

# **TRANSIT PREFERENTIAL STREETS PROGRAM SOURCEBOOK**

Guidelines for Implementing Transit Preferential Streets Measures



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This document was prepared to complement the Transit Preferential Streets Program Final Report.

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# Compatibility Matrix

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The following Compatibility Matrix summarizes all of the Transit Preferential Streets measures illustrated in this document. The matrix also characterizes each measure's relationship to other measures described in the sourcebook. Certain measures are designed to work well together (e.g., *Queue Bypass* and *Queue Jump*) while other measures are mutually exclusive (e.g., *Curb Extensions* and *Exclusive Bus Lane*).

Compatibility Matrix

	Signal Priority	Curb Extensions	Boarding Islands	Queue Bypass	Queue Jump	Bus Stop Consolid.	Bus Stop Relocation	Exclusive Bus Lane	Parking Restriction	Timing or Phasing Change	Low-floor Techn.	Fare Collection Change	Turning Restriction Exemption
Signal Priority	•	-	-	-	×	-	✓	-	-	-	-	-	-
Curb Extensions	-		×	×	×	-	-	×	×	-	-	-	-
Boarding Islands	-	×		×	×	-	-	-	-	-	-	-	-
Queue Bypass	-	×	×		✓	-	-	-	-	-	-	-	-
Queue Jump	×	×	×	✓		-	×	-	-	✓	-	-	-
Bus Stop Consolid.	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Stop Relocation	✓	-	-	-	×	-	-	-	-	-	-	-	-
Exclusive Bus Lane	-	×	-	-	-	-	-	□	✓	-	-	-	-
Parking Restriction	-	×	-	-	-	-	-	✓	□	-	-	-	-
Timing or Phasing Change	-	-	-	-	✓	-	-	-	-	□	-	-	-
Low-floor Techn.	-	-	-	-	-	-	-	-	-	-	□	-	-
Fare Collection Change	-	-	-	-	-	-	-	-	-	-	-	□	-
Turning Restriction Exemption	-	-	-	-	-	-	-	-	-	-	-	-	□

Legend: ✓ best if coupled with; - unrelated; × non compatible

# Traffic Signal Priority

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## **Type:**

Operational

## **Range:**

Local to System-wide

## **Applicability:**

- Intersections where buses experience extensive signal timing delay.

## **Benefits:**

- Increases transit operating speed by reducing signal timing delay.
- Improves on-time performance.

## **Conditions:**

The controlled intersection should be operating at less than saturation capacity, where occasional timing or phasing changes will not significantly degrade the level of service.

Reliable communication between buses and traffic signal controllers - without increasing bus drivers' work loads - is a necessity. Therefore, an appropriate communication system between vehicle and way-side controller is essential. Several priority systems have been studied by Tri-Met, but for a variety of reasons most studies were inconclusive. Many third party systems are available, including systems that can relay information from buses equipped with an automatic vehicle location (AVL) system directly to the signal controller.

## **Experience/Results:**

Initial analysis of installations in San Francisco showed a reduction in signal timing delay of between 14% and 25%, even with a mechanical transit vehicle detection device failure rate ranging from 10% to 40%.

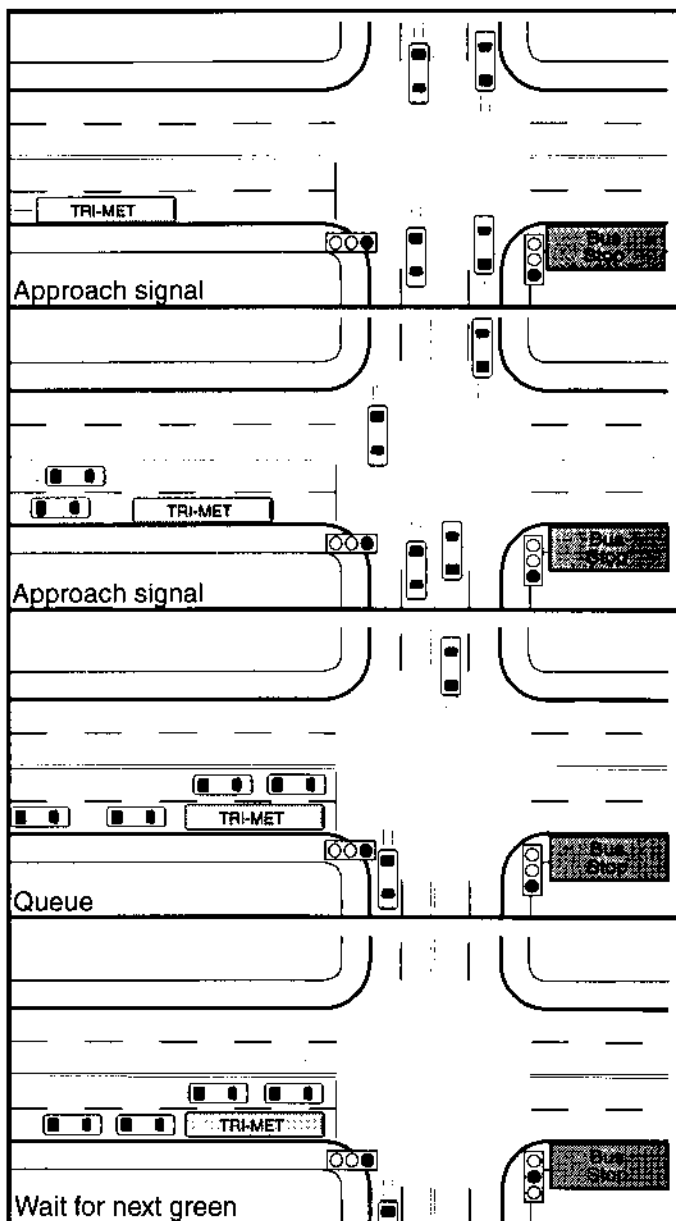
In the Portland area, Tri-Met's latest study of a bus signal priority pilot project on Tualatin Valley Highway (T.V. Highway) from S.W. Murray Boulevard through S.W. 234th Street shows bus travel time savings ranging from 1.4% to 6.4% for one direction, and 6.4% for both directions combined. These travel time savings correspond to traffic signal delay reductions ranging from 19.6% to 20.3% for one direction, and a two-way average of 20.0%.

## **Caveats:**

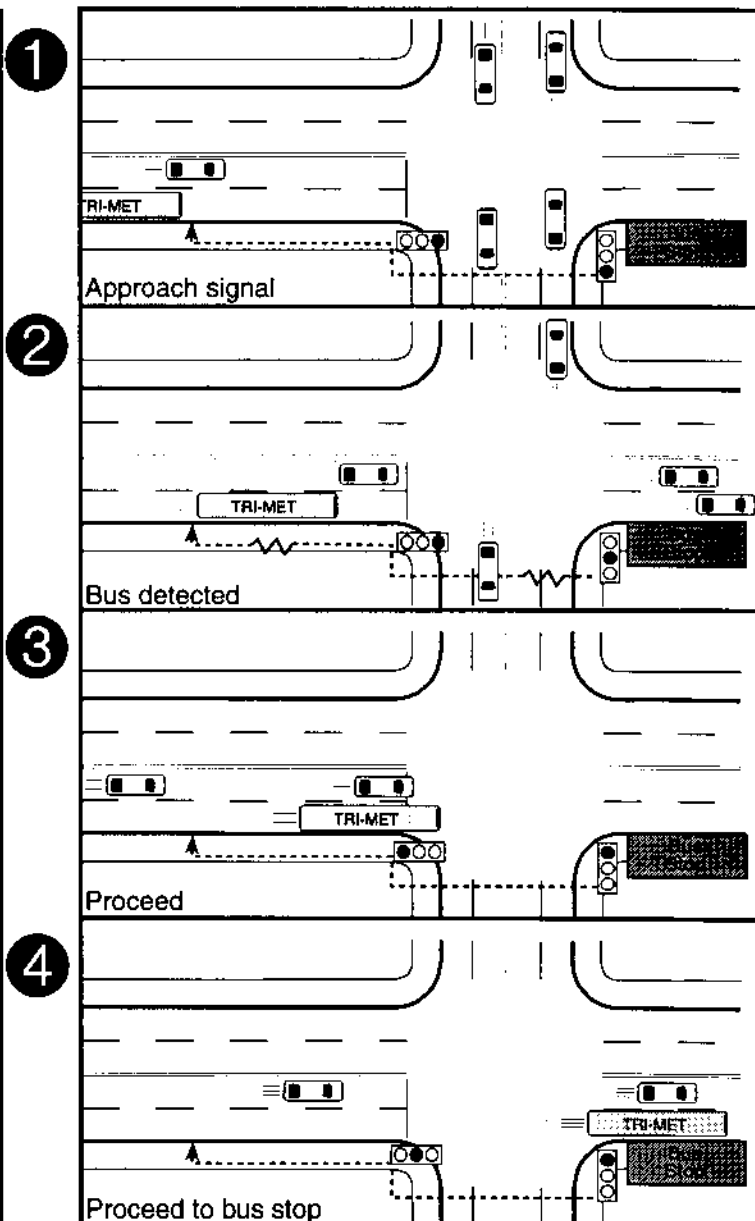
- Risk of interrupting coordinated traffic signal operation.
- Potential degrading of traffic signal level of service (especially if affected intersection is saturated).
- Requires continued inter-jurisdictional and inter-agency coordination and agreement on priority treatment system and strategy.

