C1

Appendix C1: Priority Cycling Network Development – Star Analysis

MEMO: Star Analysis and Bicycle Network Development

Report

In response to: City of Vaughan

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1 Introduction

The planning of future bicycle networks is a combination of science and art. This memo lays out the process that was undertaken to develop the bicycle network for the City of Vaughan. The Mobycon Star Analysis method served as the primary resource for initial route selection based on identifying travel patterns within the city. Initially selected routes are then refined based on land use patterns and validation through various forms of public consultation. The outcome is a network that is designed to serve the highest proportion of potential cycle trips in Vaughan in a safe, comfortable, and attractive manor.

2 Network Development

2.1 Star Analysis

The Star Analysis was developed as a multifaceted methodology in order to develop ideal bicycle networks. The ideal bicycle network is considered to be one that will safely and effectively accommodate the greatest number of users (existing & potential). At the heart of this approach is gaining an understanding of the travel motives and patterns of all residents and identifying existing trips that are well suited to using a bicycle. This understanding of travel demands along with further evaluation of land use can then be translated into a conceptual bicycle network. This preliminary conceptual network is then referenced against existing infrastructure and validated with local knowledge during the route allocation phase. The following steps outline the process of developing the bicycle network in Vaughan.

2.1.1 Identification of travel patterns

The analysis is initiated with mapping origin and destination trip relationships based on the TTS Origin-Destination Survey. For this mapping the analysis is based on zones that approximate a neighbourhood scale in the built-up urban area (zones are larger in less dense regions). The reference for the zones is established based on the traffic analysis zones (TAZ) from the TTS survey. Each zone aims to contain a reasonable population, while having logical geographic boundaries. These boundaries between zones are based on natural 'borders' such as highways, rivers, or parks.

The OD relations between zones are visualized as thinner and thicker lines (dependant on number of trips) in star shapes (as the crow flies). This step visualizes the relative scale of trip relationships between all zones in the study area as well as the surrounding region (*Figure **2-1***). It is important to recognize that this stage of the analysis is not intended to reveal corridors or routes of travel, but rather just the origin-destination links. The current choice of mode, corridor, etc. is largely shaped by the existing condition of a transportation network. This process aims to identify the trip motives and transform that information into a network that best serves those motives rather than catering to the existing means.

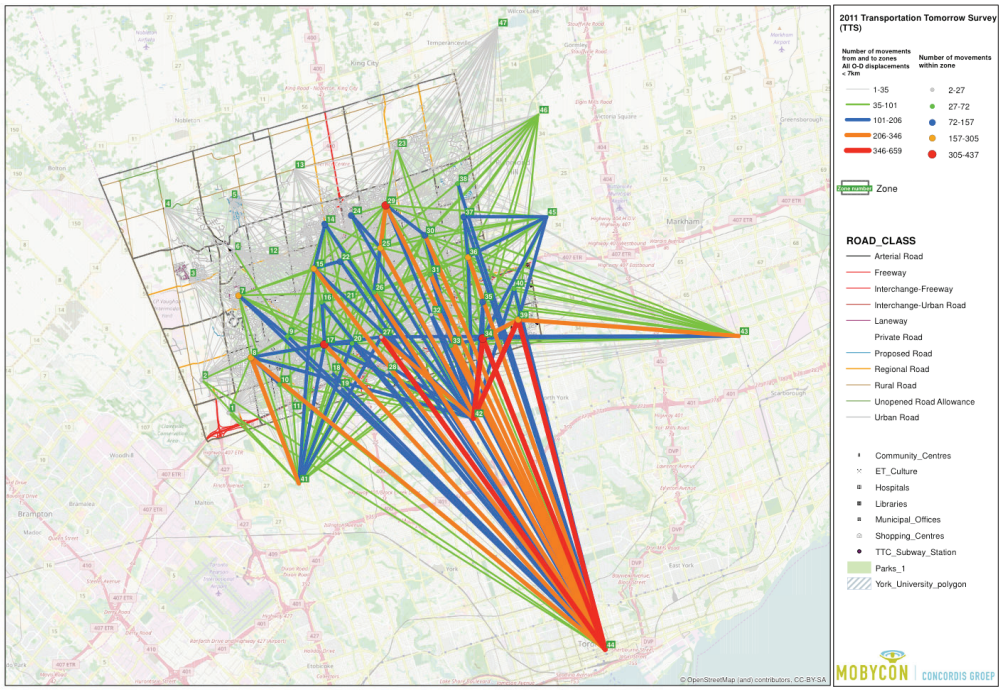

Figure 2-1: All O/D links in Vaughan and surrounding area

What is found at a high level for travel in and around Vaughan is that the strong links are with the surrounding region rather than within Vaughan. The strongest links are found to the south of Vaughan in Toronto. These findings are consistent with general understanding that many Vaughan residents commute into Toronto for work as well as to access amenities that may be more readily available in a larger city.

