Greenhouse Gas Emissions and Transportation Scenarios in Southwestern New Brunswick:

Past, Present and Future Opportunities to Reduce Emissions

Eastern Charlotte Waterways Inc.
On Behalf of Southwest New Brunswick Transit Authority Board
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Executive Summary

In 2019, the Southwest New Brunswick Transit Board (SWNBTAI) obtained an Environmental Trust Fund (ETF) grant to design and create a series of transit options to meet the transportation needs that service Charlotte County. There has long since been a need to attain a coordinated transportation strategy for the region and as such SWNBTAI subcontracted Dillon Consulting Inc. to create a ready-to-implement business model for multiple potential transportation services in the region. The following report is an appendix to the final Dillon project and is meant to act as a supplementary greenhouse gas emissions (GHG) model to assist the SWNBTAI with gaining future grants needed for capital investment in the transportation scenarios proposed by Dillon Consulting. This report was completed with the assistance of the final Dillon report entitled *Southwest New Brunswick Transit Authority Inc: Integrated Public Transportation Plan* and through consultation with several board members. These projections were created with data obtained through the report, Statistics Canada and other relevant resources. It is Eastern Charlotte Waterways (ECW) intention to provide SWNBTAI with an accurate, relevant and useable greenhouse gas emissions model, most importantly where the potential greenhouse gas savings and reductions exist, for their transportation services.

It is important to note that the following calculations were made from available data sources and do not reflect "exactitude" but rather relative accuracy based off what we know and what was made readily available to us. Many assumptions, most notably the number of currently used single use passenger vehicles, were made to create a baseline to produce GHG reduction model results. That being said, there are many households and individuals in the region who do not own a vehicle or regularly use the vehicles that they do own. It was assumed that the number of single passenger vehicles stated in StatsCan reports[1] (2016) are used frequently in the region which demonstrates the high amount of emissions generated from transportation. However, the number of passengers in the vehicles, frequency of use, distance travelled and fuel consumed was assumed to be a 'high emissions scenario' in which case the baseline for this report assumes **(a)** all single passenger use vehicles undergo regular use **(b)** each single passenger vehicle has a single driver and **(c)** a high annual commuting distance of 30,000 kms is driven.

The following report contains:

1. A section dedicated to methodology and an overview of how greenhouse gas emissions and reduction models were created and subsequently calculated.
2. An overview of total emissions generated, and potential emission reductions, from each municipality's vehicle use as well as past transportation scenarios and current transportation scenarios available in southwestern New Brunswick
3. Calculations that reflect possible greenhouse gas emissions generated from potentially acquired vehicles and their usage in Dillon transportation scenarios.
4. A cross comparison of total emissions from past and current transportation scenarios to projected greenhouse gas emission levels proposed from the transportation scenarios provided by Dillon Consulting Inc.
5. Adjusted numbers for 'daily ridership potential' expressed by the Dillon Report to be reduced by 50% and 25% to account for (**a)** time for the introduced transportation scenario to adjust and grow a customer base and (**b)** time for the transportation scenario to grow to the 'optimal daily ridership potential' as proposed by Dillon.
6. An expansion on the GHG emissions scenarios provided by Dillon Consulting Inc. to provide emission scenarios possible for each proposed transportation scenarios on a high to low demand scale

[1] Statistics Canada. 2016 CENSUS Report.

7. A case for a greenhouse gas emissions reduction from previously used models to proposed models to provide adequate justification for other grant funders

Methodology:

The following project uses the Natural Resources Canada's (NRCAN) Greenhouse Gas equivalency calculator to determine the estimated $CO_{2e,}$ which assumes 0.002347 metric tons of CO_{2e} equivalent emissions per litre of gasoline combusted.

In order to do the necessary calculations, several assumptions had to be made:

- Fuel efficiency (FE) by single use passenger vehicle to be 8 L/100 km or 0.08.
- Average Distance Travelled (ADT) is to be 15, 864 kms annually.

