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INNOVATING FOR A BETTER TOMORROW

TRANSIT PRIORITY BEST PRACTICES

REGIONAL DEDICATED TRANSIT LANES STUDY

June 2022

ACKNOWLEDGEMENTS

Prepared for Southern California Association of Governments (SCAG) by Cambridge Systematics, Nelson Nygard and Here LA.

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INNOVATING FOR A BETTER TOMORROW

ABOUT SCAG

SCAG is the nation's largest metropolitan planning organization (MPO), representing six counties, 191 cities and more than 19 million residents. SCAG undertakes a variety of planning and policy initiatives to encourage a more sustainable Southern California now and in the future.

VISION

Southern California's Catalyst for a Brighter Future

MISSION

To foster innovative regional solutions that improve the lives of Southern Californians through inclusive collaboration, visionary planning, regional advocacy, information sharing, and promoting best practices.

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Foothill Transit Silver Streak connects the San Gabriel and Pomona Valleys with downtown Los Angeles

Source: Flickr users Frederick Dennstedt

CHAPTER 1

Introduction

There are over 100 agency and municipal transit operators in the SCAG region, serving over 19 million people across six counties. As part of its metropolitan transportation planning activities, The Southern California Association of Governments (SCAG) works with transit operators, the region's transportation planning agencies, and the California Department of Transportation (Caltrans) to develop goals, objectives, plans, and policies to provide effective and sustainable transit options for the region.

As part of these efforts, SCAG conducted a Regional Dedicated Transit Lanes Study to explore the opportunities, needs, challenges, and best practices for developing not only a regional network of dedicated bus lanes, but also bus rapid transit (BRT) corridor projects, other transit priority treatments that would enable enhanced transit services, improve mobility, accessibility and sustainability, and advance implementation of Connect SoCal, SCAG's 2020 Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS).

With demands on the transportation network and supporting infrastructure increasing, transit operators are finding new and innovative ways to implement transit priority treatments to improve and/or maintain speed and reliability within their service areas. To better understand how transit lanes and other priority treatments have been successfully programmed, funded, and implemented in other regions, SCAG commissioned a technical review of transit priority treatment design guidelines, transit performance analysis tools and techniques, and operational best practice documents published by transit operators and stakeholders from across the U.S. and internationally.

While the most significant benefit to transit speed and reliability is gained from operating in dedicated transit-only spaces, this toolkit of potential priority treatments, as well as supportive policies, tools, and practices, can be tailored to a variety of local needs and constraints in Southern California communities.

BEST PRACTICES PURPOSE AND APPROACH

Purpose

The purpose of this document is to identify a range of best practices and lessons learned from the development and implementation of dedicated bus lanes and other transit speed and reliability improvements (Transit Priority Treatments) relevant to the SCAG region. The goals of this research are to:

- **Inspire** municipalities, transit operators and local jurisdictions to implement transit lanes or other speed and reliability improvements, and increase investment into the multimodal network.
- **Identify** criteria used to select projects, capitalizing on implementation opportunities while mitigating potential risks, and measure performance progress.
- **Outline** municipal coordination needed for implementation and operation of pilot and permanent transit lanes, including considerations for a variety of potential infrastructure and operational profiles/configurations.
- **Incorporate** considerations for transit dependent and disadvantaged communities through an equity-focused lens for needs identification and selection of context-sensitive treatment solutions.
- **Generate** considerations for how SCAG might guide development of policies, tools, and programs that support regional partners with identifying, developing, funding, and implementing transit priority projects.

Approach

The best practice research follows a two-pronged approach. First, references are drawn from a collated group of transit priority design best practice documents from established sources including:

- Transportation Cooperative Research Project (TCRP)
- National Association of City Transportation Officials (NACTO)
- National Resources Defense Council (NRDC)
- Institute for Transportation & Development Policy (ITDP)

As well as similar documentation developed by municipal operators across North America. A full list of sources can be found in Appendix A.

To supplement the literature review, the team facilitated conversations with transit operators and regional and local stakeholder agencies from peer metropolitan regions who are operating and implementing multijurisdictional transit priority programs across diverse geographies and urban forms.

Las Vegas, NV.

Source: Flickr user hami

Transit Priority Treatment Objectives

Speed is the ability of transit vehicles to move along their routes in reasonable amounts of time.

Reliability is the ability for transit vehicles to arrive at stops at consistent and predictable times.

Outcomes from a robust transit priority treatment program include faster travel times, safer traveling environments, improved schedule reliability, increased rider confidence, and a better user experience.

PEER REGIONS

The team created a standardized questionnaire for agency staff representing local transportation agencies and stakeholders playing a number of key roles during the lifetime of BRT and transit priority projects in their respective regions. These discussions provided additional best practice insight around interdepartmental and interagency coordination, and stakeholder roles and responsibilities through project identification, development, implementation, and continued operations that are not typically documented in transit priority design guidelines and literature reviews. Stakeholder representatives from peer regions were asked questions related to:

- Transit lane, speed and reliability implementation strategies and design solutions.
- Interagency coordination and supporting policy development.
- Transit lane deployment and operations during COVID 19.
- Deployment and impacts of transit priority projects in disadvantaged and equity communities.

An overview of the peer regions engaged, and their respective transit priority programs is provided below. Additional examples of transit supportive policies adopted within the regions are identified in Chapter 4.


Source: Nelson\Nygaard

Boston, MA

Since 2018, the Metro Boston Transportation Authority (MBTA) has been working on the Better Bus Program in partnership with more than 50 municipalities and Massachusetts Department of Transportation (MassDOT) to implement bus only lanes, transit priority treatments, fleet electrification and facility upgrades. The 5-year capital investment plan also includes the Rapid Response Bus Lanes Program-- to implement up to 14 miles of bus lanes throughout Boston, Chelsea, Somerville, and Everett. Additional key stakeholders include: City of Boston, Boston Region MPO, Metropolitan Area Planning Council (MAPC), and other incorporated cities.

MBTA is a state agency, with backing from the Governor's office and legislature, mitigating potential interjurisdictional coordination challenges to implementing transit priority treatments on state-controlled roadways. As a large regional entity with experience delivering major capital projects, MBTA also offers on-call design services and offers to pay for transit component of infrastructure. This has proved helpful for smaller cities who may not have staff capacity or expertise to design and implement transit priority treatments themselves.


Source: Nelson\Nygaard

Minneapolis-St. Paul, MN

Metro Transit began implementing speed and reliability projects in 2015 and currently operates two BRT corridors as well as Freeway BRT on I-35W (Orange Line), with one in construction, another in design, and one in the planning phase. The recently adopted Network Next plan also identified a series of Better Bus Routes that are candidates for quick build capital improvements and near-term (within 1 year) operational improvements to increase speed and reliability. Metro Transit began experimenting with red paint implementation of bus lanes in 2019 and has accelerated several pilots through 2020 including downtown bus lanes.

Many of the primary travel corridors supporting high-ridership routes are under the jurisdiction of Hennepin County, both within the urban cores of the Twin Cities, and the predominantly suburban communities and land uses at end-of-lines (e.g. Roseville, Brooklyn Center). Metro Transit has developed a robust data analytics team that has worked closely with the county and cities to define roles and responsibilities, to implement pilot projects and collect performance data used to justify program expansion.

Washington, D.C.

There has been extensive planning in the Capitol-area region related to BRT and transit priority treatments among the Washington Metropolitan Area Transit Authority (WMATA) and other regional operators, with state regional and local municipalities with neighbors in Maryland and northern Virginia. The alignment of regional transportation goals, policies, and strategic investments over time has been an enabling driver for transit operators and agencies with jurisdictional control to coordinate complex issues supporting both corridor-wide project development as well as localized hotspot investments. Regional transit operators have been coordinating closely with District DOT (DDOT) and regional stakeholders including the Metropolitan Washington Council of Governments (MWCOG), Montgomery County Department of Transportation (MCDOT), and Northern Virginia Transportation Commission (NVTC).

Within the District of Columbia (The District), the catalyst for transit priority investments began with an FTA TIGER grant awarded in 2016, but successful deployment has led to over $60M in additional local capital funding to support over 50 location-based transit speed and reliability projects since that time.

Refer to Chapter 7 for additional lessons learned and findings from discussions with peer region stakeholders.

COVID-19 RESPONSE AND RECOVERY

The impacts of the COVID-19 pandemic on global transportation, including public transit resulted in significant initial reductions in service. Initial impacts of the pandemic nationally include transit ridership drop by 79% in 2020 compared to 2019 levels. Implementing on-board and operating safety protocols; as well as changes in commuter patterns by riders with options to work from home contributed to ridership remaining about 65% below pre-pandemic levels at the start of 2021.[1] However, BRT and high frequency routes that served traditionally minority communities and essential workers have often shown resiliency through the pandemic.

Several transit operators and agency stakeholders around the country recognized these trends and were able to capitalize on the decreased traffic volumes to implement and accelerate transit priority treatment projects. Many agencies also experimented with fare free policies, rear door boarding, as well as responding to non-traditional peak demand periods that challenge traditional service planning and route scheduling conventions. According to the FTA FY22 Annual Report on Funding Recommendations, nine Small Starts and one New Starts BRT projects have entered into Project Development and another four have received Construction Grant Agreements since February 2020.

Despite capitalizing on the opportunities to prioritize right of way for transit and alternative modes, operating high frequency service remains constrained by limited funding and revenue streams to support the costs of increased fleet deployment. In addition, transit providers are trying to cope with changes in the labor market, higher costs related to training, personal protective equipment (PPE), personnel absences, and growing labor costs. Initial staff decreases when service cuts were implemented early in the pandemic are having a lasting effect on the labor pool of qualified operators, many of whom have elected to seek alternative employment.

As traffic volumes have rebounded to near pre-pandemic levels over the course of 2021 and 2022, justifications for implementing transit priority treatments to capitalize on low traffic volumes are limited. However, the quick build-opportunities that demonstrate opportunities for situational transit priority investments remain an important strategy for transit operators and stakeholders to expanding high quality, frequent service.

1 The Impact of the COVID-19 Pandemic on Public Transit Funding Needs in the U.S. (January 2021, EBP US, Inc)


Source: Flickr user Elvert Barnes

The sbX BRT Green Line travels a 16 mile-corridor through San Bernardino and Loma Linda and has 5 miles of dedicated bus-only lanes.

REPORT ORGANIZATION

The focus of this report is on the planning, design and implementation of elements that improve both actual and user-perceived experiences of transit (travel) speed and service reliability. The subsequent chapters of this report are organized as follows:

- **Chapter 2: Project Identification / Prioritization –** methods for identifying opportunities for transit priority treatments; integration with policy and decision-making.
- **Chapter 3: Speed & Reliability Design Treatments –** transit lane configurations and operations, intersection treatments, bus stop/station area improvements, and complementary active transportation facilities.
- **Chapter 4: Speed & Reliability Operations and Technology –** policies, tools, and technologies such as stop location, signal priority, and fare collection.
- **Chapter 5: Supporting & Enabling Policies –** identifies areas where federal, state and local policies may influence transit speed and reliability project development, prioritization, and implementation.
- **Chapter 6: Getting On Board –** principles for education and outreach; examples of how to communicate the benefits of transit priority projects.
- **Chapter 7: Lessons Learned –** roles and responsibilities among transit operators and stakeholders coordinating project development, implementation, and operations within constrained right of way.

Additional elements of an enhanced corridor experience include comfort and convenience, as shown in the illustration on the following page.

ELEMENTS OF ENHANCED TRANSIT CORRIDORS

The best transit service has four main ingredients:
(1) Reliability (2) Speed (3) Comfort and (4) Convenience.

These categories include everything from the speed of the bus to having a bench at the bus stop. Agencies and municipalities are encouraged to develop area-specific programs to dedicate resources to tackling Reliability, Speed, and Comfort on corridors with frequent bus service.

Reliability

People want to be on time to work and appointments. Reliability means the bus arrives on schedule, day after day.

CONSISTENCY BUILDS CONFIDENCE IN THE BUS

RIDERS RELY ON ACCURATE REAL-TIME TRAVEL DATA AND EFFECTIVE COMMUNICATION BY OPERATORS

Speed

Transit priority treatments can make transit trips faster, better serving today's riders and attracting new riders.

BUS LANES MAKE TRANSIT TRAVEL TIMES CLOSER TO CAR TRAVEL TIMES

35%

The new Burnside Bridge eastbound bus-only lane reduced the time it takes to cross the bridge by 35% during congested conditions at rush hour.