**Description:** Transit vehicles are detected as they approach an intersection. Upon receiving a priority call from a transit vehicle, the traffic signal controller either terminates conflicting phases early without violating pedestrian clearance intervals (“early green”) or extends the current green phase (“green extension”).

**Before**



**After**



# Curb Extensions (Bus Bulbs)

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Physical

**Range:**

Local

**Applicability:**

- Locations where buses experience high dwell delay when merging back into the travel lane after servicing the bus stop.
- Locations with inadequate pedestrian space.

**Benefits:**

- Increases transit operating speed by eliminating the need for merging into traffic.
- Increases boarding comfort.
- Increases riding comfort by eliminating the need for the bus to turn in and out of the stop.

- Increases available on-street parking by eliminating the need for the taper typically required for pullouts and bus zones.
- Increases space for additional pedestrian and transit rider amenities.
- Reduces street crossing distances for pedestrians.

**Conditions:**

- Suitable for roadways with on-street parking.

**Experience/Results:**

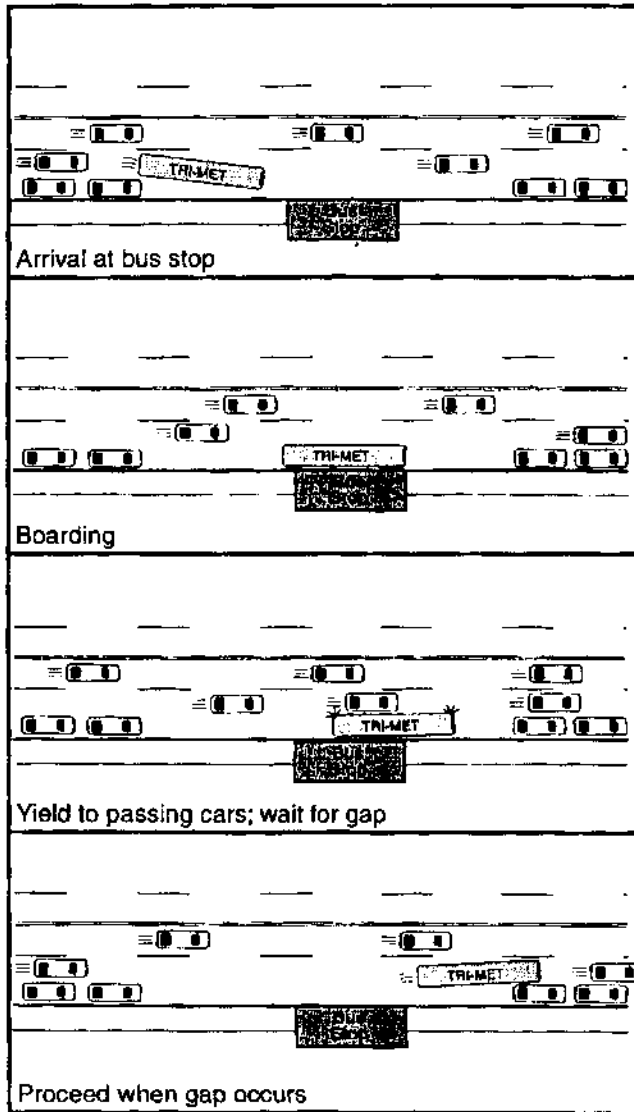
- Positive experience in Portland and other areas.

**Caveats:**

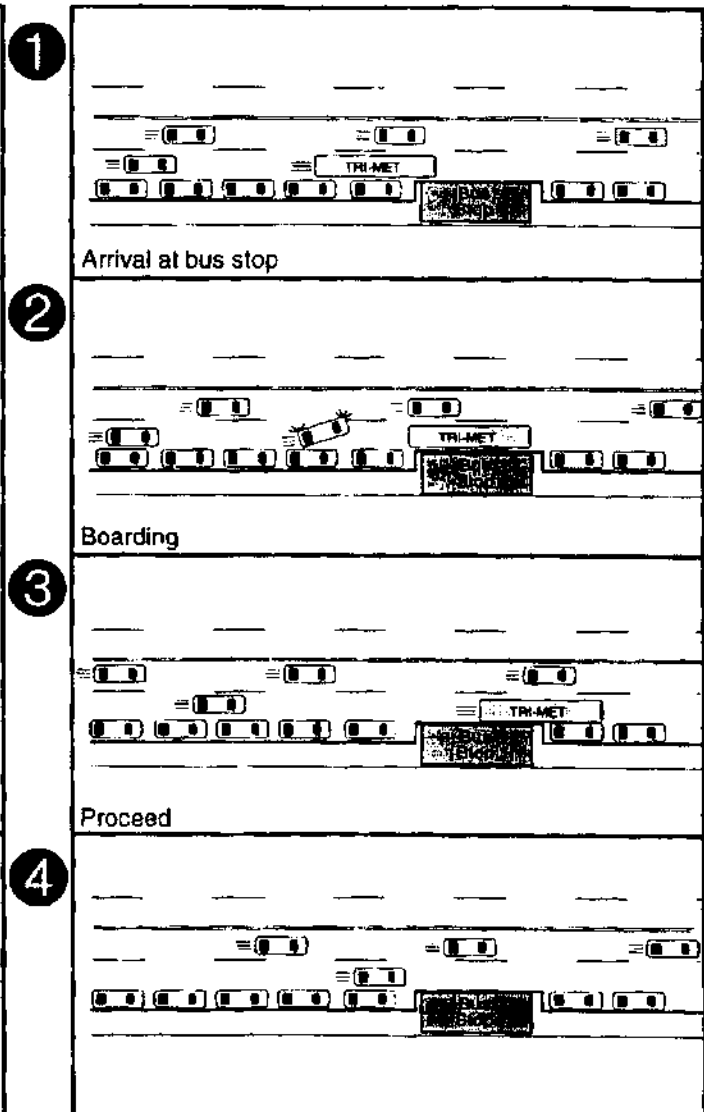
- Requires at least two travel lanes in the bus's direction of travel to allow other vehicles to pass the bus while it is stopped in the rightmost travel lane.

*Description: Curb extensions create a "bulb" at a bus stop, usually the width of the parking lane, bringing the curb to the edge of the travel lane for passenger boarding and de-boarding.*

**Before**



**After**



# Boarding Islands

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Physical

**Range:**

Local

**Applicability:**

- Areas with high side friction caused by right-turning vehicles waiting at a crosswalk, delivery vehicles, parking maneuvers, etc.

**Benefits:**

- Increases transit operating speed by allowing buses to use the faster-moving left lane.

**Conditions:**

- The roadway must have at least two travel lanes in each direction, with a significant difference between left- and right-lane travel speed.
- There must be sufficient right-of-way to accommodate the introduction of the boarding island.

**Experience/Results:**

- Positive experience in San Francisco.

