Planning of Emergency Evacuation for Persons with Disability

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BACKGROUND

☐ Cities face **enormous risks** from natural disasters, man-made disasters, and extreme weather

☐ Cities with high proportion of **persons with disability (PWDs)** are at the **most risk**

HALIFAX

9% Population growth

Provincial average is 5.0% and national average is 5.2%

25% Physically impaired

Persons by 2030

☐ The Regional Centre holds

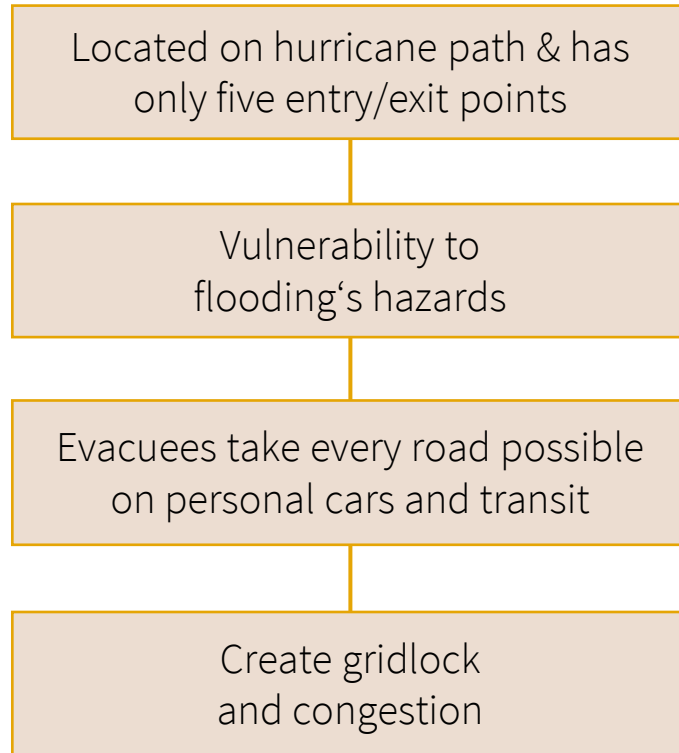↓ vehicle ownership   ↑ transit pass ownership

compared to the HRM

From 1975 to 2006, there was an increase of:

3X Natural disasters

10X Man-made disasters

(El-Sioufi, 2009)

| Located on hurricane path & has only five entry/exit points |

| Vulnerability to flooding's hazards |

| Evacuees take every road possible on personal cars and transit |

| Create gridlock and congestion |

❑ **Integrated evacuation modelling** tool can aid evacuation planning with the knowledge of:

- Network vulnerability

- Population's vulnerability

- Evacuation routing

- Traffic operation improvement strategies

to develop more **inclusive evacuation policies**

Inclusive Evacuation Plan

SCOPE AND ASSUMPTIONS

- ❑ Evacuation of PWDs requiring mobility assistance from public Hospitals (Hs) & Nursing homes (NHs) in the peninsula

- ❑ Nova Scotia provincial Emergency Medical Service (EMS) administrative database for mobilization time

- ❑ Destinations within 100km radius of the Halifax Peninsula

- ❑ Only provincially-owned ambulances are utilized – assume a 50% availability

6 Public hospitals and nursing homes (i.e., long-term care facility

90 Ambulance vehicles

512 Persons with disability

❏ Three-stage approach

1 Selection of candidate routes

2 SWOT and point system

3 Planning recommendations

❏ SWOT Analysis

- Strength
- Weakness
- Opportunities
- Threats

Roadway Element Evaluation

| Roadway element evaluation criteria	Score		
	Zero	One	Two
# of 4-way intersections	16-20	10-15	3-9
# of 3-way intersections	24-31	16-23	8-15
# of signalized intersections	13-16	9-12	4-8
# of inbound lanes	1.00-1.33	1.34-1.66	1.67-2.00
# of outbound lanes	1.00-1.33	1.34-1.66	1.67-2.00
# of inbound transit lanes	0	0.01-0.49	0.50-1.00
# of outbound transit lanes	0	0.01-0.49	0.50-1.00
Flood risk	2.9m & 3.9m	>=7.9m	None
Wind i.e., possibility of closure/restrictions	Yes	No	-

Flood risk and Traffic microsimulation models

Five exit points, including (i) Macdonald Bridge, (ii) Mackay Bridge, (iii) Armdale Rotary, (iv) 102 Highway, and (v) Bedford Highway