FE = fuel efficiency
ADT = average distance travelled
TLC = total litres of gas combusted

Therefore:

CO_{2e} per average single use passenger vehicle in Charlotte County:

$FE * ADT = TLC$ ⟹ *$= 0.08 * 15, 864 = 1269.12$ L*

$TLC * 0.002347 = ACO_{2e}$ ⟹ *$= 1269.12 * 0.002347 = 2.97$ or 3 $MtCO_{2e}$*

Avg. CO_{2e} in single passenger vehicle = 3$MtCO_{2e}$ annually

The reduction potential methodology:

In order to make a case for greenhouse gas emission reduction, Eastern Charlotte Waterways created a baseline model to demonstrate how the proposed transportation models would reduce single passenger vehicle emissions annually in Southwestern New Brunswick (SWNB). This translates directly into single passenger vehicles being taken off the road to be replaced by alternative transit services. The following data was calculated using CENSUS 2016 data which provided total number (#) of single passenger vehicles in SWNB. Assuming all passenger vehicles are of an average fuel efficiency (8 L/100 km) and being used regularly, the total average distance and the total average CO_{2e} emissions were calculated for an individual passenger vehicle used annually in Southwestern New Brunswick.

The table below demonstrates *how* the baseline data was created. Subsequently, the greenhouse gas (GHG) reduction model shows the average annual emissions from a single passenger vehicle that may be removed from the road in the event of the driver selecting one of the proposed transit models. This shows how the proposed transit models, with appropriate ridership uptake, will demonstratively reduce the total number of GHG emissions contributed by single-passenger vehicle use. The reduction model uses the high GHG emissions model (assumed from single use passenger vehicles driving 30,000 kms a year) to account for rural needs and uniqueness. However, the average annual emissions rate was calculated using 15,864 kms as the baseline.

Other resources used to complete this project included the NRCAN *Vehicle Emissions Comparison Tool.* This tool is used to find out how much GHG emissions are generated from different vehicle model types and varying levels of fuel efficiencies. It uses information from the Fuel Consumption Guide from Natural Resources Canada to calculate emissions for gasoline and diesel vehicles. The tool was used to calculate various vehicle model type emission rates. The vehicles that were selected are identified in a table below and were selected due to data acquired from AutoTrader Online, the New Brunswick Consumer Reports and other vehicle registration records from Statistics Canada to identify the most commonly driven cars in New Brunswick. This was then

compared to the three (3) vehicle models currently being explored by the SWNBTAI to demonstrate overall GHG emission rates from each vehicle while in use in different transportation scenarios.

Baseline: 24, 045 passenger vehicles with (8 L/100 km efficiency) driving 10,000 km (low) to 30,000 km (high) annually. Whereas *p = passenger, dt = distance in kms, fe = fuel efficiency* (8 L/100km), *TLC = total litres of gas consumed and m = 0.002347* (CO_{2e} for 1 litre of gas combusted)

Baseline Scenarios

P^1 (low distance travel scenario)
*[fe * dt] = TLC*

*0.08 * 10,000 = 800 L*
TLC M*
*800 * 0.002347*
= 1.88 $MtCo_{2e}$ (total P^1 emissions for 10,000 km)

P^2 (high distance travelled scenario)
*[fe * dt] =TLC*

*0.08 * 30,000 = 2,400 L*
*TLC * M*
*2,400 * 0.002347*
= 5.63 $MtCo_{2e}$ (total P^2 emissions for 30,000 km)

(AAE) Average Annual Emissions = 3 $MtCO_{2e}$ (*for 15,864 kms driven annually****)***

CO_{2e} Reduction Model = $\frac{\textit{AAE * total \# of annual potential ridership – total GHGs from transportation scenario}}{\textit{High GHG emissions model of all emissions from all passenger vehicles annually}^1}$

[1]High GHG emissions model assumes each passenger vehicle is travelling 30,000 kms annually and emitting 5.63 $MtCO_{2e}$.