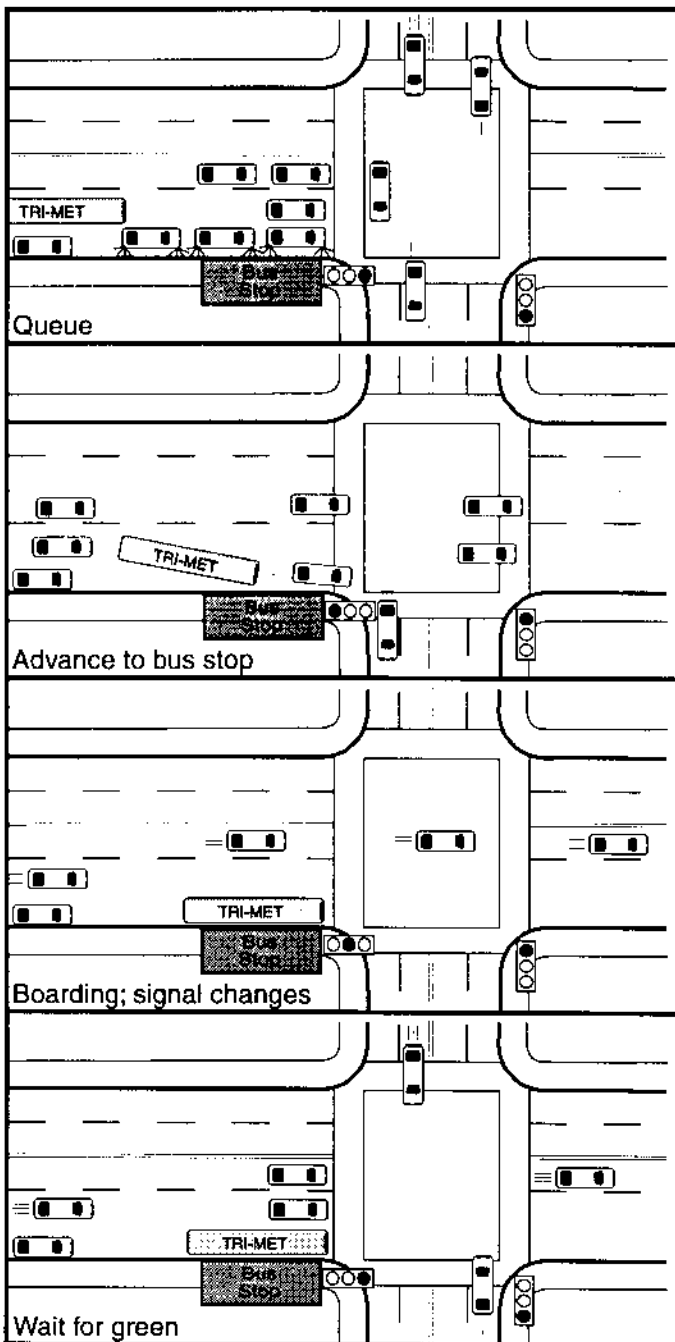
**Caveats:**

The following should be carefully examined before installation of boarding islands:

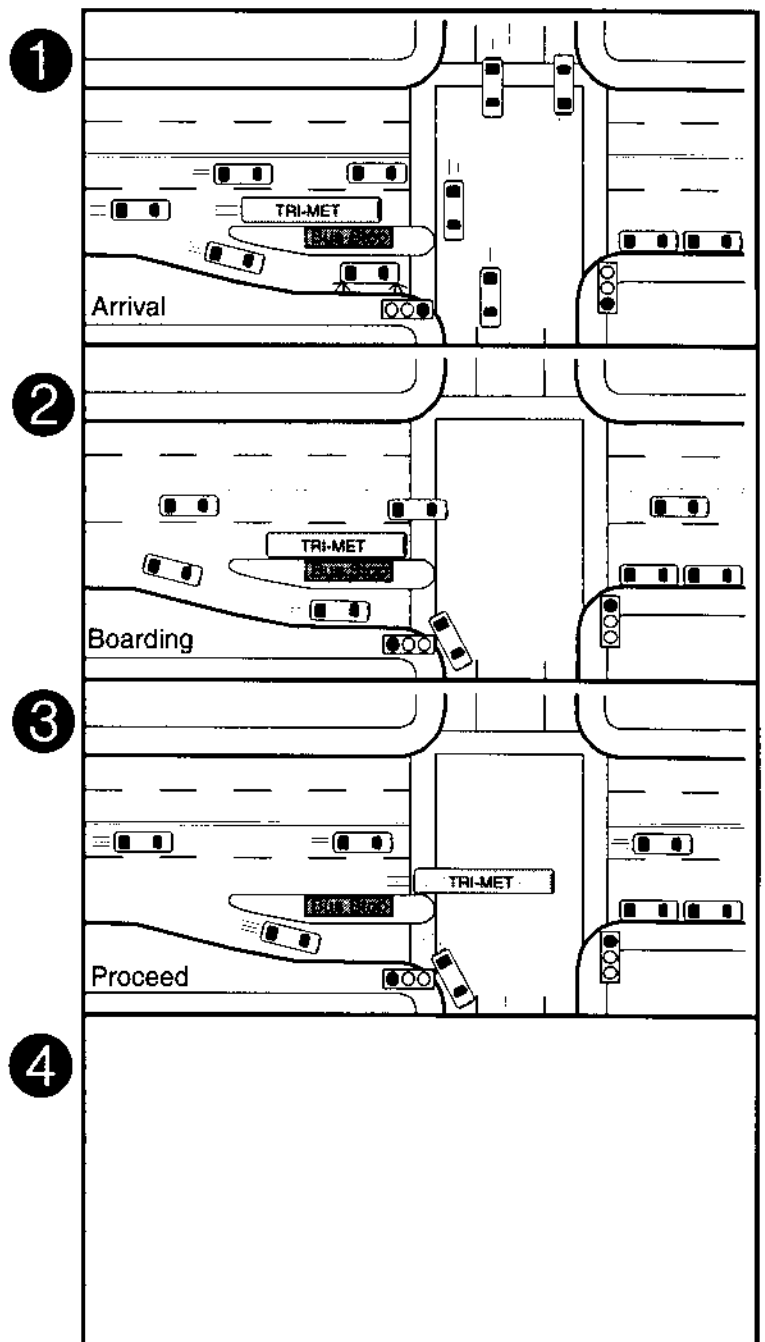
- Passenger accessibility and ADA requirements.
- Passenger comfort.
- Passenger safety.
- Effects on all bus and car movements.

**Description:** Boarding islands allow buses to operate in a non-curb travel lane without having to merge to the right lane to pick up or drop off passengers at the curb.

**Before**



**After**



# Queue Bypass

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Physical

**Range:**

Local

**Applicability:**

- Intersection approaches with high through lane queue delay.

**Benefits:**

- Increases transit operating speed by reducing queue delay on the approach to the intersection.

**Conditions:**

The turn lane must be less congested than through lanes, and longer than the back of the queue.

**Experience/Results:**

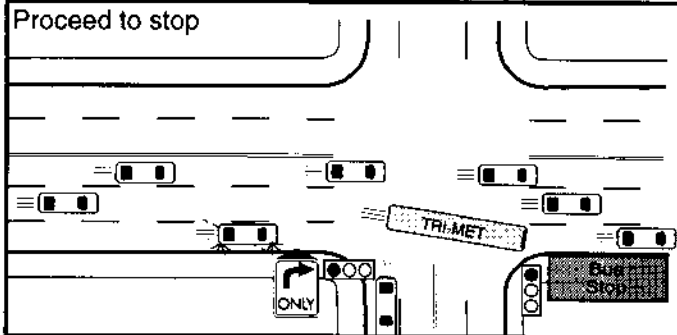
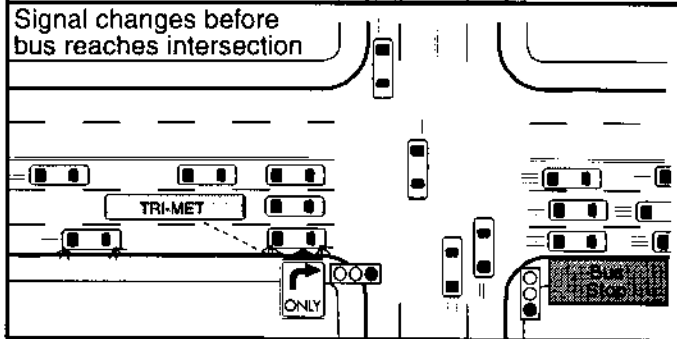
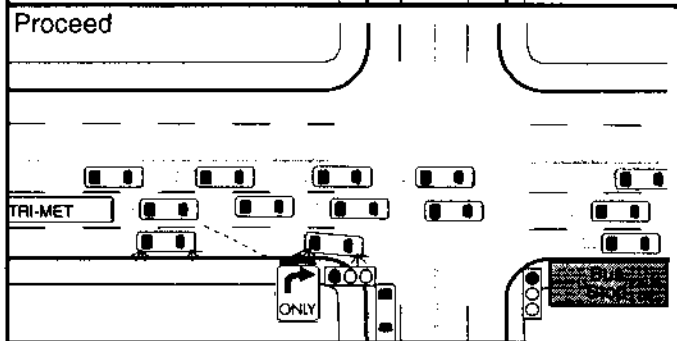
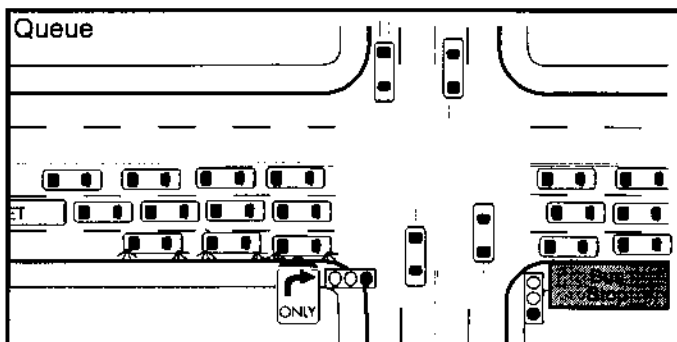
- Positive experience in Portland and other areas.