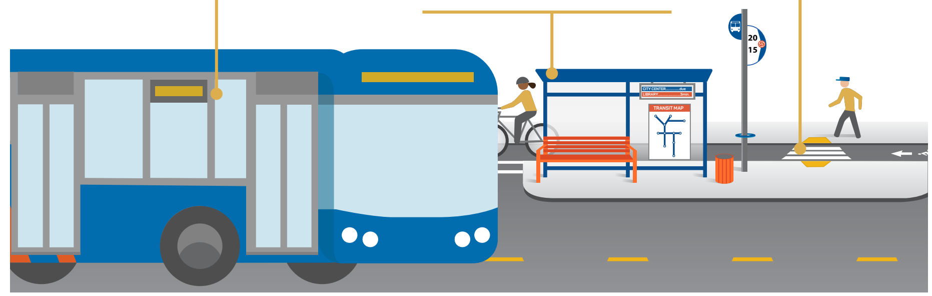
Comfort

A comfortable and safe travel experience onboard vehicles, as well as at stations and stops makes transit a stress-free option.

SAFE STREET CROSSINGS GET PEOPLE TO AND FROM BUS STOPS

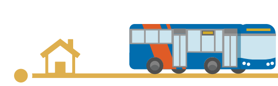
LARGER VEHICLES ON BUSY ROUTES GIVE PEOPLE MORE SPACE

SEATING AND SHELTERS MAKE WAITING EASIER



Convenience

Convenient transit covers everything from the route design to the schedule.



DIRECT ROUTING connects destinations.

STOP LOCATIONS can help to balance speed, access, and walking distances.

FREQUENT BUSES mean less wait time.

HOURS OF OPERATION covering early morning, night, and weekends give you more options.

CHAPTER 2

Project Identification and Prioritization

FRAMING MOBILITY NEEDS

Where Do We Start?

Existing Planning and Policy Documents

Traditional planning methods and processes, such as short- and long-range Transportation Plans (SRTPs / LRTPs) and comprehensive operational assessments (COAs), may identify recommended rapid transit or enhanced transit corridors where transit priority treatments are warranted. Corridors where high-performing fixed route services currently operate or where recurring delay is observed are good candidates for transit speed and reliability improvements. These corridors often serve highly urbanized areas or connect suburban communities with urban or regional job centers, but even less dense communities can experience congestion "hot spots" throughout the day.

Performance Monitoring

Municipalities and transit operators are evolving with the information age to better collect, monitor, and analyze their transit operations and performance data. Data can be used to identify choke points, high delay areas, and other priority stops, segments, and intersections along transit corridors.

Community Input

Community input from people who currently use the system often provides the most insight into transit reliability issues and needs. Passenger intercept surveys, online surveys, and engagement with hard-to-reach audiences at local community and activity centers can further identify problem areas in the transit network.

Is It Right For My Service Area / Geography?

Land use and development patterns are a key consideration for selecting the appropriate speed and reliability treatments. Each treatment shown in Chapters 3 and 4 will indicate which contexts they may be suited for.

Urbanized areas with a concentration of trip generators (job and activity centers, residential density), high existing bus ridership, and a convergence of fixed routes along primary thoroughfares, are often the ideal location for transit only lanes and BRT treatments. Urban areas typically have dense grids of streets that can provide redundancy and alternative routing options when prioritizing or reallocating right-of-way for transit-only use.

Suburban and exurban areas often have concentrated travel along major arterials and corridors due to more dispersed and lower density land use patterns and a circuitous roadway network with little redundancy. This limits the availability of alternative roadways for priority modal designations. While the existing roadway conditions may support opportunistic bus only spaces, operational treatments and those that can be applied at specific intersections or stations, such as transit signal priority (TSP), are good candidates for this land use context.

Are there clear benefits for my community?

In addition to understanding the geographic context, it is crucial to understand whether a potential project is right for the community who will be impacted, and the community transit serves. Key questions to ask as an agency include:

- How does this project satisfy unfulfilled community needs or issues?
- How would the proposed project benefit bus riders and surrounding communities? Who would be burdened? How does it potentially benefit other users?
- How does the project complement or enhance existing multi-modal services in the community?
- How would the proposed project impact the ways residents, local businesses, workers, and visitors currently use the corridor?

Additional data points that agencies may consider using to further understand potential community impacts and engage with riders more effectively include but are not limited to:

- Demographics of current bus riders and that of the residential/worker population served by fixed routes.
- Mobility needs of community members with greatest barriers to service.
- Histories of mobility service (dis)investment.
- Passenger delay experience and drive time competitiveness.
- Planned changes to land use and/or other community amenities.

Best practices for outreach qualitative data collection include but are not limited to:

- Develop innovative ways of administering on-board rider surveys and community surveys that collect preferences related to potential benefits, impacts and tradeoffs; as well as justification and decision making.
- Build relationships with established community partners to participate in activities, engagements, and events to gather public input in addition to traditional public meetings and webinars.
- Engage bus operators who drive the corridor to learn about observed issues and trends impacting speed and reliability.
- Record observations on project area conditions including street and curbside activities across a sampling of days and times.

IDENTIFYING SPEED AND RELIABILITY CHALLENGES

There are several scales at which key performance indicators (KPIs) and other metrics of transit speed and reliability can be evaluated, based on project need and other service goals.

- **Systemwide –** An agency typically conducts a systemwide analysis when there have been significant changes in the residential population or number of jobs along fixed routes or high-frequency/quality routes.
- **Line-level –** An agency may evaluate a specific transit route or line when there are particular, ongoing challenges on the route, such a delays due to congestion.
- **Project-specific –** Project-specific evaluations are carried out to justify or monitor the performance of capital infrastructure investments supporting transit priority.
- **Location-specific –** Monitoring indicators such as delay, throughput, and reliability help an agency or jurisdiction understand challenges and successes at a particular location.
- **Person / Rider-level –** Understanding the user experience at the rider level for typical scenarios to improve overall journey times and minimize transfers and delays. This includes access time to transit, wait time, and the journey time itself.
- **Gap analysis –** Gap analysis looks at barriers to mobility access, racial and social equity impacts, climate impacts, and more.

Once the desired goals and level of analysis have been established, appropriate metrics can be selected to evaluate or justify transit priority treatments. While evaluation metrics and threshold may be used at multiple scales, each scale may require a unique set of data or evaluation approach.

Performance Indicators, Thresholds, and Metrics

Transit agencies that use data analytics to determine the need for speed and reliability improvements have developed KPIs for a common set of topic areas. These KPIs can also be used to track performance and impacts of improvements during and after implementation. Topic areas typically considered include, but are not limited to:

1. Travel time and delay
2. Reliability
3. People throughput
4. Equity
5. Access to jobs and opportunities
6. Changing travel patterns
7. Climate and environmental justice

Source: Nelson\Nygaard

Travel Time and Delay

What is it?

Travel Time is the length of time a passenger spends on a transit vehicle between their origin and destination. Reducing travel times or, conversely-- improving travel speeds, is frequently the primary operational goal of implementing transit priority treatments. Unlocking travel time savings is typically tackled by understanding where, when, and what kind of delay is experienced along the route and measuring its magnitude and effects to both vehicles and passengers.

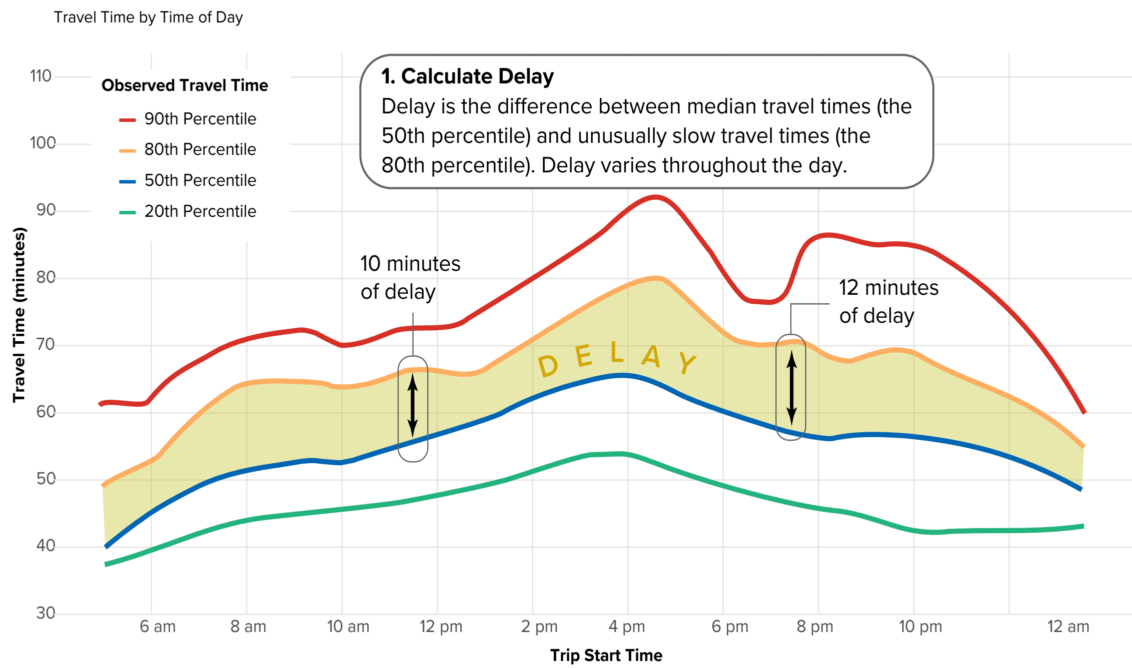
Vehicle Delay is the additional travel time a transit vehicle experiences during slower/congested conditions relative to faster/free-flow conditions. This measure is calculated based on many trips over multiple days and weeks. It is not something that can be observed from one trip. As shown in Figure 2-1, one way to calculate delay is to take the difference between median (50th percentile) travel times and unusually slow (80th percentile) travel times.

Passenger delay is a separate metric that weights the delay by the passenger load or ridership of a route. It is the cumulative delay experienced by all passengers.

Since it considers the beginning and end point of rider trip patterns, the on-board load is a significant factor in calculating Passenger Delay. (i.e., where is the bus most crowded?).

Vehicle delay (congestion) may be caused by any number of roadway conditions (peak periods of vehicular and/or pedestrian demand, facility construction or reconfiguration, land use changes, weather, signalization issues, driver behaviors, or other operating conditions).

Figure 2-1 Example Delay Variation Throughout the Day



How is it measured?

Vehicle Delay

Vehicle Delay for transit typically includes:

- Running delay (time stuck in traffic)
- Signal delay (additional travel time caused by signal)
- Merge delay (time spent merging back into traffic from a bus stop)

Delay is measured as the difference between percentile travel times between two stop pairs, timepoints, or route endpoints (e.g., the difference between the 80th percentile and 20th percentile travel times). Figure 2-2 shows a sample of different methods for calculating delay. Automatic vehicle location (AVL) data of observed run times between two locations can be used to calculate the percentile travel times.

