

Evaluating Public Transit Accessibility and Commute Efficiency in the City of Calgary

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April 5, 2025

Section A: Introduction

Calgary, one of Canada's largest and fastest-growing cities, continues to face increasing challenges in ensuring efficient and convenient service for an expanding population. Despite the extensive bus and CTrain networks throughout the city, there continues to be escalating demand for public transit, resulting in overcrowding, prolonged commute times, and service gaps in certain areas. These issues result in people having longer commutes and reducing the overall effectiveness of public transit.

This report will present an analysis of transit accessibility and how efficient a person's commute is within the City of Calgary. Transit accessibility can be described by how easily individuals can reach their specific destination by using public transit. While commuting efficiency can be represented by the total time of the commute, including wait times, travel times, delays, and transfers. An effective transit system will be accessible to all the communities in Calgary while also reducing the amount of time it takes to get to a person's destination. For this research project, an effective transit system is also defined as one where all citizens have a transit stop within a 500-meter radius of their home.

The primary objective of this analysis is to identify key issues within the City of Calgary's Transit system and propose data-driven solutions. The focus of the analysis will be on recognizing communities without adequate transit access, determining potential bottleneck areas in the current transit system, pinpointing priority areas for improvements in transit infrastructure, and comparing primary areas of concern to transit enhancements proposed by the City of Calgary.

By evaluating these aspects of the City of Calgary's transit system, this report aims to provide data-driven insights that can be used to support decision making and policy development around transit. Enhancing transit accessibility and commute efficiency will allow for a transit system that can accommodate a growing population by providing a positive commuter experience and ensuring that public transit remains a viable option for all current and new residents of the City of Calgary.

Section B: Analysis Questions

This section will aim to create 5 study questions centered around City of Calgary Transit Accessibility and Commute Efficiency:

- 1. Which communities have the lowest public transportation rank and thus require the most improvement?**
- 2. What neighborhoods use transit the most as their main mode of transportation?**
- 3. Which dense population areas are not adequately covered by public transit?**
- 4. Do the City of Calgary's proposed transit infrastructure improvements address some of these issues already?**
- 5. Which areas of the city have the most daily transit bottlenecks?**

Section C: Obtaining Data

To facilitate our analysis of various transit dimensions we gathered data from multiple sources. Each source is described below along with its accessible link. All data collected adheres to ethical guidelines and as such, all data collected came from publicly available sources such as the City of Calgary Open Data Portal, the Calgary Transit Website, and Statistics Canada.

City of Calgary Neighborhood Information:

<https://www.calgary.ca/communities/profiles.html>

The following dataset was acquired from the City of Calgary website and was created by combining key attributes from each of the 206 neighborhoods in Calgary. This dataset was used as it comes directly from the City of Calgary and is the most accurate and up to date information regarding each neighborhood that we could find. Each community profile includes information gathered from the “Census of Population” from Statistics Canada. These profiles for each community include key attributes that can help us answer our analysis questions such as community population, commute duration, time leaving for work, and number of residents who use transit as their main mode of transportation to work. Due to the community profiles being in a PDF format and the inclusion of irrelevant information to our analysis on public transit, the key metrics mentioned above had to be manually entered into the dataset for use in our analysis.

Using the community Abbeydale as an example, the following tables were extracted:

- Community population (in private households):

Abbeydale		
	Number	Per cent
Population in private households	5,925	100%

- Number of employed workers and main mode of transportation to work (specifically focused on the public transit row):

Abbeydale		
	Number	Per cent
Employed labour force aged 15 years and over in private households	2,335	100%
Driver – car, truck or van	1,785	76%
Passenger – car, truck or van	230	10%
Public transit	260	11%
Walked	15	1%
Bicycle	0	0%
Other methods	45	2%

- Communing duration of residents (in minutes):

Abbeydale		
	Number	Per cent
Employed labour force aged 15 years and over in private households	2,335	100%
Less than 15 minutes	345	15%
15 to 29 minutes	1,260	54%
30 to 44 minutes	465	20%
45 to 59 minutes	105	4%
60 minutes and over	155	7%

- Time leaving for work (to determine busier commute times):

Abbeydale		
	Number	Per cent
Employed labour force aged 15 years and over in private households	2,335	100%
Between 5 a.m. and 5:59 a.m.	290	12%
Between 6 a.m. and 6:59 a.m.	420	18%
Between 7 a.m. and 7:59 a.m.	530	23%
Between 8 a.m. and 8:59 a.m.	300	13%
Between 9 a.m. and 11:59 a.m.	275	12%
Between 12 p.m. and 4:59 a.m.	525	22%

The data was then manually entered into a dataset showing different attributes relating to public transit for each neighborhood in the city.

Neighborhoods of Calgary	Community Population	Employed Workers	Commute to Work Using PT	
Neighborhood	Population in Private Households	Employed Workers	Public Transit as Main Mode to Work	Duration < 15 Minutes
Abbeydale	5925	2335	260	345
Acadia	9915	3840	410	1270
Albert Park Radisson Heights	6740	2430	410	490
Altadore	7290	2245	120	780
Applewood Park	6830	2790	320	435
Arbour Lake	10335	3280	270	730
Aspen Woods	9435	2405	125	320
Auburn Bay	18090	7470	250	1465
Banff Trail	3805	1260	255	275
Bankview	5125	2280	270	630
Bayview	670	115	10	50
Beddington Heights	11295	4170	320	705

Calgary Transit Route Schedules:

<https://hastinfo.calgarytransit.com/HastinfoMVCWeb/RouteSchedules>

To determine frequency of transit services for bus and C-Train routes in various neighborhoods we had to collect the service schedule for each bus and train line within the city. This information was gathered directly from the Calgary Transit website and has up-to-date and accurate times for each route. By including the frequency of service dimension in our analysis, it can help us determine which neighborhoods have less frequent service and which areas in the city have bottlenecks as a result and may be an area of interest for future transit improvements. Along with the stop times, the dataset also includes route number, route name, and route direction. While gathering the scheduling data, we only included the schedule for the first stop of each route since the frequency of service on a specific route will be the same regardless of the station. Additionally, we decided to exclude school routes as they do not run on a frequent basis and as a result would not provide useful analysis to answer our study questions.

