LET'S ROLL!

Using Network Analysis to Map a Least-Risk Route for Bike Accidents in Connecticut's "Plainville Gap"

BACKGROUND

The Farmington Canal Heritage Trail (FCHT) is a 56.5 mile-long multi-use path running north-to-south from New Haven to Suffied, Connecticut. Before the FCHT was a paved multi-use trail, it was a railway route running north from New Haven into Massachusetts, mostly along the abandoned Farmington Canal network. As automobiles replaced rail service, the Farmington Canal Rails-to-Trails Association formed to transform the railway and canal infrastructure into recreational trails, hence the name "Farmington Canal Heritage Trail" (Farmington Valley Trail Commission [FVTC], 2023). The FCHT continues north into Massachusetts where its governing organization changes hands. The path is part of the larger East Coast Greenway, a system of recreational paths spanning from Florida to Maine (East Coast Greenway Alliance).

The FCHT is not complete, and new lengths of trail are often proposed. The largest gap is 4-miles wide halfway up the length of the trail in Southington and Plainville. This gap is commonly referred to as the "Plainville Gap." In 2024, a 5-mile on-road route was selected and marked to bridge the gap between the trail's extent at Aircraft Road in Southington and the trail's resumption at Northwest Drive in Plainville. However, this direct route travels along high traffic main roads. Given the goal of the FCHT to provide a safe path for recreational activity, this on-road route may be a shock to cyclists. This project provides an alternative on-road route to prioritize bicyclist safety and reduce accident risk within the "Plainville Gap."

METHODOLOGY

Using QGIS 3.42.0-Münster, I used 5 road and bike path layers containing information relevant to bike accident risk: speed limit, annual average daily traffic, limited access roadways, separated bike paths, and road classification. The separated bike paths layer was manually edited using the **vertex tool** to update the path network to 2025 status. This involved cross-referencing OSM with FCRTTA newsletters and directly reaching out to FVCT board members to confirm trail status (FCRTTA, 2021).

Each of these layers was **rasterized**, with the cells for each layer "burned-in" with the attribute fields for each factor. The **reclassify by table** tool was used to reclassify each of the risk factors on a scale from 1-5 with 5 being the highest accident risk (Table 1, Figures 1-5). The **raster calculator** was used to create an additive raster surface combining all 5 factors on a scale from 1-20. In order to effectively perform the network analysis in the next step, the risk scale was inverted using the **reclassify by table** tool, so a ranking of 1 now denotes highest accident risk. The **merge vector layers** tool was used to create a line layer containing all roads and bike paths in Connecticut. Using the **split lines by maximum length** tool, this new layer was split into segments of maximum 0.05 mile lengths.

The **drape (set Z value from raster)** tool was used to transfer the mean cell value from all cells intersecting with each 0.05 mile line segment to a new attribute field on the vector line layer. The risk index was altered using the **field calculator**, where each segment's value was multiplied to create a new 1-100 risk index with 100 indicating the safest line segments (Table 2, Figure 6).

Network analysis: **shortest path (point to point)** was performed between the FCHT's terminus at Aircraft Road and resumption at Northwest Drive. In order to prioritize the safest routes, the "fastest" function under the **shortest path** tool was used, selecting the attribute field with the 1-100 weighted mean as the "speed field [optional]." Using this method, the algorithm interprets the 1-100 risk index as speed (km/h) and will prioritize the safest segments because they have the fastest associated "speed." (QGIS project, 2025).

To create a line graph of the current "Plainville Gap" route and the new safer route, I placed **points along geometry** spaced 0.05 miles along both routes. I used the **Join attributes by nearest** tool set to 5 feet to transfer the risk index values from the line layer to each individual point. The layers were exported as CSV files and the graphs were created in an external graphing software.

Table 1: Raster Reclassification by Layer.

Inital Reclassification Score	Separated Bike Paths	Speed Limit (mph)	AADT (vehicles/day)	Road Classification	Limited Access Roadways
1 (safe)	Yes	10 - 15	10 - 9000	Local	–
2	–	15 - 25	9000 - 24400	Minor Collector	–
3	–	25 - 30	24400 - 50200	Minor Arterial & Major Collector	–
4	–	30 - 45	50200 - 93300	Other Principal Arterial	Partial Control
5 (unsafe)	–	45 - 65	93300 - 167200	Interstates, Freeways, Expressways	Full Control

Table 2: Accident Risk Multipliers by Road Classification.

