

## **1.0 Introduction**

Major Mackenzie West Terminal is a bus terminal in Vaughan serving five year-round bus routes (three of which end there) and two seasonal routes serving Canada's Wonderland guests (both of which end there). Buses using the terminal spend excess time exiting, requiring passengers to spend extra time on their commute. To reduce the time passengers spend on buses exiting the terminal, this report describes new slip lanes (one westbound and one eastbound) to be constructed to bypass the existing exit route. It also proposes changes to the timing of the traffic signal which would reduce the wait at the intersection. All three proposals are recommended for implementation.

## **2.0 Problem statement**

### ***2.1 Experienced Problem***

Buses at Major Mackenzie West Terminal spend excessive time exiting the terminal. Data from site visits shows that buses spend between 93 and 270 seconds exiting the terminal (Appendix A). For each trip a passenger takes at the terminal, they must spend an average of 3 minutes exiting it. The impact on one trip is minor, but its impact extends to every passenger and bus route using the terminal.

### ***2.2 Traffic Signal Timing***

The traffic signal at the intersection of Wellness Way and Major Mackenzie Drive shown in Figure 1 has a cycle length varying between 140 and 162 seconds, causing a large variance in exit times (Appendix A, Figure A2). According to the intersection design practices of Toronto and Vancouver, traffic signal cycle lengths beyond 135 seconds are rarely permitted [1][2]. However, 135 seconds is noted for where four phases are common [2]. Thus, a two-minute maximum is more applicable here. Buses should not need to wait excess time at intersections, especially longer than city guidelines permit.

### ***2.3 Circuitous Exit Loop***

Buses also occasionally get stopped by other traffic on Wellness Way travelling out of the hospital (Appendix A, Figure A2). The rest of the exit time is spent on the circuitous 550-metre Coaster Way loop, shown in Figure 1 [3]. According to Toronto's and Vancouver's best design practices for bus terminals, bus circulation between them and the nearby road network should be considered in a terminal's design [4][5]. The exit's length should be reduced to hasten the flow of buses in and out of the terminal.



Figure 1. All buses at Major Mackenzie West Terminal exit via a circuitous loop. Satellite imagery: [6]

## 2.4 Criteria

The distance buses need to travel to exit the terminal should be reduced. A shorter exit route onto Major Mackenzie will allow a bus to spend less time going through the exit road, saving passengers' time. The distance measured is from where the bus leaves the terminal to where it reaches Major Mackenzie Drive.

The time spent waiting at intersections should also be reduced. A problem with the current design is the wait time at the 2 intersections at the end of the loop. Waiting less time at intersections will allow passengers to get to their destinations faster.

The monetary cost of this project should be kept low. The local government funding this project would prefer to save its taxpayers' money or allow its money to be spent on other projects instead.

## 3.0 Potential solutions

### 3.1 Eastbound exit

An additional exit is built east from the terminal as shown in Figure 2, connecting to an existing slip lane onto eastbound Major Mackenzie Drive, reducing the exit distance to approximately 90

metres (Appendix B, Figure B1). The lanes on Major Mackenzie Drive will be rearranged so that the slip lane goes directly to the right-turn lane of Major Mackenzie Drive and cars exiting Canada's Wonderland can yield to buses, preventing buses from waiting as they exit. This will save the buses using it 1 to 4 minutes per trip through the lack of wait and the more direct route to eastbound Major Mackenzie Drive. The new slip lane would be built on a bridge over the existing walkway and grass, shown in Figure 2. It would be 20 metres long and 3.3 metres wide, the minimum width for curb lanes on local bus routes [7]. The height difference between the existing bus terminal loop and the walkway is 3.1 metres, high enough to avoid lowering the walkway (Appendix A, Figure A3) [8][9].

As part of construction of the bridge, the existing walkway and slip lane will occasionally need to be closed. To mitigate any impacts, these closures should occur when Canada's Wonderland is closed to prevent traffic impacts on Canada's Wonderland guests. However, there are multiple other exits so traffic impacts would not be severe.