**Caveats:**

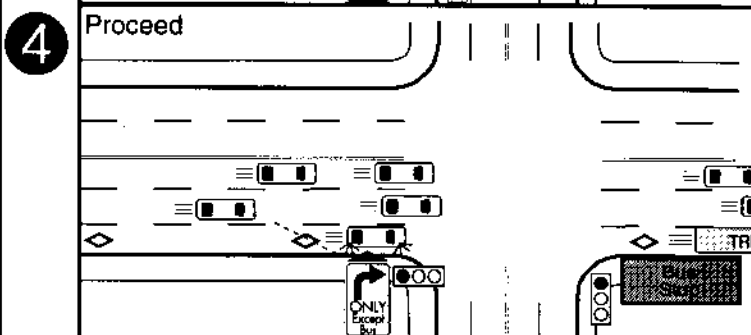
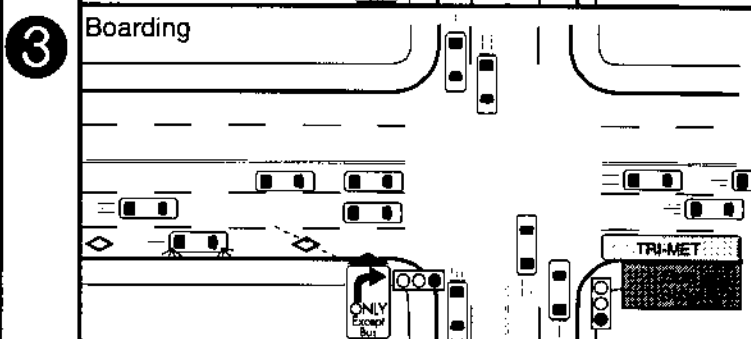
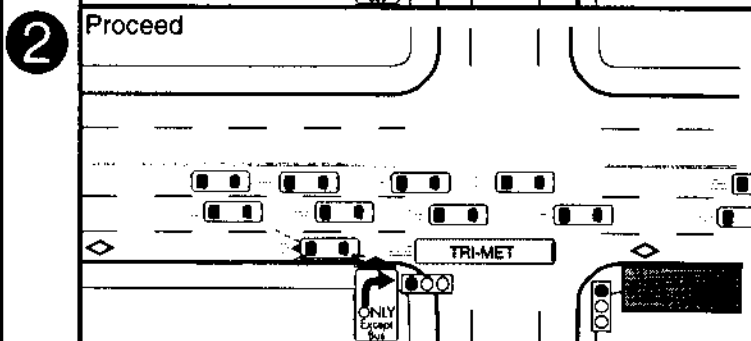
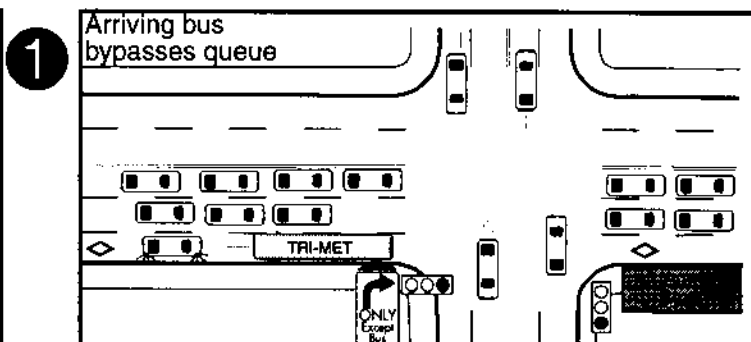
- Either a far-side refuge for the bus or Queue Jump is required.

**Description:** A queue bypass is a short lane used by buses to bypass traffic queues at signalized intersections. The bypass is usually a right-turn lane that allows through travel for buses only. In conjunction with Traffic Signal Priority, however, bypasses can also be created with left-turn lanes.

**Before**



**After**



# Queue Jump

**Type:**

Operational

**Range:**

Local

**Applicability:**

- Where there is a Queue Bypass without a corresponding lane for the bus to enter on the far side of the intersection.

**Benefits:**

- Allows buses to merge into traffic at the end of a Queue Bypass.

**Conditions:**

- Applicable only in conjunction with Queue Bypass.
- Bus stop must be located on the near side of the intersection.

**Experience/Results:**

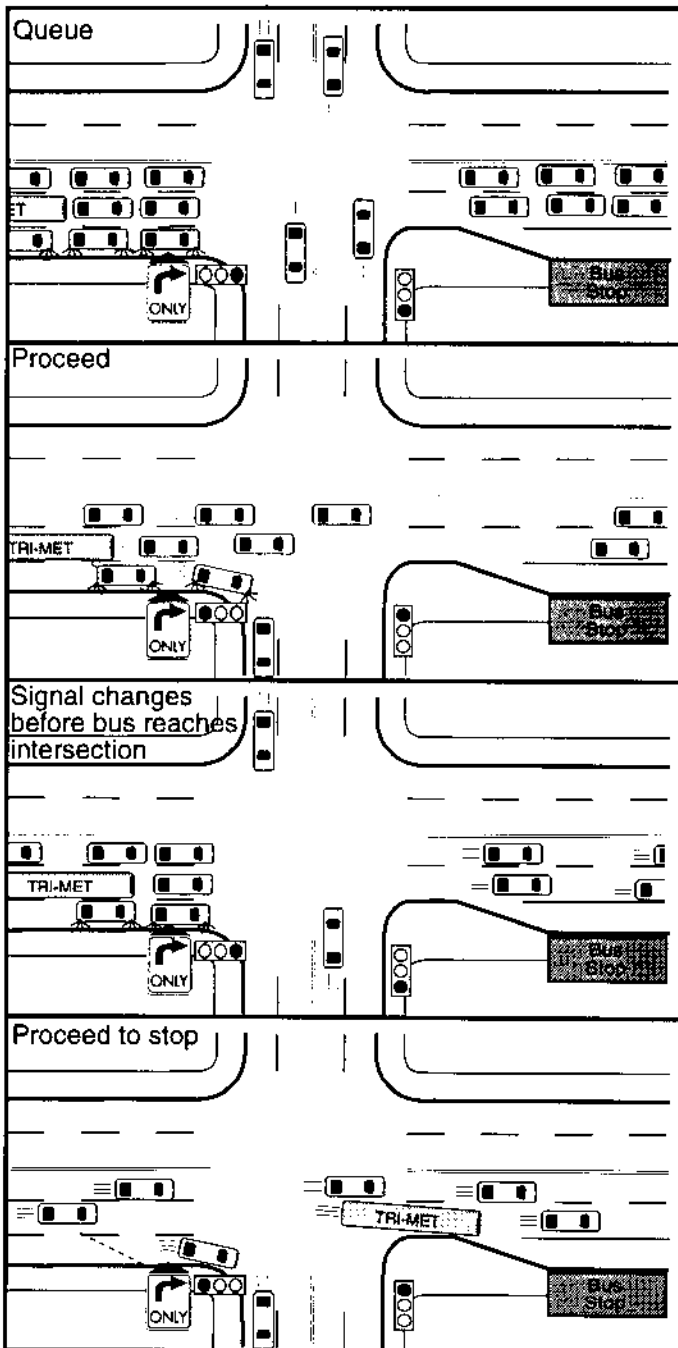
- Positive experience in Portland and other areas.

