Part 4: Bus Priority Infrastructure

WE ARE MAKING PROGRESS IN REDUCING BUS DELAY

Significant investments in transit priority are working

Bus delay is a problem that can be solved by transit priority measures. To that end, TransLink has invested $40 million over the past four years to support more than 100 studies and projects. This is the greatest expansion of bus priority in the region's recent history.

For the first time, TransLink is reporting the results of the bus priority projects implemented across the region during this period. We are evaluating 35 pilot and capital projects that were completed by fall 2022. This section of the Bus Speed and Reliability Report examines which projects were most effective and what factors led to success.

Overall, we found that:

- **Transit priority improved bus performance.** Bus priority projects improved bus speeds by 5–35% depending on project type, location, and scale.
- **Most projects yield a return-on-investment within 10 years—many within two years.** Expanding bus priority will allow us to make better use of limited resources, now and in the future.
- **RapidBus projects hit targeted 20% travel time savings.** This provides momentum for future RapidBus routes, including the launch of R6 (2024), alignment planning for R7 and the other BRT and RapidBus corridors planned for the region.
- **Transit priority works best at scale.** Customers and TransLink accrue the most benefits when priority measures are focused along a corridor. We can reinvest these savings to expand or enhance service.

Evaluating each bus priority project by type, we are also learning from experience and developing regional knowledge about best practices for future investments. This will inform future work by TransLink and municipalities on bus priority, including future proposals for the Bus Speed and Reliability (BSR) municipal funding program.

IMPLEMENTING BUS PRIORITY

Bus priority projects improve travel time, reliability, customer experience, and safety

Travel Time: Transit service operates at an optimal speed throughout the day, with minimal delay from traffic congestion, and passengers can board and alight efficiently.

Reliability: Transit operates on schedule and is consistent and predictable throughout the day and each day of the week.

Customer Experience: Bus priority projects are an opportunity to improve travel options and enhance stop amenities and pedestrian infrastructure to make transit feel appealing, comfortable, safe, and easy-to-use.

Safety: Transit operates efficiently while supporting the safety of customers, pedestrians, cyclists, or other drivers.

How Speed and Reliability Improvements Benefit our Customers.

When the bus is faster, I have time to do a few errands before dinner.

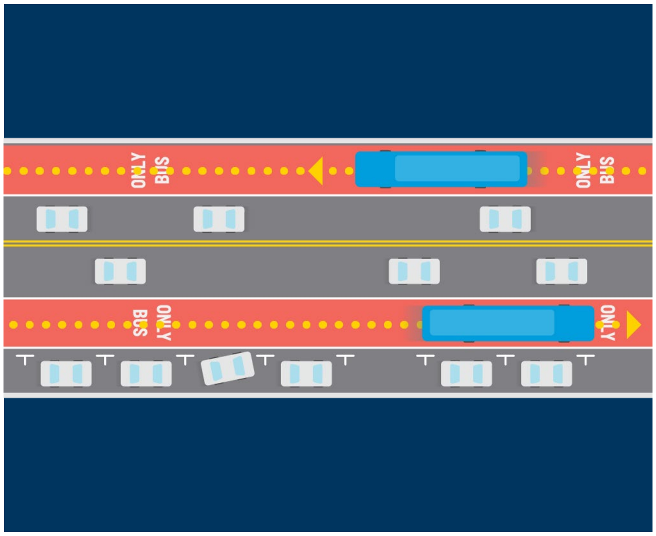
Even if there's traffic, I can count on the bus to get me to school on time.

This bus route is so much better, I don't need to use my car as often.

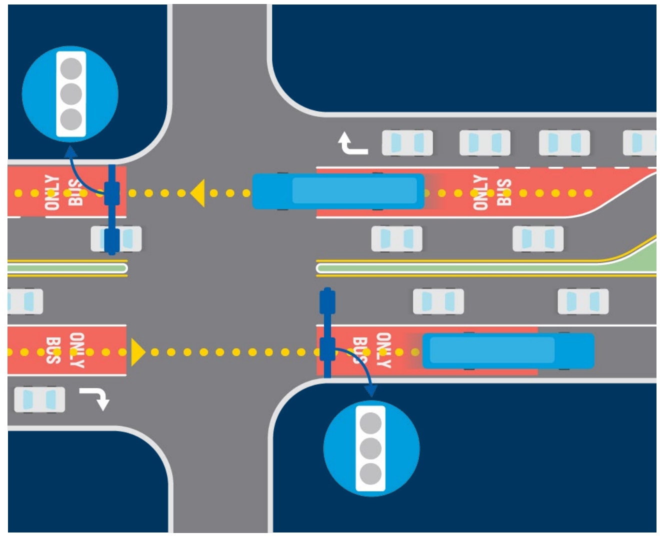
Fewer cars are speeding now that there's a red bus lane.

THERE ARE MANY TYPES OF BUS PRIORITY PROJECTS

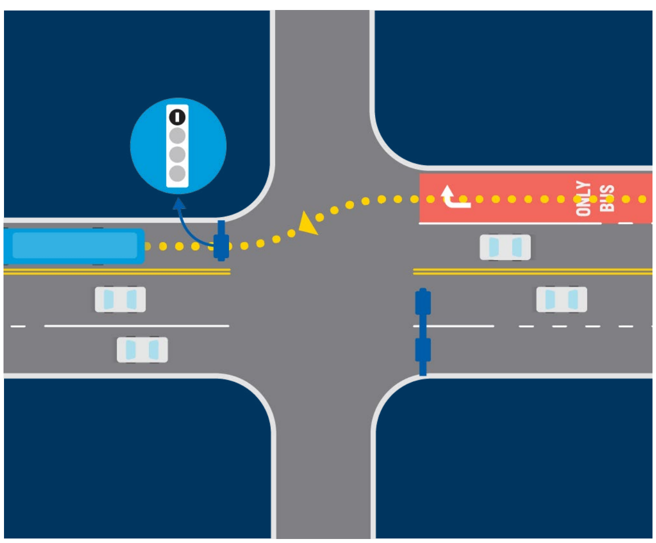
Different bus priority measures address different kinds of delay



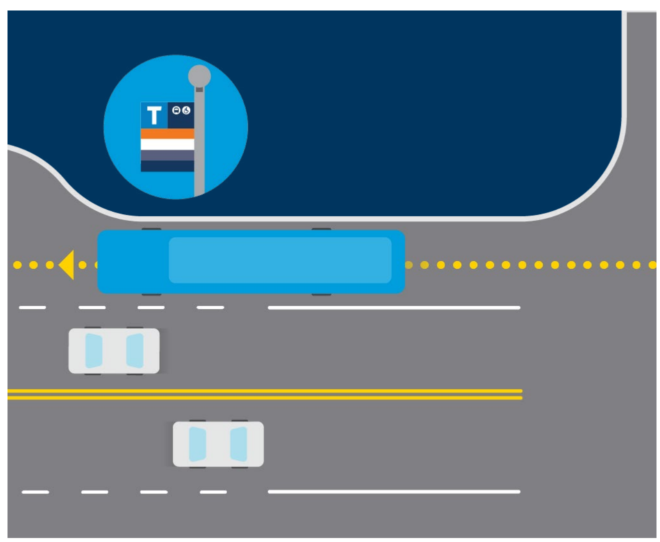
Bus / BAT Lanes: Bus lanes are lanes reserved for the use of buses. Dedicated bus lanes are exclusive to buses at all times, whereas Business Access & Transit (BAT) lanes allow vehicles to make right-turns. Peak-hour bus lanes allow for general use or parking during off-peak times.



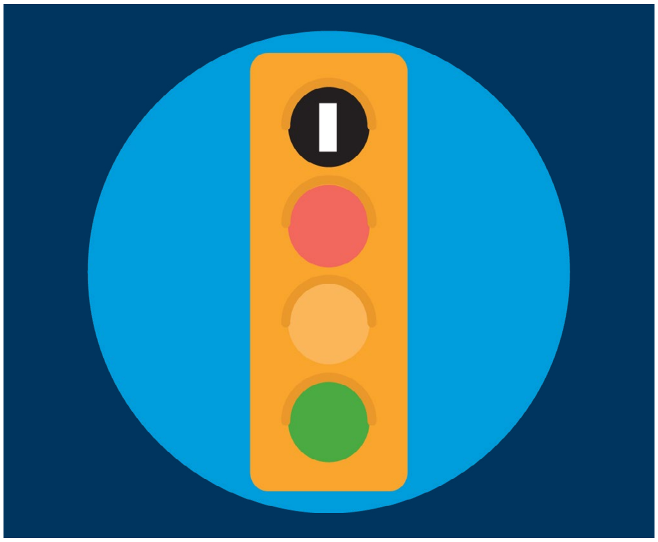
Approach Lanes: Approach lanes are short, dedicated lanes at intersections that separate buses from traffic queues. Approach lanes allow buses to bypass traffic queues and proceed through the intersection on the green light with other motorists.



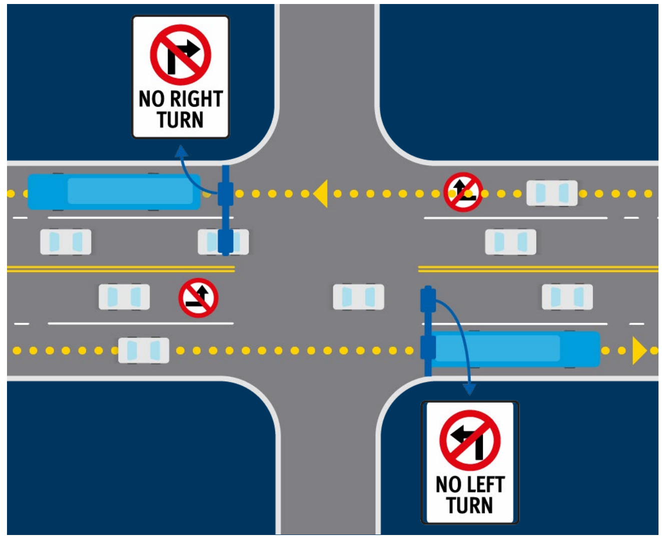
Queue Jumps: Queue jump lanes are short dedicated transit lanes (similar to approach lanes) or a shared turn pocket paired with a transit signal treatment that allows transit vehicles to get ahead of traffic at an intersection.



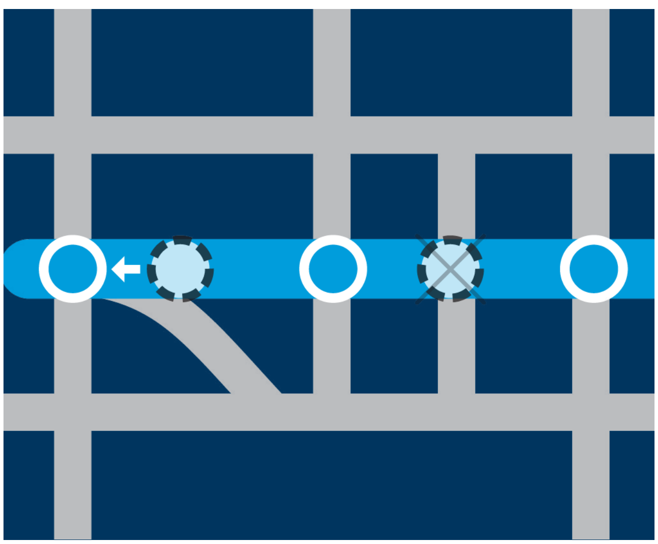
In-Lane Stops (Bus Bulbs / Floating Bus Stop): In-lane bus stops allow buses to stop directly in the travel lane in front of the bus stop. Bus bulbs or island bus stops may be used to create the in-lane stop.



Signal Upgrades: Signal upgrades may add a new traffic signal or signal phase.



Turn Restrictions: Turn restrictions limit left- or right-turns for general traffic to reduce delay for buses and other vehicles traveling along a corridor. Buses may be exempted from the restrictions.



Bus Stop Balancing: Bus stop balancing (also called "bus stop consolidation") includes thoughtful removal and/or relocation of bus stops along a corridor to achieve more consistent spacing, maintain convenient access, and provide faster, more reliable service.

All-Door Boarding: All-door boarding is an operational policy that allows customers to board a bus at any open door.

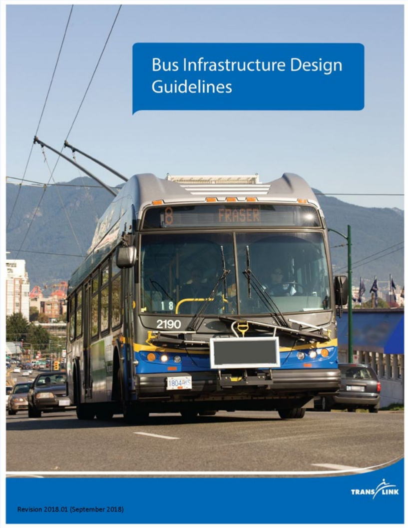
RapidBus

RapidBus is a brand of TransLink bus service that improves customer experience via more widely spaced stops, all-door boarding, and extensive bus priority like queue jumps or bus lanes. RapidBus also runs with high frequency and has additional amenities at bus stops.

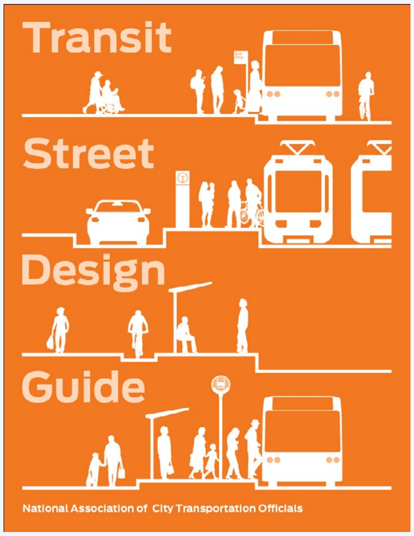
GUIDANCE TRANSLINK AND MUNICIPALITIES USE TO IMPLEMENT BUS PRIORITY

TransLink and municipalities have drawn upon resources developed by TransLink and organizations such as the National Association of City Transportation Officials (NACTO) when implementing bus priority projects. These include the following:

TransLink Transit Priority Toolkit



TransLink Bus Infrastructure Design Guidelines



NACTO Transit Street Design Guide

OUR APPROACH TO MEASURING PROJECT EFFECTIVENESS

We focused where new bus priority measures would have an impact.

We assessed travel time changes only along road sections that benefited from new bus priority measures. This reduces the noise from elsewhere along the corridor. For most projects, the project area covered a few blocks or less. For RapidBus routes, it was the entire corridor. All the bus routes impacted were included in the analysis.

We typically evaluated just travel time between stops to avoid distortion due to changes in boarding activity. We included dwell time at bus stops for some projects that are meant to reduce time spent at stops (e.g., bus stop balancing and in-lane bus stops).

We used metrics based on customer experience and operating costs.

"Travel time savings" describes the experience of a customer along a typical trip, including all-day average and peak-period. We looked at seconds or minutes saved but used % improvement to compare different scales of projects.

Metrics like "annual bus-hours saved" and "payback period" describe the benefits to operating costs and account for the larger-scale savings of more extensive projects.

We sought clean before-after comparisons.

We generally compared fall 2019 and fall 2021 as "before" and "after." By focusing on fall periods, we accounted for seasonal changes in traffic and ridership patterns. Fall 2019 is just before the pandemic disrupted normal patterns. And by fall 2021 overall traffic had roughly returned to pre-pandemic levels. (See "Bus delay is back to the same levels as before the pandemic" on page 16.)

Where necessary, we adjusted these before-after periods to avoid distortion due to known construction activity, or to accommodate projects completed before fall 2019 or after fall 2021.

We interpreted results in context.

With a relatively small number of projects to evaluate, we avoided drawing strong conclusions from any individual project, or evaluating project effectiveness by location type or by sub-region. In addition, some projects were implemented quickly using interim materials or reduced scope. The project costs used in the analysis may not reflect actual costs ultimately incurred to municipalities, especially if these projects are made permanent in the future.

Where possible we supplemented analysis with available information on background traffic changes, traffic counts, and on-site observation. Recommendations for future projects are based largely on best industry practice.

What measures did we use?

We evaluated particular types of projects depending on how they improve travel time and reliability for people on buses. The graphic below illustrates the different components of bus travel time—run time and dwell time. We evaluated the change in travel time over the extent of new bus priority that was implemented, including all bus routes that serve the location.

Time spent traveling between bus stops, including delay from traffic congestion, time stopped at signals, and time to decelerate and accelerate when stopping to pick up passengers.

Run Time

~80%

Time spent picking up and dropping off passengers at bus stops, in some cases including waiting to merge back into traffic.

Dwell Time

~20%

We evaluate each type of bus priority project based on run time, dwell time, or both, depending on the components of bus travel time it addresses.

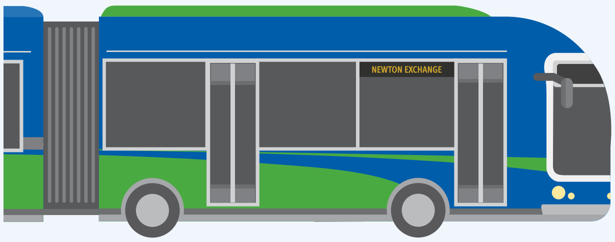
The table below describes the benefits we expect to see from each type of project and whether we evaluated it based on run time, dwell time, or both.

Project Type(s)	Expected Benefits	How can we measure benefits? [1]	
		Run Time	Dwell Time
Queue Jumps and Approach Lanes (Includes Turn Pockets)	Buses move through signalized intersections with less delay	✓	
Bus/BAT Lanes	Buses have priority through a congested area including multiple intersections [1]	✓	
In-Lane Bus Stops	Buses do not have to merge into traffic from a bus stop (reduces wait time)	✓	✓
Signal Upgrades	Buses spend less time waiting for a green light and don't have to wait for multiple signal cycles	✓	
Turning Restrictions for All Traffic	Prevent vehicles from backing up at intersections and delaying buses (and other vehicles)	✓	
Bus Stop Balancing	Avoids overly frequent stops and saves buses time to accelerate, decelerate, and merge back into traffic	✓	✓
RapidBus Route	RapidBus includes multiple types of treatments	✓	✓
All-Door Boarding	Allows passengers get on the bus efficiently using all doors of the bus and reduces dwell time at bus stops		✓

Notes: 1. See page 24 for an illustration of how we measured bus travel time and delay. 2. In cases where bus lanes replace on-street parking, they can also result in more in-lane bus stops, which also reduces dwell time.

