

**Least Cost Path Analysis for a Proposed Light Rail Transit Route in
Halifax, Nova Scotia**

GGR273

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Part 1:

Background

This project was contracted to generate a least cost path (LCP) for a proposed light rail transit (LRT) route connecting a suburban origin to the downtown Halifax train station using a multi-criteria impedance surface developed in ArcGIS Pro. The need for expanded public transit in Halifax is supported by research linking daily commuting to reduced subjective wellbeing. Commuting is often associated with higher stress, negative emotions, and lower life satisfaction, especially when trips are long or affected by congestion (Chatterjee et al., 2020). Car-dependent commuters, who represent a large share of suburban workers, experience higher commute-related stress than those using active or rail-based transportation. Improvements in rail services, such as shorter travel times and more reliable schedules, have been shown to reduce commuter stress (Chatterjee et al., 2020). Based on this context, the proposed LRT route aims to provide a more predictable alternative to private automobile travel while improving transit accessibility in areas with higher commuter demand.

Mythology

To conduct the analysis, an impedance surface was created using four criteria selected by the proponent: slope, distance to water bodies, distance to wetlands, and commuter density by dissemination area (DA).

First, a slope raster was generated from the LiDAR DEM using the Slope tool, with values measured as percent rise. The raster was reclassified into impedance values, where flatter areas received lower costs, reflecting better suitability for rail construction.

Next, Euclidean Distance rasters were created for lakes (polygon features), rivers (line features), and wetlands (swamp polygons). The lakes and wetland polygons were extracted from the *Nova Scotia Water (Areal Features)* dataset. Each distance raster was reclassified into impedance values representing construction constraints near water features, and water bodies were assigned the highest impedance values to prevent route crossings.

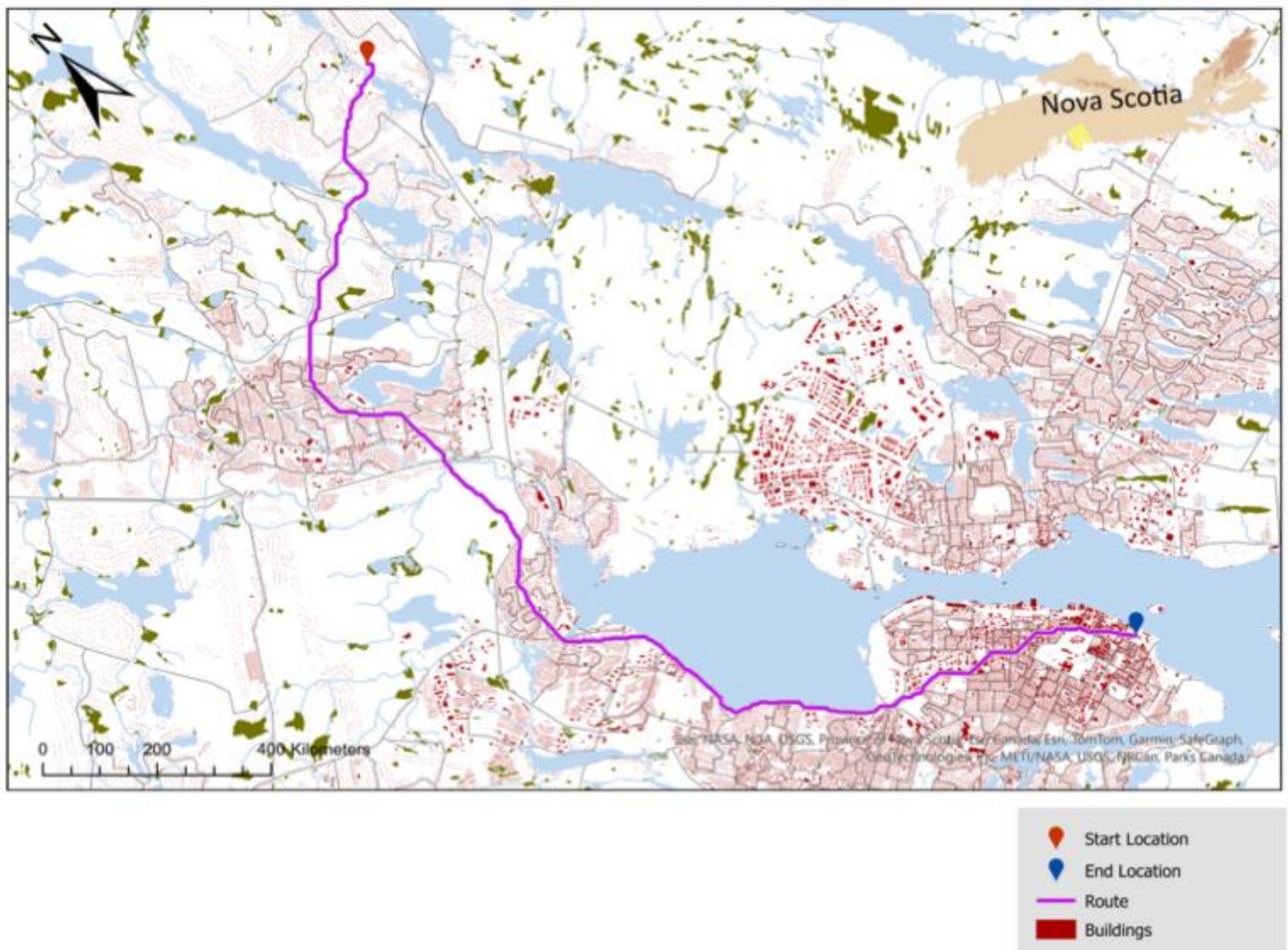
Commuter data from the Census were joined to dissemination area boundaries using the DAUID field. A combined commuter variable (COM_DRIVER + COM_PASS) was calculated and converted to raster format using the *Feature to Raster* tool. Areas with higher commuter counts were assigned lower impedance values to represent greater transit demand.