**Caveats:**

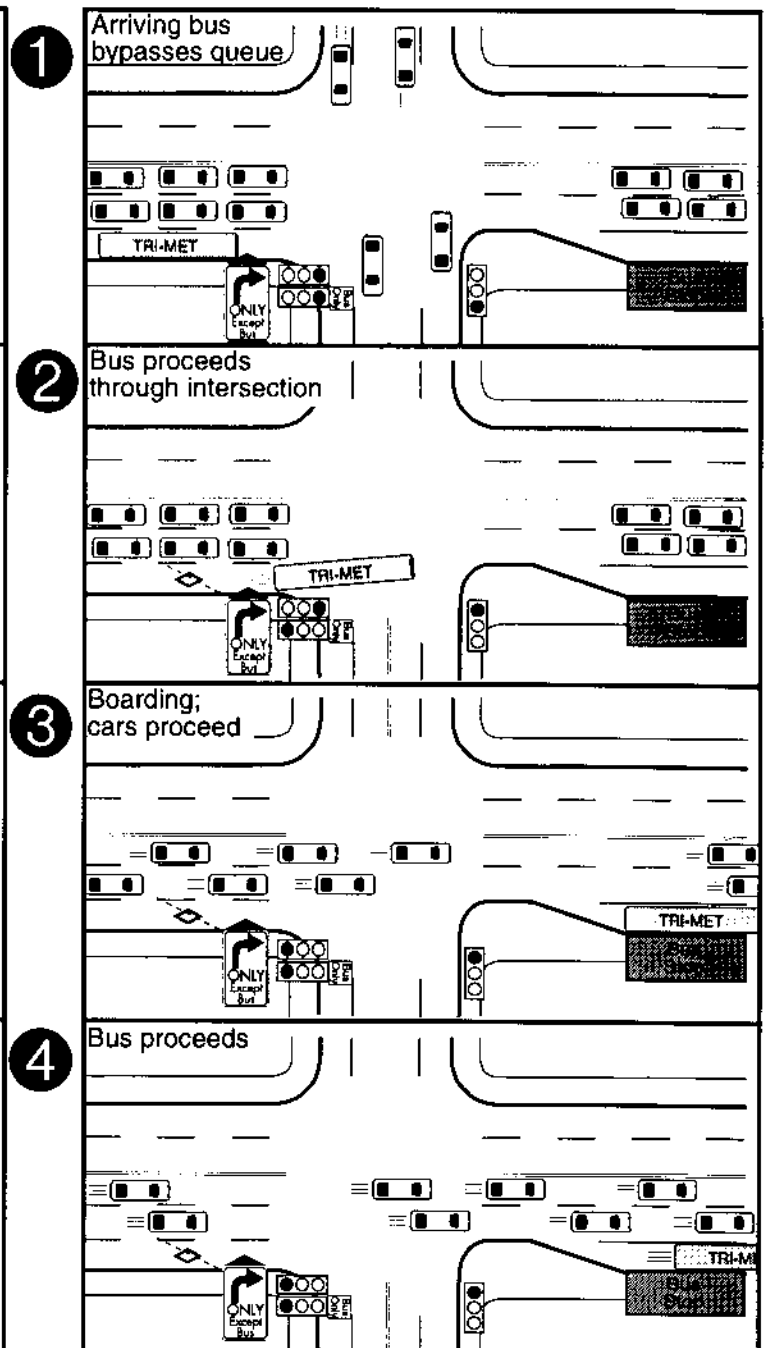
- Effective green time reduction may result in an unacceptable level of service at saturated intersections.
- Increased work load for bus drivers, who must watch the traffic signal closely to avoid missing their short period of green time.

**Description:** Used in conjunction with a Queue Bypass at the intersection approach, a queue jump allows buses to call for an early green phase that starts 2-3 seconds ahead of the normal green phase. This exclusive early green allows buses to proceed into the intersection and merge back into a mixed-flow traffic lane in front of regular traffic.

**Before**



**After**



# Bus Stop Consolidation

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Operational/Physical

**Range:**

Corridor-wide

**Applicability:**

- Portions of bus routes with low average bus stop spacing.

**Benefits:**

- Increases transit operating speed by reducing the number of service stops.

**Conditions:**

A detailed land use and passenger flow analysis should be undertaken before attempting to eliminate or relocate bus stops to avoid creating hardships for passengers (especially senior citizens and people with disabilities).

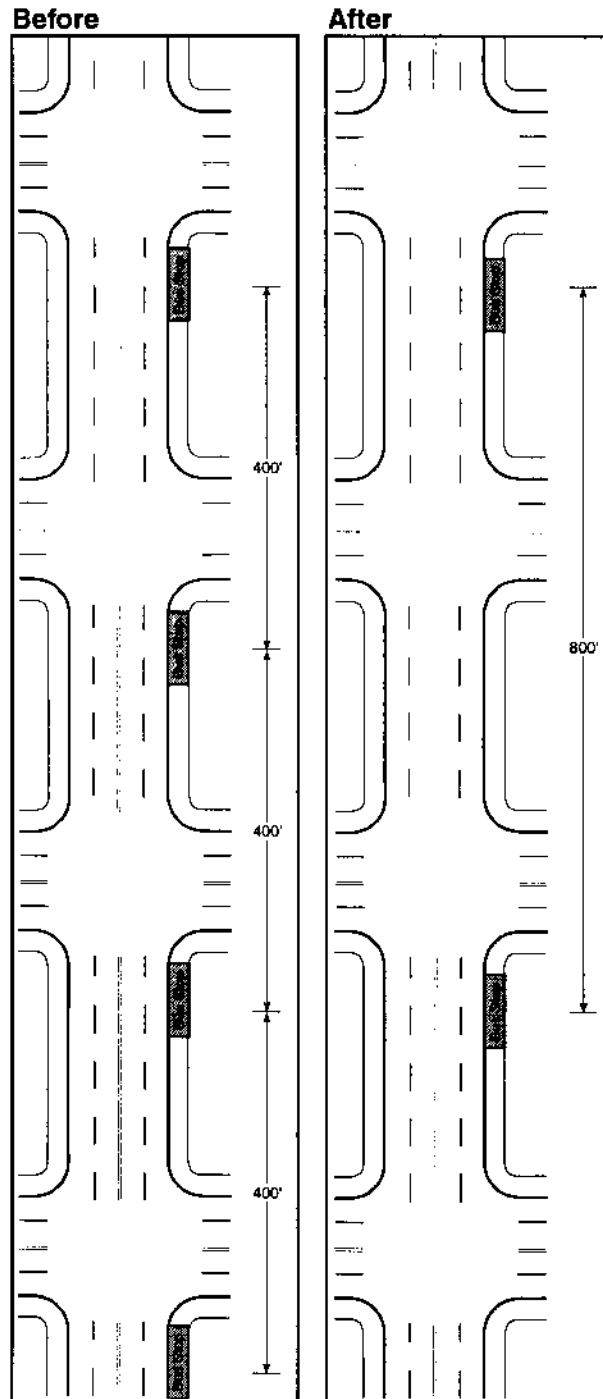
**Experience/Results:**

In San Francisco, analysis showed that consolidations on all major trunk and cross-town lines could eliminate up to 40% of all bus stops on some street segments, with an overall reduction of 10% to 15% per route. Initial analysis of some of the bus stop consolidation measures showed that an average travel speed increase of 4% to 14% could be achieved with a bus stop reduction of approximately 33%. The analysis also showed that ridership did not suffer as a result of this measure.

**Caveats:**

- Requires weighing of the needs of some patrons against the benefit of an overall reduced travel time for all passengers.

*Description: Bus stops are consolidated to achieve an 800- to 1,000-foot spacing, rather than the standard 400- to 800-foot bus stop spacing of transit systems in the U.S.*



# Bus Stop Relocation

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Operational/Physical

**Range:**

Local

**Applicability:**

- Isolated intersections where proceeding through the intersection before stopping will eliminate missing the green after boarding or de-boarding passengers.
- Intersections with Traffic Signal Priority for transit vehicles.
- Corridors with good signal progression designed for automobile traffic.

**Benefits:**

- Increases transit operating speed.

**Conditions:**

- Adequate space for waiting passengers and station equipment (e.g., shelter).

**Experience/Results:**

- Positive experience in Portland and other areas.

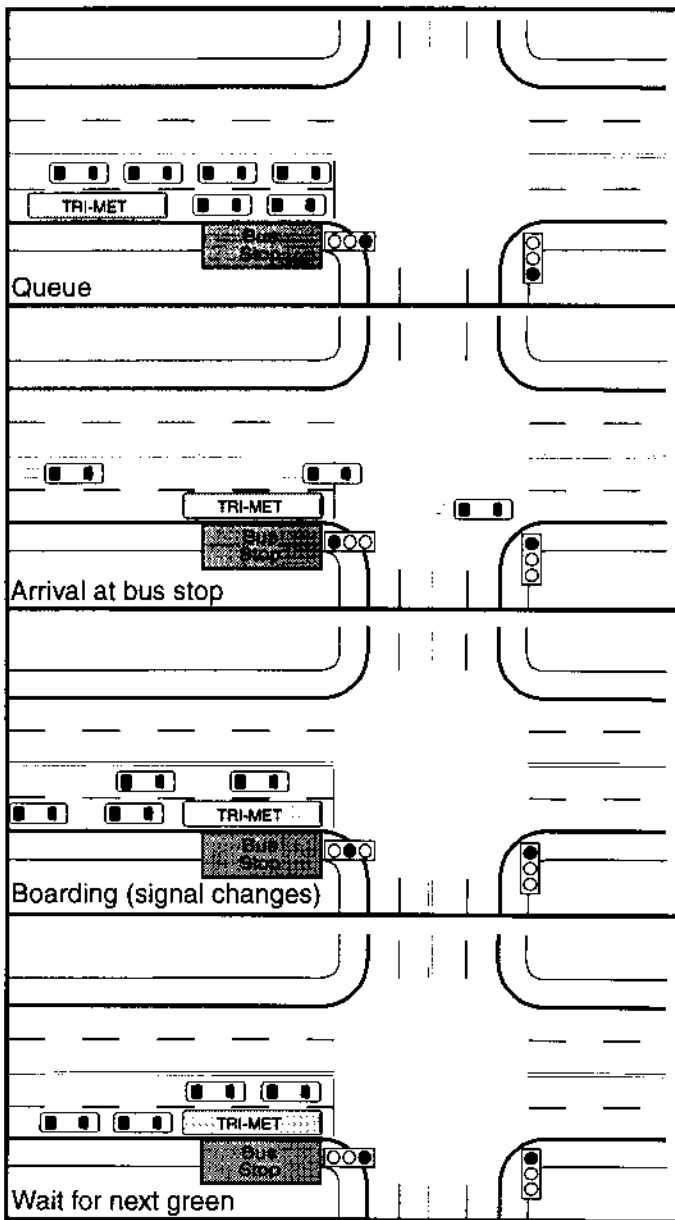
**Caveats:**

- Potential increase of walking distance for passengers transferring to a cross-street bus.