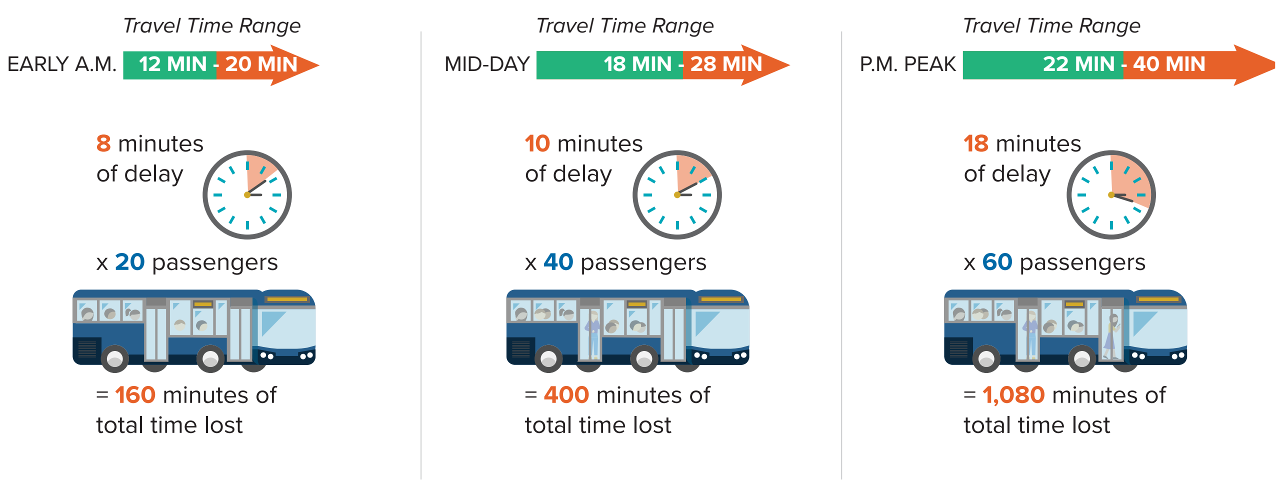
Figure 2-2 Potential Methods for Measuring Delay

Description	Benefits	Challenges
Compares the range of travel times for individual trips or by hour, slowest (80/90) and fastest (20/10).	Ability to identify which times of day have more variability, regardless of what occurs at other times of day.	Fails to easily identify where transit faces speed and reliability challenges all day (i.e., no increase in delay during peak hours could be masking all-day delay).
Compares slower trips (80/90) to the fastest trips (20/10) during the day; and may include peak and off-peak conditions.	Identifies the locations that experience more severe congestion; useful for identifying where bus lanes or Business Access and Transit (BAT) lanes are most likely to be beneficial.	Does not identify reliability challenges that individual trips experience day-to-day.
Compares typical conditions at peak to typical conditions off-peak.		

Passenger Delay

Passenger delay is calculated by multiplying the delay value by the on-board load between two locations (Figure 2-3). At the route-level, passenger delay can be calculated using total route ridership.

Figure 2-3 Calculating Passenger Delay



Measuring improvements

If the vehicle and passenger delays calculated through comparison of travel times variations for individual trips (see Figures 2-1 and 2-2) sufficiently meet agency-established performance thresholds, transit priority initiatives may be studied and implemented to achieve faster travel speeds and/or reduced variability in travel times. During planning and implementation, the potential and actual improvements should be measured. Travel times savings can be achieved at stops, at signals, and along segments of roadway.

Using Planning-Level Travel Time Savings Estimates

Figure 2-4 lists the potential savings for various transit priority interventions. These savings should be used as a preliminary estimate. Each location is unique, and savings can vary considerably based on traffic volumes, number of lanes, intersection spacing, signal cycle times, and additional local context. It is recommended agencies use data gathered from local precedents to inform travel time savings estimation.

Using Existing Travel Time and Delay

This section provides additional methods for estimating travel time savings and delay reductions. Unlike the values from above, these methods use an agency's own travel time and delay values (from AVL) to provide an estimate along specific corridors or locations. These methods only apply to segments or corridors with planned bus lanes.

Figure 2-4 Estimated Travel Time Savings per Treatment

Treatment	Savings	Example	Source
Transit signal priority (TSP); Signal coordination	8-12% of travel time; 15-80% of signal delay.	Adding TSP along a corridor that takes 60 minutes can reduce travel time to 54-56 minutes.	TCRP 165, pg 6-44.
	3 sec per TSP.	Adding TSP to 33 intersections results in approximately 1 minute of savings (average per trip).	TCRP 118, pg S-9.
In-lane stops (filling in bus pullouts)	7% increase in speed (for corridor-wide application).	Travel speeds at 20 mph can increase 1-2 mph with in-lane stops.	TCRP 165, pg 6-51.
Stop consolidation	Elimination of acceleration, deceleration and door close/open for each stop removed. • Acceleration: 3.3 ft /sec/sec. • Deceleration: 4.0 ft/sec/sec. • Door open + close: 2-5 sec (avg 3.5 sec).	• At top speed of 15 mph, removing 3-4 stops results 1 minute of savings. • At top speed of 20 mph, removing 3 stops results in 1 minute of savings. • At top speed of 25 mph, removing 2-3 stops results in 1 minute of savings.	TCRP 165, pgs 6-4 & 6-6.
Queue jump	5-15% of travel time through intersection.	3-10 seconds of savings for each minute of travel time to get through an intersection.	TCRP 165, pg 6-48.
	6 sec per queue jump.	Approximately 1 minute of savings with 10 queue jumps.	TCRP 118, pg S-9.
Bus lane	Travel time savings: • 20-60 seconds per mile. • 35-45% of travel time. Reduction in variation of travel: • 12-30% change in the coefficient of variation (i.e., the standard deviation divided by the mean).	Approximately 1 minute of savings for every 1-3 miles of bus lane.	TCRP 165, pg 6-39 & 6-40.

Delay Reduction

Delay reduction measures the change in the average transit delay target (80th/90th percentile) along a route. Figure 2-5 through Figure 2-7 illustrate a potential 3-step process for identifying and assessing potential delay reduction resulting from implementation of bus or business access and transit (BAT) lanes.

- **Step 1** – Calculate existing delay (by time of day).
- **Step 2** – Establish expected delay reduction after implementation of a transit priority treatment (for example, 20% reduction or 80% of current delay).
- **Step 3** – Calculate expected 80th percentile travel times with transit priority treatment.

Similar analysis may be applicable for other transit priority treatments or require collection and use data for the segment or portion of the route where the transit priority treatment is located.

Figure 2-5 How to Calculate Potential Delay Reduction per Treatment – Step 1

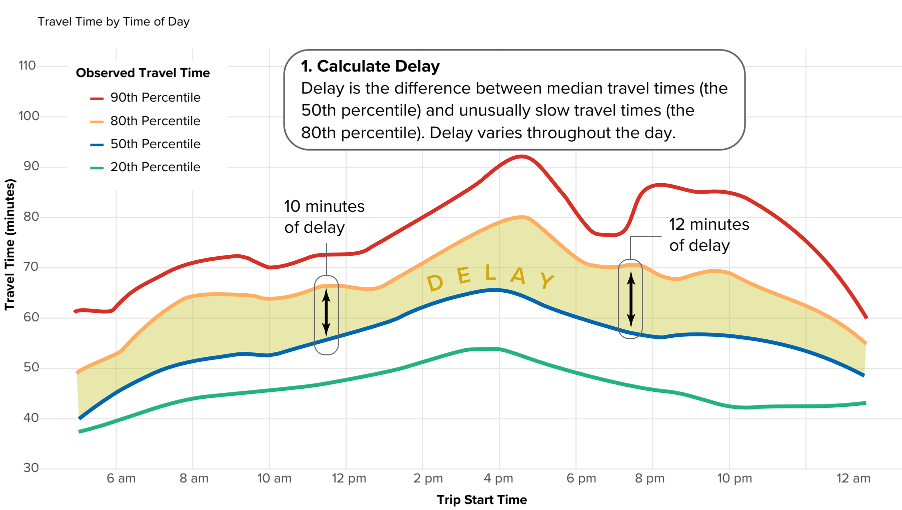


Figure 2-6 How to Calculate Potential Delay Reduction per Treatment – Step 2

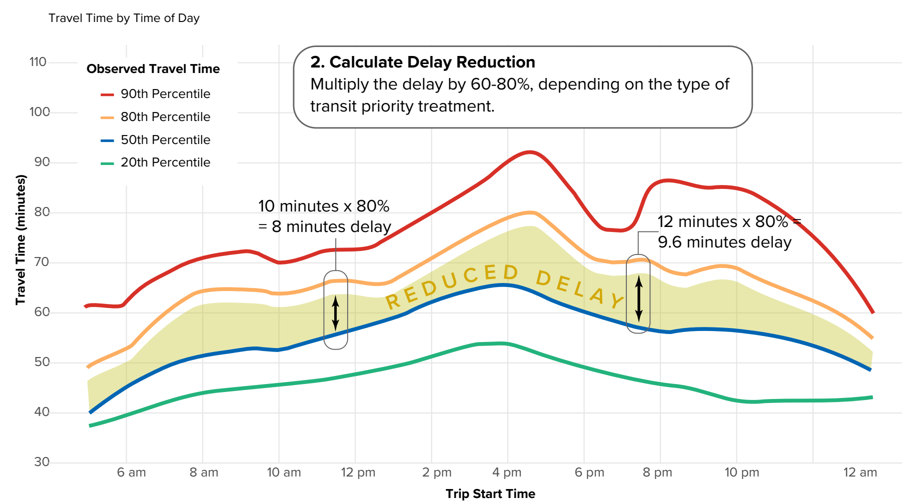
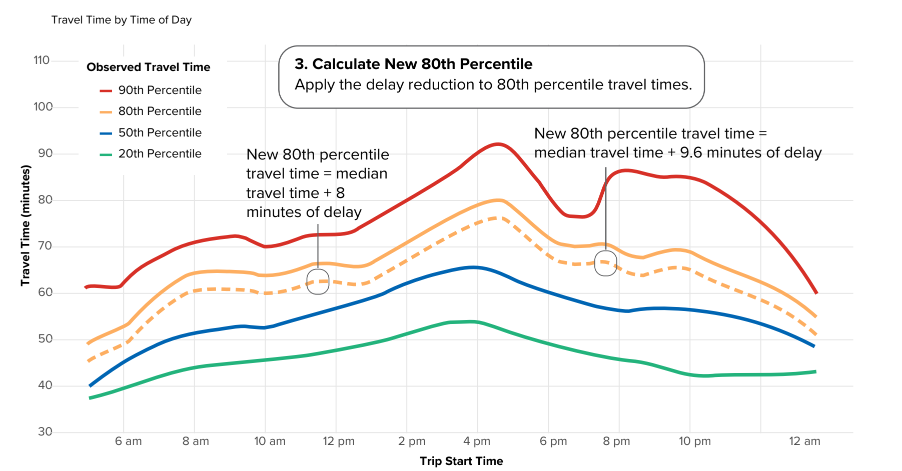


Figure 2-7 How to Calculate Potential Delay Reduction per Treatment – Step 3



Travel Time Savings

This analysis estimates the travel time savings that can be achieved with a transit priority treatment by comparing travel times during congested periods with times of the day when traffic is light and generally free-flowing. This analysis cannot be used for corridors with chronic all-day congestion and slow speeds. Use a similar 3-step process as described for calculating potential delay reduction, using data for the segment or portion of the route where the transit priority treatment is located.

Figure 2-8 Potential Travel Time Savings per Treatment (bus/BAT lane) – Step 1

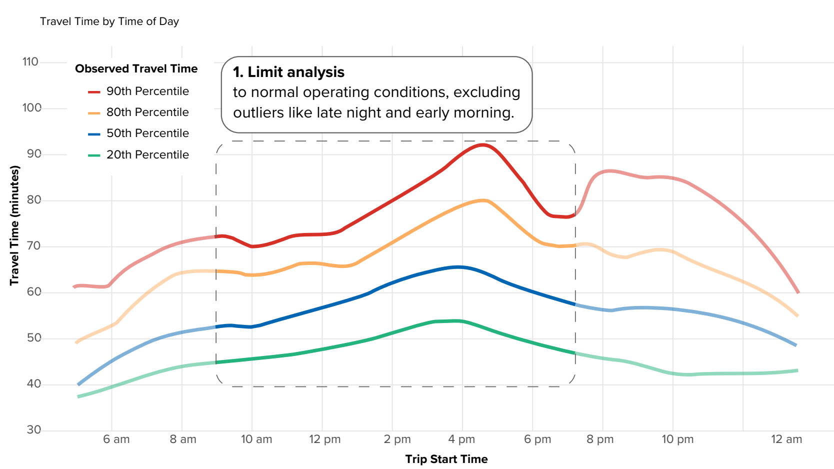


Figure 2-9 Potential Travel Time Savings per Treatment (bus or BAT lane) – Step 2