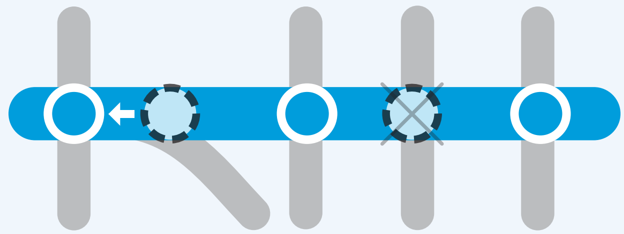
Quantity of Bus Priority Measures Evaluated, by Project Type, 2019–2022

RapidBus



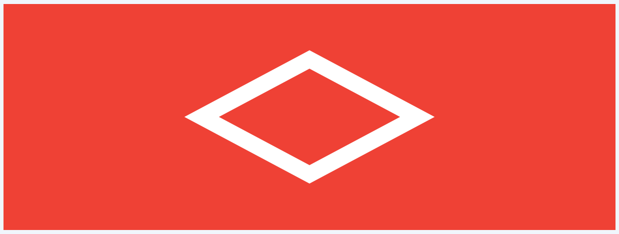
3 RapidBus routes with new transit priority including over 30 km of bus or BAT lanes

Bus stop balancing



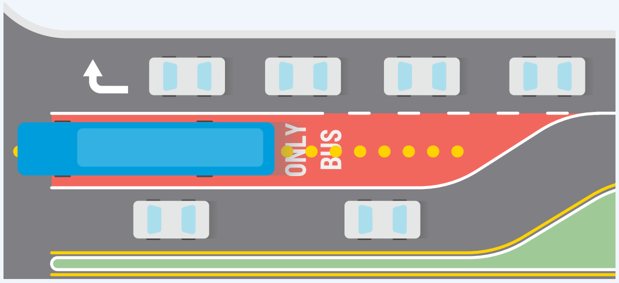
5 routes optimized by consolidating or relocating 86 stops

Bus/BAT lanes



10 projects creating nearly 22 km of bus or BAT lanes [1]

Approach lanes

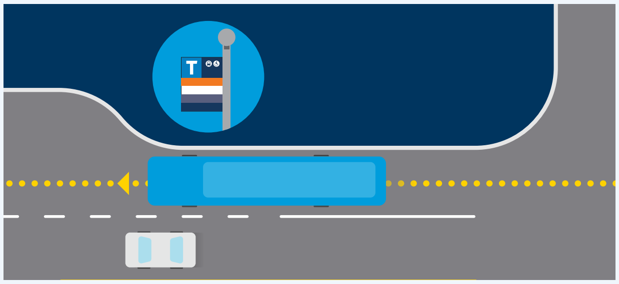


3 projects improving the approach to 5 intersections

Queue jumps

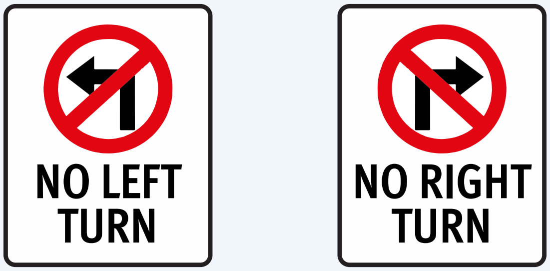
2 projects improving the approach to 3 intersections

In-lane bus stops



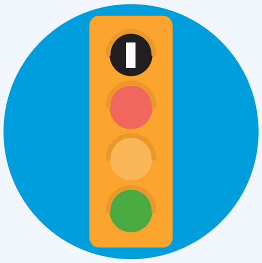
5 projects creating 19 in-lane bus stops

Turn restrictions



1 project optimizing traffic flow at 1 intersection

Signal upgrades



6 projects upgrading 7 signals

BUS PRIORITY PROJECTS COMPLETED SINCE 2019

TransLink has invested $40 million in bus priority since 2019.

Our investments include:

- $24 million for RapidBus bus priority construction, including the R2, R3, and R4 lines.
- $15 million in small- to medium-scale bus priority improvements made possible by the Bus Speed and Reliability (BSR) municipal funding program, including 37 awards for studies, 14 awards for pilots, and 52 awards for capital projects.

This has been a historic expansion of transit priority.

The region has added about 70 km of new bus priority measures, an expansion of nearly 50%. This report is evaluating 35 bus speed and reliability projects including three new RapidBus routes that were completed between 2019 and 2022, across all seven subregions. The number of projects includes some individual projects built as part of RapidBus projects.

These projects:

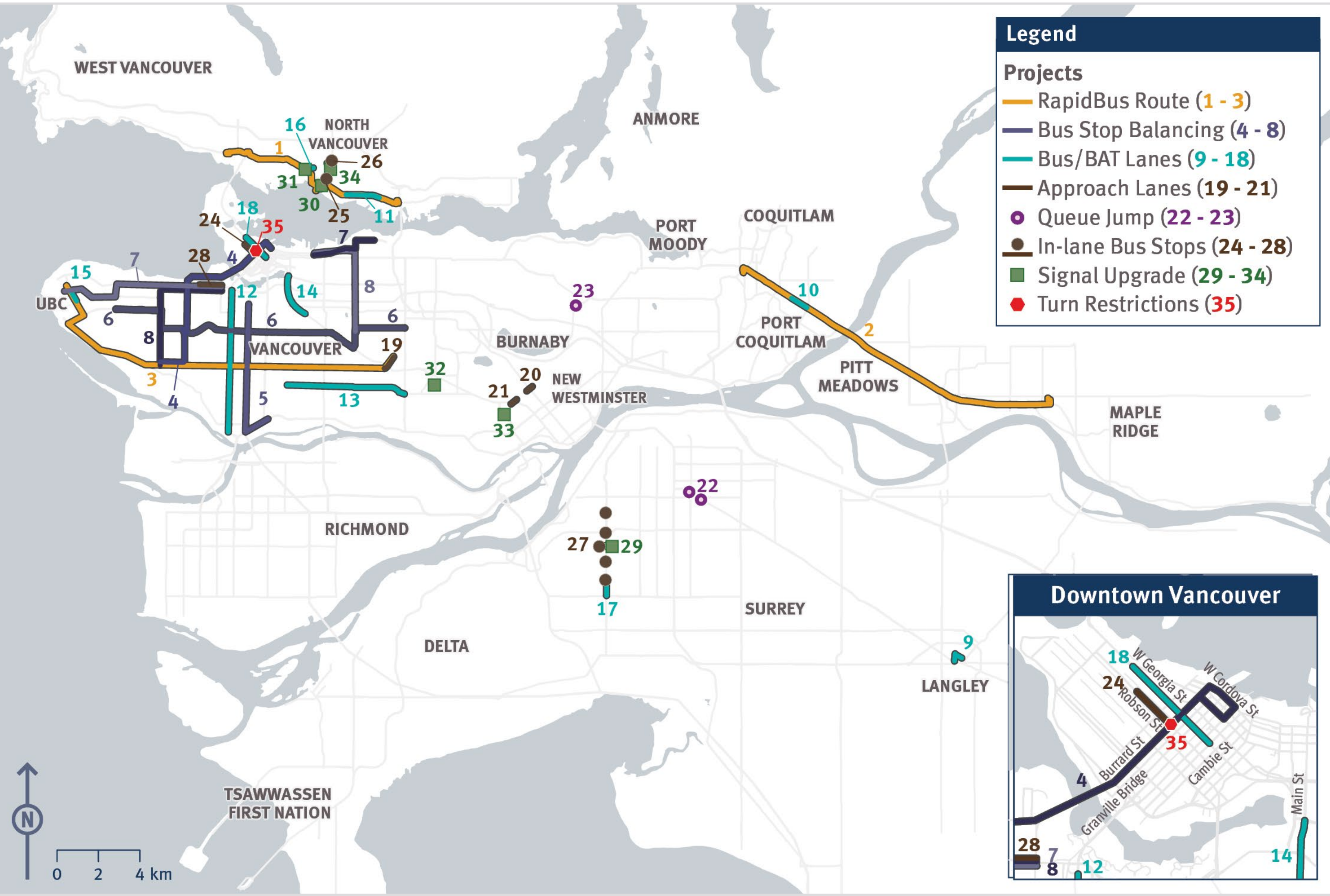
- Serve over 60 routes that carried over half of TransLink's ridership in fall 2021.[35]
- Address network segments that accounted for over 560 hours of bus delay (nearly a quarter of the systemwide total) and nearly 8,500 hours of person delay (nearly 30% of the systemwide total) per day in 2021.
- Make service faster and more reliable for nearly 190,000 passenger trips that pass through these network segments on an average weekday (2021), which is approximately a third of the total.

MAP AND INVENTORY OF BSR PROJECTS

The map below shows the projects funded by the BSR program over the past four years and evaluated for this report. (Additional bus priority projects completed during this time period, including municipal-led projects and BSR projects completed in late 2022, were not evaluated and are not shown on the map.)

The table on the following page provides a description of each project including the sub-region(s) where it is located; the type of project and the metrics used to evaluate each type of project; time periods used in the evaluation; a summary of travel time savings; and the projected return on investment.

Map of Completed BSR Projects Evaluated in this Report, 2019–2022



Summary of Implemented Projects, 2019–2022, Percent Change in Transit Travel Time, Before and After Implementation, and Projected Return on Investment

Map	Project Name	Project Type	Sub-Region	Transit Metrics		Periods Compared		Percent Change in Transit Travel Time (Weekdays) [1]		Return on Investment [2]	
				Run Time	Dwell	Before	After	Avg Daily (6 a.m. to 10 p.m.)	Avg AM/PM Peak	Cost	Payback Period (Years)
1	R2 Marine Dr: R2 vs 239	RapidBus route	North Shore	X	X	Sep 2018	Sep 2021	-24%	-26%	$8,096,000	7.6
2	R3 Lougheed Highway: R3 vs 701	RapidBus route	Northeast & Maple Ridge/Pitt Meadows	X	X	Sep 2018	Sep 2021	-35%	-35%	$8,096,000	5.5
3	R4 41st Ave: R4 vs Local (41)	RapidBus route	Vancouver/UBC	X	X	Sep 2018	Sep 2021	-26%	-27%	$7,683,000	13.8
4	Route 2 bus stop balancing	Bus Stop Balancing	Vancouver/UBC	X	X	Sep 2019	Sep 2021	-11%	-14%	$82,000	0.3
5	Route 17 bus stop balancing	Bus Stop Balancing	Vancouver/UBC	X	X	Nov 2019	Nov 2021	-6%	-7%	$142,000	0.6
6	Route 25 bus stop balancing	Bus Stop Balancing	Vancouver/UBC & Burnaby/New Westminster	X	X	Nov 2019	Nov 2021	-6%	-6%	$163,000	0.4
7	Route 4 bus stop balancing	Bus Stop Balancing	Vancouver/UBC & Burnaby/New Westminster	X	X	Apr 2019	Apr 2022	-8%	-7%	NA	-
8	Route 7 bus stop balancing	Bus Stop Balancing	Vancouver/UBC	X	X	Apr 2019	Apr 2022	-7%	-4%	NA	-
9	Langley City bus lanes	Bus/BAT lanes	Southeast	X	-	Sep 2018	Sep 2021	-3%	-3%	$146,000	7.7
10	Lougheed Highway bus lane	Bus/BAT lanes	Northeast	X	-	Sep 2018	Sep 2021	-5%	-11%	NA	[3]
11	East 3rd St bus lane	Bus/BAT lanes	North Shore	X	-	Sep 2018	Sep 2021	-4%	-4%	NA	[3]
12	Granville St bus lanes	Bus/BAT lanes	Vancouver/UBC	X	-	Sep 2019	Sep 2021	-6%	-7%	$171,000	4.8
13	49th Ave transit project	Bus/BAT lanes	Vancouver/UBC	X	-	Sep 2019	Sep 2021	-4%	-5%	$48,000	0.4
14	Main St and Kingsway bus lanes	Bus/BAT lanes	Vancouver/UBC	X	-	Sep 2019	Sep 2021	-4%	-4%	$97,000	8.3
15	Wesbrook Mall bus lane	Bus/BAT lanes	Vancouver/UBC	X	-	Sep 2019	Sep 2021	-15%	-13%	$500,000	5.7
16	West Keith Rd transit project	Bus/BAT lanes	North Shore	X	-	Nov 2019	Nov 2021	-9%	-9%	$108,000	9.9
17	Scott Rd / 120 St BAT lane	Bus/BAT lanes	Southwest & Southeast	X	-	Sep 2019	Sep 2022	No Change	No Change	$65,000	-
18	W Georgia St bus lane	Bus/BAT lanes	Vancouver/UBC	X	-	Sep 2019	Sep 2022	-3%	5%	$41,000	1.5
19	R4 Joyce Street approach lanes	Approach lanes	Vancouver/UBC	X	-	Sep 2018	Sep 2021	-34%	-33%	NA	[3]
20	Edmonds St approach lanes at Canada Way	Approach lanes	Burnaby/New Westminster	X	-	Sep 2019	Sep 2021	0%	-3%	$59,000	› 20

Map	Project Name	Project Type	Sub-Region	Transit Metrics		Periods Compared		Percent Change in Transit Travel Time (Weekdays) [1]		Return on Investment [2]	
				Run Time	Dwell	Before	After	Avg Daily (6 a.m. to 10 p.m.)	Avg AM/PM Peak	Cost	Payback Period (Years)
21	Edmonds St approach lanes at Kingsway	Approach lanes	Burnaby/New Westminster	X	-	Sep 2019	Sep 2021	**-2%**	**-2%**	$59,000	**› 20**
22	Fraser Highway queue jumps	Queue jump	Southeast	X	-	Jun 2019	Jun 2021	**-15%**	**-21%**	$443,000	**3.3**
23	Broadway and Gaglardi Way queue jump	Queue jump	Burnaby/New Westminster	X	-	Sep 2019	Sep 2021	**-15%**	**-15%**	$52,000	**4.1**
24	Robson St transit project	In-lane bus stops	Vancouver/UBC	X	X	Sep 2019	Sep 2022	**-8%**	**-8%**	$100,000	**1.8**
25	Lonsdale Ave bus bulbs at 4th St and 5th St	In-lane bus stops	North Shore	X	X	Nov 2019	Nov 2021	**-5%**	**-3%**	$395,000	**› 20**
26	Lonsdale Ave bus bulbs at 15th St	In-lane bus stops	North Shore	X	X	Sep 2019	Sep 2021	**-5%**	**0%**	$94,000	**7.5**
27	Bus pullout infills on Scott Rd / 120 St	In-lane bus stops	Southwest & Southeast	X	X	Sep 2018	Sep 2022	**0%**	**-4%**	$427,000	**19.3**
28	West 4th Ave bus bulbs	In-lane bus stops	Vancouver/UBC	X	X	Oct 2019	Oct 2022	**-14%**	**-16%**	$52,000	**0.3**
29	Signal upgrade on Scott Rd at 84 Ave	Signal upgrade	Southeast	X	-	Sep 2018	Sep 2019	**-15%**	**-7%**	$40,000	**16.8**
30	Signal upgrade on Lonsdale Ave at East Esplanade	Signal upgrade	North Shore	X	-	Sep 2020	Sep 2021	**-3%**	**-6%**	$12,000	**1.8**
31	Signal upgrade on Marine Dr at Keith Rd and Bewicke Ave	Signal upgrade	North Shore	X	-	Sep 2019	Sep 2021	**-9%**	**-9%**	$12,000	**0.4**
32	Signal upgrade at Metrotown bus loop	Signal upgrade	Burnaby/New Westminster	X	-	Sep 2019	Sep 2021	**-18%**	**-19%**	$70,000	**1.8**
33	Signal upgrade on 18th Ave at Griffiths Dr	Signal upgrade	Burnaby/New Westminster	X	-	Sep 2019	Sep 2021	**-11%**	**-13%**	$10,000	**0.2**
34	Signal upgrades on 15th St W	Signal upgrade	North Shore	X	-	Sep 2019	Sep 2022	**-2%**	**-2%**	$45,000	**9.8**
35	Turn restriction on Robson St	Turn restrictions	Vancouver/UBC	X	-	Sep 2019	Sep 2022	**-9%**	**-6%**	NA	**[4]**

Notes: 1. Transit travel time change is a trip-weighted average calculated by hour from TransLink AVL data for the before and after time periods. 2. Costs are based on values provided by municipalities in funding applications, funding reallocations, or submitted invoices (if received). RapidBus launch also included significant investments in stop amenities and service increases. The brand is an upgraded service rather than efficiency improvement. Some projects lacked sufficient cost data to estimate a payback period. Some of the projects listed were constructed using temporary/interim measures, while others may be more permanent and have different associated costs. 3. Subset of a project constructed as part of RapidBus implementation. 4. Robson Street turn restrictions project may include some run-time benefits from stop consolidation, implemented concurrently, which could not be isolated as a separate project.

EVALUATING COMPLETED BUS PRIORITY PROJECTS

What did we learn?

- **Transit priority improved bus performance.** Most projects provided the benefits expected, generally ranging from 5–35% reduction in travel time.
- **RapidBus projects exceeded targeted 20% savings.** The three routes with new transit priority achieved significant improvements over the previous local service—each in different contexts.
- **Most projects pay for themselves within 10 years.** Faster and more reliable buses can provide more trips each day. They support more efficient schedules and reduce the need to add resources in the future, due to increasing traffic, ridership, etc.

  We quantified the return on investment (ROI) based on operating cost savings that are realized as bus schedules can be adjusted to take advantage of faster and more reliable bus run times and shorter dwell times at stops. Some projects perform even better, with an ROI of only 1–2 years. Even after the payback period, speed and reliability savings continue to accrue. And projects can reduce the need to add buses in the future to maintain frequencies due to increasing traffic.
- **Service levels affect return on investment.** Projects along high-frequency corridors pay back faster because they benefit many trips.

