The following document includes samples from student work at Planning for Active Transport (URBP 506) taught at McGill University by Ahmed El-Geneidy. The contents posted here represent the students' opinions and approach to analyze various intersections in Montreal and propose improvements to the existing bicycle network and infrastructure.

The studied intersections are Rue Rachel & Rue Saint-Urbain, St-Urbain & ave des Pins

April 2018

Proposal for the Redesign of Intersection Rue Rachel & Rue Saint-Urbain

To: The Head of Transportation, City of Montreal
Prepared by: Ely DeSandoli, Transportation Planning Representative for Vélo Québec
March 28th, 2018

SUMMARY

Saint-Urbain, one of Montreal's main southbound corridors, urgently requires a redesign of its current bicycle infrastructure. At the intersection of Rue Rachel, a protected bicycle track, bus boarding island, and a traffic signal prioritizing bicycle left-turns would be vast improvements for this important route. These redevelopments would increase the safety, connectivity, and efficiency of the city's overall bicycle network and strengthen Montreal's standing as the friendliest city for bicycling in North America.

CONTEXT

The city of Montreal has consistently been ranked the number one city in North America for bicycle infrastructure and accessibility.[i] To maintain this reputation, the city aims to add hundreds of kilometres to its existing bicycle network in order to encourage ridership.[ii] However, these initiatives have frequently been criticized as an issue of "quantity over quality", where painted bicycle lanes are favoured over protected paths.[iii] Efficiency of cost should not be prioritized over safety.

Furthermore, the city's current bicycle network has considerably fewer routes running north-south than east-west.[iv] Rue Saint-Urbain is one of the main southbound arteries for the Plateau borough of Montreal. As such, bike lanes along this corridor have high rates of ridership and traffic, yet they are nonetheless widely recognized as unsafe. This report will illustrate the dangerous features of the current design at the intersection of Saint-Urbain and Rue Rachel and will propose a safer and more efficient redesign for bicyclers, public transit users, and pedestrians.

SITE ANALYSIS

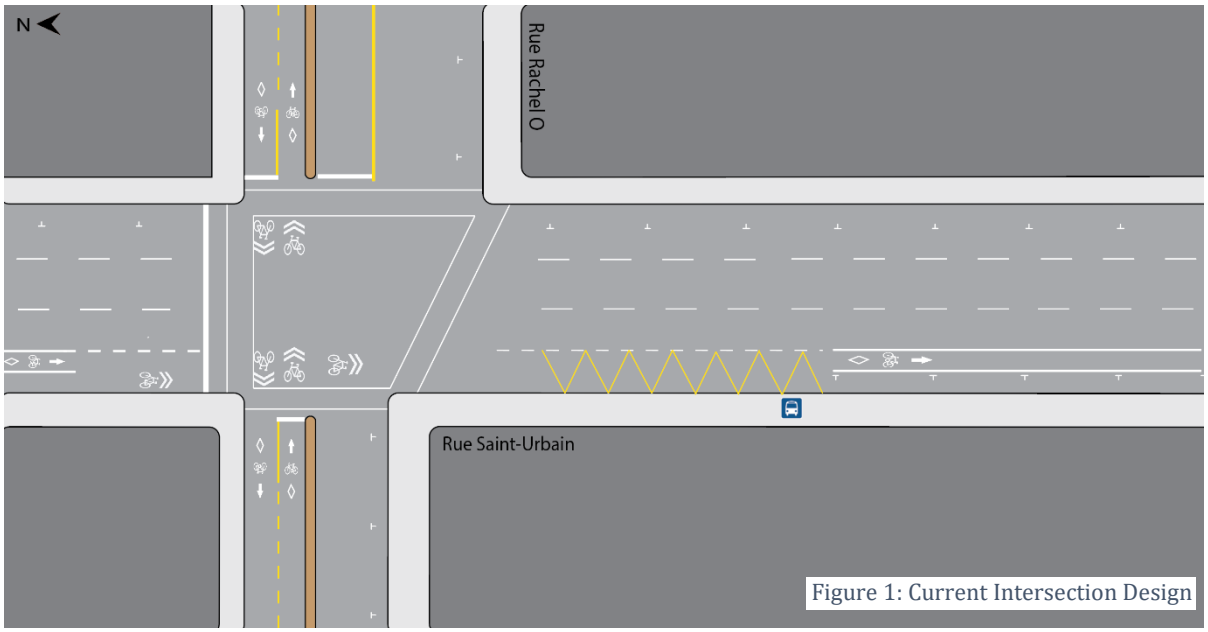


Figure 1: Current Intersection Design

Figure 1 provides a visual of the current intersection. The majority of Saint-Urbain's bicycle network consists of conventional lanes painted directly on the road, squeezing cyclists between parked cars and moving traffic. The intersection at rue Rachel is particularly problematic, with several conflict zones existing between cyclists and car users. While cyclists do make use of the protected bicycle path on Rachel as well as the conventional lane on Saint-Urbain, frequent usage of the current infrastructure does not rule out existing dangers.

CONFLICT ZONES

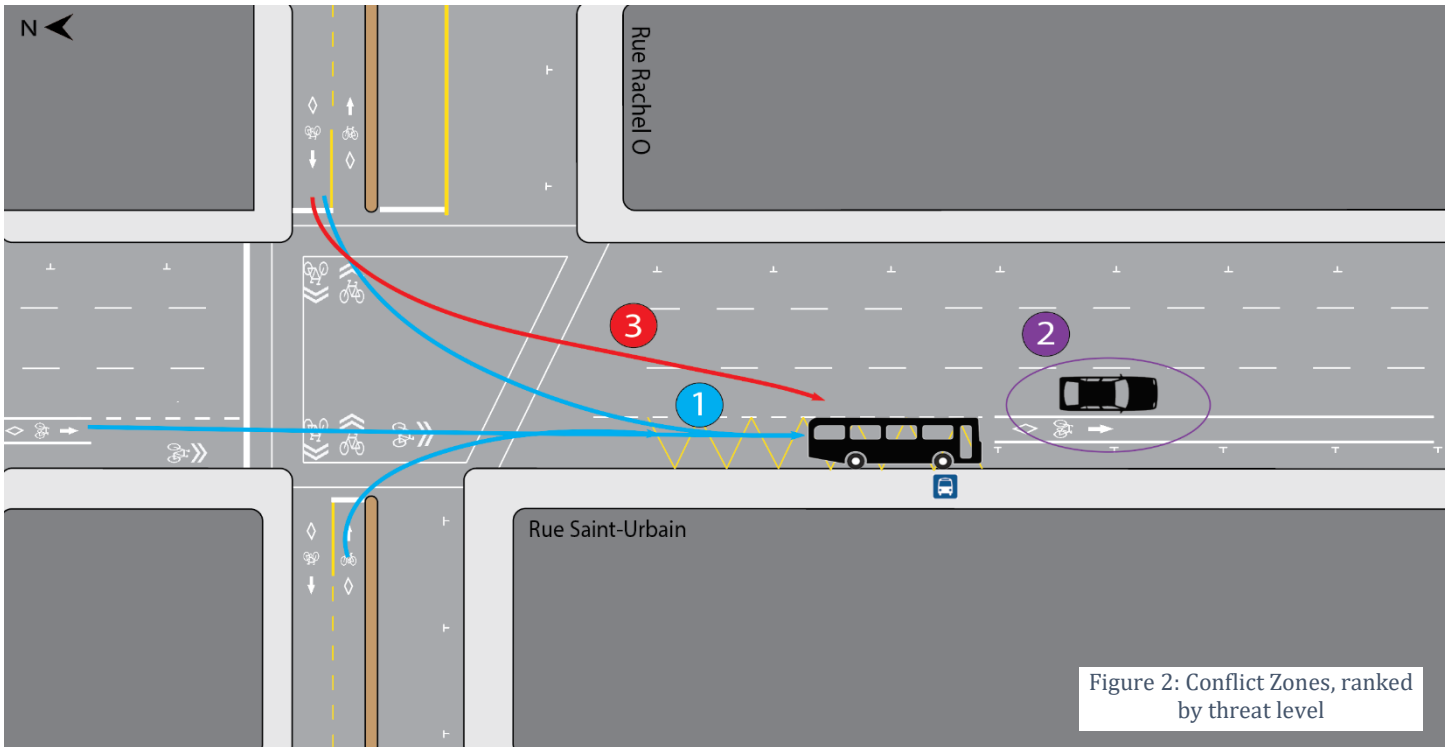


Figure 2: Conflict Zones, ranked by threat level

1 Designated Bus Zone

A considerable amount of space (marked by crossing yellow lines) is allocated to public bus loading and unloading. Here, the bicycle lane disappears causing cyclists to ride through the bus loading zone. When there is a bus present, cyclists are forced to enter moving traffic on the left to get around. As well as posing a large safety risk, this reduces the efficiency of the bicycle lane as cyclists are forced to swerve around both loading buses and moving cars to continue along Saint-Urbain.

2 "Dooring"

Conventional cycle lanes offer the least amount of safety, space, and comfort for cyclists. In particular, cyclists are vulnerable to both moving traffic on their left and opening doors—also known as "dooring"—from parked cars on their right. To avoid this tight space, some confident cyclists ride with vehicle traffic, creating an even bigger safety risk. Furthermore, painted lanes can easily become obstructed or worn away. Idling cars, unloading trucks, or plowed snow in the winter season all create obstructions within the cycle lane.

3 Left-turn Crossing

For bikers to turn from the Rachel bike path, they must cross across two lanes of traffic to reach the Saint-Urbain bike lane. An absence of a designated bicycle signal causes cyclists to cross with either the pedestrian or vehicle signal. This crowded turn causes conflict when bicyclists must wait for pedestrians crossing the crosswalk, often leaving cyclists stranded mid-turn in the middle of the intersection. Furthermore, the pedestrian signal does not give cyclists enough time to cross, oftentimes putting them dangerously close to oncoming vehicles who are turning or continuing straight through. This situation is further strained when a bus is in the designated loading zone, forcing turning cyclists to cross over Saint-Urbain and continue in the car lane, putting them at further risk of a collision.

