

Overview

Under *Action Item A3: Annual Crash Analysis*, the Arlington County [Vision Zero Action Plan](#) states that the Vision Zero team will perform crash hot spot reviews of all reported crashes to identify individual intersections or locations that experience relatively high numbers of crashes to inform implementation of quick-build crash mitigation measures. The Vision Zero team will conduct a hot spot analysis roughly every two years and then assess and implement safety treatments at each location over that two-year period.

To track the effectiveness of safety improvements at hot spots over time, the Vision Zero team maintains an inventory of hot spots, including crash data and applied treatments. The team will assess improvements at each identified hot spot to ensure the treatments implemented effectively reduce crashes at the hot spot.

The term “hot spot” is relative. Compared to larger jurisdictions with higher volume and higher speed roads, Arlington’s hot spots can have significantly fewer crashes and/or injuries. However, we recognize the importance of identifying safety needs from our crash data and implementing safety improvements wherever possible to achieve Arlington’s Vision Zero goals.

This memo describes the process used to derive the 2018 – 2022 Arlington County Crash Hot Spots (2023 Hot Spot Analysis), which was completed in 2023. It includes the following sections:

- A. Methodology Update
- B. Datasets
- C. Step-by-Step Methodology
 - Step 1: Process and Create Datasets
 - Step 2: Join Crash Data to Roads
 - Step 3: Incorporate Equity Emphasis Areas
 - Step 4: Apply Crash Weighting
 - Step 5: Conduct Sensitivity Testing
 - Step 6: Finalize Crash Hot Spot Locations

Methodology Update

This section documents the methodological changes made between the 2023 Crash Hot Spot Analysis and the analysis carried out in the previous round published in 2022.

StreetLight Volumes

As part of sensitivity testing in Step 5, the team compared the hot spot scoring results with and without StreetLight volumes. The team downloaded weekday roadway volumes from StreetLight for all roads in the County and followed the initial process prescribed in the 2022 methodology. The 2022 methodology used StreetLight volumes to normalize crash and hard-

brake incidents. After the top hot spot scoring locations with volumes were compared to the top hot spot scoring locations without volumes, it was decided to exclude volumes from the analysis. Inclusion of the StreetLight volumes had the potential to overinflate a location’s score if it had a high volume. As such, the team did not incorporate StreetLight volumes in the 2023 Crash Hot Spot Analysis Methodology.

Midblock Crashes

The methodology described in this memo was carried out for both intersection and midblock crashes. Midblock crashes are all crashes that took place on a roadway outside intersection buffers. After the first iteration of hot spot scores were assigned to both intersection and midblock locations, the County suggested that midblock hot spots had been sufficiently captured by the County’s High-Injury Network (HIN) and scoring and ranking them for the 2023 Crash Hot Spot Analysis Methodology may be duplicative. For this iteration of the hot spot scoring and ranking, the midblock hot spot dataset was reduced to only include ramps.

Wejo Hard-Braking Data

Both the 2023 and 2022 Crash Hot Spot Analysis Methodology use Wejo’s Hard-Braking dataset to determine hot spot scores and rankings. WeJo provides anonymous connected vehicle data such as vehicles movements and driving events like hard braking. As of 2023, Wejo has taken steps toward filing for bankruptcy. Wejo’s 2019 hard-braking data is available and can be used on projects, but it is uncertain if new datasets will be available for future years. For future iterations of this methodology, other data sources for near-misses and hard-braking incidents should be explored.

Crash Weighting

The crash severity weighting applied to the final crashes was modified since the previous hot spot analysis. As part of the Sensitivity Testing in Step 5, two new weighting ranges were tested and compared to the previous hot spot analysis weighting. A new weighting range was selected and is listed in Table 4.

Datasets

The 2023 Hot Spot Analysis uses the datasets in Table 1.

Table 1. Datasets Used in Crash Hot Spot Development

Dataset	Creator
Crash data (2018-2022)	Virginia Department of Transportation (VDOT)
Street centerlines	Arlington County
Intersections	Arlington County
Midblock locations	Fehr & Peers (see Step 1 below)
Hard-braking incidents (2019)	WeJo
Equity emphasis areas	Arlington County

Step by Step Methodology

Step 1. Process and Create Datasets

Once crash data have been assembled for the desired time horizon (in this case, 2018 – 2022), the following steps are completed to prepare the data for the hot spot analysis:

- Remove freeway crashes from the crash dataset.
 - Remove crashes along I-66, I-395, and George Washington Memorial Parkway.
 - Keep crashes at ramps intersecting surface streets.
- Classify street centerlines as *arterial* or *neighborhood* based on the GIS attributes shown in Table 2 below.