Final Reclassification Based on Road Classification	
Local	x5
Minor Collector	x4
Minor Arterial & Major Collector	x3
Other Principal Arterial	x2
Interstates, Freeways, Expressways	x1

"PLAINVILLE GAP" ROAD NETWORK

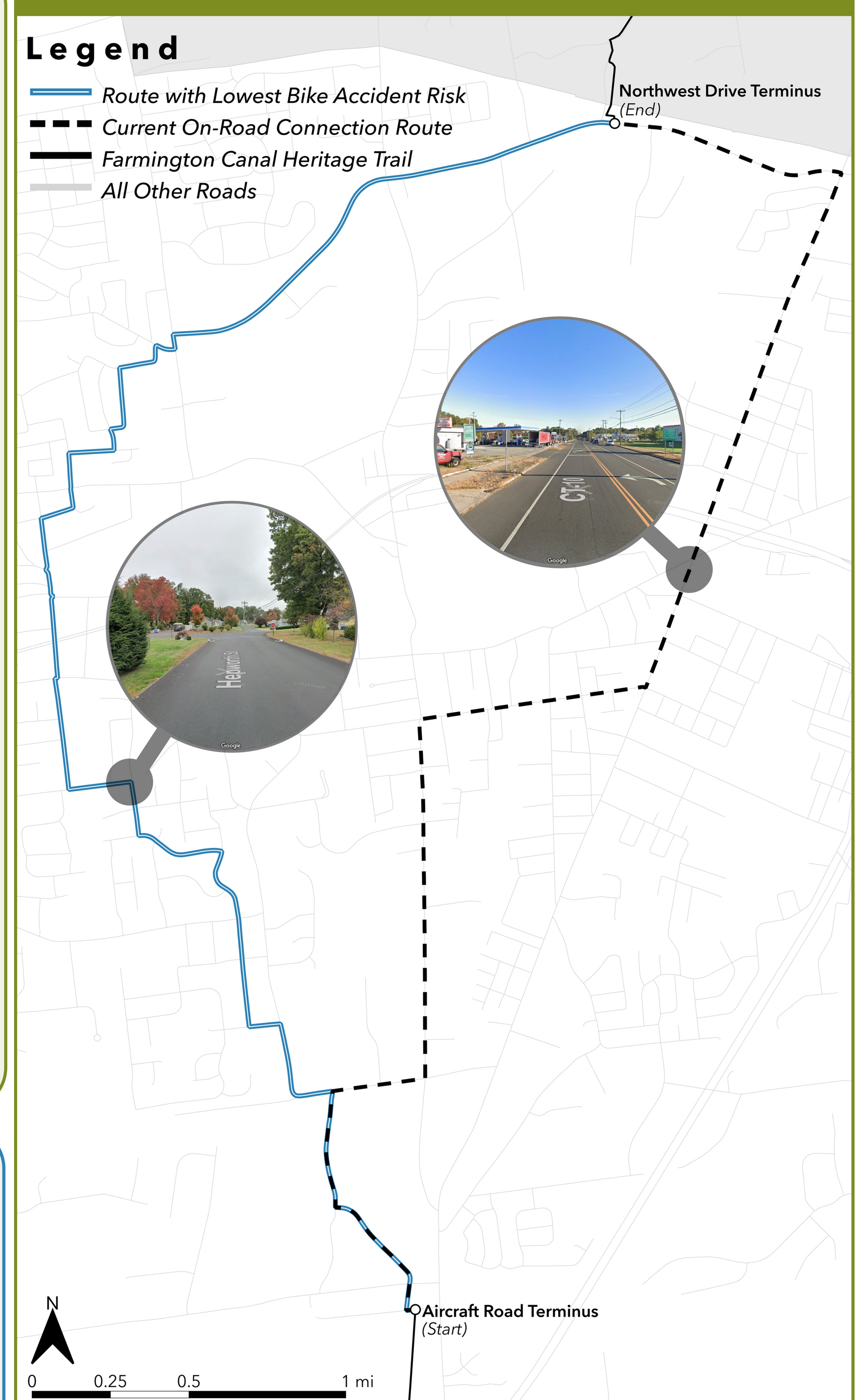

Figure 9: Preexisting (black dotted) and Alternative (blue striped) On-Road Routes.