RECOMMENDATIONS

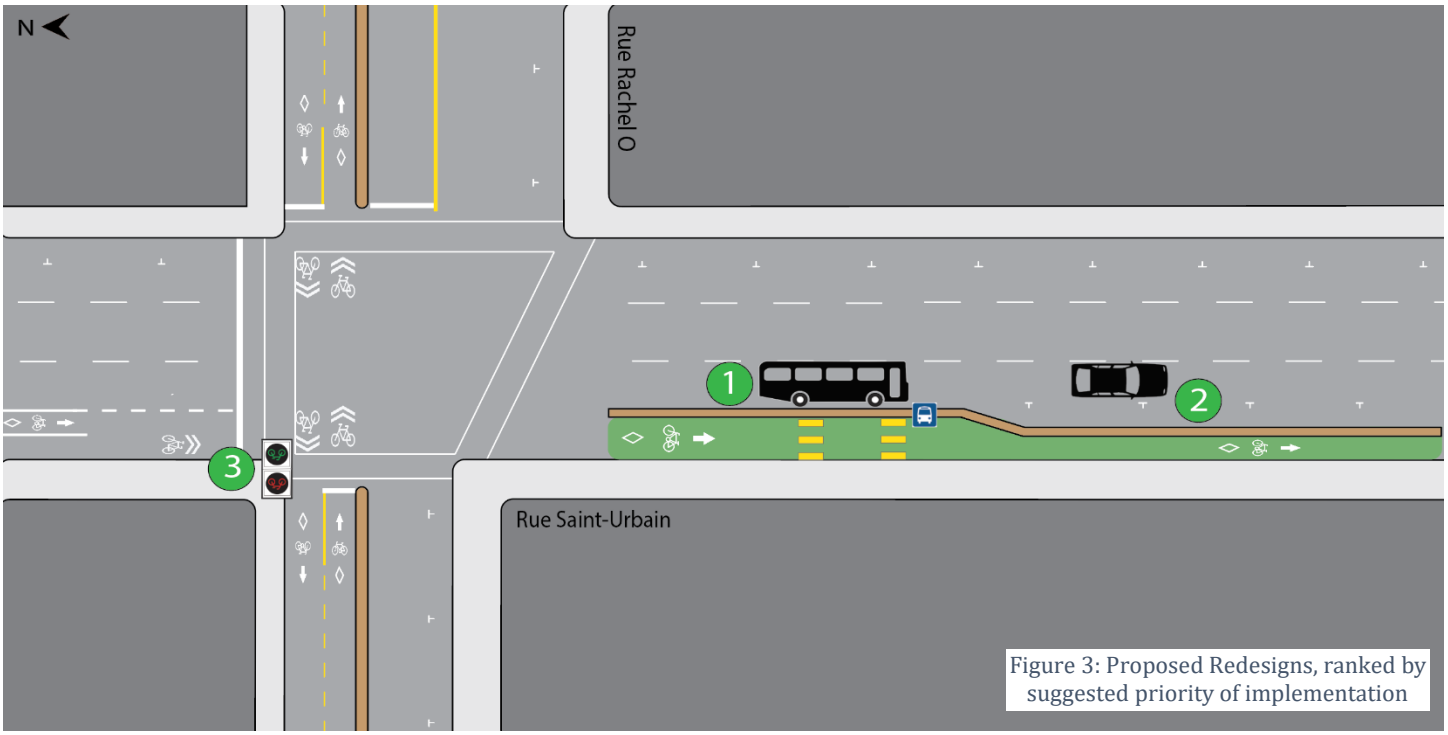


Figure 3: Proposed Redesigns, ranked by suggested priority of implementation

1 Bus Boarding Island with Protected Cycle Track

A designated cycle track protected by an elevated concrete median doubles as a space for both cyclists and transit users boarding the bus. The combination of an outward-jutting island and protected cycle track helps increase continuity and efficiency of these transit routes: buses no longer need to pull in and out of the designated loading zone, nor do cyclists need to swerve to avoid the stopped bus. Green and yellow paint help draw attention to the newly allocated lane and crosswalks.

Safety: Excellent
Comfort: Excellent
Space: Good (2 metres for cycle track, 1 metre for buffer)
Installation: Easy
Cost: Low

See Figure 4 for a successful example of this design, located one block south of Rue Rachel on Saint-Urbain.

Figure 4: Successfully implemented bus boarding island with protected cycle track located on Rue Saint-Urbain and Avenue Duluth. Source: Google Maps.

2 Extension of Protected Cycle Track

The extension of the protected cycle track and raised median is a natural continuation of the bus boarding island design. This track would extend south and connect with the current protected track at the intersection of Avenue Duluth, further increasing the connectivity of the Saint-Urbain cycling network. In addition, swapping the location of the bicycle lane and parking spaces creates an additional buffer between cyclists and moving traffic. The raised median then acts as extra protection against any risks of "dooring" from the row of parked cars. Furthermore, a concrete buffer can help with the beautification of the street by adding greenery onto the median itself.

Safety: Excellent
Comfort: Excellent
Space: Good (2 metres for cycle track, 1 metre for buffer)
Installation: Easy
Cost: Low

See Figure 5 for a successful example of a combination raised median and parked car buffer and Figure 6 for an example of added greenery for street beautification.

Figure 5: An example in San Francisco of a two-part buffer through the use of a median (unraised in this example) and a row of parked cars. Source: SFMTA Municipal Transportation Agency.[v]

Figure 4: Greenery added to a raised buffer as part of beautification efforts. Located at the intersection of Rue Rachel and Rue Clark, one block east of our case intersection. Source: Google Maps

3 Cycle Signal

At places with high traffic or conflict, designated bicycle signals can substantially improve the safety and confidence of cyclists without needing to change street infrastructure.[vi] A cycle signal facing Rue Rachel can be included in the regular traffic signal phase for those turning left onto Saint-Urbain. Implementing Leading Bicycle Intervals (LBI) will allow cyclists to advance ahead of vehicle traffic, reducing any possible conflicts with left-turning cars.[vii] LBI will also reduce confusion from using pedestrian signals, reducing any instances of cyclists pausing mid-intersection to wait for crossing pedestrians.

Safety: Excellent
Comfort: Excellent
Installation: Easy
Cost: Fair (approximate same cost as vehicle traffic signals)

CONCLUDING REMARKS

To increase ridership numbers, it is not enough to simply meet quotas of bicycle lane kilometers. It is crucial to create bicycle infrastructure that is comfortable, spacious, and safe for new and current riders alike. Rue Saint-Urbain is a highly frequented artery in Montreal's bicycling network. As one of the few southbound throughways, its current bicycle infrastructure is considerably lacking in both safety and form. Creating protected bicycle tracks along the entirety of Saint-Urbain would be the most ideal redevelopment, however we recognize the associated costs given the length of the street. Fortunately, many protected tracks and bus boarding islands already exist at select Saint-Urbain intersections (Avenue Duluth and Ave des Pins are successful examples). Therefore, we recommend similar raised buffers and bus boarding islands to match other intersections, as well as additional parked-car protection and cycling signals for maximum cycling safety. These recommendations would help develop a safer southbound passageway and connect our case intersection with the well-developed east-west cycling path on Rue Rachel, thereby increasing the overall connectivity, continuity, and efficiency of Montreal's cycling network.

SUPPORTING MATERIAL

[i] Copenhagenize Design Co. 2017. "Montreal, Quebec". *Copenhagenize Index 2017.* Retrieved from http://copenhagenizeindex.eu/20_montreal.html

[ii] Riga, A. 2017, October. "Project Montréal vows to build network of 'express' protected bike lanes." *Montreal Gazette.* Retrieved from http://montrealgazette.com/news/local-news/projet-montreal-vows-to-build-network-of-express-protected-bike-lanes

[iii] Madger, J. 2016, June. "Montreal's bike path network: Mind the gaps." *Montreal Gazette.* Retrieved from http://montrealgazette.com/news/local-news/cyclists-say-montreals-bike-path-often-leads-nowhere

[iv] Ibid.

[v] Bialick, A. 2017, March. "SF's First Raised, Parking-Protected Bike Lane is Here". *SFMTA Municipal Transportation Agency*. Retrieved from https://www.sfmta.com/blog/sfs-first-raised-parking-protected-bike-lane-here

[vi] National Association of City Transportation Officials. 2017. *Global Street Design Guide.* Island Press. Retrieved from https://globaldesigningcities.org/wp-content/uploads/guides/global-street-design-guide.pdf, p.97

[vii] Pedestrian and Bicycle Information Center. n.d. "Bicycle Signal Heads". *Pedestrian and Bicycle Information Center.* Retrieved from http://www.pedbikeinfo.org/planning/facilities_crossings_bikesignals.cfm

Anders Turim
Redesigning Saint Urbain and Rachel Intersection Memorandum
March 28, 2018

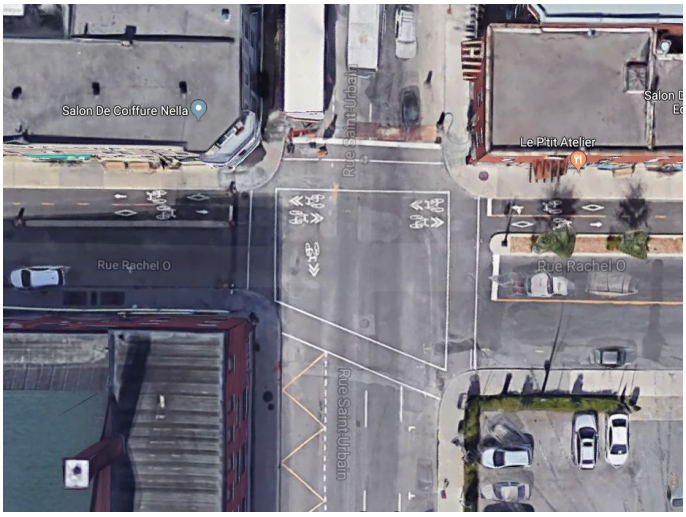
Summary
The intersection of Rue Saint Urbain and Rue Rachel was redesigned in 2012 to improve cyclist and pedestrian safety. Despite this, the current design of the intersection creates conflicts between cyclists and non-cyclists. The suggestions presented in this planning memorandum are meant to address these conflicts. These suggestions are based on an analysis of the intersection's existing infrastructure as well as on observations of users' travel behaviour in the afternoon of March 22nd, 2018. The intersection presents the following conflicts to cyclists:

1) A lack of marking and signage results in collision potential between cyclists turning left from Saint Urbain and pedestrians on the northwest corner of the intersection.
2) The lack of space for cyclists to halt when turning left from Saint Urbain results in cyclists changing lanes on Saint Urbain to turn left onto Rachel. This may lead to collisions with high speed traffic.
3) The lack of marking and signage results in collision potential between southbound cyclists and vehicles turning right from Saint Urbain.
4) The bus stop on the southwest corner of the intersection results in buses crossing the bike lane on Saint Urbain to pick up and drop off passengers. This may lead to collisions with buses and cyclists or cars and cyclists as cyclists alter their path to make way for buses.

To address the conflicts of the current design we recommend a new design for the intersection. Based on our analysis of the Rachel - Saint Urbain intersection, we propose the following changes to the intersection:

1) Inclusion of a protected cycle track going southbound on Saint Urbain.
2) A new traffic light to signal when cyclists can safely cross Rachel.
3) A Protected Intersection design on the northwest corner of the intersection.
4) Moving the current bus stop on the southwest side of the intersection onto a protected curb.

Figure 1: Current Intersection Design



Background

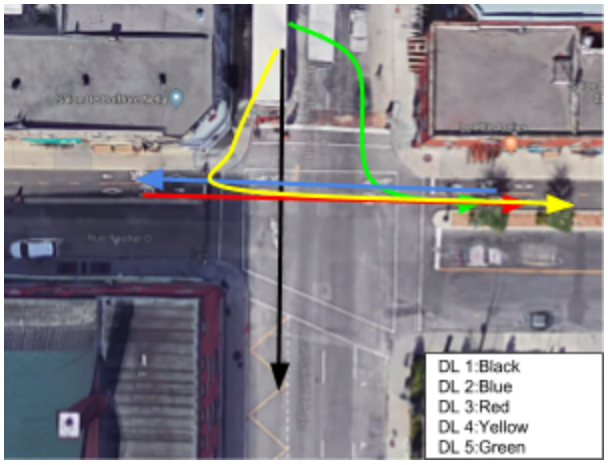
The intersection of Rachel and Saint Urbain is located in Montreal's Plateau neighbourhood, just east of Parc du Mont Royal. Saint Urbain is an important north-south route as it is one of the few major one way roads heading south. The intersection is also an important cycling crossing as each street features a major artery of Montreal's cycling network; a southbound bike lane along Saint Urbain, and the bidirectional east-west protected cycle track along the northern edge of Rachel.