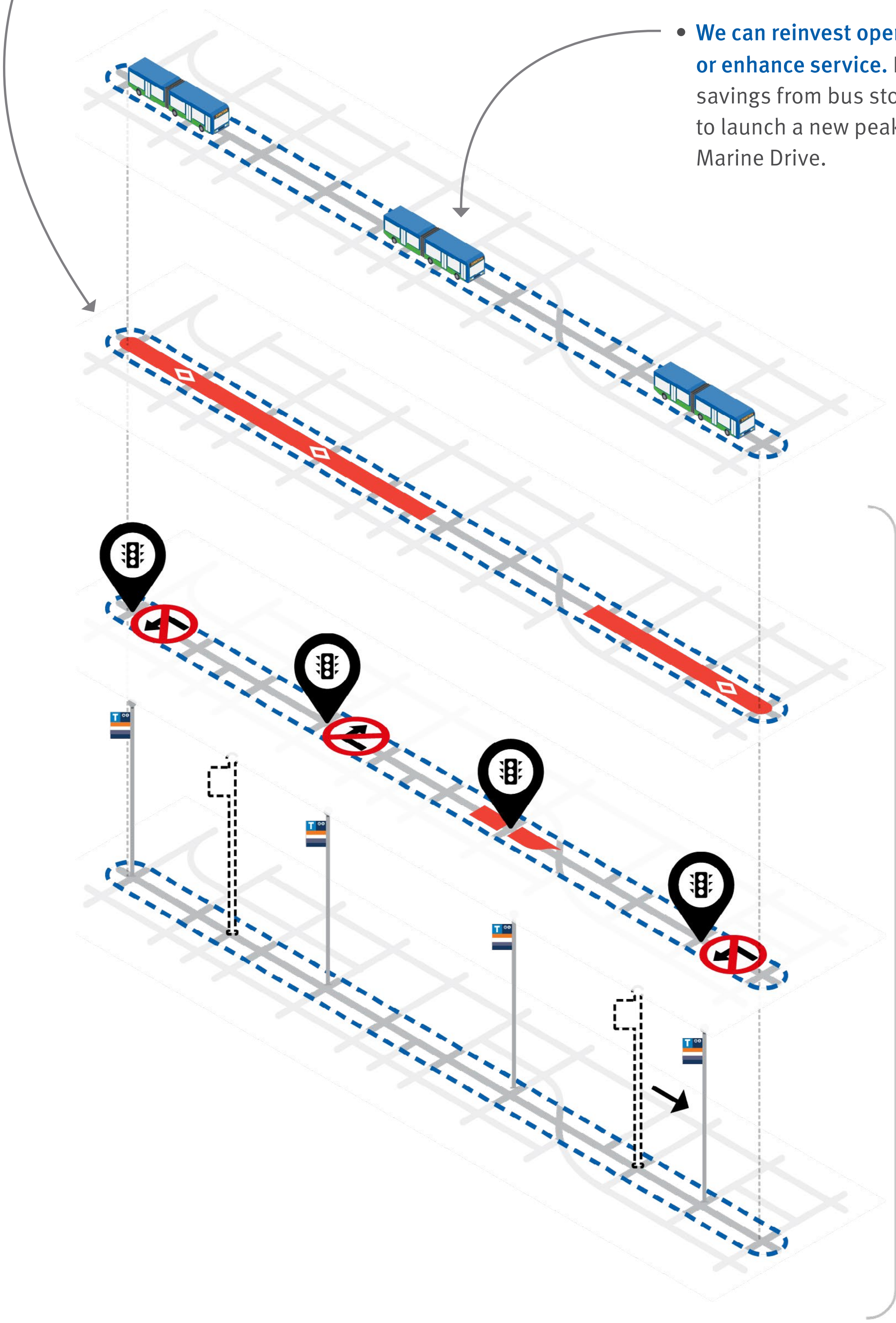
Travel Time and Return on Investment from Bus Priority

Project Type	# of Projects	Travel Time Savings (Weekdays) [2]	Typical Return on Investment [3]
RapidBus route [1]	3	25–35%	N/A [4]
Bus Stop Balancing [1]	5	5–10%	‹1 year
Bus/BAT lanes	10	Up to 15%	0-10 years
Approach lanes	3	Up to 35%	N/A [5]
Queue jumps	2	Approx. 15%	‹5 years
In-lane bus stops [1]	5	Up to 15%	0–15+ years
Signal upgrades	6	Up to 20%	0–15 years
Turn restrictions	1	Approx. 10%	N/A [5]

Notes: 1. Benefits include both faster travel time between stops AND reduced dwell time at stops. 2. Daily travel time savings between 6 am and 10 pm. 3. Costs are based on values provided by municipalities in funding applications, funding reallocations, or submitted invoices (if received). 4. RapidBus launch also included significant investments in stop amenities and service increases. The brand is an upgraded service rather than efficiency improvement. 5. Insufficient cost data.

- **Transit priority works best at scale.** Customers and TransLink accrue the most benefits when priority measures are focused along a corridor or full route—such as RapidBus and bus stop balancing projects that include bus stop consolidation at a corridor level. Larger-scale projects are more likely to yield schedule changes that result in actual operational savings. (See project highlights from “RapidBus” on p. 57 and “Bus Stop Balancing” on p. 67.)

- **We can reinvest operational savings to expand or enhance service.** For example, we reinvested savings from bus stop balancing into service to launch a new peak-hour bus route along Marine Drive.



Between stops,

bus and BAT lanes keep buses moving when streets are congested.

They also make queue jumps, signal priority, and turn restrictions more effective.

At the intersection,

queue jumps, signal priority, and turn restrictions help buses get through the lights.

This means they’re able to get to stops faster.

At stops,

in-lane stops as well as all-door boarding on RapidBus make it faster to pick up passengers.

Bus stop balancing means spacing stops so that buses are faster and more reliable.

BUS PRIORITY PROJECT HIGHLIGHTS

Project Highlights: RapidBus

RapidBus is TransLink's brand of fast and frequent bus service operating along key corridors in the Vancouver region.

Supported by extensive transit priority, all-door-boarding, and limited stopping, RapidBus routes run all-day, every day—at least every 10 minutes during peak times and 15 minutes during off-peak times.

Passengers also benefit from enhanced passenger amenities such as real-time schedule information and accessibility features such audio information and tactile walking surface indicators.

The first five RapidBus routes (R1–R5) launched in 2020, with extensive new transit priority along three of the routes (R2, R3, and R4) as well as enhancements to 116 bus stops and a significant expansion in service levels, via 110 new, articulated buses.

A sixth route, R6, will launch in 2024, and will represent the biggest service expansion since the pandemic.

Map of RapidBus Projects

Overview of RapidBus Performance

Since its launch in 2020, the RapidBus brand set a target of at least 20% faster service compared to previous local buses.

The three RapidBus routes with new transit priority (R2, R3, and R4) achieved 24 to 35% savings in combined run and dwell time on weekdays, compared to comparable local bus routes. This demonstrates success for the RapidBus brand in three different contexts across the region. These savings are due to extensive new transit priority measures as well as shorter dwell times due to bus stop consolidation and all-door boarding onto larger 3-door buses.

- The R2 saved 24% in end-to-end run time all day, between 5 to 12 minutes.
- The R3 saved 35%, with savings ranging from 11 to 28 minutes.
- The R4 lines saved 26% overall, ranging from 11 to 19 minutes during the day.

The two RapidBus routes that were pre-existing routes (R1 and R5) benefited from improved stop amenities, new buses, all-door-boarding, and greater frequencies.

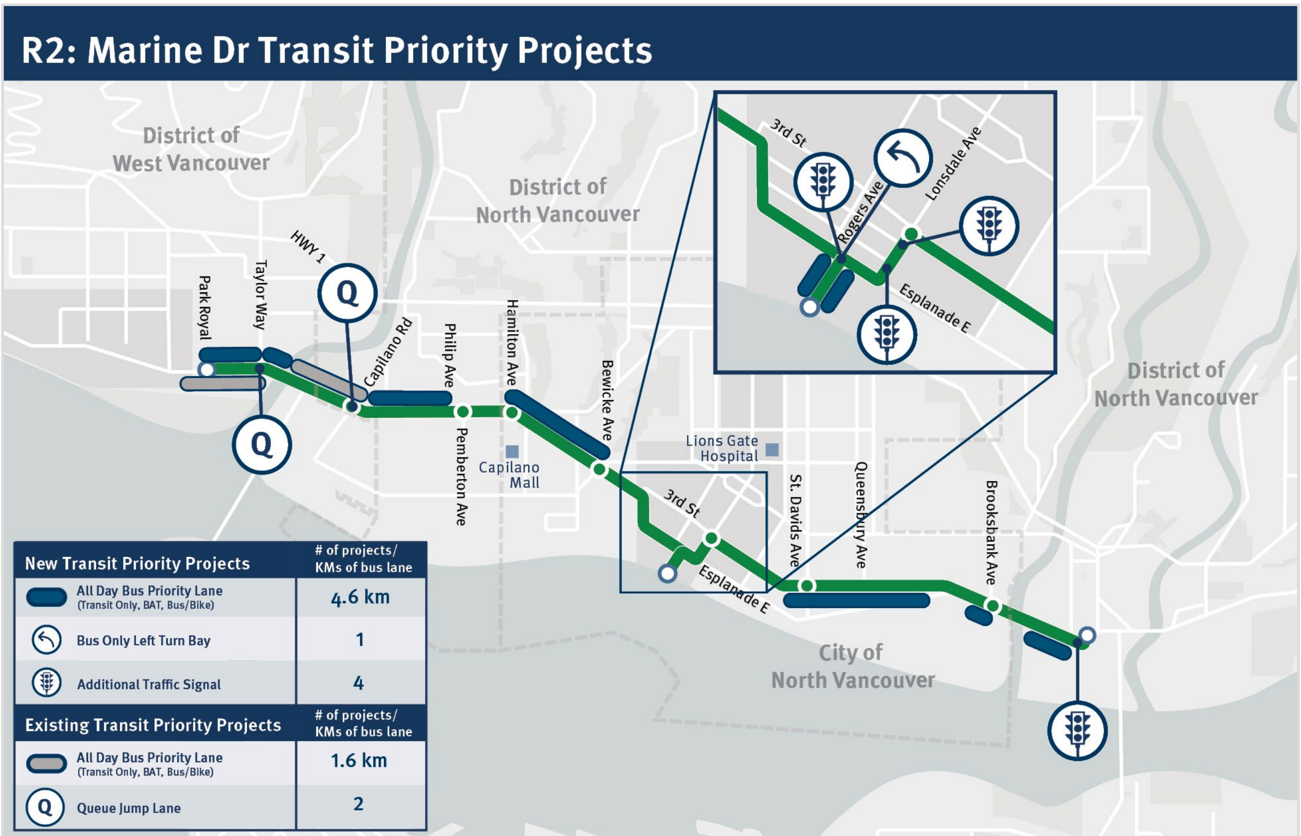
Peer Highlight: In the Seattle (WA) region, King County Metro's RapidRide arterial BRT service has also achieved its goal of up to 20% faster travel time. Ridership increased by 70% on its six lines in service as of 2019, before the pandemic.[36]

RapidBus routes have succeeded in different parts of the region.
Top: R4 at Kingsway.
Middle: R3 at Coast Meridian Rd.
Bottom: R2 at Lonsdale Ave.

R2 RapidBus: Marine Drive

The R2 RapidBus runs between Park Royal, Lonsdale Quay, and Phibbs Exchange via Marine Drive, 3rd Street and Main Street. The R2 RapidBus replaced local bus Route 239 and introduced new transit priority including bus lanes, queue jumps, turn pockets, and transit priority signals along with reducing the number of stops, allowing all-door boarding, and improving bus stops.

Map of R2 RapidBus Transit Priority



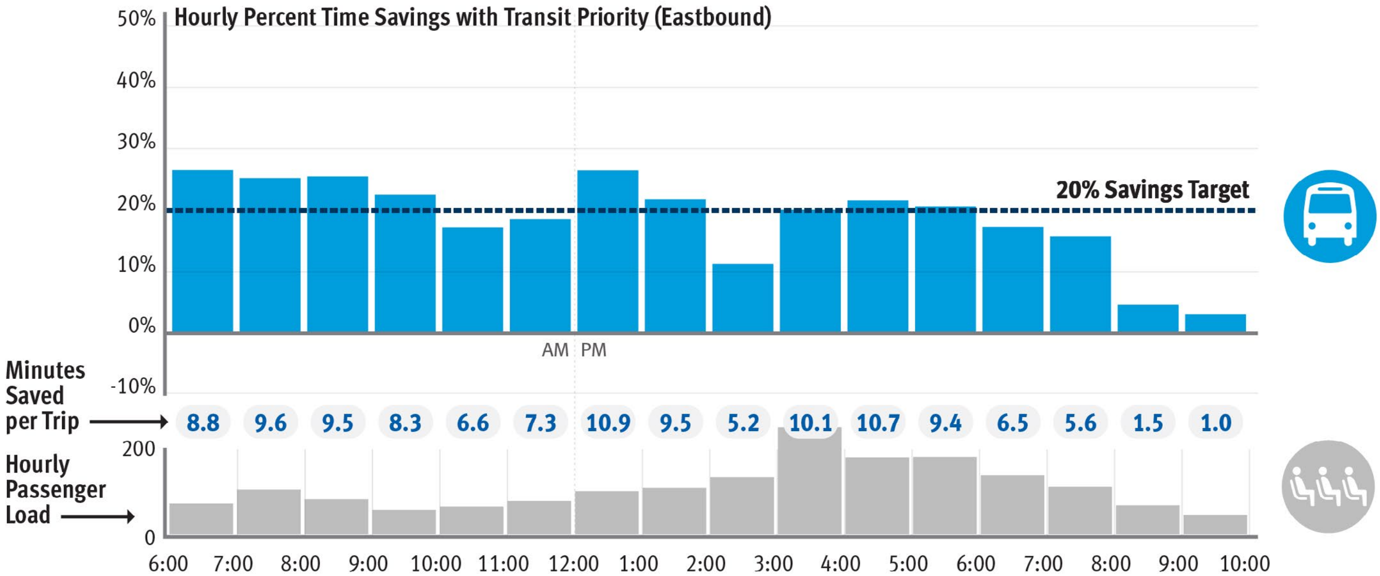
Overview of R2 RapidBus Performance

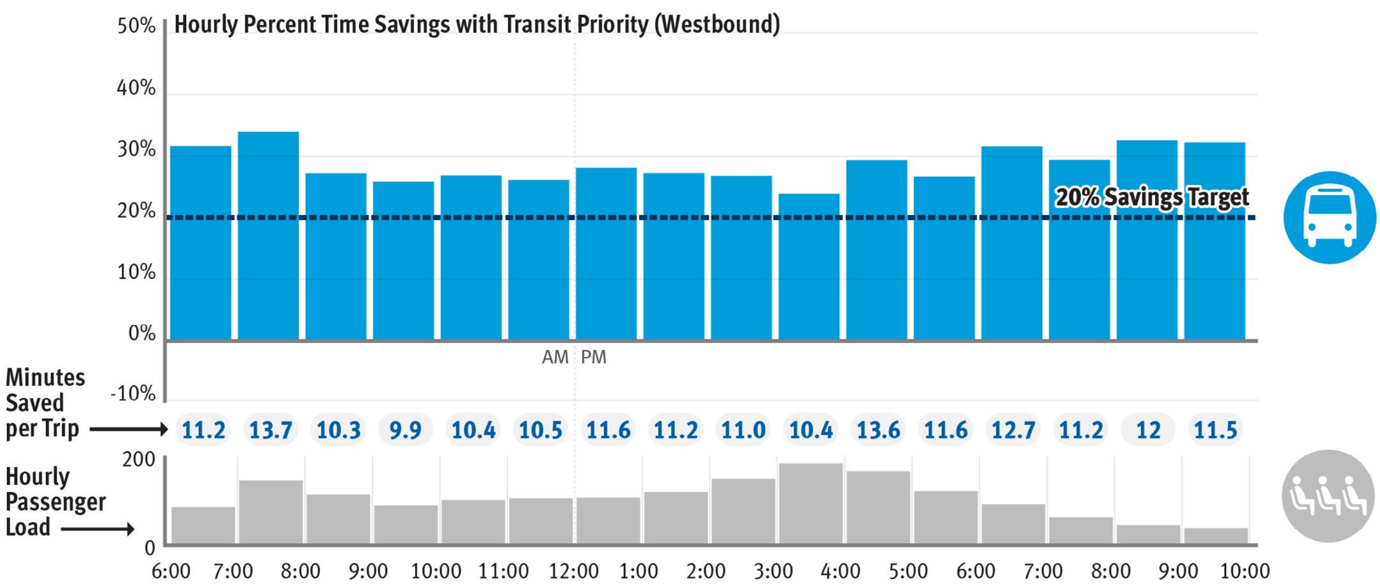
- Compared to Route 239, the R2 RapidBus reduced run time and dwell time by 24% on weekdays between Park Royal and Brooksbank Avenue in the City of North Vancouver.
- Travelling eastbound, the R2 experienced run time savings at all times of the day, with the highest percent savings between 6 a.m.–9 a.m., 12 p.m.–1 p.m., and 3 p.m.–6 p.m.
- The R2 experienced higher and more consistent run time savings travelling westbound, exceeding 20% at all times of the day.

R2 Implementation Challenges

- The western terminus of the proposed route was truncated from Dundarave to Park Royal in response to some community members' concerns about service levels and bus priority measures.
- Travel lanes along Marine Dr, 3rd St, and Main St vary between three and one, so transit priority measures for the R2 are intermittent.
- Construction around the Mosquito Creek Bridge delayed implementation of bus lanes originally planned to support the route at launch.