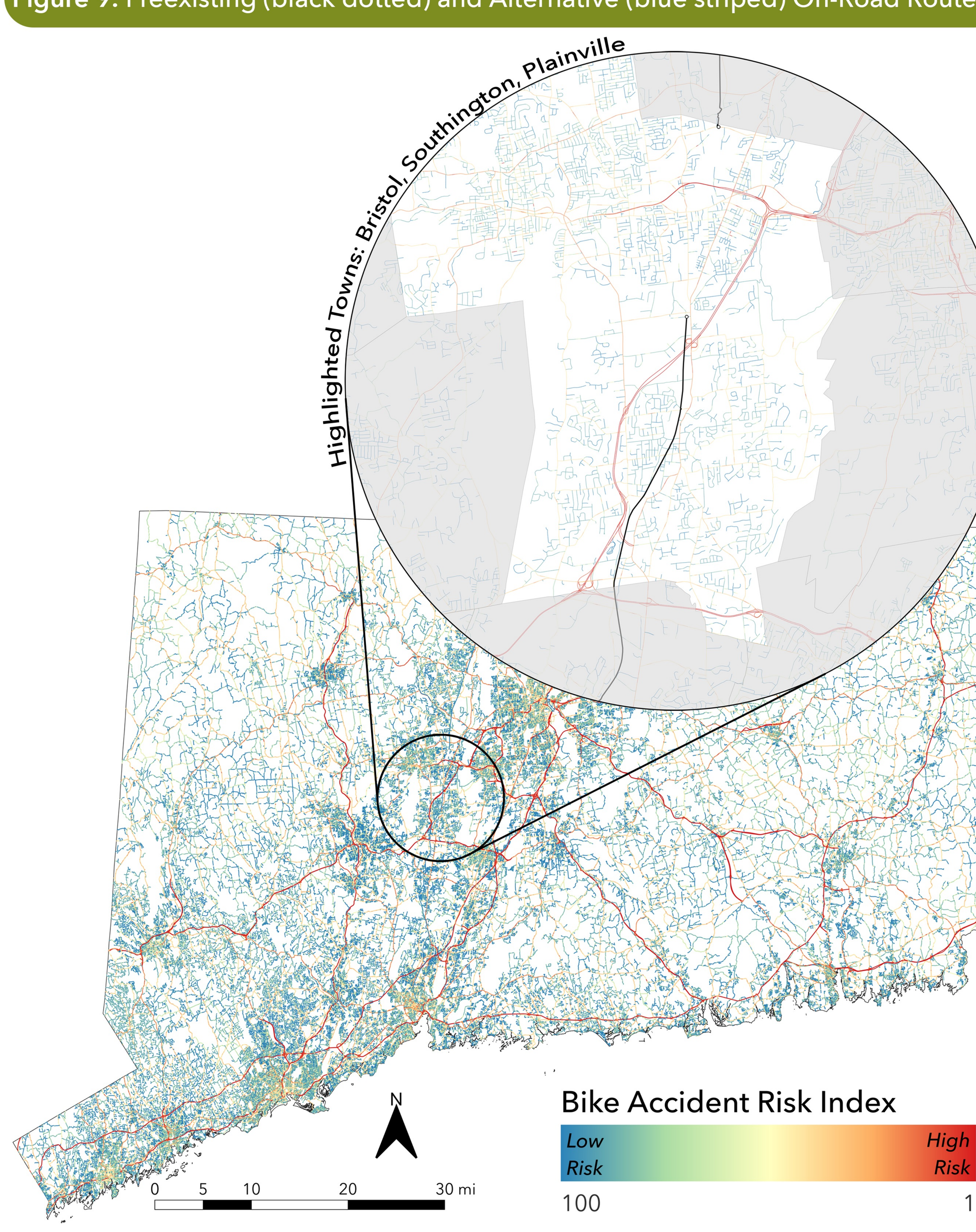

Figure 6: Weighted Bike Accident Risk on Connecticut's Road and Trail Network. Northeast State Polygon, October 2019, Connecticut Department of Energy & Environmental Protection; TIGER/Line Shapefile, 2019, state, Connecticut, Current County Subdivision State-based, 2019, US Census Bureau.