The intersection was redesigned in 2012 to improve the connections and safety of pedestrians and cyclists. Despite being an important and heavily used intersection by pedestrians, cyclists, and motorized vehicles, the intersection still presents areas of potential conflict. Movement patterns of cyclists, pedestrians, and motor vehicles were noted as well as conflicts between the different modes of transportation. The observations taken were used to identify sources of conflict generated from the current design, and document how cyclists were using the infrastructure in alternate ways.

Desire Line Analysis

Desire lines are shown in Figure 2. This Figure shows that the most cyclist traffic occurs from southbound trips on Saint Urbain, represented by the DL 1. This is followed by DL 2, which represents cyclist going west on Rachel. This shows that cyclist traffic is highest on the northwest corner of this intersection. Two potentially problematic desire lines were observed. One was DL 5, which featured cyclists outside of the bike lane and crossing traffic on Saint Urbain, and DL 4, which featured cyclists taking a sharp right turn onto a pedestrian sidewalk.

Figures 2 & 3: Desire Line Analysis & Frequencies



Desire Line	Frequency
Desire Line 1	18
Desire Line 2	14
Desire Line 3	9
Desire Line 4	2
Desire Line 5	2

Critique of Intersection

The current design of the Rachel - Saint Urbain Boulevard intersection leads to Conflict Zones that primarily endanger the safety of the cyclists. The four Conflict Zones can be viewed in Figure 4.

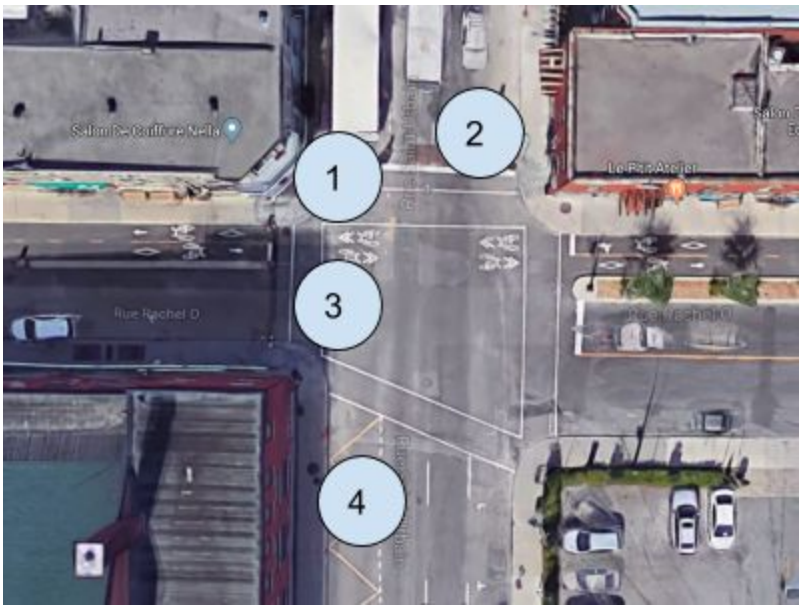
Conflict Zone 1: The cycle track along Rachel does not extend into Saint Urbain, so eastbound cyclists coming from Saint Urbain must proceed onto the sidewalk to safely move out of traffic, or dangerously cross lanes before the intersection in order to cross Saint Urbain.

Conflict Zone 2: Eastbound cyclists from Saint Urbain might choose to cross the three lanes of traffic in order to make the faster but more dangerous left turn onto Rachel.

Conflict Zone 3: Southbound cyclists from Saint Urbain have collision potential with drivers who are turning right onto Rachel from Saint Urbain.

Conflict Zone 4: Southbound cyclists from Saint Urbain must bike along fast moving traffic with no physical protection, which may result in a lack of perceived safety and comfort. Buses also regularly pick up and drop off passengers at this location, which could result in confusion and collision potential as the space for cyclists is unclear.

Figure 4: Conflict Zones



Design Interventions

In order to improve the safety, function, and efficiency of the intersection for cyclists, the following design interventions are recommended. This strategy is designed to mitigate motor vehicle-cyclist conflicts but will also increase the amount of space for the quantity of cyclists waiting at the intersection, and relieve conflicts between pedestrians and cyclists.

1) **Protected Cycle Track on Saint Urbain**

The key proposal of this memo is the extension of the protected cycle track on Saint Urbain. The inclusion of a protected cycle track heading south on Saint Urbain, ideally protected by a curb on both the northwest and southwest corners of the intersection, will improve the safety and comfort of southbound moving cyclists on Saint Urbain by providing a separation between themselves and the high speed traffic. This will minimize the conflict in Conflict Zones 1 and 4 by providing a protected space for southbound cyclists along Saint Urbain.

2) **New traffic light for southbound cyclists on Rachel and Saint Urbain**

A new traffic light on the southwestern corner of the intersection will indicate to cyclists when it is safe to cross Rachel and continue their trip southbound on Saint Urbain. This light will precede the light for motor vehicles, allowing for increased visibility, and a clear indication to cyclists that they have the priority. This will minimize the threat in Conflict Zone 3 since there will be a clear stream of cyclists across Rachel before motor vehicles are allowed to proceed.

3) **Bus stop moved onto the protected curb south of the intersection**

Moving the bus stop to the protected curb will minimize the conflict between busses and cyclists since buses will no longer have to cross the bike lane to pick up or drop off passengers. The design of this bus stop will be similar to that on the northwest corner of the Saint Urbain and Pins intersection three streets south of the Saint Urbain and Rachel intersection.

4) **Introduction of the six elements for a Protected Intersection on the northwest corner of Rachel and Saint Urbain**

Please see the Protected Intersection section below..

Protected Intersection

Well-designed protected intersections are intuitive and comfortable, provide clear right-of-way assignment, promote predictability of movement, and enhance safety of cyclists and pedestrians (Massdot, 2015). The introduction of this design will improve safety at Conflict Zones 1 and 2 by allowing a space for southbound cyclists to queue on Saint Urbain. This design will be comprised of the following six elements:

1) **Corner Refuge Island** will allow the bikers to be physically separated up to the intersection crossing point where potential conflicts with turning motorists can be controlled more easily. This element will provide the benefits of increased space for forward bicycle queuing area, reduced crossing distances for cyclists and pedestrians, and controlled motorist turning speeds.
2) **Forward Bicycle Queuing Area** will provide space for cyclists to stop while being within the view of motorists who are waiting at the stop bar, thus improving cyclist visibility.
3) **Motorist Yielding Zone** will provide a space for motor vehicles to yield while cyclists and pedestrians cross Rachel.
4) **Pedestrian Crossing Islands** will provide a space within the street buffer where pedestrians may wait between the street and the separated bike lane. This will prevent any conflicts between pedestrians and cyclists waiting at the intersection.
5) **Pedestrian Crossing of Protected Bike Lane** will provide a signal to cyclists that pedestrians have the right of way and will provide a clear and direct path for them to reduce the chance or likelihood that they step within the bike lane.
6) **Pedestrian Curb Ramp** will help the transition between the sidewalk and street where there is an elevation change.

Figure 5: Proposed Redesign of Northwest Corner https://www.massdot.state.ma.us

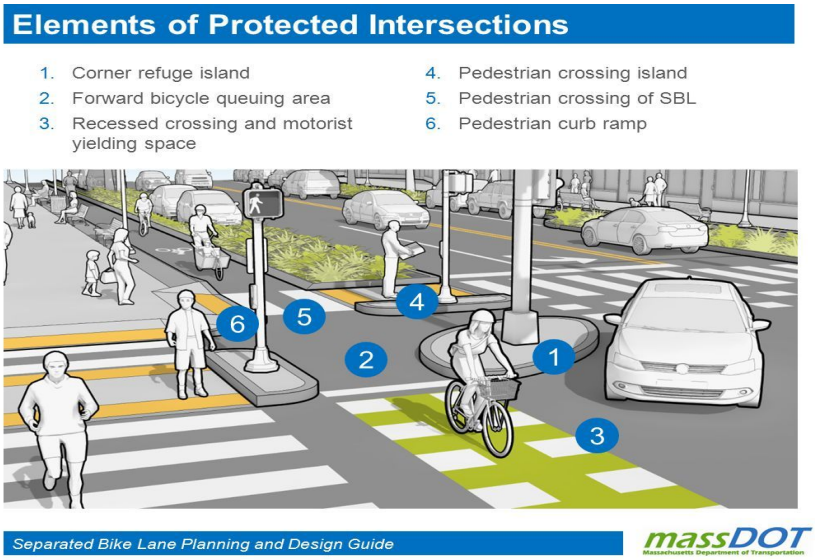
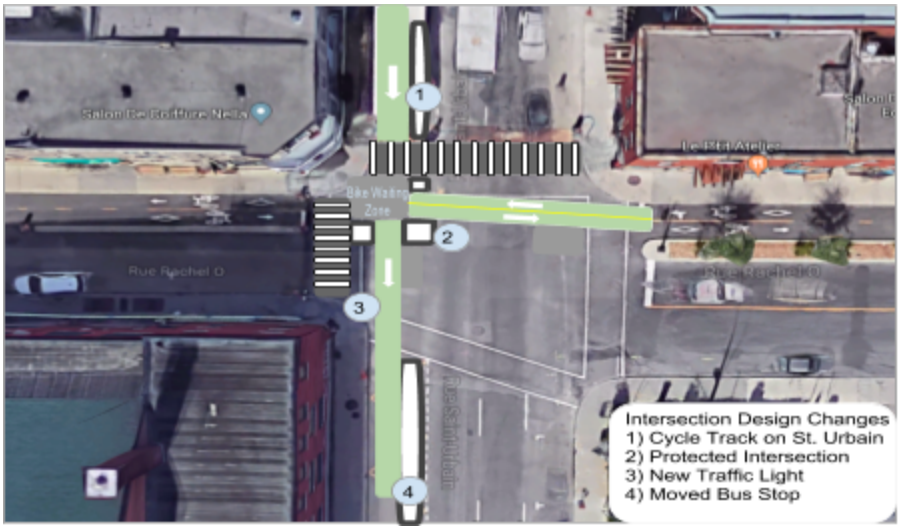


Figure 6: Proposed Redesign of Intersection



Conclusion

By providing a protected cycle track on the western side of Saint Urbain, southbound cyclists will be given a seperated and designated space, which will result in improved safety and comfort. The risk of conflict between southbound cyclists and westbound vehicles coming from Saint Urbain will also be minimized due to the new traffic light prioritizing cyclists, and the protected intersection design which forces motorists to yield while pedestrians and cyclists cross Rachel. Finally, the risk between buses and cyclists will be minimized with the new bus stop that is outside of the protected cycle track. As described, this proposed intersection design will be a clear net benefit to safety. If implemented, this redesign has the potential to save lives, attract further ridership in the area, and set a precedent for multimodal intersection design.