While many of these trips to Toronto and the surrounding area are too great a distance for most to cycle, understanding these links have important implications for the cycle network. Firstly, these longer trips can often be well served by transit; therefore it will be important the cycle network in Vaughan provides high quality access to transit connections. Secondly, for trips to adjacent communities that are within a practical cycling distance, the corridors chosen to connect them should be carefully considered to optimize their usefulness.

In order to better understand the internal trips within Vaughan, external trips were filtered. This analysis (*Figure **2-2***) illuminates key connections within the city and begins to reveal larger travel patterns within Vaughan. Two major barriers that begin to reveal themselves at this level of analysis are MacMillan Yard and the Kortright Centre for Conservation (and surrounding parklands). These features play an apparent role in shaping travel patterns around the city.

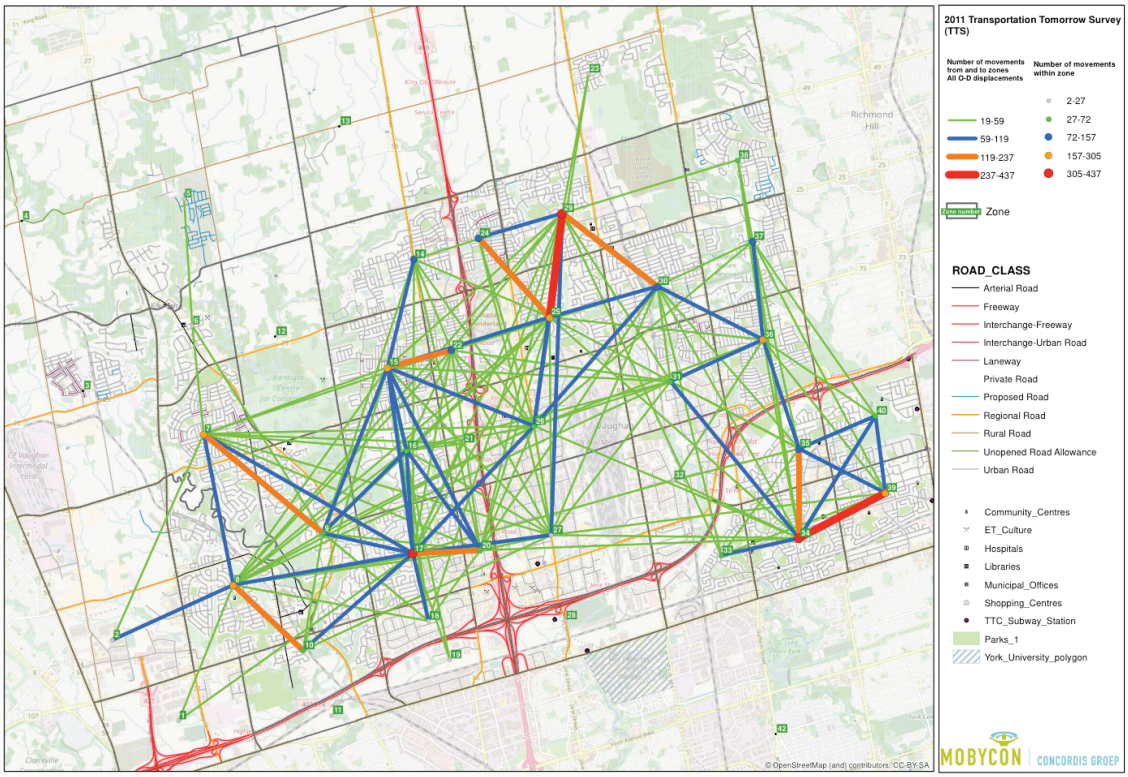

Figure 2-2: All internal O/D links in Vaughan

2.1.2 Isolate high potential bicycle trips

In order to identify which trips, and therefore interzonal relations, are best suited to the bicycle, a filter must be applied to the initial trip data. The primary filter is based on a distance boundary that will encompass the greatest potential for cycling. Several factors are considered in setting this boundary:

- Research shows that modal share of bike trips drops off significantly for trips above ~7.5 km and all but disappear above 10km (CROW)
- The average Canadian commute is 31min, which is ~8km by Bike (FCM)
- The bicycle is time competitive with cars in urban environments for trips up to ~8.5km
- >60% of all trips taken by any mode are shorter than 8km

The combination of these factors illustrate that the greatest potential for cycling trips are those below ~7.5-8.5 km. This boundary represents a majority of all trips made (by any mode), as well as a behavioural limit where an increased number of people will not longer choose a bicycle for their trip. While there will certainly be many cycle trips that exceed 8.5 km, they do not represent the core of potential cycle trips, especially those focused on transportation rather than recreation.

In order to apply this boundary to the star analysis, the trip distance (on the road network) needs to be converted to a distance as the crow flies. This is accomplished by applying a detour factor, which represents the extra distance required to make a trip on the road network compared to the most direct theoretical route (as the crow flies). Taking this into consideration, the analysis focuses on interzonal relations less than or equal to 7 km (as the crow flies).

The star patterns that immerge from this analysis represent the highest potential links for cycling. The thickness of each relation line at this stage should be interpreted as the relative bicycle potential, rather than a measurable mode share. The exact bicycle share is dependent on many factors, like the quality, safety, and directness of the bicycle route between the zones, as well as other factors like the cost of driving a car, the ease of driving, the motive of the user, the type, gender and age of the user and more. These considerations are addressed later in the process.

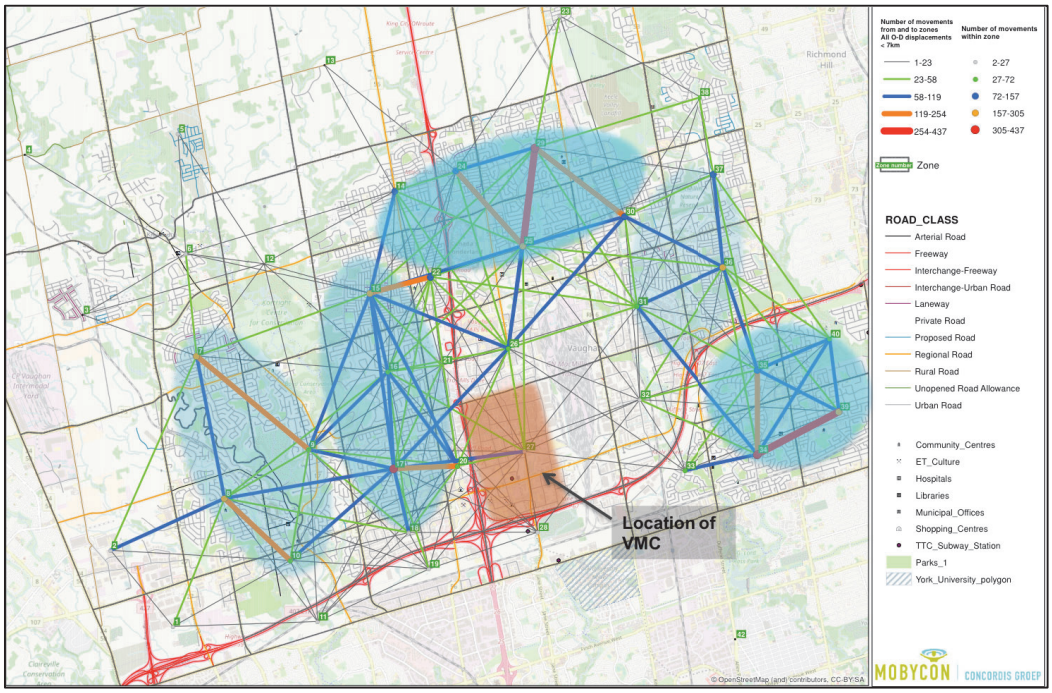

Figure 2-3: Internal O/D links in Vaughan <7km in length

*Figure **2-3*** illustrates the links that represent these highest potential for bicycle trips. The blue shaded regions represent larger zones that currently contain a higher probability of bicycle trips within them. Intrazonal displacements in these locations, with smaller distances, are still well for bicycle use. Bicycle facilities in these zones largely make up the secondary network, focused on short 'local' trips that provide quality access to destinations. This secondary network requires strong connectivity to the primary network in order to provide seamless access to destinations not directly served by the primary network.