Using Bus Route 1 (Bowness/Forest Lawn) East as an example:

5027 - Bowness Terminal NW	04:31 AM	04:47 AM	05:03 AM	05:19 AM
8805 - EB 48 AV NW @ 88 ST NW	04:32 AM	04:48 AM	05:04 AM	05:20 AM
6739 - SB 85 ST NW @ 48 AV NW	04:33 AM	04:49 AM	05:05 AM	05:21 AM
5028 - SB 85 ST NW @ 46 AV NW	04:33 AM	04:49 AM	05:05 AM	05:21 AM
8807 - EB Bowness RD @ 85 ST NW	04:34 AM	04:50 AM	05:06 AM	05:22 AM
5029 - EB Bowness RD @ 83 ST NW	04:34 AM	04:50 AM	05:06 AM	05:22 AM

Each bus route's service times were then manually entered into our Transit Route Schedule dataset:

Route Number	Route Name	Direction			
1	Bowness/Forest Lawn	East	4:31 AM	4:47 AM	5:03 AM
1	Bowness/Forest Lawn	West	4:32 AM	4:48 AM	5:04 AM
2	Mount Pleasant/Killarney 17 Av SW	North	4:56 AM	5:26 AM	5:40 AM
2	Mount Pleasant/Killarney 17 Av SW	South	5:10 AM	5:24 AM	5:40 AM
3	Sandstone/Elbow Dr SW	North	4:28 AM	4:48 AM	5:08 AM
3	Sandstone/Elbow Dr SW	South	4:20 AM	5:02 AM	5:22 AM
4	Huntington	Clockwise	5:26 AM	5:45 AM	6:04 AM
5	North Haven	Counterclockwise	5:14 AM	5:33 AM	5:52 AM
6	Killarney/26 Av SW	East	5:00 AM	5:23 AM	5:46 AM
6	Killarney/26 Av SW	West	5:38 AM	6:01 AM	6:24 AM

The City of Calgary's proposed plans to improve transit:

<https://www.calgarytransit.com/content/dam/transit/plans---projects/2023%20RouteAhead%20Annual%20Status%20Update.pdf>

This is the PDF file from which we did qualitative analysis to determine if the City of Calgary has proposed improvement already. This PDF was chosen as the most recent publication and included progression updates on projects since their initial approval in 2023. Since this was a PDF, we did not have any quantitative datasets or numbers to analyze, so we used qualitative data analysis to obtain the information needed to answer our analysis question. Some of the biggest takeaways from this source were regarding the Primary Transit Network (PTN) and the Base Transit Network (BTN). By comparing these projects to population and frequency of service we can determine if communities, especially growing ones, will see an increase in frequency and better access to the Primary Transit Network.

Transit Routes:

https://data.calgary.ca/Transportation-Transit/Calgary-Transit-Scheduling-Data/npk7-z3bj/about_data

Transit routes were gathered from the scheduling data on the City of Calgary Open Data Portal. These files were in a .txt format and had to be transferred into excel using the “Get Data” feature. This allowed us to have a table format in excel that was usable for analysis. Gathering the transit routes and their respective route numbers allows us to look at the number of routes in each neighborhood to help analyze service levels across the city.

	A	B	C	D	E	F	G	H
1	route_id	route_short_n	route_long_n	route_desc	route_type	route_url	route_color	route_text_co
2	1-20759		1 Bowness/Forest Lawn		3			
3	1-20760		1 Bowness/Forest Lawn		3			
4	2-20759		2 Mount Pleasant/Killarney 17 Av		3			
5	2-20760		2 Mount Pleasant/Killarney 17 Av		3			
6	3-20759		3 Sandstone/Elbow Dr SW		3			
7	3-20760		3 Sandstone/Elbow Dr SW		3			
8	4-20759		4 Huntington		3			
9	4-20760		4 Huntington		3			
10	5-20759		5 North Haven		3			
11	5-20760		5 North Haven		3			
12	6-20759		6 Killarney/26 Av SW		3			
13	6-20760		6 Killarney/26 Av SW		3			
14	7-20759		7 Marda Loop		3			

Routes by Neighborhood:

<https://www.calgarytransit.com/content/transit/en/home/rider-information/lrt-and-bus-station-maps.html>

To identify which neighborhoods are served by each route, we created an additional dataset. To determine the outreach of each route, the information was gathered from the City of Calgary Transit System Map (2023). This allows us to discover which neighborhoods have a greater connection to more transit lines which allows for greater accessibility to easily reach more areas of the city. While some routes may have been slightly modified since 2023, that was the most current and up-to-date map published on the Calgary Transit Website.

To accomplish the allocation of transit routes to each neighborhood, we added a Neighborhood ID (a unique number to each neighborhood) into the Neighborhood Dataset.

	Neighborhoods of Calgary	Community Population
Neighborhood ID	Neighborhood	Population in Private Households
1	Abbeydale	5925
2	Acadia	9915
3	Albert Park Radisson Heights	6740
4	Altadore	7290
5	Applewood Park	6830
6	Arbour Lake	10335
7	Aspen Woods	9435
8	Auburn Bay	18090

Then, in a separate spreadsheet, each corresponding route was added to the appropriate Neighborhood ID based on the service map.

Neighborhood ID	Route Number
1	42
1	49
1	67
1	68
1	127
2	10
2	81
2	99
2	106
2	149
2	306

Data Layers used in ArcGIS Online Map Layers:

For later analysis using the ArcGIS platform, we used the following data sources to construct a mapping visual for questions 3 and 4. This allows us to visualize graphically which areas of the city are currently being unserved by the current transit system and which areas are/are not properly addressed based on the proposed transit improvement plans by the city.

- Transit LRT Stations (<https://data.calgary.ca/Transportation-Transit/Transit-LRT-Stations-Map/c6ee-wk9g>)
- Calgary Transit Stops (https://data.calgary.ca/Transportation-Transit/Calgary-Transit-Stops/muzh-c9qc/about_data)
- Calgary Transit Routes (<https://data.calgary.ca/Transportation-Transit/Calgary-Transit-Routes/npim-ffnh>)
- City of Calgary Perimeter
(<https://ucalgary.maps.arcgis.com/home/item.html?id=aa42f6c4733b4df7b0018cdb2a028771>)
- Community Districts
(<https://ucalgary.maps.arcgis.com/home/item.html?id=d2c80c1d2de24ad4bfa64a2f267f69f8>)
- Map used in Question 4 (Future Rapid Transit Network): <https://www.calgary.ca/green-line/about/future-extensions.html>

Section D: Cleaning Data

The following section explores how the data acquired was cleaned and prepared for further analysis.

Neighborhoods, Route Schedules, and Routes by Neighborhood Datasets:

The neighborhoods section of our data did not require any cleaning. This is because all the data was handpicked and organized by our data collectors to ensure all the information that was needed was there, meaning there were no extreme outliers and no missing data points.

The Route Schedules (Frequency of Service) and the Routes by Neighborhood section of our data did not require any cleaning either. This is because all the data was manually pulled from the City of Calgary Transit website, so it was cleaned manually and reformatted as it was entered into the data sheet.