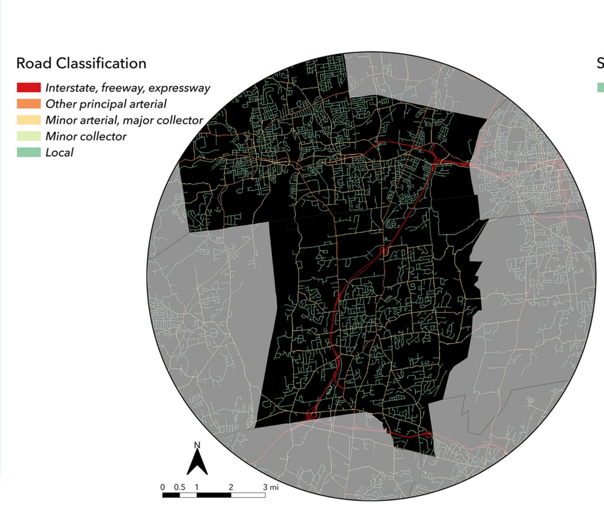

Figure 1: Road Functional Classification. Functional Class, December 2024, Connecticut Department of Transportation.

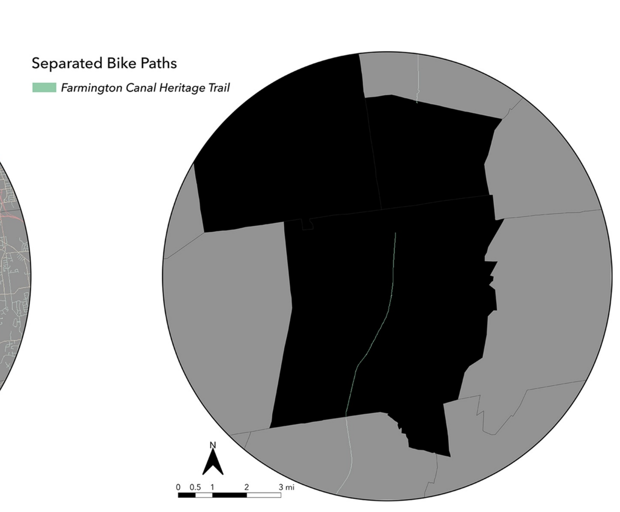

Figure 2: Separated Bike Paths. DEEP Trails Set, October 2024, Connecticut Department of Energy & Environmental Protection.

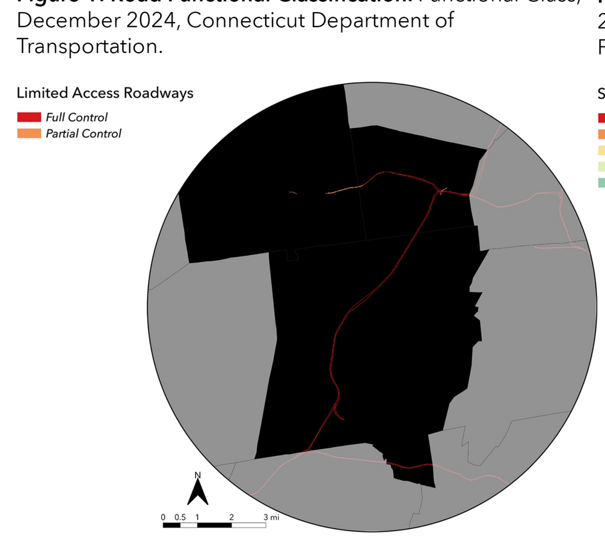

Figure 3: Limited Access Roadway Status. Limited Access, December 2024, Connecticut Department of Transportation.

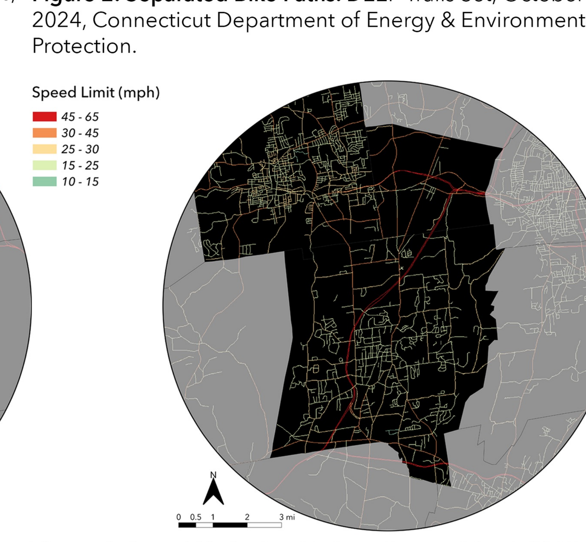

Figure 4: Speed Limits (mph). State Routes, March 2025, Connecticut Department of Transportation; Local Roads, March 2025, Connecticut Department of Transportation.