Planning Memorandum
Redesigning Montréal's rue St-Urbain & ave des Pins Intersection

TO: Head of Department of Transportation, City of Montréal
FROM: Jolène Labbé, Vélo pour tous Project Manager
DATE: March 28, 2018
SUBJECT: Redesign proposal for the rue St-Urbain & ave des Pins intersection

Executive Summary

The rue St-Urbain - ave. des Pins intersection is located in the Milton-Parc neighbourhood just north of Montréal's downtown core and east of the Mont Royal. The recommended redesign for this intersection are based on an analysis of the intersection infrastructure as it currently exists and on two 30 minute site observations of intersection users behaviour on March 22 (8:30-9am) March 23 (12-12:30 pm and 4:30-5 pm) . Observations included cyclist, pedestrian, vehicle and public bus counts; cyclist desire lines, intersection signal times, and pedestrian behaviour. The intersection, in its current design, presents several threats to both pedestrian and cyclist safety:

1) Pedestrians getting off the 55 bus on St-Urban are not segregated properly from cy clists going south on st-urbain in the bicycle lane. The pedestrian platform is not wide enough and crosswalks are not visible enough to cyclists. The bus stop in current near side of the intersection location blocks traffic and causes backups and conflicts with cyclists.

2) Potential for right hook collision between cars and cyclist when the cycling advance light on St-Urbain is red and cyclists continue through it (illegally), and left hook colli sions between cars and cyclists when cyclists turn left onto des Pins or St-Urbain.

3) Cyclists going east or west on avenue des pins risk being hit or doored by a vehicle because there is no designated space for cyclists on ave. des Pins. There is a high risk of cyclists being doored on St-Urbain because they are not protected from traffic.

4) The designed bicycle traffic light does not account for cyclists turning left onto des Pin from St-Urbain or left onto St-Urbain from des Pins (there are a high number of cyclists making this left hand turn illegally).

5) The current design of the intersection does not account for the high number of cyclists using the bicycle path along St-Urbain and results in backups of cyclists at the intersection.

To address conflicts at this intersection and improve safety for the most vulnerable road users -pedestrians and cyclists - we recommend a redesign for this intersection. The proposed redesign includes adding two unidirectional bicycle paths on ave des pins with bicycle boxes at the intersection along ave des Pins; moving the bus stop platform along St-Urbain from the near side to the far side of the intersection; and creating a bicycle box on St-Urbain and a cyclist only advance signal for turning at St-Urbain and des Pins to allow cyclists to get a head start on vehicles and make safe right and left turns through the intersection.

BACKGROUND INFORMATION

LOCATION & CONTEXT

The rue St-Urbain - ave. des Pins intersection is located in the Milton-Parc neighbourhood just north of Montréal's downtown core and east of the Mont Royal. The four-way intersection sees a high number of vehicle, pedestrian, and cyclist traffic throughout the day and evening, with peak numbers of through-traffic during the morning (St-Urbain and des Pins) and evening rush hour (primarily des Pins).

Figure 1. Location of intersection within surrounding neighbourhoods

OVERVIEW OF CURRENT INTERSECTION DESIGN AND USER BEHAVIOUR

Motorised Vehicles

St-Urbain is a one-way street with three-lanes of southern moving traffic, where one of the lanes acts as on street parking except for at the intersection. Additionally, the 55 bus line runs on St-Urbain with a stop at the corner of St-Urbain and des Pins, and the 144 bus line runs both east and west on des Pins with stops at the both corners of the intersection.

Pedestrian Movement

Pedestrians are permitted to cross in four directions. Pedestrian crossing lights crossing des Pins on St-Urbain are 13 seconds. and 10 sec crossing St-Urbain on des Pins.

Cyclist desire lines analysis

This intersection is a main route on an important cycling commuter route from Rosemont, le Plateau and the Mile End neighbourhoods going south to the downtown core and to McGill University. Along St-Urbain, the bicycle infrastructure consists of a conventional cycle lane that is 1.8 m wide with park cars to the right of the lane and vehicle traffic to the left.

Cyclists move fast along St-Urbain as the street is on a downward slope. At the intersection, the bicycle path at is located between the sidewalk and a raised bus platform stop. Other facilities include a 13 second cyclist light, allowing cylists to go straight through St-Urbain with the southern moving vehicle traffic. Conflicts between cyclists and cars in the current design were identified through observation of legal and illegal cyclist behaviour moving through the intersection. These movement paths are called cyclist desire lines and are depicted in Figure 2.

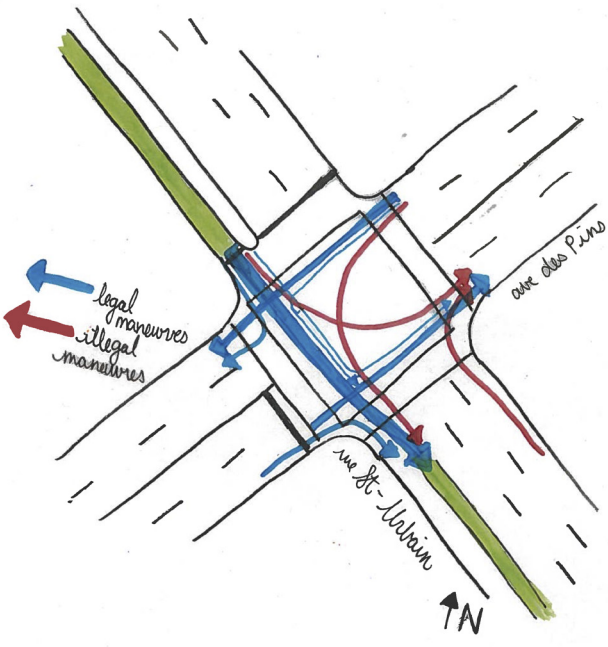


Figure 2. Cyclist desire lines analysis

ANALYSIS OF CONFLICT ZONES

The design of the intersection creates five conflict zones, where the safety of pedestrians and cyclists is compromised due to conflicts between cyclist and pedestrians, and cyclists and vehicles.

Conflict zone 1: Crosswalk - Inadequate space on bus platform, which in pedestrians standing in the bicycle lane; and pedestrians crossings are barely visible causing pedestrians to cross the bicycle lane anywhere along the platform. Additionally, during rush hour the bus stop slows traffic and causes a backup of vehicles at the light on St-Urbain because of its near side of intersection location.

Conflict zone 2: Right Hook Collisions - Potential for right hook collision between vehicles and cyclists when the cycling advance light on St-Urbain is red. This conflict is caused by cars turning right off st-urbain onto ave des pins during the advance right turn traffic signal for vehicles and cyclists continuing through intersection in the bicycle lane on St-Urbain (illegally).

Conflict zone 3: Left Hook Collisions - The designed bicycle traffic light does not account for cyclists turning left onto des pin going southbound on St-Urbain or left onto St-Urbain from des Pins. This may lead to collisions between cyclists and cars going straight on St-Urbain or turning.

Conflict zone 4: Lack Of Cycling Infrastructure - Cyclists going east or west on avenue des Pins risk being hit or doored by a vehicle because there is no designated space for cyclists on ave. des Pins and on certain portions of St-Urbain up and downstream from the intersection.

Conflict zone 5: Infrastructure Capacity Limited - The current design of the intersection does not account for the high number of cyclists using the bicycle path along St-Urbain and results in backups of cyclists at the intersection during morning rush hour between 8-9:30am, and on des Pins headed east during evening rush hour between 4-6pm. turning.

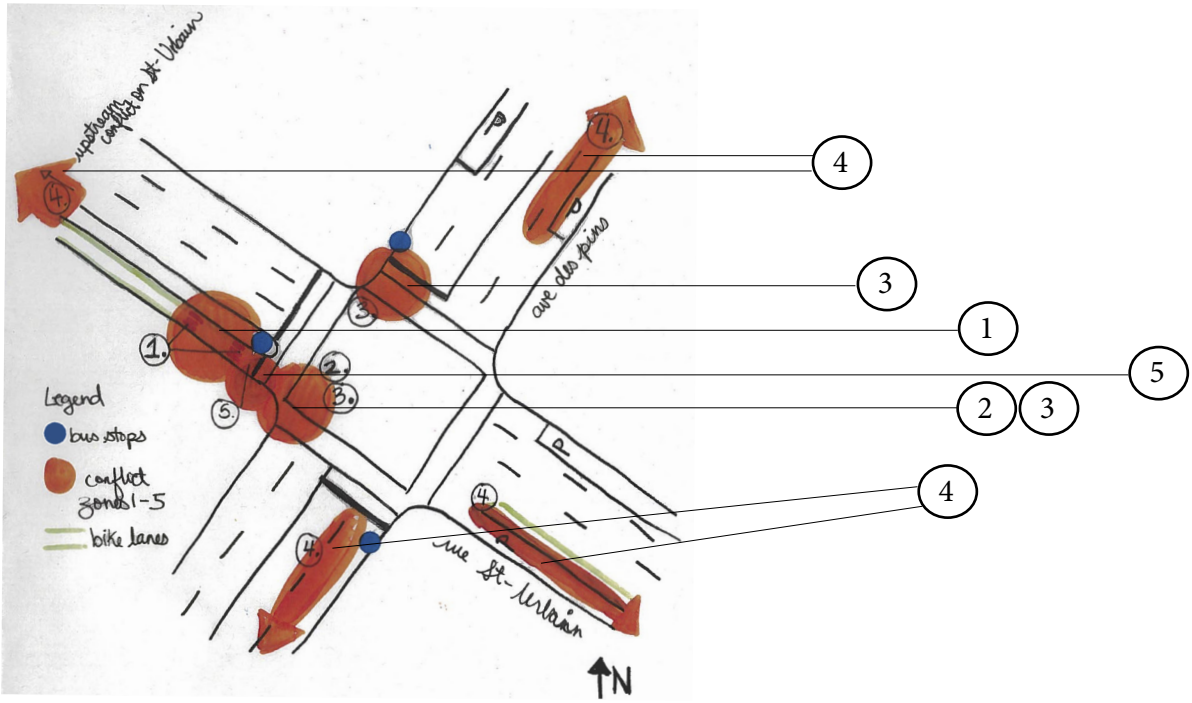


Figure 3. Graphic showing bus stop locations and conflict zones 1-6 between pedestrians and cyclists, and cyclists and vehicles. Information based on site observations

PROPOSED DESIGN CHANGES

Based on the analysis of the St-Urbain and des Pins intersection, we proposed the following five design changes to decrease conflicts between different road users and improve the safety for cyclists and pedestrians. Changes are laid out according to the conflict zones they address:

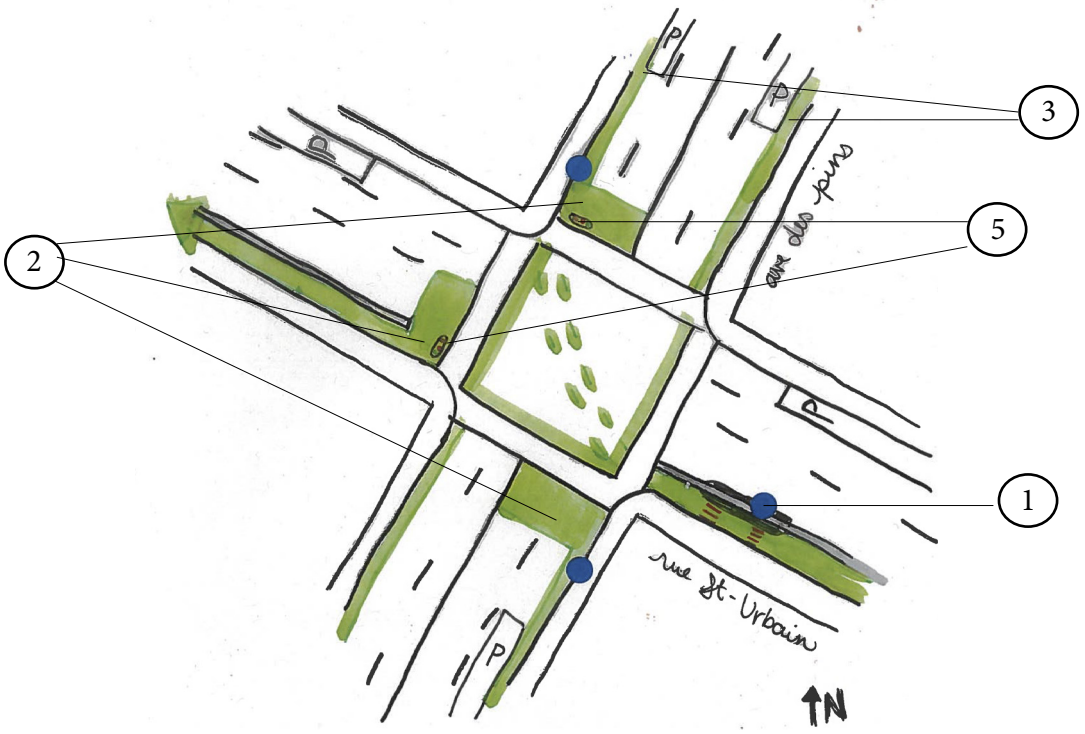
1. **Moving the bus stop to the far side** of the intersection on St-Urbain, widening the bus stop platform to create additional space for pedestrians, and increasing the visibility of pedestrian crosswalks across the bicycle lane. With the 55 bus stop on the far side of the intersection, the stop will be more efficient and improve traffic flow (Addresses conflict in zone 1).

2. **Creation of three bike boxes:** one in each direction on des Pins and one at the northern portion of the intersection on St-Urbain. Bike boxes will allow cyclists to get to the front of the intersection and have an advance start to safely cross the intersection while increasing their visibility to vehicles and pedestrians. Additionally, on street paint should accompany the new boxes to guide cyclists turning left (Addresses conflicts in zone 2 3 and 5).

3. **Two unidirectional bicycle lanes** heading east and west along ave. des Pins. These should be 1.5-1.8m in width and located between the sidewalk and parked cars to provide a protective barrier for cyclists from traffic. Ave des Pins currently has wide on-street parking on both sides of the street and can accomodate the addition of these lanes without removing or affecting the existing parking or traffic lanes (Addresses conflict in zone 3)

4. **Moving the bicycle lane on St-Urbain** to the inside of parking, next to the sidewalk. The parking will create a physical barrier between cyclists and traffic, and will decrease the risk of cyclists being doored or falling or swerving into traffic into on St-Urbain in the case of a collision. This is upstream of the intersection and is not depicted (Addresses conflict in zone 3)

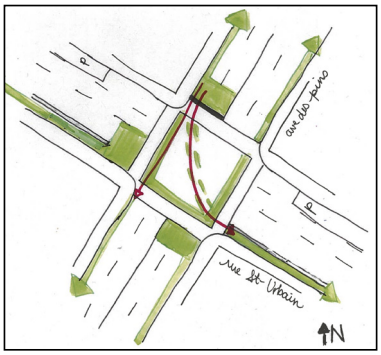
5. **Cyclist only advance lights** on both roads can minimize conflicts between cyclists and vehicles and improve safety of the new far side 55 bus stop (Addresses conflict in zone 4)



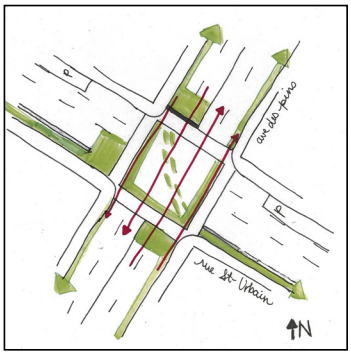
PROPOSED DESIGN CHANGES

A new advanced left turning signal for cyclists will be installed on des Pins for cyclists wishing to turn left onto St-Urbain lane. An advance in all directions for cyclists at the St-Urbain light will allow cyclists to cross the intersection before vehicles and buses. Allowing cyclists to pass first should also decrease the number of cyclists passing by the relocated St-Urbain far side bus stop when the bus is stopped and make it easier for pedestrians to cross. See Figures above for proposed light phasing.

1. Traffic light on Ave. des Pins

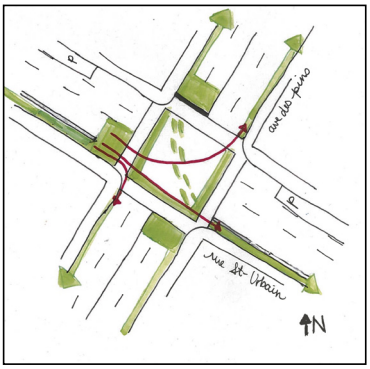


Phase 1: advance left & straight for cylists

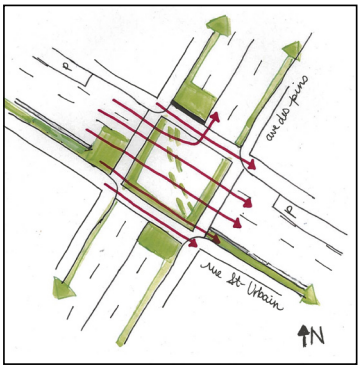


Phase 2: normal traffic light for all users

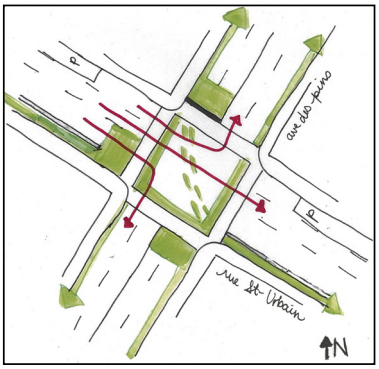
2. Traffic light on St-Urbain



Phase 1: advance all directions for cyclists



Phase 2: advance straight through for cyclists, vehicles, and left turn for vehicles. Pedestrians can cross



Phase 3: Right turn advance for vehicles, with straight through and left turns permitted. No cyclists or pedestrians cylists

CONCLUSION AND PRIORITISATION

The St-Urbain - Ave. des Pins intersection is a important and busy intersection that is heavily used by motorised vehicles, cyclists, and pedestrians. Several conflicts between these users create threats to pedestrian and cyclist safety.

This policy memorandum presents present a series of five relatively low to medium cost design solutions that address these conflicts and improve the safety of this intersection for pedestrians and cyclists and improve connectivity of the east-western cycling network. Recommendations 2, 3, and 5 should be prioritised if all five design changes cannot be implemented or completed first in phased project because these address the most dangerous conflicts between vehicles and cyclists. To implement recommendation 4, consultation with a traffic engineer is needed to determine signal time lengths for proposed new light phasing.

PLANNING MEMO

SAINT-URBAIN & RACHEL INTERSECTION REDESIGN

Prepared For:
Department of Transportation
City of Montréal

Prepared By:
Catherine Cui
McGill University

March 28, 2018

EXECUTIVE SUMMARY

Montréal has always been considered one of the best cycling cities in the world. The city has the most separated bicycle lanes in Canada, an extensive network of continuous multi-use trails along the edge of the island as well as a well-developed bike sharing program that has been used as a model for bike share programs in other North American cities. Unfortunately, cycling safety is a problem in Montréal as the city has the highest crash rate per trip compared with other major Canadian cities[1].

While the city has adopted VISION ZERO, there are no specific actions outlined in the Montréal Cycling Master Plan to address the cyclist safety. It is prudent that the design of cycling infrastructure on major routes and nodes are adequate to reduce the risk of injury to cyclists.

It has been shown that cyclist collisions with motor vehicles occur more often at intersections. In fact, a report on cycling safety published by the City of Vancouver found that around 51% of collisions between cyclists and motorists occur at intersections compared to 40% at mid-blocks[2]. Therefore, it is worthwhile to examine the safety at major cycling intersections in cities.

The purpose of this planning memo is to **propose a redesign of the intersection** of Rue Saint-Urbain and Rue Rachel from a cyclist's perspective based on observed cyclists flows at the intersection. First, an overview of the intersection in question and its **current state** in terms of existing cycling infrastructure is provided. As part of the analysis process, **desire lines** are presented based on these observations and **five conflict points** were identified.

These conflict points are as follows:

1. Saint-Urbain cycle path ends just before intersection and becomes mixed traffic zone
2. Bus stop south of intersection forces cyclists to merge into traffic to bypass bus
3. Potential for dooring due to parked vehicles on Saint-Urbain cycle path upstream and downstream of intersection
4. Conflicts with traffic for cyclists turning left onto Rachel from Saint-Urbain
5. Conflict with traffic for cyclists turning left onto Saint-Urbain from Rachel

The **proposed design** aims to address these conflicts through a modification of the conventional cycle path on Saint-Urbain into a protected cycle track, replacement of the curbside bus stop with a boarding island, implementation of cycle signals, construction of a two-stage turn queue box in the north-west corner of the intersection and an Advanced Stop Bar (ASB) on Saint-Urbain heading south. Short-term and inexpensive strategies such as ASB, queue box and cycle signals should be implemented soon to improve safety while strategies that require significant infrastructure changes need to be added to the Plateau Mont-Royal borough budget to be carried out over a longer period.

CONTEXT

The intersection of Rue Saint-Urbain and Rue Rachel is located in the Plateau Mont-Royal neighborhood of Montréal. The two streets that meet at this intersection, Rachel and Saint-Urbain, are major routes in the Montréal cycling network. Rue Rachel is a two-way street that becomes one-way west of the intersection and it is equipped with a protected bidirectional cycle track on the north side of the street extending from Boulevard Pie-IX from the east to Parc Jeanne Mance on the west. Saint-Urbain on the other hand is one-way with a conventional cycle lane that starts at Rue Bernard in the Mile End neighborhood and ends at Boulevard René-Lévesque in downtown Montréal. These two routes are important to cyclists because for one, the Rachel cycle track is one of the few complete cycle lanes to connect neighborhoods on the east side of the city to the downtown area. As well, the Saint-Urbain cycle lane serves to connect cyclists from neighborhoods north of the CP train tracks in Mile End to downtown. It also connects cyclists with the downtown Maisonneuve cycle path.