Transit Routes Dataset:

Before:

	A	B	C	D	E	F	G	H	I	J	K	L
1	route_id	route_short_n	route_long_n	route_desc	route_type	route_url	route_color	route_text_co				
2	1-20759		1 Bowness/Forest Lawn		3							
3	1-20760		1 Bowness/Forest Lawn		3							
4	2-20759		2 Mount Pleasant/Killarney 17 A		3							
5	2-20760		2 Mount Pleasant/Killarney 17 A		3							
6	3-20759		3 Sandstone/Elbow Dr SW		3							
7	3-20760		3 Sandstone/Elbow Dr SW		3							
8	4-20759		4 Huntington		3							
9	4-20760		4 Huntington		3							
10	5-20759		5 North Haven		3							
11	5-20760		5 North Haven		3							
12	6-20759		6 Killarney/26 Av SW		3							
13	6-20760		6 Killarney/26 Av SW		3							
14	7-20759		7 Marda Loop		3							
15	7-20760		7 Marda Loop		3							

The Transit Routes section of our data required some minor cleaning, as there was some data present that was unrelated to the analysis being performed. We excluded the columns “route_id”, “route_short_name”, and “route_type” as they provided unnecessary information that provided no value to our analysis. Similarly, the three columns on the right were removed as they had missing values and also did not provide any meaning in the context of our analysis. There were duplicate values for several routes as they represented different directions of travel, and as a result were removed. There was no additional missing data or extraneous values in the Transit Routes dataset, so no further cleaning was necessary.

After:

Route Number	Route Name
1	Bowness/Forest Lawn
2	Mount Pleasant/Killarney 17 Av SW
3	Sandstone/Elbow Dr SW
4	Huntington
5	North Haven
6	Killarney/26 Av SW
7	Marda Loop

ArcGIS Dataset:

For the Transit LRT Stations Dataset used in the ArcGIS Map, we had to reformat the location coordinates as ArcGIS only accepts latitude and longitude in separate columns for CSV files, but the original dataset had the location stored as points in the same column.

Before:

A1													STATIONNAM	
	A	B	C	D	E	F	G	H	I	J	K	L		
1	STATIONNAM	LEG	DIRECTION	DIST_NB	DIST_SB	DIST_EB	DIST_WB	ROUTE	STATUS	the_geom				
2	45 Street S West	West/East						202	Current	POINT (-114.1541947 51.0379605)				
3	Sirocco St West	West/East						202	Current	POINT (-114.1690442 51.0383797)				
4	City Hall S DT	Westbn West				200		201/202	Current	POINT (-114.0570028 51.0463789)				
5	1st Street S DT	Westbn West		0	0	467	439	201/202	Current	POINT (-114.0640924 51.0465842)				
6	Dalhousie NW	North/Sou		3966	2732	0	0	201	Current	POINT (-114.1605254 51.1032838)				

After:

A1											
STATIONNAM											
	A	B	C	D	E	F	G	H	I	J	K
1	STATIONNAM	LEG	DIRECTION	DIST_NB	DIST_SB	DIST_EB	DIST_WB	ROUTE	STATUS	long	lat
2	45 Street S West		West/East					202	Current	-114.154	51.03796
3	Sirocco St West		West/East					202	Current	-114.169	51.03838
4	City Hall S DT	Westbn	West			200		201/202	Current	-114.057	51.04638
5	1st Street S DT	Westbn	West	0	0	467	439	201/202	Current	-114.064	51.04658
6	Dalhousie NW		North/Sou	3966	2732	0	0	201	Current	-114.161	51.10328

The Calgary Transit Routes, Calgary Transit Stops, City of Calgary Perimeter, Community Districts datasets used in the ArcGIS online map did not need to be cleaned and were plugged and played with ArcGIS. There were no errors in importing these datasets into ArcGIS, which has a robust checking system, and manual checks were used to ensure that all the points were in the City of Calgary and not misplaced wrongly.

Section E: Visualizations and Findings

This section will aim to answer the 5 study questions created in Section B through visualizations and findings.

1. Which communities have the lowest public transportation rank and thus require the most improvement?

Since Calgary is one of the largest growing major cities in Canada, there is an increasing rate of Calgarians seeking transport each year. As a result, the Calgary Transit system will need to frequently update and improve its transit network across the city to keep up with the demand of its growing population. When analyzing each community's transit efficiency, communities can be ranked to prioritize the communities that are in greater need of transit improvement than others. We can then specifically look at the communities that have the lowest "rank" when it comes to public transportation, and thus, require the most improvement.

However, if we wish to understand which communities have the lowest "rank", we must assess critical metrics that play a role in transit accessibility for each community. We came up with a formula that allowed us to take the key data from each community relating to transit and allowed us to rank these neighborhoods to understand the lack of transit accessibility they likely experience. This can be realized by analyzing three core aspects that significantly impact transit use for each community, and by weighing them we can compute a "community impact score". These three elements, and their respective weightings include:

1. Commute time (Weight: 34%)

Communities with shorter commute times score lower (less impact).

Communities with longer commute times score higher (greater impact).

- 0-20 minutes = 1 point
- 21-40 minutes: 2 points
- 41-60 minutes: 3 points
- 61+ minutes: 4 points

2. Community Population (Weight: 33%)

Larger communities will score higher because more people are affected.

- < 5,000 = 1 point
- 5,001 – 10,000 = 2 points
- 10,001 – 15,000 = 3 points
- > 15,001 = 4 points

3. Frequency of Service (Weight: 33%)

Communities with more frequent service score lower because they have less impact.

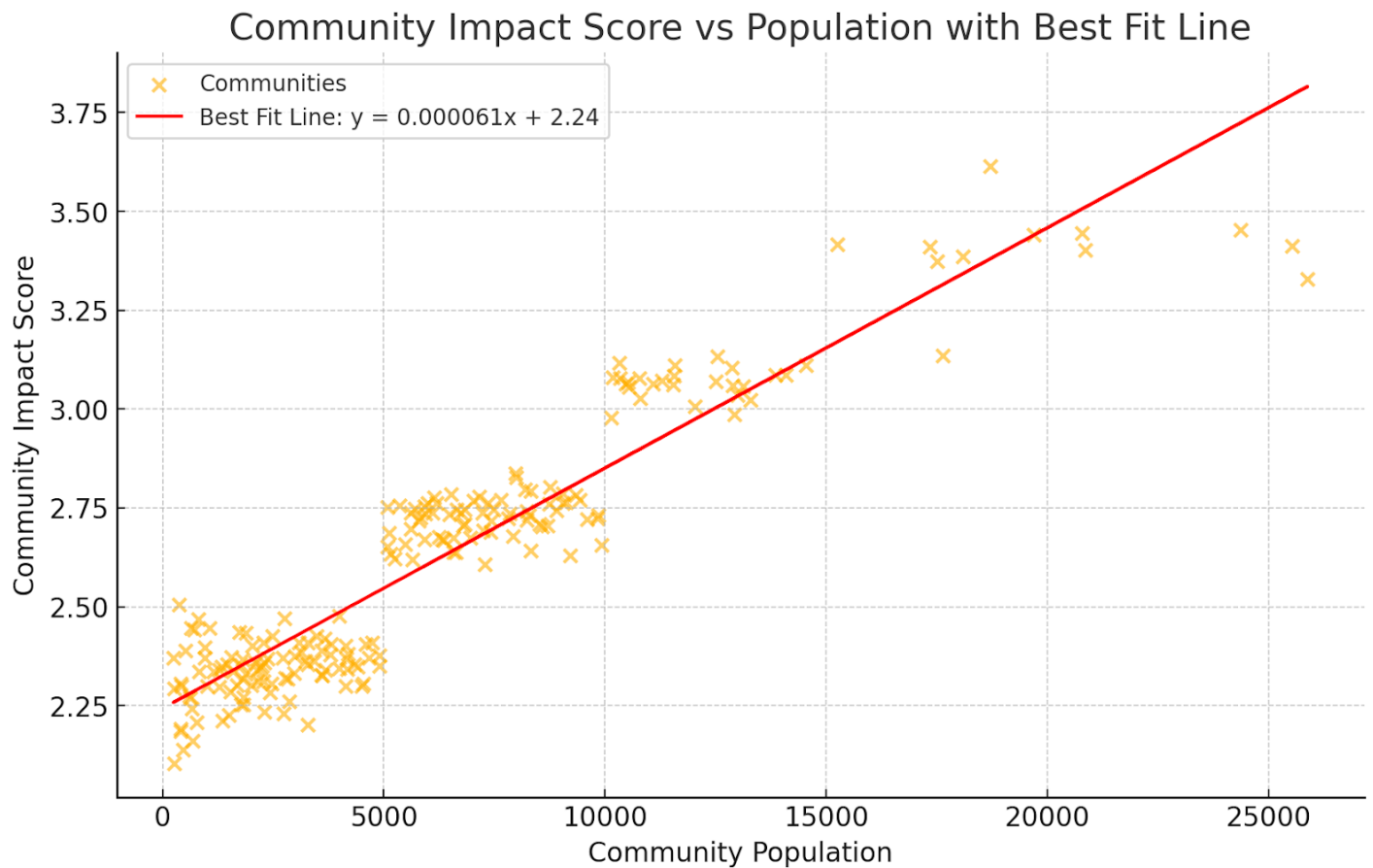
- Daily service, frequent intervals (less than 30 minutes) = 1 point
- Daily service, less frequent intervals (30-60 minutes) = 2 points
- Limited service (only peak hours or less than 3 days/week) = 3 points
- No service = 4 points