R2 RapidBus Travel Time Savings by Hour, Weekdays, R2 vs. Route 239, between Park Royal and Brooksbank Ave



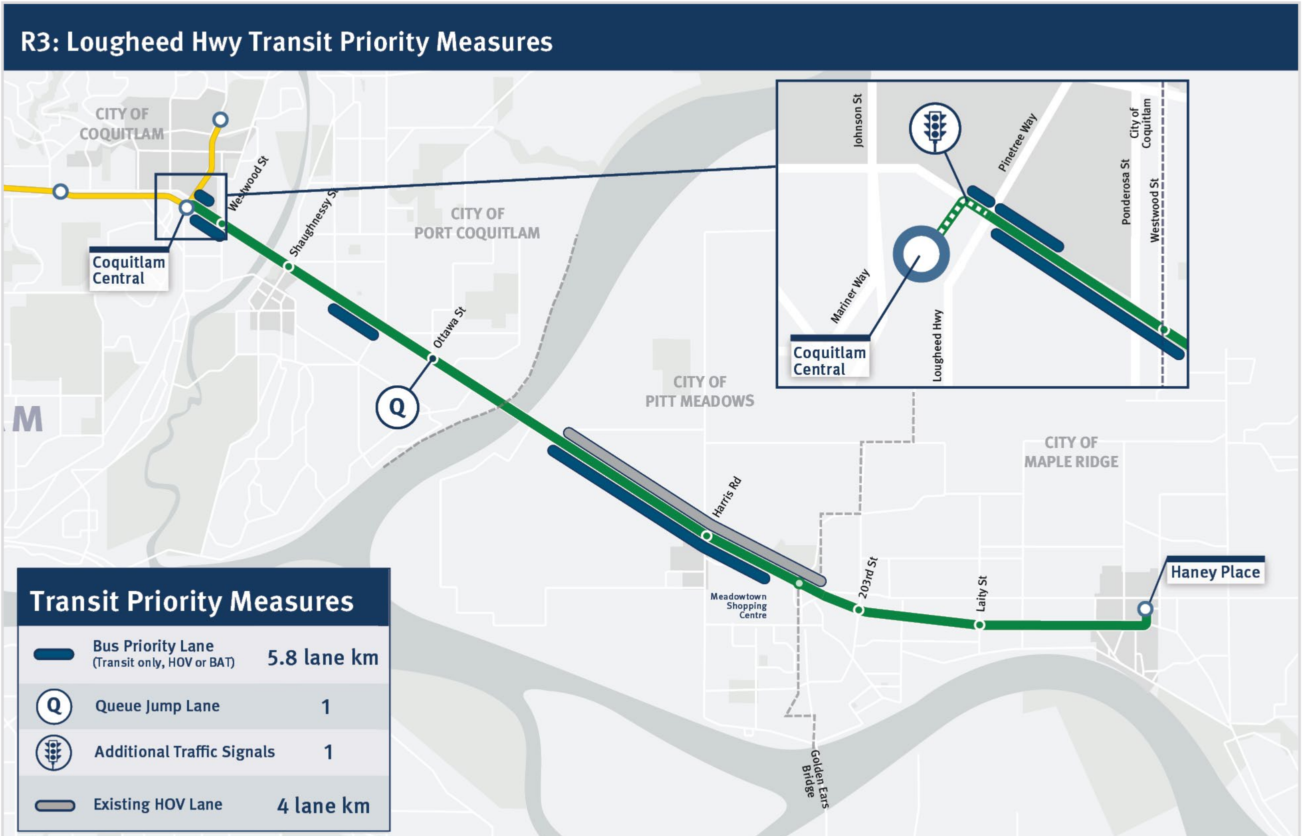


The blue vertical bars (top) show the percentage savings by hour of day, relative to RapidBus' target of 20% faster service compared to previous local buses; the labels below the bars show the average minutes saved per trip. The grey bars (bottom) show the passenger load (number of passengers on board) in each hour.
Note: Based on combined run and dwell time.

R3 RapidBus: Lougheed Highway

The R3 RapidBus runs between Coquitlam Central SkyTrain Station and Haney Place via Lougheed Highway. The R3 largely runs alongside and complements local Route 701. It added bus priority lanes expanding on an existing HOV lane along with providing a more direct route compared to Route 701.

Map of R3 RapidBus Transit Priority



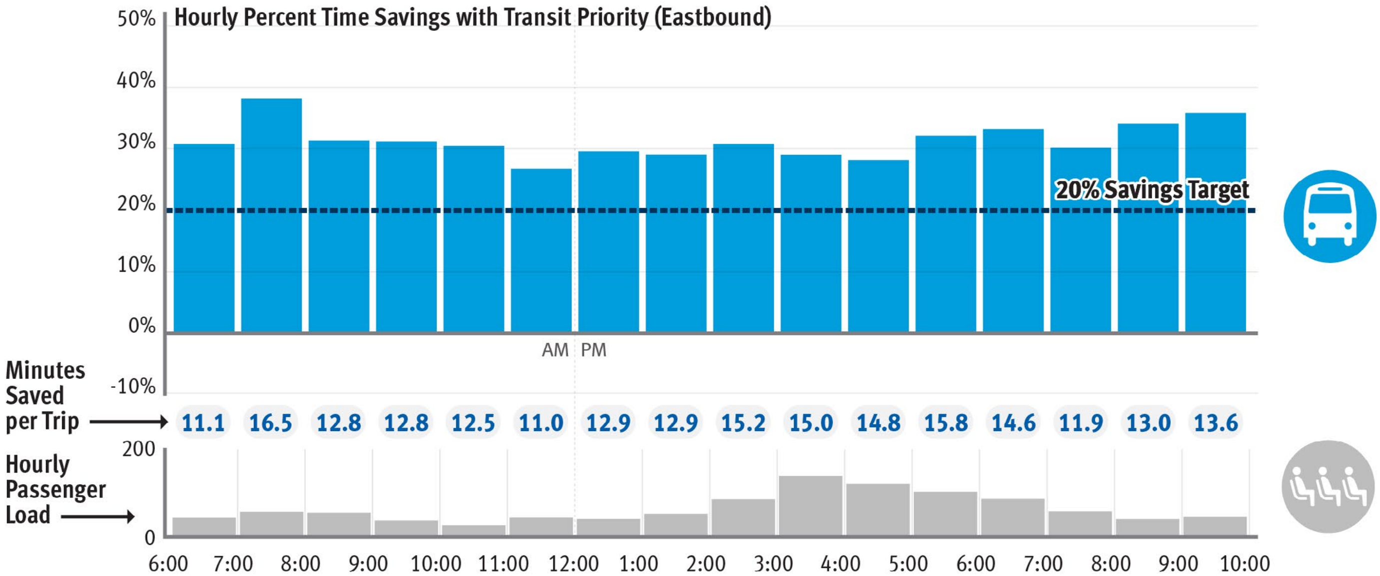
Overview of R3 RapidBus Performance

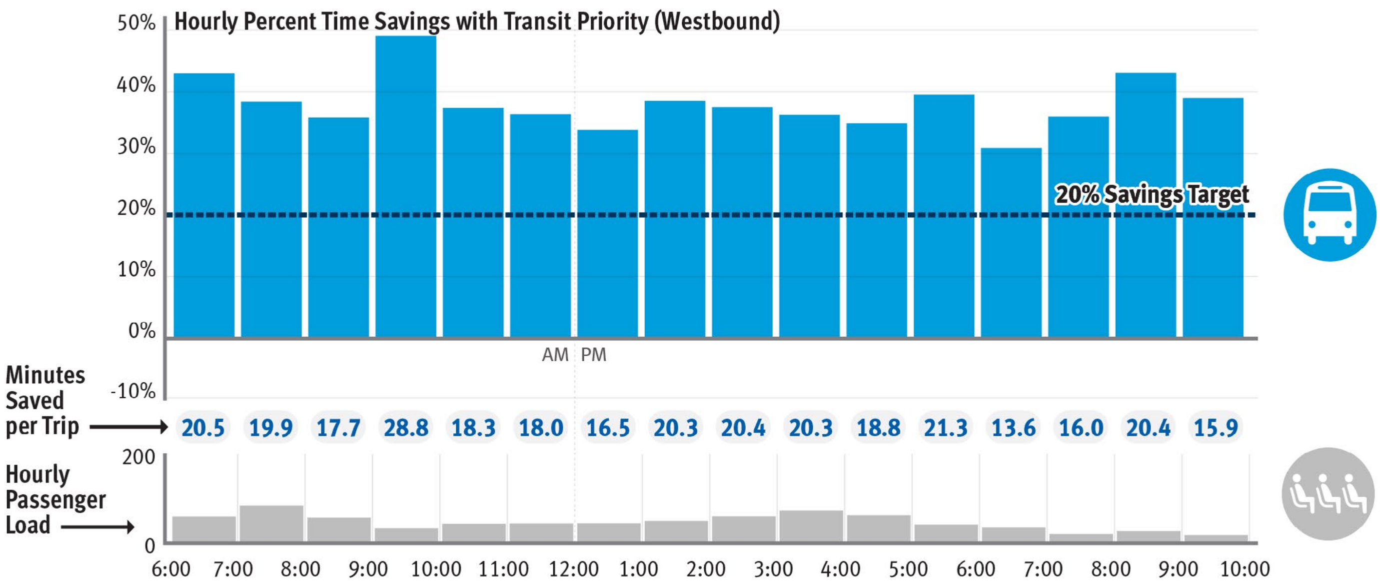
- Travelling both eastbound and westbound, the R3 provided consistent travel time savings at all times of the day, exceeding 30% at all times of the day traveling eastbound.
- This is a significant improvement, providing a much faster transit connection between Maple Ridge and the rest of the region, including a more direct connection to the Millennium Line SkyTrain.
- With average speed (36 km/hr) and stop-spacing (2.45 km) exceeding those of the Canada Line (32 km/hr and 1.22 km), **the new R3 has service attributes comparable to SkyTrain**. This is an example of what can be accomplished with at-grade bus service.
- Largely as a result of the introduction of the R3, ridership in the whole sub-region has been more robust since the COVID-19 pandemic. In fall 2022, Maple Ridge/Pitt Meadows led all sub-regions, with a ridership recovery of 98% since before the pandemic, compared to 79% system-wide.

R3 Implementation Challenges

- The Coquitlam River Bridge is a two-lane bottleneck that is due to be replaced. Implementation of bus priority measures in this area was not possible prior to the launch of R3.

R3 Travel Time Savings by Hour, Weekdays, R3 vs. 701



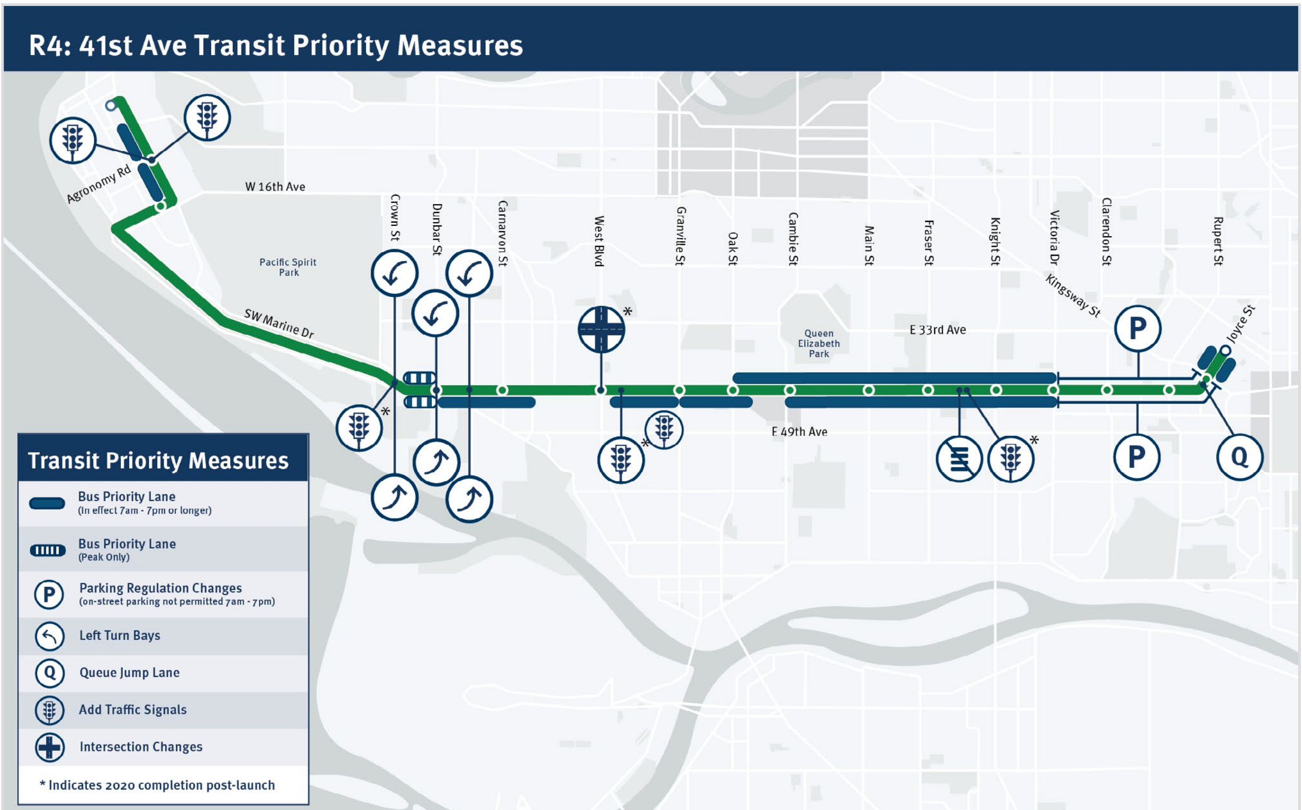


For each direction, the blue vertical bars (top) show the percentage savings by hour of day, relative to RapidBus' target of 20% faster service compared to previous local buses; the labels below the bars show the average minutes saved per trip. The grey bars (bottom) show the passenger load (number of passengers on board) in each hour.
Note: Based on combined run and dwell time.

R4 RapidBus: 41st Ave

The R4 RapidBus runs between UBC to Joyce–Collingwood SkyTrain Station via 41st Ave. The R4 replaced Route 43, the previous weekday-only limited stop service. It also replaced the local Route 41 west of Marine Drive. The RapidBus route added transit priority measures including bus lanes and queue jumps along with turn restrictions and traffic signal changes. The RapidBus launch introduced all-door boarding and provided frequent limited stop service including on weekends.

Map of R4 RapidBus Transit Priority



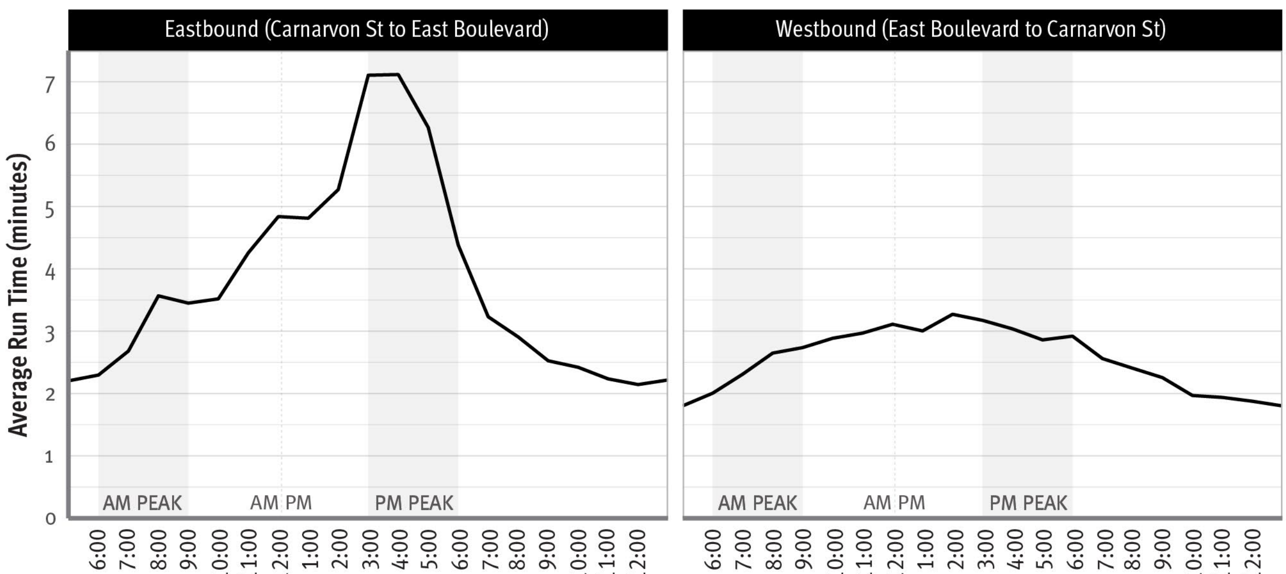
Overview of R4 RapidBus Performance

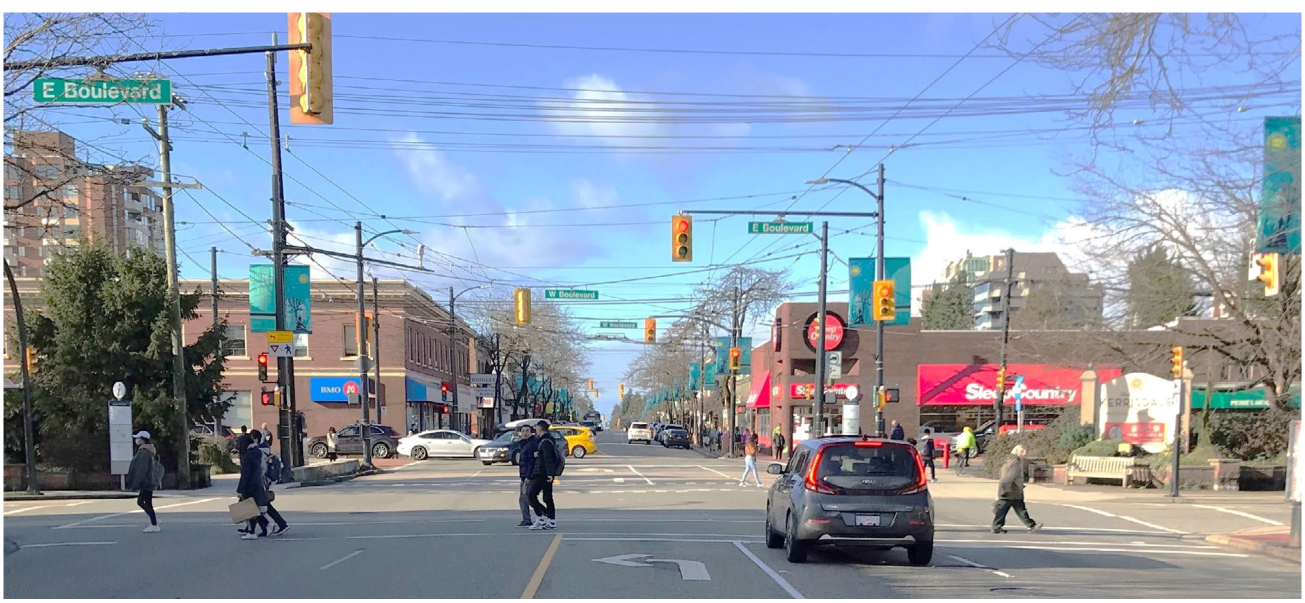
- Comparing the R4 RapidBus with the previous local Route 41, the R4 saw a 26% reduction in run and dwell time between Joyce–Collingwood Station and UBC, and a 29% reduction between Joyce–Collingwood Station and Dunbar St.
- Prior to the implementation of the R4, local Route 41 travelled between UBC and Joyce–Collingwood Station. RapidBus service provided travel time savings of over 20% throughout the day compared to the pre-existing local route, and over 30% at some times of the day.

