Introduction

In May 2021, the County Board approved the Vision Zero Action Plan, which details a comprehensive and holistic approach to eliminating traffic fatalities and serious injuries in the County. The Vision Zero Action Plan recommends an annual analysis of traffic crash data, including a "systemic" review to identify common factors and trends across crash data that can assist with holistically addressing and preventing common crash factors.

This 2016-2020 systemic crash evaluation methodology builds on Arlington County's prior systemic crash assessment (covering 2017-2019 data) and latest crash hot spot analysis (covering 2016-2020 data). The County's prior systemic assessment investigated factors related to critical (serious or fatal) crashes to identify major crash types of concern, and the hot spot analysis identified relatively high crash locations based on reported crash data. This systemic analysis builds from both of these assessments, extending them by introducing contextual variables—roadway-related, built environment-related, and socioeconomic—that may be influencing the types and locations of crashes that have occurred, or may occur, across Arlington County.

When patterns emerge among certain types of crashes and roadway or built environment factors, we can use these patterns to identify locations with similar characteristics that may be at risk for certain crash types, even though few or no crashes have been reported. Introducing socioeconomic data lends to an equity-driven approach that can help answer whether crashes disproportionately affect certain racial, economic, or geographic segments of the community.

This memorandum provides a summary of (1) the data parameters and the methodology used to assess and identify common crash risk factors ("crash profiles"), (2) the resulting crash profiles for both equity-focused and Countywide geographies, (3) a plan for assessing opportunities for potential improvements to address systemic risks, and (4) lessons learned for future geospatial-based systemic analysis.

1. Data Parameters & Analysis Methodology

This 2016-2020 systemic analysis built on the crash dataset utilized in the 2016-2020 hot spot analysis. This dataset is the Full Crash Dataset provided by Virginia Department of Transportation (VDOT), developed in-house by the VDOT Traffic Engineering Division Highway Safety section for crash analysis purpose based on Virginia's Traffic Records Electronic Data System (TREDS). TREDS reports crash data in Arlington from police reports (both local and state police) of crashes that result in injury or over $1,500 in property damage.

The hot spot analysis primed the 2016-2020 crash dataset in the following ways for analysis:

- Classified all crashes as midblock or one of four intersection types (based on number of travel lanes as derived from the County's travel model)
- Disaggregated crashes by mode (vehicle-only, pedestrian-involved, bike-involved)
- Normalized crashes by traffic volumes (to assess the instances of crashes at a location relative to the typical volume of vehicles traveling at that location)
- Weighted crashes by:

    - Non-crash vehicle incident data (e.g. hard braking, speeding)
    - Equity
    - Crash severity
- Resulted in an index used to prioritize crash hotspots

The County's prior systemic analysis investigated factors related to critical (serious or fatal) crashes derived from the categorized and binary response fields in VDOT's crash dataset. The analysis established a more detailed understanding of how crash factors interrelate and the top crash types of concern in the County. This analysis extended the breadth of the previous systemic analysis by using GIS mapping software to associate socioeconomic, roadway, and built environment variables with the same crash dataset used for the hot spot analysis. These contextual variables provide a broader perspective on the transportation and land use factors that may be influencing crash patterns. They also help identify populations in the County who may be disproportionately affected.

Variables analyzed in geospatial relation to the 2016-2020 crash dataset included:

- Travel Modes Involved (vehicle, pedestrian, bike)
- Average Daily Traffic (ADT) Volumes
    - Low: 0 - 14,999 vehicles
    - Medium: 15,000 - 29,999 vehicles
    - High: 30,000+ vehicles
- Posted Speed Limit
    - Low: 15 – 25 MPH
    - Medium: 30 – 35 MPH
    - High: 40 – 45 MPH
- Roadway Type
    - Signalized Intersection (incl. presence of red-light camera)
    - Unsignalized Intersection (incl. presence of all-way stop)
    - Midblock Location (incl. presence of speed humps, sidewalks, RRFBs)
- Pre-Crash Movements (ex. making left turn, making right turn, proceeding straight, etc.)
- Crash Factors (ex. alcohol, senior)
- Crash Types (ex. angle, fixed object, rear end, sideswipe, head on, etc.)
- Vehicle Type (ex. bike, bus, passenger car, motorcycle, pick-up or SUV, tractor truck, etc.)
- Proximity to a Bike Share Station
- Nearby Land Use
    - Within ¼ mile of a school, community facility, park, or hospital
    - Share of residential, commercial, mixed-use, or public uses
- Equity Indicators
    - Low-vehicle access (percentage of households with no vehicle available)
    - Limited English (percentage of population 5 years and older living in limited English-speaking households)
    - Disability status (percentage of population with disability)