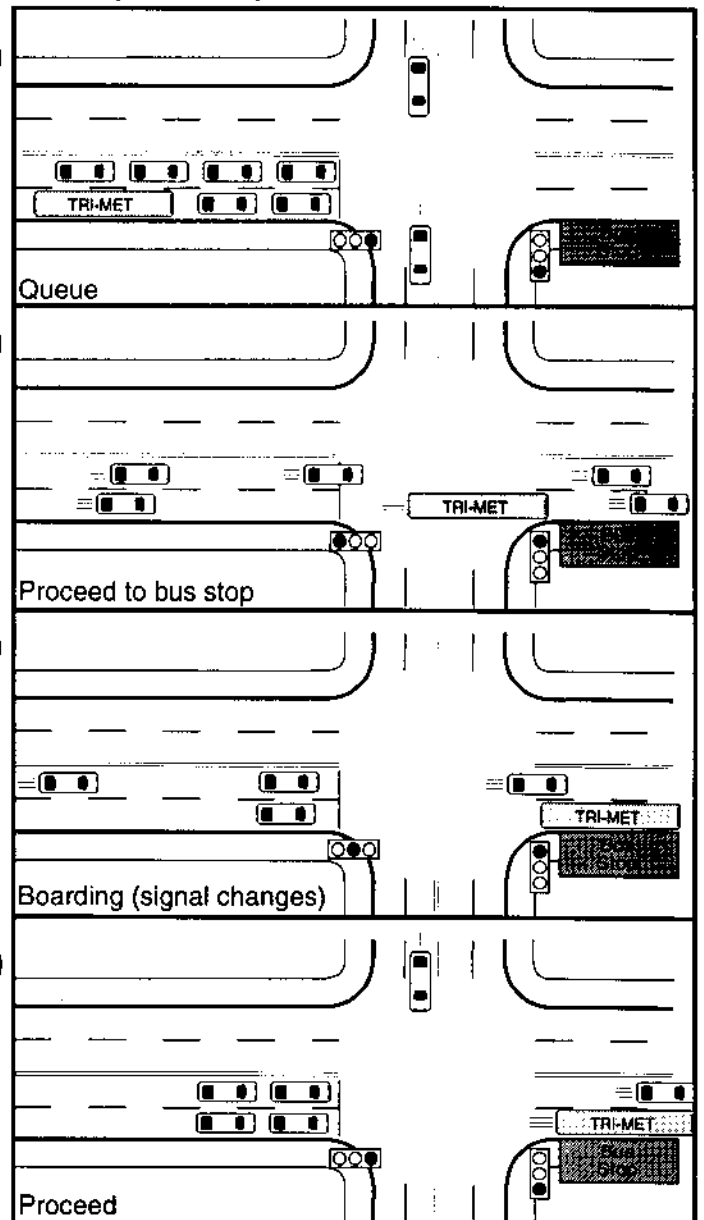
**Description:** The bus stop is relocated from the near side to the far side of an intersection, or vice-versa. With far side stops, traffic signal timing delay for buses is reduced because the bus proceeds through the intersection after the signal changes to green, then stops for boarding, and proceeds when ready. At near-side stops, buses arrive at the back of a traffic queue, proceed to the bus stop with the start of green and then stop for boarding. During

the boarding interval, the signal changes to red and the bus must wait for the next signal cycle. In a coordinated traffic signal environment, the alternation of near-side and far-side bus stops allows buses to use two consecutive dwell times to fall back into signal progression.

**Before (near-side)**



**After (far-side)**



# Exclusive Bus Lane

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**Type:**

Physical

**Range:**

Local

**Applicability:**

- Areas with high congestion or side friction (delay caused by parking maneuvers, delivery trucks, etc.).

**Benefits:**

- Increases transit operating speed by reducing conflicts with parking cars, side friction, general congestion, and queues at traffic signals.
- Improves on-time performance.
- Increases transit visibility and recognition (marketing).

**Conditions:**

- Availability of a travel lane for exclusive use by transit vehicles. This may be an existing travel lane, or a lane created by eliminating on-street parking or new construction.

**Experience/Results:**

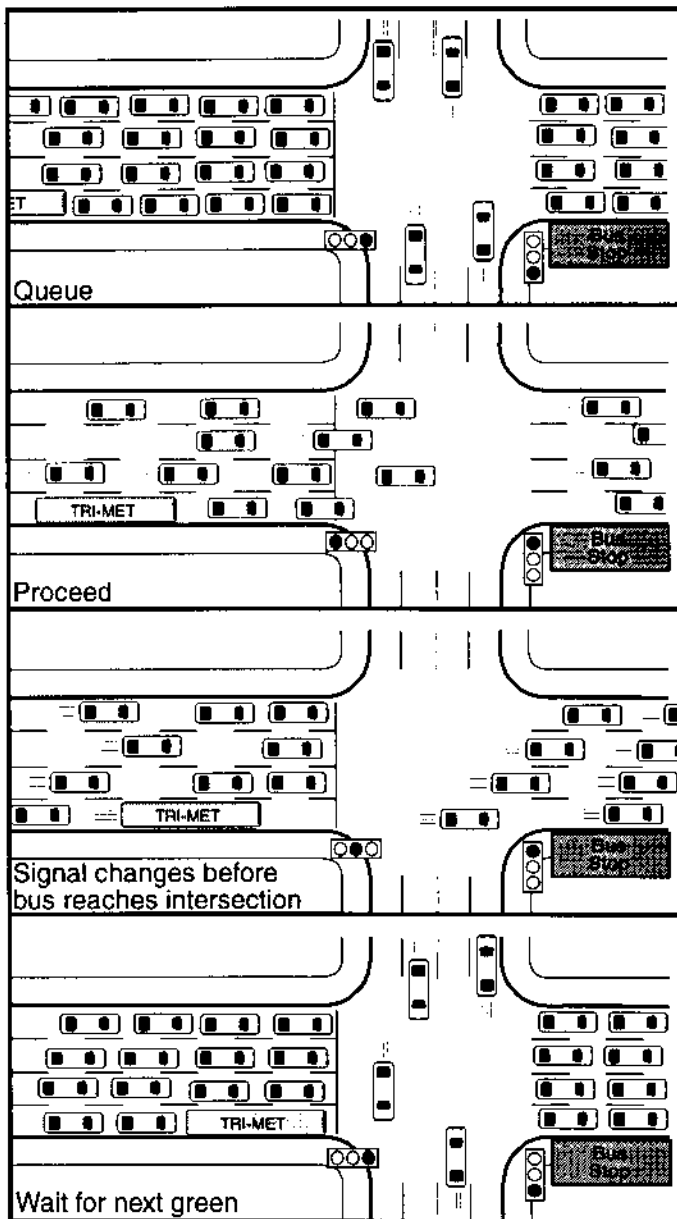
- Positive experience in San Francisco and other areas.