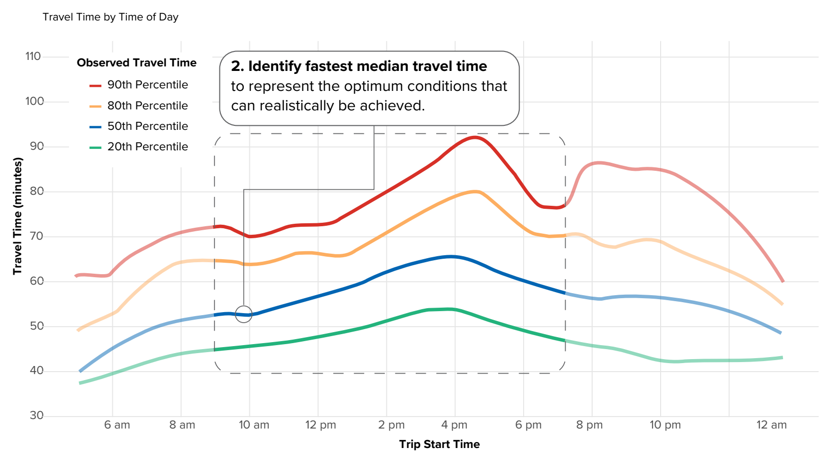
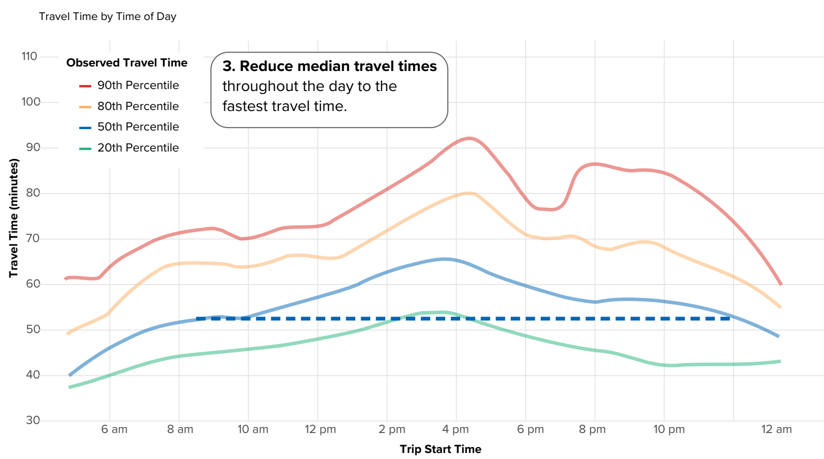


Figure 2-10 Potential Travel Time Savings per Treatment (bus/BAT lane) – Step 3



Reliability

What is it?

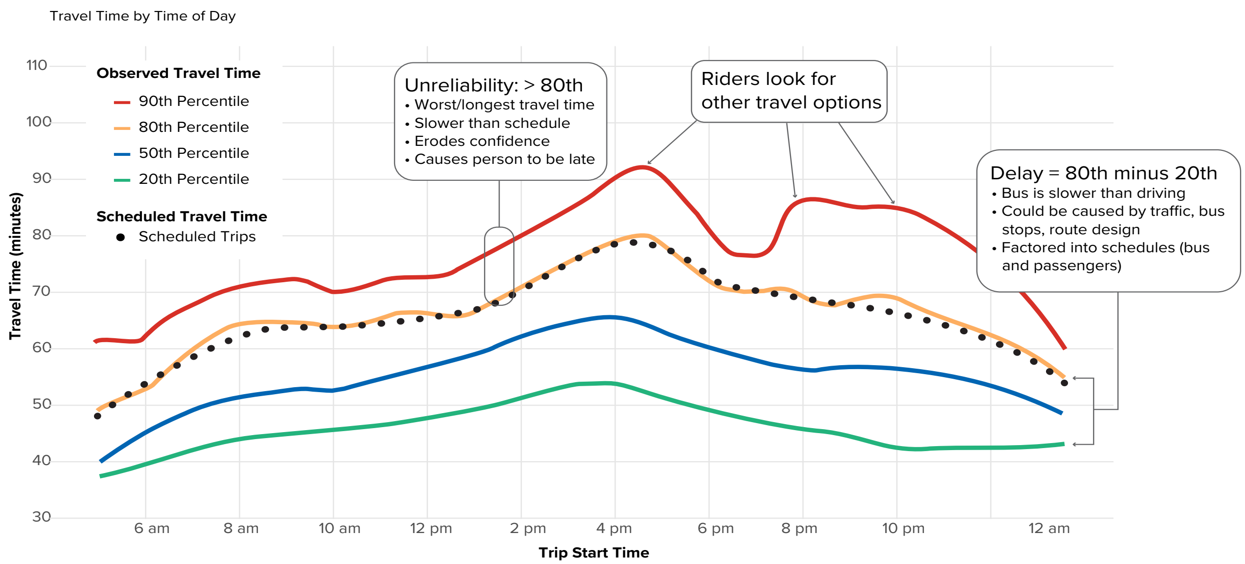
Reliability refers to the concept of consistency – the bus arrives at the same time or at predictable intervals, day after day. Reliable service helps to meet passenger needs and expectations, allowing them to know when to arrive at a stop to get to work on time or to make a scheduled appointment. Reliability builds rider confidence in the bus service; as riders know they can get where they're going on time. For many, the reliability of the service is equally or more important than the absolute travel time or speed of the service.

How is it measured?

Reliability is measured as the variability of travel time for a particular transit trip, along a full transit route or a portion of a route. Travel time data is typically collected using AVL technology. Agencies often communicate travel time data using actual travel times and grouping them in percentiles. For example, an 80th percentile travel time for a particular run means 80% of trips are equal to or faster than that travel time. Schedules are often based on the 80th or 90th percentile to be conservative so passengers aren't late.

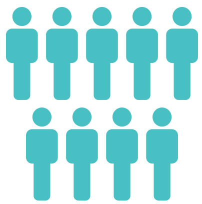
There is an important distinction between reliability and delay, as illustrated in Figure 2-11. Delay is often accounted for in schedules and is caused by traffic. But reliability refers to the amount of variability in travel times, day after day, that can cause people to lose confidence in the bus. When the bus is the most unreliable – i.e., when the 90th percentile trip (or the worst day out of ten) is significantly slower than the average trip – riders lose confidence and search for other ways to travel.

Figure 2-11 Unreliability and Delay



People Throughput

What is it?



People throughput is the number of individuals that can move through an intersection or along a corridor. It measures individual people using all modes, rather than vehicle throughput, as is more traditional. Throughput metrics may analyze the entire roadway facility, individual lanes, and intersections by mode of travel. Scenario testing may be used to compare potential impacts of converting spaces for bus or transit-only use on total person throughput.

Because transit can carry more people per square foot than personal vehicles can, a greater volume of people can be accommodated in a transit lane than in a general-purpose lane with frequent service headways. Figure 2-12 shows an illustrative example of how people throughput could increase when a general purpose traffic lane is converted to a Business Access and Transit lane, allowing for more frequent service.

How is it measured?

Calculating throughput is specific to each corridor, as the variables that determine throughput are location-dependent. Figure 2-13 includes formulas for calculating the throughput for each lane.

- The number of people that can be carried by transit is based on the on-board load and frequency.
- Transit throughput should be compared to vehicle throughput to gauge percent of people that pass through the corridor on transit.

Figure 2-12 Example of Existing and Estimated Future People-Throughput

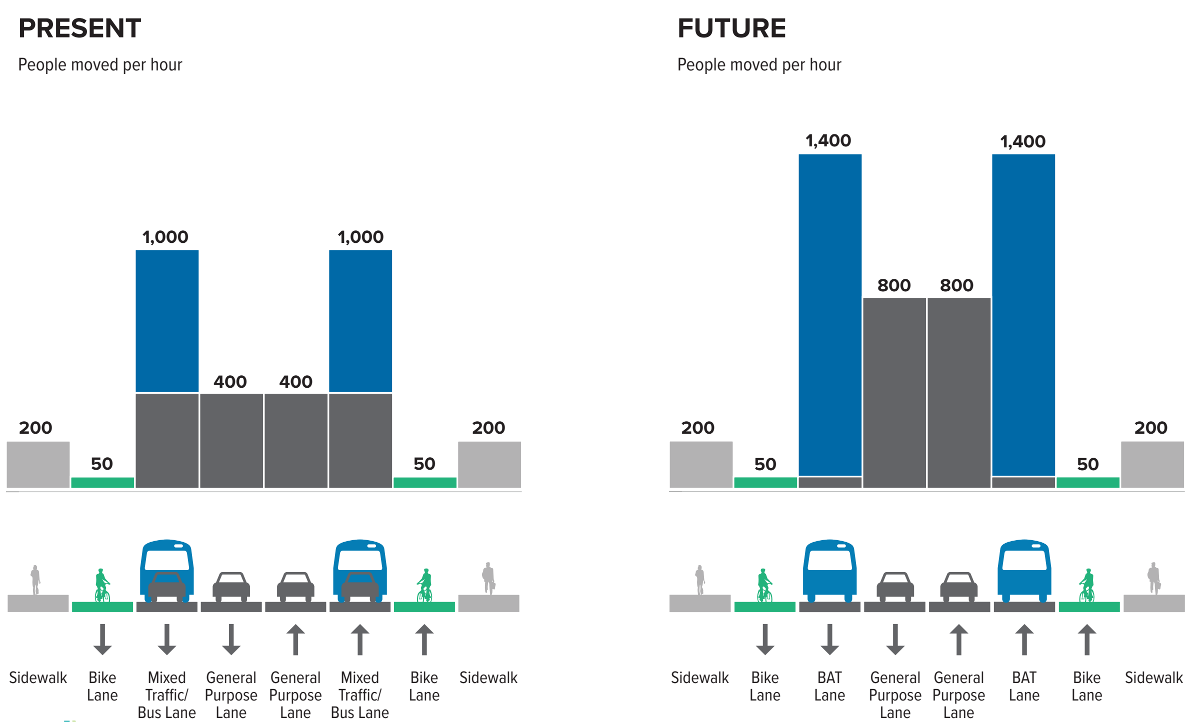
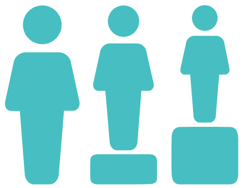


Figure 2-13 Roadway Throughput (People per Hour)

Lane type	Formula
General purpose lane	Vehicles per hour passengers per vehicle.
General purpose lane with bus in mixed traffic	(Vehicles per hour passengers per vehicle) + (Buses per hour passengers per bus).
Bus lane	Buses per hour passengers per bus.

Equity



On May 6, 2021, SCAG's Regional Council adopted The Racial Equity Early Action Plan, which guides and sustains SCAG's regional leadership in service of equity and social justice. The Early Action Plan provides a definition of equity and establishes goals, strategies, and a set of "early actions" to advance racial equity through SCAG's policies, practices and activities.

What is it?

Transportation decisions have significant equity impacts. An assessment of equity must consider historic inequities and the lasting impacts of unequal distribution of transportation benefits, such as access to opportunities, and costs, such as but not limited to noise, pollution, indirect service, and travel delays.

The Early Action Plan developed a working definition of equity to support the overarching goal of the creation of a just and equitable society.

> ***"As central to SCAG's work, racial equity describes the actions, policies, and practices that eliminate bias and barriers that have historically and systemically marginalized communities of color, to ensure all people can be healthy, prosperous, and participate fully in civic life."***

Adopted equity indicators were grouped into categories aligned with the goals of SCAG's long-range plan, Connect SoCal: Economy, Healthy and Complete Communities, Mobility, and Environment.

How is it measured?

To evaluate current equity conditions and the potential improvements that can be made, questions to ask include:

- Are there parts of the network that serve more disadvantaged or low-income communities, and are there unserved communities with high demographic stress indicators (described below)?
- What types of mobility challenges or barriers exist for potential riders?
- How are those areas impacted by delay and unreliability as compared to other places?
- What are the travel time savings for riders who rely on transit compared to the driving population?
- How much will proposed improvements increase access to jobs and other opportunities for disadvantaged populations?

In addition to assessing the benefits, any changes to transit service must be examined for their potentially negative equity impacts.

Demographics

The most recent US Census American Community Survey 5-year estimates are typically the basis of any demographic analysis. Demographics such as people with low incomes, people of color, and households without access to a car are strong indicators of mobility challenged, and potentially disadvantaged, communities. Additional indicators of potential mobility need, and distressed communities may include, but are not limited to, seniors, persons with disabilities, single parents, people with limited English proficiency, and/or communities with a high pollution burdened. The California Office of Environmental Health Hazard Assessment (OEHHA) CalEnviroScreen tool is the preferred data source for this last indicator.

People of color includes any race other than white and people who identify as Hispanic/Latino ethnicity, regardless of race. U.S. Census data on people with disabilities may not be available for smaller geographies or have a high margin of error. Transit agency data on use of disability fares, wheelchair lifts, and paratransit has proven a valuable data source.