- Equity Emphasis Areas - Identified through Arlington Transit's Title VI Requirements for the Federal Transit Administration (FTA). Included Census Block Groups:
    - With a Black, Indigenous, or people of color (BIPOC) population of 38.5% or higher
    - Where 50%+ households have a median income of $50,000 or less (we further refined the Title VI income threshold from 17.5% to 50% of households with a median income of $50,000 or less to prioritize neighborhoods with lower incomes)

The project team joined these contextual variables to the crash dataset. This expanded dataset allowed for the development of a systemic matrix. The Y-axis of this matrix indicated factors related to the crash (including crash type or data related to the parties involved). The X-axis indicated the contextual variables. The cells within the matrix displayed how many times each crash-contextual pattern occurred. This matrix allowed the project team to isolate risk factors that could increase risk across the County, even where no or few crashes have been reported. The project team created two systemic matrices: the first included all reported crashes and the second only included critical crashes (those that resulted in a severe or fatal injury), which allowed for the identification of disproportionalities across fatal or severe crashes.

2. Developing Crash Profiles

Using the systemic matrices, the project team identified combinations of crash factors and contextual variables for which crashes were overrepresented in the dataset. These combinations are titled "crash profiles." The team identified 20 crash profiles: 10 profiles were specific to combinations of crash factors/geographic characteristics common within Equity Emphasis Areas and 10 were combinations of crash factors/geographic characteristics common throughout the entire County.

Each crash profile resulted in a further analysis and map documenting the following aspects:

- Number of incidents, by location, where the crash profile has occurred
- Locations where, based on similar characteristics, the crash profile may be likely to occur
- Crash profile summary statistics
- Potential crash abatement countermeasures (as identified in Arlington's Multimodal Safety Engineering Toolbox)

Equity Emphasis Area Crash Profiles

The project team analyzed crashes within equity emphasis areas separately from total crashes. Dividing total critical crashes within equity emphasis areas by total crashes within equity emphasis areas provided a percentage, where closer to 100% indicates a higher number of critical crashes in the geography. To further understand the significance of each percentage, the team applied the following thresholds: If a percentage was greater than 5% and the total number of crashes was higher than 25 at a given location, then it would be labeled "Yes," and if these thresholds were not met, then it would be labeled "No."

The following crash profiles met the threshold of having greater than 5% share of critical crashes compared to total crashes within equity emphasis areas and more than 25 crashes:

1. Pedestrian-involved crashes within ¼-mile of a community facility

- 68 total crashes (in equity emphasis areas only)
- 12 critical crashes (resulted in fatal or severe injury in equity emphasis areas)
- 12/68 = 18%

2. Pedestrian-involved crashes with motor vehicle proceeding straight in low vehicle access areas
   - 30 total crashes (in equity emphasis areas only)
   - 5 critical crashes
   - 5/30 = 17%
3. Pedestrian-involved crashes within residential areas
   - 43 total crashes (in equity emphasis areas only)
   - 5 critical crashes
   - 5/43 = 12%
4. Senior-involved (60+) crashes within 50 feet of a bus stop or Metrorail station entrance
   - 40 total crashes (in equity emphasis areas only)
   - 4 critical crashes
   - 4/40 = 10%
5. Pedestrian-involved crashes with motor vehicle turning left in low vehicle access areas
   - 26 total crashes (in equity emphasis areas only)
   - 2 critical crashes
   - 2/26 = 8%
6. Left turns in commercial areas
   - 60 total crashes (in equity emphasis areas only)
   - 4 critical crashes
   - 4/60 = 7%
7. Under 19-involved crashes in residential area
   - 30 total crashes (in equity emphasis areas only)
   - 2 critical crashes
   - 2/30 = 7%
8. Alcohol-involved crashes within ¼-mile of a school
   - 30 total crashes (in equity emphasis areas only)
   - 2 critical crashes
   - 2/30 = 7%
9. Alcohol-involved crashes in residential areas
   - 76 total crashes (in equity emphasis areas only)
   - 4 critical crashes
   - 4/76 = 5%
10. Left turns within ¼-mile of a school
    - 57 total crashes (in equity emphasis areas only)
    - 3 critical crashes
    - 3/57 = 5%

Countywide Crashes

The project team divided the share of critical crashes by total crashes, where closer to 100% indicates a high number of critical crashes within a location To further understand the significance of each percentage, the team applied the following thresholds: If a percentage was greater than 5% and the total number of crashes was higher than 25 at a given location, then it would be labeled "Yes," and if these thresholds were not met, then it would be labeled "No."