Formula:

Community Impact Score = (Commute Time Score × 0.34) + (Population Score × 0.33) + (Frequency Score × 0.33)

This system weighs each component and determines a total impact score based on how each category is affected. Commute time was given slightly more weight (1%) because commute time is the most noticeable from a commuter's standpoint and to ensure the calculation reached a total of 100%. The impact is scored from a scale of 1-4, with a 4 indicating a greater impact score. For commute times, the longer the commute time, the larger the impact score. For a community population, a larger population indicates a greater number of people affected by public transit and therefore a greater impact score. For frequency of service, communities with less frequent service will be more affected by transit times and therefore have a greater impact score.

Using the calculated community impact scores, we created a scatter plot that displays the range of community impact scores according to community population for all 206 communities by calculating the community impact score properly and using tableau to graph this data:



The reason for choosing the given visualization is that it shows how the communities follow certain norms and how they group in clusters depending on their population. It gives us a mean line for what should be the norm and then if a community is impacted a lot, it falls on the left side of the line, and if it is well catered to, then it is on the right side of the line. There is a very common grouping, and almost obvious trend for all communities with populations under 15000 when it comes to their impact score. These clusters occur because of how we created our intervals for commute time, assuming all other factors are held relatively constant (population and service frequency). For example, a community that has a commute time of 13 minutes is going to have all the same impact score as a community that has a commute time of 8 minutes, assuming that all other factors are constant. This is something that can definitely be improved, but for our scale it allows us to draw out the fundamental ideas we wish to discover and analyze as we move into communities with higher impact scores.

Upon crossing the 15000 mark there is greater variance and spread, immediately giving evidence to how greater population sizes appear to have a strong correlation with community impact scores when it comes to transit. This tells us that larger communities are the ones that take the brunt of the lacks in transit and should therefore be prioritized when it comes to transit improvement to better serve these communities. Based on our analysis, the five communities with the greatest transit impact score (and therefore are ranked the lowest in terms of public transit accessibility) are:

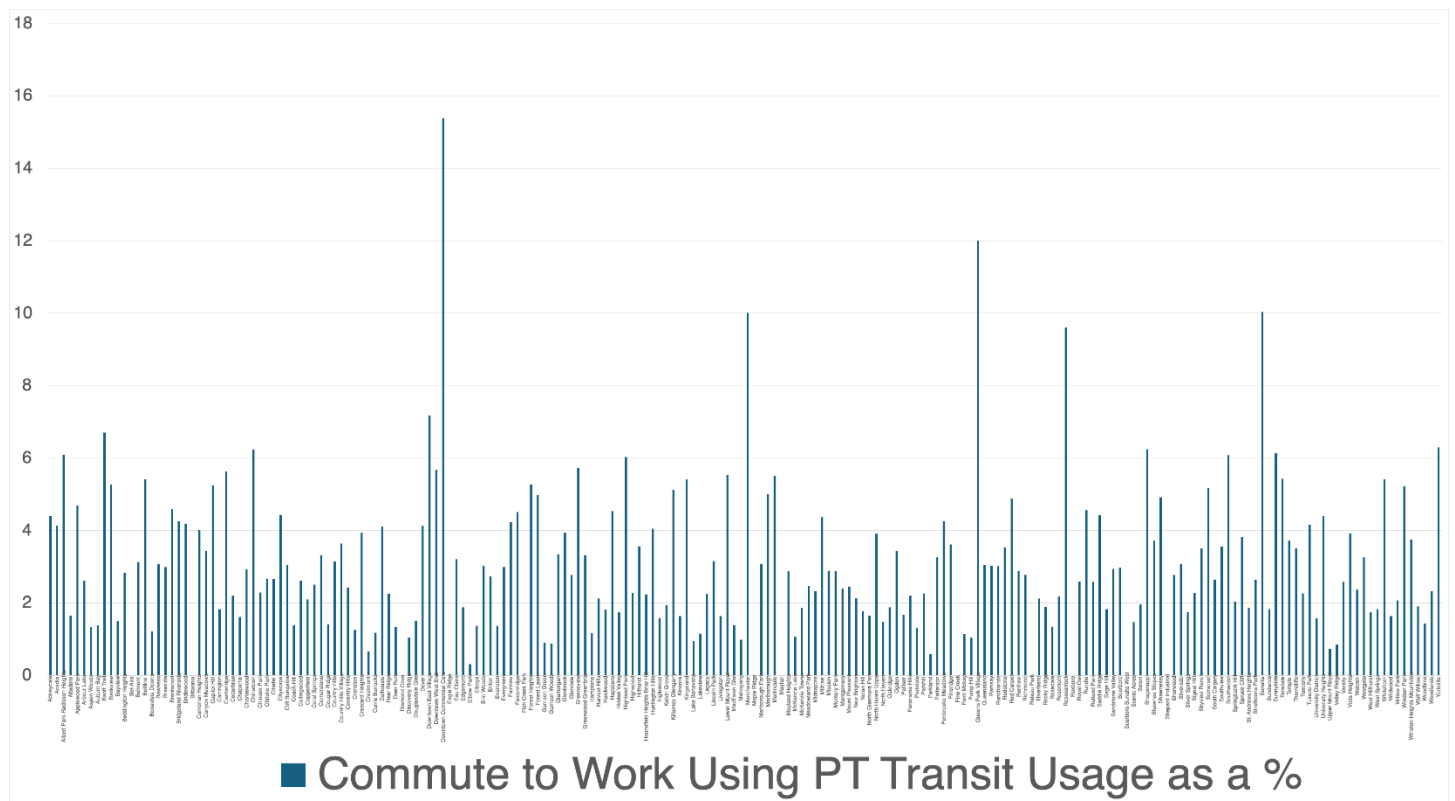
1. Evanston – 3.61
2. Saddle Ridge – 3.45
3. Evergreen – 3.45
4. Tuscany – 3.44
5. Edgemont – 3.42

