Corridor Optimization + Rider Experience
Enhancing streets for transit and people

BEST PRACTICES TOOLBOX
JUNE 2023
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INTRODUCTION
INTRODUCTION

DART bus riders, many of whom rely on the service for their daily needs, often experience delays and unreliable travel times as a result of their bus being stuck in traffic or delayed at an intersection.

DART bus service is not just essential for the daily needs of riders, but plays a critical role in supporting the mobility plans, comprehensive plans, and safety plans of service area cities. By providing access to opportunity and supporting a healthy economy and quality of life, bus service is a vital component of the local and regional mobility network.

However, to fully realize the benefits of bus-based mobility, we need to recognize its value and invest in streets to enhance the role of transit and move buses and people more effectively. The Bus Corridor Improvement Program, referred to as CORE (Corridor Optimization + Rider Experience), is designed to promote transit priority within key bus corridors, enhance operational efficiency, and increase ridership by improving the customer experience.

The initial phase of the CORE program focuses on DART’s 22 Frequent Routes and leverages a data-driven, stakeholder-informed, and partnership-oriented methodology. By aligning with DART and partner goals and objectives and drawing on best practices from other metropolitan areas that have made bus speed and reliability a priority, CORE provides a powerful approach to enhancing bus service.

By taking action and supporting the development and implementation of CORE, we can help make a real difference in the lives of DART riders and the communities we serve. With buses capable of carrying over 40 passengers at any given time, let’s ensure that this critical mode of transportation reaches its full potential and continues to support the needs of our growing service area.
What are Bus Corridor Improvements?

The CORE program includes these three primary focus areas:

**TRANSIT PRIORITY TREATMENTS**
Traffic management strategies that allow buses to bypass traffic congestion and improve their travel time and reliability. Examples of transit priority treatments include bus lanes, signal priority, and queue jump lanes.

**CONNECTIVITY AND SAFETY**
Improving access to bus stops, reducing conflicts and enhancing safety for cyclists and pedestrians along bus corridors.

**ADDITIONAL MOBILITY IMPROVEMENTS**
Corridor enhancements that align with and support local jurisdictions and community goals and objectives.

Why Make Bus Corridor Improvements?

To make transit service on DART’s busiest corridors faster and more reliable, and to offer an improved customer experience that will attract more riders. In addition, these improvements will:

- **Enhance** the attractiveness and competitiveness of public transit as a mode of transportation, which can encourage more people to use it instead of driving alone.
- **Reduce** vehicle miles traveled (VMT) and greenhouse gas emissions by shifting trips from private cars to buses, which have lower per capita environmental impacts.
- **Improve** mobility and accessibility for all, but with an emphasis on transit-dependent individuals who rely on buses for their daily needs.
- **Support** economic development and social equity by connecting people to jobs, education, health care, and other opportunities across the region.

To benefit not only transit riders but also drivers, pedestrians, cyclists, businesses, and the environment by supporting more livable, sustainable, and inclusive communities.
DESIRED OUTCOME

Promote transit priority within key corridors to improve the rider experience, enhance efficiency and increase ridership

CORE GOALS

Enhance Speed & Reliability
Coordinate with service area cities to prioritize and implement speed and reliability improvements
Estimate benefits and measure against performance standards

Improve Operational Safety
Reduce conflicts between corridor users

Improve Access & Connectivity
Identify and deploy bike and walk safety upgrades for better transit access

IDENTIFYING BEST PRACTICES

To identify the most appropriate actions DART and service area cities can take to develop and implement transit priority treatments, a nationwide scan of best practices was completed. This scan found a range of approaches with strong collaboration between the transit agency and service area cities being the most essential common ingredient.