Table 2. Street Centerline Classifications for Hot Spot Development

Street Centerline Type	Hot Spot Designation	
	Arterial	Neighborhood
New		X
Other Jurisdiction	X	
Controlled Access	X	
Other Principal Arterial	X	
Minor Arterial	X	
Neighborhood Principal		X
Neighborhood Minor		X
Private Street		X
Access Ramp	X	
Alleys		

Note: Alley are not classified as either an arterial or a neighborhood roadway. Alleys are utilized in the analysis as designated in the intersection file received from Arlington County.

- Use combinations of *location type* and *street type* to establish *buffer distances*, as shown in Table 3. Buffer distances are used in GIS to assign a crash to one of the three location types: *signalized intersection*, *unsignalized intersection*, or *ramp location*.

Table 3. Buffer Distances for Assigning Crashes to Location Types

Location Type	Street Type	Buffer Distance
Intersection	Arterial intersecting arterial OR four or more intersecting arterials	200'
	Arterial intersecting neighborhood	100'
	Neighborhood intersecting neighborhood	50'
Ramp	Ramp intersecting all street types	25'

Arlington County 2023 Crash Hot Spot Analysis Methodology

Note: Buffer distances were established using an iterative process that considered intersection size and proximity of nearby intersections. Crashes not assigned to a signalized or unsignalized intersection that overlap with a ramp segment are assigned to the ramp location. Alley buffer sizes were generated based on the corresponding intersecting street types.

- Classify and clean *intersections* dataset.
 - Categorize all intersections as Signalized or Unsignalized using the field “TrafficControlType” in the Intersections dataset.
 - All intersections with the “Signalized” attribute in this field are considered Signalized. All other intersections (All-Way, None, T – with stop, Two-way and Yield) are categorized as Unsignalized.
 - Manually review intersection points that are within 30 feet of each other. If the intersections seem to overlap and create a single system, their points are merged at the midpoint. The roadway segments are then edited to join at the new merged point.
 - If two or more intersections are merged and any one of them are signalized, the new merged intersection is considered Signalized.
- Create and prioritize *intersection* buffers.
 - Create intersection buffers based on distances established in Table 3.
 - Using GIS, clip overlapping intersection buffers based on buffer size. Smaller buffers have a higher priority than larger buffers, so smaller buffers are clipped out from all larger overlapping buffers. This correctly assigns crashes to the minor intersection when they occur near a larger intersection.
 - For buffers of the same size, the “remove overlap” tool is run using the “Thiessen” method, so that overlapping areas are evenly split between intersections.
- Clean *ramp location* dataset.
 - Manually review ramp locations for accuracy.
 - Create a buffer of reasonable size (25’ was used as part of this analysis) around ramps to accurately capture crashes occurring on these facilities.
- Identify all road segments where a crash occurred as the basis for acquiring WeJo data.

Note: For future years, consider replacing Wejo data with another near-miss dataset.

 - Select road segments (ramp or intersection approach) where a crash occurred to pull Fall 2019 WeJo hard-braking data from Fehr & Peers’ WeJo dataset.
- Conduct quality assessment of datasets for accuracy.

Step 2. Join Crash Data to Roads

Complete the following process to create a spatial connection between crash data, location data, and WeJo hard-braking data:

- Using the buffers created in Step 1 assign crashes based on the following hierarchy to each location type:
 - Assign signalized intersection crashes first, then non-signalized intersections, and then ramp locations.
 - For each location type start with the smallest buffer and increase to largest buffer.

Arlington County 2023 Crash Hot Spot Analysis Methodology

- Assign crashes to only one location.
- Assign WeJo hard-braking data, or substitute near-miss data, to each crash location.
 - If Wejo assigns multiple hard-braking values associated to a single roadway segment because of differences in segmentation, pull the highest hard-braking value.
 - At intersections, sum the Wejo hard-braking values associated with all legs of the intersection.
 - At ramps, use the Wejo hard-braking value associated with that roadway segment.
 - Each crash is assigned to a location, and each location has hard-braking data joined to it; therefore, each crash hot spot will receive an associated hard-braking value.
- Conduct quality control (QC) of buffers, crash assignments to locations, and hard-braking data assignments to locations.

Step 3. Incorporate Equity Emphasis Areas

Complete the following steps to incorporate equity data from the County:

- Request the latest Equity Emphasis Areas shapefile from Arlington County.
- Assign crashes to Equity Emphasis Areas:
 - Crashes that fall within the designated Equity Emphasis Area polygon are Equity Emphasis Area crashes.
 - Crashes that fall outside the designated Equity Emphasis Area polygon are non-Equity Emphasis Area crashes.

Step 4. Apply Crash Weighting

Weighting crashes involves the following steps:

- Determine crash severity weighting using the values in Table 4.