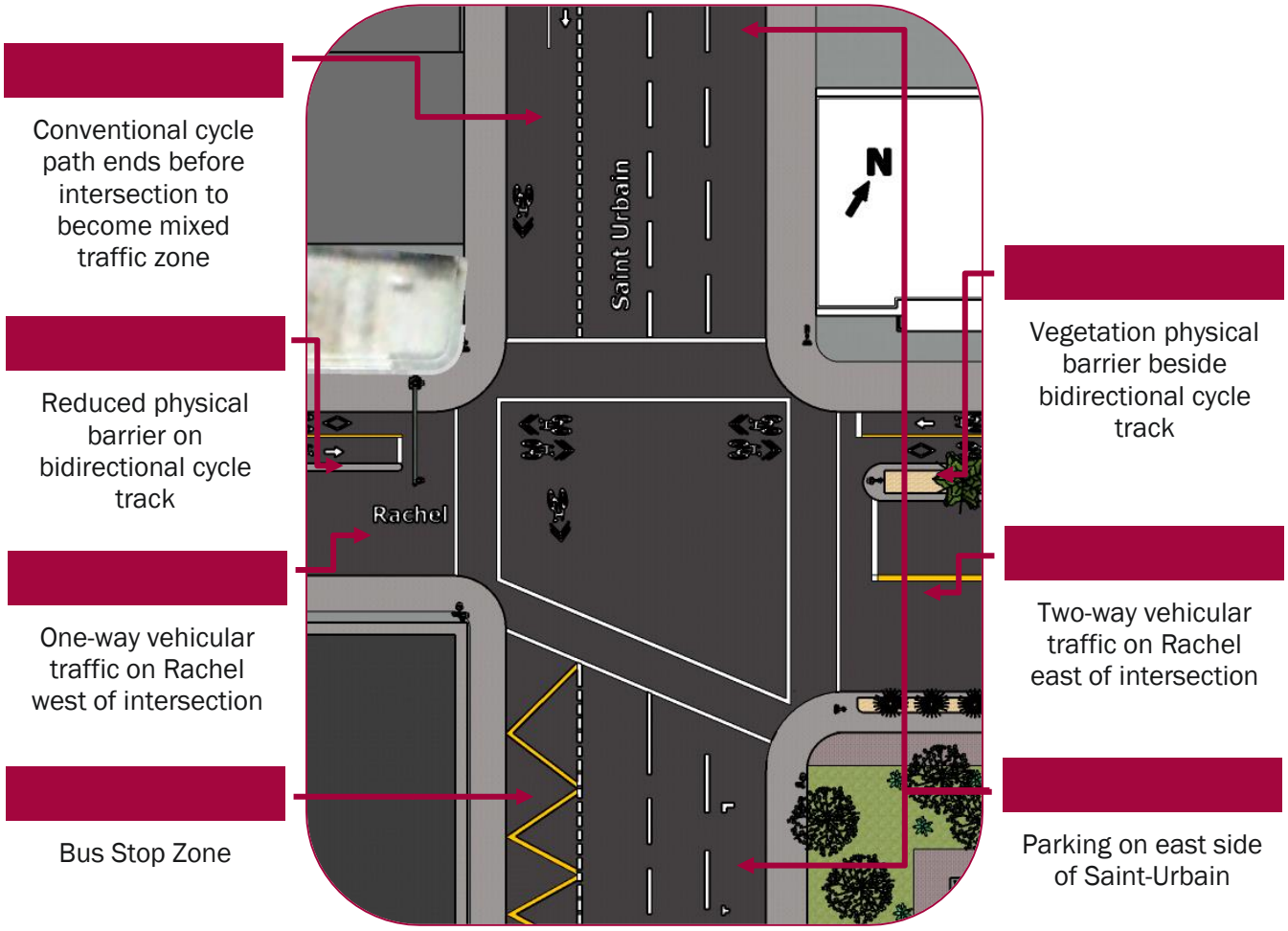


Figure 1: Illustration of the Saint-Urbain and Rachel intersection and its important features

METHODOLOGY

Two sets of cyclist counts were obtained at the intersection, one on Wednesday, March 22 and the second on Thursday, March 23. The first set of counts were observed between 4:30 PM and 5:30 PM and the second were observed between 4:15 PM and 5:15 PM. The combined cyclist counts are shown in **Figure 2** in the form of a desire lines diagram. There is a total of eight cyclist maneuvers that were observed at the intersection and they are ranked here from the most observations recorded to the least:

1. Straight through on Rachel from west to east
2. Straight through on Saint-Urbain from north to south
3. Straight through on Rachel from east to west
4. Left turn onto Rachel going east from Saint-Urbain heading south (some cyclists chose to turn left on the east side of the street instead of where the cycle path is; best way to carry out this turn is unclear)
5. Right turn onto Rachel going east from Saint-Urbain heading north (ILLEGAL)
6. Left turn onto Saint-Urbain going south from Rachel heading west
7. Right turn onto Saint-Urbain going south from Rachel heading east
8. Right turn onto Rachel going west from Saint-Urbain heading south

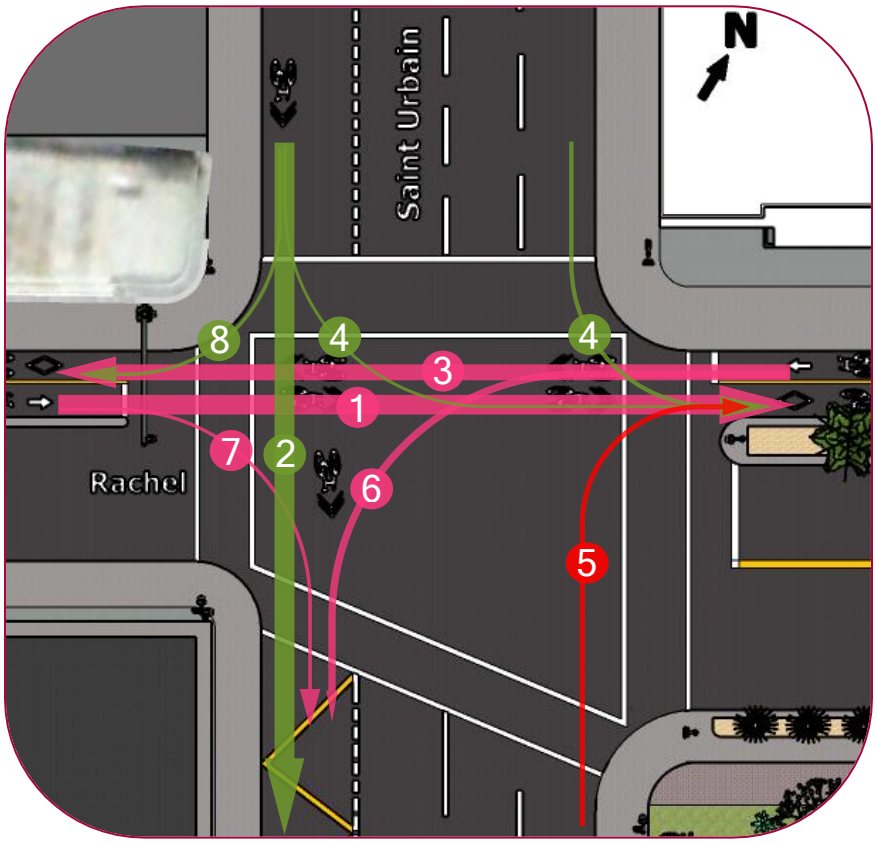


Figure 2: Cyclist traffic flows shown as desire lines. Line shown in red indicate illegal maneuver. Thickness of lines represents frequency of observations.

CONFLICT POINTS

#1 Ending of Saint-Urbain cycle path at intersection	Mixing of traffic increases cyclist risk of collision as they need to swerve into traffic around vehicles making right turns
#2 Bus stop south of intersection forces cyclists to merge into traffic	Bus stop is located on the sidewalk which means that cyclists passing through the intersection need to anticipate bus movements and merge into traffic when bus is stopped
#3 Potential for dooring on Saint-Urbain	Unprotected Saint-Urbain cycle path with curbside parking can lead to dooring incidents
#4 Conflicts with traffic for cyclists turning left onto Rachel	Cyclists on Saint-Urbain who wish to turn onto Rachel need to cross left-turning and straight-moving vehicles unless they go south, then east, the north to turn onto Rachel (against traffic)
#5 Conflicts with traffic for cyclists turning left onto Saint-Urbain	Cyclists on Rachel who wish to turn onto Saint-Urbain must yield to oncoming cyclists and vehicles proceeding straight on their left unless they do a box-style turn by going west and then south

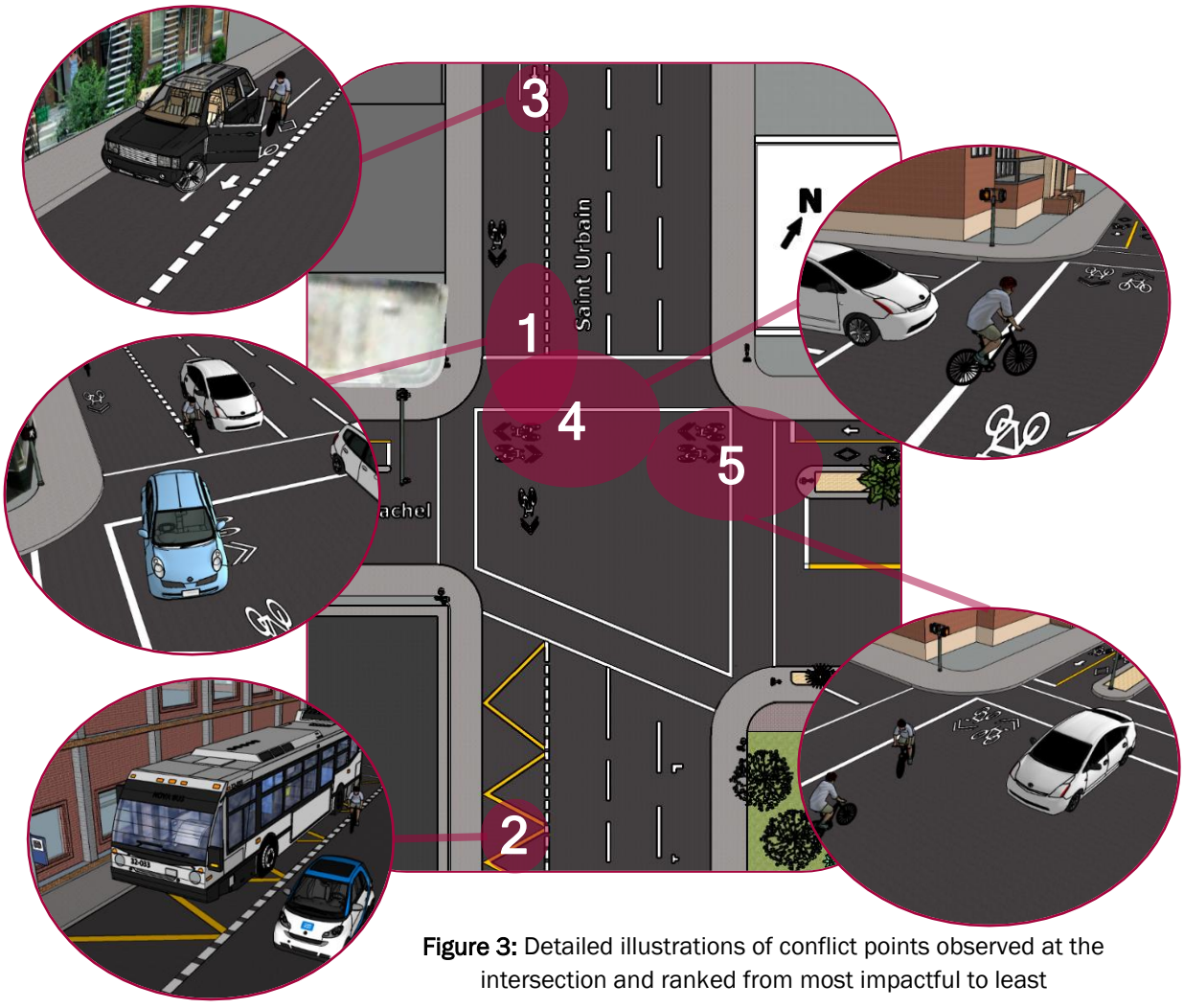


Figure 3: Detailed illustrations of conflict points observed at the intersection and ranked from most impactful to least

PROPOSED DESIGN CHANGES

It would be ideal for the bidirectional cycle track on Rachel to be replaced with buffered one-way paths on both sides of the road as bidirectional tracks increase the probability of collisions between cyclists travelling in opposite directions. This design also has safety implications for this intersection as shown by **conflict point #4** where left-turning vehicles on Saint-Urbain will need to cut through the cycle track to get into the proper lane, creating problems for left-turning cyclists. Some cyclists even chose to turn from the non-cycle path side of the street (**path #4 in Figure 2**). However, we are not considering a re-build of this cycling infrastructure as it would too costly for the entire stretch to be replaced. Therefore, looking past the potential for collisions between cyclists on Rachel, our proposed changes help to mitigate safety concerns at the intersection.