Best Practice Examples include:

- Help DART buses get ‘unstuck’ from traffic
- Maximize person throughput on DART’s busiest corridors
- Improve the rider experience

Seattle
NYC
Charlotte
Chicago
Denver
Portland
Vancouver BC
2

TRANSIT PRIORITY TREATMENTS
POTENTIAL TRANSIT PRIORITY TREATMENTS

Based on the nationwide best practices review, four categories of potential transit priority treatments are recommended, including:

**STREET AND INTERSECTION DESIGN**
Tools that improve speed, safety, access and reliability through the physical design of streets and intersections.

**BUS STOPS AND ROUTING**
Tools that improve speed and reliability through stop location and spacing.

**TRAFFIC REGULATIONS**
Transit-beneficial operational modifications that require minimal capital investment, including, when necessary, enforcement.

**TRAFFIC SIGNALS**
Tools that modify signal timing, phasing, and indications to improve bus speed and reliability.

*Categories derived from King County Metro Transit Speed and Reliability Guidelines and Strategies, August 2021.*
## POTENTIAL TREATMENTS OVERVIEW

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<thead>
<tr>
<th>STREET AND INTERSECTION DESIGN</th>
<th>GOALS</th>
<th>CONSIDERATIONS</th>
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<td>Enhanced Speed &amp; Reliability</td>
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<td>Dedicated Bus Lane</td>
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<td>Queue Bypass (Short Bus Lane)</td>
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<td>Roadway Channelization</td>
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STREET AND INTERSECTION DESIGN

Tools that improve speed and reliability through the physical design of streets and intersections
DEDICATED BUS LANE

Dedicated bus lanes are a portion of the street designated by signs and markings for the preferential or exclusive use of transit vehicles, sometimes permitting limited use by other vehicles.

Figure 1: Dedicated Bus Lane Example from NACTO

DEDICATED BUS LANE EXAMPLE

Houston METRO has implemented dedicated bus lanes that improve transit speed and reliability. They have also included an additional lane that promotes ridesharing by dedicating the lane to buses and high-occupant-vehicles (HOV).

- Implemented on Travis Street from Gray St. to Commerce St. in Downtown Houston
- Implemented in 2005

The red striping and markings provide visual instruction to road users. These red lanes improve traffic flow by having designated lanes for public transit vehicles, and they can also improve safety for drivers, cyclists, and pedestrians.

BUS CORRIDOR TREATMENT RATING

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<td>Improve Access &amp; Connectivity</td>
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Queue Bypass or short bus lanes, allow transit vehicles to bypass long queues that form at major cross streets.

MTA in New York City initiated the Better Buses Restart initiative in 2020 which resulted in over 16 miles of new dedicated bus lanes.

Queues along W 86th Street approaching Central Park West during peak hours often prevented the bus from accessing the stop.

The queue jump lane at E 86th Street at the approach to 5th Avenue provides a better positioning for buses. The design of the lane created channelization that reduced the general travel lanes to a single lane to further prioritize bus movements.

86th Street is part of MTA’s Select Bus Service, their bus rapid transit (BRT) network. Customer travel times typically improve 10-20% along corridors with priority treatments.

**BUS CORRIDOR TREATMENT RATING**

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**TYPICAL APPLICATION**

At the approaches to signalized intersections via separate lane and transit signal.

**POTENTIAL BENEFITS**

Allow transit vehicles to bypass general vehicle queues and right-turn queues.

**CHALLENGES**

Subject to encroachment due to double-parking, deliveries, or taxicabs. Strict enforcement is necessary to maintain their use and integrity.

**Figure 2:** Queue Bypass Example from NACTO
ROADWAY CHANNELIZATION

Roadway channelization for buses helps by having different lanes serve a specific purpose, such as having bus-only lanes.

**ROADWAY CHANNELIZATION EXAMPLE**

New York City implemented several improvements to the Sheepshead Bay Road Corridor to improve safety. Some of the improvements will also aid bus services such as creating channelized roadways to increase bus reliability.

**TYPICAL APPLICATION**
Can be implemented on any transit corridor served by bus or other forms of transit such as streetcars.