Current Transportation Scenarios and Greenhouse Gas Emissions Models in Southwestern New Brunswick

In 2015, ECW obtained funding to create GHG inventories for four municipalities in southwestern New Brunswick: St. Stephen, St. George, Blacks Harbour and Grand Manan. Through this process, several calculations were made including a comprehensive overview of 'community emissions levels.' Community emissions were calculated using the *Partners for Climate Protection* tool available through the Federation of Canadian Municipalities (FCM).

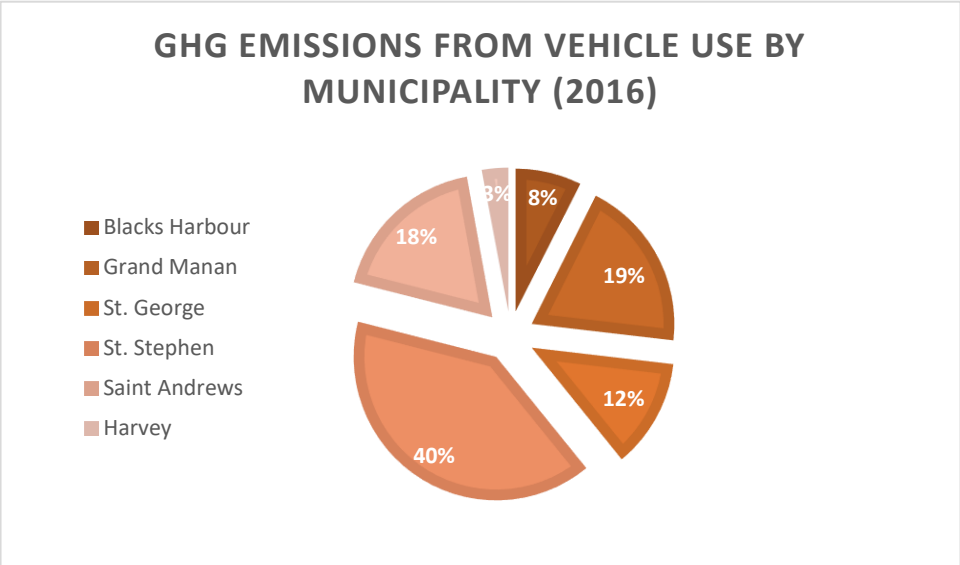

Figure 1: Total (relative) emissions by vehicles in comparison to other community emissions sectors by municipality in 2016

This tool focused on five major areas of emissions by residents and community members in the region. These areas included: residential, commercial, industrial, **transportation** and solid waste. The following graph, with the additions of the town of Saint Andrews and the village of Harvey (**Figure 1**) represents the breakdown of current emissions by municipalities with St. Stephen having the highest level of emissions produced from transportation uses (only single-use passenger vehicles). These numbers were calculated using the PCP tool which takes into consideration the number of households in the community, the average number of vehicles per household in New Brunswick and the average annual distance traveled by vehicles in New Brunswick. As provided by the PCP Milestone tool, the average number of vehicles per household was 1.60 and the average annual distance traveled by vehicles in New Brunswick was 15,864 kms.

The following table represents the total CO_{2e} generated from single-use passenger vehicles used by the Charlotte County and York County population. Statistics Canada reported in 2016 that there was a total of 24,045 single passenger vehicles in Charlotte County. That number was used as a representative baseline for all of Charlotte County to determine which municipalities emit the most emissions from vehicle use.