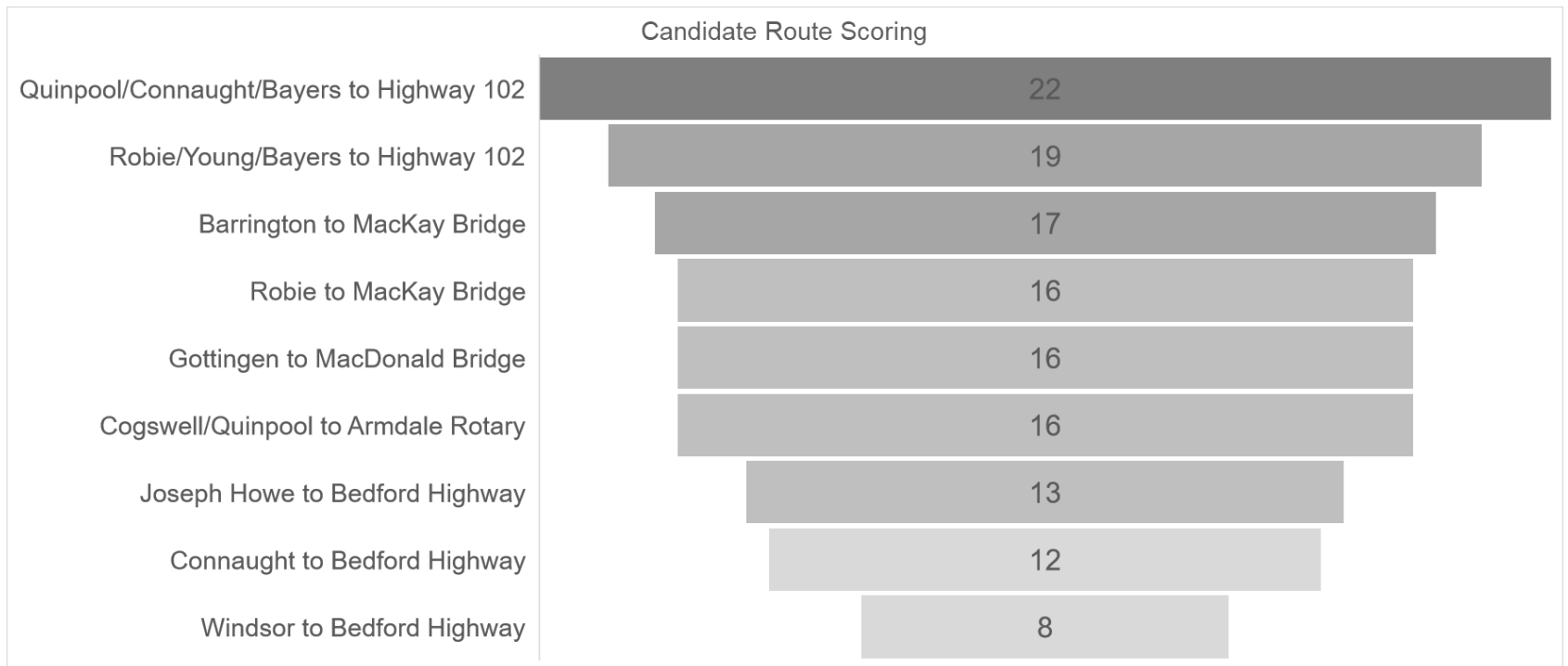Flood Extent: 2.9m, 3.9m, 7.9m and 30m CGVD28
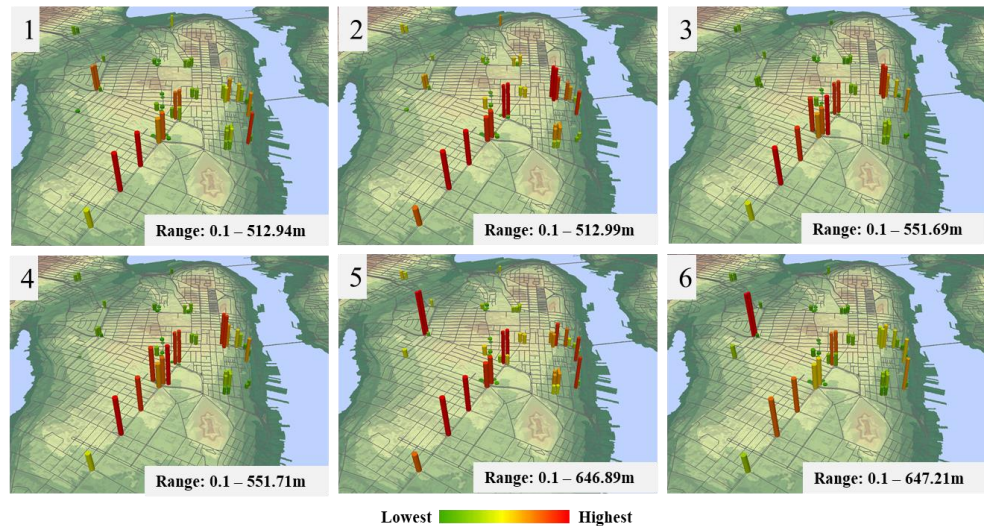
Congestion points at intersections