**POTENTIAL BENEFITS**
- Allows buses to safely and conveniently move into specific lanes.

**CHALLENGES**
Conflicts with other road users can occur causing delay.

**BUS CORRIDOR TREATMENT RATING**
- Enhance Speed & Reliability: Low
- Improve Safety: Medium
- Improve Access & Connectivity: High
TURN RADIUS IMPROVEMENTS

Transit vehicles typically require an effective turning radius of approximately 20–30 feet depending on lane width and presence of curbside parking lanes.

**Figure 4: Turn Radius Improvement Example from NACTO**

**TURN RADIUS IMPROVEMENTS EXAMPLE**

The City of St. Paul has developed a new streets design manual that calls out specific designs for curb radii that considers turning movements of buses and how to effectively design turns that won’t impede on bus travel.

**TYPICAL APPLICATION**

At the approaches to signalized intersections.

**POTENTIAL BENEFITS**

Curb extensions typically reduce pedestrian crossing distances.

**CHALLENGES**

May have to use part of the oncoming travel lane and/or move stop bar to accommodate for the wide turn.

**BUS CORRIDOR TREATMENT RATING**

- **Enhance Speed & Reliability**: ♦
- **Improve Safety**: ♦
- **Improve Access & Connectivity**: ♦

**Typical Curb Radius - Signalized Intersection**

20' standard curb radius

**4-lane Signalized Intersection**

Bus turns into inside lane.
SPEED HUMP MODIFICATIONS

Modifications to speed humps include speed humps that have wheel cut-out openings to allow large vehicles like buses to pass unaffected while continuing to reduce car speeds.

**Figure 5:** Speed Hump Modification Example from NACTO

### TYPICAL APPLICATION

On roadways that have or need traffic-calming measures.

### POTENTIAL BENEFITS

Reduces speeds for vehicles while minimizing impacts and reducing wear and tear on buses.

### CHALLENGES

Requires coordination with city to construct.

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**SPEED HUMP MODIFICATIONS EXAMPLE**

The City of Cincinnati installed temporary speed cushions on Winneste Avenue as a pilot project. The speed cushions help reduce traffic speed and increase pedestrian safety while having minimal delay to transit operations.

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
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<tbody>
<tr>
<td>Percentage of Vehicles Speeding</td>
<td>95%</td>
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<tr>
<td>Average Speed</td>
<td>37 mph</td>
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<td>Percentage of Vehicles Exceeding 40 mph</td>
<td>25%</td>
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**BUS CORRIDOR TREATMENT RATING**

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- **Enhance Speed & Reliability**: ◆
- **Improve Safety**: ◆
- **Improve Access & Connectivity**: ◆
Tools that improve speed and reliability through stop location and spacing
BUS STOP LOCATION OPTIMIZATION

Relocation or consolidation of bus stops to optimize placement and minimize delay while considering pedestrian accessibility.

**TYPICAL APPLICATION**

On bus corridors where very close stop placement results in excessive bus delay.

**POTENTIAL BENEFITS**

Improve bus flow, speed and reliability.

**CHALLENGES**

Bus stop siting and relocation can raise rider and neighborhood concerns.

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**BUS STOP LOCATION OPTIMIZATION EXAMPLE**

Chicago Transit Authority (CTA) conducted a study on bus stop spacing for corridors where transit service was modified.

Stop consolidation and the introduction of the express routes led to time savings of 5-7% for both local and express routes.*

ROUTE DESIGN

Simple, direct routing on arterials without major deviations or loops simplifies the system and reduces travel times, may be paired with first/last mile improvements for accessibility.

ROUTE DESIGN EXAMPLE

Dallas Area Rapid Transit (DART) completed a major restructuring of their entire bus network, and made it operational in January 2022. Overall DART streamlined routes, and significantly expanded on-demand service (Go Link). By making the new bus routes more direct, focusing on major transit corridors, and reducing the number of bus stops, DART bus service is faster, ensuring passengers get to their destinations quicker and improving connections.