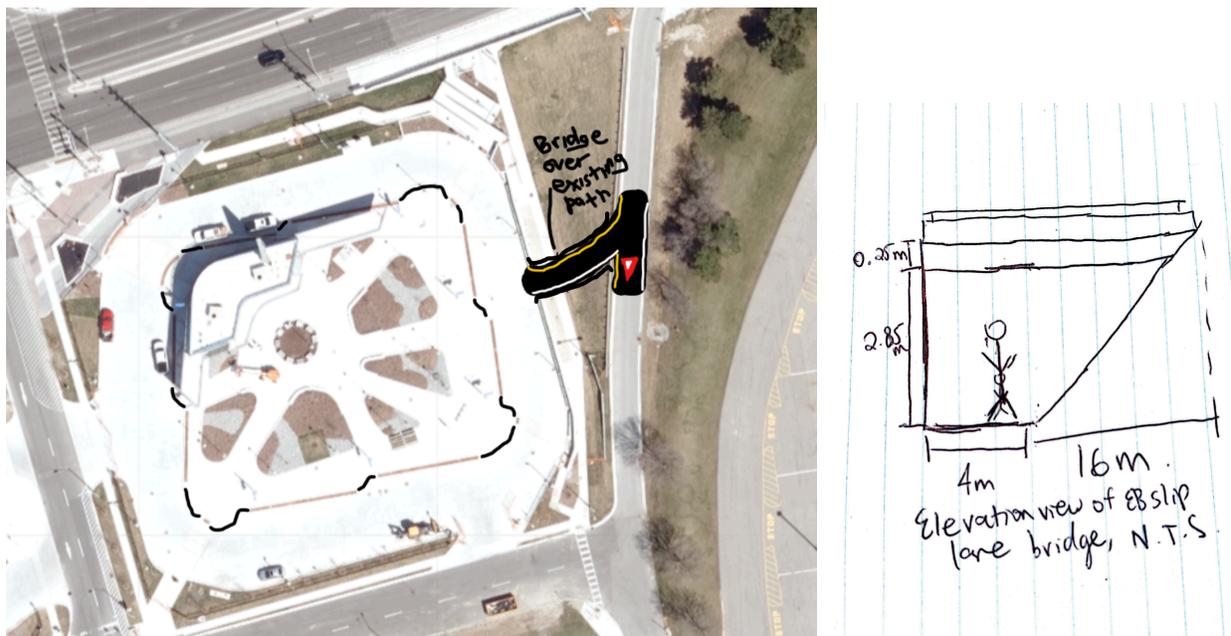


Figure 2. Conceptual plan view (left) of the terminal and eastbound slip lane, and conceptual elevation view of the new bridge (right). Satellite imagery: [6].

### 3.2 Traffic Signal Timing Change

The Major Mackenzie Dr. and Wellness Way intersection's signal cycle length is reduced to 2 minutes: 83 seconds green time for Major Mackenzie, 23 seconds for Wellness Way (7 seconds red light time, in line with observations in Appendix A, Figure A2). The reduction would bring the intersection in line with Toronto and Vancouver's best design practices and reduce the amount of time bus passengers will wait by up to 40 seconds per trip [1][2]. While such a change may reduce the capacity of the intersection to handle vehicles on Major Mackenzie Drive, the

traffic signal never had a line long enough during site visits to necessitate a long green time (Appendix A, Figure A3). However, more research is needed at other times of day to determine the true impact of such a change.

### ***3.3 Westbound Slip Lane***

A bus-only slip lane is added from Coaster Way to go directly to Major Mackenzie Drive, as shown in Figure 3. This lane will allow the two year-round and two seasonal routes travelling west from the terminal to avoid the Wellness Way and Major Mackenzie Drive intersection, saving passengers on these routes the up to 2 minutes they would have spent waiting there. The lane would be 3.3 metres wide, the minimum curb lane width for local bus routes [7]. Occasional lane closures of the loop and Major Mackenzie Drive would be needed to facilitate construction of this slip lane, which would be best done when Canada's Wonderland is closed to prevent traffic problems from a high load of people exiting the park. There would be no notable impacts after construction.



Figure 3. Conceptual plan view of the westbound slip lane. Satellite imagery: [6].

## **4.0 Evaluation**

Both the eastbound and westbound slip lanes bypass the Wellness Way and Major Mackenzie Drive intersection without introducing new traffic signal waits, though the routes using the westbound slip lane may still need to wait less than a minute for traffic to clear to merge onto Major Mackenzie. Combined, both ramps allow all buses using the terminal to wait 1-2 minutes less due to bypassing the traffic light. The traffic signal modifications would reduce the time

spent at intersections by up to 30 seconds through the reduction of the cycle's length, but it will not affect any bus route which is able to bypass the traffic light (Appendix A, Figure A3).