All reclassified rasters were combined using the *Raster Calculator* to create the final impedance surface (Raster_TOTAL), with values ranging from 125 to 17,025. The *Cost Distance* tool was then applied using the suburban origin as the source and

Raster_TOTAL as the cost surface, producing cost distance and backlink rasters. Finally, the *Cost Path* tool was used with the downtown train station as the destination to generate the least cost route, which was converted into a polyline using the *Raster to Polyline* tool.



Flowchart 1



Map 1

Part 2:

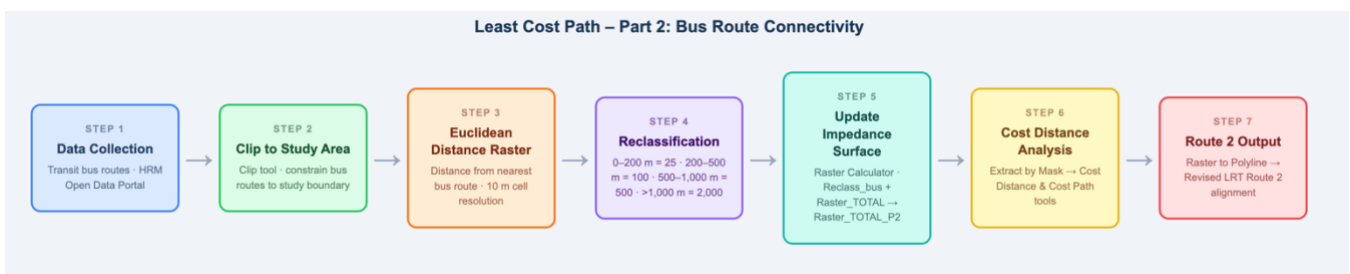
Expanded Analysis

The proponent's analysis included important biophysical and sociodemographic factors but did not consider the spatial distribution of existing transit infrastructure in the Halifax Regional Municipality. A new light rail line should be located near existing bus routes to allow easier transfers between services and improve overall network connectivity. Integrating different transit services is important for improving accessibility and overall service quality, since public transit performance depends on how well supply factors such as routes, accessibility, and service design support passenger experience (Liu et al., 2025). Research on service-oriented public transit systems shows that improving connections between transit services can enhance usability and attract more riders by making transit more convenient and reliable (Liu et al., 2025). The Halifax Regional Municipality Rapid Transit Strategy (2020) also emphasizes coordinating new rapid transit corridors with existing services to support a more connected and sustainable transportation network. Therefore, proximity to existing Halifax Transit bus routes was added as an additional impedance criterion in the expanded analysis.