- With the implementation of this new service, 74% of DART service-area residents have access to transit services within walking distance.
- The new service increases the number of jobs that an average resident of the DART Service Area can reach in one hour by 34% compared to the prior bus network.

TYPICAL APPLICATION
Systemwide where feasible.

POTENTIAL BENEFITS
Fewer turning movements improves travel times and makes the system more legible for customers.

CHALLENGES
High ridership locations may not be along arterials, requiring route deviations.

BUS CORRIDOR TREATMENT RATING

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- Enhance Speed & Reliability: ♦ ♦
- Improve Safety
- Improve Access & Connectivity

Figure 7: Bus Route Example from NACTO

DART BEST PRACTICES TOOLBOX

DART BEST PRACTICES TOOLBOX
**BUS STOP LENGTHENING**

Short transition distances into bus stop areas or pullouts add delay to transit service and require sharper transitions to the curb.

**BUS STOP LENGTHENING EXAMPLE**

New York MTA removed several bus stops along its B38 route to accommodate the transition to longer buses. With this they also updated some of the stops to be longer to accommodate the longer buses. The longer buses will make the route more efficient by carrying more people.

![Bus Stop Lengthening Example](image)

**Figure 8: Bus Stop Lengthening Example from NACTO**

**TYPICAL APPLICATION**

Applicable where sharp entry/exit angles slow entry or exit.

**POTENTIAL BENEFITS**

Longer stops ease transitions into and out of stops. Can be used to distribute queuing riders along the sidewalk.

**CHALLENGES**

Require more curb length, reduces curbside parking spots.

**BUS CORRIDOR TREATMENT RATING**

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**Figure 8:** Bus Stop Lengthening Example from NACTO

**Figure 9:** TYPICAL APPLICATION & POTENTIAL BENEFITS

**Figure 10:** CHALLENGES

**Figure 11:** BUS CORRIDOR TREATMENT RATING

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**DART BEST PRACTICES TOOLBOX**
**BUS BULBS**

Bus bulbs are permanent sidewalk extensions that allow buses to pull up to the curb without leaving the travel lane, saving valuable time.

**BUS BULB EXAMPLE**

A study conducted by the City of New Jersey looked at the benefits a bus bulb would have on transit travel times. The study concluded that bus travel time savings as a result of the bus bulbs ranged between 15 and 30 seconds per bus stop.

**TYPICAL APPLICATION**

Applicable in both dedicated and mixed-traffic conditions for locations where buses are delayed re-entering travel lanes.

**POTENTIAL BENEFITS**

Reduces travel delay and boarding delay, by eliminating transition movements into and out of bus stop areas. This also acts as a curb extension to shorten pedestrian crossings.

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**CHALLENGES**

Traffic buildup behind transit vehicles.
BOARDING ISLANDS

Boarding island stops provide dedicated space for transit passengers and amenities while maintaining a clear pedestrian path on the sidewalk, and/or bicycle lane behind the island.

Figure 10: Bus Boarding Island Example from NACTO

TYPICAL APPLICATION

Applicable on streets with center-running transit, or on routes where high-volume bike lanes are in place.

POTENTIAL BENEFITS

Reduces transit vehicle dwell times, provides a refuge area for pedestrians crossing the street, and minimizes bus/bike conflicts at stops.

CHALLENGES

Right-of-way limitations can restrict feasibility.

BOARDING ISLANDS EXAMPLE

In partnership with TriMet, PBOT installed two types of temporary platforms. The first platform removes the conflict with the bike lane making it safer for bicyclist traveling in the bike lane. They also installed a temporary asphalt platform to assist in boarding of buses.
Transit-beneficial operational modifications that require minimal capital investment, including, when necessary, enforcement.
TURN RESTRICTIONS/EXEMPTIONS

Prohibiting automobile turns (primarily left-turns) where there are no dedicated turn lanes that would present issues to efficient bus movement or pedestrian access, and shifting turn volume to the intersections where they can be best accommodated using signal phases and turn lanes.

