U.S. Department of Transportation, 2023j).

SAFE SYSTEM APPROACH

A safe system approach is a “human-centered approach that anticipates human mistakes and accommodates human vulnerabilities by designing and operating the roadway system to be safe for everyone” (U.S. Department of Transportation, 2023e). This approach is comprised of six principles, which are outlined in Figure 2: “deaths and serious injuries are unacceptable, humans make mistakes, humans are vulnerable, responsibility is shared, safety is proactive, and redundancy is crucial.” There are also five elements of a safe system that include “safe road users, safe vehicles, safe speeds, safe roads, and post-crash care.” Finally, a safety culture is also essential for the safe system approach; this should include prioritizing investment decisions with the understanding that serious injury and fatality in road systems are “unacceptable and preventable” (U.S. Department of Transportation, 2023j).

Figure 2. Illustration. The Safe System Approach (U.S. Department of Transportation, 2023j).

The Highway Safety Improvement Program (HSIP) is a federal aid program aiming to reduce traffic fatalities and serious injuries on federal and state-owned roads, as well as non-state-owned roads and roads on tribal lands. It was the first federal effort to reduce highway-related crashes by providing financial assistance to states with the goal of accelerating safety programs. The federal HSIP influences state-level HSIPs and Strategic Highway Safety Plans (SHSP) on factors such as performance and data-driven strategy (U.S. Department of Transportation, 2022b,U.S. Department of Transportation, 2023a).

In 2020, the U.S. DOT completed an informational report titled *Integrating the Safe System Approach with the Highway Safety Improvement Program*. Researchers considered how well the principles of a safe system approach aligned with the foundational elements of HSIPs, SHSPs, and state HSIPs. The elements of the different plans were considered and evaluated against each safe system principle on a scale of full alignment, partial alignment, and no alignment. Discussion notes were also provided along with the ratings. For example, the HSIP foundational elements considered included purpose and performance management requirements. For the element of purpose, alignment with the safety system principle "death/serious injury is unacceptable" was concluded to be in partial alignment, with authors noting, "The HSIP is focused on reducing fatalities and serious injuries; however, it could be further strengthened to focus on eliminating death and serious injury" (Finkel et al., 2020).

The Vision Zero Network participated in a consortium to develop recommendations for agencies to consider in working "toward a more equitable transportation system" using a safe systems approach (Shahum, 2021). The recommendations note that zero injuries and fatalities are foundational for safe systems and that a focus on equity is required to achieve that goal. Road users include "people of all ages, abilities, races, ethnicities, and income levels," providing a

clear opportunity to address needs in marginalized communities. Implementation efforts in roadway systems should be prioritized using data that captures local needs and "not only the immediate impact of crashes but also their second- and third-order effects, such as limiting opportunities for physical activity and access to jobs and education, then we can implement the safe system approach in an equitable way" (Johns Hopkins Center for Injury Research and Policy, 2021).

Safe streets that have a context dependent design are an outcome of a safe system approach to Vision Zero. Safe streets encourage safe behavior and "discourage dangerous driving by design." Figure 3 provides an example of an unsafe street, which has wide streets with multiple lanes serving different functions, such as vehicle travel lanes, turn lanes, unprotected bike lanes, as well as an unsignalized intersection with an unprotected pedestrian crossing. Additionally, there is a lack of street lighting, decreasing visibility for all the different transport modes and increasing the overall risk in the environment (City of Portland & Portland Bureau of Transportation, 2016).

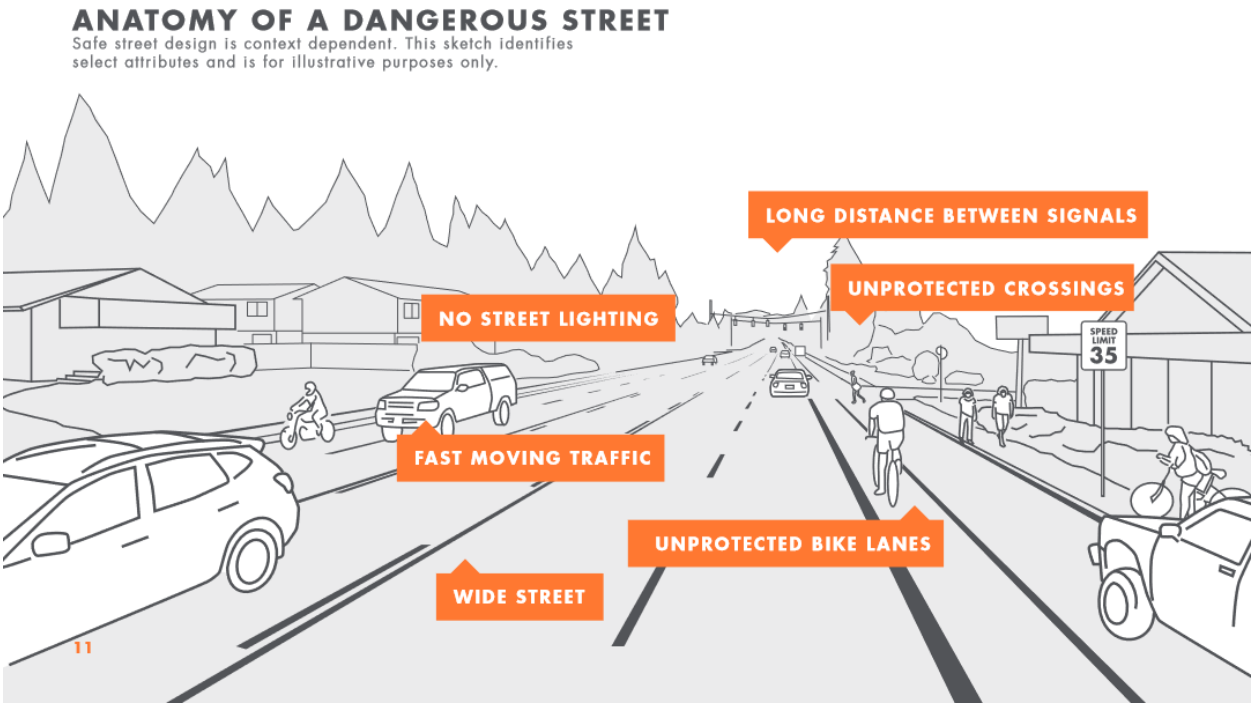

Figure 3. Diagram. Anatomy of a Dangerous Street (City of Portland & Portland Bureau of Transportation, 2016).

CHAPTER 2. CASE STUDIES

RICHMOND, VIRGINIA

An area of focus for Virginia has been reducing pedestrian fatalities. In 2016, there was a noteworthy increase in pedestrian fatalities, with the number rising from 111 to 122 per year, and by 2022, the number increased to over 170. Vision Zero objectives were included in Virginia's state SHSP, and emphasis was put on equity and safety culture as integral to a safe system. An overall goal of a 50% reduction in fatalities and injuries by 2045 was included in Virginia's plan (Virginia DOT [VDOT], 2022). Richmond's Vision Zero action plan similarly notes 22 traffic fatalities within Richmond, accounting for a rate of almost 10 fatalities per 100,000 people living in Richmond. An overall goal of a reduction to zero fatalities is currently targeted for 2030 (City of Richmond, 2021).

Vision Zero

Richmond's Vision Zero action plan offers strategies and action items that are a culmination of a crash data review; research on best practices; and outreach to local, regional, and state agencies. A systems-based and data-driven approach will be utilized along with community engagement and public outreach. Traffic crash data was obtained and evaluated, resulting in the implementation of safety treatments on the High Injury Street Network (HISN), which is where the highest numbers of traffic deaths and serious injuries are occurring. Data sources and further details are outlined in the following subsections. The Vision Zero goals from Richmond's plan are outlined in Table 1, with action items related to equity in transportation safety presented in Table 2 (City of Richmond, 2021).

Table 1. Richmond's Vision Zero goals (City of Richmond, 2021).

EXECUTIVE
Institutionalize Vision Zero as Richmond's approach to its transportation system.
Work with leaders to coordinate safety activities in strategic and master planning development.
Establish and implement policies to promote a culture of safety across all agencies.
Develop a speed management program.
Promote transportation safety and mobility, and the support of equitable, healthy communities.
Evaluate Vision Zero efforts.
LEGISLATIVE AND BUDGET
Establish and/or support policies, regulations, or laws that support a safe systems approach and safety culture in Richmond.
Identify opportunities to improve safety during land use and development activities.
Identify fiscal opportunities and establish budgetary support for a sustainable Richmond Vision Zero program.
Identify partnership opportunities and establish budgetary support for Richmond Vision Zero programs that support the design of an infrastructure that is safe for all users.
Implement safety treatments on the high injury street network.

CULTURE
Communicate effective, positive messages to all transportation system users and partners.
Educate and support trained, informed drivers on our streets.
Emphasize the safe travel of non-motorized users of transportation system.
Deploy effective law enforcement actions and community engagement strategies to promote safety.
Expand partnerships to incorporate and reflect the diverse community of Richmond and to promote equity in our transportation system.

Table 2. Richmond's Vision Zero goals and action items related to equity in transportation (City of Richmond, 2021).

Goal	Action Items
Develop a speed management program	Perform an evaluation of current design speeds on the HISN and explore ways to make physical engineering changes.
	Create messaging on the HISN to promote safe speeds and compliance with traffic laws.
	Determine *slow zones* on the HISN and fund engineering improvements based upon the target speed for each zone.
Promoting transportation safety and mobility and the support of equitable healthy communities.	Providing multiple modes to make the same trip safety for all resident through the Complete Streets approach.
	Provide safe access to transit stops in high priority areas.
	Identify and address transportation challenges for older road users.
	Implement policies to provide safe passage for all transportation modes during special events or in temporary work zones.
Implement safety treatments on the HISN	Develop annual list of engineering projects working towards vision zero goal.
	Apply signal timing/crossing modifications.
	Implement proven geometric intersections treatments.
	Install or upgrade pedestrian crossing treatments.
	Enhance lighting on HISN to improve visibility.
	Determine gaps in the sidewalk network to prioritize locations for annual improvement.
	Develop messages for drivers to improve yielding to pedestrian and other non-motorized users.

Goal	Action Items
Emphasize safe travel of non-motorized users of transportation system	Work with bicyclist and pedestrian organizations to develop materials for both motorized and non-motorized users.
	Work with partners such as mobile phone companies to address road user distraction.
Expand partnerships to incorporate and reflect the diverse community of Richmond and to promote equity in our transportation system.	Work with a broad range of agencies such as faith institutions, schools, businesses, and advocacy groups to promote transportation safety.
	Engage civic associations city-wide and from each of the nine council districts.
	Work with bike share companies, taxi companies, transportation network companies, car share companies, and GRTC to encourage alternatives to driving.
	Work with bars and restaurants to increase awareness of safe alternatives to impaired driving.

Health Opportunity Index

The Virginia Department of Health's (VDH's) Health Opportunity Index (HOI) tool "examines how the opportunity to live a long and healthy life can vary widely depending on where you live, work and play." The HOI index contains 13 factors providing a composite measure of social, economic, educational, demographic, and environmental factors, as shown in Figure 4. In developing the factors, input from public health literature, stakeholders, and health districts were considered as were "the consistency and availability of quality data at the Census Tract level across the State." The model uses spatially weighted regression techniques. VDOT evaluated whether pedestrian fatality and serious injury could be predicted using the HOI and found almost 60% of injuries and deaths "fell into census tracts with low or very-low health opportunity" (U.S. Department of Transportation, 2023c,Virginia Department of Health, 2015).

13 HOI Factors	
	Environmental Quality Index (EPA)
	Population Churning Index
	Population-Weighted Density Index
	Walkability Index
	Affordability Index
	Education Index
	Segregation Index
	Townsend Deprivation Index
	Food Accessibility Index
	Employment Access Index
	Income Inequality Index
	Job Participation Index
	Access to Care

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Figure 4. List Image. Thirteen HOI Factors (U.S. Department of Transportation, 2023c).

The HOI Dashboard provides overall ratings and charts indicating profile values for factors such as economic opportunity, consumer opportunity, community environment, and wellness disparity by health district, as seen in Figure 5. The dashboard also allows for Health Opportunity to be examined by Census Tract representing neighborhood or groups of neighborhoods with similar characteristics as seen in Figure 6 (Virginia Department of Health, n.d.).

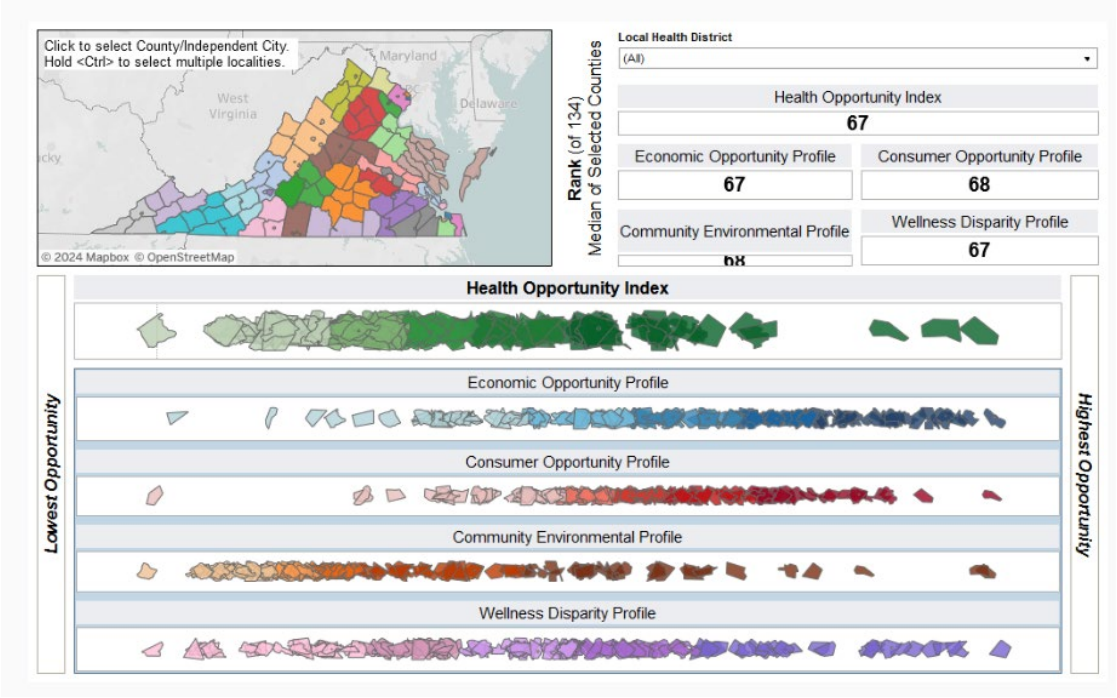


Figure 5. Map and Legend. Health Opportunity Landscape across HOI's (Virginia Department of Health, n.d.).

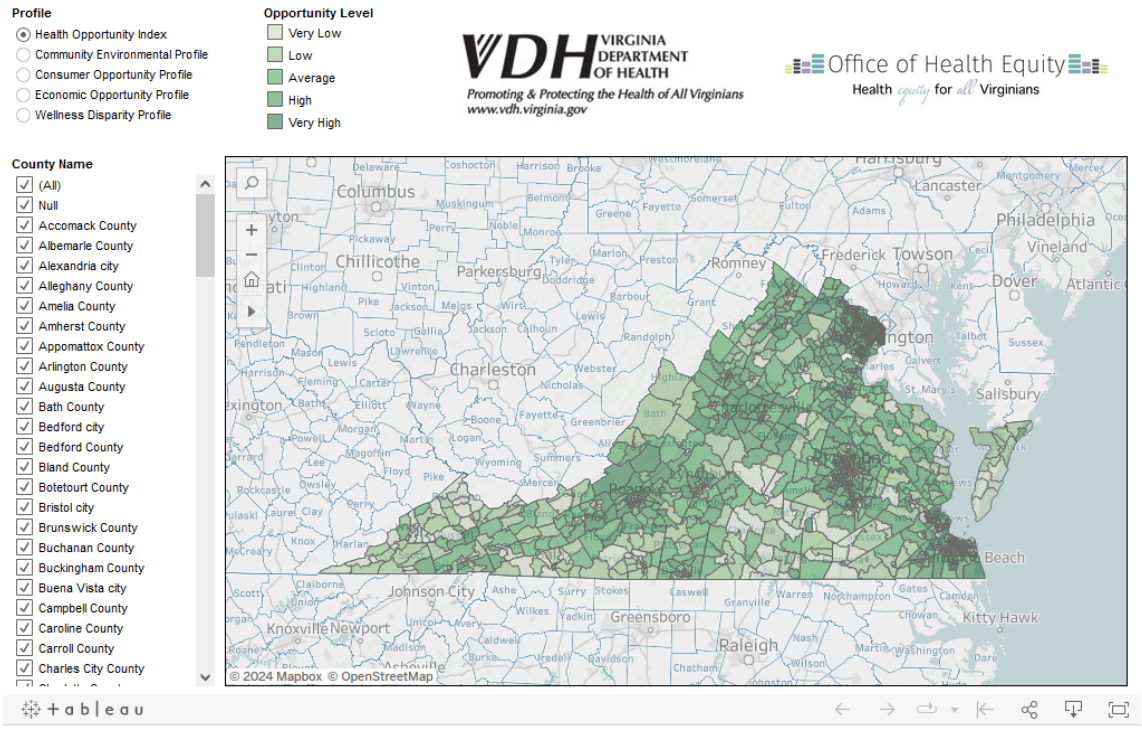


Figure 6. Map and Legend. Health Opportunity Landscape by Census Tract (Virginia Department of Health, n.d.).

Pedestrian Safety Action Plan

VDOT developed the Pedestrian Safety Action Plan (PSAP) in response to the continuing increase in pedestrian fatality rates in Virginia. The tool utilized 12 engineering, social, behavioral and land use metrics to identify areas with a high risk of pedestrian fatality. A recent update incorporating the following HOI data created a more robust dataset for analysis (U.S. Department of Transportation, 2023c).

- Annual average daily traffic
- Posted speed limit
- Number of lanes and presence of a median
- Zero vehicle households (Census block group-level)
- Population below the poverty line (Census block group-level)
- Population density (Census block group level)
- Density of employed persons (Census block group-level)
- Existing pedestrian crash history
- Urban/rural context (as defined by Census-defined urbanized boundaries)
- Proportion of alcohol-related crashes by VDOT district
- Proximity to a park (within ¼ mile)
- Proximity to a school (within ¼ mile)

The current version of the PSAP tool includes statewide pedestrian priority corridors and crash clusters. The corridors are grouped between Statewide Priority and Regional Priority categories. The Statewide Priority category is displayed in red and reflects corridors that rank in the top 1%, while the Regional Priority category is displayed in blue and reflects corridors that rank in the top 5%. A heat map layer also shows the relative density of pedestrian and bicycle crashes with top crash clusters denoted with green stars. The tool also has layers that can be applied to the map view, as seen in Figure 7 (Virginia Department of Transportation, n.d.-a).