R4 Implementation Challenges

- Travel lanes along 41st Ave vary between one and two so transit priority measures could not be applied continuously along 41st Ave.
- Along much of the corridor, bus lanes were created by removing on-street parking. This requires additional stakeholder engagement, but expands capacity for both buses and other vehicles.
- Kerrisdale is a retail area that remains a hotspot of congestion along the corridor with delays most evident in the eastbound direction in the afternoon (see charts below). Creative solutions will be required to alleviate this congestion given limited road space and many competing demands—including parking, pick-up/drop-off and pedestrian access.
- Ongoing construction of Oakridge Centre will continue to cause disruptions to bus service until its completion after 2025.

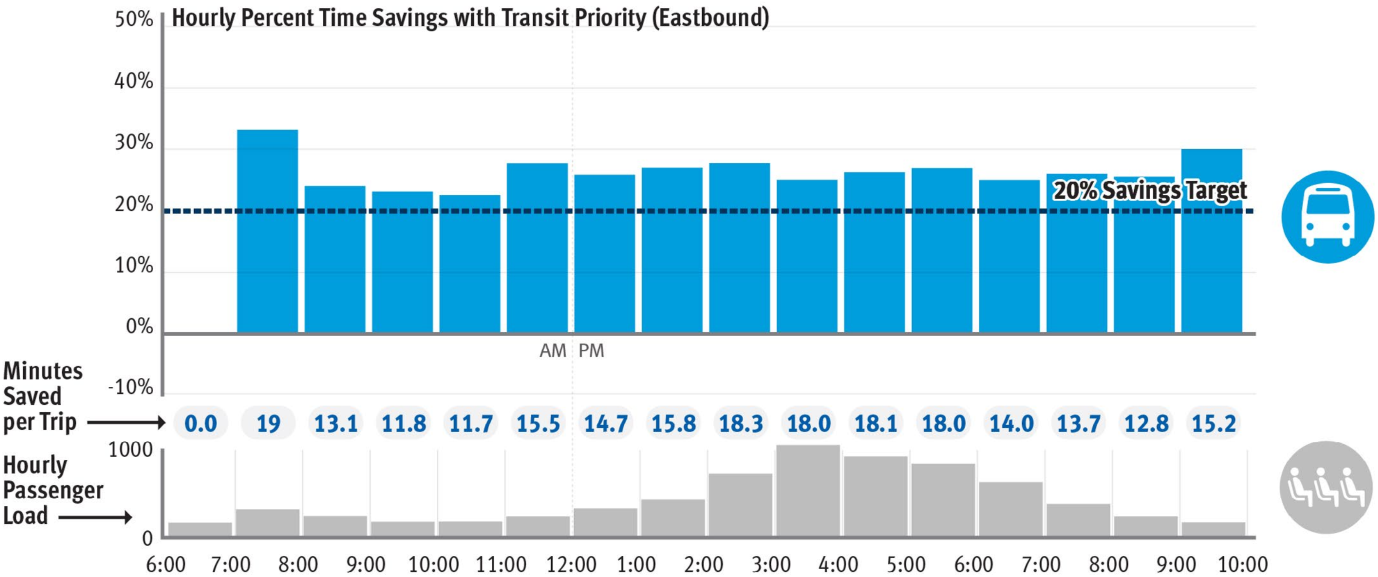
R4 Average Weekday Travel Time by Hour (Excluding Dwell Time) in Kerrisdale between Carnarvon St and East Blvd, Fall 2021

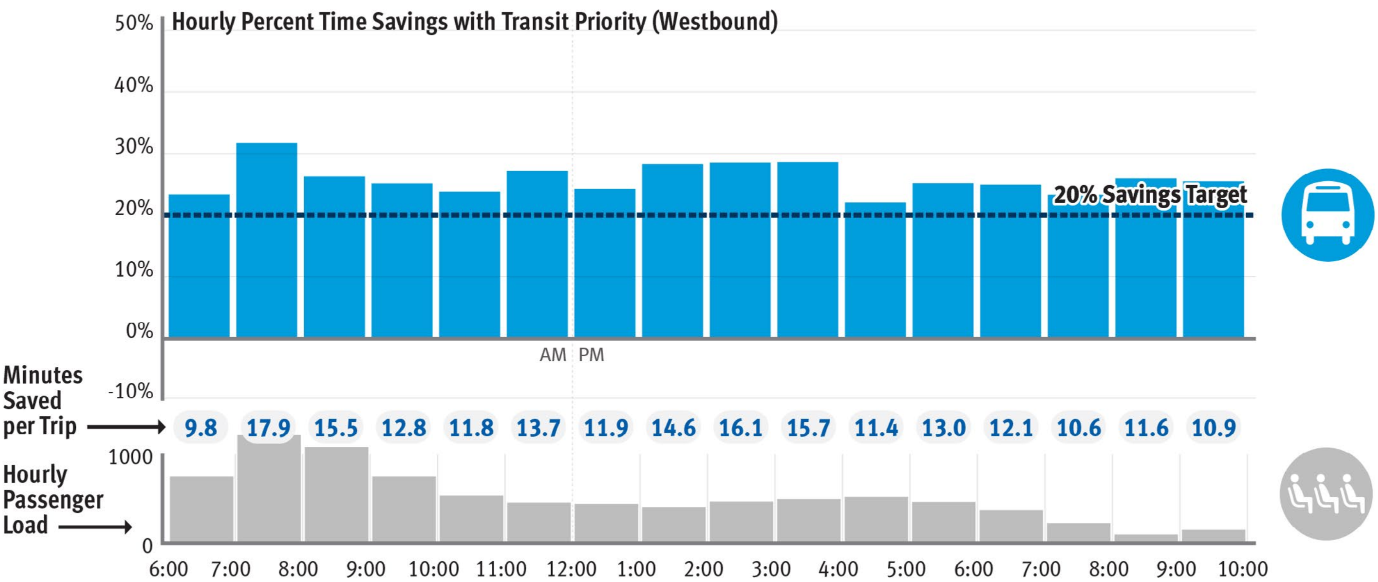




West 41st Ave at East Blvd, facing west.

R4 Travel Time Savings by Hour, Weekdays, R4 vs. 41

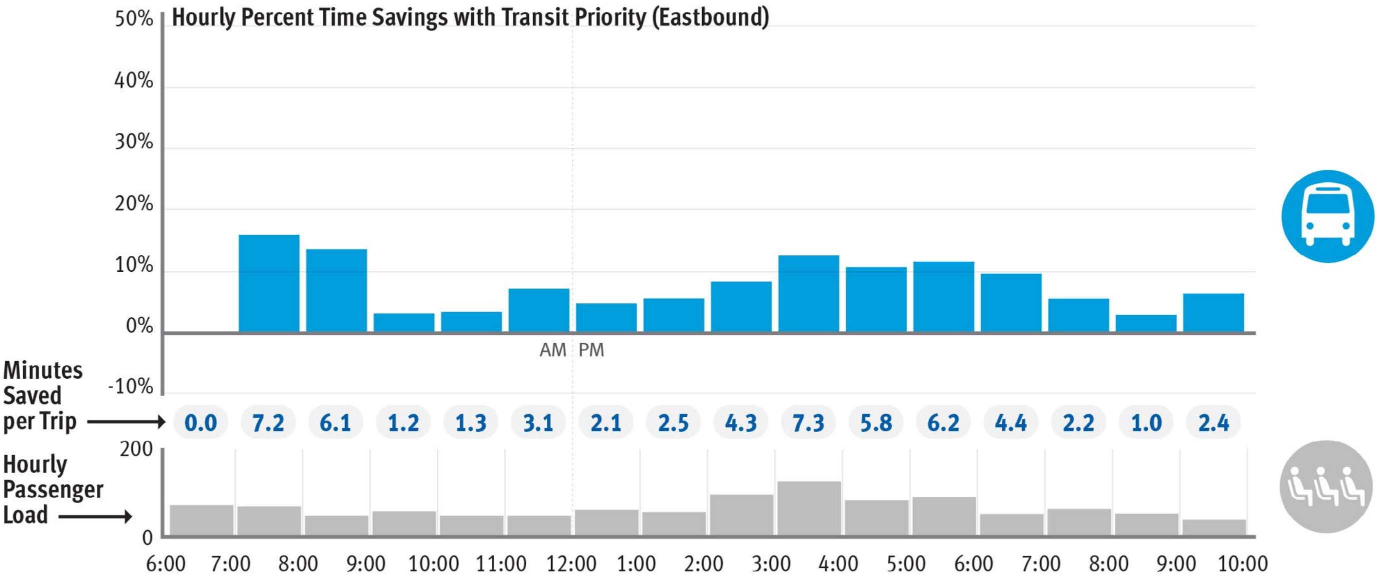


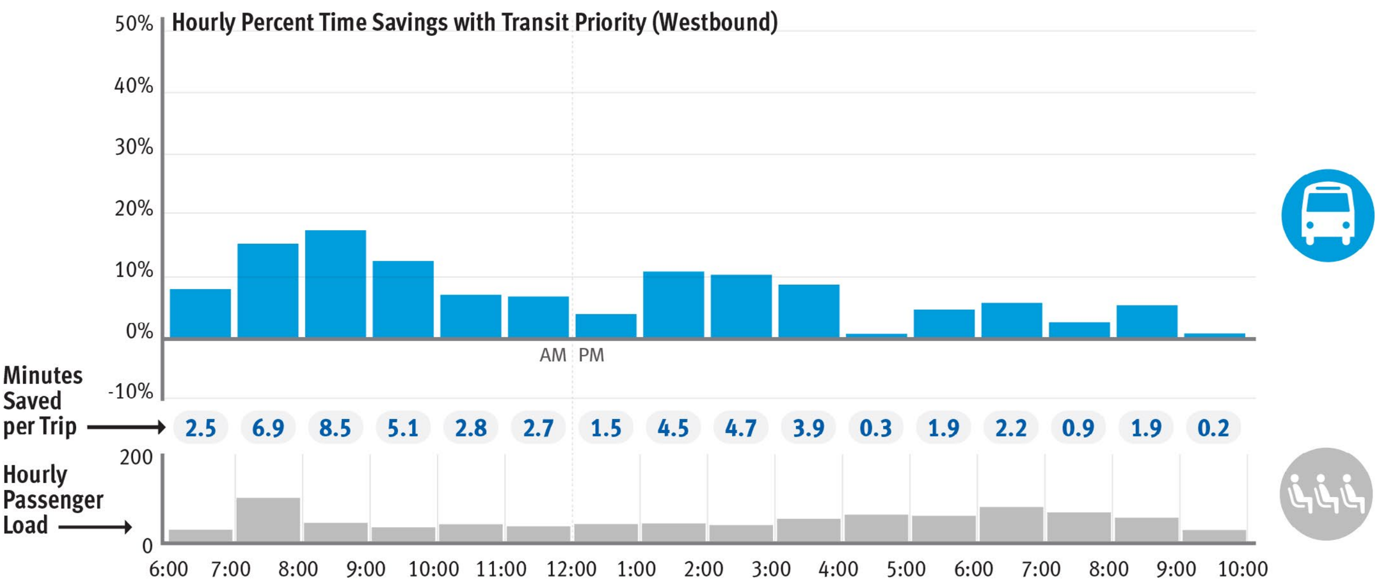


For each direction, the blue vertical bars (top) show the percentage savings by hour of day, relative to RapidBus' target of 20% faster service compared to previous local buses; the labels below the bars show the average minutes saved per trip. The grey bars (bottom) show the passenger load (number of passengers on board) in each hour.
Note: Based on combined run and dwell time.

The local service on Route 41 saw a 9% reduction in run and dwell time, demonstrating transit priority measures benefit all routes that travel on the corridor. Since implementation of the R4, local Route 41 now terminates at Crown Street. The graphic below shows the hourly travel time savings compared to the previous Route 41 between Dunbar Street and Joyce–Collingwood Station. Travel time was lower on Route 41 at all times of the day, exceeding 10% savings during some hours in the morning (both directions), late afternoon (eastbound), and mid-afternoon (westbound).

Local Bus Travel Time Savings by Hour, 41 Before and After, Joyce–Collingwood **Station – Dunbar**





For each direction, the blue vertical bars (top) show the percentage savings by hour of day; the labels below the bars show the average minutes saved per trip. The grey bars (bottom) show the passenger load (number of passengers on board) in each hour.
Note: Based on combined run and dwell time.

TransLink is continuing to improve and expand the RapidBus network.

The existing RapidBus routes remain focus areas for continuing improvements.

- Along the **R2,** new bus lanes continue to be implemented. This includes the "East 3rd St bus lanes" project (evaluated under "Bus/BAT Lanes" in this report). Notably, the necessary road space for this project was created via a transportation-oriented land-use rezoning. Another gap in bus lane is also being filled eastbound between Queensbury and Gladstone (under construction). And new bus lanes around the Lynn Creek Bridge are also planned (though yet to be funded).
- Along the **R4,** the Northbound "Wesbrook Mall Bus Lane" was completed since launch, complementing an upgrade to the bus loop at University of British Columbia. Other spot changes are being completed, including a new bus shelter and permanent bus lanes around Oakridge Centre, once construction is complete.
- The City of Burnaby and TransLink are in the planning stages for a future corridor-level upgrade for the **R5.**

The success of the initial launch of RapidBus routes also provides momentum for an expansion of the RapidBus network, including:

- Launch of the R6 along Scott Road in Surrey and Delta (see map on page 57).
- Alignment planning for the R7 to connect Richmond to the Expo Line SkyTrain.
- Up to 11 future RapidBus corridors highlighted in the region's Transport 2050: 10 Year Priorities (see map in "Regional Investments in Bus Priority"—on page 33).
- Nine new Bus Rapid Transit Routes, including upgrades to existing or proposed future RapidBus routes (see map in "Future Bus Rapid Transit"—on page 94).

Plans are underway to improve the R5 RapidBus corridor in Burnaby.

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Project Highlights: Bus Stop Balancing

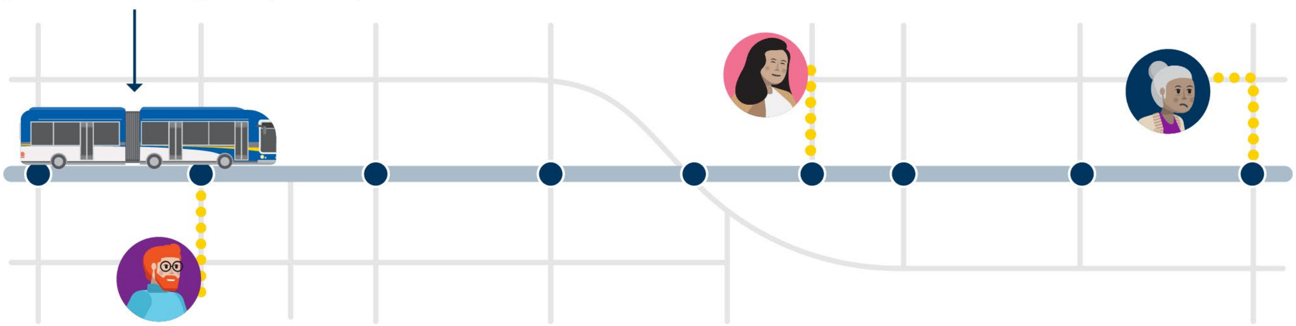
Bus stop balancing projects yield savings at scale.

Bus stop balancing involves carefully consolidating or removing bus stops that are too close together, in order to improve travel times and reliability for bus customers. As the name suggests, it aims for a balance between convenient access and effective service. While bus customers must sometimes walk a little bit further to their stop, their trip on the bus will be much shorter.