Additional data analysis

Data sets viewed through different lenses may reveal a diversity of potential hotspots. Transit operators and stakeholders should conduct equity-based demographics analyses as aligned with their stated goals and policies. However, if opportunities exist, entities should also develop metrics appropriate to the making up their respective service areas or jurisdictions.

While the daylighting of new data tools that emphasize the value of people over route productivity is encouraged, incorporating additional indicators may also come with data prioritization challenges. In some cases, agencies may consider equity-centered analytics that aggregate demographic and socioeconomic data indicators and assign weighted values to each indicator to develop a 'composite' rating of mobility need or burden. Of the potential equity indicators, low-income and zero car households bear the strongest influence toward personal access to mobility options and may therefore be prioritized among weighted values

Thresholds to determining the most burdened communities within each demographic indicator should be calculated using standard statistical analyses (i.e., aligned with standard deviations or natural breakpoints; quantiles-top 25% or quantiles-top 20%) and should be normalized with countywide or regional population totals.

As additional barriers to mobility and transit usage are identified, more detailed and intentionally rich data collection may support deeper analyses of these aspects of the rider experience. Traditional data collection methods, such as on-board survey data, could be expanded to inform the analysis of access and connectivity benefits and impacts at the route or stop level such as but not limited to:

- **Identifying walksheds around each station area** based on existing pedestrian network conditions and compare with the community demographics across intersecting block groups as a baseline measure of existing access to transit for communities with greatest mobility burden. The baseline condition could be used for future comparative analyses of potential equity benefits and impacts of the proposed programs, projects, and policies.
- **Overlay of rider origin-destination patterns and/or boarding-alighting (stop ID) locations** to complement or validate traditional travel demand modeling data. It may also be used in conjunction with the equity index analysis results to focus in on travel trends of core transit riders and other potential communities of interest.
- **When analyzing travel patterns to regional employment centers**, consider the markets for low wage jobs and shift workers, as well as supporting activities of daily living including but not limited to healthcare, education, food and retail centers.
- **Identify presence of sidewalk and station amenities** in communities with high concentrations of mobility challenged residents. This could be used to support alignment of capital investments in bus stop improvements with other public works or utility investments in equity focused areas.


Source: Getty Images

Access to Jobs and Opportunities (Accessibility)

What is it?

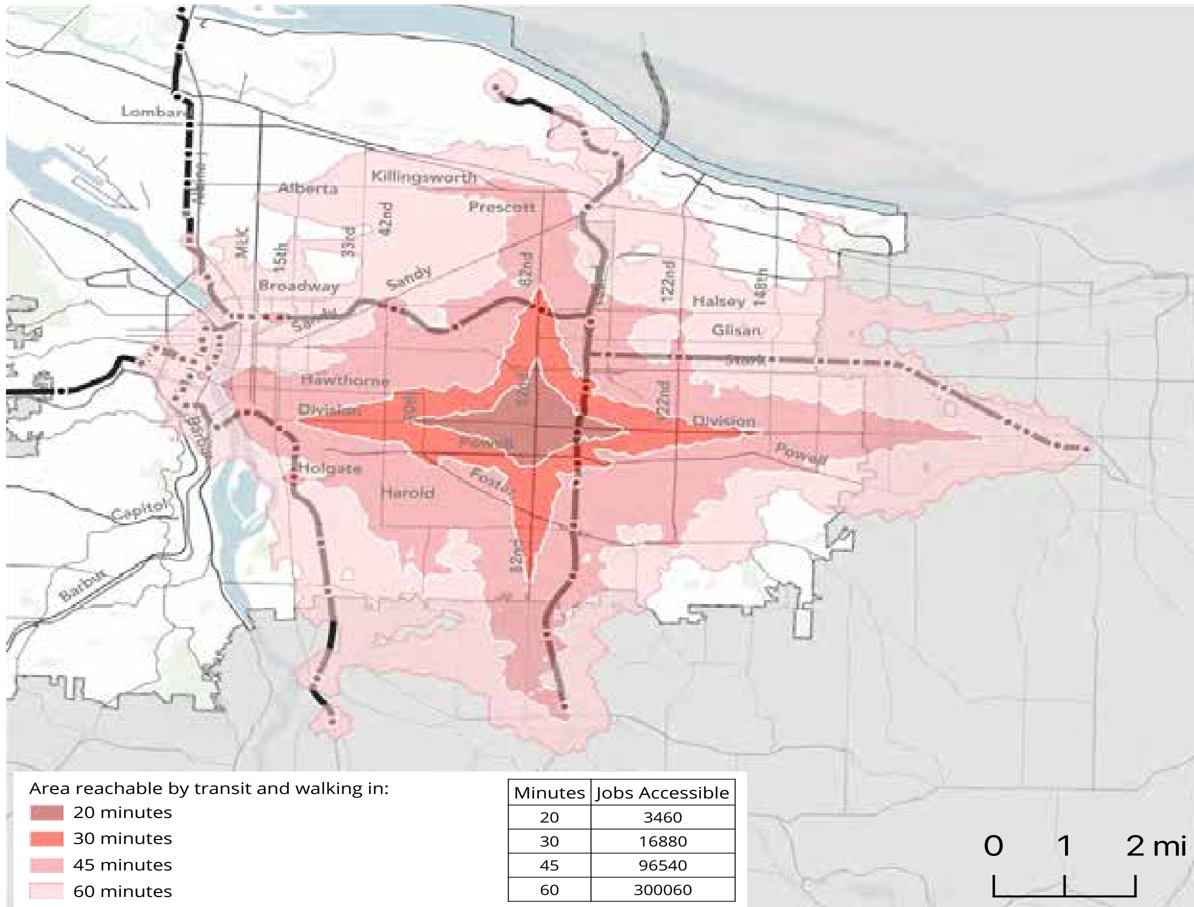
Accessibility, or access to jobs and opportunities, measures how readily jobs, healthcare, schools and other key resources can be reached by transit. By implementing a transit priority project, agencies can help demonstrate that small travel time savings have a big impact on the increase in number of jobs and opportunities available, particularly to high need populations. Figure 2-14 maps some of the results of an accessibility analysis carried out for the Portland Bureau of Transportation's Rose Lane Project.

How is it measured?

The following steps are typically applied to measure accessibility:

- **Identify the population of interest within a geographic area.** This could be the total population but is frequently an equity-focused population or community with high mobility needs.
- **Calculate the number of jobs** (or other types of destinations) that are accessible within a specific travel time, for example 30- or 45-minutes. Agencies may consider assessing concentrations of low-wage jobs as well as all levels of employment.
- **Estimate the travel time improvements for a transit priority project** and demonstrate the change in number of jobs that are accessible within the specified travel time.

Figure 2-14 Example Accessibility Analysis



Minutes	Jobs Accessible
20	3460
30	16880
45	96540
60	300060

Travel Time Isochrone Map - Area reachable by transit from PCC SE at 5:00 PM with the Existing Network.

Source: https://www.portlandoregon.gov/transportation/article/753783

Changing Travel Patterns

What is it?

Bus lane projects are often evaluated based on traffic impacts. But when a traffic lane is changed to a different use like a bus lane, communities have found this can alter transportation behavior. Some people choose to take the bus (which is now faster). Drivers may choose to travel along a different route or at a different time of day. For example, the installation of bus lanes by the MBTA along Brighton Avenue in Allston, MA resulted in an 8% increase in transit ridership and a 13% reduction in general purpose traffic. Traffic analysis can assume some "traffic evaporation" to add a more realistic look at potential outcomes.

Changing patterns among the riding public should also be observed and monitored, where possible. Collecting specific bus stop loading and unloading locations as well as the passenger home and destination locations with onboard surveys may allow insights into the overall user experience.

How is it measured?

- **Collect baseline traffic data** to understand current travel patterns for all modes.
- **Compare the traffic volumes before and after a project is implemented, at different times of day.** If traffic volumes decreased after implementation, the volume reduction means peoples' travel patterns changed.
- **Observe line ridership by time of day** as well as increases in midday or early afternoon traffic volumes to understand how delay to transit riders may have changed.
- **Use origin and destination and loading/unloading data at bus stops** to assess transfers as well as potential first last mile behaviors and challenges.

Climate and Environmental Justice

What is it?

Climate change has placed a growing urgency on the reduction of vehicle miles traveled (VMT) and emissions. Many projects and services are carefully assessing their potential impacts on the environment, air quality, and on communities living in areas with heightened exposure to pollutants and/or contaminants (pollution burdened).

This assessment may include estimates of increased transit ridership and associated reductions in automobile use in the project service area, projected in the short term based on transit investments.

How is it measured?

Regional travel demand forecasting models are a common tool used to assess regional VMT reduction from new or improved transit services.

The California Air Resources Board (CARB) has also developed quantification methodologies to estimate the direct effects of reducing VMT and associated GHGs from transit investment projects. Their VMT Impact spreadsheet tool and the California Climate Investments (CCI) quantification methodologies may be used for significant Transit and Intercity Rail Capital Projects. However, it does not currently have a methodology for determining the indirect effects on a local scale.

In California, areas with a heightened exposure to pollutants are typically identified using the California Office of Environmental Health Hazard Assessment (OEHHA) CalEnviroScreen tool, which compiles environmental, health, and socioeconomic information to produce scores for every census tract in the state.

PROJECT PRIORITIZATION

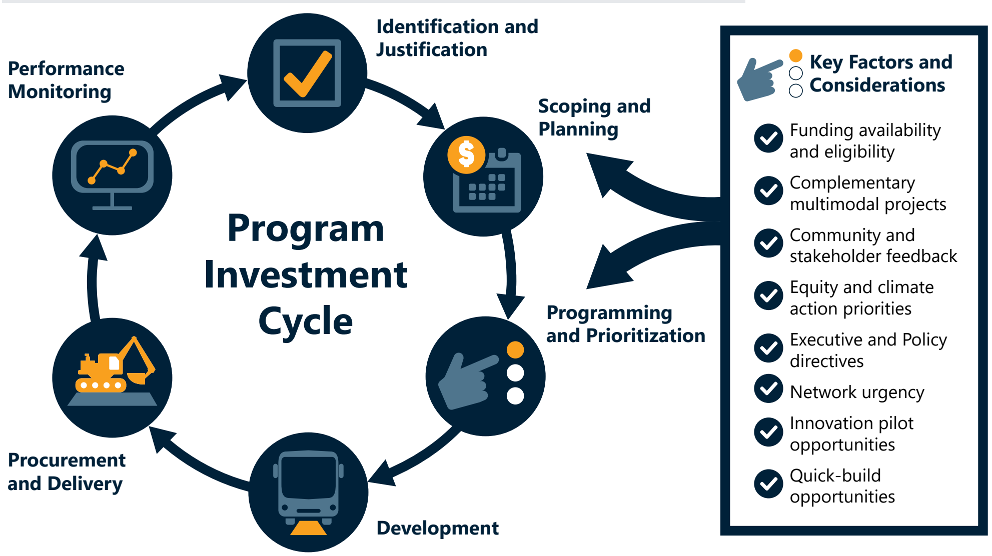
Deployment of transit priority treatments along a corridor or across a regional network may require more significant levels of investment for infrastructure and capital construction. To advance design and implementation for more complex and costly speed and reliability projects, transit operators often need to partner with local jurisdictions to integrate projects into stakeholder capital improvement planning (CIP) processes or partners with others to seek external grant opportunities.

To capitalize on opportunities to incrementally advance transit priority spaces or treatments, transit operators should work with local and regional transportation planning stakeholders to establish a programmatic cycle of coordination regional transportation and capital investment planning processes. The graphic in Figure 2-15 emphasizes the Scoping and Planning as well as Project Programming and Prioritization steps, where various factors may influence or elevate the competitiveness of transit speed and reliability projects.

Where local or regional municipalities have control over project eligibility, scoring criteria and weighting, elevating transit speed and reliability projects has been effective when emphasis is placed on:

- **Quick build projects** that can be implemented in the near term, are low cost, and align with other multimodal and investment packages.
- **Investment in designated High-Capacity Transit (HCT) corridors**, transit oriented developments/ communities, or transportation investment zones.
- **Projects that improve transit travel time competitiveness**, have minimal impacts on traffic operations, and provide potential benefits to climate through VMT reduction or mode shift.
- **Investments in mobility access for equity-focused** and/or under invested communities.
- **Community driven factors** including but not limited to ballot initiatives, or direction from authority Board or Executives.
- **Projects that provide critical regional network connections** and align with recommendations and complementary projects from adopted transportation plans.