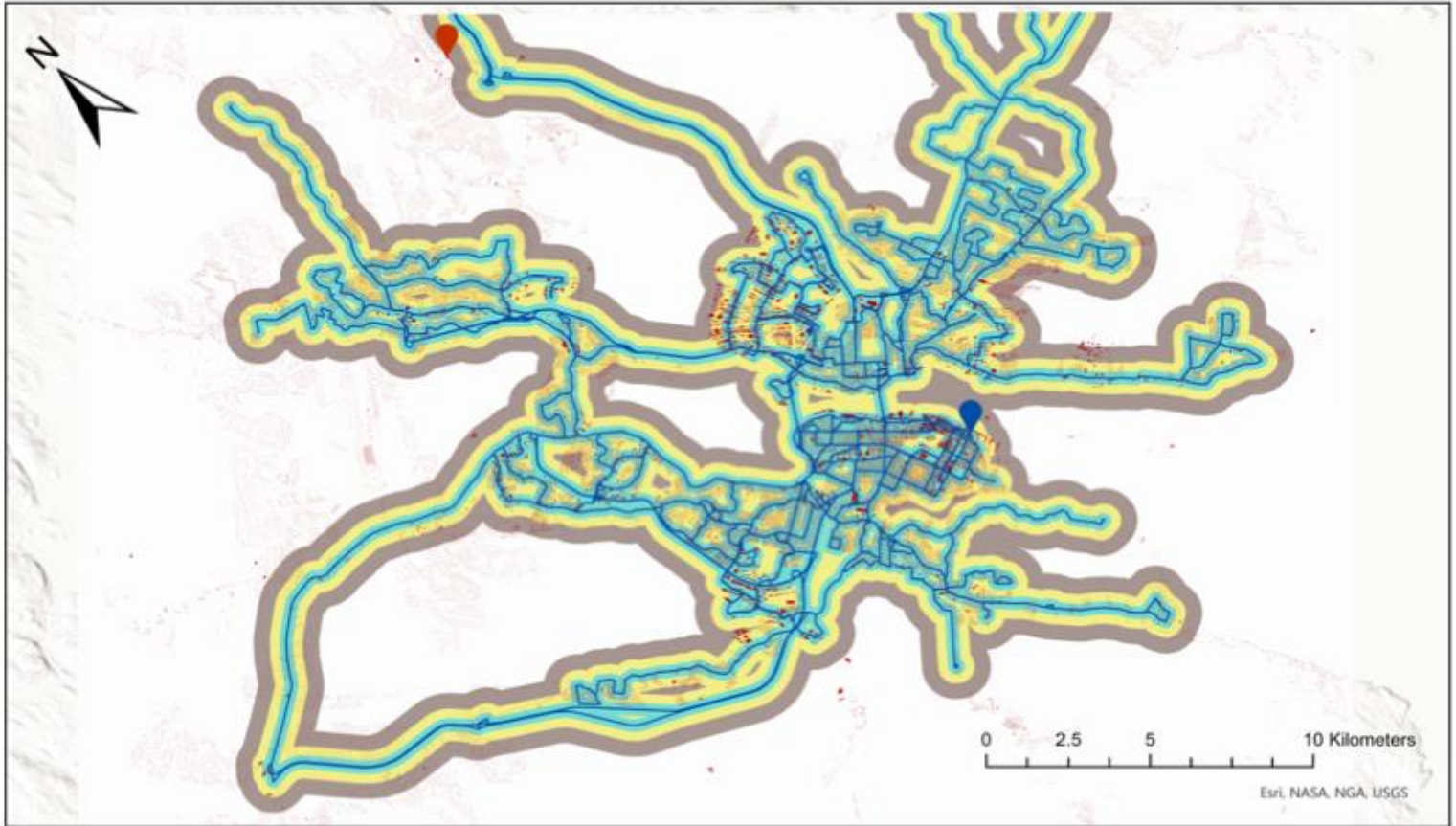
Methodology

Transit bus route data was obtained from the Halifax Regional Municipality Open Data Portal (HRM, 2026). The dataset was first clipped to the study area boundary. A Euclidean Distance raster was then generated from the clipped bus route layer at a 10-metre cell resolution, producing a