The eastbound ramp reduces the distance required for the routes running east from the terminal by 460 metres (920 metres for route 20) (Appendix B). Meanwhile, the westbound ramp reduces the distance required for the routes running west from the terminal by about 70 metres (Appendix B). In contrast, the traffic signal timing change does not reduce the distance travelled due to it not introducing a new exit route.

The traffic signal timing change is the least costly due to the lack of new infrastructure to be built. The westbound ramp is moderately more costly, requiring approximately \$83,000 for pavement and curb replacement (Appendix C). The eastbound slip lane would be the most costly. The 20-metre bridge and pavement would cost about \$143,250 to build (Appendix C). However, the combined cost of the solutions (below \$250,000) is negligible when compared to York Region's \$1 billion annual capital budget [10]. Thus, none of the solutions would be too costly.

## **5.0 Recommendation**

Both the westbound and eastbound slip lanes should be constructed as they will save 1 to 4 minutes for all bus routes using the terminal, while not being expensive compared to the rest of the budget. Both slip lanes would require time to construct. In the interim, the traffic signal timing change should be implemented as a pilot as it can be done quickly and to ensure reversing the change is an option in case of increased traffic congestion.

## 6.0 Reference List

- [1] City of Vancouver, BC, Canada. “Traffic Signal Timing Guidelines,” p. 5, October 2023. Accessed: Sept. 23, 2024. [Online]. Available: <https://vancouver.ca/files/cov/eng-tdm-signal-timing-guidelines-phase-1-final.pdf>
- [2] City of Toronto, ON, Canada. “Traffic Signal Operations Policies & Strategies,” p. 29, May 2015. Accessed: Sept. 23, 2024. [Online]. Available: [https://www.toronto.ca/wp-content/uploads/2017/11/91d6-0\\_2015-11-13\\_Traffic-Signal-Operations-Policies-and-Strategies\\_Final-a.pdf](https://www.toronto.ca/wp-content/uploads/2017/11/91d6-0_2015-11-13_Traffic-Signal-Operations-Policies-and-Strategies_Final-a.pdf)
- [3] Google. “Coaster Wy, Maple, ON L6A 1S6 to 43.8480958, -79.5414481”, Google Maps. Accessed: Oct. 9, 2024. [Online]. Available: [https://www.google.com/maps/dir/43.8474535,-79.5402236/43.8480958,-79.5414481/@43.8482303,-79.5421092,17.56z/data=!4m5!4m4!1m0!1m1!4e1!3e0?entry=tu&g\\_ep=EgoyMDI0MTAwNS4yIKXMDS0ASAFOAw%3D%3D](https://www.google.com/maps/dir/43.8474535,-79.5402236/43.8480958,-79.5414481/@43.8482303,-79.5421092,17.56z/data=!4m5!4m4!1m0!1m1!4e1!3e0?entry=tu&g_ep=EgoyMDI0MTAwNS4yIKXMDS0ASAFOAw%3D%3D)
- [4] City of Toronto, ON, Canada. “Bus Terminals,” *Transit Design Guide*, p. 13, 2022. Accessed: Sept. 23, 2024. [Online]. Available: <https://www.toronto.ca/wp-content/uploads/2022/02/9575-TDGGuidelinesBusTerminals-CITY-REV.pdf>
- [5] Translink, Vancouver, BC, Canada. “Bus Infrastructure Design Guidelines,” p. 99, September 2018. Accessed: Sept. 23, 2024. [Online]. Available: [https://www.translink.ca/-/media/translink/documents/plans-and-projects/managing-the-transit-network/transit-oriented-communities/bus\\_infrastructure\\_design\\_guidelines-sept\\_2018.pdf](https://www.translink.ca/-/media/translink/documents/plans-and-projects/managing-the-transit-network/transit-oriented-communities/bus_infrastructure_design_guidelines-sept_2018.pdf)
- [6] York University et. al. “Land Information,” 2023. Accessed: Sept., 28, 2024. [Online]. Available: <https://maps.york.ca/Html5ViewerPublic/Index.html?viewer=LandInformation.YorkMaps>
- [7] City of Richmond Hill, ON, Canada. “Transportation and Roadworks: Standards and Specifications Manual,” p. 11, n.d. Accessed: Oct. 10, 2024. [Online]. Available: <https://www.richmondhill.ca/en/find-or-learn-about/resources/Design-Standards/Division-C-Transportation-and-Roadworks.pdf>
- [8] K. M. Barnes. “Minimum Bridge Deck Thickness,” Montana Department of Transportation, Helena, MT, United States, Feb. 6, 2017. Accessed: Oct. 10, 2024. [Online]. Available: [https://www.mdt.mt.gov/other/webdata/external/bridge/design\\_memos/2017-02-06\\_Minimum\\_Bridge\\_Deck\\_Thickness.pdf](https://www.mdt.mt.gov/other/webdata/external/bridge/design_memos/2017-02-06_Minimum_Bridge_Deck_Thickness.pdf)