The following recommendations are ordered by their effectiveness to address conflicts observed at the intersection. Estimates for cost, traffic disturbance (to existing traffic flow) and time to implement are also provided. Refer to Figure 4 for an illustration of the new intersection design combining the proposed design changes.

1 Modify cycle path on Saint-Urbain to a **one-way protected cycle track**	A protected cycle track with a buffer zone to the left of the track protects cyclists from traffic. Bollards will be placed in buffer zone. Traffic flow is not impacted as existing lane is wide enough but parking on west side of the street will need to be removed. Cycle path will be 2 m wide and marked green at the intersection. *Current Application:* New York City *Cost:* Low (paint and bollards) *Traffic Disturbance:* Low (no reduced lanes of traffic but less parking spaces available) *Time to Implement:* Long (need to modify entire stretch of Saint-Urbain cycle path)
2 Replace curbside bus stop with **boarding island** with cycle lane behind it	Bus boarding island reduces conflicts between buses and cyclists as no in-and-out merges will be required. As the bus stop is currently located after the intersection, boarding island should extend from the intersection to the stop to allow pedestrians to get onto the island from the intersection. Cycle path be reduced to 1.5 m to allow the 2 m wide island. There will be a marked crossing mid-block for pedestrians. *Current Application:* Berkley, CA[3] *Cost:* Moderate (island construction) *Traffic Disturbance:* Moderate (bus will be stopping on traffic lane) *Time to Implement:* Long (requires construction of the island)

3

Implement **cycle signals** at the intersection

Dedicated cycle traffic signals separate cycle and vehicle movements to reduce conflicts. The proposed cycle signals on the south side of the intersection will have a left-turn cyclist-only phase to accommodate left turning cyclists from Saint-Urbain onto Rachel. Pedestrian movements are prohibited during this phase. Ideally, positioning of the two cycle paths should be altered to ease box-style movements at the intersection but would require significant changes to entire lengths of the routes.

Current Application: Copenhagen, Denmark[4]

Cost: Moderate (construct signals)

Traffic Disturbance: Moderate (motorists need to wait longer at intersection because of left-turn cyclist-only phase)

Time to Implement: Short (coordination of traffic cycles at the intersection as well as upstream and downstream signals)

4

Create a **two-stage turn queue box** in northwest corner of intersection

A two-stage turn box increases safety for cyclists such that no merging into traffic will be required to make left turns. This will be constructed at the northwest corner to allow cyclists on Rachel to turn left onto Saint-Urbain safely. The turn box will be 2m x 2 m and marked in green. The turn box will be protected by the curb line in that corner. Pedestrian crossing on Saint-Urbain will be shifted north to accommodate the queue box. Curb in this corner will be modified to account for this shift in pedestrian crossing.

Current Application: Portland, OR[5]

Cost: Low (paint and curb cuts required)

Traffic Disturbance: Low (traffic flow is not hindered)

Time to Implement: Medium (time to modify curb)

5

Construct an **Advanced Stop Bar** (ASB) on the north side of intersection

ASB provides an area ahead of vehicles at the intersection to allow cyclists to get ahead as they wait during a red light. Combined with cycle signals, this will allow more left-turning cyclists on Saint-Urbain to complete this maneuver quicker. The ASB will be 3 m deep and marked in green.

Current Application: Intersection of Milton and University, Montréal

Cost: Low (paint)

Traffic Disturbance: Low (traffic flow is not hindered)

Time to Implement: Short (no extensive construction needed)

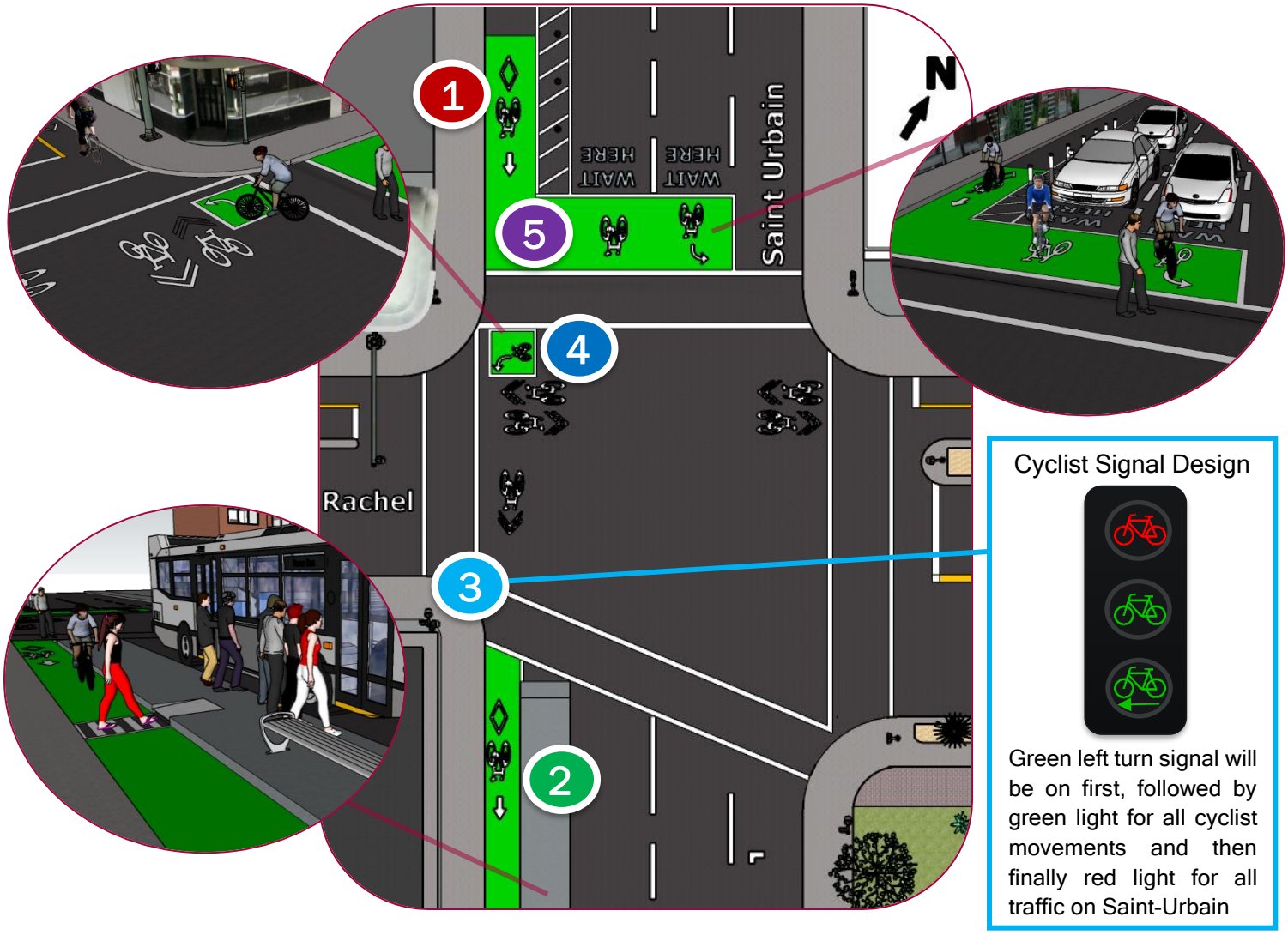


Figure 4: New design for the intersection and its major features

CONCLUSION

Based on our observations of the Rue Saint-Urbain and Rue Rachel intersection, we've identified in this document several conflict points for cyclists moving through this intersection. As a result, we are proposing a redesign of the intersection through a modification of the conventional cycle path on Saint-Urbain into a protected cycle track, construction of a bus boarding island to replace a curbside bus stop, implementation of cycle signals, construction of a two-stage turn queue box in the north west corner and an Advanced Stop Bar (ASB) on Saint-Urbain heading south. Components of the redesign that are inexpensive and can be done in the short term include ASB, queue box and cycle signals. Long-term but more impactful strategies such as modification of the cycle path and construction of bus boarding island should be included in Le Plateau's borough budget within the next five years. When implemented together, these changes will yield safety benefits to cyclists at this intersection.

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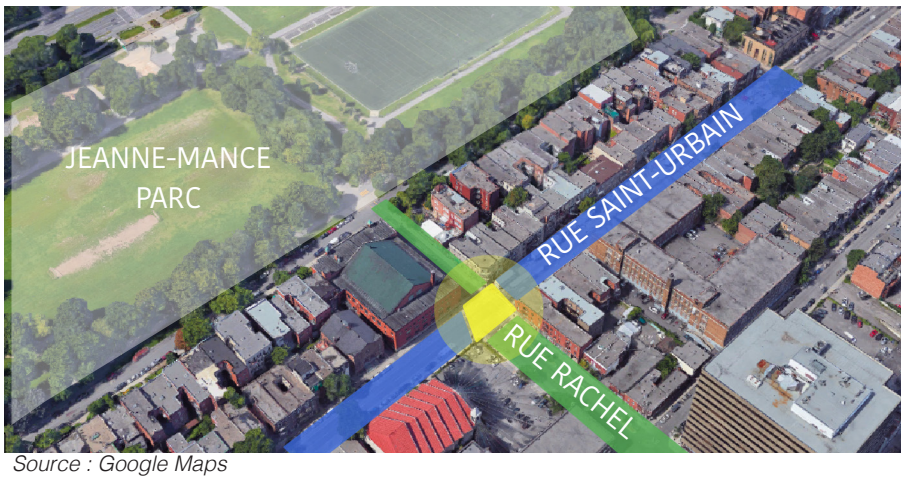
VILLE DE MONTRÉAL
TRANSPORT ET MOBILITÉ DURABLE

PLANNING MEMO : RUE SAINT-URBAIN AND RUE RACHEL INTERSECTION PROBLEMS AND SOLUTIONS

EXECUTIVE SUMMARY

Located in the heart of the **Plateau Mont-Royal** borough, a cycling haven inside the city of Montreal, the intersection of two of Montreal's most popular cycling streets, rue Saint-Urbain and rue Rachel, is not up to par. **The current configuration** of the intersection is **problematic and potentially dangerou**s for its users due to conflicts between pedestrians, cyclists, cars and buses. Something needs to be done to **create a safer space** for the active commuters that use this intersection every day. In this planning memo **4 solutions** are proposed to **reduce the user conflicts** and create a more cohesive environment.