All 5 of these communities are found in the upper right portion of the graph and similarly all have high community populations (greater than 20,000). It is important to note from this that based on the formula derived earlier, population does have an influence on the impact score. However, it is possible to negate any overlap and bias because we find that these communities vary far away from the line of best fit, meaning that other underlying factors have had influence on the resulting high impact score. This can be understood because if it were simply population that was influencing these communities, then the community impact score and population would have been a linear relationship. However, since it is found that the communities with higher impact scores vary away from the line of best fit, it is possible to draw the conclusion that the other metrics the calculation is based on, have been affected by the impact score derived.

Furthermore, something to note is that most of these communities are some of the older communities in the city of Calgary, with the exception of Evanston, which is relatively new. Due to these communities being older, they have had more opportunities to grow and have grown more than most new communities. Based on other factors in our formula, it is possible to understand that these communities have lacked the equivalent growth in transit services in the same duration of time, particularly services that improve frequency of transit and commute times.

Therefore, we can understand based on these results that communities with a larger population require greater transit services to accommodate the large volume of residents who are commuting each day. This means that actions must be made to counteract this negative community impact score by addressing attributes (such as frequency, commute time, and service routes) to better facilitate these communities. By ranking each community and determining communities who are greatly impacted by transit, this gives us a better understanding about which communities will require greater transit improvement in the future.

This analysis question compares the number of residents who rely on public transit as their primary mode of transportation against the total population of each neighborhood to figure out which neighborhoods have the highest transit usage rate. The rate is then shown as a percentage. Due to clarity issues given the number of neighborhoods, a chart showing only the top 5 is included to present the data in a more readable way. Although, the full thing is also present. These graphs were made using Excel and are shown below:



The reason for choosing this visualization is that it suits the formula well, a ratio is decided on how many of the total people in a community utilize public transit, and then it is converted to a percentage and showcased on a bar chart to directly answer the question.

The Formula for this question is:

$$\text{Transit Usage Rate} = (\text{Total Population} / \text{Transit Users}) \times 100$$

Hence, the Top 5 Communities by Usage Rates are:

1. Downtown Commercial Core
2. Queens Park Village
3. Sunalta
4. Manchester
5. Rosscarrock

High rates of students being housed, easy access to public transportation, fewer private vehicles, and many apartment complexes are common themes across these five communities. Students may not yet have access to a private vehicle, or their school is near to the destination of a public transit station, which makes it a convenient and cheap choice for them. For others, the easy usage of public transportation will play a factor as they seek convenience. Fewer private vehicles likely stem from people in these neighborhoods having less expendable income to use on transportation and seeking cheaper alternatives as a result. People who live in apartment complexes may choose not to drive a car as parking spaces can often be limited and annoying to use.

Other things noticed after performing this analysis include:

- Inner city neighborhoods and areas close to transit corridors have the highest proportion of transit users. Downtown Core recorded the highest concentration of transit commuters. Beltline was another notable example of this being the case.
- Some low-income areas with limited vehicle ownership were found to have increased usage of public transit.
- Areas well-serviced by transit (e.g., Downtown, Beltline, Brentwood) show higher adoption rates.
- Suburban areas with limited bus frequency and longer commute times show lower transit reliance.
- Neighborhoods which consist of apartment complexes and multi-unit housing tend to also have higher transit usage. This is often due to a mix of demographics including students, young professionals, and lower-income households.

This information helps generate ideas about which areas may need more transit with regards to future infrastructure planning. Furthermore, this highlights the importance of expanding access to services in high-frequency transit areas as they help a lot of people on a daily basis. These findings emphasize the need for increased frequency of service in areas with high transit demand, expansion of bus routes and transit hubs in suburban neighborhoods with potential for growth, and infrastructure investments to improve transit accessibility for underserved communities.

3. Which dense population areas are not adequately covered by public transit?

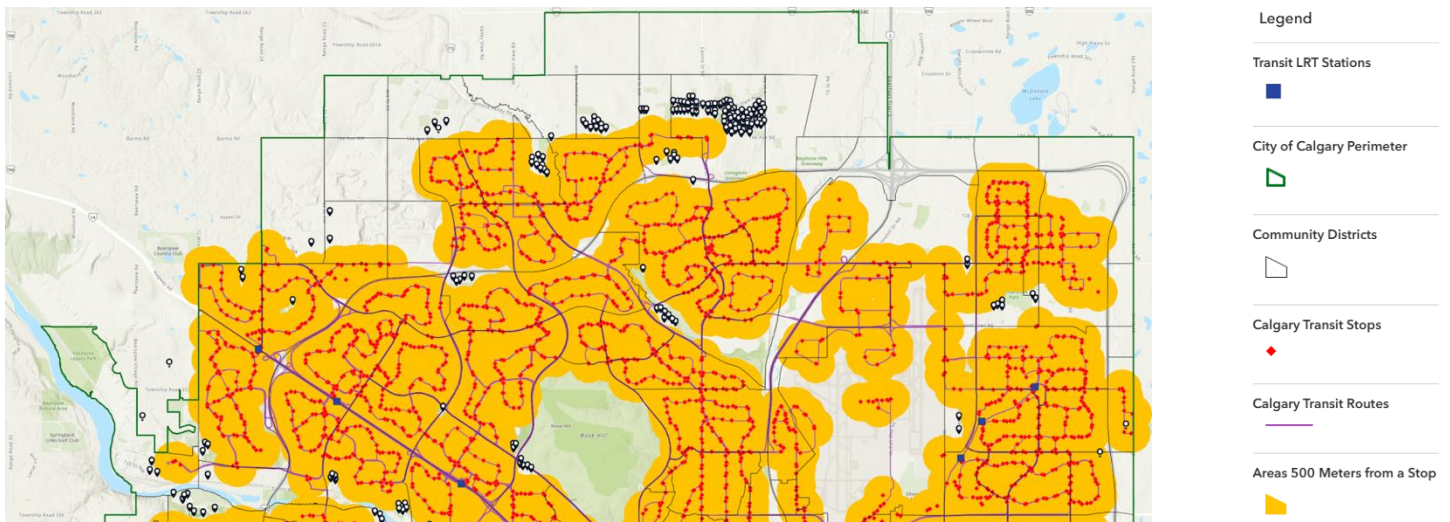
This question was answered through building a map and running a buffer analysis on it. ArcGIS as a mapping software was chosen to build the Map of the City of Calgary. All transit station points (bus and c-train) were analyzed to create a 500-meter circle around them. All residential housing areas which were not covered by the circles were therefore highlighted and pointed out. For this question, a developed transit network was assumed as one where any residential house is at most 500 meters from a transit stop.