❑ SWOT Result Analysis

▪ Strength criteria – 11; Weakness criteria – 4; Opportunity criteria – 4; Threat criteria – 5

Candidate Route Scoring

Route	Score
Quinpool/Connaught/Bayers to Highway 102	22
Robie/Young/Bayers to Highway 102	19
Barrington to MacKay Bridge	17
Robie to MacKay Bridge	16
Gottingen to MacDonald Bridge	16
Cogswell/Quinpool to Armdale Rotary	16
Joseph Howe to Bedford Highway	13
Connaught to Bedford Highway	12
Windsor to Bedford Highway	8

❏ In Summary: Route "Quinpool/Connaught/Bayers to Highway 102" is found optimum with-

- Competitive number of strength points (3) & limited/no weakness/threats in SWOT analysis

- Maximum score (22) in road way element evaluation
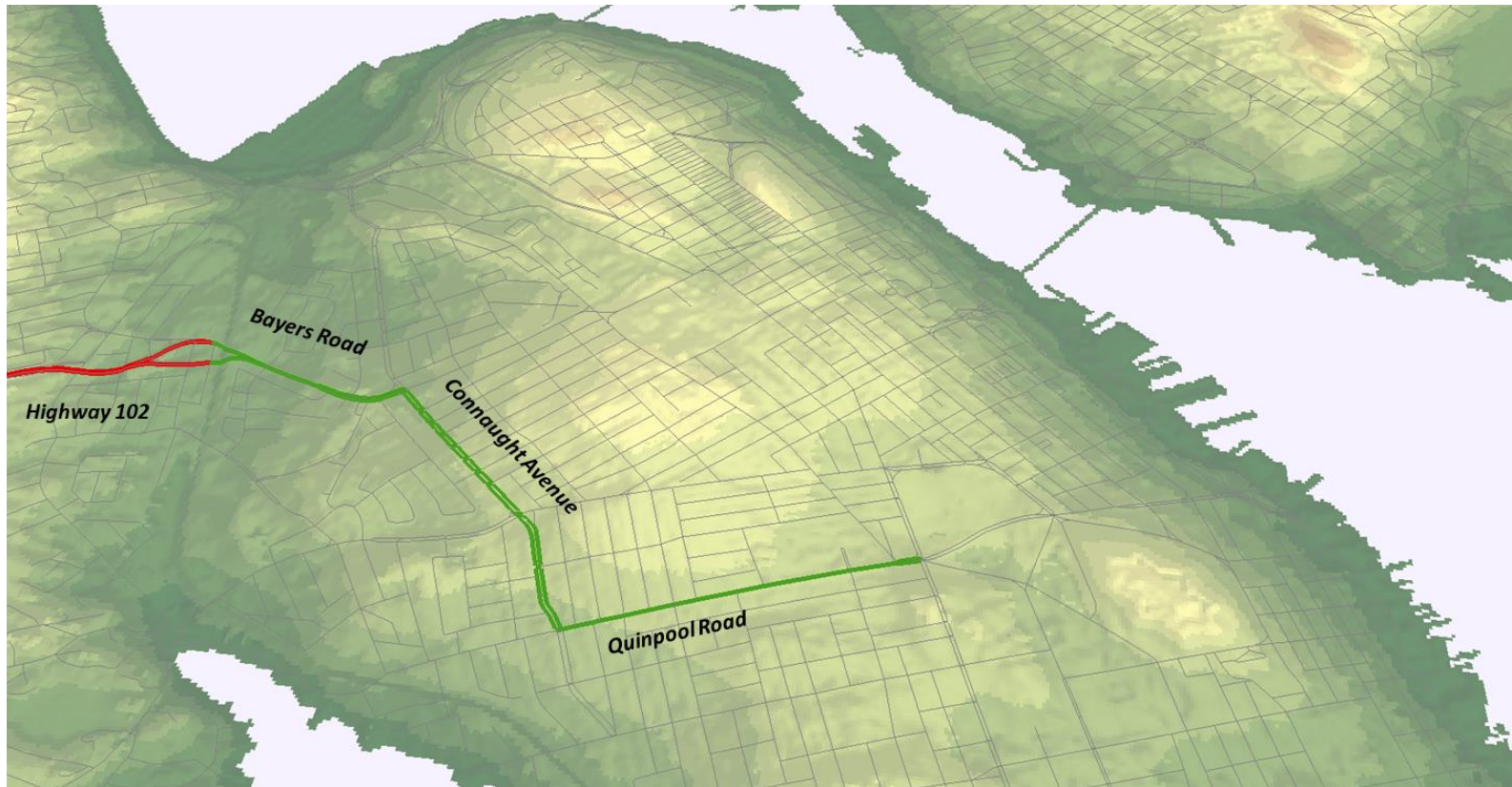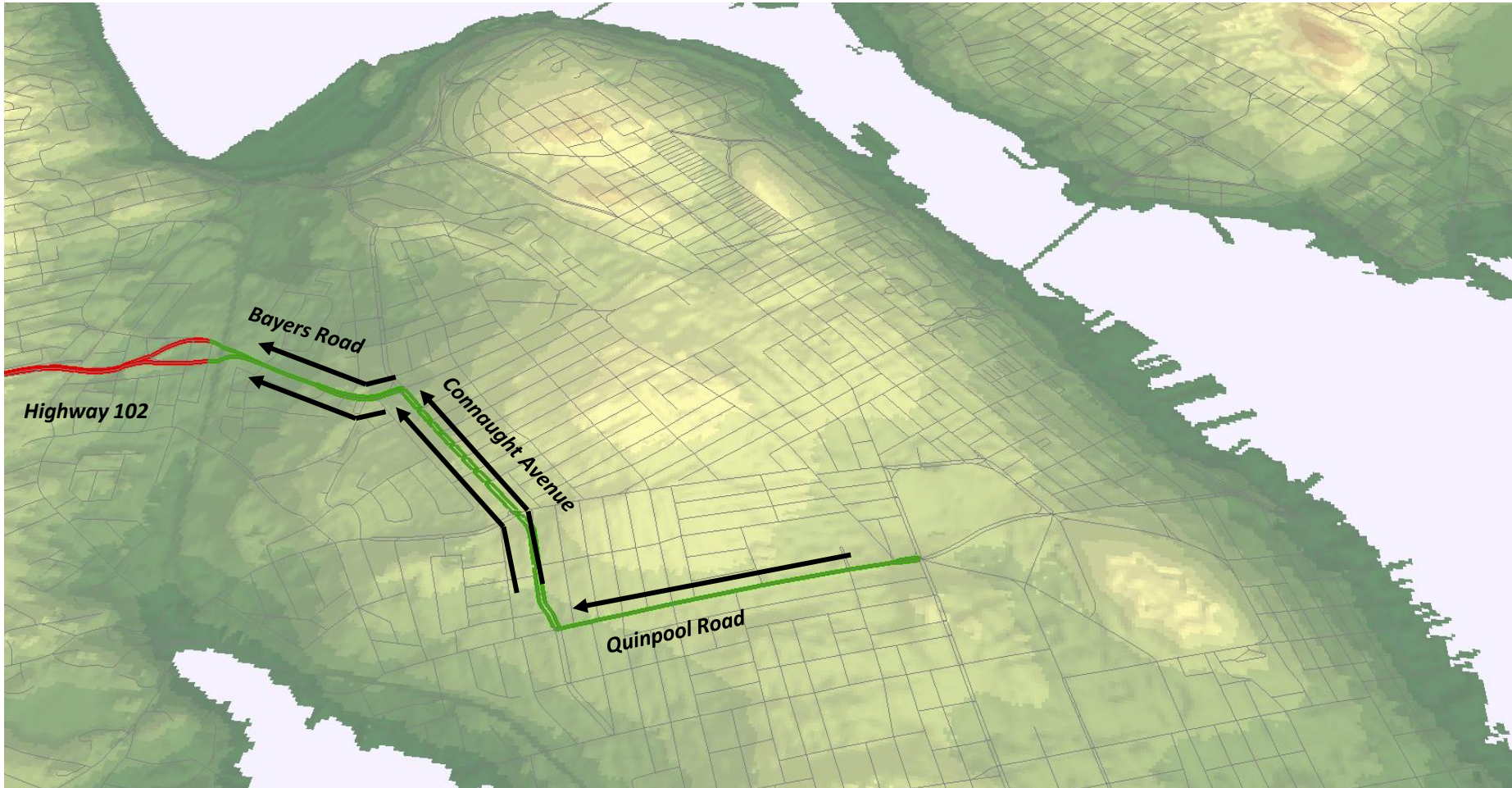
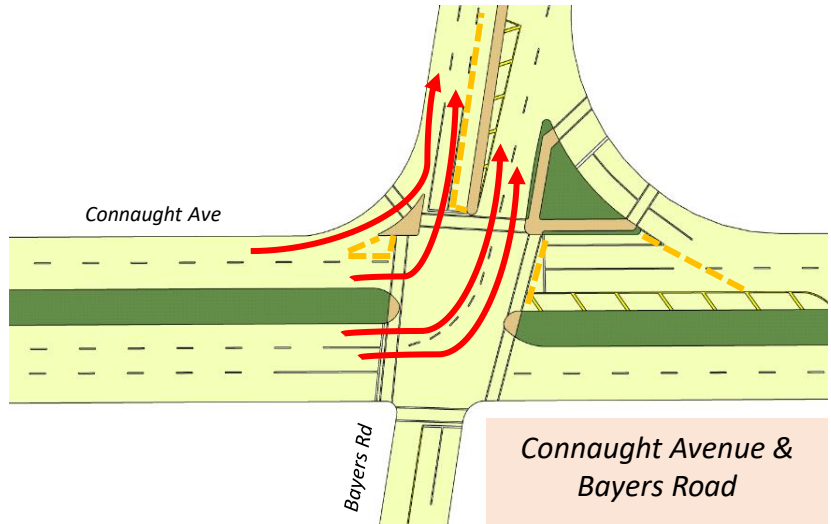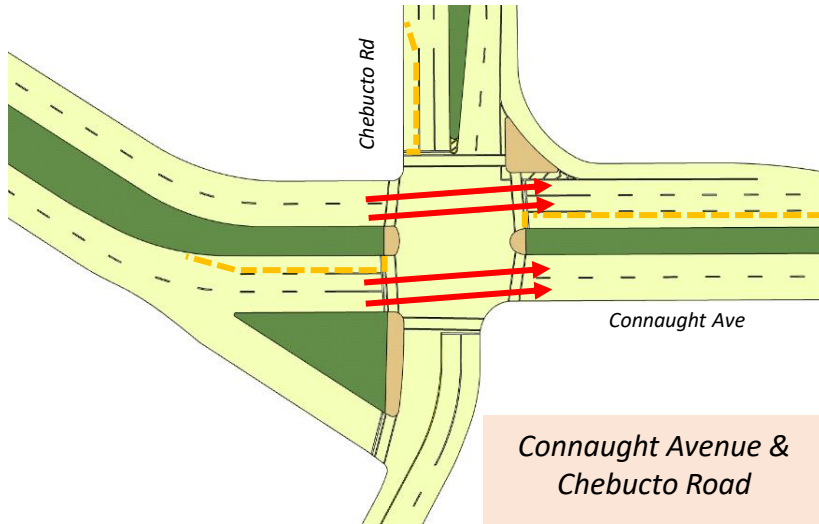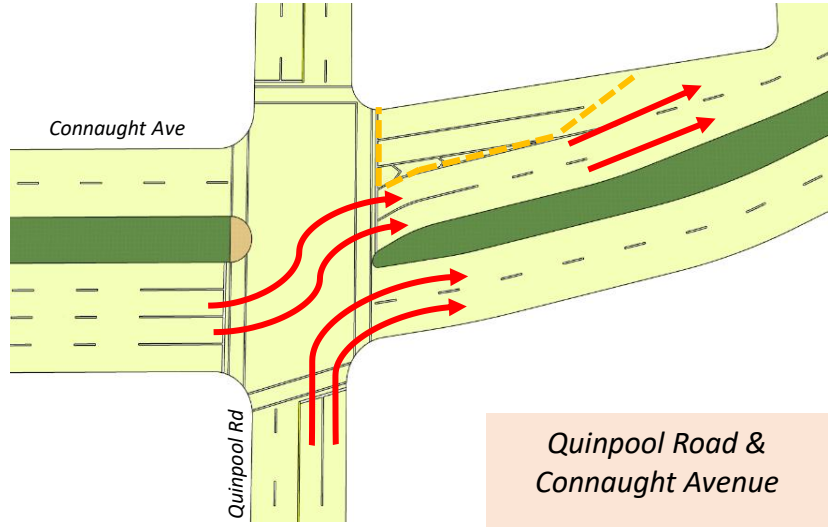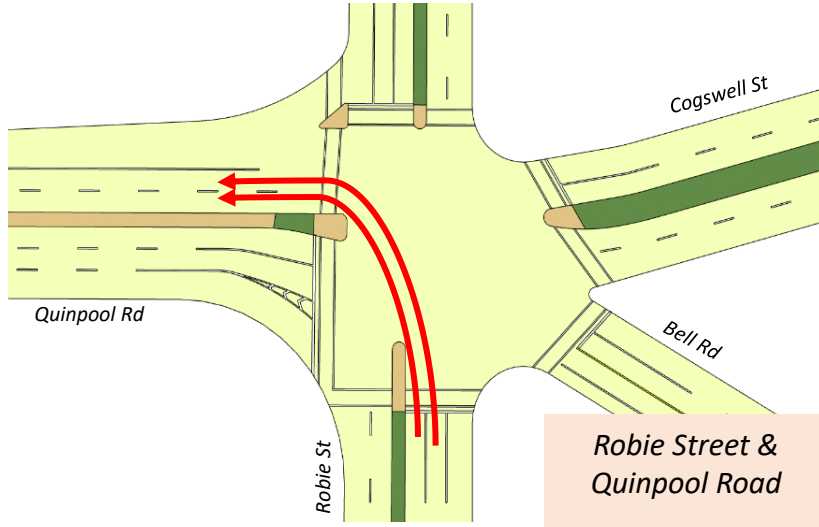❑ Selected Evacuation Route – SWOT and Point System Analysis