Figure 11: Turn Restriction Example from NACTO

TYPICAL APPLICATION
Urban roadways, gridded road networks.

POSSIBLE BENEFITS
Improve transit performance, general traffic performance, and walking and bicycling safety.

CHALLENGES
May be viewed as an inconvenience by motorists.

BUS CORRIDOR TREATMENT RATING
Enhance Speed & Reliability
Improve Safety
Improve Access & Connectivity

TURN RESTRICTIONS/EXEMPTIONS EXAMPLE

As part of the Geary Blvd. Improvement Project, SFMTA proposed left-turn restrictions at some intersections to reduce conflicts between vehicles and people walking and improve traffic safety by increasing driver visibility and providing space for larger center median pedestrian refuges.
PARKING REMOVAL/ALTERATIONS

The removal of parking completely or removal of parking spots is sometimes necessary to implement transit measures such as bus lanes.

**PARKING REMOVAL/ALTERATIONS EXAMPLE**

San Francisco and SFMTA have implemented a project throughout the city to remove over 1,000 on-street parking spots to improve the safety and speed of bus boarding.

**TYPICAL APPLICATION**

Urban roadways where bus lanes or transit lanes are planned.

**POTENTIAL BENEFITS**

Allow spaces for bus lanes and transit lanes as well as bus stop improvements.

**CHALLENGES**

Stakeholder perceptions regarding loss of parking.

**BUS CORRIDOR TREATMENT RATING**

- **Enhance Speed & Reliability**: Low
- **Improve Safety**: Low
- **Improve Access & Connectivity**: Medium

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**Figure 12**: Parking Removal/Alterations Example from NACTO
Tools that modify signal timing, phasing, and indications to improve bus speed and reliability.
PASSIVE TRAFFIC SIGNAL RETIMING

Traffic signal modification to create “green wave” for buses.

Figure 13: Passive Traffic Signal Retiming Example from NACTO

TYPICAL APPLICATION
Urban roadways with frequent signalized intersections.

POTENTIAL BENEFITS
Reduces dwelling time stopped at signalized intersections and bus delay.

CHALLENGES
Signal timing without consideration of dwell times at bus stops can further cause bus dwell time at intersections.

PASSIVE TRAFFIC SIGNAL RETIMING EXAMPLE

Metropolitan Transportation Commission in California has created the Program for Arterial System Synchronization (PASS) to coordinate with the city on signal timing to improve traffic flow, address safety concerns, prevent stop delays and cut down on air pollution.

PASS BENEFITS

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<tr>
<th>Benefit</th>
<th>Description</th>
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<tbody>
<tr>
<td>Travel time savings</td>
<td>23%, or more than 3.2 million hours</td>
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<tr>
<td>Fuel consumption savings</td>
<td>16%, or over 3.1 million gallons</td>
</tr>
<tr>
<td>Average auto speed increase</td>
<td>38%</td>
</tr>
<tr>
<td>Total emissions reduction</td>
<td>124 tons</td>
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<tr>
<td>Total project costs</td>
<td>$1.4 million</td>
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<tr>
<td>Total lifetime benefits</td>
<td>$86.2 million</td>
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<td>Overall benefit-cost ratio</td>
<td>61:1</td>
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Low | Medium | High
TRANSIT SIGNAL PRIORITY (ACTIVE)

Transit Signal Priority (TSP) tools modify traffic signal timing or phasing when transit vehicles are present, and can work on thru, left-, and right-turning movements.

Figure 13: Transit Signal Priority Example from NACTO

TYPICAL APPLICATION

Urban roadways with significant traffic and transit volumes.

POTENTIAL BENEFITS

Reduces bus delay and enhances service reliability.

CHALLENGES

Requires coordination with city and bus and signal technology integration.