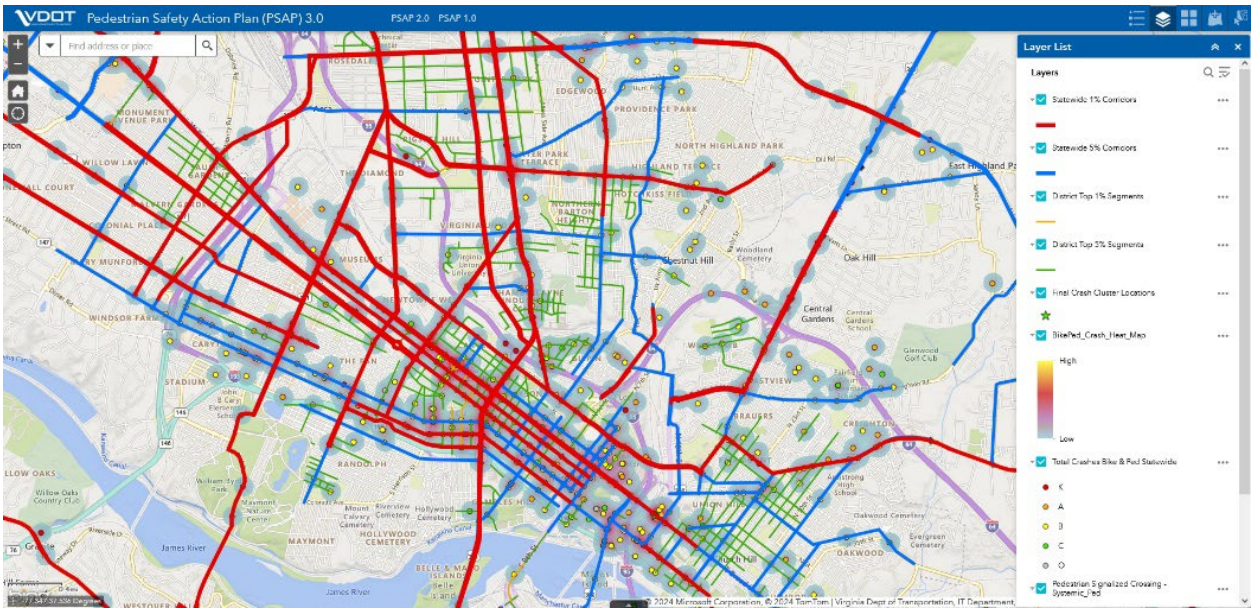


Figure 7. Map with legend. PSAP Tool, Version 3.0 (Virginia Department of Transportation, n.d.-a).

These were identified through the PSAP planning process. Detailed crash data can also be viewed using the tool and can be aggregated in the attribute table, where it can be exported to a CSV file. Data can also be viewed on the ArcGIS Desktop as well as through a webpage. This allows for crashes to be viewed by priority corridor and is used for pedestrian safety countermeasure planning in Virginia (Virginia Department of Transportation, n.d.-a).

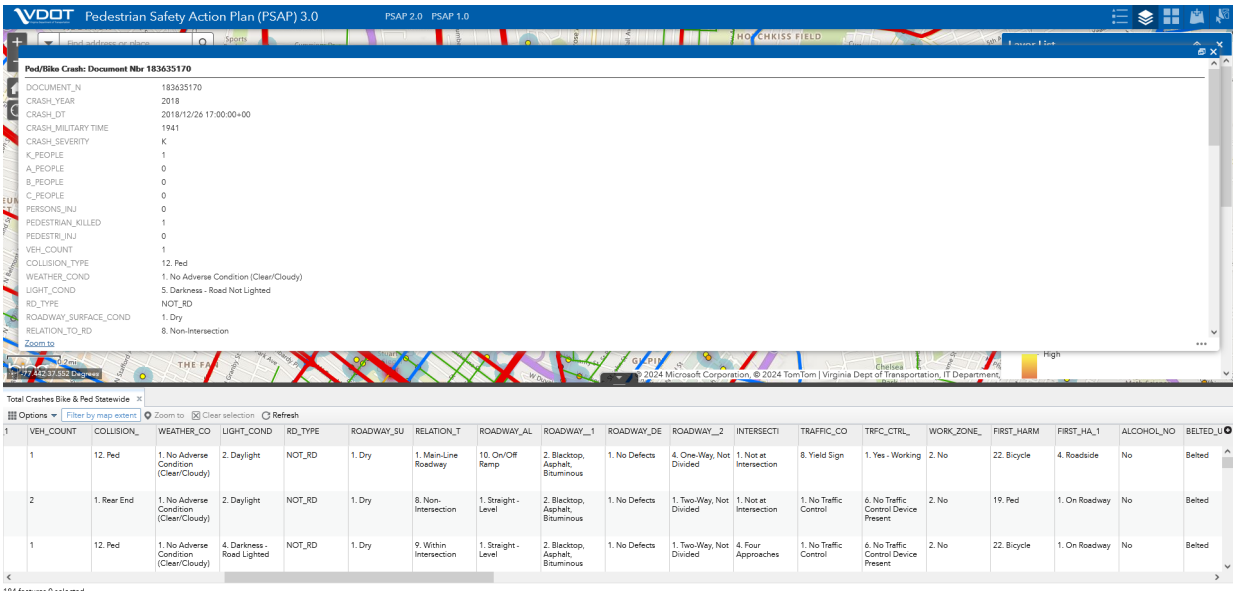


Figure 8. Screen capture. PSAP 3.0 Aggregated table at the bottom with detail view at the top.

High Injury Street Network

To help identify areas and populations of concern, Richmond's Vision Zero action plan investigated multiple data sets, including the HOI data, along with crash and fatality data provided by VDOT. Figure 9 visualizes an HISN overlaid on top of the HOI data. Richmond's HISN was identified using crash data from 2017–2019, and analysis showed that while only 7% of all road mileage in Richmond is highlighted in the network, over 62% of all crashes occurred within the HISN. Streets highlighted in the HISN typically have wider lanes, more travel lanes, higher speed limits, and larger volumes of traffic. Most of the HISN runs through areas with a very low HOI.

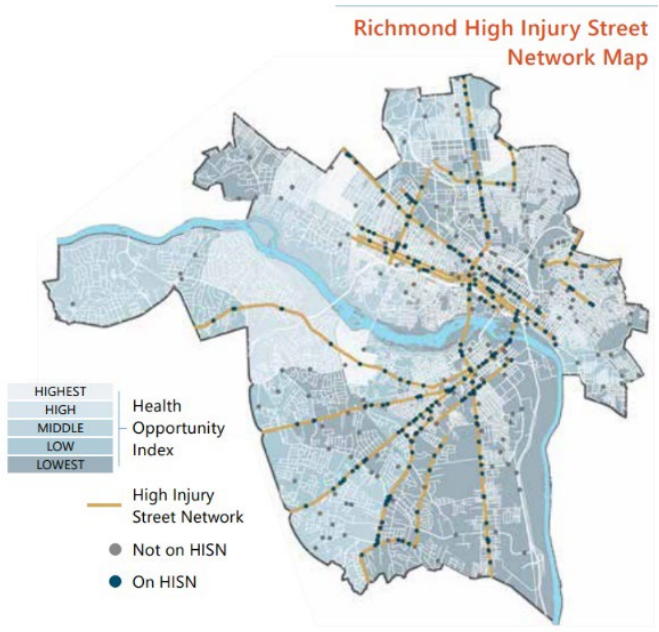


Figure 9. Map. Richmond, Virginia's HISN overlaid on top of the HOI information (City of Richmond, 2021).

The HOI represented in Figure 9 is a measure of social, economic, educational, demographic, and environmental factors related to a community's well-being. The two factors directly related to equity in transportation safety that are considered in the HOI are the walkability of a neighborhood and access to transportation. Figure 10 gives a summary of the injuries and fatalities in Richmond each year based on the HOI of the area they occurred in. Areas of Richmond identified as having a very low HOI have three times as many traffic fatalities and serious injuries as all other HOI areas combined. The Vision Zero stakeholders and the City of Richmond (COR) decision-makers plan to use these metrics to identify factors influencing high crash rates in very low HOI communities and to develop countermeasures aimed at harm reduction (City of Richmond, 2021).

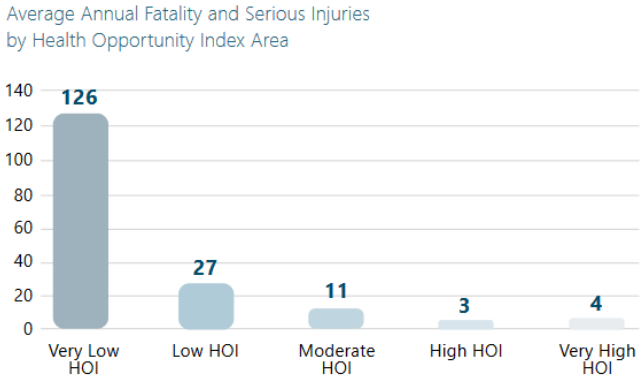


Figure 10. Chart. Annual Average Fatality and Serous Injuries by Health Opportunity Index Area (City of Richmond, 2021).

Vision Zero Dashboard

As part of its plan objectives, the COR developed a Vision Zero dashboard containing crash, injury, and fatality data that can be viewed in ArcGIS Desktop as well as through a webpage. The interactive map contains details on individual crashes, where the user can select data points to receive detailed tooltip information containing over 60 variables. Variables available for viewing include fatalities, crash date, crash time, crash location, roadway geometry, and contributing factors. The dashboard also provides data for all HISN roadways as well as information like street type, speed limit, and street name. Figure 11 shows the interactive map that is published for viewing, while Figure 12 gives an example of the detailed tooltip information available for each crash and HISN location. Figure 13 shows the Vision Zero dashboard as of August 2023 (City of Richmond, n.d.).

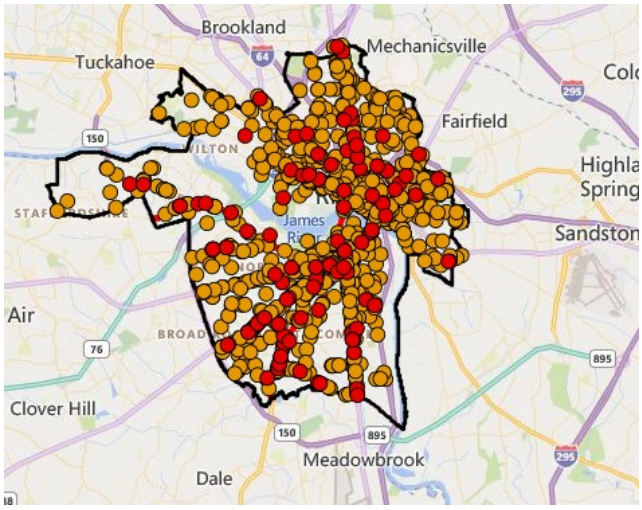


Figure 11. Map. Vision Zero Dashboard map highlighting crashes and high injury network streets in Richmond, Virginia (City of Richmond, n.d.).

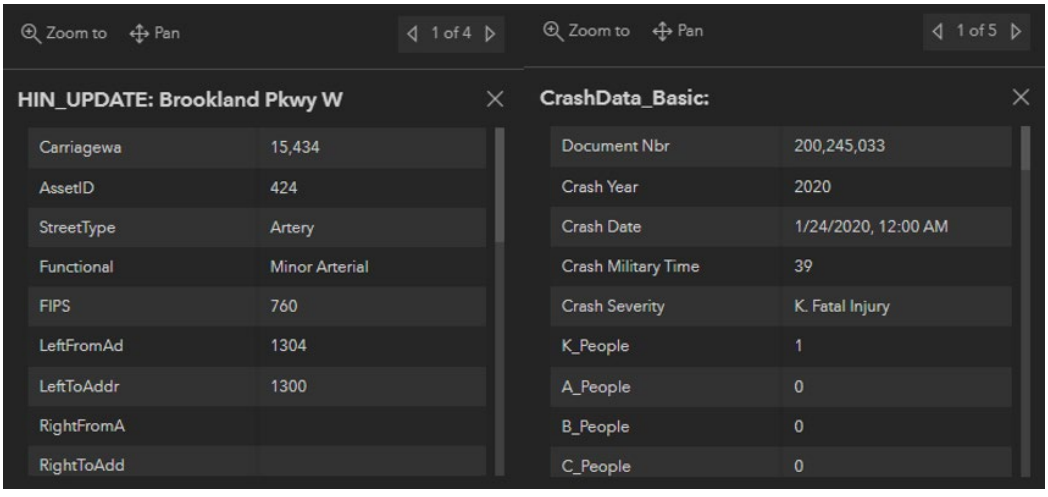


Figure 12. Screenshot. Vision Zero Dashboard tooltip on the left and the Crash Data tooltip on the right (City of Richmond, n.d.).

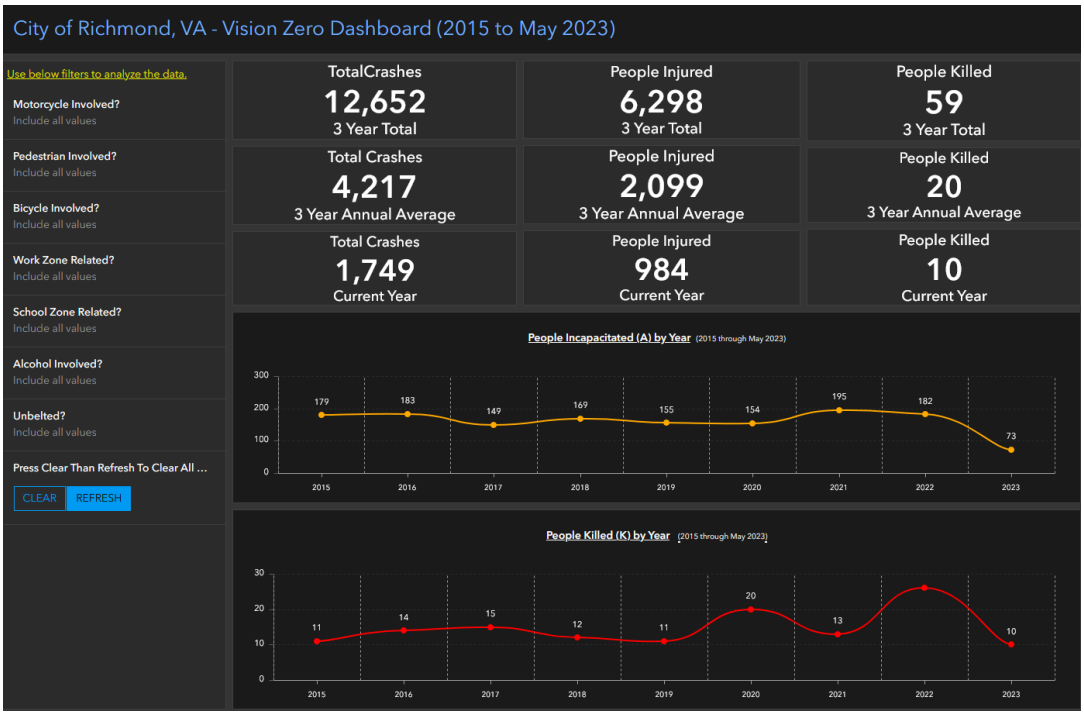


Figure 13. Screenshot. Vision Zero Dashboard through May 2023 (City of Richmond, n.d.).

Path to Equity

Adopting a Vision Zero mindset led to the creation of the Path to Equity policy guide that the COR uses to inform transportation decisions and investments. The Path to Equity plan was built using the city's master plan: the *Richmond 300: A Guide for Growth* (City of Richmond, 2022). The *Richmond 300* was adopted in December 2020, with the overall goal of providing a framework for shaping the growth of Richmond. It was developed over 2.5 years, using the input from community surveys, working groups, and civic association meetings. The plan consists of policy recommendations and maps that are intended to be used in tandem to inform decision-making in areas such as transportation, sustainability, and economic development. The *Richmond 300* presents five topic visions, including the vision of providing equitable transportation through prioritizing the movement of people over the movement of vehicles within a safe, reliable, equitable, and sustainable transportation network. Richmond envisions a future where high-quality and easily accessible transportation is available to all residents regardless of income or physical abilities (City of Richmond, 2020).

In spring 2022, the COR began development of an equitable mobility and accessibility action plan as part of the Richmond Connects plan compendium. The plan will present a needs assessment that gives weight to the equity factors outlined in the Path to Equity plan. The end goal of the Richmond Connects action plan is to create a list of transportation needs and recommendations, with the most pressing needs and solutions adopted for immediate implementation. Richmond Connects will also develop a scenario plan that looks towards the future and asks what impact large scale investments will have on equitable transportation through the year 2050 (City of Richmond, 2022).

The Richmond Connects program is not meant to replace the Richmond 300 plan, but rather to act as the data-driven transportation element of Richmond 300. Richmond's Path to Equity plan and Connects programs seek to fulfill the transportation-related goals and objectives outlined in the Richmond 300 plan. The Path to Equity proposes a set of transportation investment need categories that are simplified from the goals and objectives detailed in Richmond 300. These investment categories are meant to support the existing regional, state, and federal funding program project types, and will allow for more specific equity planning by assigning category weights based on the needs of specific communities of concern. The Richmond Connects process will develop a scoring metric for measuring potential projects and programs in each of the following investment categories (City of Richmond, 2020).

- Bicycle/Pedestrian
- Freight
- Safety
- Maintenance Needs
- Technology
- Transit
- Land Use
- Connectivity Needs
- Economic Development
- Sustainability

Public Outreach

The Path to Equity team reviewed nationwide equity surveys that were available through open access. Using best practices research, the team concluded that equity surveys should focus on identifying communities of concern. This can be "used as a means to identify priority areas and may help provide weight to scoring criteria." Communities of concern include geographic areas as well as types of people. These surveys often include questions on elements such as race, age, income, disability status, sexual orientation, and gender. Furthermore they "may include questions on how the participant uses the transportation network, questions on what improvements a participant desires, questions on what a participant values, and questions on how funding should be allocated" (City of Richmond, 2022).

For their survey, distribution occurred through various means intended to reduce barriers to completion and reach populations of interest. The team utilized paper surveys, as well as digital, increasing means of access and recruitment. The survey was offered in both English and Spanish. Three events titled "Tacos for Transportation" featured food trucks and survey booths aiming to create a "relaxed and fun environment to engage meaningfully with the community and build trust." Additionally, the team utilized canvassers at a bus stop in July to intercept transportation service users. Surveys were distributed to libraires and advertised on radio stations, including a Spanish-speaking station.

Survey demographics are shown in Figure 14; most participants were between the ages 25 and 44 years old (54%). Race demographics are shown in Figure 15; 30% of participants were Black or African American and 52% were white. The age group 25 to 44 years represents 33% of city residents, Black or African American represents 47% of city residents, and white represents 45%.

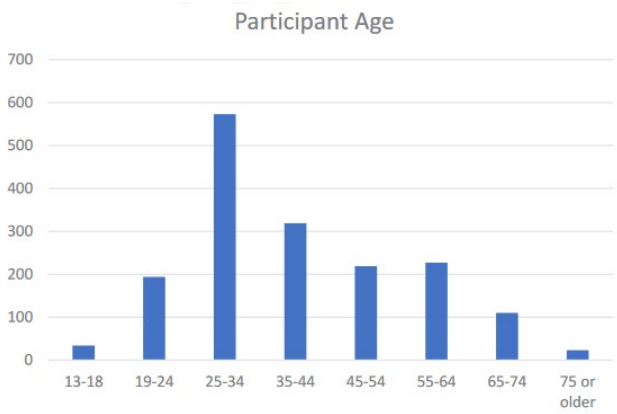


Figure 14. Bar graph. Participant age. Most participants were between 25 and 44 years old (City of Richmond, 2022).

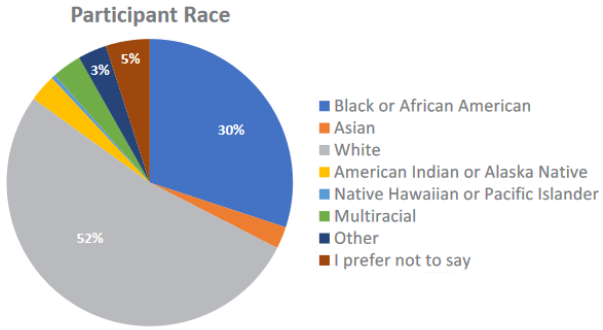


Figure 15. Pie chart. Participant race (City of Richmond, 2022).

Transportation-focused questions were compared to the 2019 5-Year American Community Survey's (ACS's) projections. The ACS covers social, economic, demographic, and housing characteristics of the U.S. population (U.S. Census Bureau, 2024). Results showed the most common mode of travel to be personal vehicles at 59% compared to the ACS projection of 70%. Participants using the bus as a primary mode of transit were 19% compared to the ACS's projected 6%. Statements from participants included feedback that "the city is too focused on the automobile" and "called for an expansion of transit." Comments on the lack of sidewalks were noted, as were participant experiences with near-miss events (City of Richmond, 2022).