❑ Selected Evacuation Route – SWOT and Point System Analysis

❑ Contraflow Traffic Operation

Robie Street &
Quinpool Road

Quinpool Road &
Connaught Avenue

Connaught Avenue &
Chebucto Road

Connaught Avenue &
Bayers Road

EVACUATION MODELLING FOR PWD

❑ Two-stage approach

1 — Optimization: origin, destinations & ambulance schedule

Origin 1
Time t3

Origin 2
Time t1

Tour 1

Tour 2

Time t2

Time t4

Shelter 1

Shelter 2
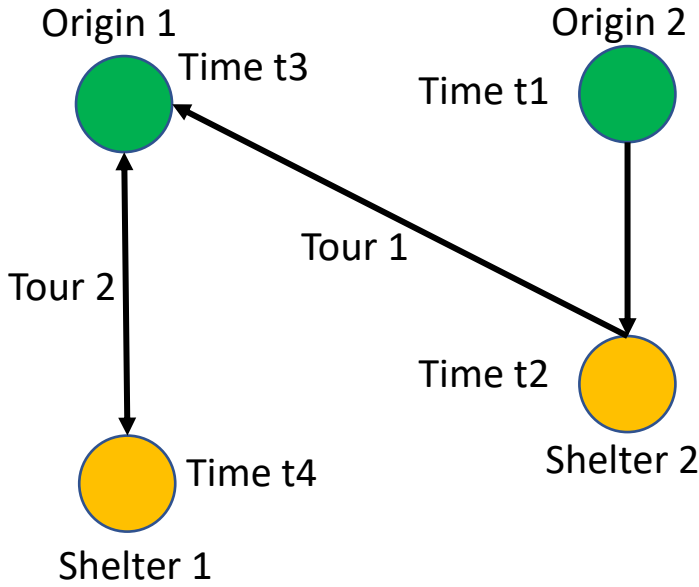
2 — Traffic Simulation: PWD evacuation w/o evac. route

❑ Origins and Destinations

Evacuation Shelters (Within 100 KM)