Figure 2-15 Transit Speed & Reliability Program Investment Cycle



sbX BRT station in San Bernardino, CA.

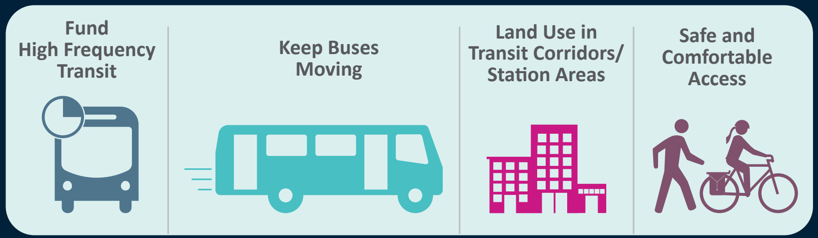
Source: Omnitrans

CHAPTER 3

Speed and Reliability Design Treatments

Infrastructure investments make transit faster and more reliable.

Transit agencies operate buses, but local and state jurisdictions own streets and sidewalks. By working together, municipalities and agencies can provide safe access to high-quality transit. This chapter focuses on design treatments that can improve speed and reliability, and which require interagency coordination.



Guide to Cost-Coordination Metrics

Each design treatment described in this chapter includes an order-of-magnitude typical cost and coordination complexity metric, defined as follows.

Cost	$$	Coordination	Low

Cost estimates use a rating scale of one ($) to four ($$$$) dollar signs, equating to the following amounts:

$	Interventions typically **less than $50,000**
$$	Interventions typically **between $50,000 and $100,000**
$$$	Interventions typically **between $100,000 and $250,000**
$$$$	Interventions typically **over $250,000**

Coordination estimates use a rating scale of low to high, equating to the following:

Low	Requires **little to no coordination** amongst stakeholders, other agencies, etc.
Medium	Requires **a fair amount of coordination** amongst stakeholders, other agencies, etc.
High	Requires **an extensive amount of coordination** amongst stakeholders, other agencies, etc.

BUS LANES

Cost **$$$** Coordination **High**

What Is It?

Bus Lanes provide a dedicated space for transit vehicles to operate, improving reliability and reducing travel times by keeping buses out of traffic. Bus lanes can have many variations in how they operate in space and time. They may include barrier separation for dedicated BRT lanes or non-separated facilities that allow mixed traffic or limited auto operations.

Bus lanes could be exclusive to transit or permit other vehicles under certain conditions. Hours of operation may also range from 24-7 to peak commute hours only.

What Are The Benefits?

Jurisdictions experience most significant **travel time savings** with dedicated lanes:

- **Buses are able to bypass congested segments of roadway in their own lane**, reducing delays, improving travel speed and maintaining schedule reliability over time.

Complementary Treatments

- **Transit signal priority (TSP)** to extend green time for buses approaching signalized intersections.
- **Bus stop / station platform location and amenities** to promote safe, comfortable, and accessible connections to the station.

Travel Time Improvement Case Studies

- **In San Francisco**, SFMTA's Church Street Transit Lanes Pilot reduced travel time by 12-13% and travel time variability by 27%, providing faster and more reliable service along the corridor.
- **In Los Angeles**, LA Metro's Wilshire BRT (which included Dedicated Bus Lanes), reduced travel times by approximately 30- 45 seconds per mile or PM peak buses resulting in improved reliability by 12-27%.*

* Observed improvements were pre-pandemic. National Academies of Sciences, Engineering, and Medicine (2010). Bus and RailTransit Preferential Treatments in Mixed Traffic. Retrieved from https://doi.org/10.17226/13614.

When Is It Used?

Bus lanes are often deployed in urbanized areas that have an established roadway grid network with alternative routing options for existing auto traffic.

Other conditions that may warrant bus lanes include, but are not limited to, the following:

- **Suburban-urban arterial connectors** with sufficient right-of-way (ROW) and traffic conditions that support construction of new bus lanes or conversion of existing underutilized lanes.
- **Corridors where implementation of BRT** or enhanced bus lines with high frequency service have been proposed.
- **Future high-density land use patterns** and congestion mitigation strategies call for increased transit service and accessibility.
- **Corridors or segments that can support operation of multiple fixed routes** that result in high frequency service when headways are combined.
- **Support high ridership lines** that experience high delay due to traffic congestion; or where increased capacity is warranted to meet demand or mitigate potential crowding at bus stop locations.

BUS LANES

What kinds of bus lanes are there?

Side-running lane in Clackamas County, OR.

Floating lane in East Portland, OR.

Center-running Bus Rapid Transit Lane in Curitiba, Brazil.

Side-Running

Buses run in the right-most travel lane (nearest the curb).

- Right-turning vehicles may be restricted to designated intersections and may be signal controlled.
- Buses are not delayed by interactions with parking or loading vehicles; however adequate enforcement is necessary.
- Side running lanes can have flexible uses throughout the day depending on conditions, such as parking or a shared bus-bicycle use.
- Side running lanes may be used in operation as a couplet along 1-way street pairs in downtown core areas.

Floating

Buses run in the right lane, but are offset from the curb by street parking, curb extensions, or bicycle facilities.

- Safely separates cyclists and pedestrians from the traffic lane.
- Keeps bus in lane to reduce merging in and out of the travel lane.
- Applicable to segments with separated bicycle/ pedestrian lanes and areas with heavy traffic and bicycle/pedestrian safety concerns.

Center-Running

Buses run in the middle of the road. Lanes are often separated from other traffic by curbs or median islands.

- Signalized left turn storage lanes are often desired next to center-running lanes.
- Applicable to bus routes where traffic congestion affects reliability and are often more effective than side running lanes.
- Center-running lanes serve buses and streetcars at potentially very high capacity and volume, while improving the pedestrian and passenger experience of the street.
- Center-running lanes eliminate conflicts with drop-offs, deliveries, or illegal parking along the roadway edge, as well as with bicyclists and some turning movements.
- Center transit lanes can be applied as part of the implementation of a BRT line or other bus improvements, on any bus routes with suitable stations.

What kinds of bus lanes are there? *(continued)*

Peak-only bus lane signage.

Peak-Only Lanes

Bus lanes that are reserved for transit at peak travel periods (such as the morning and evening commute) and are used for general traffic or parking at other times.

- Peak-only bus lanes supports transit service by substantially improving both reliability and transit travel times on streets where congestion at peak causes transit delays.
- Peak-Only Lanes can potentially decrease travel times during peak periods, improve reliability, and allow off-peak parking and lane access to non-transit vehicles.
- Applicable to corridors with high peak-period bus frequency and generally high traffic volumes and on corridors with predictable bus delay due to peak-period vehicle traffic, particularly due to queuing.

BAT lane in Portland, OR.

Business Access and Transit (BAT)

Dedicated bus lanes that allow intermittent access for vehicles turning at intersections and vehicular access to driveways to reduce travel times, improve reliability, and maintain business and community access.

- Right turns from BAT lanes can impede transit speeds.

Example of Metro Transit's bus-on-shoulder system.

Bus-on-Shoulder

Buses run on the shoulder along limited-access roadways such as state or interstate highways.

- May require special permission or agreements with jurisdictional authority and only under specific conditions (ex: only when travel speeds reach below an established mph threshold).

What kinds of bus lanes are there? *(continued)*

Reversible lanes signals in Vancouver, BC, Canada.

Reversible

A single exclusive bus lane that allows buses to travel in either direction, depending on the time of day.

- Improves traffic flow during peak periods by having overhead traffic lights and lighted street signs to notify drivers which lanes are open or closed to driving and/or turning.
- May be used on freeway segments with limited ROW to support peak period directional capacity needs.

Contraflow lane in Boston, MA.

Contraflow

Bus lanes operates against the flow of traffic on a one-way street.

- Contra-flow bus lanes enable connectivity and shorten travel times for bus routes.
- Typically applied to bus routes to create strategic, efficient connections rather than as a continuous application along a corridor.

Design Elements

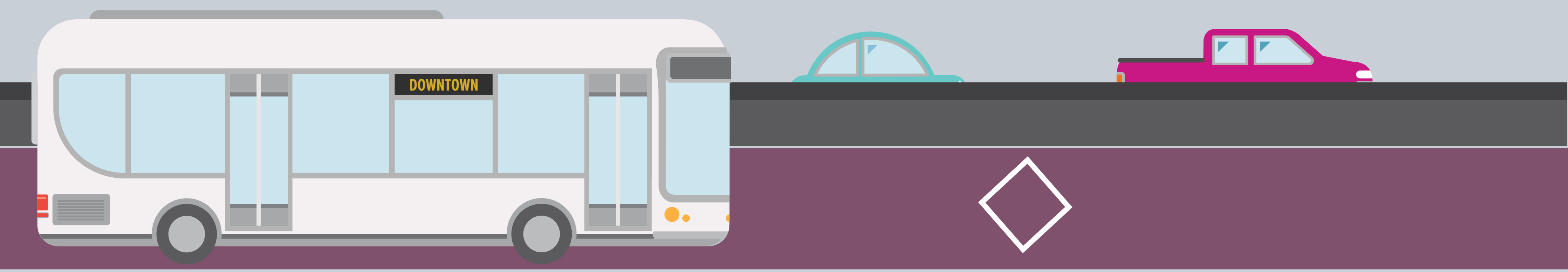
- Dedicated bus lanes may require repurposing existing travel lane, parking lane, or additional right of way to support new construction.
- Combinations of low-cost investments such as signage, red paint, or tinted asphalt can be used to demarcate exclusive bus use of the lane.
- Physical barriers (e.g., bollards, hard curbs, etc.) may be installed to prevent non-transit vehicles from entering the bus lane.
- Bus lanes treatments may require modifications to the built environment such as but not limited to reconstruction of existing roadways dependent upon the condition of road, construction material (ex – asphalt or concrete), the anticipated traffic volumes and resultant life-cycle maintenance requirements.
- Additional design elements and may be considered to accommodate appropriate choice bus lane treatment.

Other Considerations

- Buses equipped with cameras and enabling legislation (such as AB917) to allow citations against cars driving or parking in bus lanes increase compliance and ensure speed and reliability.
- Installation of bus lanes can mean repurposing travel or parking lanes. Bus lanes may increase congestion in adjacent vehicle travel lanes (or be perceived to by the public).
- Dedicated Bus Lanes are designated by signage and pavement markings for exclusive transit use and may be on a separate right-of-way, concurrent with adjacent traffic or contraflow with adjacent traffic. Dedicated bus lanes may also be shared with bicyclists and emergency vehicles.
- Higher cost projects include additional right of way or physical barriers, lower cost projects can include repurposing existing travel lanes with signage and pavement markings.
- Red paint or tinted asphalt is currently being used as an experimental treatment approved by FHWA and may require permitting for use within some jurisdictions. It has been effective as a quick-build deployment strategy but requires additional maintenance of the aesthetic due to the effects of regular wear.
- Bus lane design and implementation should be accompanied by traffic studies to justify installation and mitigation of potential traffic, curb management, and parking impacts.
- Jurisdictions having control over roadways should coordinate bus lane projects with all transit operators and transportation providers in their area to establish and communicate policies governing shared use of bus lanes.

FREEWAY BUS LANES

Cost	$$-$$$$	Coordination	High



What Is It?

Buses run in exclusive transit-only lanes within limited-access highway facilities; or along with mixed vehicles within HOV and other managed lanes in the highway.

What Are The Benefits?

- **Travel Time.** Buses operate in HOV or managed lanes and can bypass freeway congestion.
- **Reliability.** Bus lanes allow for consistent travel times. Freeway bus lanes often serve regional commute markets with time-sensitive passengers.
- **Safety**, Bus only lanes limit conflicts between buses and auto traffic, but would require dedicated space for access and egress at select locations.

What Does It Look Like?

- Median bus-only lanes run the center of the freeway or buses can share freeway lanes with HOV or managed lane facilities (such as HOT lanes).
- Service may also operate on freeway slip-ramps and parallel utility corridors during route segments.
- Freeway bus lanes are often paired with park-and-ride facilities to expand their market reach beyond those within walking or bicycling distance.

When Is It Used?

- When HOV or managed lanes are present, or planned freeway facility expansion or widening.
- When there are long distances between stops and the freeway is the fastest route.
- When there is space in the median for bus lanes and conditions support conversion.

Shared bus/HOV lane (Houston, TX).

Source: Houston Public Media

FREEWAY BUS LANES

Houston Metro Park and Ride Facility off I-45.