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Enhance Speed & Reliability: High
Improve Safety: Medium
Improve Access & Connectivity: Low

TRANSIT SIGNAL PRIORITY (ACTIVE) EXAMPLE

SamTrans (California) is implementing a TSP project on its El Camino Real transit route. This project will improve SamTrans’ on-time performance by reducing bus delays at intersections in order to provide more reliable service. This project will also have negligible impacts to cross streets.

Combined with other measures, 15 to 20 minutes in travel time savings could result from implementing TSP as one of the measures.

In NYC, TSP has reduced bus travel times about 14% during weekday peak morning and evening commuting periods.
**SIGNAL MODIFICATIONS**

Intersections updated with shorter signal cycles reduce net delay to transit vehicles, especially at near-side stop locations, or across freeway corridors where frontage roads exist, may also include protected left-turn movements at signalized intersections where they are currently unprotected.

**SIGNAL PHASE MODIFICATION EXAMPLE**

NYC has created a program to implement shorter traffic signal phases to reduce delay to transit buses. In addition to these shorter phases, the city has also installed other traffic signal measures such as the leading pedestrian signal to promote pedestrian safety.

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**TYPICAL APPLICATION**

On signalized streets with frequent transit service, in mixed-traffic or dedicated lanes.

**POTENTIAL BENEFITS**

Reduce delay at intersection for buses and other users such as pedestrians.

**CHALLENGES**

Need to accommodate pedestrian clearance times and crossing distance.
NEW SIGNAL INSTALLATION

New signal installation can help in phasing out older signals with new modern traffic signals to promote Transit Signal Progression.

NEW SIGNAL INSTALLATION EXAMPLE

Nashville MTA completed several intersection upgrades along Murfreesboro Pike, one of its busiest corridors. The improvements included technology enabled to help smooth traffic flow and allow WeGo (Nashville’s transit system) buses to improve their on-time performance.

BUS CORRIDOR TREATMENT RATING

- **Enhance Speed & Reliability**: Medium
- **Improve Safety**: Medium
- **Improve Access & Connectivity**: Medium

TYPICAL APPLICATION

Typically, when intersections are reconstructed.

POTENTIAL BENEFITS

- Improve bus reliability, reduce delay.

CHALLENGES

- Can be competing priorities for signal ‘share’.

**Figure 15**: TSP signal Example from NACTO
Queue Jumps allow buses to easily enter traffic flow in a priority position.

**Queue Jumps Example**

To keep buses moving, King County Metro added a queue jump at the intersection at Interurban Ave. S. and 52nd Ave. S. Buses and right-turning vehicles now share the right lane. Just before southbound traffic gets a green light, the queue jump signal is activated, and buses can go through the intersection before other vehicles.

- Morning commute times saw a 5% improvement in on-time performance
- Morning and afternoon commute trips saw up to an 8-second travel time improvement

**TYPICAL APPLICATION**

On signalized streets with moderately frequent bus routes.

**POTENTIAL BENEFITS**

Significantly reduce bus delay at signalized intersections.

**CHALLENGES**

Right-turn lanes can pose an issue.

**BUS CORRIDOR TREATMENT RATING**

<table>
<thead>
<tr>
<th>Enhance Speed &amp; Reliability</th>
<th>Improve Safety</th>
<th>Improve Access &amp; Connectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Medium **</td>
<td>High **</td>
</tr>
</tbody>
</table>

Figure 16: Queue Jump Example from NACTO
SUMMARY
SUMMARY

• National scan of transit priority treatments indicates a wide range of methods exist to improve bus speed and reliability and enhance the customer experience.

• Case study examples demonstrate benefits and cost-effectiveness of transit priority treatments when well-planned and implemented.

• Careful analysis of bus corridors and ‘hot spots’ needed to identify most promising alternatives.

• Pilots and demonstration projects can help build support and demonstrate efficacy.