Area of Interest	Approximate # of vehicles (1.60 per household * # of households)	Total amount of emissions ($MtCO_{2e}$)	% of emissions for region from single use passenger vehicles
Charlotte County	24,046	72, 138	-
St. Stephen	3529.6	10, 588.8	14.7%
Grand Manan	1720	5,160	7.15 %
St. George	1089.6	3, 268.8	4.53 %
Blacks Harbour	657.6	1, 972.8	2.73%
Saint Andrews	1612.8	4, 838.4	6.7 %
Harvey	252.8	758.4	1.05%

Table 1: Total approx. emissions rate from each municipality in comparison to overall emissions rate from region

An overview of total emissions from past and present transportation models

It is important to have a comprehensive picture of what the current levels of emissions from community-based transportations scenarios potentially look like and to also compare it to present or past transportation scenarios occurring in SWNB. The following table demonstrates an overview of total annual emissions from past (Rural Lynx bus) and present transportation models (single-use passenger cars and Charlotte Dial-A-Ride programs). In order to provide a more comprehensive picture, several GHG emissions models were created based off various distance travelled as we do not have exact data that reflects distance travelled in the region annually. The distance traveled for single passenger vehicles were scaled to a low and high usage model with 10,000 km annually being the lowest distance travelled and 30,000 kms annually being the highest. Generally, reports indicate that the average New Brunswicker travels 15,864 kms annually. However, that is perceived to be mildly conservative given the rural nature of SWNB and the long distances between municipalities and as such we present an annual distance of 30,000 kms as a high estimate of total distance travelled for individuals who reside in the region.

The Rural Lynx distances were measured knowing that the bus travelled (approximately) a fix route from St. Stephen to Saint John twice daily, seven times a week. The higher distance travelled for this route was calculated by adding the Bangor, Maine trips that occurred twice weekly in 2018. These numbers are meant to assume a low-high range and are not exact. The Dial-A-Ride data was acquired directly from the Executive Director, Dana Planetta, and reflect exact distance travelled. Dial-A-Ride is unique because it uses approximately twenty-one (21) vehicles, all of varying model types and fuel efficiencies. However, from communication with Dial-A-Ride, the models assume a fuel efficiency of 8 L/100 kms as most of the vehicles used are 2015 and newer.

Transportation Scenarios	**Means of Transportation**	**Annual Vehicle Kilometers Travelled (km)**	**Annual Fuel Consumption (L)**	**CO_{2e} (Metric tons)[2]**	**Total Ridership Uptake (annually)**	**CO_{2e} Reduction Potential from Baseline High Emissions Scenario**
Single Passenger Vehicles ***FE = 8 L/100 km***	24,045 single drivers[3]	**Low:** 10,000	**Low:** 19, 236,000	**Low:** 45, 146	+/- 24, 045	0%
		High: 30,000	**High:** 57,708,000	**High:** 135,373		
Rural Lynx ***FE: 32 L/ 100 km***	1 Diesel transit bus (on single fixed route)	**Low:** 164, 396	**Low:** 52, 606.72[4]	**Low:** 123.47	2, 190[5]	+/- 4.7%
		High: 227, 196[6]	**High:** 72, 702.72	**High:** 170.63		

[2] The formula provided by NRCan = 0.002347 $MtCO_{2e}$ per litre of gasoline combusted.
[3] An average fuel efficiency of 8 L/100 km was assumed. The number of single passenger vehicles was acquired from 2016 CENSUS data.
[4] Fuel efficiency of a diesel bus is 32 L/100 km.
[5] This was calculated based off the average # of daily passengers (6) multiplied by the total # of days in a year (365). The data was acquired from p. 2 of the Dillon Report. It is important to note that for the duration of its service, Rural Lynx provided approximately 3, 250 passenger trips from 2017 to 2019.
[6] This low mileage number was calculated using the total distance on the fixed route from St. Stephen to Saint John (112.6 km) multiplied by two return trips daily (450.4km) multiplied by 365 days a year. The higher mileage number accounted for the services Rural Lynx provided in 2018 during which time there was 2 trips a week to Bangor Maine from St. Stephen, NB. The total distance from St. Stephen to Bangor, Maine (154 km) multiplied by two trips weekly.

Charlotte Dial-A-Ride **FE = 8 L/ 100km**	21 passenger vehicles[7] (on flex schedules)	**Exact:** 174, 176.9	**Exact:** 13934.2	**Exact:** 32.7	6,639[8]	+/- 14.7%

Table 2: Possible GHG emissions models from current and previous transportation scenarios in the region using low and high projections of distance travelled.