Performance Measures

The ConnectRVA 2045 program is the Richmond region's Long Range Transportation Plan, which is federally mandated and covers a 20-year planning period (City of Richmond, 2020). The plan outlines five broad performance areas through which the plan can be evaluated. Of particular interest is performance area 4, detailing the environmental justice analysis. The environmental justice analysis looks at the impacts of proposed investments on historically disadvantaged people in the Richmond region (Richmond Regional Transportation Planning Organization, n.d.).

Six indicators of disadvantage are considered and combined to form an overall index that is used to identify Communities of Concern. Communities of Concern (or Equity Emphasis Areas) are the focus of the Richmond Regional Transportation Planning Organization's (RRTPO's) equity analysis. The two primary indicators are people of color and people in poverty, and the four secondary indicators are zero-car households, older adults, people with disabilities, and people with limited English proficiency. The RRTPO referenced the American Community Survey of Richmond residents to determine the region's mean and standard deviation for each of the six indicators. The mean was used to determine points applicable for each indicator relative to the regional average for scoring purposes.

Data was only considered on the census level tract because more precise information was not available for four of the indicators. The RRTPO also applied a multiplier to the indicators, which denotes the relative importance of each factor. The primary indicators were given more weight than the secondary ones. Any census tract area with a combined final index score of 3 or greater was classified as a Community of Concern. Figure 16 shows the breakdown of each indicator, where the data was gathered from, descriptive statistics, and the scoring range.

	People of Color		People in Poverty		Zero Car Households		Older Adults (65+)		People with Disability		People with Limited English	
ACS Table	B03002		B17001		B18101		B101001		B18101		B16005	
Original Geography	Block Group		Census Tract		Census Tract		Block Group		Census Tract		Census Tract	
Significance	Primary		Primary		Secondary		Secondary		Secondary		Secondary	
Multiplier	1.5		1.5		0.5		0.5		0.5		0.5	
Regionwide Mean	42.50%		13.20%		7.90%		13.90%		12.10%		2.20%	
Standard Deviation	27.20%		13.00%		11.00%		5.90%		5.30%		3.80%	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
0 points	0.00%	42.50%	0.00%	13.20%	0.00%	7.90%	0.00%	13.90%	0.00%	12.10%	0.00%	2.20%
1 point	42.60%	69.60%	13.30%	26.10%	8.00%	18.80%	14.00%	19.70%	12.20%	17.30%	2.30%	5.90%
2 points	69.70%	96.80%	26.20%	39.10%	18.90%	29.80%	19.80%	25.60%	17.40%	22.60%	6.00%	9.70%
3 points	96.90%	100%	39.20%	100%	29.90%	100%	25.70%	100%	22.70%	100%	9.80%	100%

Figure 16. Chart. Equity emphasis area indicators (Aryal et al., 2021).

The RRTPO's methodology was designed such that areas with significant concentrations of people in poverty or people of color would always be included. Combinations of the secondary and primary indicators can also trigger inclusion, provided the summed index score is 3 or greater. Figure 17 shows the regions of Richmond within the PlanRVA area that were identified as Communities of Concern (Equity Emphasis Areas). Analysis found that approximately 32% of the region's residents lived in a Community of Concern.

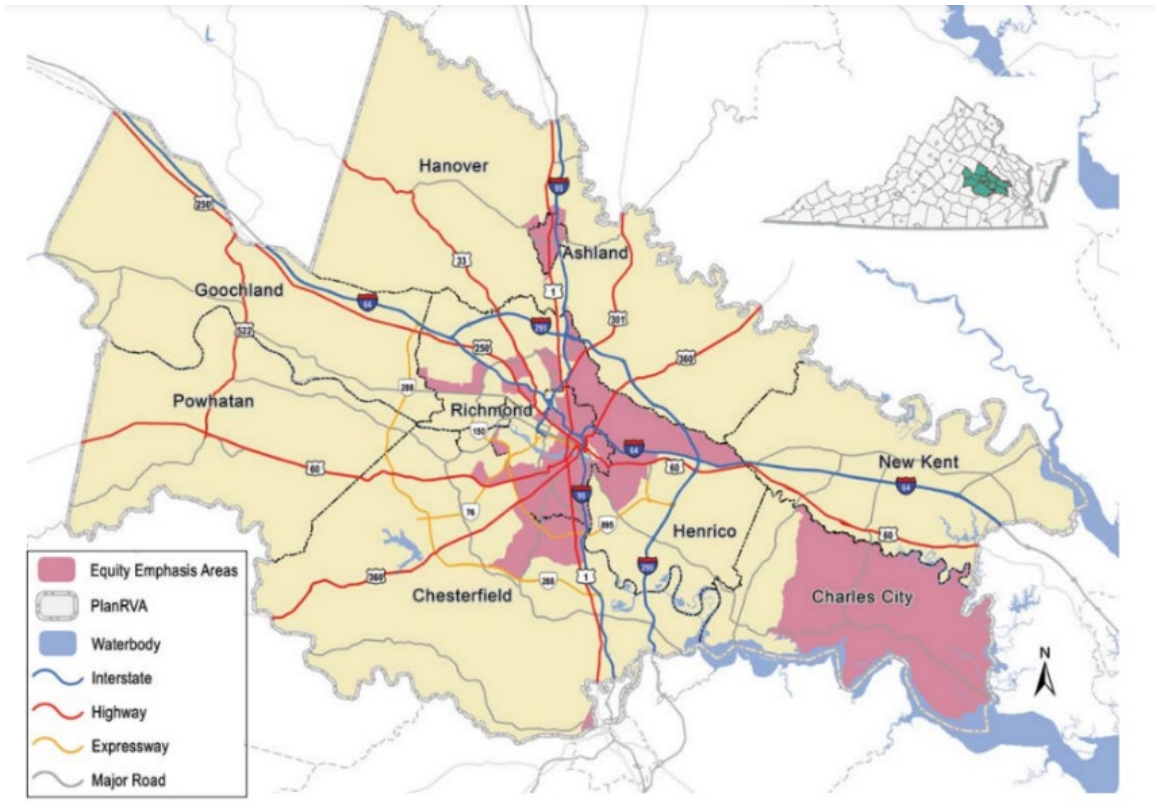


Figure 17. Map. Equity emphasis areas identified by the RRTPO's environmental justice analysis (Richmond Regional Transportation Planning Organization, n.d.).

The RRTPO uses a tiering system for evaluating criteria for proposed projects. Tier 1 projects have the smallest area of impact and usually serve residents who will walk or bike. Tier 2 projects are located on minor roadways and have a broader impact than Tier 1. Tier 3 projects have the widest reaching impact and, outside of rail, are usually automobile oriented. If a project's planned investment overlapped at least one third of a census tract, then it would be deemed to serve that area. This methodology helps to assess which investments would serve Communities of Concern and to ensure that resources are equitably distributed between historically underserved communities and the rest of the region. The RRTPO evaluation found that 63% of Richmond's selected projects served Communities of Concern, which totaled 59% of investment funds. Since only 32% of the population was found to be living in Equity Emphasis Areas, the proposed investments were found to be equitably distributed (Aryal et al., 2021).

The Long Range Transportation Plan methodology evaluates each proposed project through the lens of five goals. The goals and their associated weights are as follows: Safety (25%), Mobility (15%), Equity and Accessibility (25%), Economic Development (15%), and Environmental/Land Use. (20%). The weights were guided by the results of an online survey conducted by the RRTPO from June to October 2020. Each goal has its performance measures weighted during the scoring process to form a combined index. Equity and accessibility are worth 25% of the total index score with 50% of the equity and accessibility performance measure weights applicable to environmental justice areas. The full breakdown of performance measure weights

used in assessing equity and accessibility are shown in Table 3. Equity is measured through the change in average access to employment opportunities and weighted destinations (per 1,000 persons) as a result of project implementation for the environmental justice populations.

Table 3. Equity and accessibility performance measure weights (Richmond Regional Transportation Planning Organization, 2021).

Performance Measure (PM)	PM Weight
EA1. Access to Jobs	30%
EA2. Access to Jobs (EJ Areas)	20%
EA3. Access to Destinations	30%
EA4. Access to Destinations (EJ Areas)	20%
Total	100%

The cumulative index, known as the Benefit Score, is computed by the RRTPO, with the first step being to calculate the raw value for each of the 15 performance measures for each project. For every performance measure, the values are normalized (scale 100) across all projects. Then the normalized values are applied to each of the performance measure weights and summed to create the goal value for each project. The goal weight is then applied to each project's goal value for all five goal categories. Adding all the weighted goal values together gives the Benefit Score, which is then divided by the total project cost (in $10 million) to determine the project score. Project scores can then be compared during the evaluation process to come up with needs, goals, and a performance-based fiscally constrained transportation project list for the Richmond Metropolitan Planning Area (Richmond Regional Transportation Planning Organization, 2021).

Summary

Richmond's approach included incorporating data from multiple sources to provide further insight into traffic fatality data and highlighting target areas for improvement to achieve the Vision Zero Action Plan objectives. VDH developed HOI data that was integrated with VDOT's pedestrian safety data in an update to the PSAP tool. This significantly increased factors for analysis within the pedestrian priority corridors and crash clusters that the tool identifies to aid in pedestrian safety countermeasure planning in Virginia. HOI data from VDH was also integrated with the HISN data from VDOT and the results published in the Vision Zero Dashboard detailing crash and traffic safety data across Richmond.

Path to Equity policy was developed to inform transportation decisions and investments while the Richmond Connects process developed a scoring metric for potential projects and programs within investment categories. These investment categories allow for equity planning by assigning category weights based on the needs of communities of concern identified through an outreach survey review. The RRTPO built on this, forming an overall index to identify communities of concern and creating a tiering system for evaluating criteria for proposed projects to help ensure more equitable distribution of resources.

MINNESOTA

The Minnesota Department of Transportation (MnDOT) created and put into use multiple active transportation assessment tools that seek to analyze equity, including the Suitability of Pedestrian and Cyclist Environment (SPACE) and Priority Areas for Walking (PAWS).

SPACE Program

The SPACE program looks to quantify equity for proposed projects and outlines demand for walking and biking projects within the state of Minnesota. This framework captures an estimate for demand but does not quantify the existing infrastructure. To prioritize bicycle and pedestrian accommodations, the SPACE program uses aggregate data highlighting key characteristics across the state.

Characteristic data is used to help identify priority populations, latent demand, and environmental justice areas. Data is obtained from many sources including the following:

- United States Census Bureau
- Minnesota Department of Agriculture
- Minnesota Department of Education
- The Economic Research Service
- MnDOT

These characteristic data, shown in Figure 18, are calculated for half-mile hexagons across the state, comprising a SPACE score out of a total of 100 points, with higher scores indicating "latent demand and a potential need for bicycle and pedestrian facilities" (U.S. Department of Transportation, 2023h). These can be viewed in ArcGIS Desktop as well as through a webpage (MnDOT, n.d.-b).

% population **AGE 5-17** ≥ average	"Area of concern" by MPCA **ENVIRONMENTAL JUSTICE**
% population **AGE 65+** ≥ average	≥ 25% population within ½-mile of **SUPERMARKET**
% population **FOREIGN BORN** ≥ average	≥ 25% population within 1 mile of **K-12 SCHOOL**
% population **NATIVE AMERICAN** ≥ average	≥ 25% population within 500-feet of a **BUS STOP**
% population with **DISABILITY** ≥ average	≥ 25% population within an **URBAN** area
% workers **COMMUTING 15 MIN** or less ≥ average	**UNEMPLOYMENT** rate ≥ average
% workers **COMMUTING BY TRANSIT** > 0%	% population in **POVERTY IN URBAN** area ≥ 25%
% workers **COMMUTING BY WALKING** > 0%	Contains a state **BICYCLE TRAIL**
% workers **COMMUTING BY BICYCLE** > 0%	**HIGH RISK** trunk highway intersection for non-motorists
% workers with **NO ACCESS TO A VEHICLE** > 0%	

Figure 18. Chart. SPACE score's 19 social and demographic factors (U.S. Department of Transportation, 2023h).

The process is accomplished by dividing the entire state of Minnesota into hexagons with an area of approximately 104 acres, a size slightly larger than the Mall of America property. Figure 19 gives an example of the hexagonal sections, of which a total 522,263 were created to encompass

the entire state. Each hexagon is scored based on several factors depending on the priority scoring used.

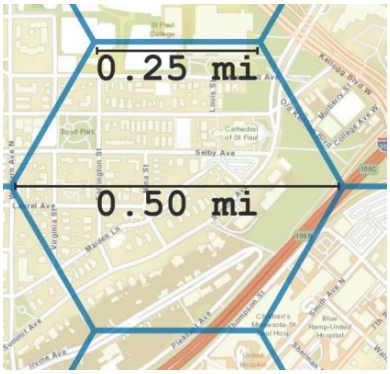


Figure 19. Map with markup. Example of hexagonal divisions used in the SPACE analysis by the state of Minnesota (Devoe, 2022).

Scoring for the district bike plan priority consists of 14 factors that detail the demographics of each hexagon's constituents. The metrics tracked include information such as the percentage of people with a disability within a hexagon and compares that number to the state's average. Other factors like poverty level and vehicle access are also scored against the state average and then standardized to produce a score between 0 and 100. A higher score indicates the area is a candidate for bike plan investments (Devoe, 2022).

MnDOT's analysis determined that a hexagonal division with a SPACE score higher than 50 is an indicator of fatal and serious injury non-motorized crashes. A noteworthy 71% of serious injuries and fatalities for non-motorists occur in regions with a SPACE score greater than 50. As seen in Figure 20, regions with a SPACE score greater than 50 comprise only 15% of the state's road-miles, highlighting the weight the metric provides.

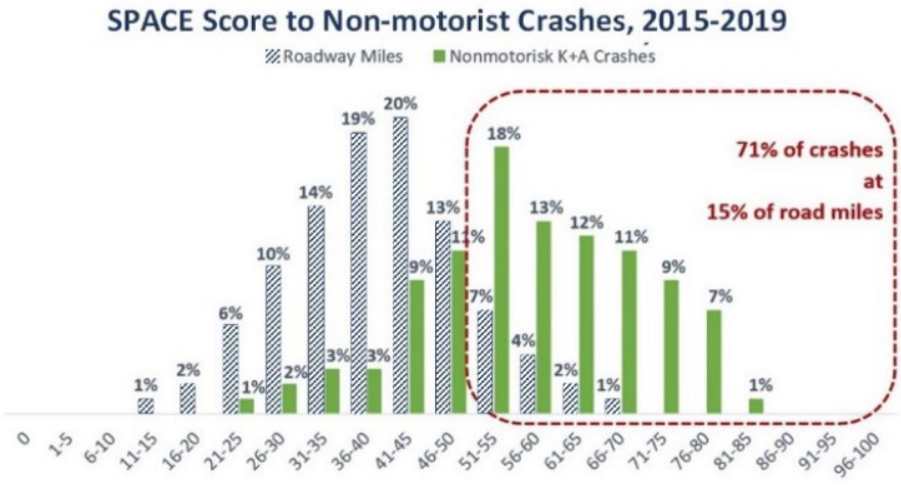


Figure 20. Bar chart. SPACE score as an indication of risk factor (U.S. Department of Transportation, 2023d).

Integrating the SPACE score in MnDOTs project selection and identification process aids in allocating and distributing limited resources to areas where it is most critical. This helps with the identification of locations with higher risk of non-motorist crashes. Additionally, this enables a process conducted by MnDOT that entails walking the area identified to understand its users' experiences. This can involve stakeholders that may include local government officials as well as local health improvement partners. This scoping process assesses motorized conditions, such as speed limit and traffic volume as well as non-motorized conditions, such as assessing crash history and crossing distance, types of roadway users, project context, origins, destinations, and crossing locations.

Countermeasures to address outcomes of scoping are compiled and recommended to local project teams for consideration. MnDOT conducts outreach sessions with localities and partners to contextualize the SPACE tool output. An example shown in Figure 21 warranted further investigation, leading to the identification of multiple uncontrolled crossings around a single clover interchange labelled with an "A" in Figure 22. The MnDOT transportation team was able to add transportation routes to the interchange area, including a route with walking and biking facilities connecting the two sides of the highway area (U.S. Department of Transportation, 2023h).

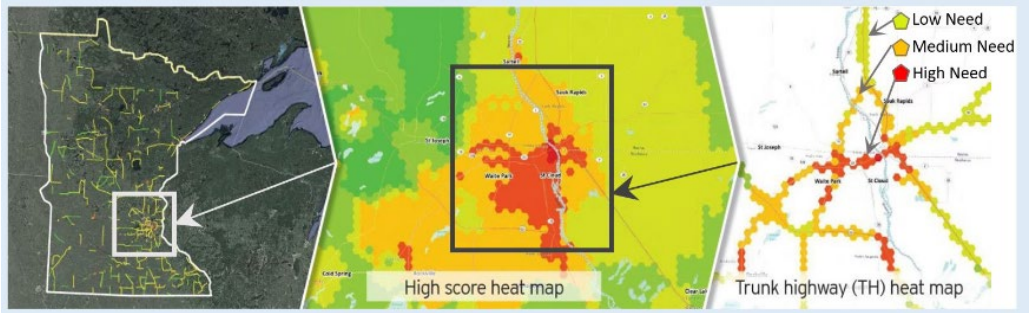


Figure 21. Maps. St. Cloud SPACE output (U.S. Department of Transportation, 2023h).

Figure 22. Aerial photographs. St. Cloud uncontrolled crossing (U.S. Department of Transportation, 2023h).

PAWS Program

The PAWS program uses a similar approach to identify locations to prioritize as part of the Minnesota Pedestrian System Plan. PAWS divides the state into half mile hexagons and integrates factors like safety, equity, land use, health, and infrastructure to pinpoint areas of concern for pedestrians, such as trunk highways. In total, 19 factors are used to identify demand for walking and needs for improvement to the walking environment. Areas with higher scores would be asked to prioritize the safety and comfort of walking over other modes of transportation. The results of the PAWS analysis produce an overall score comprised of a summation of individual infrastructure, health, land use, safety, and equity score totals (MnDOT, n.d.-a).

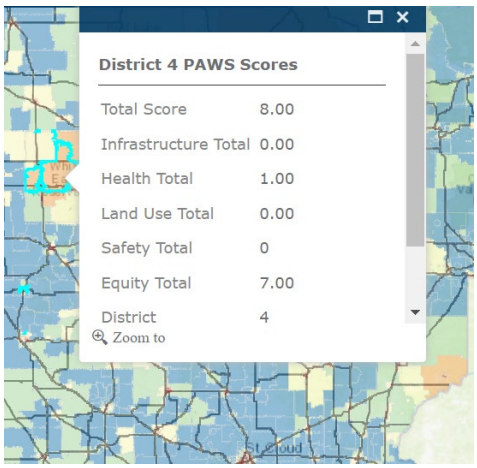


Figure 23. Map with Score Display. The PAWS program interactive ARCGIS map showing total score and a score for each subcategory (MnDOT, n.d.-a).

Equity Indicators

MnDOT defines priority populations as those individuals, groups, or communities who are more likely to rely on walking, biking, or public transit for transportation; are more vulnerable to unsafe traffic conditions; or have suffered historic economic disinvestment in safe infrastructure. The Student Transportation Equity for Priority Populations (STEPP) program sets forth a framework for equitable scoring during the grant application process for the Safe Route to Schools Program. Data used to compute scores for the STEPP program includes the following metrics:

- Number of students eligible for free or reduced-price lunch
- Number of students of color or American Indian
- Percentage of total population aged 5–17
- English language learning students
- Household with access to one or fewer motor vehicles
- Workers commuting by biking and walking

Data for these metrics is obtained from resources such as the Minnesota Department of Education, United States Census Bureau, MnDOT, and the ACS. The overall goal is to use these metrics to identify priority populations with a higher need for Safe Routes to Schools assistance. Minnesota's Safe Routes to Schools program awards points to each application that is received, based on these indicators, to inform the evaluation of equitable distribution of past Safe Routes to School resources and to equitably allocate resources in the future (MnDOT, n.d.-c; MnDOT, 2022a).