2.1.3 Develop Conceptual Network

From the bike-specific star patterns, connecting the strongest interzonal relationships helps develops a conceptual network. This network illustrates high-level flows of cycle traffic through the city. The conceptual network is used both to illustrate the overall form the bicycle network takes as well as identifying the primary cycle connections. This identification of primary cycle connections is critical in prioritizing the implementation of facilities as well as understanding the facility types required for different parts of the network. High relation links should be accommodated with the highest quality infrastructure.

*Figure **2-4*** identifies the strongest interzonal relations in order to develop the conceptual network.

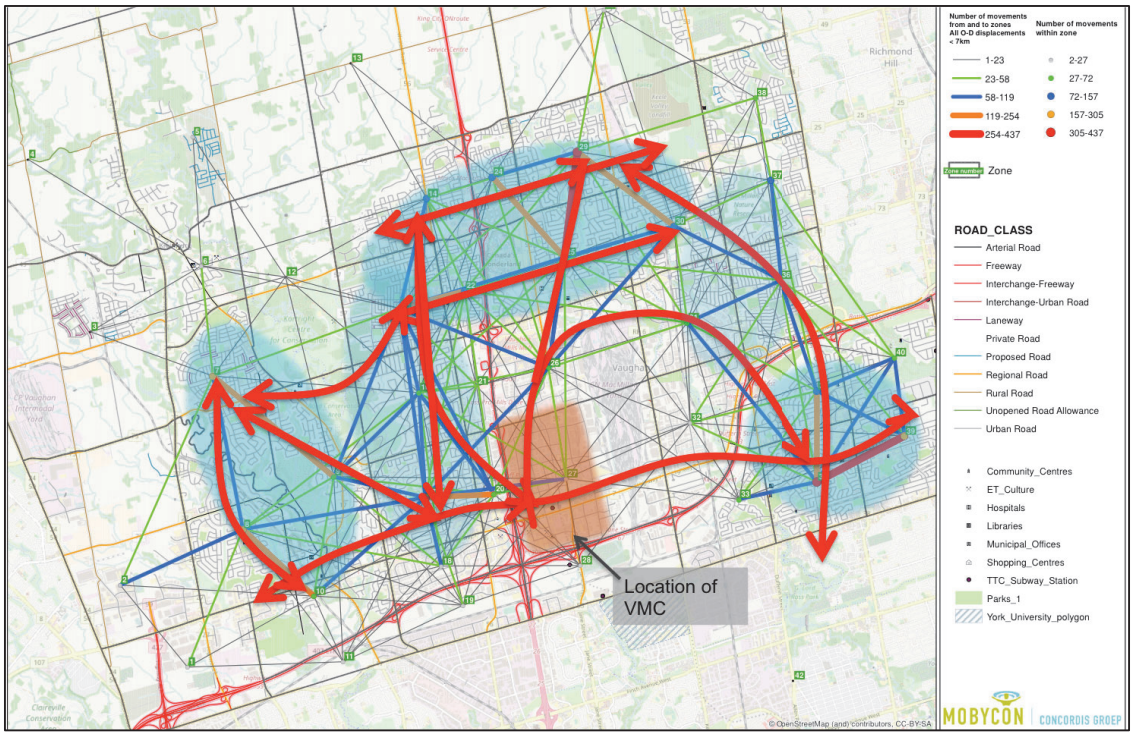

Figure 2-4: Major interzonal and intrazonal trips in Vaughan

2.2 Route allocation

From the conceptual network (*Figure **2-4***) a primary network is developed. The primary cycle network should identify the priority cycling routes that contain the highest quality of facilities and how they connect together. The network represents a plan of how cyclists can move through the city.
In allocating routes for the primary bicycle network they should be:

- Straight → In order to be direct;
- Connected → In order to be coherent;
- Separated →In order to be safe;
- Flat → In order to be comfortable;
- Attractive → In order to heighten user experience and encourage new users

Furthermore, when evaluating how these routes fit into the existing context, the following criteria should be considered:

- Make use of existing bicycle infrastructure, but only if it's of acceptable quality and the location within the network maintains safety and directness.
- Retrofit collector car routes and other straight and direct roadways to accommodate bicycles if no existing direct route is available.
- Investigate opportunities for more direct routes that are not part of the current road network (i.e. through parks, undeveloped lands, etc.). Social security should be of particular consideration for these routes.
- Incorporate indirect trails, as secondary (and recreational) routes.