CONTEXT

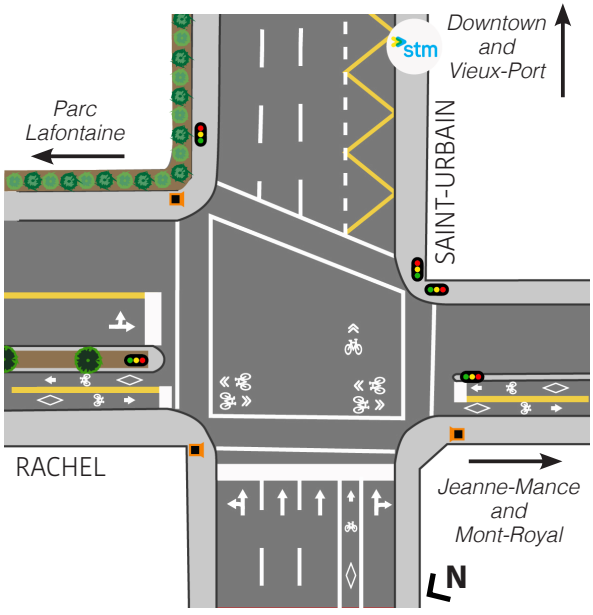


Source : Google Maps

The environment surrounding the meeting of two main cycling arteries includes two of the cities most beautiful parks: Jeanne-Mance and Mont-Royal. Both parks are highly visited in the spring, summer and fall and are primarily accessible by foot, bike or bus due to the scarcity of vehicle parking in the vicinity.

The main entrance into Jeanne-Mance Park is accessed via rue Rachel on rue Rachel is one of the most used in both the borough and the city and begins at Jeanne-Mance Park. The path was built in response to a high demand for a safer biking corridor to connect the two biggest parks in the Plateau: Jeanne-Mance and Lafontaine.

Rue Saint-Urbain is a one-way street that traverses the entire Plateau Mont-Royal neighborhood and gives a direct access to the city centre and Vieux-Port. Despite it not being bicycle friendly, due to high traffic volume and the presence of a bus routes, the city hasn't been able to keep cyclists off of it. The street is a cycler's dream: a 4 km long downhill that intersects with all the most used bike paths throughout the downtown core. A bike lane and other measures have been implemented to improve safety conditions but there are still many safety and road sharing concerns for cyclists.



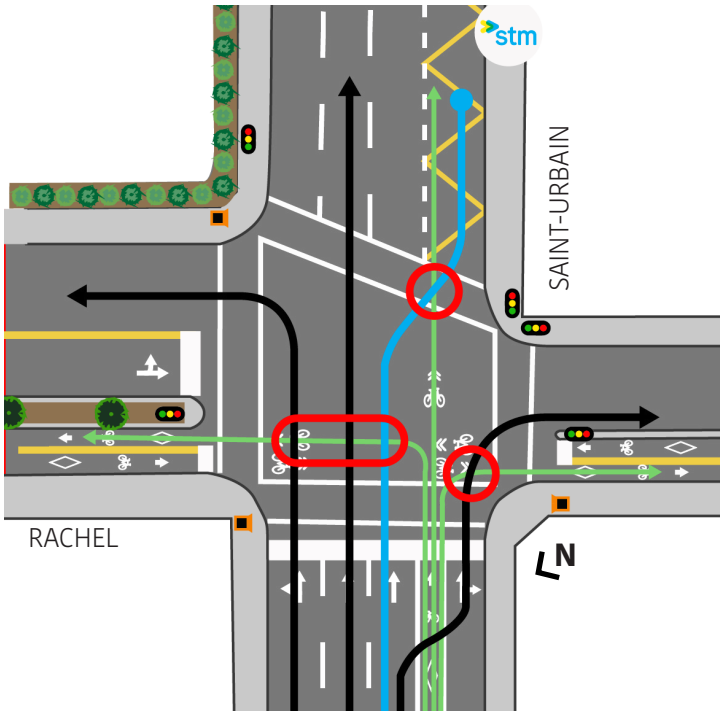
The presence of the parks and the importance of both streets for public, automobile and active transit stress the importance of this intersection and that something needs to be done to make it a safer place.

CURRENT SITUATION : PROBLEMS

The particularities of the intersection:

West of Saint-Urbain, Rachel goes from a two lane two-way to a one lane one-way street
Rachel also has a bi-directional protected bike lane and Saint-Urbain has a conventional one-way bicycle lane
The bus stop on Saint-Urbain is placed after the light and not before it
Pedestrians have a priority light that allows them to cross Rachel before cars and cyclists
It's shape (not being square or rectangular) due to the lane reduction on Rachel Street

The unusual shape of the intersection and the changes in lanes create user conflicts for each street. The conflicts are particular to the traffic flow for each light change.



SAINT-URBAIN : CONFLICTS

Cyclists and cars
Cyclists going straight down ↑ Saint-Urbain have to wait for cars turning right onto Rachel off of Saint-Urbain

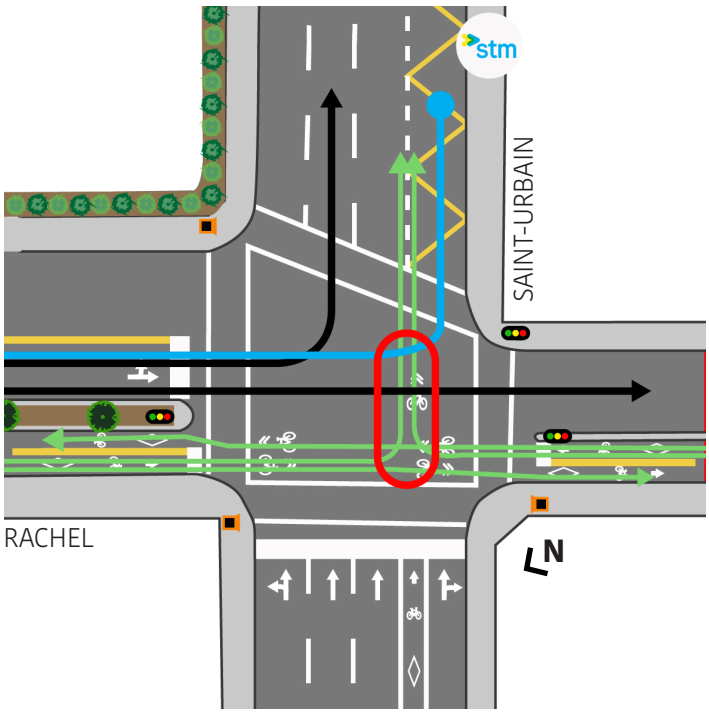
Cyclists and buses
Cyclists going straight down ↑ Saint-Urbain have to wait for the bus to pass and arrive at its stop if they want to stay in their bicycle lane

Cyclists and cars/buses
Cyclists who want to turn left ↰ onto the Rachel bike path have to cross three lanes of traffic and a bus route

RACHEL : CONFLICTS

Cyclists and cars/buses
Cyclists wanting to leave the Rachel bike path and turn right ↱ onto Saint-Urbain have to wait for cars to go straight through and for a bus to turn and arrive at its stop before going

Cyclists and cars/buses/cyclists
Cyclists turning left ↱ onto Saint-Urbain have the same problem as well as having to wait for cyclists going straight through the intersection



GOING FORWARD : SOLUTIONS

Action is required to prevent accidents. All the solutions presented are viable options and are based on examples of what has been done at other problematic cycling intersections or along important cycling corridors in Montreal. Each option is assessed according to its contribution to the improvement of safety, its feasibility and its cost.

1 ELIMINATING THE RIGHT TURN OFF SAINT-URBAIN ONTO RACHEL

Why? Eliminates conflict between cyclists going straight through the intersection.
Example: Montreal is known for it's no turning policies on busy streets

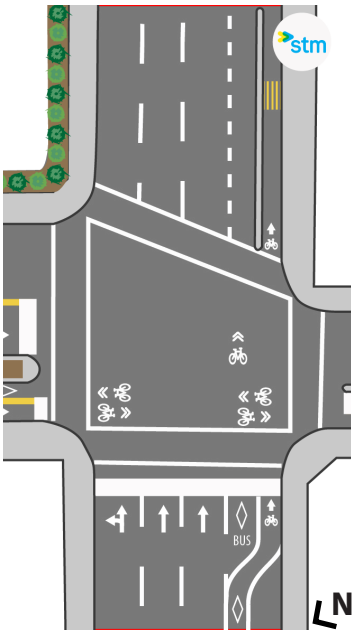
Safety	2/5	
Cost	5/5	
Feasibility	3/5	**Total 10/15**

2 IMPLIMENT PRIORITY BICYCLE LIGHTS ON RACHEL

Why? Eliminates conflict between the cyclists, cars and buses for cyclists turning off Rachel and onto Saint-Urbain and encourges cyclists to be courteous towards one another.
Example: Intersection of Des Pins and Saint-Urbain.

Safety	5/5	
Cost	3/5	
Feasibility	3/5	**Total 11/15**

SOLUTION 1 & 3

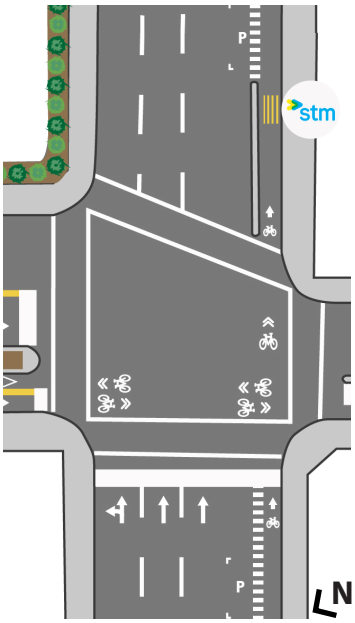


3 BUILD CONCRETE BUFFER FOR BICYCLE LANE AT THE BUS STOP

Why? Allows cyclists to remove themself from traffic, out of the bus stop zone and cross the intersection more safely.
Example: Intersection of Saint-Urbain and Duluth and Saint-Urbain and Des Pins

Safety	4/5	
Cost	2/5	
Feasibility	4/5	**Total 10/15**

SOLUTION 1 & 3 & 4



4 MAKE SAINT-URBAIN'S BICYCLE LANE A CURBSIDE BUFFERED CYCLE LANE

Why? Completely removes cyclists from traffic and eliminates most conflict on Saint-Urbain.
Example : Bike lane along Clark Street.

Safety	5/5	
Cost	2/5	
Feasibility	2/5	**Total 9/15**

SUMMARY

We have presented four viable options to address the problems at this important intersection, all would contribute to reducing the conflicts among the users and improving the safety of cyclists. There is not one solution that will solve all the intersection's problems but a combination of a few that would eliminate all conflicts. The figures show how more than one solution can be used at the same time and how to implement them.

Before adopting a quick fix our recommendation would be to consider any action taken on this intersection in the larger context of the policy to promote active transportation in Montreal. Building a concrete buffer at the bus stop or a curbside buffered cycle lane on Saint-Urbain would signal the city's commitment to making Montreal a premier cycle-friendly city.