continuous surface representing the distance of each cell from the nearest existing bus route. This distance raster was reclassified into impedance values as follows:

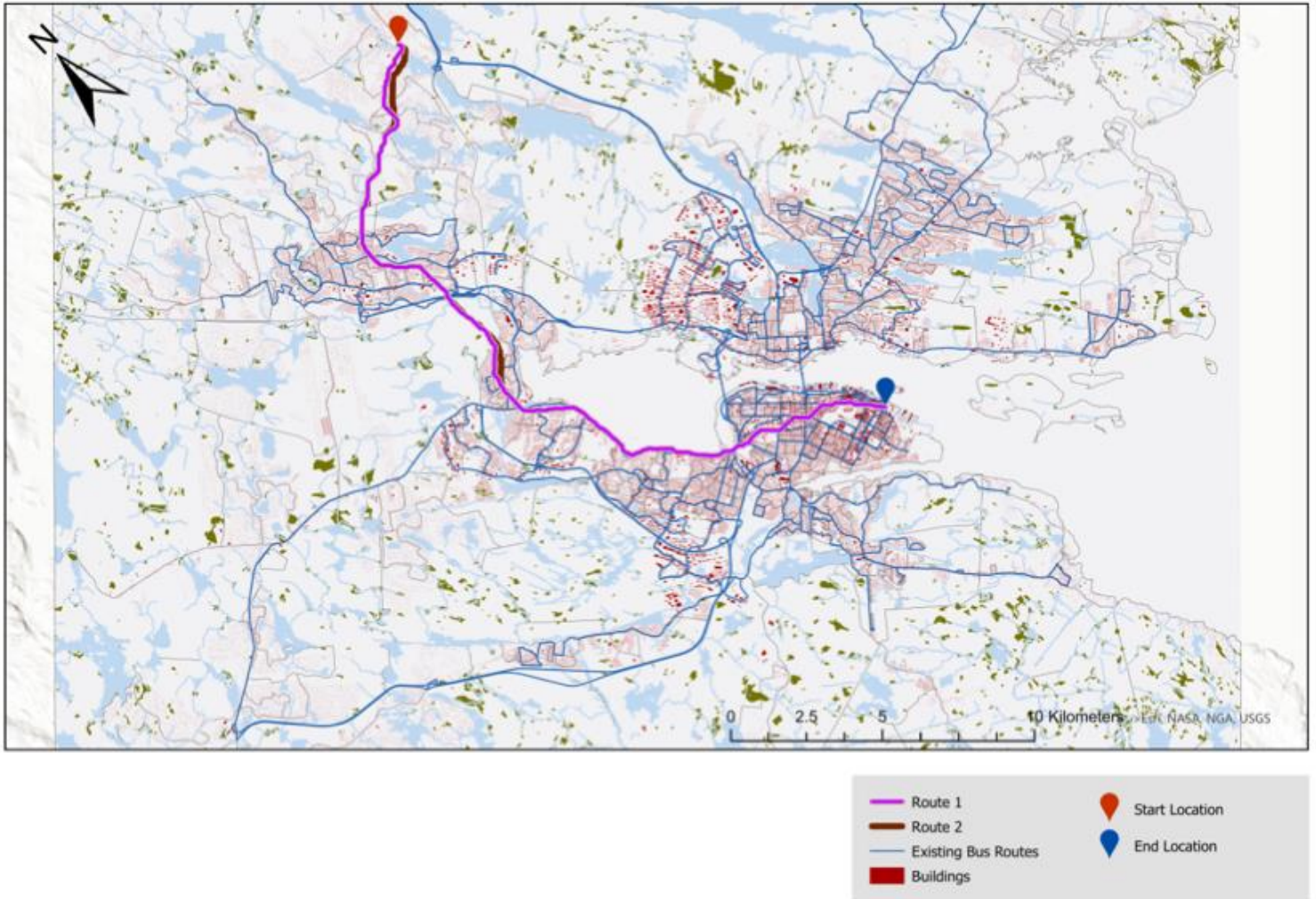
- 0–200m = 25 (desirable),
- 200–500m = 100 (good),
- 500–1,000m = 500 (undesirable),
- Greater than 1,000m = 2,000 (highly undesirable)