The Map consists of 5 normal layers and 2 analysis layers, which are:

- Normal:
 - Transit LRT Stations (from the City of Calgary Open Data Portal)
 - Calgary Transit Stops (from the City of Calgary Open Data Portal)
 - Calgary Transit Routes (from the City of Calgary Open Data Portal)
 - City of Calgary Perimeter (from the City of Calgary Open Data Portal)
 - Community Districts (from the City of Calgary Open Data Portal)
- Analysis:
 - Areas 500 Meters from a Stop (Polygon Circles made using Buffer Analysis with a 500m distance from a point, where points are taken from Transit LRT Stations & Calgary Transit Stops)
 - Sample Improvement Areas (Points manually added to all residential areas in the City of Calgary where the Circles do not overlap with the houses)

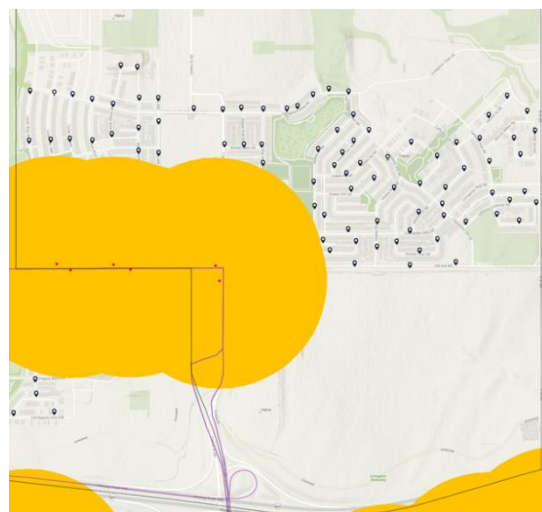
For the Visualization, the link to the map is below:

<https://ucalgary.maps.arcgis.com/apps/instant/media/index.html?appid=097a69efc49d4c04b5bc8429a79346b7>



The reason for showcasing this visualization as an ArcGIS map was because ArcGIS allowed us to run a buffer analysis on the bus stops to figure out which areas are being covered by public transit and which areas are not. As shown in the map, most of the dense communities that are in the inner city are adequately covered by transit services. However, the map clearly shows many developing and new housing projects, especially around the city's border, which are not yet connected by public transit services and, therefore, need funding and improvement.

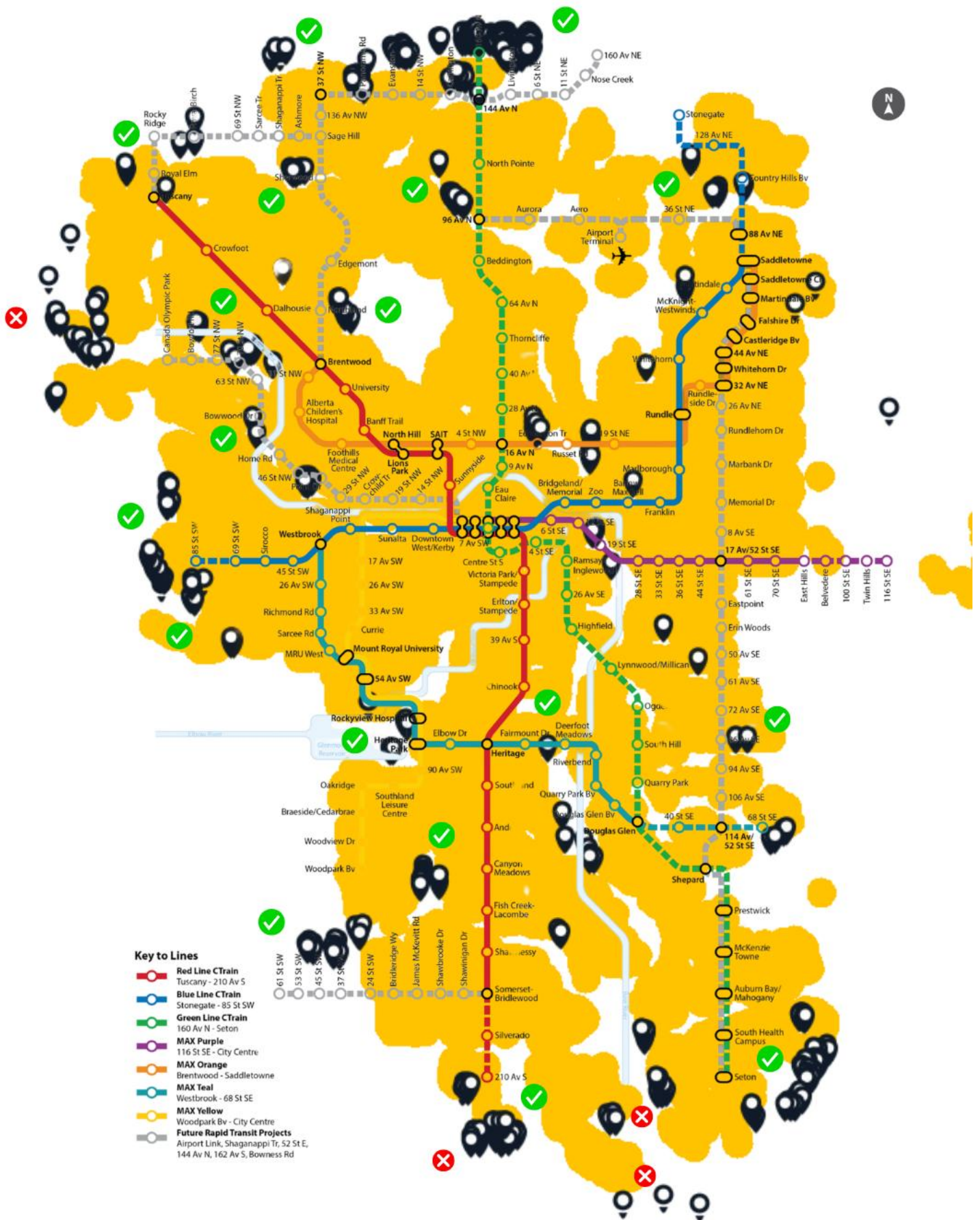
One such community is Livingston, which is a relatively new community in North Calgary, with development starting around 2016 and continuing to this day. Henceforth, from this information and our analysis in the picture below, we have outlined spots in this community which are not connected to the Calgary Transit System and thus need improvement:



4. Do the City of Calgary's proposed transit infrastructure improvements address some of these issues already?

Calgary is one of the fastest-growing major cities in Canada, and its public transportation system is under increasing pressure to keep up with that growth. This analysis explores whether the City of Calgary's strategic transit infrastructure improvements are effectively targeting the communities most in need of better service. We will compare the City of Calgary's approved strategic plan for transit improvements and new routes (the dotted lines in the map below) against the areas which we marked as having 'not adequate transit facilities' in Question 3. These highlighted residential areas from Question 3 that are now properly addressed (within a 500-meter radius of a transit stop) are represented with a green checkmark. On the other hand, the highlighted residential areas still not adequately covered by the major transit network, even with the proposed improvements, are shown on the graph with a red 'X'.