The following crash profiles meet the threshold of having greater than 5% share of critical crashes compared to total crashes and more than 25 crashes:

1. Pedestrian-involved crashes at signalized intersections with high ADT and medium speed limit
    - 34 total crashes (countywide)
    - 7 critical crashes (countywide)
    - 7/34 = 21%
2. Pedestrian-involved crashes within 50 feet of a bus stop or Metrorail station entrance
    - 51 total crashes (countywide)
    - 13 critical crashes
    - 13/51 = 25%
3. Pedestrian-involved crashes with motor vehicle making left turn in mixed use areas
    - 53 total crashes (countywide)
    - 9 critical crashes
    - 9/53 = 17%
4. Pedestrian-involved crashes on arterial streets in low vehicle access areas
    - 211 total crashes (countywide)
    - 32 critical crashes
    - 32/211 = 15%
5. Pedestrian-involved crashes with motor vehicle proceeding straight at unsignalized intersections and midblock locations with low ADT and low speed limit
    - 65 total crashes (countywide)
    - 10 critical crashes
    - 10/65 = 15%
6. Bicycle proceeding straight and motor vehicle making right turn within ¼-mile of a community facility
    - 38 total crashes (countywide)
    - 5 critical crashes
    - 5/38 = 13%
7. Alcohol-involved crashes at unsignalized intersections and midblock locations with low ADT and low speed limit
    - 220 total crashes (countywide)
    - 14 critical crashes
    - 14/220 = 6%
8. Left turns at unsignalized intersections with high ADT and medium speed limit
    - 61 total crashes (countywide)

- 4 critical crashes
- 4/61 = 7%

9. Right turns at signalized intersections with medium ADT and medium speed limit
    - 70 total crashes (countywide)
    - 4 critical crashes
    - 4/70 = 6%
10. Left turns at signalized intersections with medium or high ADT and medium speed limit
    - 414 total crashes (countywide)
    - 19 critical crashes
    - 19/414 = 5%

See Appendix 1 for the 20 crash profiles listed above, as well as the "potentially at-risk locations" identified because they had similar characteristics as the locations identified in each profile. These crash profiles/"potentially at-risk" locations are the basis for engineering assessment and potential improvements.

3. Implementing Improvements

The next step to enhance safety across all "potentially at-risk locations" is to inventory and assess conditions on all segments to ensure that they meet current County standards for sight distance, signage, and pavement markings. Pedestrian ramps and lighting will be assessed as well to determine their safety impacts. During this inventory staff will also assess the potential for further safety measures from Arlington's Multimodal Safety Engineering Toolbox then prioritize and program those additional safety updates, as well.

Due to the high volume of roadways to be assessed and considered for systemic improvement, the County will begin by inventorying, reviewing, and implementing improvements within the Equity Emphasis Areas.

Starting with Equity Emphasis Areas

Focusing in on the Equity Emphasis Area crash profiles alone, there are over 500+ locations for review when narrowed down to either (1) intersection locations or (2) mid-block crossings. The County will begin by tackling the inventory and assessment of these locations in 2023 to ensure they meet current County standards for sight distance, signage, and pavement markings. Pedestrian ramps and lighting will be assessed simultaneously but may require further assessment to determine construction feasibility. This inventory will utilize an online form and PowerBI dashboard for recording and tracking information.

After the review of each location is submitted in the online form, the results will be tallied, making note of each standard that was not met. This tally of unmet standards will then be used to prioritize the locations most in need of upgrades and build out a work plan for upgrading crossings and intersections within Equity Emphasis Areas.

Plans for Countywide Review & Implementation

Once all potentially at-risk locations are reviewed in Equity Emphasis Areas, the team will assess next steps for Countywide application.

Communication of Improvements

Once the work plan for upgrading crossings and intersections within Equity Emphasis Areas is ready to implement, the County's communications team will share information with the community about upcoming changes. While the changes may be minimum in scale (mostly signage and marking improvements), the advanced community outreach will let residents know what types of changes to anticipate in their neighborhood and educate community members about the positive safety impacts of such changes in the neighborhood. See below for a communication process diagram for systemic upgrades.

4. Lessons Learned

This robust geospatial systemic safety analysis was the first of its kind for Arlington County. While the analysis effectively leads to a work plan for necessary safety upgrades throughout the County focused on "potentially at-risk areas," we did arrive a list of considerations and recommendations that we will utilize for future geospatial systemic analysis in the future to ensure that the analysis and actions are fine-tuned and actionable within a reasonable timeframe and budget.

Future considerations for systemic safety analysis include:

- Incorporating new spatial inventory elements that were not available at the time that this study was initiated (for example, the streets inventory that includes street widths, lanes, parking, and other features that would be useful for systemic analysis).
- Excluding alcohol-related crashes since there is little that engineering improvements can do to rectify such crashes.
- Reducing the number of factors contributing to the complex analysis matrix (looking less at land use and personal characteristics, focusing more on roadway features).

Wrap-Up

Look out for the results of the Equity Emphasis Areas inventory and assessment in late 2023 along with communications about the resulting systemic improvements through the Vision Zero Listserv and on the Vision Zero Systemic Safety Improvements page. We will provide updates on how to tackle Countywide updates, as well as plans for future analysis through these channels, as well. Stay tuned!