**Caveats:**

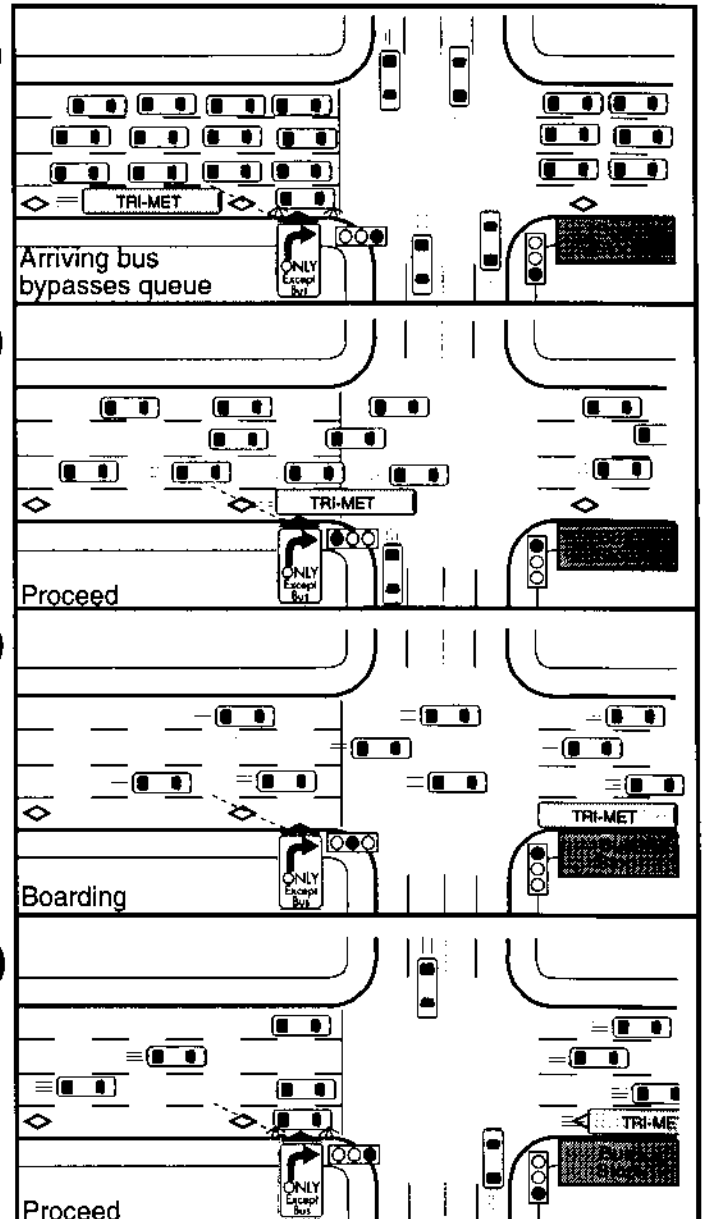
- Enforcement of exclusive bus lanes is difficult, in particular at curbside locations.
- Elimination of an existing travel lane or on-street parking may cause substantial impacts on nearby properties, particularly for uses that require on-street parking.

**Description:** Exclusive bus lanes are travel lanes reserved for use by transit or high occupancy vehicles (HOV) to bypass congested travel lanes. They can be operated during peak periods only, or throughout the day.

**Before**



**After**



# Parking Restriction

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Physical

**Range:**

Local

**Applicability:**

- Areas with high side friction caused by parking maneuvers or delivery vehicles.
- To create right-of-way either for an Exclusive Bus Lane or a Queue Bypass.

**Benefits:**

- Increases transit operating speed by decreasing side friction caused by parking maneuvers.
- Increases riding comfort by eliminating the need for buses to pull in and out of the travel lane for boardings.

**Conditions:**

- Availability of a continuous curbside parking lane.

**Experience/Results:**

- Positive experience in San Francisco and other areas.

**Caveats:**

- Requires continuous enforcement.
- Potentially high impact on surrounding land uses (business or residential).

**Description:** *Parking is restricted or eliminated along a segment of a bus route, either permanently or only for specified peak hours.*



# Signal Timing or Phasing Change

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**Type:**

Operational

**Range:**

Local

**Applicability:**

- Traffic signal locations with inadequate timing or phasing.
- Coordinated signal systems optimized for automobile traffic only, but which can be adapted to better serve buses' needs.

**Benefits:**

- Increases transit operating speed by reducing signal timing delay.
- Reduces general traffic delay by improving the functioning and level of service of a traffic signal.

**Conditions:**

- The affected intersection and traffic signal must have an optimization margin.

**Experience/Results:**

- Positive experience in Portland and other areas.

**Caveats:**

- Improvements could benefit automobile traffic more than bus transit, further widening the travel time gap between the two modes.
- An increase in average vehicle delay may result.

**Description:** *The operating characteristics of a signal controller are altered by changing signal timing or phasing, or both, to achieve better functioning, emphasizing the reduction of delay for all vehicles with particular emphasis on transit vehicles. Signal timing changes could include increasing green time for a particular movement, or modification of a*

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*coordination scheme to create a signal progression favorable to buses. Phasing changes could include changing a permissive left-turn to a protected left-turn.*

# Low-floor Bus Technology

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Operational

**Range:**

System-wide

**Applicability:**

- Preferable on all bus routes.

**Benefits:**

- Increases transit operating speed by increasing passenger flow, thus reducing passenger service time.
- Increases transit operating speed by eliminating the need for a wheelchair lift.
- Enhances comfort, especially for senior passengers or passengers with physical disabilities.

**Conditions:**

- As a measure to reduce passenger service times, this strategy is only successful if implemented on entire bus routes.

**Experience/Results:**

- An average passenger service time reduction of 15 percent has been observed (according to the Ann Arbor Transportation Authority).
- Positive experience in other areas, and especially in Europe.

**Caveats:**

- The transit vehicle maintenance department may need to make major changes in order to accommodate the service needs of low-floor technology buses.

**Description:** *Low-floor technology on buses eliminates the need for passengers to negotiate steps for boarding and de-boarding.*



*Photo provided by Tri-Met*

# Fare Collection Change

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Operational

**Range:**

System-wide

**Applicability:**

- Generally applicable to all transit systems.

**Benefits:**

- Increases transit operating speed by eliminating the requirement to pay the driver, thus reducing passenger service time.
- Increases transit operating speed by increasing passenger flow through boarding at both the front and rear doors, thus reducing passenger service time.

**Conditions:**

- As a measure to reduce passenger service times, the strategy is successful only if implemented on parts of a system, such as all express routes, rather than on isolated buses.

**Experience/Results:**

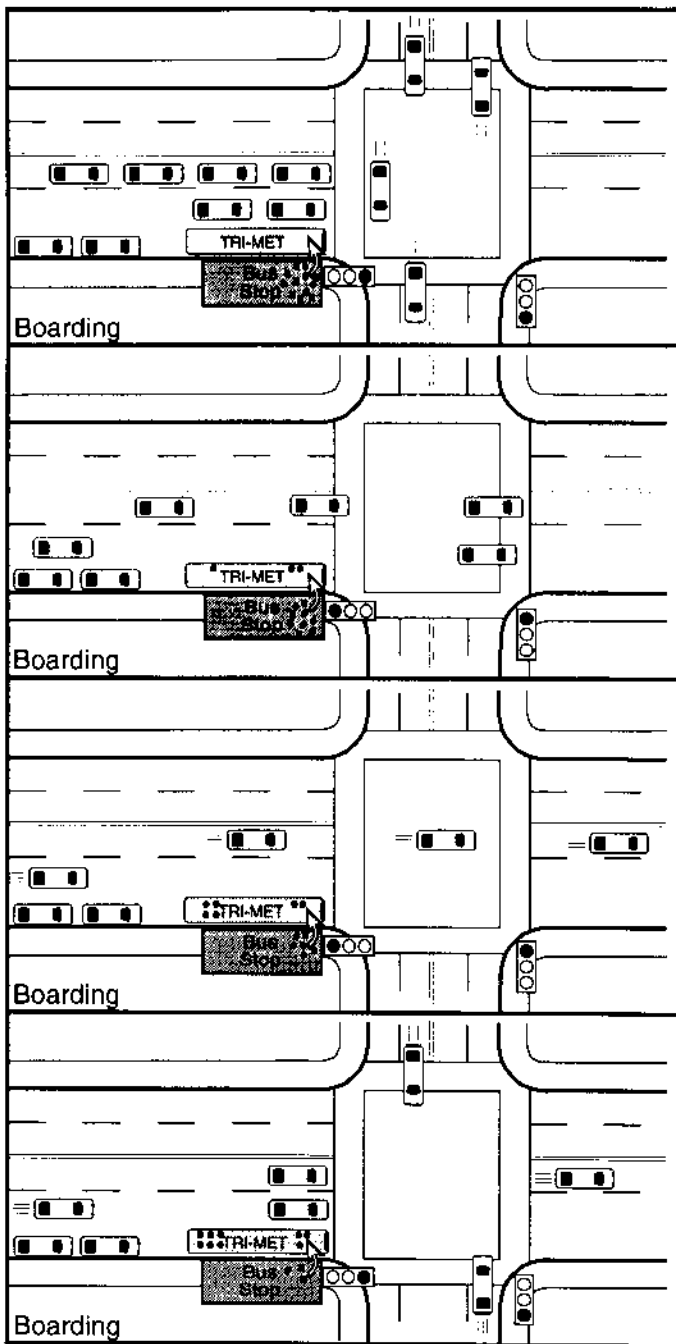
- Positive experience in other areas, especially in Europe.
- Negative experience with a Tri-Met test in the early 1980's (see Caveats).