Bus Stop Spacing Before and After Balancing

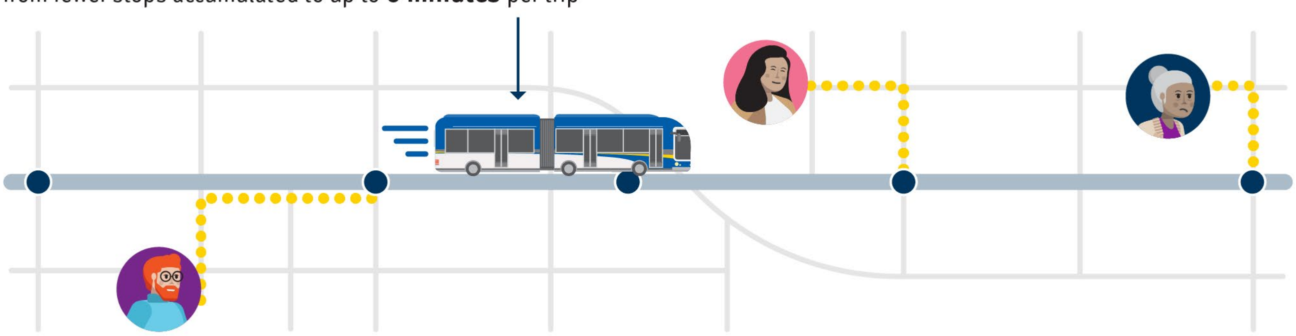
Shorter walk; slower bus

Before bus balancing: up to 75% of stops exceeded spacing guidelines, resulting in frequent stops and slower buses

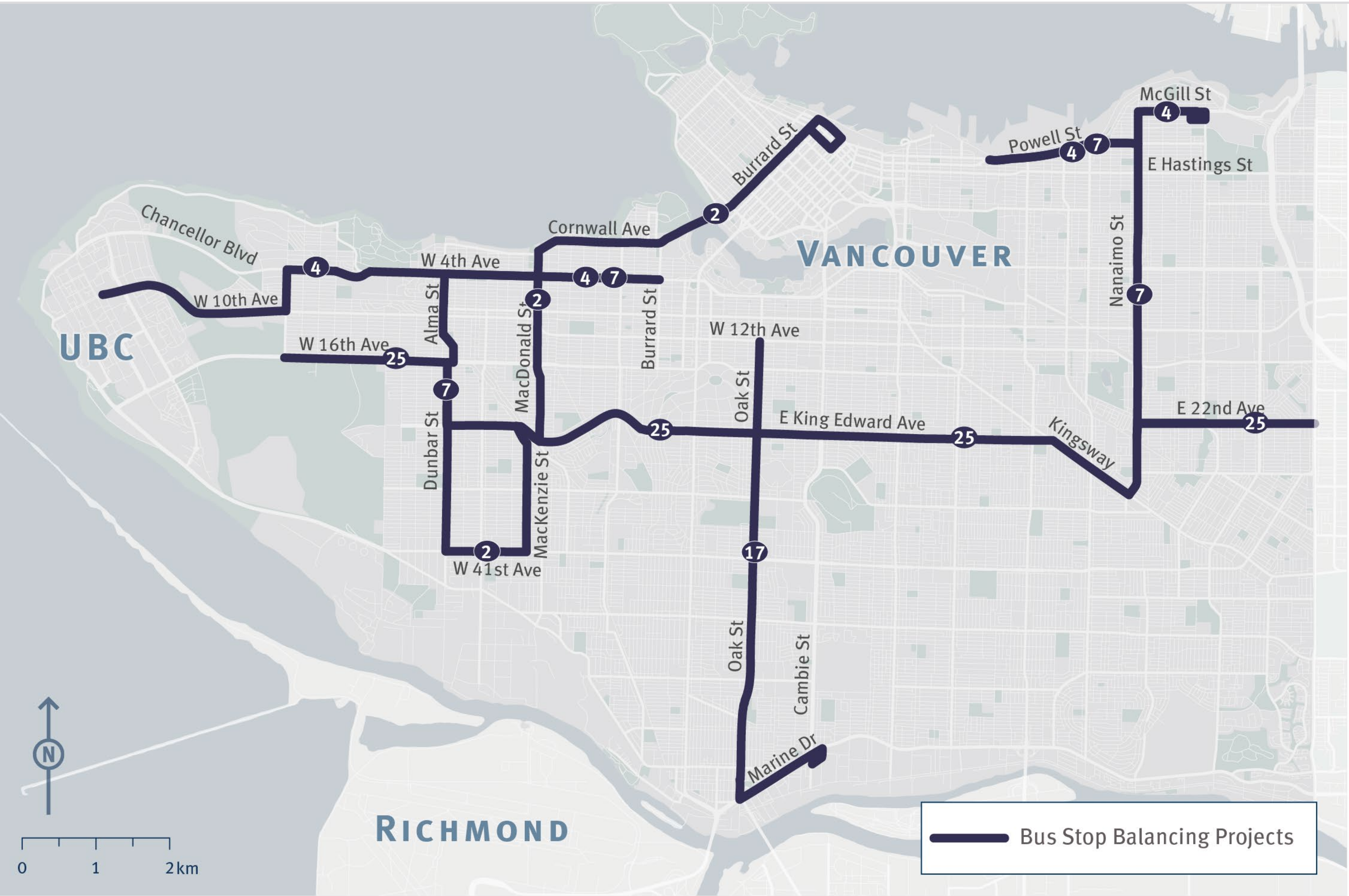


Slightly longer walk; faster bus

After bus balancing: buses ran **4% to 14% faster**—time savings from fewer stops accumulated to up to **6 minutes** per trip



Map of Bus Stop Balancing Projects (Routes 2, 4, 7, 17, and 25)



Between 2020 and 2022, TransLink and the City of Vancouver worked together on the Bus Stop Balancing project, which focused on five bus routes. Up to 80% of stops on these routes were closer than TransLink's service guidelines (300 m). After consolidating 86 bus stops, the vast majority of customers could still use their original stop, especially those with mobility limitations, and most customers affected were still within a 2- to 3-minute walk of their original stop. But all customers experienced a significant improvement in travel times. These project areas are illustrated in the map above, which shows only the portions of Routes 4 and 7 where stops were balanced; downtown Vancouver stops were not included in the projects.

Overview of Bus Stop Balancing Performance

- On the five routes with rebalanced bus stops, travel time savings averaged approximately 4% to 14% (3 to 6 minutes) across the day.
- Reducing the number of stops most clearly improves dwell time, as buses are less often sitting still at a stop. But run-time is also reduced, as buses spend less time decelerating, accelerating, and merging back into traffic.
- Run time savings are most pronounced during weekday peak periods, when buses can experience more delay from accessing bus stops and re-entering traffic.
- Optimizing timing points—a set location along the route where bus operators wait if they are ahead of schedule—can have a major impact on improving speed and reliability. The removal of the timing point in the Route 2 Bus Stop Balancing project accounted for up to one-third of dwell time savings.

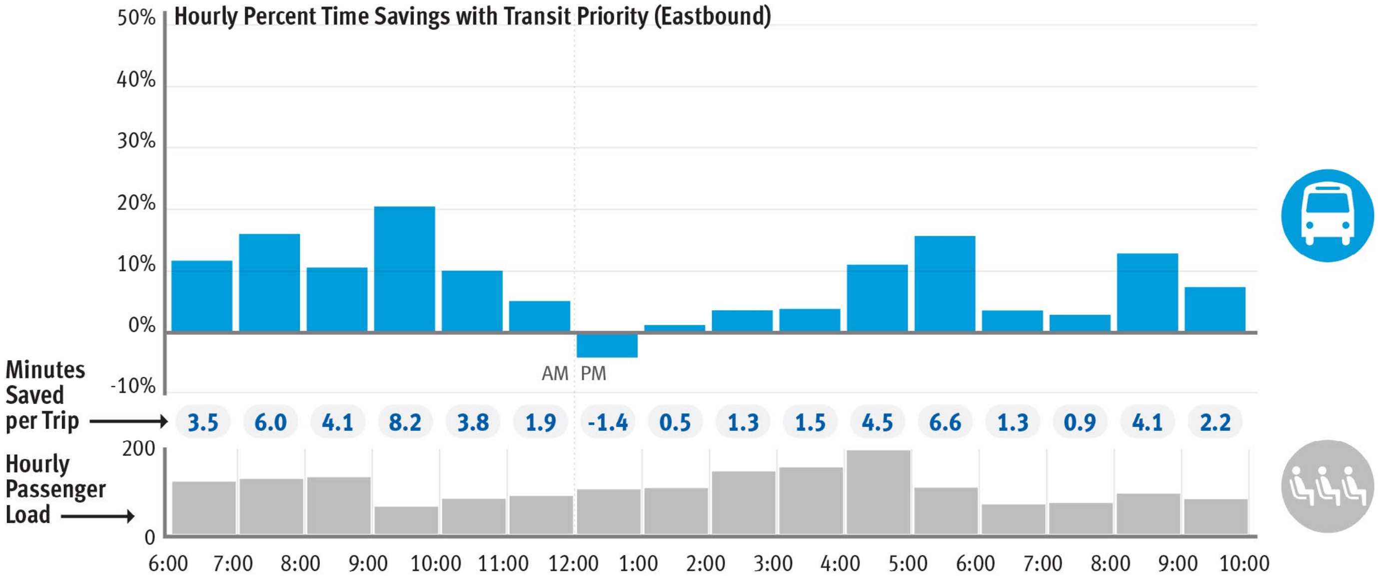
Bus Stop Balancing Project Statistics

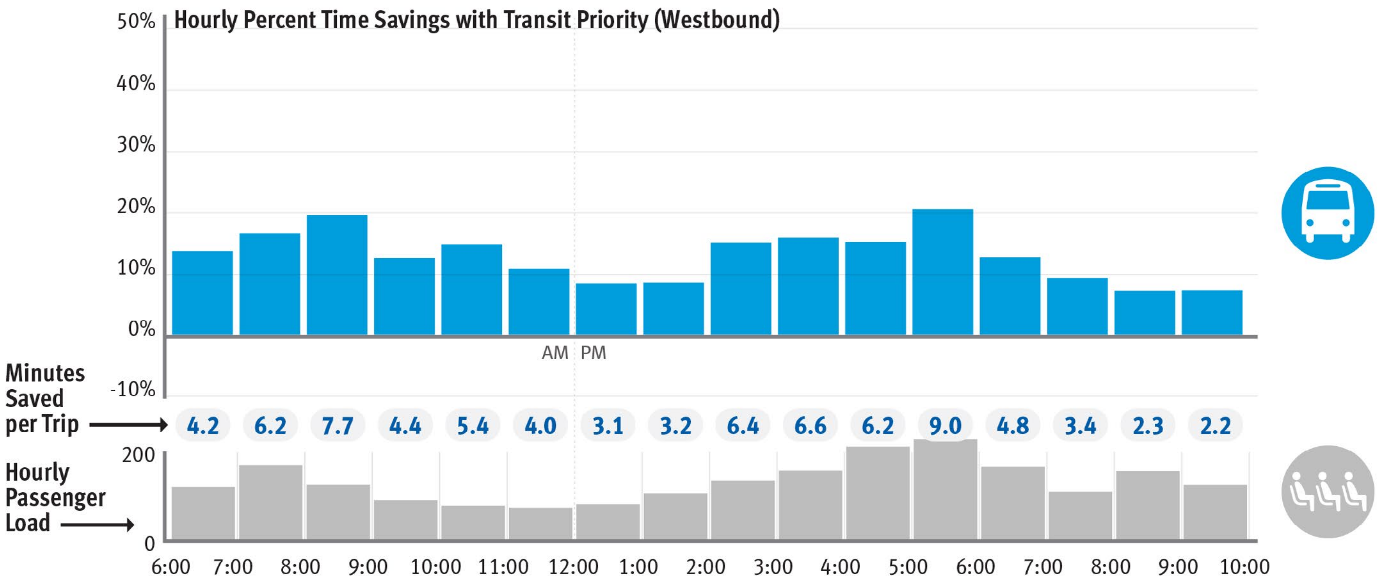
Route	Sub-Region	Closely Spaced Stops [1]		Travel Time Change [2]		Cost/Benefit [3]
		Before	After	Daily	AM/PM Peak	Payback Period
Route 2	Vancouver/UBC	81%	45%	-11%	-14%	0.3
Route 17	Vancouver/UBC	76%	56%	-6%	-7%	0.6
Route 25	Vancouver/UBC & Burnaby/New Westminster	52%	33%	-6%	-6%	0.4
Route 4	Vancouver/UBC & Burnaby/New Westminster	65%	48%	-8%	-7%	-
Route 7	Vancouver/UBC	77%	52%	-7%	-4%	-

Notes: 1. Closer than the recommended 300m per TransLink's Service Guidelines before implementation. 2. Daily average change per trip, for trips between 6 am and 10 pm, including run time and dwell time. 3. Costs are based on values provided by municipalities in funding applications, funding reallocations, or submitted invoices (if received). Some projects lacked sufficient cost data to estimate a payback period.

Bus stop balancing projects require thoughtful public outreach to minimize disruption to customers, including multilingual announcements at stops.

Bus Stop Balancing: Example of Travel Time Savings Achieved on Route 2





The blue vertical bars (top) show the percentage savings by hour of day; the labels below the bars show the average minutes saved per trip. The grey bars (bottom) show the passenger load (number of passengers on board) in each hour. After bus stop balancing, eastbound travel on Route 2 saw mostly decreases in travel time, with travel time savings of up to 20% in some hours of the day.

Considerations for Future Projects

- Corridors with very close and busy stops benefit the most. These are often concentrated in downtown areas.
- It is important to avoid increasing walking or rolling distances to bus stops for people with accessibility needs, especially if their new route would involve a steep slope.
- Financial payback is very high, but public outreach requirements are also high. Staff have a limited amount of time, limiting the number of corridors that can be implemented at the same time. Additional effort is also required to decommission bus stops after route adjustments have been made.

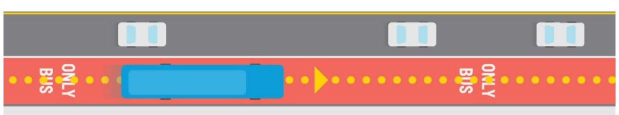
Project Highlights: Bus/BAT Lanes

Bus and BAT lane projects reduced travel times by up to approximately 15%, with payback in less than 10 years.

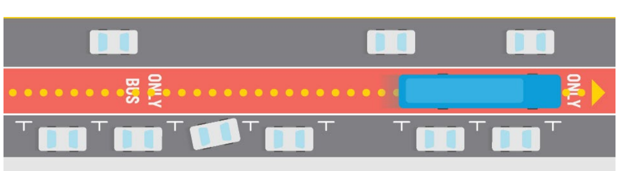
Lanes reserved for buses protect them from congestion. They may operate all-day or only during certain parts of the day, such as peak-only lanes that primarily benefit commuters. Bus lanes can also be bus-only, or they may be shared with “business access” traffic that turns across bus lanes (BAT lanes) or “high-occupancy" vehicles (HOV lanes). Bus/bike lanes are shared with cyclists. Bus lanes are typically demarcated by diamond-shapes or red paint on the road, along with curb-side or overhead signage.

There are two primary types of bus lanes in Metro Vancouver.

Curb-side bus lanes are cost-effective and quick to implement, often with limited impact to traffic if repurposing parking. Tradeoffs include conflicts with right turning motor vehicle traffic. They also require enforcement and curb management to deter prohibited uses such as parking or loading in the bus lane.



Offset bus lanes run between an on-street parking lane and a through-traffic lane and reduce competition with right-turning vehicles as well as delivery and loading vehicles. Offset bus lanes preserve parking and loading along the curb. Tradeoffs include friction between buses and vehicles that are parking or double-parked. Because passengers cannot board directly from the curb, bus bulbs can be provided additional space for passengers at bus stops and improve pedestrian safety (e.g., shorter crossing distances).



Overview of Bus and BAT Lane Project Performance

- Both peak hour and all-day bus lanes were effective at decreasing travel time. These were evaluated only during the hours the lanes were in operation.
- In general, clearly marked, red, bus-only lanes perform the best. These included the two most effective projects—Wesbrook Mall bus lane (a curb-side lane) and West Keith Rd transit project (an offset lane).
- Bus lanes that are shared with business access traffic did not perform as well, especially in areas where buses encounter frequent intersections or queues of right-turning vehicles. This includes the least effective project—the W Georgia St bus lanes. Notably this project also showed a slight worsening at the peak periods. This is due to increased road delay at the PM peak, during which there had previously been a peak-only business-access bus lane.
- The most cost-effective project achieved savings at scale, using low-cost interventions. Although the 49th Ave transit project did not have the highest percentage improvement in travel time, by changing lane markings across a more than 5 km corridor, it achieved greater absolute savings (more than 75 seconds at the AM peak). And, relying primarily on street signage and roadway paint—which are relatively cheap—it achieved a payback period of less than 6 months.

The bus lane along Keith Rd is supported by red paint, a right-turn pocket, and a left-turn restriction at the intersection with Bewicke Ave.

Bus and BAT Lane Project Statistics

Map	Project Name	Sub-Region	Time Restrictions	Travel Time Change [1]		Cost/Benefit [2]
				Daily (6 a.m. to 10 p.m.)	AM/PM Peak	Payback Period (Years)
15	Wesbrook Mall bus lanes	Vancouver/UBC	-	-15%	-13%	5.7
16	West Keith Rd transit project	North Shore	-	-9%	-9%	9.9
12	Granville St bus lanes	Vancouver/UBC	SB: 3–6 p.m. NB: 7–10 a.m.	-6%	-7%	4.8
10	Lougheed Highway bus lanes	Northeast	-	-5%	-11%	-
13	49th Ave transit project	Vancouver/UBC	Various time-restricted segments	-4%	-5%	0.4
11	East 3rd St bus lanes	North Shore	-	-4%	-4%	[3]
14	Main St and Kingsway bus lanes	Vancouver/UBC	SB: 3–6 p.m. NB: 7–10 a.m.; portion 7 a.m.–7 p.m., 7 days/week	-4%	-4%	8.3
9	Fraser Hwy bus lanes	Southeast	-	-3%	-3%	7.7
18	W Georgia St bus lanes	Vancouver/UBC	Extended peak-only lane to 7 a.m.–7 p.m.	-3%	5%	1.5
17	Scott Rd / 120 St BAT lane	Southeast	-	No change	No change	-

Notes: 1. Transit travel time change is a trip-weighted average calculated by hour from TransLink AVL data for the before and after time periods. 2. Costs are based on values provided by municipalities in funding applications, funding reallocations, or submitted invoices (if received). Some projects lacked sufficient cost data to estimate a payback period. Some of the projects listed were constructed using temporary/interim measures, while others may be more permanent and have different associated costs. 3. Subset of a project constructed as part of RapidBus implementation. 4. Table includes projects completed after RapidBus launch in 2021.

The red bus lanes along Wesbrook Mall are clearly demarcated.

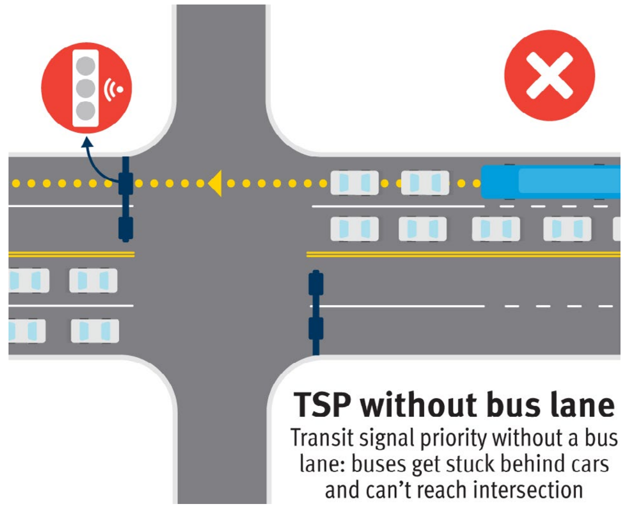
Considerations for Future Projects

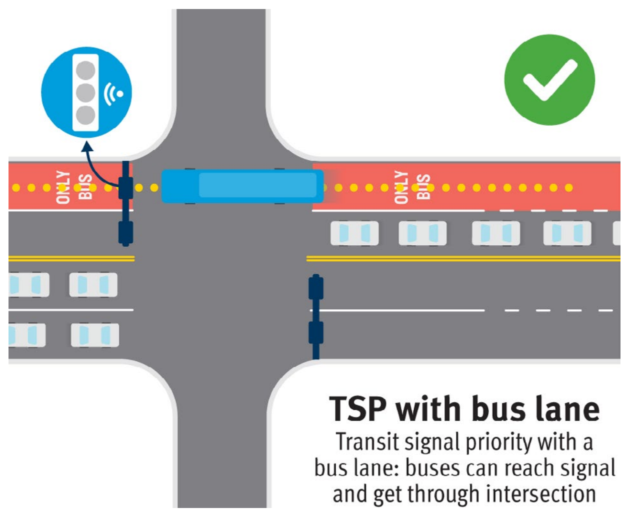
Bus lanes are complementary with other transit priority treatments.