Next, we calculated the potential GHG emissions models produced by the proposed vehicle models that may be acquired by the Transit Authority Board to satisfy the proposed transportation scenarios. Prior to calculating the total emissions levels from proposed vehicle models, we also calculated the total annual emissions levels from vehicles currently on the road in New Brunswick. Using 2017 Statistics Canada data relating to a total number of vehicle registration by type, the most searched vehicles from AutoTrader and the 2017 Consumers Report for New Brunswick, the following vehicle model types were selected.

These vehicles were then placed in the NRCAN *Vehicle Emission Comparison Tool* with a baseline average of 30,000 km/annually. The cars that were selected were provided a base year of 2017. From there, the total annual greenhouse gas emissions were calculated and converted from kilogram (kg) to metric tons (Mt).

	Vehicle Type	**Model**	**Fuel Efficiency (total L/100km)**	**CO_{2e} (in metric tons)**
Current Average Vehicle Model in New Brunswick	Ford	F-150 AS6, 6 cyl, 3.5 L	11 – 13 L	8.28
	Subaru	Outback, AV6, 4 cyl, 2.5 L	8.1 L	5.73
	Honda	Civic AV, 4 cyl, 1.8L	6.9 L	4.89
	Honda	CRV, AV, 4 cyl, 2.4 L	8.0 L	5.37
	Ford	Escape, AS6, 4 cyl, 2.5 L	7.9 – 9.1 L	6.54
	Toyota	RAV4, AS6, 4 cyl, 2.5 L	4.2 L	6.15
Proposed Vehicle Models in New Brunswick				
	Ford	E350 cutaway bus	16 L	11.27
	Mercedes	Sprinter Van	12.5 – 14 L	8.8 (Low)
	Dodge	Ram Promaster Side Entry Accessible Van	12.5 – 13 L	8.8 (Low)

After computing the total emissions from the proposed vehicles, the vehicle model type [**Dodge Ram Promaster Side Entry Accessible Van**] was placed within the transportation scenarios provided by Dillon Consulting. This was to determine how certain vehicle models, in On-Demand Transit Scenario and the Flex Route Transit Scenario, would assist in the GHG emission reduction potential based off of their fuel efficiency. From here, the desired vehicle model type from the Transit Board was placed into the transportation scenarios proposed by Dillon to calculate the amount of overall emissions each vehicle would generate from low to high usage projections (based off total distance travelled).

Finally, the GHG reduction models were created for each of the proposed transportation scenarios by Dillon Consulting. It is important to note that potential ridership does not directly translate into potential vehicles off the road as ridership can include individuals who do not have licenses or individuals who do not have vehicles could be using the transportation services. That being said, the population of New Brunswick Southwest is approximately 25, 428 which accounts for approximately 3.4% of the population of New Brunswick. The population of Charlotte County that is eligible to drive (16 years or older) is approximately 16,260 which accounts for 63.9% of the Charlotte County population. If we assumed each of those individuals had an average transportation emission rate of 3 $MtCO_{2e}$ annually (drives approximately 15, 864 kms) then the overall emissions rate from eligible drivers in the region would be approximately 48, 690 MtCO2e. This is

[7] Data obtained from Dana Planetta, communications on March 4th, 2020. Assumes an average fuel efficiency of 6.5 L/ km as most of the vehicles used by Dial-A-Ride are 2015-2020 models.
[8] Data obtained from Dana Planetta, communications on March 4th, 2020. Total amount of kms driven: 174, 176.9 km

assuming a conservative estimate of average distance travelled and not reflective of a high emissions scenario (30,000 kms annually) where the average emissions rate would be 5.63 $MtCO_{2e}$ annually which translates into an emissions rate of 135,373 $MtCO_{2e}$ annually.