**Caveats:**

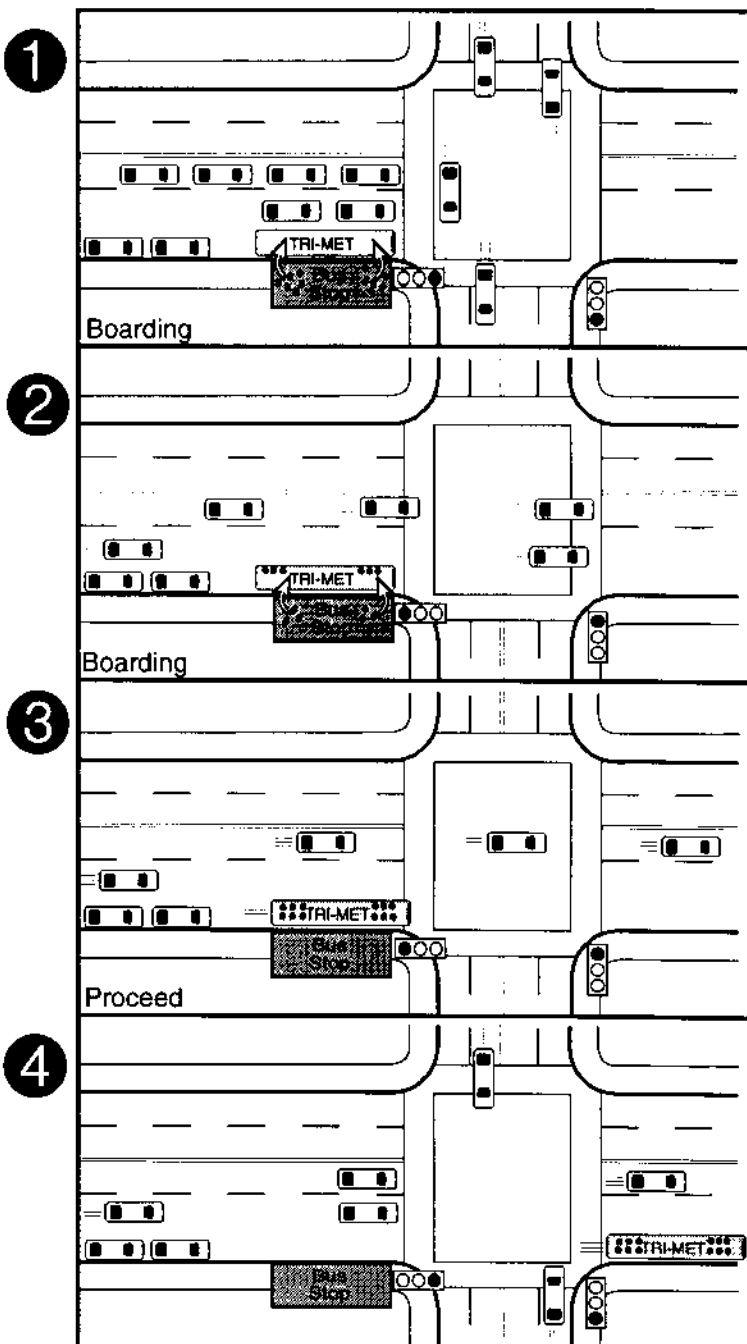
In 1980, Tri-Met received grants from the Urban Mass Transit Administration (predecessor to Federal Transit Administration [FTA]) to implement SSFC on its bus system. The SSFC system was implemented by Tri-Met in September 1982 and replaced with the traditional proof-of-payment system in April 1984. Tri-Met terminated the use of SSFC because of problems with fare evasion, high enforcement costs, unreliable fare collection equipment, low surcharge/fine collections, overburdened courts, and increased vandalism without measurable productivity improvements. State-of-the-art communication technology developed since that time, such as smart cards or proximity cards, has the potential to address most of these problems.

**Description:** A self-service fare collection (SSFC), or “honor” system, allows passengers to board buses or trains without proof of paid fare, in contrast to the traditional proof-of-payment system requiring patrons to either show their valid ticket or purchase one from the driver. New fare collection systems, using state of the art technology such as smart cards or proximity cards, combine the benefits of a self-service fare collection system with the enforceability and control of the traditional proof-of-payment system.

**Before**



**After**



# Exemption from Turning Restriction

City of Portland Bureau of Transportation • Transit Preferential Streets Program Sourcebook

**Type:**

Operational

**Range:**

Local

**Applicability:**

- Intersections with turning restrictions.

**Benefits:**

- Increases transit operating speed by eliminating the need for detours.

**Conditions:**

- Appropriate for intersections where automobile traffic turning restrictions are warranted by congestion rather than as a result of traffic safety problems.

**Experience/Results:**

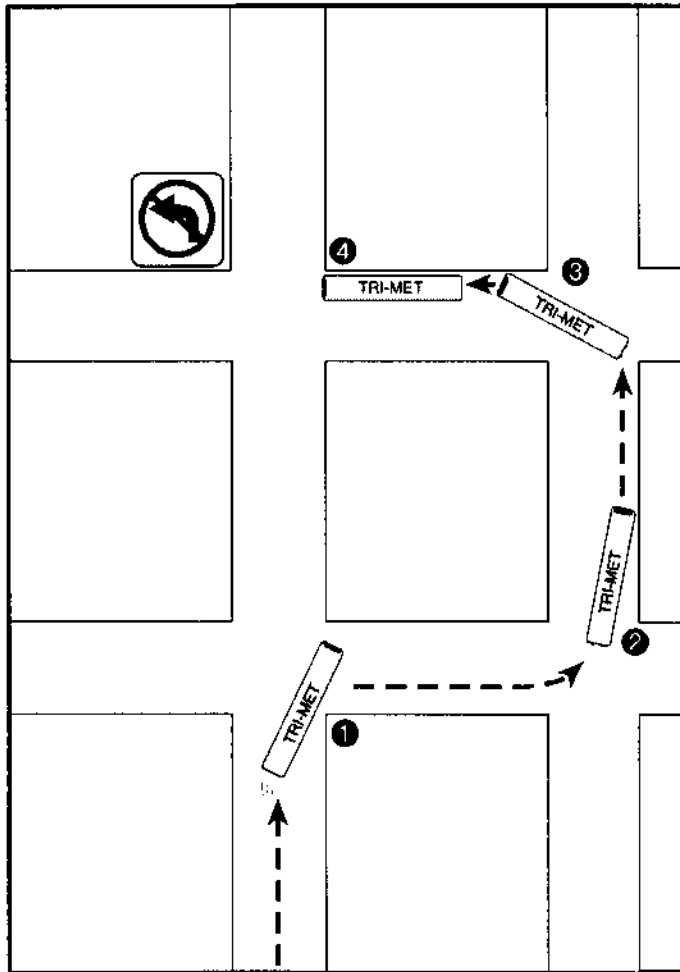
- Positive experience in San Francisco and other areas.

**Caveats:**

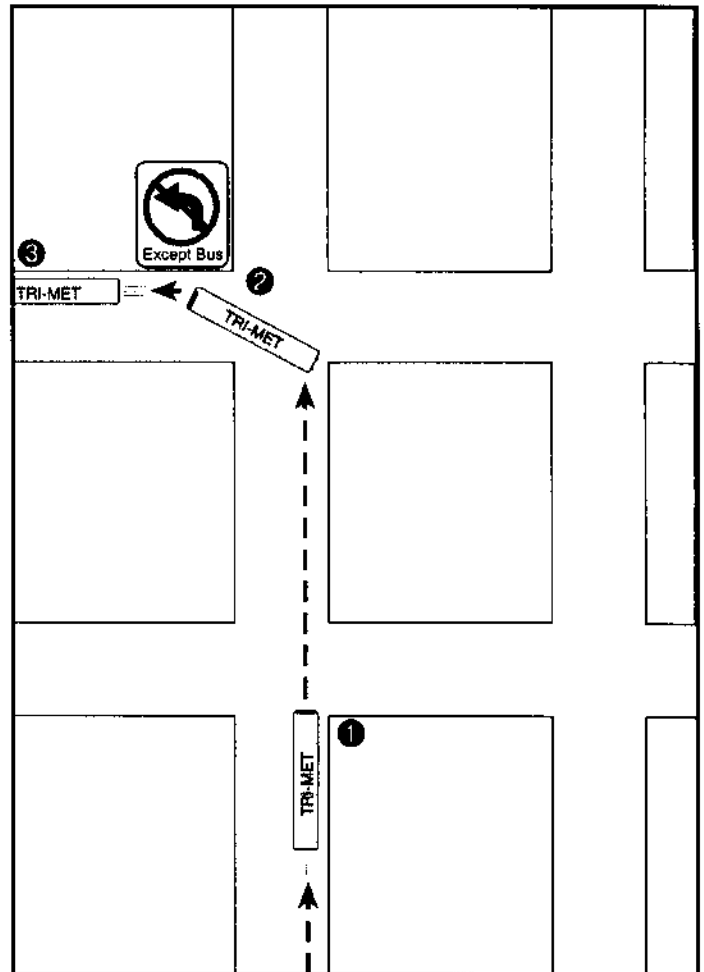
- Potential for traffic safety problems.
- Special bus-actuated turning phases may degrade intersection level of service.

**Description:** Buses are exempted from turning restrictions designed to improve overall traffic flow, such as left-turn restrictions on arterial streets without turning pockets. At signalized intersections, special bus-actuated turning phases may be warranted to exempt buses from turning restrictions.

**Before**



**After**





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