The development process for the Safe Routes to School Equity Score is shown in Figure 24. The process begins by gathering equity indicators and refining the list down to the seven metrics listed above. Some measures considered but ultimately omitted include maximum intersection non-motorist safety risk score, residents who are people of color, and students missing school due to lack of transportation. The omitted measures were either replaced with a more suitable indicator or left out due to a lack of comprehensive data. Similar to the SPACE and STEPP programs, the Safe Routes to School Equity score also divides Minnesota into half mile wide hexagons for analysis.

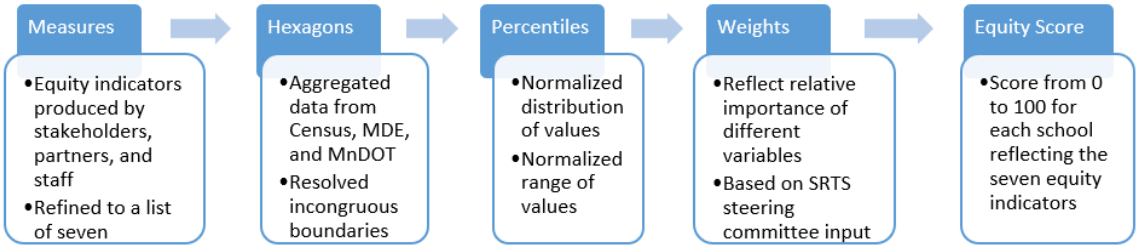


Figure 24. Flow chart. Development process of the Safe Routes to Schools equity scoring (MnDOT, 2022b).

Measures were compiled into percentiles and normalized (scored from 0 to 1) to reduce the effect of skewed data distributions. The normalized measures were then applied to all schools located within a hexagonal tile. Weights were applied to each score by multiplying the score by the weighted coefficient, for a potential maximum score of 100 and a minimum score of zero. Table 4 shows the full breakdown of each measure, the data source used, and the weighting coefficient assigned to the measure (MnDOT, 2022b).

Table 4. Safe Routes to Schools equity indicators (MnDOT, 2022b).

Measure	Source	Tier	Weighting Coefficient
Percent of students eligible for free or reduced-price lunch	MDE	A	24
Percent of students who are people of color	MDE	A	24
Percent of households with access to 0 or 1 vehicle	Census	B	18
Percent of students who are English language learners	MDE	C	12
Percent of population between the ages of 5 and 17	Census	D	6
Percent of workers commuting by biking or walking	Census	E	4

The STEPP tool can be viewed on the MnDOT website and shows the information that is available for every school in the database. Figure 25 provides an example of the interactive map offered to help identify priority populations with a special need for Safe Routes to School assistance (MnDOT, n.d.-c).

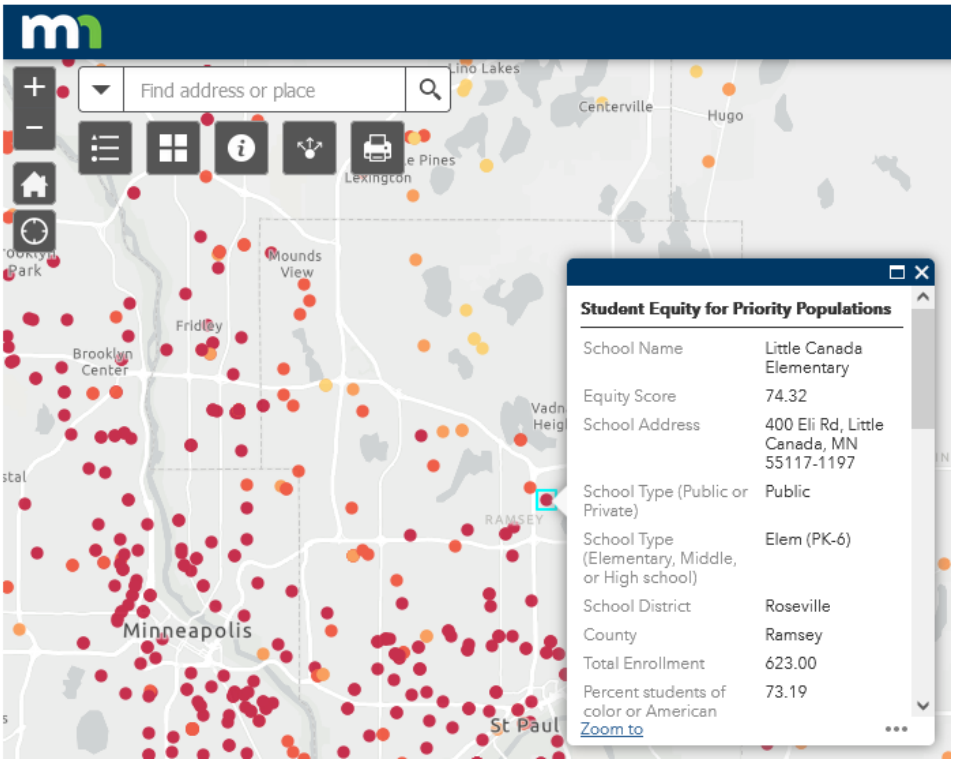


Figure 25. Map with equity information display. STEPP Tool example data for a given location (MnDOT, n.d.-c).

Summary

MnDOT sought to analyze equity through establishing and utilizing multiple active transportation assessment tools, including SPACE, PAWS, and STEPP. The SPACE program methodology produces a score for hexagonal regions with higher ratings, indicating a greater potential need for bicycle and pedestrian facilities. MnDOT's analysis considered using SPACE scores as equity indicators. The effort concluded that a score higher than 50, while only comprising 15% of the state's road miles, was an indicator of fatal and serious injury non-motorized crashes. The SPACE score was integrated into MnDOT's project selection process along with on-site outreach sessions with localities and partners to contextualize the SPACE tool output and aid in equitable distribution of resources targeted at areas where the impact can be the most significant. The PAWS program similarly utilized hexagonal divisions with the goal of identifying areas with a priority for improvements based on the demand for pedestrian safety needs.

The STEPP tool developed a framework for equitable scoring during the grant application process for the Safe Route to Schools program with the overall goal to identify priority

populations with a greater need for assistance. The Safe Routes to School program also applied a metric for equity based on hexagonal regional with data for each school available within the STEPP tool. This helps to aid in identifying priority areas and populations, evaluating the past distribution of resources, and determining future allocation of resources.

WASHINGTON

Washington State was the first state to adopt a Vision Zero program in 2000, with the goal of eliminating traffic fatalities by 2030. Rural, isolated, tribal, and indigenous (RITI) communities in the state are particularly impacted by transportation inequity factors such as vehicle fatalities compared to the overall population (Gottsacker, 2019).

Target Zero

The Washington State Strategic Highway Safety Plan: Target Zero 2019 notes that "There are 29 federally recognized tribes in Washington State, and each one is a sovereign government." The Washington Traffic Safety Commission (WTSC) analyzed data from the Fatality Analysis Reporting System (FARS), reporting that the rate of American Indian and Alaskan Native (AIAN) crash deaths was declining prior to 2013 but had started increasing significantly in recent years. Figure 26 shows the rate of fatalities per 100,000 from 2007–2016. Leading "fatal crash factors" identified in the report were impairment, speeding, and unrestrained motorists. It is also noteworthy that during this timeframe the overall rate of deaths remained relatively constant (Washington Traffic Safety Commission, 2018).

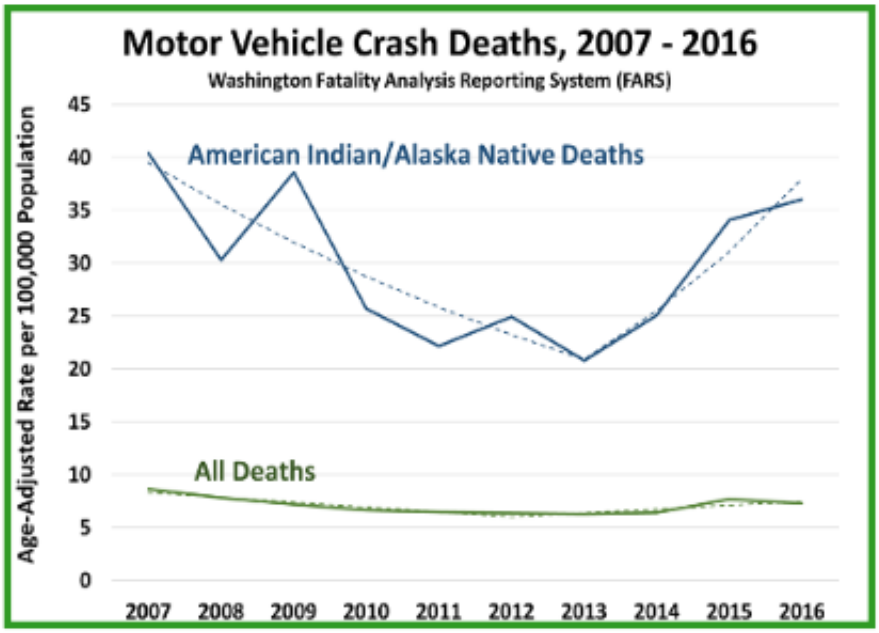


Figure 26. Line graph. Washington motor vehicle crash fatalities from 2007–2016 (Washington Traffic Safety Commission, 2018).

The SHSP: Target Zero presents key data across 3-year periods for comparison with the latest version released in 2019. Data from 2015–2017 compared to data from 2012–2014 showed a

23% increase in traffic fatalities and a 7% increase in serious injuries. Traffic fatality rates in Washington compared to national rates were also considered and were based on deaths per 100 million vehicle miles traveled using data obtained from FARS, the Washington State DOT (WSDOT), and the National Highway Transportation Safety Administration. Figure 27 visualizes this increase alongside the national average and highlights legislative changes that may have influenced trends in the data.

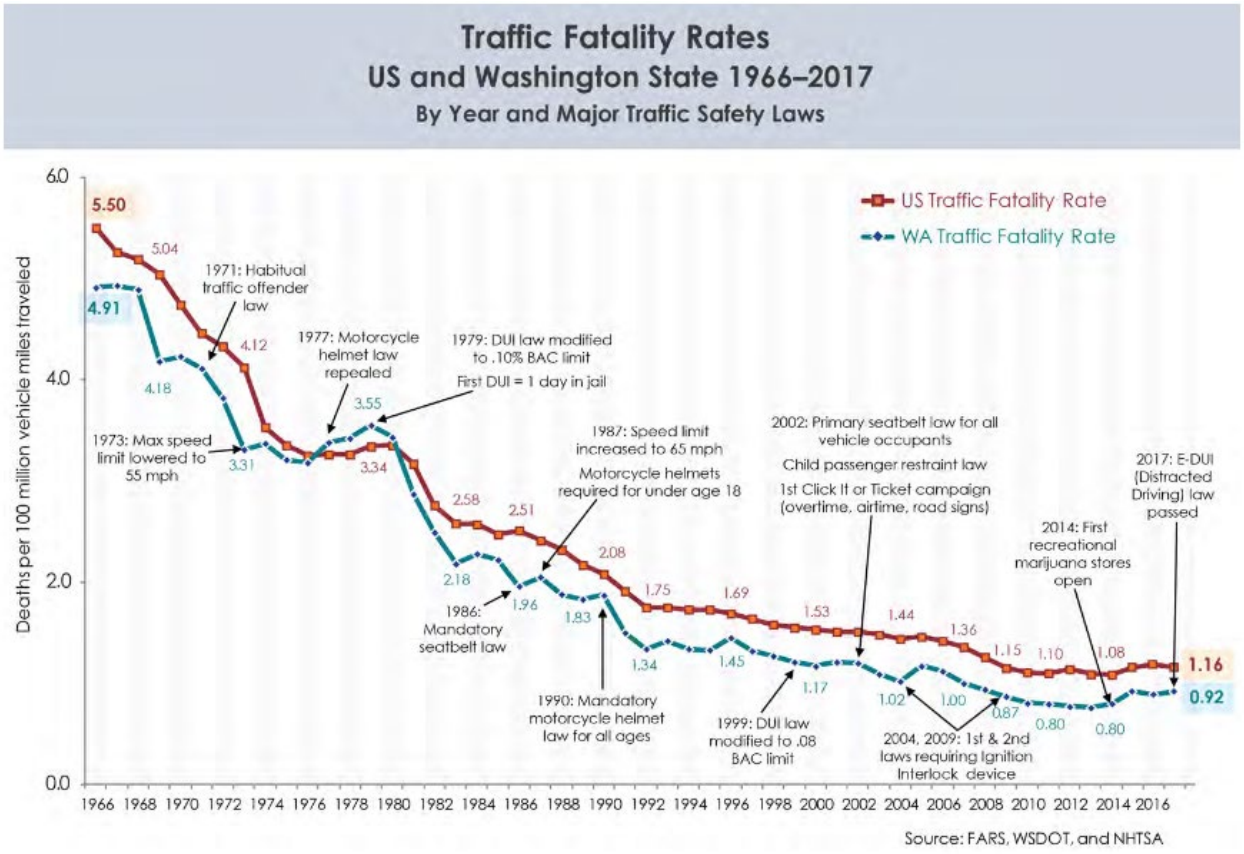


Figure 27. Annotated line graph. Traffic fatality rates US and Washington State 1966–2017 (Washington Traffic Safety Commission, 2019).

The traffic fatality rate was also considered by race/ethnicity, as shown in Figure 28. Using data from 2008–2017, the AIAN traffic fatality rate was found to be 28.5 deaths per 100,000 people. The WTSC notes that "this rate is almost four times higher than the rate for the next highest race/ethnicity." WSDOT partnered with the Bureau of Indian Affairs to use U.S. Census data for reservation boundaries in its reporting, finding 49% of AIAN crash fatalities in the state occurred on reservations. When considering traffic fatalities occurring on reservations specifically, a 50% increase was found between 2014 and 2016. Additionally, a 360% increase in fatalities for pedestrians and bicyclists was observed during the same period (Washington Traffic Safety Commission, 2019).

AIAN populations are reported to have "higher death rates involving high risk behaviors than other races." These statistics include the already mentioned 4.4 times higher total fatality rate and

a 6.4 times higher pedestrian fatality rate. The rate of unrestrained vehicle occupant deaths was reported to be 8.8 times higher with impairment involved deaths reported to be 5.8 times higher. A rate of 4.2 times higher was found for speeding involved fatalities compared to other races (Washington Traffic Safety Commission, 2019). Partners of the Target Zero program "suspect there is underreporting due to gaps in data sharing between Washington State and tribes." Tribal representatives have echoed this as well, noting that the "number of fatalities and serious injuries occurring on their reservations in the recent past exceeded what has been reported to the state" (Harborview Injury Prevention and Research Center, 2019).

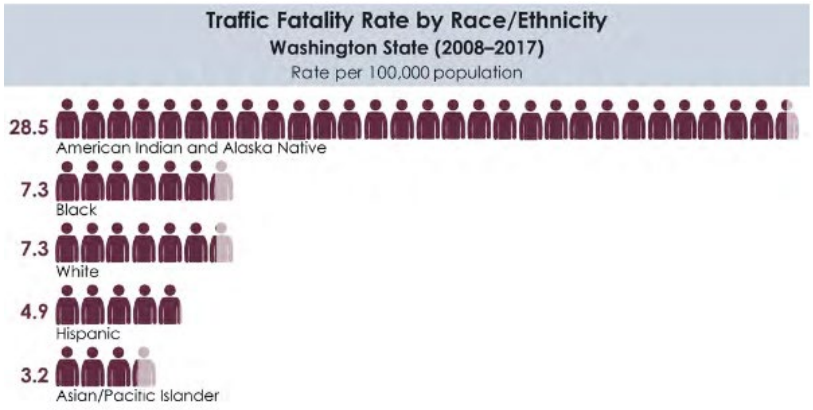


Figure 28. Graphical chart. Traffic fatality rate by race/ethnicity (Washington Traffic Safety Commission, 2019).

This is visualized in Figure 29, where counties in Washington State are shown alongside census population data and characterized by AIAN traffic fatality data. On the map, blue regions indicate counties with equal representation of racial and ethnic groups and yellow regions indicate counties with an overrepresentation of AIAN populations. Overlaid are reservation area boundaries and reported AIAN traffic fatalities occurring from 2006–2017. Using this approach, groupings of AIAN traffic fatalities can be visualized on reservations as well as in AIAN overrepresented counties (Washington Traffic Safety Commission, 2019).

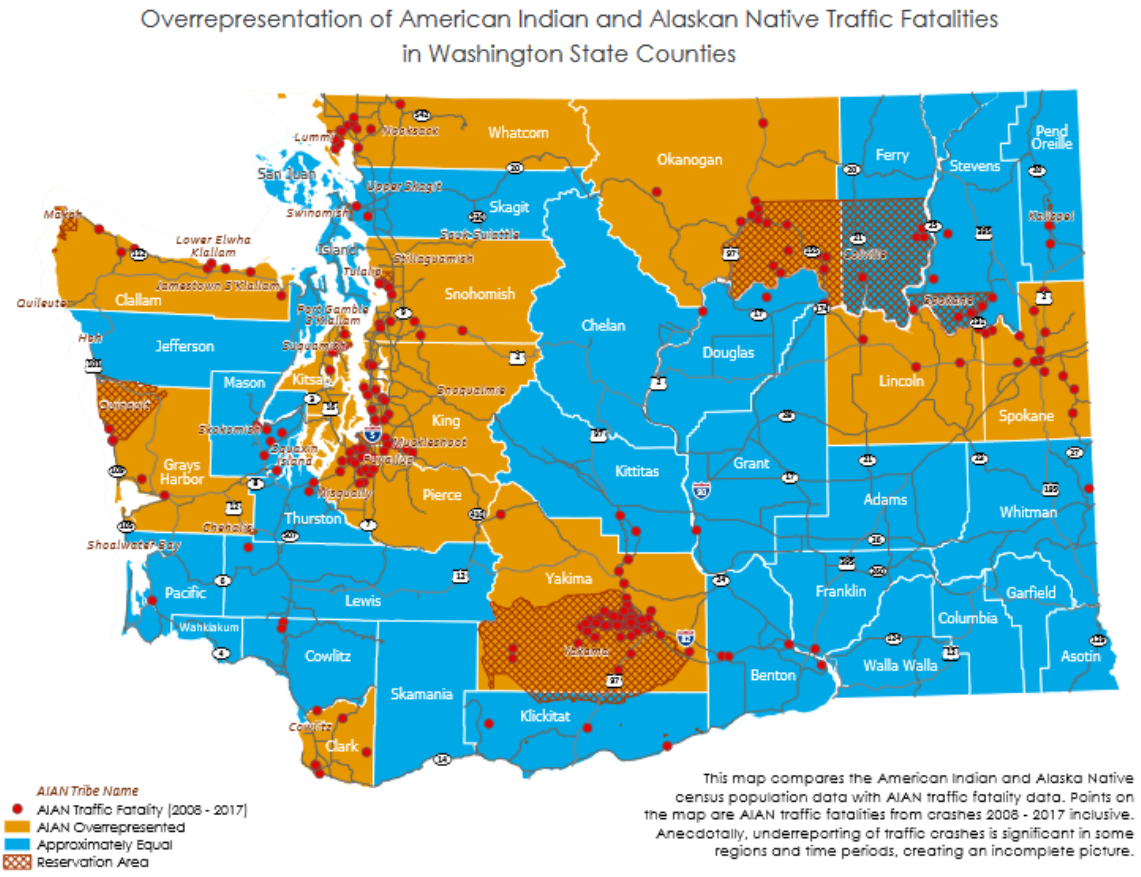


Figure 29. Map with legend. Overrepresentation of American Indian and Alaskan Native traffic fatalities in Washington State Counties (Washington Traffic Safety Commission, 2019)

RITI Framework

Framework for the RITI traffic crash analysis involved three stages for implementation, and included six steps, as shown in Figure 30. The outreach component is significant because it builds the framework for collecting and assessing data. Authors recommend establishing data sharing agreements and engaging in discussions around data collection and data management, as well as consideration for alerting based on best practices. Community data should be integrated with state data and roadway segment data while maintaining as much uniformity as possible.