According to reports released by the provincial government, New Brunswick's total emissions rate for transportation is 6.1% of its annual emissions rate that accounts for all service sectors. New Brunswick has approximately 318, 285 single use passenger vehicles. Accounting for average distance travelled (15, 864 km) and average CO_{2e} (3 $MtCO_{2e}$) the emissions rate for single passenger vehicle usage in New Brunswick would be approximately 954, 855 $MtCO_{2e}$. Charlotte County has a total of 24, 045 single use passenger cars, if traveled the average distance and emit the AAE, the emissions rate for SWNB would be approximately 72, 138 $MTCO_{2e}$. That's over 7.6% of the single use vehicle owners in New Brunswick. The total amount of emissions in New Brunswick is 15,700, 000 $MtCO_{2e}$ (or 15.7 $MTCO_{2e}$) and the total transportation emissions from Charlotte County accounts for 0.5% of all emissions from New Brunswick.

Flex Route from St. Stephen to Saint John

Using a 12-passenger van vehicle (12.5 L/100 km) and projections acquired from the SWNBTAI board.

Vehicle Type	Fuel Efficency (L/100km)	# of Return Trips/Year (St. Stephen to Saint John – 128 km one way)	Distance Travelled (kms)	Annual Fuel Consumption	Annual CO_{2e}	Daily Ridership Uptake (3 times day)	Ridership Uptake[9]	Reduction Potential from High Emissions Scenario
Dodge Ram Promaster Van	12.5 L	510	130,560	16,230	38.30	**Low:** 3	**Low:** 624	+/- 1.35%
		357	91, 392	11,424	26.8			
		255	65,280	8, 160	19.15	**High:** 36	**High:** 7, 488	
		153	39, 168	4,700	11.03			+/- 16.57%

The following table was created through data provided by the SWNBTAI. The board has sought a leasing project with a Van for the "Flex Route to Saint John." The data was provided in the leasing information provided by the Move Mobility Van Company. The ridership data, created by ECW, is reflected of the proposed transportation scenario by Dillon. It accounts for a 12-passenger van being used twice weekly, 3 times a day to service the route from St. Stephen to Saint John. It assumes 1 passenger per trip as the lowest potential ridership, resulting in 3 passengers daily. It assumes a full van of 12 passengers per trip as the highest potential ridership, resulting in 36 passengers daily. These numbers were multiplied 104 service days a year (2x/week). It should be noted that it is not within the expertise of staff member at Eastern Charlotte Waterways to calculate and extrapolate on datasets that were to be achieved by the Dillon Report.

On Demand Service:

Region being serviced by 2 small 12 passenger vans with a fuel efficiency of 12.5 L/100 km

[9] These numbers were calculated on the assumption that the Scheduled Flex Route *would **only*** operate 3 times a day, twice a week, which translates into 104 days a year. The assumption was that the SWNBTAI board purchased a 12-seat passenger van. Thus, the low ridership would be 1 passenger a day, and the high ridership would be 12 passengers daily for a **single trip.**

	Annual Vehicle Kilometres Travelled (kms)	Annual Fuel Consumption (L)	CO_{2e} (Metric tons)	Daily Potential Ridership	Annual Potential Ridership	Reduction Potential in a High Emissions Scenario
Dillon Consulting Datasets	608, 400	76,050	178.4	39	14, 235	+/- 31.4%
	1, 357, 200	169,650	398.2	87	31, 755	+/- 70%
ECW Datasets to account for 50% reduction of annual potential ridership	304,200	36,504	85.7	19.5	7717.5	+/-17%
	678,600	81,432	191.1	43.5	15,877.5	+/-35%
ECW Datasets to account for a 75% reduction of annual potential ridership	152,100	19,012.5	44.6	9.75	3,558.8	+/- 7.9%
	339,300	42,487.5	99.7	21.75	7,938.8	+/- 17.5%

Community Care Partnership:

Enhances services provided within the region by leasing 1-2 vans for use to supplement work done by Dial-A-Ride programs