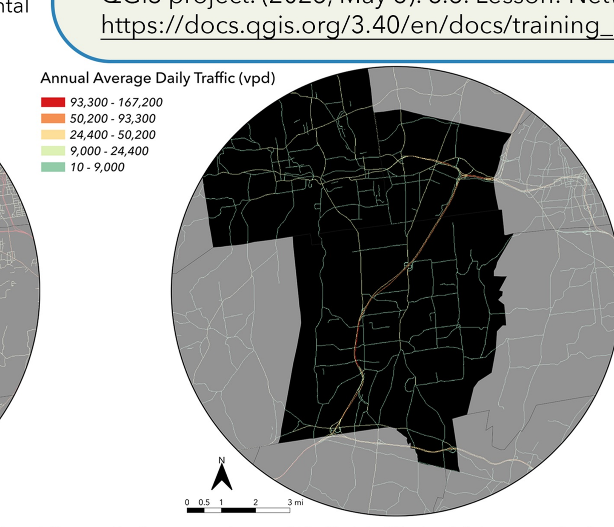

Figure 5: Average Annual Daily Traffic (vehicles per day). Annual Average Daily Traffic, March 2025, Connecticut Department of Transportation.

RESULTS

The network in Figure 6 shows that residential roads and bike paths have the lowest bike accident risk. To best avoid bike accidents within the "Plainville Gap," network analysis favors these local roads mostly due to their low traffic and low speed limits. Street views of these routes are shown for comparison (Figure 9). The new route is less direct and requires more navigation than the existing on-road route marked by the East Coast Greenway as it meanders through residential neighborhoods. This project uses the CT roads with Bike Accident Risk layer (Figure 6) to map a route in the "Plainville Gap," but this network can be applied to create a safe bike route between any locations in Connecticut.

CONCLUSION

All models incompletely represent the real world's complex systems. By looking at the data and methods driving a model, we can understand its limitations.

The focus of this road and bike path network model is to generate routes that optimize safety strictly with regards to bike accidents. However, there appear to be some unavoidable high-risk areas in the "Plainville Gap" (Figure 8).

The model does not show an overall view of cycling safety as it is focused on accdents. This focus also means the model will not select the most direct route (Figure 9). In the case that a cyclist prefers a direct route, they will not be able to optimally reduce bike-car accident risk as they will ride on higher risk roads.

This model assumes ideal weather conditions, ample light quality, and proper cyclist behavior, all of which contribute to bike accident risk (Kaygisiz & Hauger, 2017). These factors vary over time and from cyclist to cyclist, so they are impossible to include in this static model even though they contribute to cycling accident risk in reality (Ayad et al., 2024).

According to a dataset of Connecticut bike accidents from 2015 to 2025 that is not included in the final analysis of this project, a large amount of bike accidents occur in intersections. Although here is no dataset in this analysis that directly references intersection safety, the line segments that cross busy intersections often show increased accident risk (lower values). The raster values from the higher risk intersections are incorporated into the mean risk values on the line segments. These are portrayed as dips in the line graphs (Figures 7-8).