- ***Turn restrictions*** can be used to prevent cars from queuing to turn at intersections, such as where right-turns may block bus lanes. Limiting turn movements at intersections can also prevent traffic from backing up.

Cars blocking the 7AM-7PM bus-only lane on Main St at 5th Ave.

- ***Right-turn pockets and advanced right-turn signals or phases*** can separate buses from queued vehicles where there are many right turn movements and pedestrian crossings.
- ***Transit signal priority (TSP)*** benefits from bus lanes. TSP may not function effectively if a bus is stuck in traffic and is unable to activate signal priority (top right panel). Bus lanes make transit signal priority systems more effective by allowing buses to be detected reliably and far in advance of the intersection (bottom right panel).





Clearly marked and well-enforced bus lanes work better. Confusing signage and inadequate enforcement of drivers blocking the bus lane reduce their effectiveness. Strategies that other regions have used to keep buses moving smoothly through bus lanes include:

- ***Follow-up on quick build projects with permanent improvements.*** Many bus lane projects implemented in 2020 were installed using side-mounted signage for quicker project delivery. Once improvements are demonstrated to be effective, it is also important to construct permanent and more visible bus lane markings and signage.

- ***Make lanes visible.*** Many cities and transit agencies are using red-coloured pavement treatment to discourage unauthorized vehicles from using transit lanes. A study of red bus lanes in San Francisco found they reduced the number of drivers violating the lanes by approximately 50%.
- ***Increase awareness of bus lane policies and hours*** by ensuring clear and consistent signage. A variety of signs are used in bus and HOV (High-Occupancy Vehicle) lanes in Metro Vancouver.[37] Drivers may not understand that a diamond lane is a bus-only lane. Many people interpret it as an HOV lane (and drivers of electric vehicles interpret it as “EV OK”). Improved overhead signage can communicate when bus lanes can be shared with HOVs or bicycles, and when they are reserved exclusively for bus travel.

Provide consistent reinforcement to deter drivers from stopping in the bus lanes and establish a culture of keeping bus lanes clear. Active enforcement of cars in the bus lane (pick-ups/drop-offs, deliveries, double parking) keeps the bus lane clear and reminds drivers not to stop in the bus lane. Examples of innovative approaches to enforcement include:

- In 2019, the Metropolitan Transportation Authority in New York City introduced automated bus lane enforcement (ABLE) cameras on several of its buses to capture bus lane violations in real-time. Signs posted along the bus route indicate bus lane hours and notify drivers that camera-enforcement is in use. In 2022, 300 ABLE cameras were installed, and 600 more are expected in 2023.[38]
- The City of Seattle is piloting an automated transit lane enforcement system that tracks license plates of all vehicles authorized to use transit lanes and sends out notices to vehicles that are not authorized to use the lanes. The pilot also includes enforcement of markings and signage to prevent drivers from blocking intersections and crosswalks.[39]

Bus lanes benefits are most durable when they are reserved for buses only. As described elsewhere in this report (see “Existing Bus Priority in Metro Vancouver”), much of our existing bus priority lane infrastructure allows high-occupancy vehicles. Benefits from HOV lanes may decline in the future as more vehicles are allowed to use those lanes (see “HOV Lanes and Electric Vehicles” sidebar below).

HOV Lanes and Electric Vehicles

High occupancy vehicle (HOV) lanes are limited to vehicles transporting two or more persons per vehicle. HOV lanes move more people in fewer vehicles, which lowers greenhouse gas emissions and reduces congestion on our roads. In British Columbia, some vehicles are permitted to use HOV lanes regardless of the number of passengers, such as electric vehicles (EVs). EV drivers must display a provincial decal to access HOV lanes in Metro Vancouver and throughout the province. These decals do not provide EV drivers with access to bus lanes reserved exclusively for bus travel.

The number of EVs on our roads is expected to continue to grow and may increase more rapidly in response to actions to reduce transportation emissions. For example, some actions in the CleanBC Roadmap to 2030 include requiring 100% of new light-duty vehicles to be EVs by 2035, and a target of 10,000 public EV charging stations in the province by 2030. More light-duty EVs on the road will decrease emissions, but not congestion.

By 2027, the benefits of HOV lanes in reducing traffic congestion are expected to be diminished due to the volume of EVs expected. These trends would impact buses, since HOV lanes comprise nearly half of our current bus priority.

Source: MOTI, EV HOV Lane Capacity and Utilization, March 2022

Project Highlights: Queue Jumps and Transit Approach Lanes

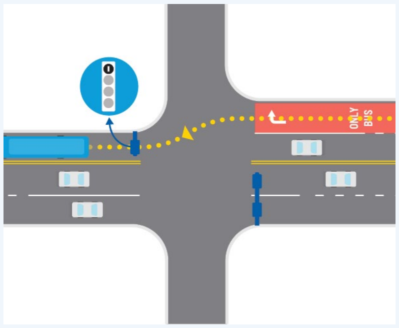
Queue jumps and transit approach lanes improved travel times by up to 35%, with payback often less than five years.

Queue jumps and transit approach lanes allow buses to bypass general traffic at congested intersections, reducing delay at traffic signals.

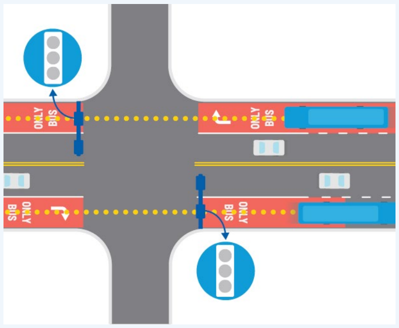
Transit approach lanes are a dedicated bus lane running through an intersection, allowing a bus to bypass congestion at the intersection.

Queue jumps are typically approach lanes that are combined with a specialized transit signal that enables buses to get a head start at the beginning of a new signal cycle. This design is particularly important when there is no receiving bus lane on the far side of the intersection, allowing buses to merge ahead of the traffic. Queue jumps can also be an approach lane with a sensor that recognizes when a bus is at or approaching the intersection, prompting the signal to stay or turn green.

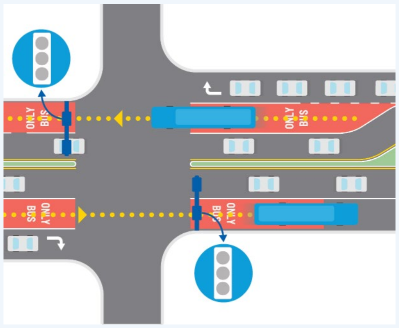
How do queue jumps and approach lanes work?



Queue jump in right-turn lane or BAT lane without a receiving lane. A specialized transit signal and/or phase is required to help the bus transition back into traffic.



Queue jump in right-turn lane or BAT lane. Signal priority is not required but may be complementary.



Dedicated transit approach lane. Signal priority is not required but may be complementary.

Overview of Queue Jump and Approach Lane Project Performance

Travel time savings for the queue jump and transit approach lane projects completed between 2019 and 2022 were evaluated based on improvements to bus run time. Results included:

- Queue jumps on Fraser Highway and at the Broadway and Gaglardi Way intersection reduced bus run times by **13% to 25% during peak periods, and 15% all-day (15 to 65 seconds).**
- Transit approach lanes implemented along Joyce Street as part of the R4 RapidBus project were the most effective, reducing bus run time on weekdays by **34% all-day and up to 40% during the PM peak**—more than a minute per trip.
- The Edmonds Street approach lanes saw more modest benefits (e.g., 6% savings in the PM peak at Canada Way and 8% savings in the AM peak at Kingsway, but were not effective during some hours of the day. This may be due to high right-turn and/or overall traffic volumes preventing buses from reaching the approach lanes. Challenges like these may be addressed via adjustments to lane configuration, on-street parking, and/or stop placement.

Transit Approach Lane Project Statistics

Map	Project Name	Sub-Region	Percent Change in Transit Travel Time (Weekdays) [1]		Return on Investment [2]
			Daily (6 a.m. to 10 p.m.)	AM/PM Peak	Payback Period (Years)
19	R4 Joyce Street approach lanes	Vancouver/UBC	-34%	-33%	[3]
21	Edmonds St approach lanes at Kingsway	Burnaby/New Westminster	-2%	-2%	› 20
20	Edmonds St approach lanes at Canada Way	Burnaby/New Westminster	0%	-3%	› 20

Queue Jump Project Statistics

Map	Project Name	Sub-Region	Percent Change in Transit Travel Time (Weekdays) [1]		Return on Investment [2]
			Daily (6 a.m. to 10 p.m.)	AM/PM Peak	Payback Period (Years)
22	Fraser Highway queue jumps	Southeast	-15%	-21%	3.3
23	Broadway and Gaglardi Way queue jump	Burnaby/New Westminster	-15%	-15%	4.1

Notes (both tables): 1. Transit travel time change is a trip-weighted average calculated by hour from TransLink AVL data for the before and after time periods. 2. Costs are based on values provided by municipalities in funding applications, funding reallocations, or submitted invoices (if received). Some projects lacked sufficient cost data to estimate a payback period. 3. Subset of a project constructed as part of RapidBus implementation.

Project Highlight: Queue Jumps on Fraser Hwy at 96 Ave and 140 St

After implementation, buses on Fraser Hwy saw decreased run times of 15% across the day and up to 25% during peak periods at these locations.

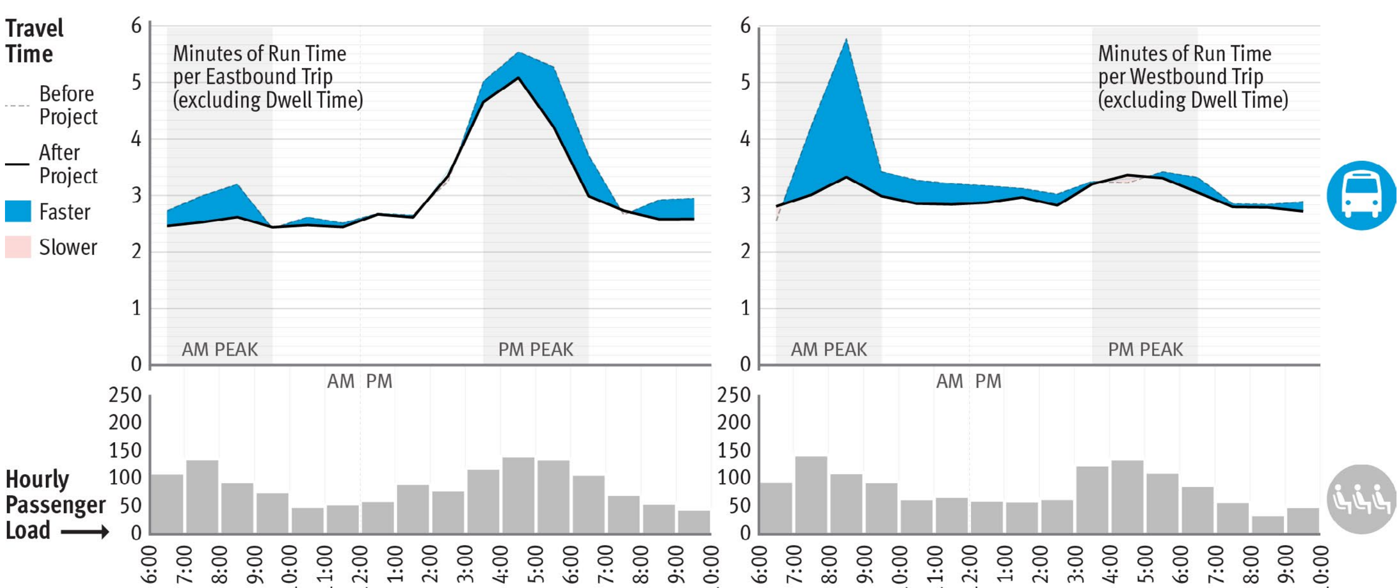
Before:

After:

Travel lanes and wide shoulders were narrowed on Fraser Highway at 96 Ave to create receiving lanes on the far side of the intersections, allowing buses to use right-turn lanes to bypass congestion, before and after. The project also prohibited right turns, which would cross a newly repaved bike lane—benefitting both bus passengers and cyclists (Google Street View). Notes: Photo showing eastbound direction. The queue jumps were removed when Fraser Hwy was widened in June 2022.

The graphs below show that the project created the greatest benefit when bus ridership was highest, particularly westbound in the morning, during which delay was almost eliminated—declining by about two minutes. It reduced but did not eliminate eastbound delay in the afternoon.

Illustration of Travel Time Savings from Fraser Hwy Queue Jumps, Weekdays, Fall 2021 vs. Fall 2019



This graphic illustrates bus run time before implementation (dotted line) compared to after implementation (solid line), by hour. Blue shading highlights the run time improvement. The grey bars below the graphs show the hourly passenger load (number of passengers on-board buses).

Project Highlight: Queue Jumps on Broadway & Gaglardi Way

Implementation of a queue jump with transit signal priority enabled buses to bypass vehicles queued at the signal and get a head start when the light turns green. Along this segment of Route 145 to Simon Fraser University, the improvement saved buses 15% of run time.

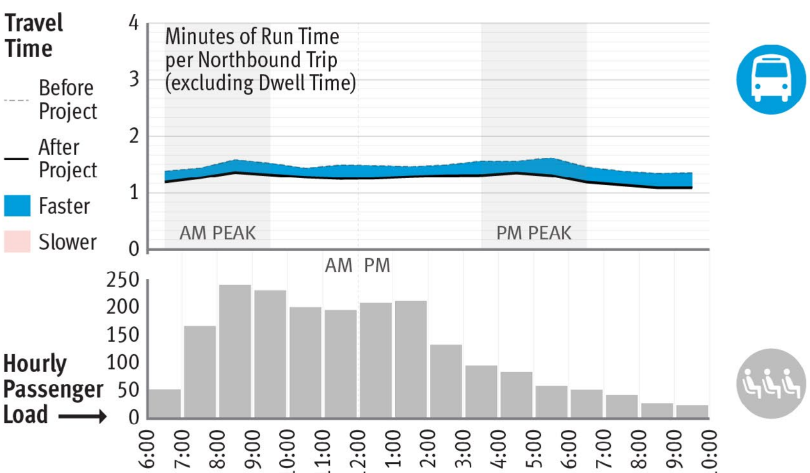
Before:

After:

Before (left) and after (right) showing a bus queue jump lane with transit signal priority that was installed at the intersection of Broadway and Gaglardi Way in late 2020 (Google Street View).

The graph below shows buses consistently saved time throughout the day.

Illustration of Travel Time Savings from Broadway & Gaglardi Way Queue Jump, Weekdays, Fall 2021 vs. Fall 2019



This graphic illustrates bus run time before implementation (dotted line) compared to after implementation (solid line), by hour. Blue shading highlights the run time improvement. The grey bars below the graph shows the hourly passenger load (number of passengers on-board buses).

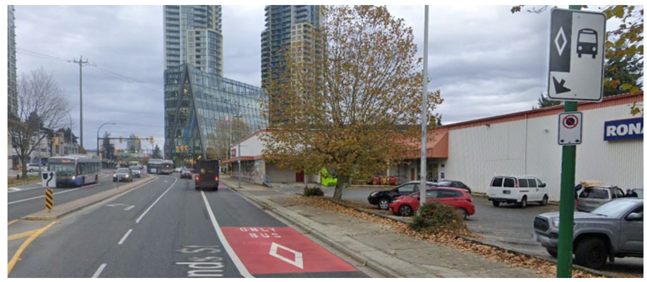
Project Highlight: Edmonds St Approach Lanes at Canada Way and Kingsway

Southbound transit approach lanes were implemented along Edmonds St at Kingsway and at Canada Way in late 2020. Northbound right-turn except bus lanes were also implemented. Approach lanes are used to allow buses to bypass vehicles that are queued to make right-turns, where right-turn volumes are high.

For Route 106, connecting Edmonds and New Westminster Stations, the improvements saved buses up to nearly 6% of runtime at Canada Way in the PM Peak and up to nearly 8% of run time at Kingsway in the AM Peak, but did not perform consistently across the day, as described in more detail below.

Before:

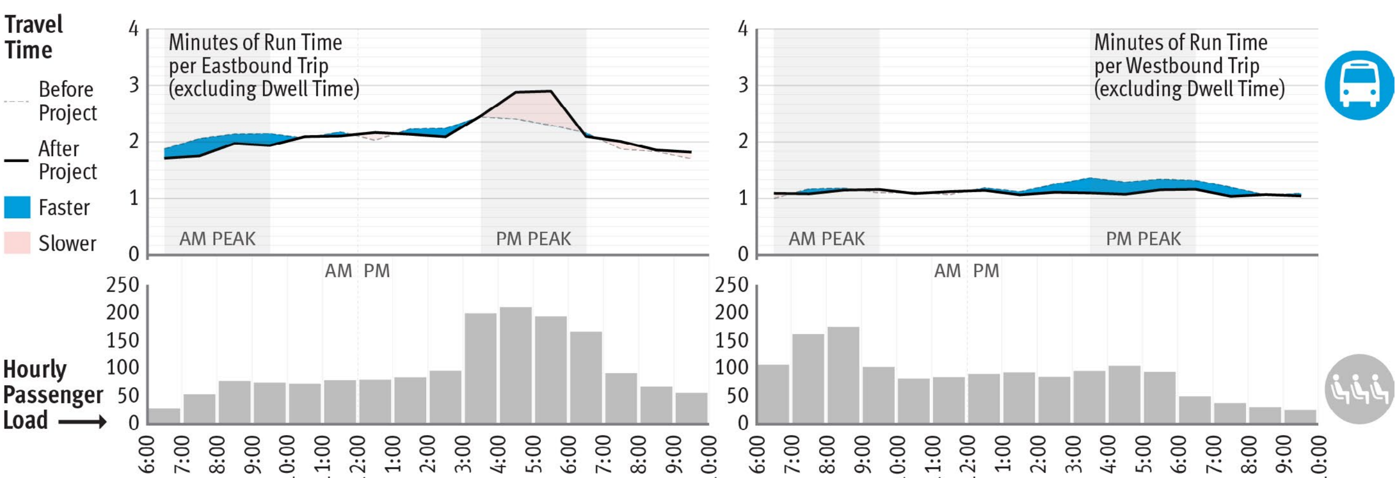
After:



Before (left) and after (right) showing the eastbound right-turn except bus lane that was installed at the intersection of Edmonds St and Kingsway in late 2020 (Google Street View).