- [9] Transport for NSW. “Pedestrian underpass design guideline,” Sydney, NSW, Australia, p. 13, June 2023. Accessed: Oct. 10, 2024. [Online]. Available: <https://www.transport.nsw.gov.au/system/files/media/documents/2023/pedestrian-underpass-guideline.pdf>
- [10] York Region, “York Region approves \$1 billion capital budget for 2024”, Dec. 22, 2023. Accessed: Oct. 11, 2024. [Online]. Available: <https://www.york.ca/newsroom/backgrounder/york-region-approves-1-billion-capital-budget-2024>
- [11] Google. “Vaughan, ON”, Google Maps. Accessed: Oct. 10, 2024. [Online]. Available: [https://www.google.com/maps/@43.848158,-79.5396739,314m/data=!3m1!1e3?entry=ttu&g\\_ep=EgoyMDI0MTAwNy4xIKXMDSOASAFQAw%3D%3D](https://www.google.com/maps/@43.848158,-79.5396739,314m/data=!3m1!1e3?entry=ttu&g_ep=EgoyMDI0MTAwNy4xIKXMDSOASAFQAw%3D%3D)
- [12] C. Crail and C. Tynan. “How Much Does It Cost To Pave A Driveway In 2024?,” Forbes Home, Mar. 4, 2024. Accessed: Oct. 11, 2024. [Online]. Available: <https://www.forbes.com/home-improvement/driveway/cost-to-pave-a-driveway/>
- [13] WSP, “Cost Estimate – Concrete Curb,” *LOWER YONGE PRECINCT Municipal Class Environmental Assessment Study Environmental Study Report*, p. 2, May 31, 2018. Accessed: Oct. 11, 2024. [Online]. Available: <https://www.waterfrontoronto.ca/sites/default/files/documents/appendix-n---cost-estimate-breakdown.pdf>
- [14] Statistics Canada, “Industrial product price index, by major product group, monthly,” Sept. 20, 2024. Accessed: Oct. 11, 2024. [Online]. Available: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810026501&cubeTimeFrame.startMonth=05&cubeTimeFrame.startYear=2018&cubeTimeFrame.endMonth=08&cubeTimeFrame.endYear=2024&referencePeriods=20180501%2C20240801>
- [15] Texas Department of Transportation, “Bridge Unit Costs,” p.1, 2016. Accessed: Oct. 11, 2024. [Online]. Available: <https://ftp.txdot.gov/pub/txdot-info/library/pubs/bus/bridge/unit-costs-16.pdf>