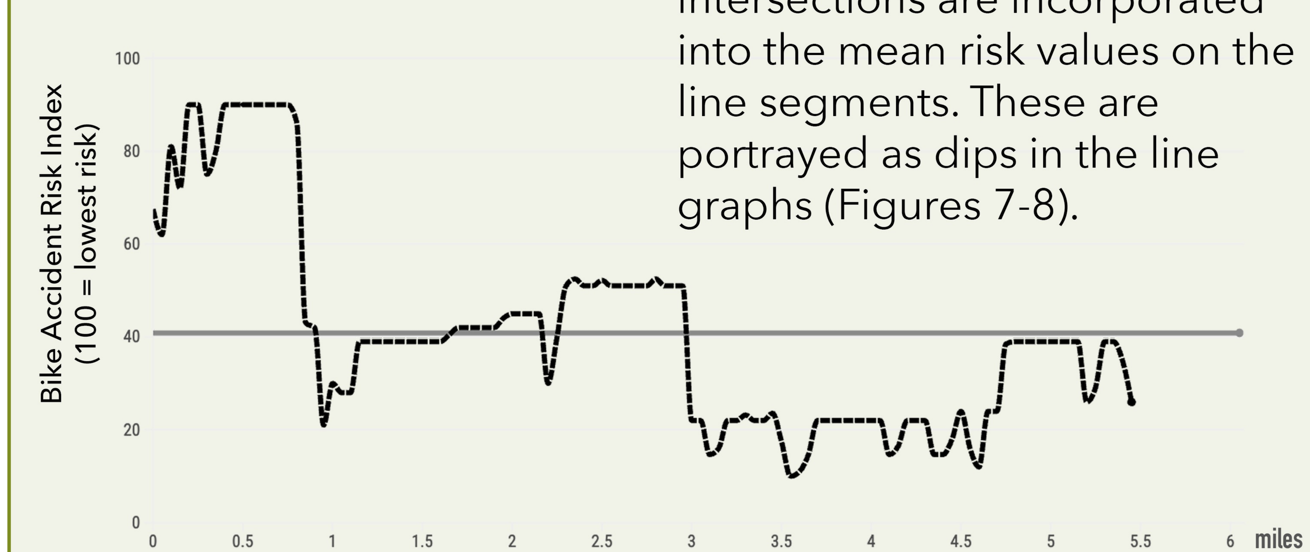

Figure 7: Accident Risk Along the Preexisting On-Road Route. (Mile 0 = Aircraft Road Terminus)

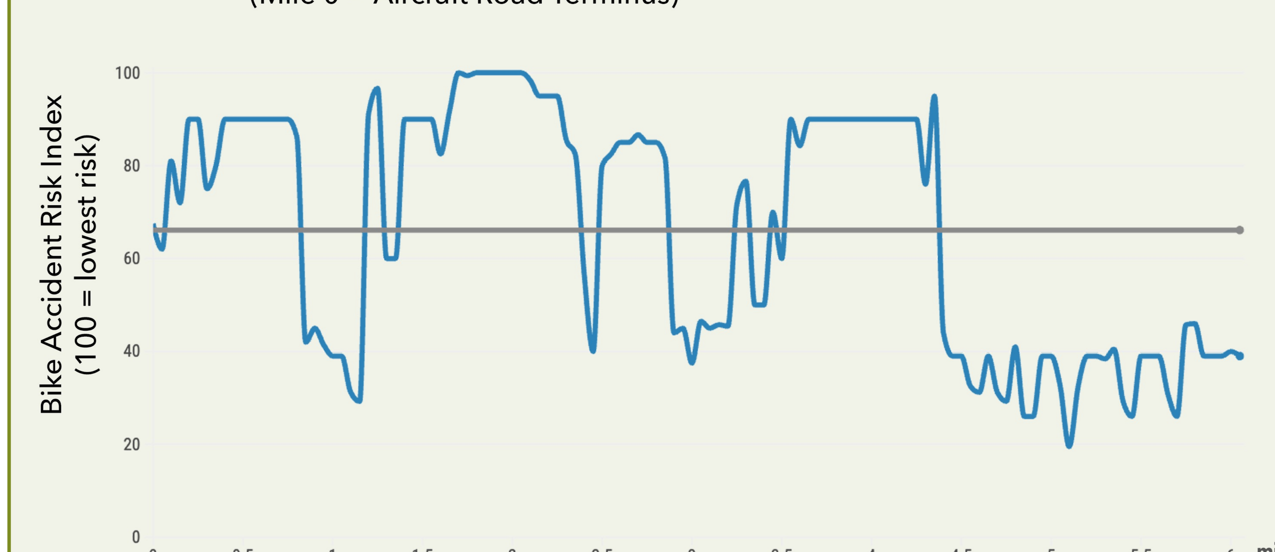

Figure 8: Accident Risk Along the New Least-Risk Route. (Mile 0 = Aircraft Road Terminus)

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