The graphs below show that at Kingsway, the eastbound right-turn except bus lane pictured above improved bus run time in the morning, but there was an increase in run time in the afternoon, which can be attributed to high right-turn volumes in the shared lane (see left panel below).[40] The westbound transit approach lane improved travel time for buses in the afternoon (see right panel below).

Illustration of Travel Time Change at Eastbound Right-Turn Except Bus Lane and Westbound Transit Approach Lane on Edmonds St at Kingsway, Weekdays, Fall 2021 vs. Fall 2019

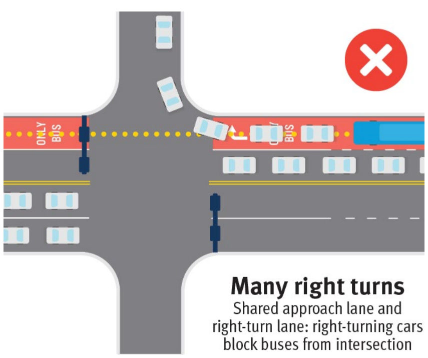


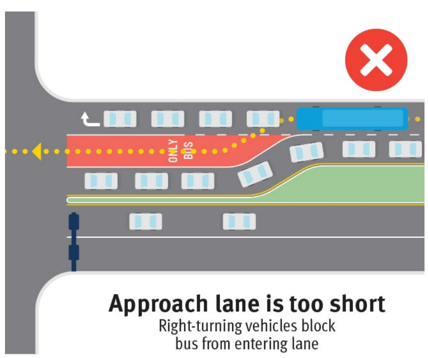
This graphic illustrates bus run times before implementation (dotted lines) compared to after implementation (solid lines), by hour. Blue shading highlights the run time improvement, while red shading indicates an increase. The grey bars below the graphs show the hourly passenger load (number of passengers on-board buses).

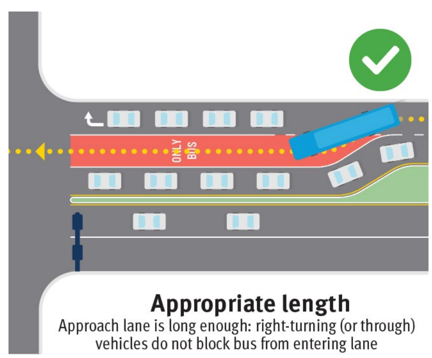
The westbound approach lane on Edmonds St at Kingsway is supported by a right-turn pocket, allowing buses to bypass queues and get through the intersection quickly.

The approach lane on Joyce St at Kingsway is supported by a right-turn pocket. Parking was removed to lengthen this pocket and minimize friction with buses. The project reduced average travel times by more than 30% all day.

Considerations for Future Projects







Both approach lanes and queue jumps must be long enough for buses to reach them before encountering congestion.

Particularly where there are many right-turning vehicles or pedestrians crossing the street, right-turn lanes can back up and prevent buses from getting to the front of the queue.

Project Highlights: In-Lane Bus Stops

In-lane bus stops improve travel times by up to approximately 15% and can pay back investments quickly.

In-lane stops allow buses to serve customers from the travel lane. They improve travel time and reliability by eliminating delays caused by merging into and out of the travel lane at bus stops. Bus bulbs extend the sidewalk areas out to the travel lane in locations with on-street parking. Travel time reduction may be appear as a reduction in run time or dwell time (waiting time at a stop) depending on bus operator behaviour and whether a bus is registered as at, or nearby, a stop.

Creating bus bulbs or filling in bus pullouts areas can provide more space for passengers waiting for the bus and make stops more accessible, safe, and visible for passengers. For example, along the R6 RapidBus corridor, infilling several bus pullout areas to make in-lane stops was necessary to accommodate a ramp for mobility devices.

Overview of In-Lane Bus Stops Project Performance

Overall, in-lane bus stops and bus bulbs contributed to reduced run time and dwell time along the routes they serve, as shown in the table below. The projects evaluated saved between 5-40 seconds (up to 16%) at different times of day. This is consistent with TransLink's Transit Priority Toolkit, which suggests peak savings of 15-30 seconds as a general rule-of-thumb.

Payback periods were as short as a few months. In general bus bulb cost-effectiveness will vary based on how permanent the construction materials are, and how many buses benefits from the improvement.

In-Lane Bus Stop Project Statistics

Map	Project Name	Sub-Region	Travel Time Change [1]		Cost/Benefit [2]
			Daily (6 a.m. to 10 p.m.)	AM/PM Peak	Payback Period (Years)
28	West 4th Ave bus bulbs	Vancouver/UBC	-14%	-16%	0.3
24	Robson St transit project	Vancouver/UBC	-8%	-8%	1.8
25	Lonsdale Ave bus bulbs at 4th St and 5th St	North Shore	-5%	-3%	> 20
26	Lonsdale Ave bus bulbs at 15th St	North Shore	-5%	0%	7.5
27	Bus pullout infills on 120 St	Southeast	0%	-4%	19.3

Notes: 1. Transit travel time change is a trip-weighted average calculated by hour from TransLink AVL data for the before and after time periods. 2. Costs are based on values provided by municipalities in funding applications, funding reallocations, or submitted invoices (if received). Some projects lacked sufficient cost data to estimate a payback period. Some of the projects listed were constructed using temporary/interim measures, while others may be more permanent and have different associated costs.

Project Highlight: West 4th Ave bus bulbs

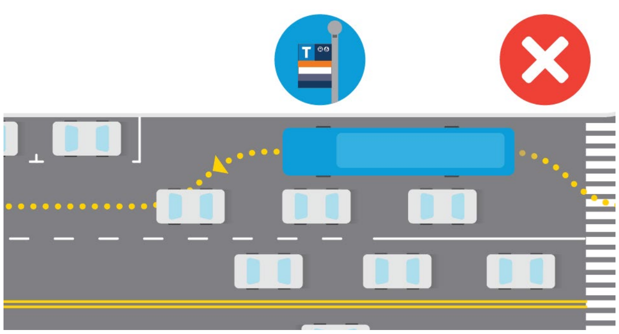
In 2022, TransLink partnered with the City of Vancouver to construct bus bulbs along West 4th Avenue. They reduced total dwell time at stops by 30% and total travel time by 10% to 20%—including both dwell time and run time—saving more than a minute at the weekday PM peak. Extending bus zones to accommodate more than one bus may also have contributed to reduced dwell times.

Considerations for Future Projects

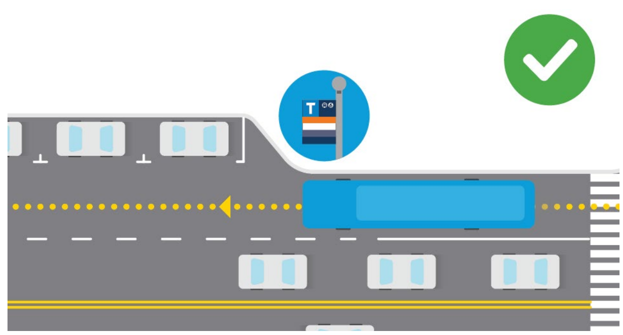
- Stops should be fully in-lane to eliminate time lost to bus merging in/out of traffic at stops.
- Bus bulbs preclude peak-hour bus lanes from operating in the parking lane.
- Savings at timing point stops—where bus operators may wait to get back on schedule—may be hard to measure and will rely on schedule tightening.
- Bus priority measures can have "co-benefits" beyond making buses faster and more reliable (see graphic below).
  - Bus bulbs improve safety by shortening pedestrian crossing distances and calming traffic. These should extend fully to the pedestrian crosswalk in order to "neck-down" the intersection.
  - They also support retail areas by expanding room for pedestrian activity, parking, loading and unloading, and landscaping, while acting as a complement to street patios.

Bus bulbs along West 4th Ave.

Bus bulb projects reduce the time buses spend merging into and out of traffic while also providing more room for people on the sidewalk, such as at Lonsdale Ave between 4th and 5th Streets.



Buses can be delayed when they need to pull to the curb to pick up passengers and then find a gap to re-enter traffic.



Bus bulbs not only enable buses to stop in-lane, they can enable other benefits such as improved amenities and safety.

Project Highlights: Signal Upgrades

Signal upgrade projects reduce travel time by up to 20% and typically pay back the investment in less than 5 years.

Upgrading traffic intersections can reduce wait times for buses at what are often hotspots for congestion. Interventions often take the form of left-turn or right-turn pockets that separate through-traffic and turning vehicles. These turn lanes can also be supported by distinct signal phases to clear queues of turning vehicles.

Signal upgrades that support overall flow of traffic, including buses that are turning alongside other vehicles, can improve bus performance. Turn pockets and signal phases can also be bus-only.

In "active" transit signal priority projects, the signal recognizes the presence of a bus, and either extends a green phase or shortens a red phase to support bus movement. In "passive" transit signal priority, multiple intersections along a corridor are timed to turn green at the speed of a typical bus, which also reduces bus wait times at red lights.

Overview of Signal Upgrade Project Performance

Signal upgrade projects decreased run time by up to 20%. The two bus-only signal upgrade projects were among the most effective: The Metrotown signal project reduced run-time by nearly 20% and the 18th Ave at Griffiths Dr project – which serves buses exiting the bus loop – reduced peak run times by 13%. These two projects had a payback period within 1-2 years.

Signal Upgrade Project Statistics

Map #	Project Name	Sub-Region	Travel Time Change [1]		Cost/Benefit [2]
			Daily (6 a.m. to 10 p.m.)	AM/PM Peak	Payback Period (Years)
32	Signal upgrade at Metrotown bus loop	Burnaby/New Westminster	-18%	-19%	1.8
29	Signal upgrade on NB Scott Rd at 84 Ave	Southeast	-15%	-7%	16.8
33	Signal upgrade on 18th Ave at Griffiths Dr	Burnaby/New Westminster	-11%	-13%	0.2
31	Signal upgrade at Marine/Keith/ Bewicke	North Shore	-9%	-9%	0.4
30	Signal upgrade on Lonsdale Avenue at East Esplanade	North Shore	-3%	-6%	1.8
34	Signal upgrades on W 15th St	North Shore	-2%	-2%	9.8

Notes: 1. Transit travel time change is a trip-weighted average calculated by hour from TransLink AVL data for the before and after time periods. 2. Costs are based on values provided by municipalities in funding applications, funding reallocations, or submitted invoices (if received). Some projects lacked sufficient cost data to estimate a payback period.

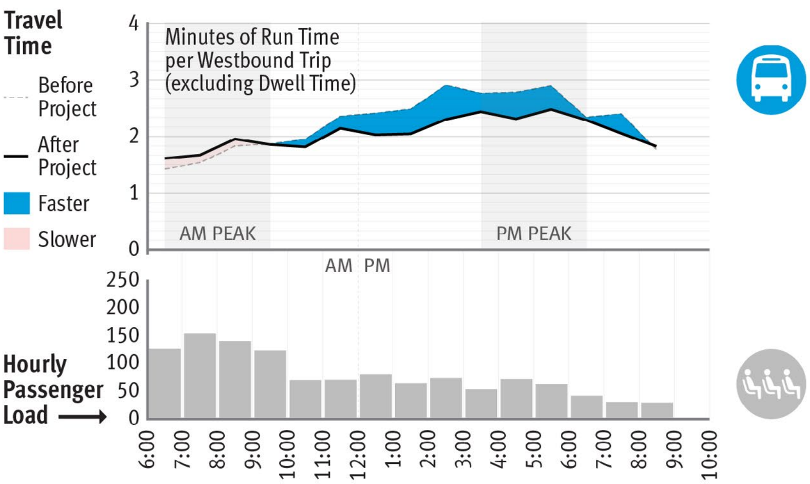
Project Highlight: Signal upgrade on NB Scott Rd at 84 Ave

Upgrading the traffic signal on Scott Road at 84th Ave to provide a northbound left-turn signal saves an average of 25 seconds per trip for Route 301, or 15% of average run time. This route connects Richmond and Surrey, including Kwantlen Polytechnic University.

When the City of Delta first installed the left turn signal in June 2019, transit buses were experiencing waits of up to 4 minutes to make the single left turn. Immediately after the change in signal operation, buses saved almost 2 minutes in travel time.

Although the project has continued to be effective overall, its benefits appear to have diminished by 2021. This may be due to additional vehicles on the road, including more vehicles taking advantage of the new signal— as travel times for general purpose vehicles along Scott Road increased by over 20% throughout the day. Nonetheless, the graphic below shows that bus run time improved for much of the day, especially in the afternoon and evening.

Travel Time Savings from NB Scott Rd & 84 Ave Signal Upgrade, Weekdays, Fall 2021 vs. Fall 2019



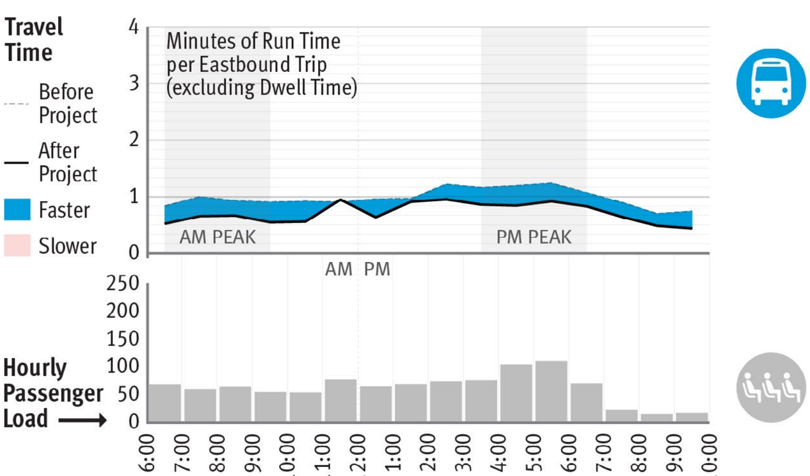
This graphic illustrates bus run times before implementation (dotted lines) compared to after implementation (solid lines), by hour. Blue shading highlights the run time improvement, while red shading indicates an increase. The grey bars below the graph show the hourly passenger load (number of passengers on-board buses).

Project Highlight: Signal upgrade at the Metrotown Bus Loop

A bus-only left-turn signal reduced run time by approximately 15% for eastbound buses turning left from Central Boulevard into the Metrotown bus loop, providing a consistent benefit averaging more than 10 seconds for approximately 2,000 bus trips every week. The City of Burnaby installed the signal and has periodically adjusted it to fine-tune the detection of buses, contributing to slightly improved performance over time. The signal also improved travel time for all vehicles by approximately the same amount, since left-turning buses no longer had to wait until the end of the green light to make the turn.

Bus-only left-turn signal into Metrotown bus loop.

Travel Time Savings from Bus-Only Left-Turn Signal at Metrotown Bus Loop, Weekdays, Fall 2021 vs. Fall 2019



This graphic illustrates bus run time before implementation (dotted line) compared to after implementation (solid line), by hour. Blue shading highlights the run time improvement. The grey bars below the graph show the hourly passenger load (number of passengers on-board buses).

Considerations for Future Projects

- Bus-only upgrades that target frequent bus corridors will pay back faster.
- Buses do benefit from intersection improvements that benefit all traffic, but transit-priority signals are more likely to have lasting benefits.
- Left-turn pockets can also improve intersection throughput, reducing delay for buses and other motorists.

Project Highlights: Turn Restrictions

Turn restrictions can improve bus travel times >5% at a low cost.

Turn restrictions, similar to turn pockets, remove locations where vehicles obstruct buses' movements, forcing them to wait or merge. Where there is one through lane, left-turn restrictions may have the most significant benefit for buses as vehicles can wait for an entire signal phase before turning. Right-turn restrictions can support buses when they are travelling in the curb-side lane, especially at locations with heavy pedestrian volumes.

Overview of Turn Restriction Project Performance

Left-turn restrictions on Robson Street contributed to a decrease in run time of nearly 10%—saving up to 16 seconds and complementing bus bulbs on the same corridor.

Signal Upgrade Project Statistics

			Travel Time Change [1]		Cost/Benefit [2]
Map	Project Name	Sub-Region	Daily (6 a.m. to 10 p.m.)	AM/PM Peak	Payback Period (Years)
35	Turn restrictions on Robson St	Vancouver/UBC	-9%	-6%	[3]

Notes: 1. Transit travel time change is a trip-weighted average calculated by hour from TransLink AVL data for the before and after time periods. 2. Costs are based on values provided by municipalities in funding applications, funding reallocations, or submitted invoices (if received). Some projects lacked sufficient cost data to estimate a payback period. 3. Robson Street turn restrictions project may include some run-time benefits from stop consolidation, implemented concurrently, which could not be isolated as a separate project.

Considerations for Future Projects

- Turn restrictions can bring low-cost benefits to both buses and general purpose traffic and complement other transit priority measures along a corridor.
- Each restriction may lead to higher traffic volumes elsewhere. They are best implemented with a corridor perspective, including in tandem with left-turn pockets at nearby intersections.
- All modes of transportation should be considered to identify conflicts.
- Right-turn restrictions in particular can benefit pedestrian and cyclist safety along a roadway, and should be considered at high volume intersections.
- The BSR Program is prepared to fund, and learn from, more projects like these.

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