Table 4. Crash Severity Weighting

Crash Severity	Weighting
Fatal injury	20
Severe injury	20
Visible injury	10
Nonvisible injury	1
Property damage only	1
Hard-braking incident	0.02

Note: Crash severity weighting is based on a scan of peer Vision Zero cities and was finalized through Step 5, Sensitivity Testing.

- Use ArcGIS field calculations to run weighting formulas for all crashes:
 - $Hot\ Spot\ Score = (\# \text{ fatal crashes} \times \text{fatal crash weight}) + (\# \text{ severe injury crashes} \times \text{severe injury crash weight}) + (\# \text{ visible injury crash} \times \text{visible injury crash weight}) + (\# \text{ nonvisible injury crashes} \times \text{nonvisible injury crash weight}) + (\#$

Arlington County 2023 Crash Hot Spot Analysis Methodology

property damage only crashes x property damage only crash weight) + (total number of hard-braking per location x hard-braking incident weight)

- Rank locations based on the hot spot score. Intersections and ramps should be ranked separately.
- Conduct quality control (QC) of outputs for accuracy.

Step 5. Conduct Sensitivity Testing

Sensitivity testing is used to measure how much a hot spot score is influenced by formula variables and the changes in those variables. During the 2018 – 2022 Crash Hot Spot Analysis three sensitivity tests were conducted: 1) crash injury severity weighting, 2) volume impact, and 3) final selection criteria.

- Crash injury severity weighting: Three different weighting ranges were tested to assess the impact weighting made on final hot spot identification. Test one used the weighting assigned in the previous hot spot analysis, test two used an internal Arlington County weighting, and test three used a modified weighting selected from a scan of Vision Zero peer cities. **After comparing the three results, test three was selected and the final weights used in this methodology are referenced in Table 4.**
- Volume impact: Hot spot scoring with and without Streetlight volumes were tested. StreetLight volumes were used in the previous hot spot analysis. The team sought to better understand if inclusion of the StreetLight volumes potentially overinflated a location's score if the location had high volumes, regardless of crashes. After the top hot spot scores with volumes were compared to the top hot spot scoring locations without volumes, a decision was made to exclude volumes from the analysis. **The team did not incorporate StreetLight volumes in the 2023 Crash Hot Spot Analysis Methodology.**
- Final selection criteria: A minimum threshold criteria was applied to all scored and ranked locations to narrow the top hot spot locations. Criteria 1 narrows the hot spot list to locations that have a minimum of 5 vehicle crashes or 3 pedestrian-involved crashes or 2 bike-involved crashes. Additionally, several other criteria were tested including combinations of number of bike-involved, pedestrian-involved crashes, severe and fatal crashes. The application of these criteria resulted in minimal change to the top crash locations determined through the hot spot score and Criteria 1. **Therefore, this sensitivity testing affirmed that the hot spot scoring and application of Criteria 1 was able to capture the top crash hot spots in the County.**

Apply final hot spot formula:

- Incorporate new variables, weighting, or thresholds into the hot spot formula after conducting the sensitivity testing.
- Run the hot spot formula.
- Rank locations based on the hot spot score. Intersections and ramps should be ranked separately.
- Conduct quality control (QC) of outputs for accuracy.

Arlington County 2023 Crash Hot Spot Analysis Methodology

When conducting sensitivity testing during the next round of hot spot analysis, one potential test could focus on the impact of a future near-miss dataset that will be incorporated.

Step 6. Finalize Crash Hot Spot Locations

Once Steps 1-5 have been completed, every location will have a hot spot score and a rank. Apply Criteria 1 to narrow down to locations with a minimum of 5 vehicle crashes **or** 3 pedestrian-involved crashes **or** 2 bike-involved crashes.

Select the top 60 hot spot locations by selecting the 55 highest-scoring crash locations and the 5 highest-scoring ramp locations **after** Criteria 1 has been met. Document the results through the following elements:

- Final infographic map of crash hot spots highlighting:
 - Hot spots (1-60)
 - Crash location by location type
 - Crash location by modes involved
 - Crash hot spots in Equity Emphasis Areas
 - Hot spot inclusion in previous hot spot analysis
- An geodatabase and tracking spreadsheet for use by the County
- Methodology memo

Host the final infographic map and methodology memo on the Arlington County Vision Zero [hot spot analysis webpage](#).

Considerations for Future Analysis

- Explore alternative near-miss data to substitute WeJo hard-braking incidents. Step 5. Conduct Sensitivity Testing could focus on the impact of various near-miss datasets or the impact of near miss data.
- Incorporate the latest Equity data as designated by Arlington County.

Project Team

This project was a collaboration with staff from Arlington County Transportation Engineering & Operations, Fehr & Peers, and Toole Design.