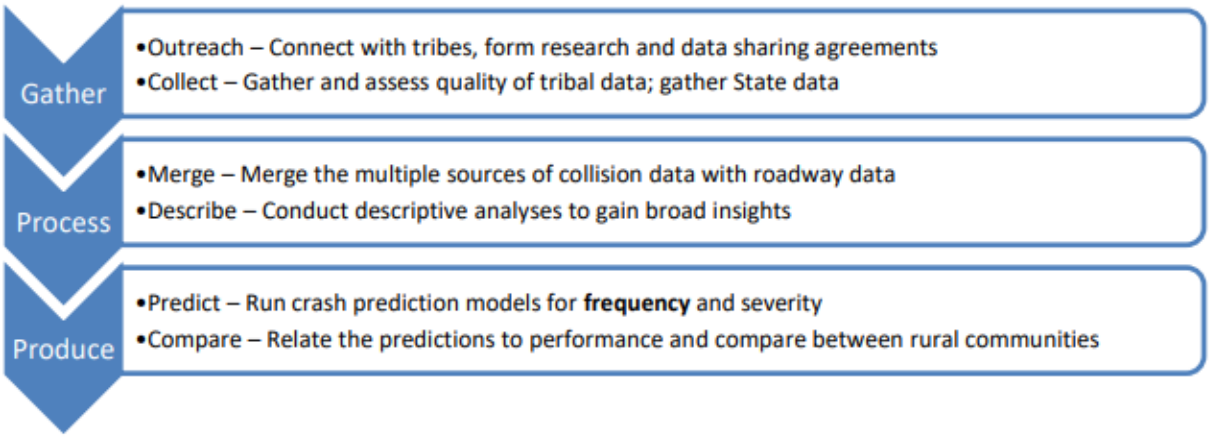


Figure 30. Flowchart graphic. Framework process outline (Gottsacker, 2019)

WSDOT has crash and road characteristic data that can be merged with other data sets by roadway segment using programs such as ESRI and ArcGIS. The Highway Safety Information System can provide data elements such as roadway characteristics, crash records, roadway grade, and roadway curvature that can be utilized for crash frequency prediction. The data can be utilized in predictive models and visualization tools, including hotspot identification and maps. The proposed safety analysis module provides crash severity prediction and crash frequency prediction by roadway type among other factors. Once established, tribal communities could "maintain ownership of their data and control access to it."

The goal of this framework is to better understand the traffic safety issues impacting rural, isolated, tribal, and indigenous communities. Outreach activities are essential to establishing relationships that enable data sharing to accurately reflect crashes in these models. This leads to data aggregation, and merging allowing for descriptive and predictive crash analysis. Visualizing these results and mapping crashes "was an important consideration learned from collaborating with tribal transportation leaders" (Gottsacker, 2019).

Summary

Washington State's RITI communities are particularly impacted by transportation inequity compared to the overall population in factors such as traffic fatalities. Analyzed FARS data indicates increased AIAN fatalities in recent years, while overall fatality data remained relatively in line with national averages. Partners of the Target Zero program and tribal leaders have strongly indicated that the FARS data doesn't reflect the total number of incidents and fatalities due to underreporting and gaps in data sharing between entities. The WTSC overlaid reservation area boundaries and reported AIAN traffic fatality data alongside population data to visualize the overrepresentation of AIAN fatalities in Washington.

A framework for incorporating RITI crash data was developed emphasizing outreach with tribes and establishing data sharing and data collection agreements. Tribes should maintain ownership and access to their data and the state should incorporate shared data into traffic analysis processes and predictive models. The collection and utilization of RITI data is critical for identifying priority areas for implementing countermeasures.

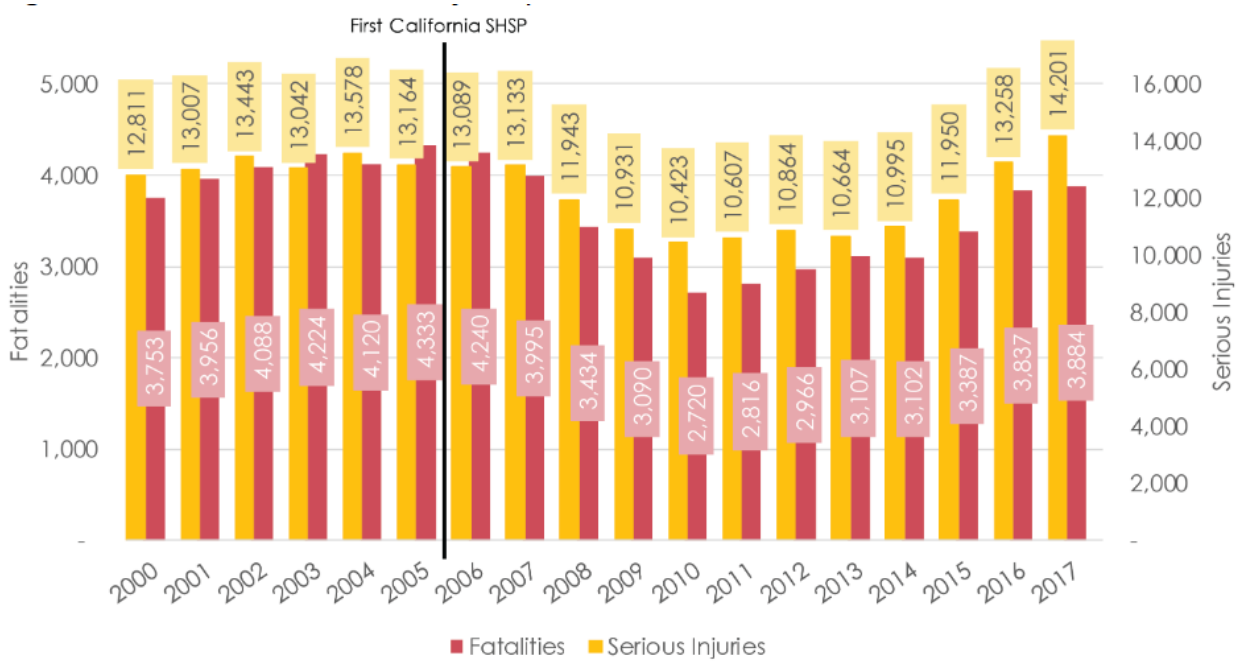
CALIFORNIA

Strategic Highway Safety Plan (SHSP)

In 2020 the California Department of Transportation (Caltrans) updated their SHSP, recognizing a "bolder and more focused approach was necessary to combat the rise in fatalities and serious injuries that have occurred on California roadways" (Caltrans, 2023). This included the adoption of four guiding principles:

- Integrate Equity
- Double Down on What Works
- Accelerate Advanced Technology
- Implement a Safe System Approach

Historical data from 2000–2017 for serious injuries and fatalities is shown in Figure 31. This analysis combined data sources from FARS as well as the Statewide Integrated Traffic Records System (SWITRS). A decrease that may have been influenced by the nationwide adoption of SHSP and associated policies can be seen from 2006–2010. The number of fatalities and serious injuries continued to increase after 2010, which supports the notion that "extra emphasis needs to be placed on traffic safety" (Caltrans, 2023).



Source: Statewide Integrated Traffic Records System (SWITRS) as of July 2019 and Fatality Analysis Reporting System (FARS) as of October 2019

Figure 31. Bar chart. Fatalities and serious injuries, 2000–2017 (Caltrans, 2023).

The following excerpt and bullet points from the U.S. DOT (2022c) provides an overview of Caltrans' SHSP mission and approach:

> Through data analysis for the SHSP update, Caltrans recognized that integrating equity is essential to address disparate fatal and serious injury crash outcomes impacting underserved communities and vulnerable road users. Caltrans believes that everyone has the right to travel safely on California's public roads regardless of race, socioeconomic status, gender, age, and ability.
>
> To ensure equity is addressed, all of the actions within the SHSP must consider a series of equity questions in their development and implementation:
>
> - Which groups will benefit from the implementation of the proposed action (target audiences, vulnerable populations, specific end-users, etc.)?
> - Who may be negatively impacted or affected by the implementation of the proposed action (low-income, persons of color, user ability, modality, etc.)?
> - What demographic and/or socioeconomic data was considered in the development of the action (race, age, income, gender, etc.)?
> - What data gaps (particularly in relation to equity-related data sets) could be addressed by a proposed action?
> - Who was involved in the process of developing the action, and who was missing?
> - What partnerships were built with community-based organizations (who have access to and trust from underserved or vulnerable populations)?
> - What culturally sensitive and/or multilingual approaches are needed to conduct outreach, engagement, or education efforts?
> - Are ADA compliance and accessibility needs considered proactively?

Ongoing efforts to include equity-related data and assessments of the quality of that data indicate limitations in current crash data collection. For example, the race/ethnicity data within SWITRS is coded "at the party level," meaning a single race/ethnicity is used to represent all parties involved regardless of variability. FARS data is reported to undergo more data cleaning processes and was utilized for analysis along with data from the U.S. Census Bureau's ACS. Figure 32 shows the distribution of traffic fatalities by race/ethnicity, a comparison of fatality rate by race/ethnicity, and income equity in traffic fatalities. Notably the "Census Block Groups with average household income less than $50,000 had a 50% higher fatality rate per population than Census Block Groups with average income greater than $50,000" (Caltrans, 2023).

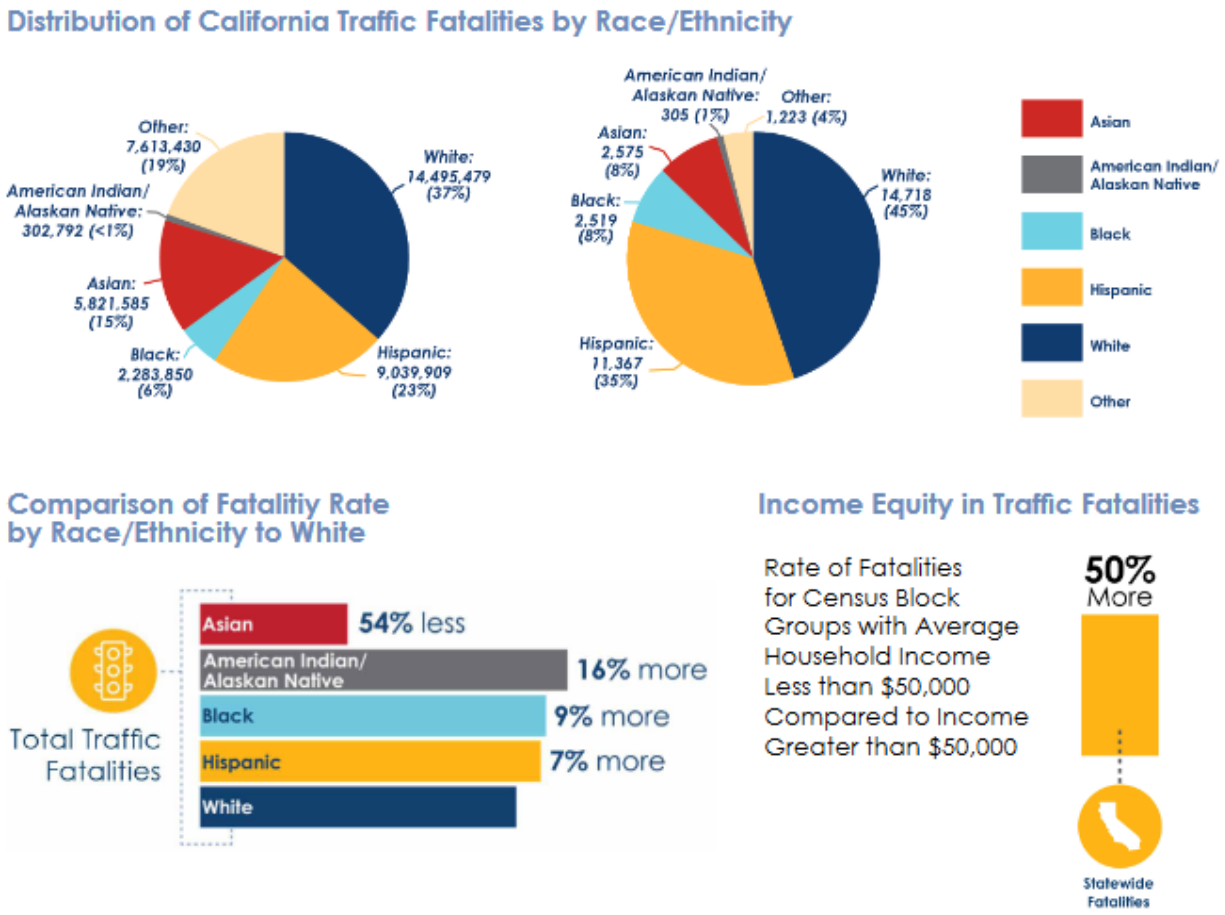


Figure 32. Charts. Equity-related data analysis for race/ethnicity and income (Caltrans, 2023).

SHSP Crash Data Dashboard

The SHSP Crash Data Dashboard was developed to provide SHSP implementers with direct access to crash data to aid in the utilization of data-driven solutions. Incorporating equity data such as race/ethnicity, gender, tribal area, and age allows for socioeconomic and demographic factors to be considered. FARS and SWITRS data from the last 10 years is included, and crash data can be filtered by number and characteristic including:

- SHSP Challenge Area
- Crash Severity
- Location: District, County, Metropolitan Planning Organization, and City
- Crash Cause
- Crash Time
- Crash Party and Victim Demographics

Registration is required for access, but a snapshot of the data is included in Figure 33, showing fatal injuries across the 10-year period across all challenge and location areas (Caltrans, n.d.-a; U.S. Department of Transportation, 2022c).

Figure 33. Screenshot. Fatal victims & crashes overview: all challenge areas (Caltrans, n.d.-a).

Summary

California's SHSP update included the principle of integrating equity as well as an analysis of traffic fatalities and serious injuries. This analysis utilized FARS and SWITRS data; however, limitations of SWITRS data were identified, including coding of race for incidents at a party level. Further analysis of traffic fatality by race/ethnicity and income was conducted using FARS and U.S. Census Bureau ACS data. As part of the SHSP initiatives, a Crash Data Dashboard was developed to provide implementers with access to crash and equity data from the past 10 years for consideration.

PORTLAND, OREGON

Vision Zero

In June 2015, the city council of Portland, Oregon, unanimously passed a resolution committing to the Vision Zero equity framework. Bolstered by support from the Oregon Safe Streets advocacy group, a Vision Zero action plan was produced and published in December 2016. This action plan set forth clear objectives to provide equitable data-driven objectives that would seek to eliminate deaths and serious injury from Portland's streets by 2025. The Vision Zero action plan sets out to make Portland's streets safer for all users (pedestrians, vehicles, and

micromobility devices). The action plan was to prioritize infrastructure investments on the most dangerous streets located in Portland's underserved communities. Its success would be measured through safety metrics and the level of investment in under-invested communities. The action plan mentions that Portland will gather safety data through traditional methods but also seek alternative sources that focus on the circumstances related to deadly crashes.

Vision Zero outlined that transportation investments would be determined through analyzing crash data as well as supplemental data sets. To identify and prioritize underserved communities, traffic crash data was paired with equity metrics, demographic information, hospital trauma data, fire response data, and Oregon liquor control commission data (related to impaired driving). TriMet, Portland's regional transit provider, composed an index of 10 measures that was used to identify Communities of Concern where investments could be prioritized. The 10 measures used to identify Communities of Concern were as follows:

- People of color
- People with disabilities
- Youth
- Affordable housing
- Poor vehicle access
- Low-income households
- Limited English proficiency persons
- Older adults
- Lower paying jobs
- Access to services

Using crash data compiled by the Oregon Department of Transportation Crash Analysis and Reporting Unit, Portland compiled the 20 most dangerous streets and 30 most dangerous intersections to form a High Crash Network (HCN). Dangerous streets were identified by the number of crashes involving vehicles, bicycles, and pedestrians; dangerous intersections were also chosen using crash data for all modes of transportation but were adjusted to account for the average traffic flow. Overall, Portland found that streets with multiple lanes in both directions that had wide fast through roads incurred a disproportionate number of traffic deaths. Often, these roads ran through lower-income neighborhoods where residents had a higher incidence of using public transportation or relied on walking. Data obtained from the Communities of Concern analysis and the HCN were combined into infographics that overlaid the two measures to help pinpoint areas in need of safety investment. Figure 34 shows the motor vehicle HCN and Communities of Concern information.

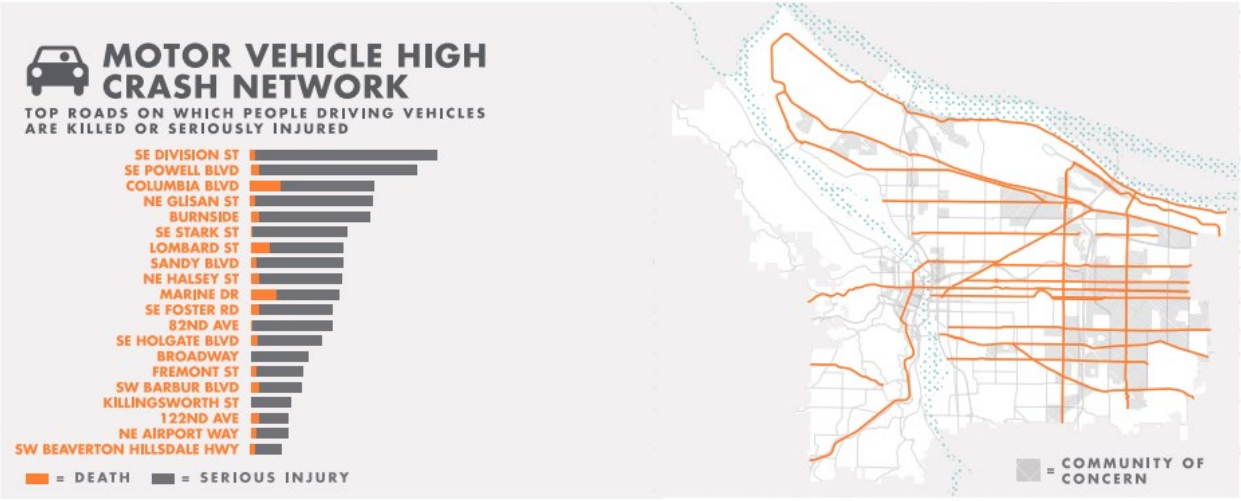


Figure 34. Map and bar graph. Motor Vehicle HCN data overlaid with Communities of Concern as identified by the City of Portland, Oregon (City of Portland & Portland Bureau of Transportation, 2016).

Portland's Vision Zero Action Plan (2016) is slated to go through a review every 2 years; this review includes an equity analysis. The action plan lays out measurable goals that can be reviewed for effectiveness and combined with community feedback. Three overarching performance measures were laid out for addressing equity in transportation safety as follows:

- Number of people killed and seriously injured in traffic crashes in the City of Portland, disaggregated by mode, age, and geography, compared to prior years.
- Whether funding is secured from new local, regional, or state sources for implementation of Vision Zero actions.
- Amount of Vision Zero infrastructure investment citywide and in Communities of Concern.

In addition to the overall goals, the Vision Zero action plan lays out 2- and 5-year action items for the five key safety areas of Street Design, Impairment, Speed, Dangerous Behaviors, and Engagement & Accountability. One of the first items approved under the Vision Zero action plan was a measure to institute a citywide gas tax that was expected to generate $64 million and would be earmarked for making safety improvements along the HCN (City of Portland & Portland Bureau of Transportation, 2016).