	Annual Vehicle Kilometres Travelled (kms)	Annual Fuel Consumption (L)	CO_{2e} (Metric tons)	Daily Potential Ridership	Annual Potential Ridership	Reduction Potential in a High Emissions Scenario
Dillon Dataset	150,800	19,000	44.6	10	3, 650	+/- 8%
	301, 600	38, 002	89.2	20	7, 300	+/- 16.11%
ECW Datasets to account for 50% reduction of annual potential ridership	75,400	9,425	22.12	5	1,760	+/-3.9%
	150,800	19,000	44.6	10	3,520	+/- 7.76%

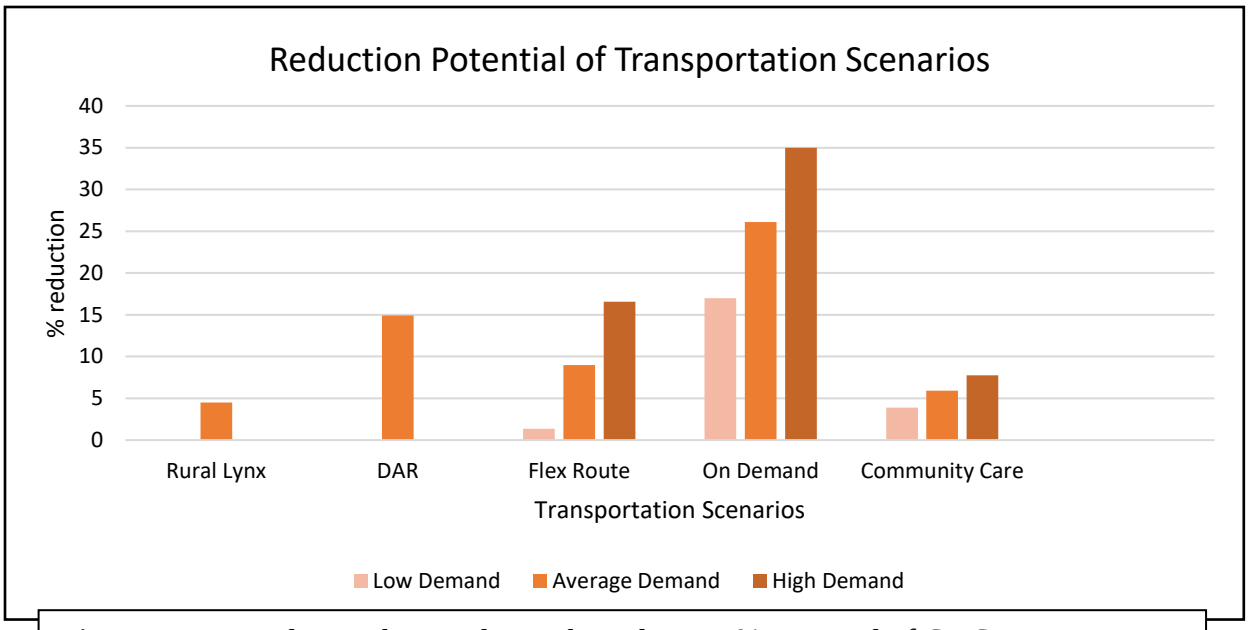

Figure: Using a cluster chart to depict the reduction % potential of GHG emissions from past and proposed transportation scenarios based upon passenger demand.

Conclusively, the case can be made that pursuing the aforementioned transportation scenarios would drastically help reduce the overall GHG emission level of SWNB and by extension, the province of New Brunswick. Investing in good, accessible and affordable transportation not only provides improved social welfare and generates increased economic revenue but also dramatically helps the environment and offsets large emission rates. This is becoming more and more important and relevant in the face of a changing climate. The Southwest New Brunswick Transit Authority Board has a unique opportunity to mitigate emissions, contribute substantially to the lives and welfare of individuals residing in Southwest New Brunswick and ultimately, helping fight against the ever-growing threat of the climate crisis. The provided emission reduction models may assist the SWNBTAI board with obtaining any of the following grants where showing a % of emissions reduced is a baseline requirement.