Upon overlaying our points from the ArcGIS Map against the City of Calgary's Future Rapid Transit Network Map, we get a rough idea of the work being done to improve the transit access for neighborhoods with poor transit facilities:



Although this map is not perfect, since the routes do not exactly scale with the actual roads, it is still a reliable overlay. The main reason for choosing this visualization is that it perfectly sums up the work being done and shows just how effective the City of Calgary is in regard to improving its transit network for new residential development areas.

From the map, we can see that all the new residential areas in the Northern, North-Western, North-Eastern, Eastern, South-Eastern, and South-Western parts of the city are being adequately connected to the future transit lines. The only areas which still need improvements are the South and Western development areas, however, the map only shows us the major bus and c-train routes, so these areas can be easily accounted for through the use of smaller bus routes.

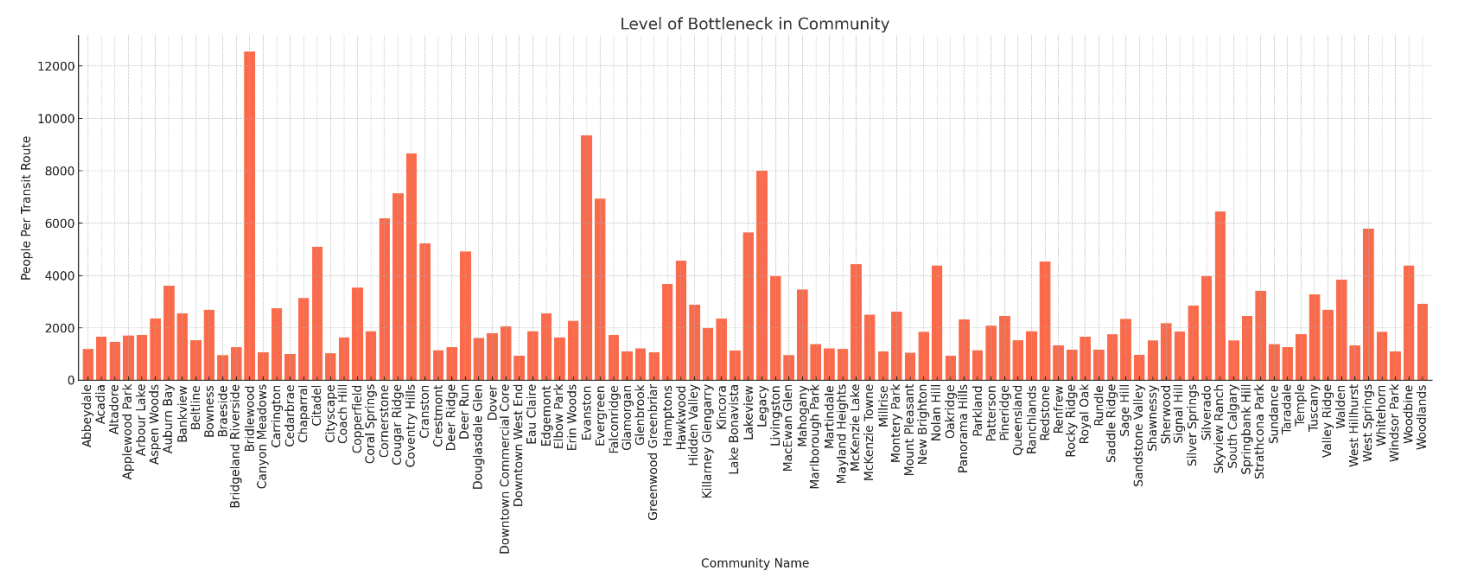
Immediately, we can see that the new transit routes directly cater to the northern and eastern parts of the city, which goes directly hand in hand with the residential boom in Calgary over the past decade.

So, in conclusion, we can confidently say that yes, the City of Calgary's proposed transit infrastructure improvements address most of the issues we found in Question 3 already. This shows that the city is being well managed for the future generations and can accommodate the projected population booms in the future.

5. Which areas of the city have the most daily transit bottlenecks?

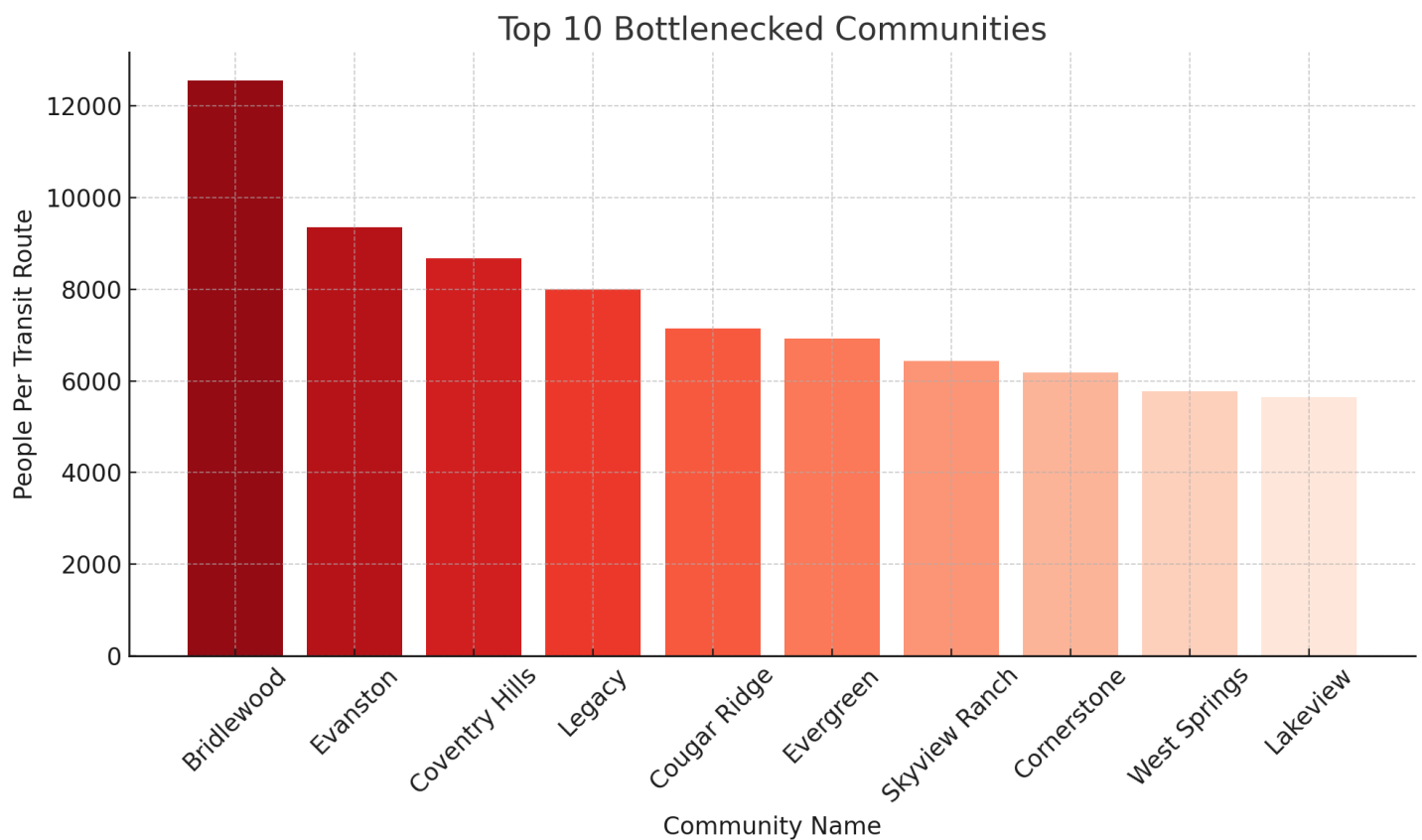
As Calgary continues to grow as one of Canada’s fastest-expanding cities, the pressure on its public transit infrastructure intensifies. In 2024 alone, there were 361 reported cases of buses too full to pick up new passengers, a noticeable increase from 266 the previous year. To address this issue and prioritize improvements, we sought to identify which communities are most impacted by transit bottlenecks, specifically, areas where public transportation is present but insufficient to meet demand.