2-Year Review

Evaluation and review of Portland's Vizion Zero Action Plan was published in 2019 and covers the 2.5 years since the program's adoption. It describes the lessons that were learned over Portland's first 2 years as a Vision Zero city.

In trying to reduce disparities in fatal crashes, the Portland Bureau of Transportation (PBOT) collaborated with multiple organizations, such as the Portland African American Leadership Forum, Immigrant and Refugee Community Organization and the June Key Dela Community

Center. PBOT conducted "Walking While Black" focus groups that included residents from underserved areas to garner recommendations that would inform equitable traffic safety decisions. Among the recommendations was focusing on personal safety in the right-of-way and the need for better street lighting.

2018 crash data showed that fatalities on Portland's roads were down 25% overall when compared to 2017; however, the East Portland area was experiencing 50% of traffic deaths while only having 25% of the total population. This is significant because East Portland is home to many of the city's low-income residents and persons of color. In total, 23 out of 34 crashes that resulted in fatalities happened in East Portland.

In keeping with international best practices, Portland reduced speed limits in areas where pedestrian, biking, and vehicular traffic mix. Figure 35 shows the distribution of streets that received a speed reduction, with residential streets marked in grey and non-residential streets marked in orange. Overall, 59 non-residential streets had their speed limit reduced, and a large network of residential roads had their speed limits reduced. Portland also, in 2018, launched the "20 is plenty" campaign to educate residents about the new changes to residential speed limits. Over 7,000-yard signs were distributed and set up to let citizens know that speeds were being reduced from 25 mph to 20 mph across the city.

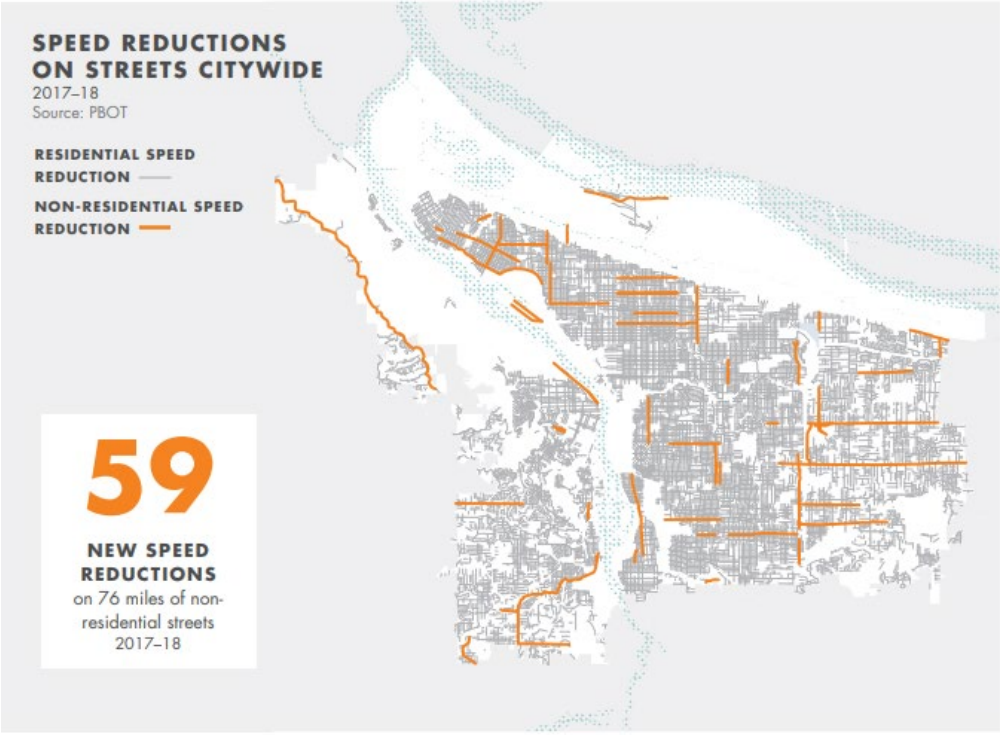


Figure 35. Map graphic. PBOT graphic showing roads that had their speed limits reduced in during the 2017-2018 calendar year (City of Portland & Portland Bureau of Transportation, 2019).

In addition to reducing speed limits, the City of Portland conducted a campaign to educate residents about the impact of speeding. It was suggested that the *struck* campaign, launched

citywide, be run again in 2019 and 2020, following the success of its initial run. A total of 58% of Portlanders said that after viewing the *struck* campaign materials, they adjusted their driving behavior. In the 2 years following the 2016 adoption of the Vision Zero equity framework, the city of Portland installed eight speed safety cameras on four of the most dangerous streets, as identified by crashes. On average, the cameras reduced speeds by 58% overall and incidence of top-end speeding was reduced by 85%. The city is also looking to reduce the tickets generated from the speed cameras from a moving violation to a civil fine, with the aim to support safe travel while not putting an undue burden on lower income residents. In addition to reducing ticket fines, first time offenders would be able to attend a safe driving class in lieu of fines. This policy has the potential to reduce the financial burden on low-income residents, assuming the cost of the class is less than the civil fine, and that classes are held in locations that are accessible.

The City of Portland also uses the HCN data to inform investment strategies, as summarized in Figure 36. In the 3 years following the adoption of Vision Zero equity framework, at minimum 49% of investments were made in low-income communities and communities of color. The numbers from 2019 are skewed due to a $22.1 million state funded project on Capitol Highway; otherwise, a significant majority of the funds would have been invested in underserved communities.

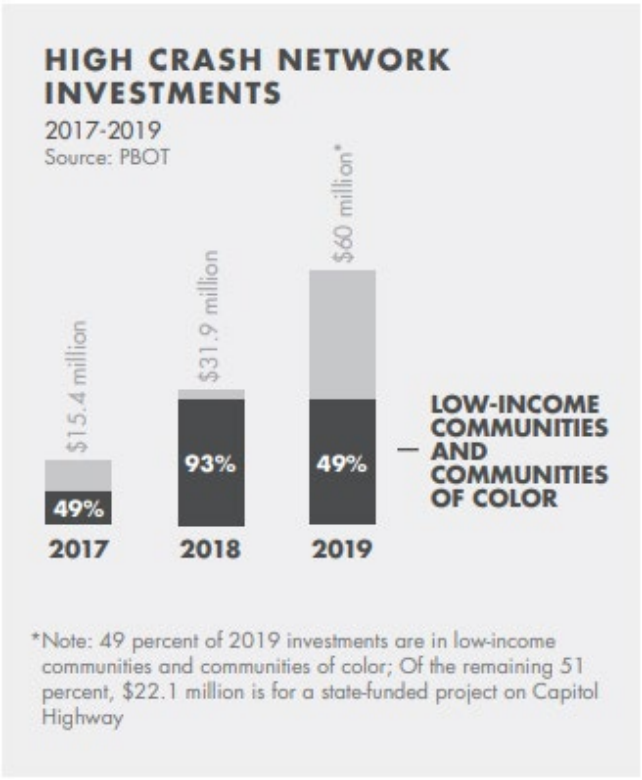


Figure 36. Bar graph. HCN investments from 2017–2019 (City of Portland & Portland Bureau of Transportation, 2019).

PBOT is taking action to address cultural disparities. The 2-year update highlights that many persons of color and new residents are being displaced and/or moving to neighborhoods along

roads with fast rates of travel and wide lanes. PBOT offers some resources targeted at limited English proficiency residents for kids and adults in these effected communities focused on traffic safety engagement such as:

- A "walk to talk" initiative in collaboration with the Portland Chinese Times and the Asian Pacific American Network of Oregon.
- In-classroom and behind-the-wheel driver education program for immigrant and refugee residents.
- Spanish-language safety training led by community members who participated in PBOT's train the trainer program focused on residents in East Portland.
- Transportation safety programs hosted by community partners that are delivered in non-English languages such as Spanish, Tongan, Burmese, and Karenic.

Portland's Vision Zero plan, published in 2016, set forth measurable actions to help move towards the end goal of zero fatalities or serious injuries on Portland's Streets. Below, Table 5, Table 6, Table 7, and Table 8 act as refence material to show the strategies employed to reduce fatalities, the objectives set forth to accomplish the harm reduction, and the commitments formed over the past 2.5 years (City of Portland & Portland Bureau of Transportation, 2019).

Table 5. Objectives and commitments to address vision Zero Strategy: protecting pedestrians (City of Portland & Portland Bureau of Transportation, 2019).

Objective	Commitment
Strategy: Protect Pedestrians	
Change signal timing and operations to make it safer to cross the street.	Install leading pedestrian intervals at new or upgraded traffic signals on HCN streets to give pedestrians a head start and make them more visible. Retrofit at least 10 existing priority crossings each year.
	Install protected left turns at new or upgraded signals on at least three priority intersections on the HCN each year.
	Put "no right on red" restrictions in place at priority HCN intersections.
Improve visibility at pedestrian crossings by removing parking and overgrown vegetation.	Include a pedestrian safety visibility review as part of all PBOT capital projects, paving projects, and development review.
	Remove parking and vegetation as needed for safe crossings as part of capital and paving projects.
	Remove parking at priority crosswalk approaches for uncontrolled crossings on at least three HCN streets each year.
Prioritize street lighting investment where the HCN, pedestrian districts, low-income	In 2019, add street lighting to SE Division Street, including pedestrian scale lighting at certain marked crossings.

Objective	Commitment
Strategy: Protect Pedestrians	
populations, and communities of color overlap.	In 2020, add street lighting to SE Stark Street, including pedestrian scale lighting at certain marked crossings.
	By 2021, develop functional lighting layouts for wide HCN streets in East Portland.
	Develop a funding strategy to advance these lighting plans.
Fill crossing gaps to reduce mid-block crashes.	Ensure all new PBOT capital projects meet Portland's pedestrian spacing guidelines.
	By 2021, increase by 10% the HCN streets that meet Portland's pedestrian spacing guidelines.
	Identify funding to accelerate to 80% HCN streets that meet spacing guidelines within 5 years.
Protect people from heavy truck injuries by installing side guards and other safety measures on City-owned and City-contracted trucks.	In 2019, retrofit eligible City heavy truck fleet with side guards.
	In 2020, advance a policy requiring all City-owned and City-contracted trucks to have safety measures in place (side guards, mirrors, cameras, and training).

Table 6. Objectives and commitments to address Vision Zero Strategy: reducing speeds Citywide (City of Portland & Portland Bureau of Transportation, 2019).

Objective	Commitment
Strategy: Reduce Speeds Citywide	
Set safe speed limits	Consistently and aggressively reduce speeds on city-owned streets until safe speed limits are established citywide.
	Gain local authority for setting speed limits on City of Portland streets.
Redesign dangerous streets to encourage safe speeds	All new HCN capital projects will include project components that help achieve safe speeds.
Educate Portlanders about the impact of speed	Re-run the citywide Struck speed campaign in 2019 and 2020 to remind people of the life-changing impact of crashes.
	In 2019 and 2020, work with agency and community partners to create location-based, community-oriented safe speed campaigns that leverage Struck messaging.
Enforce the speed limit	In 2020, add at least four speed safety cameras or dual red-light running/speed safety cameras to Portland streets.
	Add to City's legislative agenda a change in type of citation issued for automated enforcement tickets from moving violations to civil fines, which can reduce the burden of a citation while still supporting safe travel behaviors.

Table 7. Objectives and commitments by the City of Portland to address the Vision Zero strategy of designing streets to protect human lives (City of Portland & Portland Bureau of Transportation, 2019).

Objective	Commitment
Strategy: Design Streets to Protect Human Lives	
Transform wide, fast streets into streets that are safer for all modes.	In 2019, deliver corridor-wide safety projects on the following HCN streets: • NE 102nd Avenue (NE Weidler to NE Sandy) • NE Glisan Street (NE 122nd to NE 162nd) • NE Marine Drive (NE 33rd to NE 185th) • SE Foster Street (SE 50th to SE 90th)
	In 2020, deliver corridor-wide safety projects on the following HCN streets: • SE Division Street (SE 80th to SE 174th) • SE/NE 122nd Avenue (SE Foster Road to NE Marine Drive) • SW Capitol Highway (SW Garden Home Road to SW Taylors Ferry • SW Huber Street to SW Kerr Parkway
	In 2021, complete concept design plans for all HCN streets.
Pilot rapid-response installations to slow left turns and prevent pedestrian crashes.	In 2019, pilot left turn calming treatments at 40 signalized intersections and evaluate their effectiveness in slowing speeds to reduce the number and severity of crashes.
	In 2020, expand left turn calming treatments if evaluation shows they are effective.
	In 2020, identify the next rapid-response treatment to systemically address pedestrian crashes.
Evaluate deadly crash sites to identify rapid response opportunities.	After every fatal crash, evaluate crash factors, determine whether immediate safety improvements are needed, and identify whether a plan (and/or funding) is in place to address the site.
	Where feasible, put swift, temporary traffic, and operational changes in place.

Table 8. Objectives and commitments by the City of Portland to address the Vision Zero strategy of creating a culture of shared responsibility (City of Portland & Portland Bureau of Transportation, 2019).

Objective	Commitment
Strategy: Create a Culture of Shared Responsibility	
Mark the locations of tragic deadly crashes and raise public awareness of the importance of driving safely.	After every deadly crash, PBOT will install prominent electronic Variable Message Signs at the crash location on City streets.
Deploy community-based Street Teams to share safe travel tips and engage with people on Portland's HCN streets.	In coordination with community partners, conduct at least six Street Team events each year on the HCN to educate Portlanders about safe travel.
	Focus Street Team events on communities of color and low-income communities.
Improve driver stopping compliance for pedestrians at crosswalks.	In partnership with Portland Police Bureau Traffic Division, conduct monthly crosswalk education and enforcement actions with a focus on HCN streets.

Performance Measures

Performance measures were initially outlined in the 2016 Vision Zero Action Plan. Action specific performance measures were outlined by area, including Street Design, Impairment, Speed, Dangerous Behaviors, Engagement and Accountability. Overall performance measures outlined for the program were:

- Number of people killed and seriously injured in traffic crashes in the City of Portland, disaggregated by mode, age, and geography, compared to prior years.
- Whether funding is secured from new local, regional, or state sources for implementation of Vision Zero actions.
- Amount of Vision Zero infrastructure investment citywide and in Communities of Concern (City of Portland & Portland Bureau of Transportation, 2016).

In 2022, the city of Portland published a document detailing Vision Zero action plan performance measures for the 2021 calendar year. This report provides an action description, performance measure, the 2021 data, and data details on each of the action goals outlined in the action plan. For example, the City of Portland set out to gain local authority for setting safe speed limits, with a specific focus on streets identified within the HCN. Action progress indicates 75% completion of this goal through supporting successful legislation in 2021 allows the City of Portland to delegate speed limits. Over the course of 2021, PBOT reduced the speed limit on 31 segments from 27 different streets. Portland's action plan set out to track the Vision Zero infrastructure investments year by year and to also track infrastructure investment in communities of color and low-income communities. During 2021, the City of Portland invested $47.9 million citywide in Vision Zero infrastructure. Of this, $43.5 million dollars were invested in low-income neighborhoods and communities of color. Data details mention that low-income communities and communities of color are identified using the PBOT Equity Matrix to select areas with a combined score of 7 or greater (Portland Bureau of Transportation, 2022).

The City of Portland published a crash report that details the number of fatalities and serious injuries on Portland's streets during 2021. Data reported compares the 2020–2021 timeframe to the past years that the Vision Zero framework was in place (2017–2019). Of all traffic deaths, 76% occurred in areas of Portland with a High Equity Matrix score. Crash fatality data also showed that houseless community members and members of the Black, Indigenous, or People of Color (BIPOC) community were overrepresented during 2021. PBOT identified that 9.5% of traffic fatality victims were black community members and 11.1% were Latinx community members; however, black residents only comprised 5.8% of the total population and Latinx residents only accounted for 9.7% of the population. Both comparisons highlight an overrepresentation of BIPOC community members in traffic fatality statistics. PBOT also discovered that houseless members of the community were a large majority of the pedestrian fatalities. In 2021, 70% (19 out of 27) of all pedestrian fatalities involving a car were members of the city's houseless community.

Overall, 33% (21 out of 63) of all traffic deaths were identified as members of Portland's houseless community. Previously, the city had not tracked the rate of incidence for traffic fatalities amongst the houseless community. Portland plans to track houseless crash numbers in the future and address this problem, as 70% of pedestrian deaths is an alarmingly high number. Factors contributing to the overrepresentation of houseless community members among traffic fatalities are lack of shelter, lack of medical care, and a lack of social services. PBOT has extended its Vision Zero partnerships to include the Multnomah County's Public Health Department and the Homeless Urban Camp Reduction Program (among other services) to take steps towards making the streets safer for some of the most vulnerable members of Portland's community (City of Portland & Portland Bureau of Transportation, 2022).

Equity Matrix

Throughout the years, Portland has used different equity measurements across various programs and projects with varying results and outcomes. The Vision Zero program used a performance measure combining 10 different demographic measures into one index value. This measure is used in all Vision Zero action plans for the city of Portland. Both the LED streetlight conversion and the transportation system plan projects used matrices derived from the four demographic variables of race, income, elderly population, and youth population. The safe routes to school PBOT program developed an equity matrix based on race and ethnicity, income, and limited English proficiency. This matrix became the basis for PBOT's current equity matrix, which the safe routes to school team uses.

Figure 37 shows one application of Portland's current equity matrix in use. The equity matrix uses a combined index score that is formed by adding together the race and ethnicity scale score with the income score. Race and ethnicity are measured from census data and each area of Portland is assigned a score from 1–5. A higher score indicates a larger Latinx and persons of color population than a lower score. Income is also ranked 1–5 based on the reported median income level from the latest census. The two scores are then combined into the final equity index, where the minimum score would be 2 and the highest possible score would be 10. Areas with higher combined scores would have a combination of low median household income and high populations of Latinx and BIPOC community members. Figure 38 shows an example of the tool tip details provided for each geographic region in Portland. The example shown is of an area

with the lowest possible combined index score, meaning the area has a high median income level and low population of Latinx and BIPOCs (Portland Bureau of Transportation, n.d.).

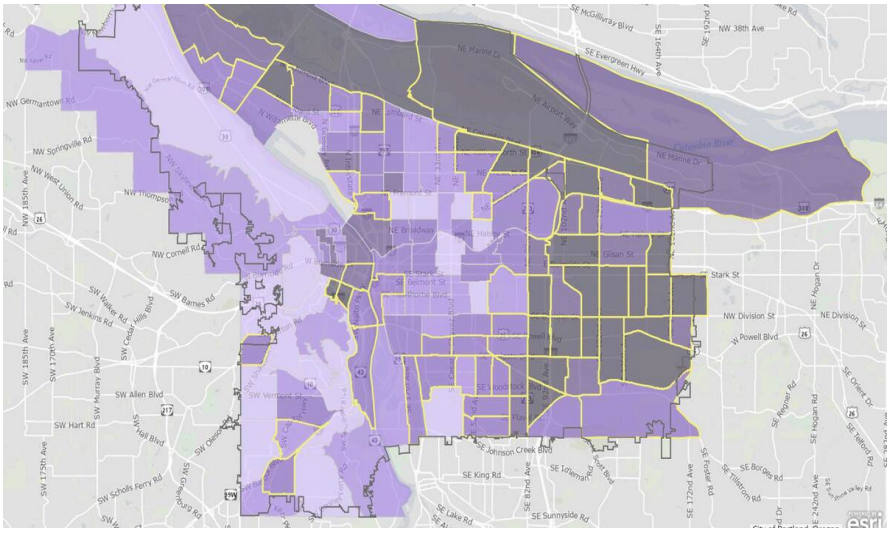


Figure 37. Map. Portland's Equity Matrix interactive map. Darker shades of purple indicate a higher combined index score. Yellow outlined areas indicate a community identified as limited English proficiency (Portland Bureau of Transportation, n.d.).

Figure 38. Map scale and tool tip. Portland's Equity Matrix combined index score scale and tool tip details shown for each shaded are on the interactive map in Figure 37 (Portland Bureau of Transportation, n.d.).