Figure ***2-5*** illustrates the proposed first phase of the cycle network. The primary network (blue) represent the key corridors that will accommodate the majority of bicycle trips and also access priority destinations such as daily amenities as well as key transit stops. The primary network is the priority as far as implementation. Although at a large scale, the minimum grid it establishes in crucial to increasing the viability of cycling in Vaughan.

The secondary network (green) is focused on access comparatively to the primary network. These routes serve to improve connections to destinations not adjacent to the primary network. These routes are likely to see lower volumes and are less direct, but extend the reach of the network.

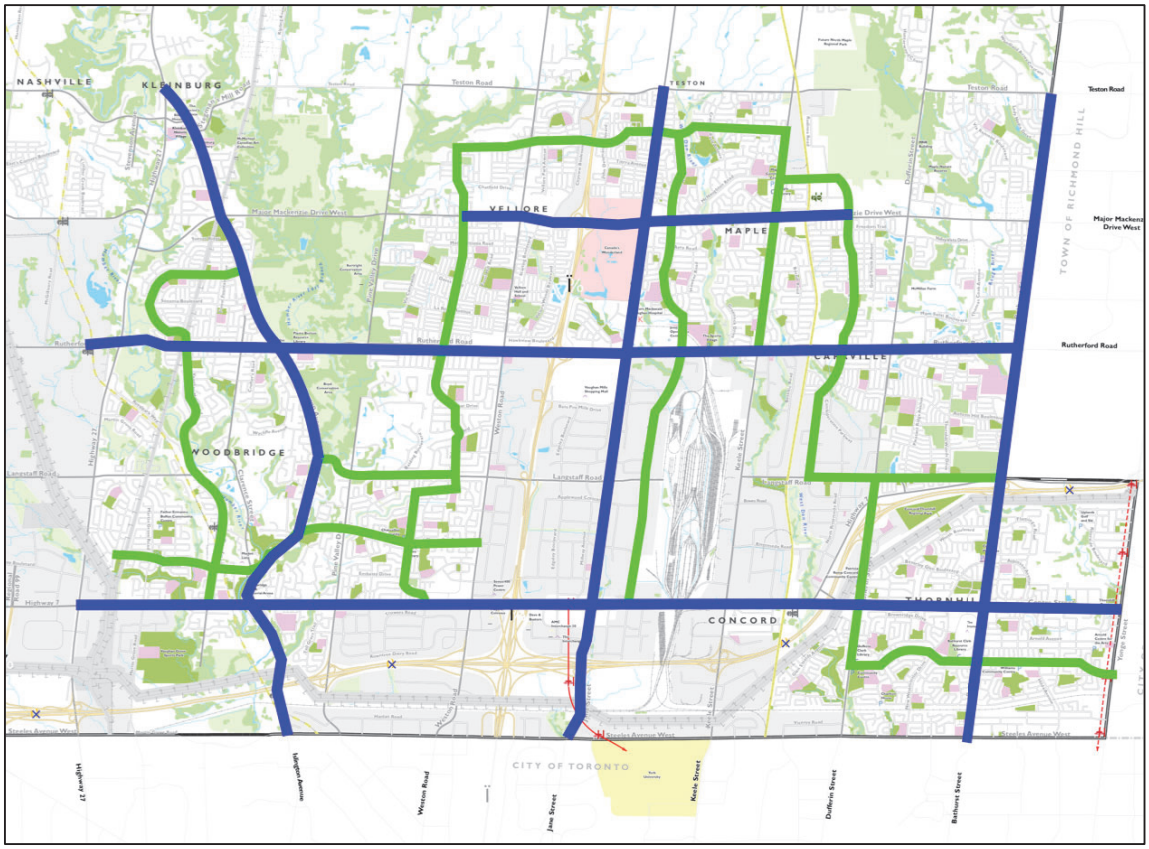

Figure 2-5: Proposed Primary & Secondary Cycle Network (2023)