Departure Facilities

Halifax Peninsula

Halifax Regional Municipality

Province of Nova Scotia
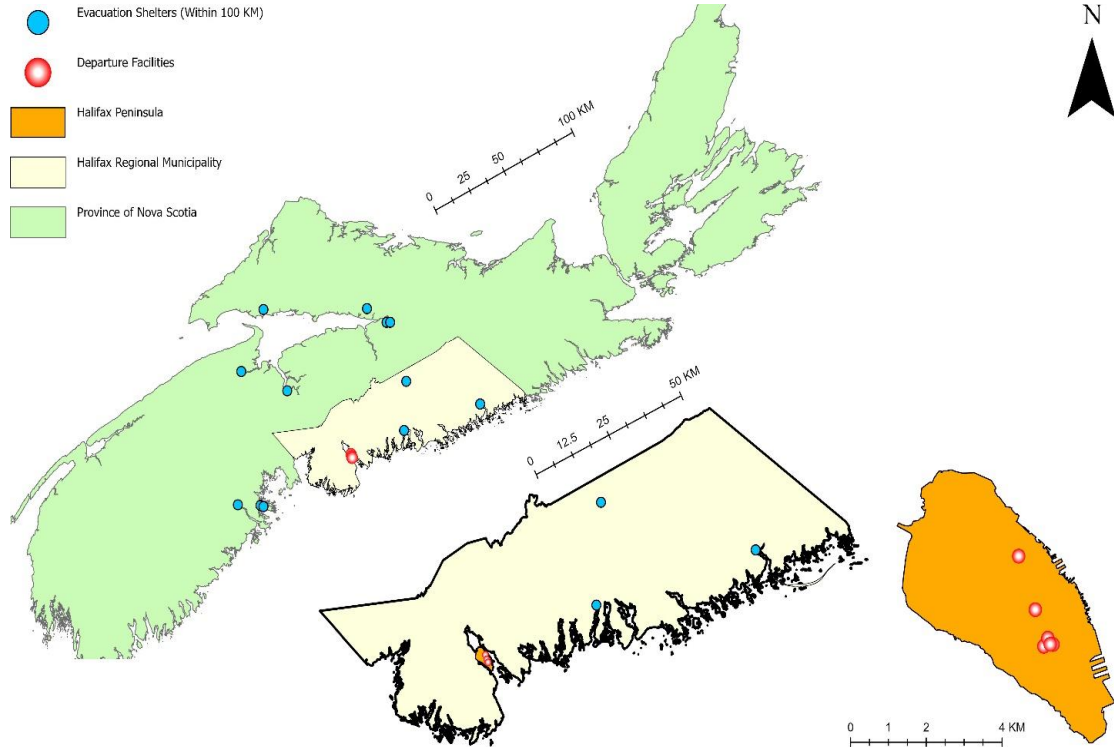
Halifax Peninsula Contextual Geography with Receiving and Departing Locations

❑ PWD Evacuation Modelling Summary

- 1784 links

- 53 intersections

- 56 traffic analysis zones

- 14 Shelters/destinations, including Hs, & NHs

- Calibration and validation, R^2: 0.82 and 0.84

- Ambulance trip attributes: origin, destination, trip start and end time

- Dedicated route with contraflow

1	Simulation Without dedicated route

2	Simulation With dedicated route

❑ Destinations Demand

- Destinations: 42km–72km: 43% of PWD

Shelter 43% of PWDs

Due to proximity to the peninsula

❑ Overall Evacuation

- Evacuation completion peaks at 4th – 9th hour
- 73% of zones improves evacuation time by **4.75 HOURS** or less

❑ PWD Evacuation Time Analysis

- Average time for ambulance to make a round trip

  6-25.2 MINUTES less with emergency route

- Travel time along the route reduces by **32.31%** with emergency route

- Total evacuation time: 21 hours

- ❑ Evacuation route paired with countermeasure improves evacuation time and network operations

- ❑ This route can be used for evacuation of PWDs at community level

- ❑ A baseline understanding – traffic operations, resource needs for PWD evacuation from public hospitals and nursing homes (long term care facility)

- ❑ Future Direction

  - ▪ Planning for shelter accessibility

  - ▪ Identifying location of PWDs at community level

  - ▪ Alternative countermeasure (e.g., Access-A-Bus evacuation)

❑ What is your opinion on the following aspects

1. Where do PWDs live in the region?

2. What other factors should we consider to address the mobility needs of PWD at community level?

3. What should the other countermeasures be to evacuate PWD from the region efficiently?

4. Are you aware of other jurisdictions that doing the similar works with whom we could share our results?