## Appendix A: Site Visit Notes

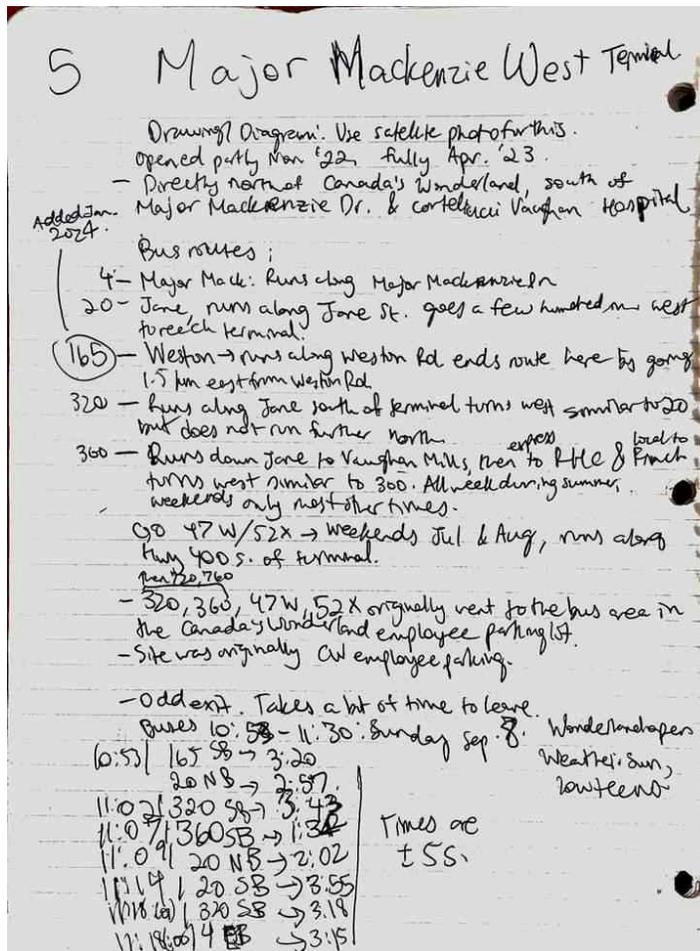


Figure A1. Page 1 of field notes

Time noted: Bus leaving platform to bus getting on Major Mackenzie Dr.

- Winderland employees (50+) observed using terminal and its bus routes to get to work an estimate (60-70)
- On map, note platform assignments.
- As Winderland had recently opened, few delays from guests exiting the park. 10-8 today.
- Minor stop from employees drinking. Very few of these

#2

11:27 | 20 SB → 3:30  
 11:27 | 20 NB → 3:31  
 11:28 | 320 SB → 4:07  
 11:28 | 4 WB → 3:40 ← this one ± 15s.

I will do another one of these Tues <sup>approx</sup> 7-8 AM.

- Traffic on Major Mack may be ~~worse~~ but Winderland will be closed.

- 360 won't be running. others will run more frequently.

M.M.W.T. #2 (Tue 9/10/24)

6:52 | 20 SB → 3:53  
 6:55 | 4 EB → 3:16  
 6:57 | 4 WB → 2:20  
 6:58 | 320 SB → 3:06  
 7:04 | 20 NB → 1:59  
 7:07 | 165 SB → 3:34  
 7:09 | 20 SB → 4:30  
 7:10 | 320 SB → 3:42  
 7:14 | 4 EB → 1:33  
 7:19 | 20 NB → 1:50 ← ± 10s  
 7:21 | 320 SB → 2:50  
 7:22 | 165 SB → 1:50 ← ± 15s  
 7:24 | 20 SB → 2:07  
 7:24 | ~~20 SB → 2:07~~  
 7:28 | 320 SB → 3:01  
 7:31 | 4 EB → 2:31  
 7:31 | 20 NB → 2:45 ← ± 10s  
 7:3 | 20 SB → 3:40

Notes: 4 WB & 165 SB do not turn left let the traffic signal remain red. (times are ± 5s unless otherwise stated). 1 car observed using the unused bus-only sea. Passenger volume rather low (quieting). 28k 320 SB stop take 260s to get out of the loop alone. 7:42 | 165 SB → 1:33 7:45 | 320 SB → 4:00

\* - data from 2018 platform

Signal phases:

Major Mack Green 2 min ± 3s  
 1/3 Green

Tue 9/24 7:26 AM

Left Turn 4: 13s  
 G (Major Mack) 0:13 - 1:51  
 G (Winderland Way) 1:56 - 2:13

Left Major Mack 2:13 - 2:53  
 G (Major Mack) 2:53 - 4:18 (M.SS)  
 G (W.W.) 4:26 - 4:58 2:26

G (M.M.) 5:03 - 6:50 2:34  
 G (W.W.) 6:58 - 7:29  
 G (M.M./loop) 7:34 - 8:03  
 G (M.M.) 8:03 - 9:19 2:35  
 G (W.W.) 9:27 - 10:10  
 G (Loop/CR.M.M.) 10:06 - 10:36  
 G (M.M.) 10:36 - 11:55 2:20  
 G (W.W.) 12:00 - 12:18  
 G/L (E.B.) 12:26 - 12:55  
 G (M.M.) 12:55 - 14:18 2:27  
 G (W.W.) 14:26 - 14:50  
 G/L (E.B.) 14:53 - 15:23  
 G (M.M.) 15:23 - 16:50 2:32  
 G (W.W.) 16:56 - 17:28  
 G (M.M.) 17:35 - 19:28 2:20  
 G (W.W.) 19:27 - 19:52  
 Cycle Length: (Next G or G/L (M.M.) → 19:55)  
 2:37  
 2:26  
 2:31  
 2:33  
 2:20  
 2:27  
 2:18  
 2:20

Time since stoplight started.