Metro Transit Orange Line (I-35W at 46th St), Minneapolis, MN.

Design Elements

Level of separation may impact travel speeds, exclusivity of use for buses, as well as potential rider access to service (stations).

- A barrier separating bus lanes from general traffic lanes is a high investment but provides the highest quality freeway bus lane in terms of safety and enforcement. Features can include but are not limited to:
  - Median openings for bus access/egress, direct connectors and slip ramps to adjacent station areas and Park and Rides.

Additional considerations for passenger circulation, safety and comfort are required at stations adjacent to or within freeway corridors. Station configuration and connectivity at the route termini, or intermittently along the freeway corridor may vary.

- Median freeway bus lanes may feature in-line stations within the median, which require vertical circulation to a connecting overpass for surface multimodal connection; or a direct connector ramp connecting to the arterial network outside of the freeway facility. ROW-often to serve designated regional transit or park and ride facilities.
- Freeway bus routes operating without barrier separation may connect with side-running stations constructed for bus pullout along access/exit ramps or slip ramps.

Bus on Shoulder is a lower level of infrastructure investment. Permission or agreement with the agency (owner) having jurisdictional authority over the ROW may be required and may include specific thresholds for use.

- Buses may be allowed to use the shoulder at any time, or there may be time restrictions (such as during congestion only).
- Buses on shoulders may also operate with speed caps in case a driver pulls into the shoulder or a vehicle is stopped in the shoulder.
- The shoulder must remain available for emergency vehicles so there cannot be a physical barrier.

Other Considerations

- Changes in regional transportation policy emphasizing alternative modes and VMT reduction may shift funding priorities from urban and rural highway facility widening and expansion where ROW envelops have been preserved, or to adaptive reuse (of overbuilt infrastructure).
- Demonstration of benefits to bus shoulder operations over time may incrementally evolve to more significant transit priority investments on freeways as the desired travel time regional competitiveness increases.
- Appropriate first/last mile surface transportation connections, including parking at end of line stations are critical supporting factors to encourage commuter mode choice changes.

FAR-SIDE BUS STOPS

Cost	$-$$	Coordination	Low

What Is It?

Far-Side Bus Stops are located after an intersection, allowing the bus to travel through the intersection before stopping to load and unload customers.

When Is It Used?

Most transit agencies prefer far-side stops as a general policy. They are also beneficial in locations with long signal cycles or short green signal times.

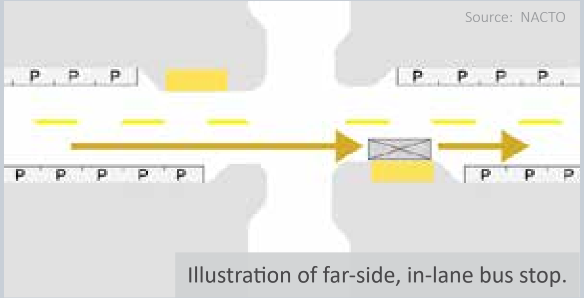


Illustration of far-side, in-lane bus stop.

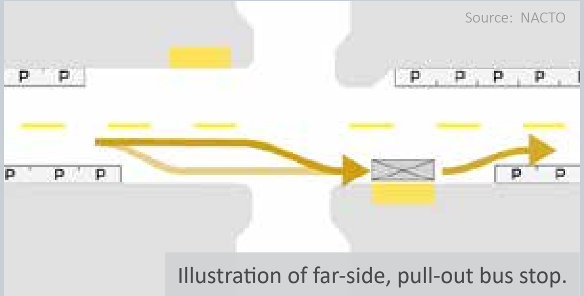


Illustration of far-side, pull-out bus stop.

What Are The Benefits?

- **Travel Time:** Far-side stops reduce delays from traffic signals. They can potentially save up to 4 to 9 seconds per stop, on average.
- **Reliability:** Reduce potential for stop-and-go service when buses can travel through the intersection before reaching the bus stop.
- **Safety:** Conflicts with right-turning drivers and pedestrians and cyclists traveling through the intersection are minimized or eliminated.

What Does It Look Like?

- **Far Side, In-lane Stops** at the far side of an intersection have the highest benefit to transit operations since buses can stop in the general purpose travel lane and proceed directly after stopping for loading and unloading.
- **Far Side, Pull-Out Stops** should only be used on streets with high posted speed limits (approximately 35 to 40 mph or above).

FAR-SIDE BUS STOPS

Design Elements

- Colored concrete can be used to demarcate the bus stop loading area.
- Bus stop length should accommodate the typical number of buses expected at the stop at one time.
- Aim for at least 10’ between the crosswalk and the back of the bus to facilitate safety and visibility for intersection users.

Complementary Treatments

- **Transit Signal Priority** allows buses to clear intersections before reaching Far Side Bus Stops.
- **Bus bulb outs** *(curb extensions)* may be used to bring boarding area into the parking lane or bicycle lane so buses can pick up or drop off customers without exiting the travel lane.
- **Bus Pullouts** designate space on the shoulder or parking lane for buses to exit travel lanes for loading and unloading but require buses to wait for a gap in traffic before proceeding.

Other Considerations

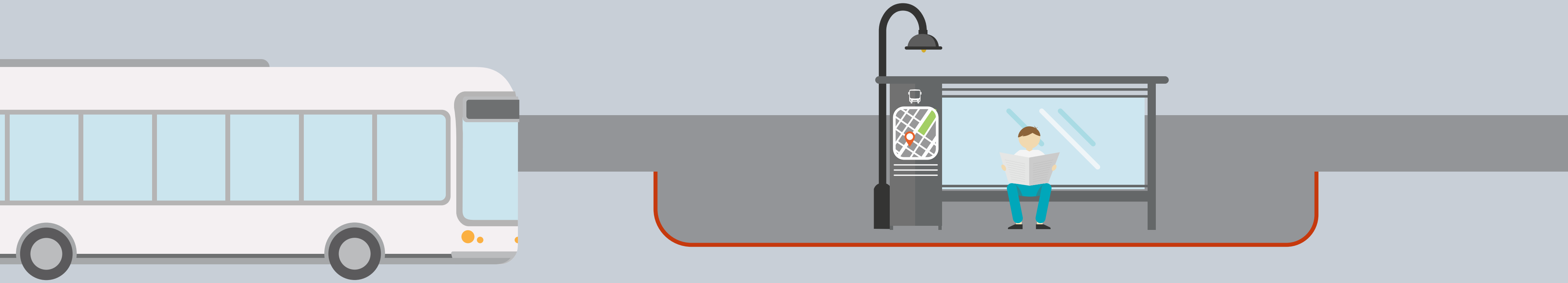
- Transit agencies typically prefer far-side stops, but other factors to consider include location of activity centers or transfer activity. These considerations may mean a stop at the near side of the intersection or between intersections (midblock) provides the best customer service.
- Pedestrian and Bicycle accessibility treatments near bus stops are crucial connections supporting the user experience.

Source: Nelson\Nygaard

Far-side bus stop in downtown Los Angeles, CA.

BUS BULB-OUTS

Cost $$-$$$ **Coordination** Low



What Is It?

Bus bulbs extend the curb ("curb extensions") into the parking lane or bicycle lane so buses can pick up or drop off customers without exiting the travel lane.

What Are The Benefits?

- **Travel Time:** Allows buses to make in-lane stops, increasing speeds by 7%. In-lane stops reduce dwell time by 15-30 seconds per stop by eliminating delays from buses pulling out of lanes at stops and waiting for a gap in traffic to proceed.
- **Safety:** Reduces pedestrian exposure to vehicles by shortening the crossing distance on the intersection leg with the bulb out.
- **Accessibility:** In-lane stops ensure buses can reach the curb and board passengers with mobility devices.
- **Customer Experience:** Bus bulbs create more space for passenger amenities while maintaining a clear pedestrian path on the sidewalk.

What Does It Look Like?

- Concrete, asphalt, or temporary material extended into the parking lane or bicycle lane.
- Can be installed near side or far side of intersection, or mid-block.

When Is It Used?

- Concrete, asphalt, or temporary material extended into the parking lane or bicycle lane.
- Can be installed near side or far side of intersection, or mid-block.

Bus bulb-out, San Francisco, CA.

BUS BULB-OUTS

Design Elements

- Bus bulbs can be created with concrete, asphalt, or temporary materials. Colored concrete can be used to demarcate the bus stop platform.
- Bulb out length should accommodate for the typical number of buses expected at the stop at one time, as well as accommodate safe loading and unloading at front and rear doors.
- Green features like bioswales or planters improve streetscape and stormwater recapture.

Complementary Treatments

- **Transit Signal Priority** to get buses through signalized intersections more efficiently to reach far side stops.
- **Bus lanes** can improve safety by mitigating potential traffic conflicts with autos queuing behind buses when stops are placed in-lane.
- **All-Door and Level Boarding** at stop locations to decrease dwell time delays.

Other Considerations

- Coordination of potential curb management impacts to commercial and/or residential parking/loading spaces with affected stakeholders may result in additional mitigation or in-kind replacement.
- When implementing bus bulb outs, stormwater management, such as drainage modifications, may be needed. Inlets between the existing curb and bulb out preserve water flow without requiring new drainage.
- Where applicable, the bus bulb out return radius must accommodate local street sweeping vehicle operating needs.
- May not be ideal when there is only one lane of traffic because this can cause traffic backups into the intersection, creating potential safety and operational issues.
- Pedestrian and Bicycle accessibility treatments near bus stops are crucial connections supporting the user experience.

Bus bulb-out, Los Angeles, CA.

Bus bulb-out, New York City.

LEVEL BOARDING

Cost	$$$	Coordination	Low

What Is It?

Level boarding means the bus platform height closely matches the floor height of buses to provide fast and easy access for passenger loading and unloading – meaning that buses do not have to kneel or deploy ramps to board people using mobility devices.

What Are The Benefits?

- **Travel Time:** Level boarding reduces dwell time and allows all passengers to quickly get on and off vehicles.
- **Accessibility:** In addition to people using mobility devices, level boarding makes accessing transit easier for people with strollers, carts, or bicycles.

What Does It Look Like?

- A platform/curb/curb height of 10-14 inches to match the floor height of most transit vehicles.

When Is It Used?

- Applicable to light rail, streetcar, or retrofitted low-floor buses.
- Most effective in bus routes/stops with high ridership.
- Stop locations where riders are known to include seniors and customers with mobility assistance devices, carts, strollers, and bicycles.

Source: Flickr user functoruser

Level boarding platform, Eugene, OR.

LEVEL BOARDING

Design Elements

- Curbs are designed with a slope or concave shape to allow the driver to pull the bus within 2 inches of the curb without scraping the bus wheels.
- Railings and/or detectable warning strips/ surfaces may be installed along the edge of the boarding platform.
- Level boarding platforms may require sloped transitions at edges to align and integrate with adjacent sidewalk and curb heights.

Complementary Treatments

- **Low Floor Buses:** are often preferred as part of new fleet procurement as a way of providing easier and more user-friendly access for all passengers.
- **All-Door Boarding:** that allows customers to board a transit vehicle at any open door to reduce dwell times and variability.
- **Bus Bulb-Outs** emphasizes bus stop location as separate boarding areas from the sidewalk and pedestrian realm.

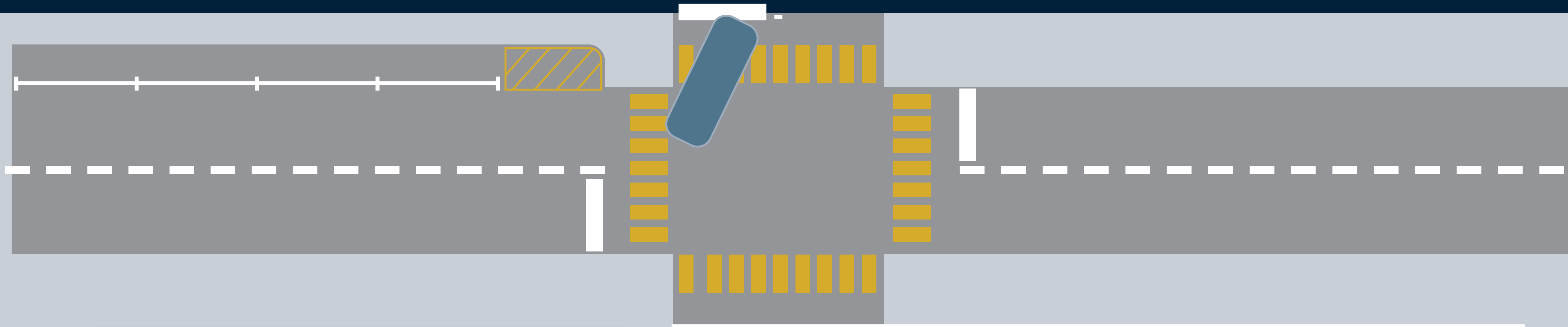
Other Considerations

- The door opening height and ramp deployment mechanisms on all existing and proposed fleet vehicles should be considered when designing and constructing level boarding platforms.
- Installation requires rebuilding the bus boarding area (sidewalk infrastructure, stormwater management, etc.).
- Level boarding platforms may be a required capital component within grant funding opportunities (ex – FTA capital improvement grant (CIG) program).