Summary

Portland's approach was outlined in their vision Zero Action plan with the objective of eliminating deaths and serious injury by 2025 through prioritizing infrastructure investments on the most dangerous streets located in Portland's underserved communities. To identify and prioritize underserved communities for implementation, crash data was combined with equity

data from multiple sources. Equity data was assessed using a rating index to identify Communities of Concern while an HCN was compiled using crash data adjusted by traffic volume. These data sources were overlaid to create a visualization tool for prioritizing safety investments.

In conjunction with Vision Zero objectives, Portland released an Equity Matrix tool. Additionally, the HCN was used to inform investment strategies, resulting in a minimum 49% of investments made in low-income communities and communities of color in the 3 years since the program's inception. Speed limits were reduced on 59 non-residential streets as well as on a large network of residential roads. Eight speed safety cameras were installed on four of the most dangerous streets in the HCN, resulting in further reduction in speeding violations.

CHAPTER 3. GIS-BASED EQUITY ANALYSIS

TASK PURPOSE AND DATA SOURCES

To demonstrate the data sources and a framework for equity in transportation, a number of sample datasets for the state of Virginia in a GIS platform were reviewed. Due to the amount of data and the large variety of data sources available, this task was primarily intended to illustrate the types of equity-relevant questions that such data can answer. To illustrate the data availability and the potential power of a GIS-based equity analysis framework, the research team assembled the following datasets in the Esri® ArcGIS™ platform:

- **Demographic, health, and income data:**
  - *American Community Survey (ACS) data.* The research team downloaded 2015–2019 5-year ACS estimates at the Census tract level for Virginia demographic and related information. Based on the ACS data, the team calculated poverty information, education information, and racial/ethnicity information for demonstration during this analysis.

    The ACS data included 29 sections describing detailed demographic information such as race, age, gender, citizenship, and migration; income and poverty-related information; household member relationship information; health-related information; education and related information; voting status; veteran status; and computer/internet usage, among others.

    The original ACS data was downloaded as part of the TIGER/Line file with detailed data tables (each table corresponds to a specific data section) provided along with a Census tract feature class. Data tables frequently required special treatment to reduce the large number of data fields to be processed/viewed correctly. The census uses a code structure for the data fields with a lookup table provided for decoding. To process the information required, the project team first identified the ACS data sections of interest, and then identified the specific data fields that needed to be used for calculating the equity-related measures from the ACS lookup table.

  - *Virginia Health Opportunity Index (HOI).* The Virginia HOI is a group of indicators relevant to the health and well-being of Virginians. The index reflects 13 indicators combined from over 30 variables measuring community environment, consumer opportunity, economic opportunity, and wellness disparity.

- **Virginia Department of Transportation (VDOT) statewide crashes:**
  - The project team obtained 2013–2020 VDOT statewide crash data for the purposes of this project. During the demonstration, the team used crash data spanning a 2-year period from 2019–2020.

- **Transportation Investment Data:**
    - *VDOT systemic safety improvement projects.* VDOT has published detailed information such as location for eight systemic safety countermeasures that have been implemented or are planned for statewide implementation as part of the Department's HSIP. The countermeasures include flashing yellow arrows, high-visibility signal backplates, pedestrian crossing improvements, centerline and edge line rumble strips, curve delineation treatments, unsignalized intersection improvements, and safety wedges. The safety treatments were widely used to address safety issues at intersections, for pedestrians and bicycles, and on rural two-lane roadways.

    - *VDOT bicycle and pedestrian facility inventory.* This dataset includes bicycle and pedestrian accommodations and facilities from the statewide bicycle and pedestrian inventory, including shared use paths, bicycle lanes, shared lanes, and paved shoulders.

GIS-BASED FRAMEWORK DEMONSTRATION

The aforementioned datasets were processed into a GIS format and assembled as different layers into one map platform in ArcGIS. This GIS data package allowed the following:

- Visualization of demographic, transportation investment, transportation facilities, health, safety, and other related data in a geospatial format.
- Visual assessment of spatial correlations between transportation infrastructure, safety, health data and demographic and demographically related data.
- Spatial integration of equity-related datasets from different sources.

The datasets included in this demonstration and other data sources available provide a framework for endless opportunities to answer questions related to equity, such as how transportation investments are located with regard to low-income populations, how traffic crashes are distributed among neighborhoods of different education levels, and how well citizens below the poverty level can access the transportation system safely and efficiently.

To illustrate the capabilities of the GIS-based equity analysis framework, the research teams created a number of sample maps overlaying different data layers at a different zoom level. For example, Figure 39 and Figure 40 illustrate the locations of transportation safety improvements, bicycle and pedestrian facilities, and crashes in relation to poverty levels by census tracts. These figures provide an opportunity to understand if the transportation projects, facilities, and crashes are located evenly across all areas regardless of poverty levels.

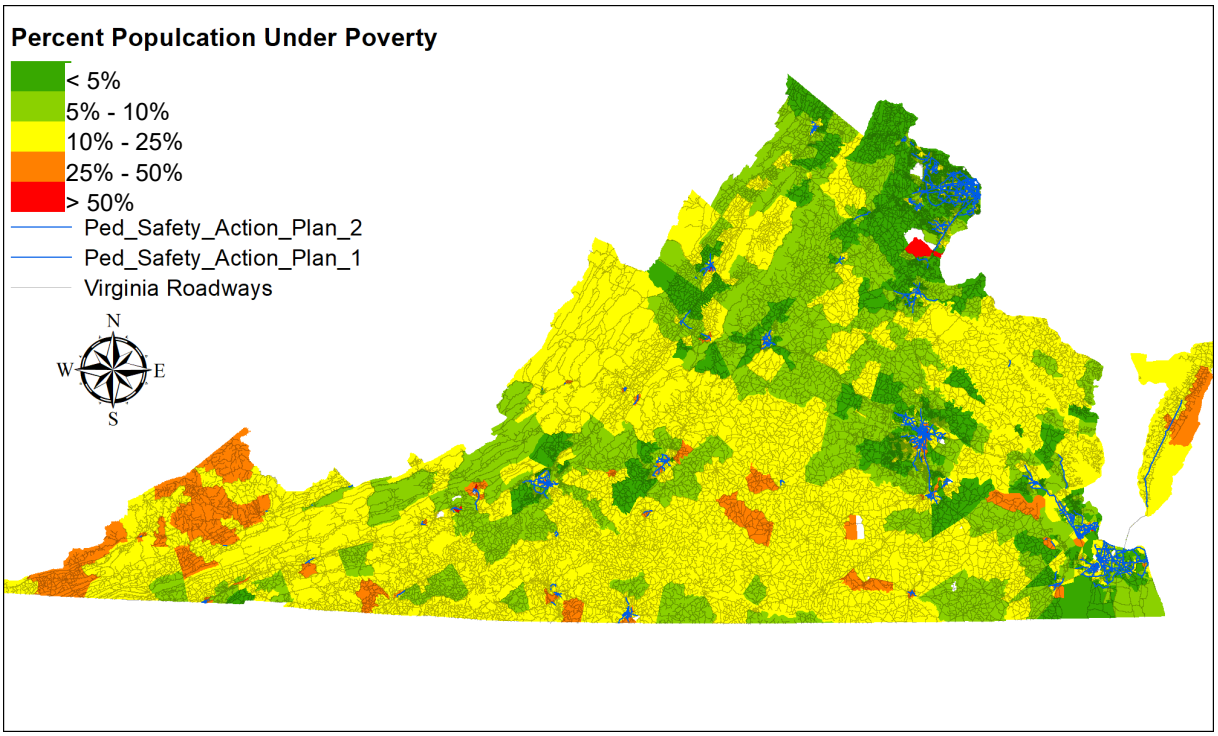


Figure 39. Map. VDOT pedestrian safety improvement corridors and percent of population under poverty.

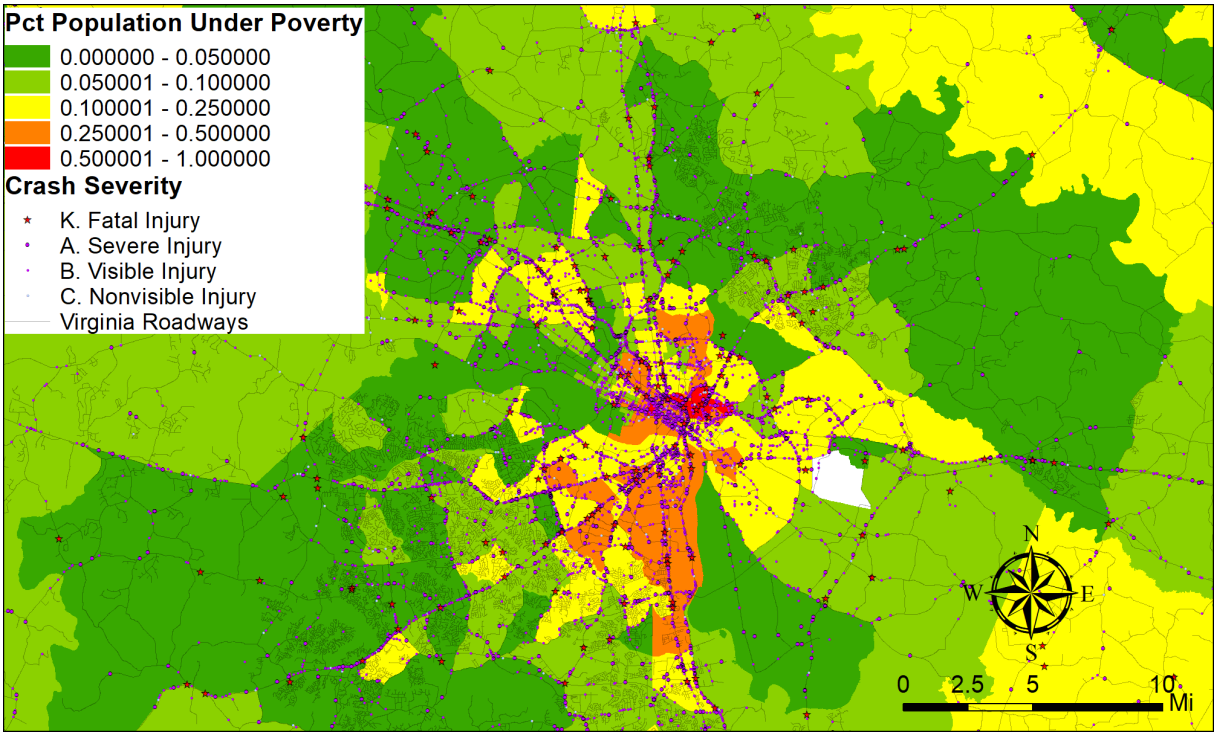


Figure 40. Map. VDOT fatal and injury crashes and percent of population under poverty in the Richmond region.

Crashes, as well as bicycle and pedestrian crashes, were analyzed with the background color coded by the percentage of underserved population at the census tract level in Figure 41 and Figure 42. For this analysis, the underserved population included Hispanic, African American, and AIAN populations. The figures illustrate the idea that, by overlaying transportation investments and crashes with the underserved population distribution, analysts may identify opportunities where transportation improvements can be implemented at neighborhoods to better serve such populations.

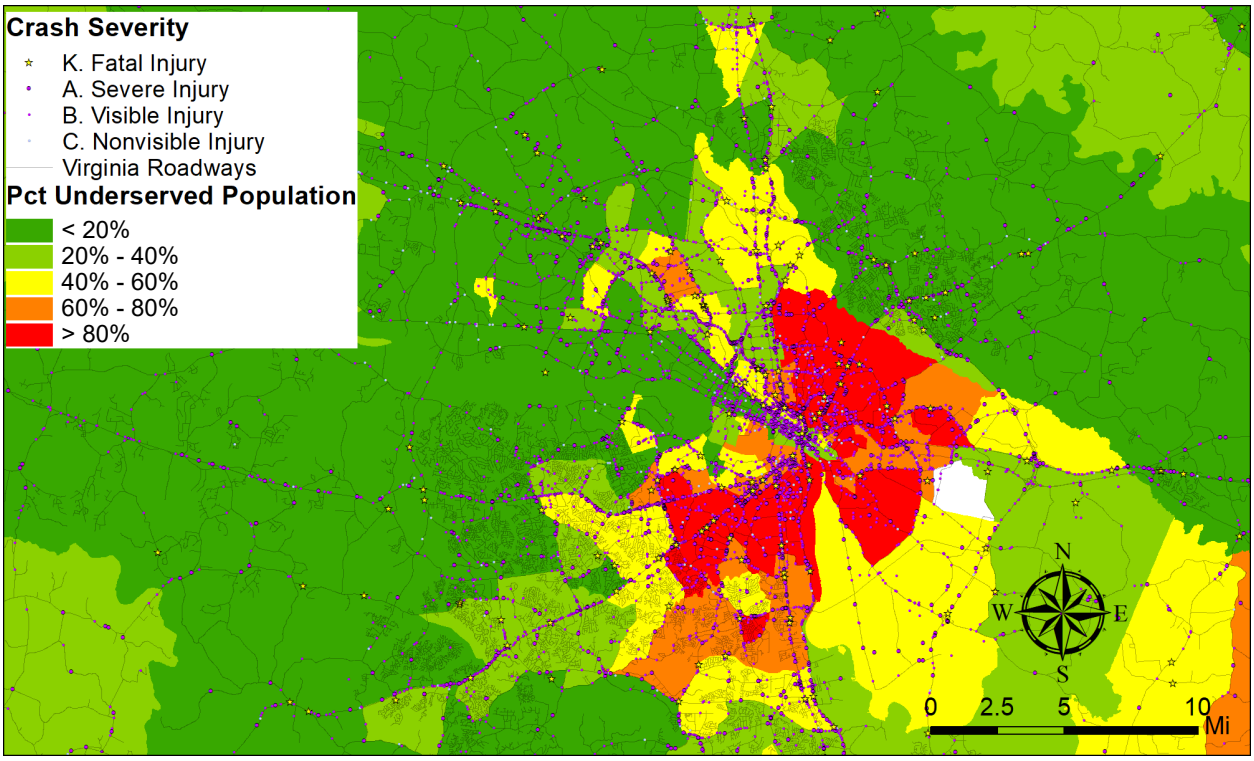


Figure 41. Map. VDOT fatal and injury crashes and percent of underserved populations in the Richmond region.

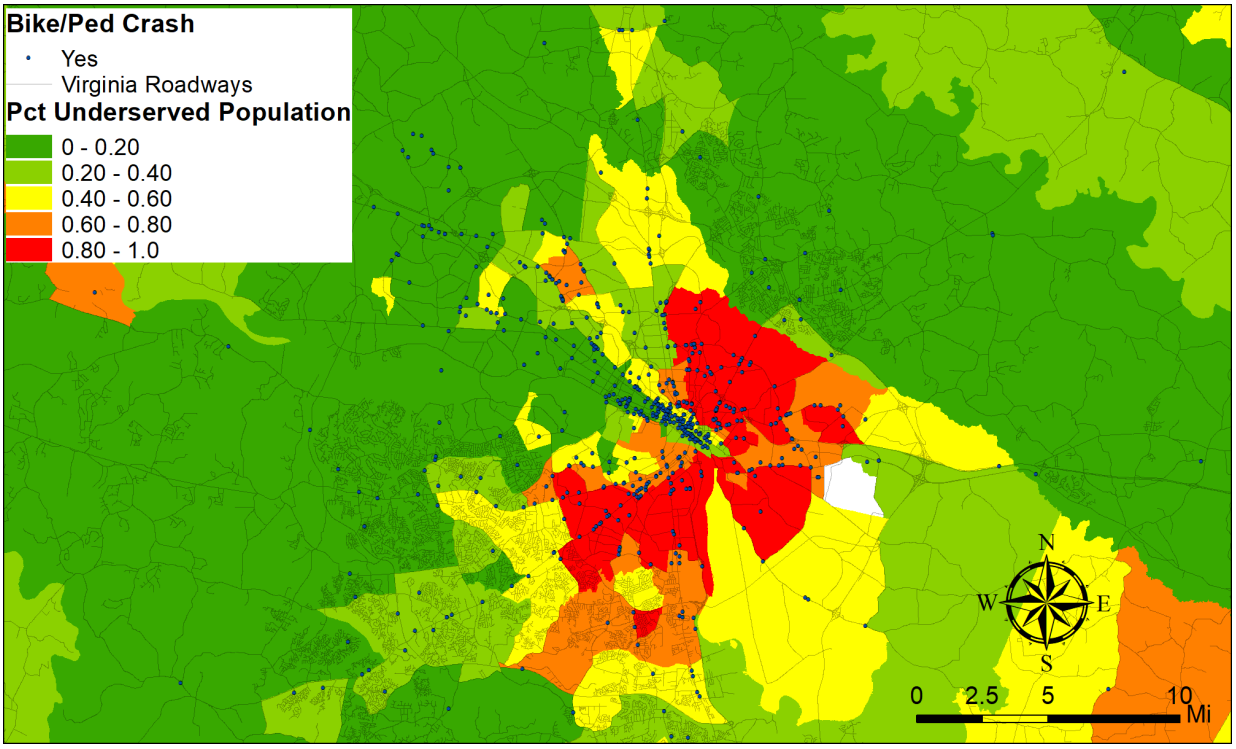


Figure 42. Map. VDOT bicycle and pedestrian crashes and percent of underserved populations in the Richmond region.

Figure 43 and Figure 44 show sample maps overlaying bike/ped facilities, crashes, and VDOT safety improvement projects with ACS vehicle ownership data for the northern Virginia region. Vehicle ownership data shows the areas where a larger proportion of households do not have access to private vehicles and therefore must rely on alternate modes of transportation. Neighborhoods with low vehicle ownership, therefore, may need special attention when considering safety and other transportation-related investments.

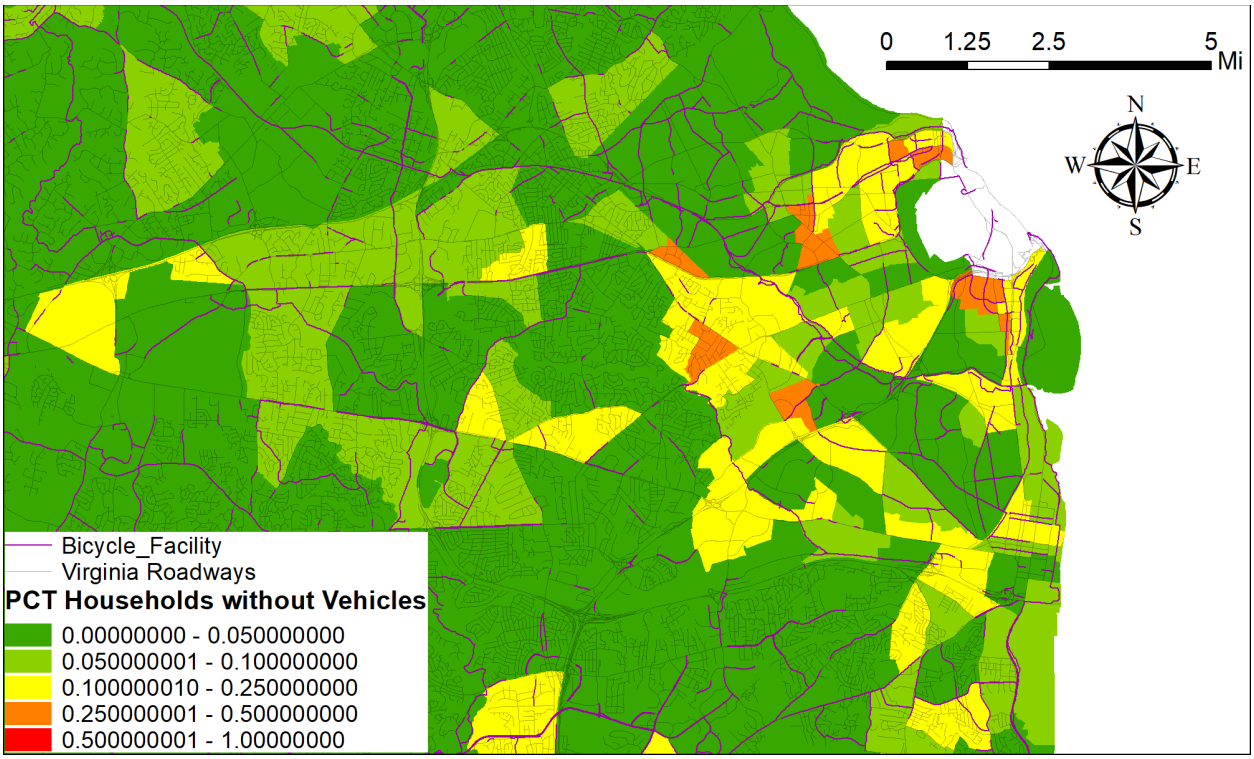


Figure 43. Map. VDOT bicycle facilities and percent of households without vehicles in Northern Virginia.