To answer this, we developed a metric called the People-To-Route Ratio. This ratio looks at the quantity of bus routes that are found within a community and takes that value and compares it to the amount of people in that community as well - calculated using the formula ‘Community Population / Community Transit Routes’. What this ratio allows for is a method to compare communities fairly in a proportional manner. Comparing the unchanged count for routes by community would introduce a bias as many communities have more bus routes to remain proportionally adequate to the population their community has. Instead, by taking the route count in a community and creating a ratio of that with the population, it will allow for an unbiased measurement of the level of bottleneck this community has. This can be done by using the formula outlined earlier and using the required to create a visualization on tableau:



The reason for choosing a bar chart to represent the ratio of routes to community population is because a bar chart allows for a clear visual comparison between each community. Along with this, the data being analyzed is discrete and requires a frequency analysis on the People-To-Route ratio. Giving more reason to use a bar chart visual to visualize this data than not.

There is one small issue that arises when attempting to draw conclusions from this large visual however, this being that it is difficult to find the communities that are precisely the most bottlenecked by having the lowest People-To-Route ratio. However, by instead taking the 10 lowest values from this visualization and visualizing that, it will allow for an analysis with greater precision. Once more, this can be done by using the same data set, reduced to the 10 lowest People-To-Route ratios, and on tableau:



It is important to note that the use of a bar chart system remains as the system continues to allow for a clear visual comparison between each of the most bottlenecked communities and for conclusions to be made with concision. This allows for the continuation of the analysis of this data.

The visualization shows the communities which have created the highest bottlenecks in the city directly through the bar heights. These top ten neighborhoods have large populations but very few scheduled transit routes serve them. As a result, they represent the most underserved yet active parts of the city's transit network. A common theme between these neighborhoods is that they do have access to some form of transit service, however, due to their large and growing populations, the current system does not fit their needs and results in bottlenecks. This visualization allows for the understanding of a few things:

1. Transit stress is not evenly distributed across Calgary, high population does not always equal high service
2. Current planning may be according to changes as they come, as opposed to changing using predictions through data analysis. However, by using a technique like the People-To-Route Ratio, we now have a simple but effective mechanism to evaluate needs when it comes to transit

Something further to derive and talk about from this visualization is the understanding of what these communities are. It is possible to note that the communities that are being bottlenecked are some of the older communities in Calgary, meaning that they all share this commonality of being old. However, we can also conclude from this that regardless of the time and opportunities that these communities have had to better their services alongside the growth of their populations, the city of Calgary has not taken the steps needed to consistently improve services to reduce bottlenecks alongside the growth of these older communities.

A final note to be made regarding this analysis is that there were a number of communities for which transit services were not adequate to cover the majority of their community. These communities were:

1. Discovery Ridge – Located at the most westernmost point within city limits
2. Fish Creek Park – Located at in southern Calgary city limits
3. Wolf Willow – Located at the southeast extreme of the city

These were not included in the visualizations as they would provide a great skew of the data, but they are noteworthy nonetheless as most of them share a common theme. These being that these are in extremities (particularly Discovery Ridge and Wolf Willow) and are new communities under development. It is easy to understand why these do not have satisfactory transit services yet because they are still under development.

In conclusion, this analysis has shown that the city of Calgary has work to do to negate bottlenecks within the city. It is safe to predict that communities still under development will eventually attain adequate transit services, but the fundamental issue with community bottlenecks is seen with preexisting communities with populations that are continuing to grow based on the findings from the use of the People-To-Route ratio developed.

Conclusion (Takeaways from the five-analysis performed):

Through our analysis we came across several key problems within the City of Calgary's current transit system that prevent public transit from being efficient. One of the most common problems was that communities near the border of the city do not currently have adequate public transportation, which was shown in our community impact score, person to route ratio, and heatmap. One such neighborhood was Evanston which ranked 1st in our impact score, 2nd in our ratio, and was isolated on our overlay map. While the neighborhood currently does not have enough routes to be efficiently serviced, it will in the future once the Green Line and other routes are developed. This is not true for all the communities we isolated, certain neighborhoods in the deep south will require the creation of more lines so they too can be connected to the Primary Transit Network. Our research also proved the communities that use transit as a main mode of transportation have adequate transit service through many routes with high frequencies. Based on our data, to make public transit more efficient, we would recommend that the City of Calgary prioritize expanding transit lines to high population communities with poor service and new developing communities, increasing the frequency of service in bottlenecked areas, and aligning transit improvement projects based on trends such as population growth and which communities have the highest person to route ratio.

Section F: Contributions

Scott: Introduction, Obtaining Data, Data Cleaning, Creating a Community Ranking System for Question 1, Editing and Refining

Ben: Data Cleaning, Key Recommendations + Findings Outside of Questions

Sarah: Obtaining Data, Data Cleaning, Introduction and Conclusion

Jaden: Coordination, Obtaining Data, Visualizations, Editing and Improvements

Muhammad Ahmad (Lead): Overall Coordination and Project Organization, Main Project Idea, Answering Questions 3 and 4, Obtaining and Cleaning Data

Saihaan: Obtaining Data, Visualizing/Findings and Answering Questions 1 and 5, Editing

Michael: Visualization and Answering Question 2

SECTION G: File Organization

The Research Project has been organized in a sequentially structured manner to reflect the order of the research performed and its conclusion reached.