W.W. → Winderland Way  
 M.M. → Major Mackenzie  
 G → Green  
 G/L or G/Left  
 Green + Left for a certain direction on Major Mackenzie.  
 E.B. → East, or W.P. → West bound

Most buses turning left taking right of way drivers going to Hwy 400

Not on 9/24 yield

Traffic jam noted E.B. on Major Mackenzie Dr. at 7:50 AM. However, it did not impact vehicles turning off the end of the loop (Winderland Way).

However, given it is not even 8 AM yet, it is likely that the jam would spill over to Winderland Way loop (coaster loop).

19:55; Mean: 2:29

Figure A2. Pages 2 (left) and 3 (right) of field notes

EB → eastbound  
WB → westbound.

## Site Visit 10-01

- Original EB ramp idea may need to be adjusted due to the elevation of the roads.
- Stairs go from lowest pt. on current bus terminal loop to lowest point on walkway below the EB ramp.
  - ↳ 19 steps.
  - Height of each step: 16.4cm (16.6 - 16.4) C.T.:
- 6:59 AM  
4:11  
Total height (existing):  $2(16.4\text{cm}) - 16.4\text{cm} = 328 - 16.4 = 311.6\text{cm}$
- 7:15 AM  
Lower bound: 16.25.19  
Subtract curb height.
- Storm drain lower at low point - connect with bridge storm ~~drain?~~
  - $311.6\text{cm} \rightarrow 308.75\text{cm}$
  - $\therefore 311.6\text{cm} \pm 2.85\text{cm}$
- Low point: 2.0m from bottom of steps. → Room to add more steps?
  - Steps are 27cm long ( $\pm 1\text{cm}$ ).

Secondary research needed:

- Height of concrete req'd for a bridge
- 7:12 AM - Required height for safe pedestrian travel (best practices)

Concrete curb level. The fence will need to be demolished where the new lane will go, as well as 1-2 existing light fixtures on the road and at for the buses.

7:18 - Slope of exit ramp from wood/lead to EB Major Mack Dr does not change enough to be noticed.

7:20 - Ramp is certainly feasible thru the two existing bus-facing light fixtures.

400 signal is red less often, could explain lack of issues.

7:33 AM Traffic count (WB Major Mack):

- 7:50 Cycle 4 → 84 (No left phase)	6 → 80 (EB Left)
2 → 79 (EB Left)	7 → 81 (EB Left)
3 → 84 (EB Left)	8 → 66 (Both sides)
4 → 80 (WB Left)	9 → 73 (Both sides)
5 → 65 (EB Left)	10 → 78 (WB Left)

## Site Visit 10-01

Additional ~~EB ramp~~ observations.

- New street lighting needed (current fixtures in the way).
- Guardrail replacement needed at end of new bus lane.
- Bridge modifications not needed for WB ramp.
- No traffic pileup lasted more than a minute unless it was from the Jane St intersection rather than this one.
  - ↳ Reducing signal cycle length appears doable
  - Pilot project to ensure everything is accounted for.
  - ↳ Assuming the ramp fails.
- The proposed WB ramp will now run immediately adjacent to Coaster/Wellness Wy. until the dirt patch to save costs & to avoid needing to tear down a decorative rock pile nearby.

Figure A3. Pages 4 (top) and 5 (bottom) of field notes

### Appendix B: Distance Measurements



Figure B1. Distance of the eastbound slip lane (left), the new pavement needed for the eastbound slip lane (middle), and the new pavement needed for the westbound slip lane (right) [11].

**Appendix C: Cost of Asphalt, curb replacement, and bridge construction**

The cost of asphalt is US\$7-13 per square foot [12]. Converted to Canadian units, that is \$104-\$193 per square metre. For the eastbound slip lane, this would cost \$6,864 to \$12,738. For the westbound slip lane, it would cost \$19,760 to \$36,670.

In May 2018, concrete curbs and gutters cost \$220 per metre [13]. Prices for concrete and similar materials have increased 38.8% since then, so the cost would be approximately \$305.36 per metre today [14]. The Changes proposed with the westbound slip lane affect 190 metres (Appendix B). Thus, the curb replacement would cost about \$58,020.

A 2016 Texas report noted Concrete Slab In Place bridges cost US\$95 per square foot for bridges between 50 and 100 feet long [15]. The price of concrete and similar materials has increased 43% since 2016 [14]. Converted to Canadian units and accounting for the price change, the bridge would cost \$2,018.93 per square metre. Given it is 20 metres long, the cost would be about \$133,250 total (Appendix B).