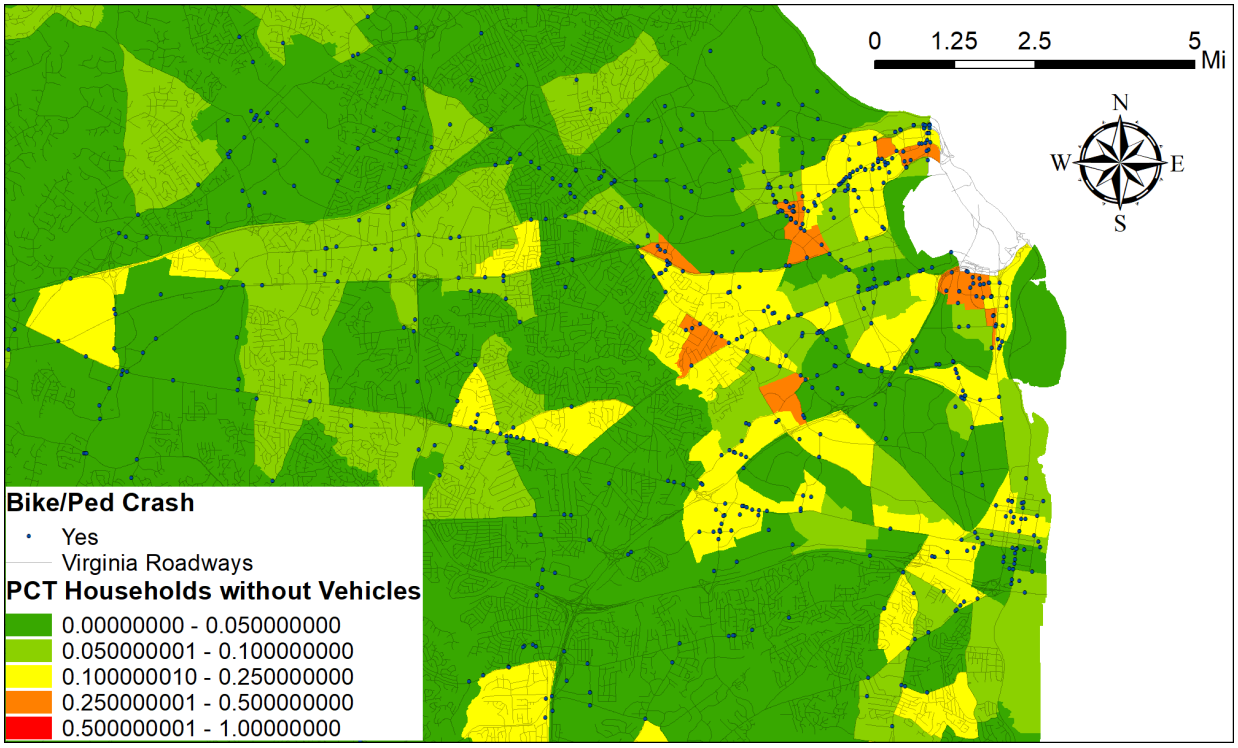


Figure 44. Map. VDOT bicycle and pedestrian crashes and percent of households without vehicles in Northern Virginia.

CHAPTER 4. CONCLUSIONS AND FRAMEWORK

DISCUSSION

The FHWA recommends collaborating with underserved communities to incorporate equity into roadway safety through collecting and analyzing data, engaging community representatives, implementing improvements, and evaluating impacts (U.S. Department of Transportation, 2023e).

"Data-driven safety analysis is key to the safe system approach." Incorporating demographic data such as race/ethnicity, gender, age, tribal area with public health data such as income, education, employment status alongside emergency response and medical data has seen many benefits. Integration with crash fatality and serious injury data as well as roadway element data and location data provide insights and opportunities for more robust and equitable analysis considerations. The most effective and equitable approach to data collection is through local and community led processes, such as walk audits, road safety audits, field safety reviews, and health impact assessments (U.S. Department of Transportation, 2023b).

"Public involvement is not an afterthought in the decision-making process, but rather a core tenet for agencies, organizations, partners, and individuals who work to evaluate, plan, prioritize, design, construct, and maintain transportation improvements and investments." Transportation professionals must work to reduce barriers to participation in outreach activities. An example of this can be recognizing limitations of in-person public meetings for underserved populations. Work should be done to reach populations through multiple avenues such as virtual, print, and digital distribution; factors such as spoken language and access for disabled populations should be considered. It is important to build trust and engage with underserved populations using a variety of public involvement techniques with the goal of understanding transportation needs and encouraging participation in decision-making processes. This can occur through meaningful public involvement as outlined in Figure 45 (U.S. Department of Transportation, 2023d).

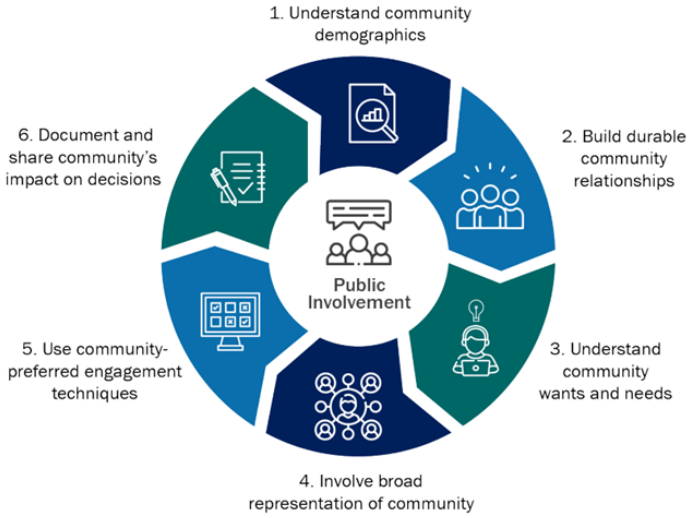


Figure 45. Circle chart. Features of meaningful public involvement (U.S. Department of Transportation, 2023d).

Improvements should be strategically considered and implemented with the goal of eliminating the disparities in crash fatalities and serious injuries. “To create a safe and equitable transportation network, transportation funding programs should prioritize safety and focus on underserved communities.” Investments should be distributed to allow for improvements in the health and living conditions for those with “fewer resources and those who face exclusion and discrimination – on the basis of race, gender, age, disability, or income.”

Recommendations include:

- “Prioritizing equity factors in project prioritization.”
- “Assessing how certain criteria, such as local matching of state funding or complaint-based repairs, may unintentionally exclude underserved communities and widen disparities.”
- “Providing additional resources, including capacity building and safety study funding, to underserved communities.”
- “Linking transportation safety investments with housing and land use policies to actively prevent unintended consequences such as displacement of local residents and businesses.”
- “Developing and revising policies, processes, guidelines, and plans based on the equitable data analysis and public engagement processes.”
- “Collaborating with public health professionals” (U.S. Department of Transportation, 2023g).

Impacts should be evaluated by obtaining metrics before, during, and after implementation efforts to ensure the planned outcomes are achieved for the target communities. Safety metrics should include crash fatality and serious injury data, safety surrogate variables such as behavioral data and vulnerable road user data, and community perceptions through surveys, road safety audits, etc. Accessibility and mobility metrics are important to consider and include such things as increases in non-motor transit, effective routing for transit, and disability access for pedestrian facilities and curbs. Health impact metrics such as hospital data, emergency response, noise and sound pollution, and air quality are additional metrics to characterize the data (U.S. Department of Transportation, 2023f).

CHALLENGES

The Urban Institute reviewed four case studies of metropolitan regions in Seattle, Lansing, Baltimore, and Nashville. The goal of the review was to “better understand how different types of regions understand and measure transportation equity and the barriers they face to providing equitable transportation.” These regions were selected based on five factors aiming to provide diverse contexts for “addressing access to opportunity through transportation.” As part of the effort, transportation leaders such as government officials and transit authorities, as well as community groups and advocates, were interviewed. The criteria for selection and data for selected regions are outlined in Table 9.

Table 9. Case study metro areas (Stacy et al., 2020).

MSA	Population	Unemployment Rate	Sprawl	Racial Segregation	Census Region
Seattle-Tacoma-Bellevue, WA	Large	Low	Fairly dense	Low	West
Baltimore-Columbia-Towson, MD	Large	High	Fairly dense	High	Northeast
Lansing-East Lansing, MI	Small	High	Middle	High	Midwest
Nashville-Davidson-Murfreesboro-Franklin, TN	Large	Low	Sprawling	Low	South

"Metropolitan regions lack a shared definition of transportation equity. This creates competing priorities between transportation leaders, planners, politicians, and advocates." Despite this theme, common challenges were recognized. Equity across travel modes was identified, including access for all citizens, that is also equitable across modes with similar travel times and without cost-prohibitive practices. Another challenge is quality across modes, including reliability, safety, cost, time of day restrictions, and frequency of transfers within and across travel modes. Regional factors create varying transportation needs and outcomes, such as the feasibility of public transit in rural areas and the limitations of individual car use in urban areas (Stacy et al., 2020).

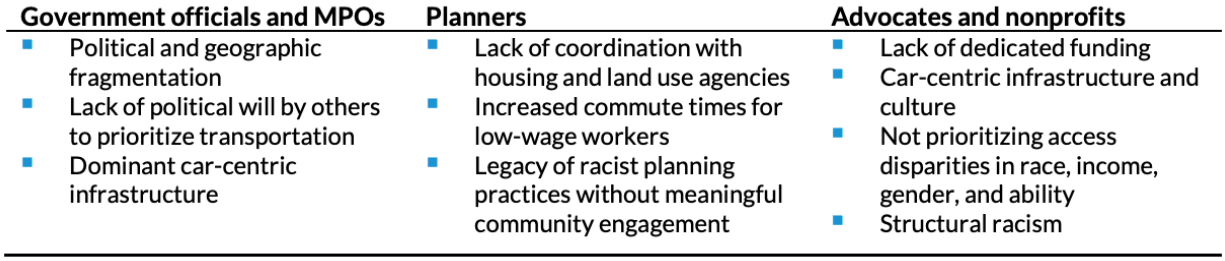


Figure 46. Graphic list. Most frequently cited barriers to ensuring equitable access to transportation (Stacy et al., 2020).

Transportation equity housing and land-use coordination requires coordination across jurisdictions and entities. There are multiple agencies responsible for different elements of the planning and maintenance of transportation systems. Researchers provide an example of addressing ADA concerns in relation to public sidewalks where the City Department of Transportation works to ensure compliance of homeowners while the Transit Authority maintains bus stops. Compliance across the region requires efforts from both entities who may have varying resources and priorities.

Another key aspect is the interconnected aspect of housing, transportation, and land use. "Decisions to expand transportation networks and increase housing density can unintentionally lead to gentrification and the displacement of the most transit-dependent residents." Additionally, transportation for individuals in rural areas has been challenging to address and is "often overlooked" in allocating resources. Coordination between agencies and priorities is needed to reduce these disparities.

Uncertain, unstable, and inadequate funding was frequently cited as a challenge to implementing equitable transportation solutions. A decline in federal grants requires state and local governments to allocate funding for projects and can impede long-term planning. For example, taxes on gas are used to operate and maintain public transit; however, this funding source can be unstable, resulting in systems without funding for continued use and maintenance (Stacy et al., 2020).

FRAMEWORK

Across the case studies and materials reviewed, themes emerged around practices commonly utilized to address equity in transportation. Integrating crash data with demographic and public health data from multiple sources was a common approach. Action plans publishing initial analysis from this perspective incited the creation of tools further visualizing areas for implementing improvements. These tools, along with rating systems, have been further utilized to evaluate proposed solutions. A common goal for these action plans is public outreach alongside aggregated data, as well as an iterative review of action plan objectives. States have released updates to their plans that include a performance review in 2-year intervals along with documented efforts conducted during the review period.

Planning, selecting, and prioritizing safety-related projects under an equity lens is a very involved process that can easily be underestimated. Approaches to project evaluation in terms of the negative impact that they will have in the affected community can result in measures to avoid the project or mitigation measures to reduce the problem. To incorporate safety equity, a focus on the benefit for underserved populations and specifically how the project can reduce existing inequities should be highlighted. Performance measures should be developed to ensure projects that will advance equity goals are ranked appropriately in relation to other projects targeting improvements at high crash locations.

The framework represents a roadmap of the elements to define and include to incorporate equity in safety project selection and prioritization. It is expected that this framework can serve as a guide to be modified for specific use while also being general enough that effective and equitable safety improvements can be made. The framework consists of several steps to be taken with several possible options that can be considered. Different approaches may be taken for the same type of project in different areas or using a different type of funding.

The intention of this framework is to have agency stakeholders align to work together towards the same objective. It is important to evaluate goals during the project selection and prioritization process. The framework defined is focused on safety projects but can be used to address inequities in other types of projects. In addition, it is possible that one project can contribute to the reduction of diverse types of inequities. As an example, building bicycle lanes will result in a reduction of crashes but also in an improvement in mobility and increased access to different modes of transportation in underserved populations. In addition, a bicycle lanes project will not only contribute to transportation equity but also to health equity.

As mentioned before, some agencies have incorporated an equity index that includes different variables. As an example, VDOT incorporates households with zero vehicle ownership, transit proximity, and the state's health opportunity index, which consists of over 30 variables that are

grouped into 13 indicators and four profiles. However, an equity index such as VDOT's can be useful and controversial at the same time. Such an index is useful because it allows agencies to consider different equity indicators for the same project and has the potential to be applicable for comparing different project areas (e.g., for congestion and safety). However, using an equity index can also dilute the real impact of specific safety projects, making the actual safety equity impacts less directly measurable for specific populations.

Step 1. Identify Agency Equity Goals

The first step of the framework is to select or identify agency equity goals. In this step, the goal can be very general, like "working to reduce inequalities;" however, it will be necessary to define subgoals to identify countermeasures and evaluation techniques

Step 2. Identify Underserved Populations

The identification of underserved populations can be done by the agency or can be imposed by law/executive order (based on funding). Similar to Step 1, the agency can include here all the underserved populations that they are planning to serve. As an example, the agency could define the underserved population as minorities or as school age children of minority populations. This step will also be used to analyze the inequities, which will be the basis of the project selection or prioritization. For example, equity emphasis areas were the focus of the RRTPO's equity analysis, where six indicators of disadvantage are considered and form an index to identify Communities of Concern (Aryal et al., 2021).

Step 3. Compute for Each Block the Underserved Population

Using the ACS, compute for each block the percentage of the different underserved populations. The population served can be a combined index of different populations. This method has been used nationally for programs like the Justice40 Initiative, which aims to deliver 40% of the overall benefits of federal investments in climate and clean energy, including sustainable transportation, to disadvantaged communities (Biden, n.d.).

As an example, Williams and Golub (2017) define Communities of Concern as follows:

- A low to moderate concentration of [Communities of Concern] is any block group with one or two of the underserved populations that exceed the countywide average by one standard deviation.
- A high concentration [Communities of Concern] is any block group with three types of underserved populations that exceeds the countywide average by one standard deviation.

Notice that the threshold values can vary by region. As such, the threshold values for a state, for example, can be different for different districts. After each block is classified based on the Communities of Concern criteria, each project is assigned a 1 or a 2 if the project serves a low or high concentration of Communities of Concern respectively.

Step 4. Integrate Demographic and Public Health Data with Crash Data

Utilized by many jurisdictions, this approach provides insight into crash data as it relates to equity data. This approach was used in Richmond to cross HOI data with High Injury Street Network data, and was also used in Portland to cross HCN data with Communities of Concern data, both highlighting regions for project prioritization.

Step 5. Weight the Different Projects Based on Impact

The impact of the project can be evaluated with indicators or weight values defined by the agency. These values will be multiplied by the index defined in Step 3. As a result, all projects can be ranked and prioritized. Notice that this prioritization uses any of the indicators used for safety equity. We can therefore give points to any of those indicators; for example, we can estimate the reduction in crashes and based on the computed BCA and use it as a weight. In general, each project is a combination of countermeasures, so we can give weight to different impacts.

VDOT's SMART Portal also evaluates each project on key factors, including improved safety, reduced congestion, increased accessibility, contribution to economic development, promotion of efficient land use, and effect on the environment. The anticipated benefits in each area are calculated and the projects are scored and ranked. This information is used to help guide and inform VDOT's project selection decision. These indicators were established based on six guiding principles:

1. Analyze what matters to people and has a meaningful impact.
2. Ensure fair and accurate benefit-cost analysis.
3. Be both transparent and understandable.
4. Work for both urban and rural areas.
5. Work for all modes of transportation.
6. Minimize overlap between measures.

For safety, the SMART scale uses two measures to consider the impact of the project based on the equivalent property damage only (EPDO) of crashes and assigns weight to each of these measures.

- EPDO of fatal and injury crashes – Weight 70%
- EPDO rate of fatal and injury crashes based on vehicle miles traveled – Weight 30%

Based on consultation with all stakeholders, the Transportation Board establishes key weight factors that are used for project selection, and which vary by different regions (Virginia Department of Transportation, n.d.-b).

APPENDIX A. EQUITY IN SAFETY ANALYSIS TOOLS

Table 10. Equity in safety analysis tools.

State	Name	Link
Virginia	Pedestrian Safety Action Plan (PSAP) Map Viewer (Virginia Department of Transportation, n.d.-a)	https://vdot.maps.arcgis.com/apps/webappviewer/index.html?id=02a155fedefa4e71bdb8c0cf524b636f
Virginia	Virginia Health Opportunity Index Dashboards (Virginia Department of Health, n.d.)	https://apps.vdh.virginia.gov/omhhe/hoi/dashboards/counties
Richmond	Vision Zero Dashboard (City of Richmond, n.d.)	https://cor.maps.arcgis.com/apps/dashboards/e6097a6342f148ce912ba98e04551e70
Portland	PBOT Equity Matrix (Portland Bureau of Transportation, n.d.)	https://pdx.maps.arcgis.com/apps/MapSeries/index.html?appid=ba500ae0b9554fc68104a2ff016e25fc
Minnesota	Priority Areas for Walking (PAWS) Dashboard (MnDOT, n.d.-a)	https://mndot.maps.arcgis.com/apps/View/index.html?appid=1cc55aa66d3844a98402c84673f73d14
Minnesota	SPACE Dashboard (MnDOT, n.d.-b)	https://www.arcgis.com/apps/mapviewer/index.html?layers=ccff5ac262cf4bcda7a493cdd8b4dfdc
Minnesota	STEPP Tool (MnDOT, n.d.-c)	https://www.arcgis.com/home/item.html?id=86fad0193aa94b37863110304ca60e72
California	SHSP Crash Data Dashboard (Caltrans, n.d.-a)	https://shsp.dot.ca.gov/
California	VRU Safety Assessment (Caltrans, n.d.-b)	https://storymaps.arcgis.com/stories/258aaa04966444c5bdc9d689c31fc17f
San Francisco	Equity Priority Communities Dashboard (San Francisco Transportation Authority, n.d.)	https://epc-map.sfcta.org/

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