While the initial network proposed services the largest number of trips, there are still many parts of the city that are left with suboptimal connectivity to the network. In order to increase the connectivity and usability of the network, additional primary and secondary links should be built once the initial network is complete (*Figure* ***2-6***). This links aim to achieve a more finely meshed network, which services more users and provides access to a greater number of destinations. The ideal mesh width of the cycle network is as follows:

- Primary routes every ~1 km
- Secondary routes every 300-500 m

Furthermore, in order to provide a fully accessible and connected bicycle experience within Vaughan, local streets that are not part of the cycle network should strive to be traffic calmed to a speed of 30 km/h. At this speed it is safe to mix traffic types in the roadway and further facilities are not required. Traffic calming these adjacent local streets further extends safe and comfortable access to the cycle network further minimizing any barriers to cycling within Vaughan.

*Figure **2-6***

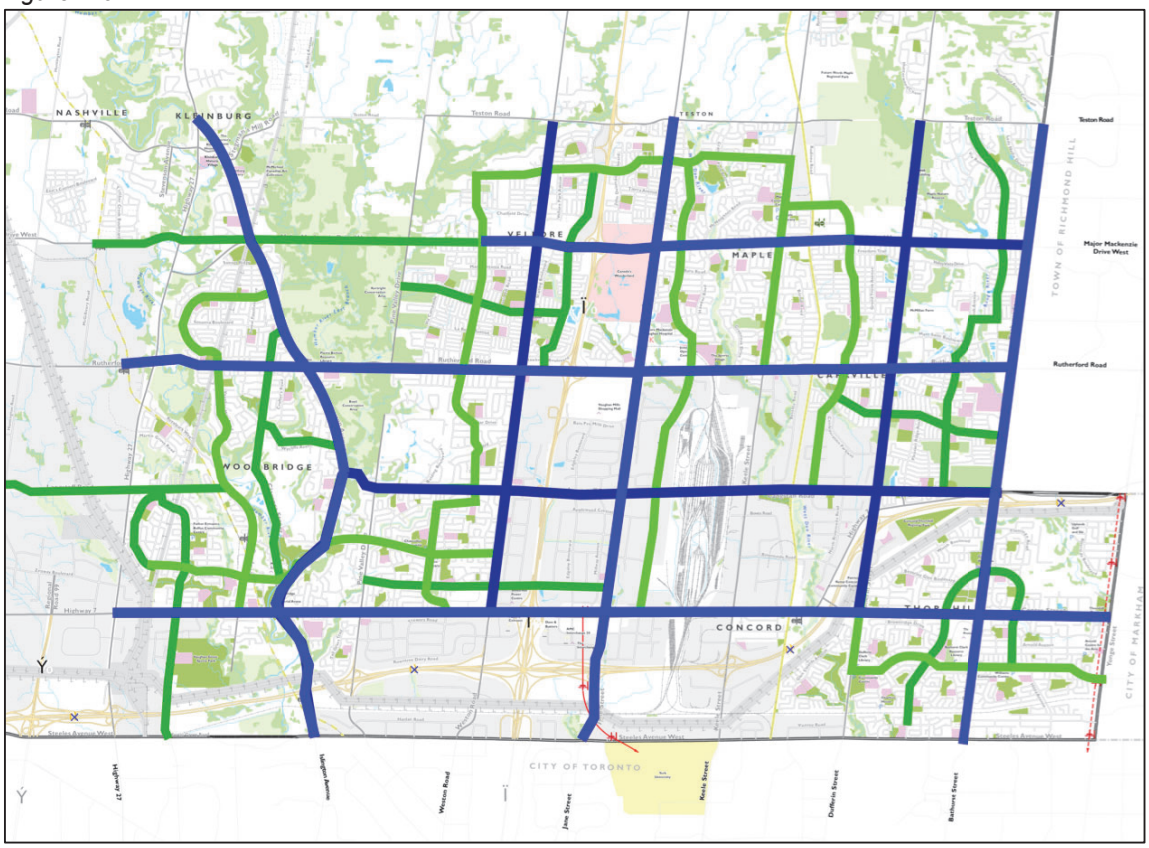

Figure 2-6: Proposed Primary & Secondary Cycle Network (2030)