Flowchart 2



Map 2



Map 3

Discussion:

The proponent’s least cost path analysis shows several methodological strengths. By incorporating slope, proximity to water bodies and wetlands, and commuter density from the Census, the analysis produced a route that avoided steep terrain and major hydrological constraints while prioritizing areas with higher transit demand. The resulting path generally follows populated commuter corridors between the suburban origin and downtown Halifax, suggesting a geographically reasonable alignment. Together, these criteria supported a route that is both physically feasible and responsive to existing travel patterns within the Halifax Regional Municipality.

However, several limitations should be considered. All criteria were combined using equal weighting, which may not reflect their actual importance in transit planning. For example, terrain constraints and environmental factors may influence route feasibility differently than commuter demand, yet each factor contributed equally to the final impedance surface. The analysis also did not include existing transit infrastructure,

land use conditions, potential expropriation costs, or broader environmental considerations beyond wetlands and water bodies. The expanded analysis addressed one of these gaps by adding proximity to existing Halifax Transit bus routes as an additional impedance criterion. Despite this change, the Part 2 route differed only slightly from the original route, suggesting that existing bus corridors already align with areas of low impedance identified in Part 1. This result indicates that the proponent's original model already captured many transit-suitable corridors. Nevertheless, the Part 2 route is recommended for presentation because it more clearly demonstrates multimodal transit integration and provides a stronger planning justification aligned with Halifax's Rapid Transit Strategy (Halifax Regional Municipality, 2020).

Reference:

Chatterjee, K., Chng, S., Clark, B., Davis, A., De Vos, J., Ettema, D., Handy, S., Martin, A., & Reardon, L. (2020). Commuting and wellbeing: A critical overview of the literature with implications for policy and future research. *Transport Reviews*, 40(1), 5–34. <https://doi.org/10.1080/01441647.2019.1649317>

Halifax Regional Municipality. (2020). *Halifax rapid transit strategy*. <https://www.halifax.ca/transportation/transportation-projects/transforming-transit>

Halifax Regional Municipality. *Transit bus routes* (GIS data set). Halifax Data, Mapping & Analytics Hub. https://data-hrm.hub.arcgis.com/datasets/69adb7a88a4e4343bf5ae7c381f2d9af_0/explore

Liu, X., Schmöcker, J.-D., Zhao, J., & Yang, X. (2025). How to make service better? A review on developing service-oriented public transit systems. *Transport Reviews*, 45(5), 672–695. <https://doi.org/10.1080/01441647.2025.2502629>