Transit curb helps facilitate level boarding.

FACILITATE RIGHT TURNS

Cost	$-$$	Coordination	Low



What Is It?

Modifications to the existing lane striping and marking at intersections, as well as potential changes to on-street parking, curb or travel lane geometry to support buses making right turns.

When Is It Used?

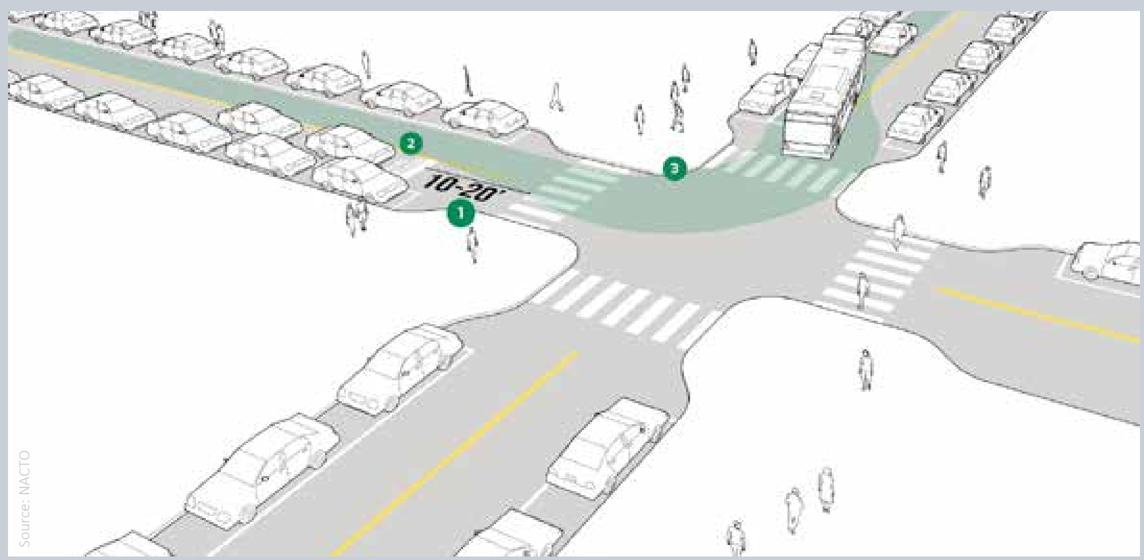
- Where bus routes require a right turn.
- Intersections in urban environments where space is constrained (narrow lane widths and turning radii) and buses may be delayed when attempting to make right turns.

What Are The Benefits?

- Low vehicle turning speeds are beneficial for all intersection users. Design treatments can be used to ensure a safe environment while also helping buses turn right.
- Reduces transit delay from making right turns.

What Does It Look Like?

- Recessed stop bars. Move stop bars back to improve turning radius for buses to maneuver through the intersection.
- Restrict on-street parking. Keep corners clear by restricting on-street parking 40-60 feet from the intersection.



Recessed stop bar (2) helps buses make a right turn.

FACILITATE RIGHT TURNS

Design Elements

- Travel lane restriping or restriping stop bars.
- Signage and pavement markings prohibiting parking.

Other Considerations

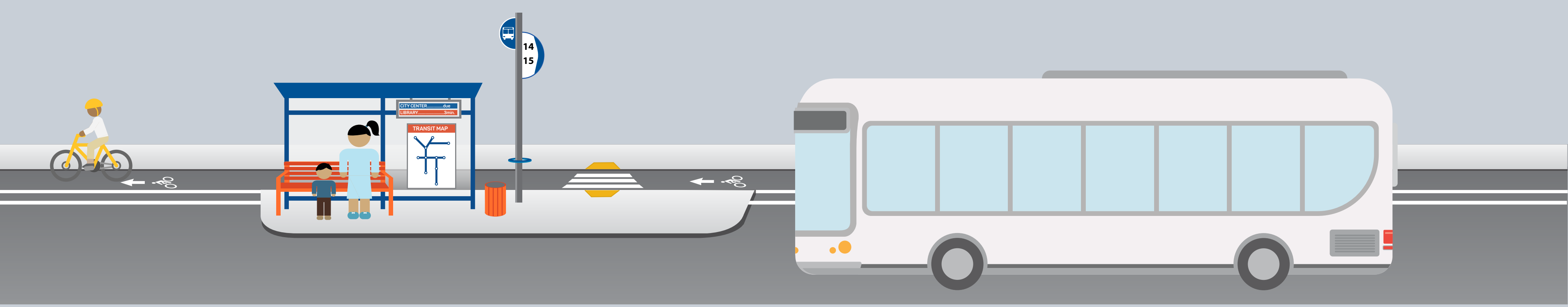
- These treatments also facilitate freight movements.
- In extreme circumstances, reconstruction of curb and sidewalk at corners may be required to improve the turning radius for buses and freight vehicles, increasing project cost.

Source: Nelson\Nygaard

Bus making right turn in an intersection with recessed stop bars.

FLOATING BUS ISLANDS

Cost	$-$$$	Coordination	Low



What Is It?

Floating Bus Islands are bus bulb outs separated from the sidewalk by a bicycle lane.

What Are The Benefits?

- **Travel Time:** Floating bus islands allow buses to stop in the general-purpose travel lane. This typically increases in-lane bus speeds and reduces dwell time by 15-30 seconds per stop by eliminating delays from buses waiting for a gap in traffic to proceed.
- **Conflict Reduction:** Floating islands allow bicyclists to pass seamlessly behind the bus stop. This improves the experience of the bus operator and the person bicycling and reduces delay caused by buses having to wait for bicyclists to pass before pulling over to the stop.
- **Safety:** Bus islands act as pedestrian refuge islands, shortening the crossing distance on the intersection leg with the bus island.
- **Customer Experience:** Bus islands provides space for stop amenities such as shelters, benches, and informational kiosks.

What Does It Look Like?

- **Floating Bus Island Stop** with bicycle lane at sidewalk level or at street level.
- May require repurposing existing parking spaces or a travel lane.

When Is It Used?

- Streets with moderate to high transit frequency, transit ridership, or bicycling volume.
- If sidewalk width permits, Floating Bus Islands may be applied to streets with curbside transit operations and a bicycle facility.

Floating bus island in East Portland, OR.

FLOATING BUS ISLANDS

Design Elements

- Concrete, asphalt, or temporary platform 8-10’ wide and long enough to accommodate the front and rear doors of buses using the stop.

Complementary Treatments

- **Class II or Class IV Bicycle Treatments** are offset from bus stop boarding areas, but require additional signage and marking to mitigate potential conflicts with riders.
- **All-Door and Level Boarding** at stop locations to decrease dwell time delays.

Other Considerations

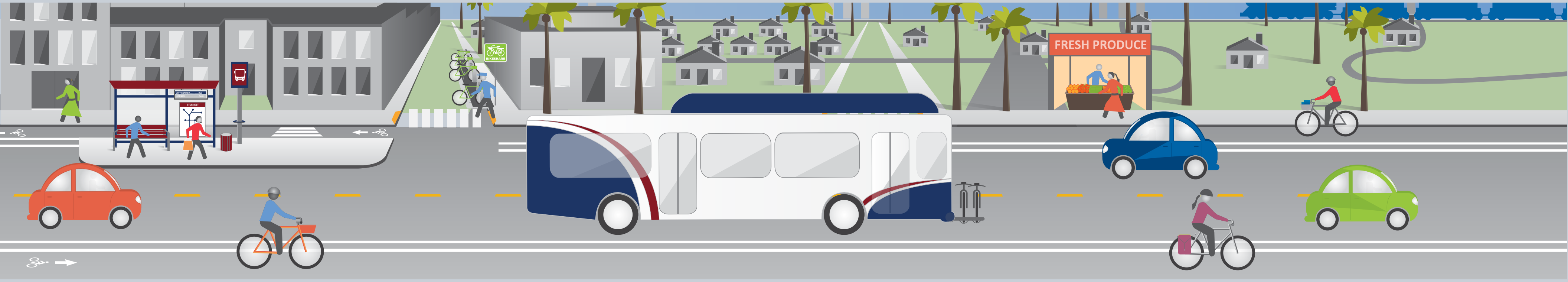
- If bicycle facilities exist or are planned, Floating Bus Islands maintain continuity of the bicycle lanes, but require consideration of how customers will cross bicycle lanes or street traffic to access the bus stop.
- Pedestrian and Bicycle accessibility treatments near bus stops are crucial connections supporting the user experience.

Floating bus island in Seattle, WA.

Separated bus and bike lanes, Portland, OR.

BUS-BICYCLE TREATMENTS

Cost	$$	Coordination	Moderate



What Is It?

Many corridors with transit also have or are planned to have bicycle facilities. Bicycle treatments can be designed to ensure fast and reliable transit through in-lane stop opportunities, reduced bus-bicycle conflicts, or shared bus-bicycle space.

What Are The Benefits?

- **Multi-Modal:** Finding ways transit can coordinate with bicycling infrastructure ensures a truly multimodal place with comfortable access by foot, bicycle, or bus.
- **Connectivity & Safety:** Integrating bicycle facilities with transit can create more safe and convenient connections to and from fixed-route service.

What Does It Look Like?

Caltrans defines bicycle ways into two major categories relevant to transit.

- **Bicycle Lanes or Buffered Bicycle Lanes (Class II)** use striping to mark space for bicyclists.
- **Protected bicycle lanes or cycle tracks (Class IV)** have a vertical separation between drivers and bicyclists.

When Is It Used?

Most communities have existing bike facilities and adopted plans for their future bicycle and transit networks.

A transit priority project affords opportunity to improve bus-bike interactions if an existing facility is in place, or to coordinate the planning and design of both a new bicycling facility and a high-quality transit service.

BUS-BICYCLE TREATMENTS

Complementary Treatments

Potential types of bicycle treatment used in combination with transit priority treatments include but are not limited:

- **Dedicated Bike Signals:** A Dedicated Bike Signal installed near busy stops or signalized intersections where buses are turning can help organize various transit, bicycle and pedestrian movements, reducing bicycle conflicts and improving traffic flow.
- **Shared Bus-Bicycle Lanes:** Dedicated travel lane shared by both buses and bicyclists.
- **Floating Bus Islands:** Floating Bus Islands are bus bulb outs separated from the sidewalk by a bicycle lane. This helps reduce bicycle and passenger conflicts.

Other Considerations

- Dedicated bus and bicycle facilities are preferred over shared bus-bicycle lanes. This facility is not appropriate on streets with high bus volumes or speeds and will not be comfortable for cyclists of "All Ages and Abilities."
- Stop locations should be designed to separate people bicycling from boarding passengers where possible.
- Enforcement is typically needed to reduce drivers parking in the bus-bicycle lane.
- Right turns across bus-bicycle lanes may need to be restricted or signalized.
- Incorporating bus and bicycle priority signalization at intersections may require additional traffic analyses to mitigate potential impacts to signal phasing and traffic delay.
- Pedestrian and Bicycle accessibility treatments near bus stops are crucial connections supporting the user experience.
- Dedicated spaces, delineated through signage and pavement markings, should be considered so bicyclists can safely queue at the intersection.
- Traffic signal timing should be adjusted to include any potential the bicycle signal phases. Adjusting signal timing may increase bus travel delay.
- If the Dedicated Bicycle Signal is used to separate through bicycle movements from right turning vehicles, then right turn on red must be prohibited when the signal is active.
- Provide additional bus operator training dealing with bicyclists in a shared environment.

A shared bike/bus lane in Portland, OR.

Source: Amy Chen Unsplash

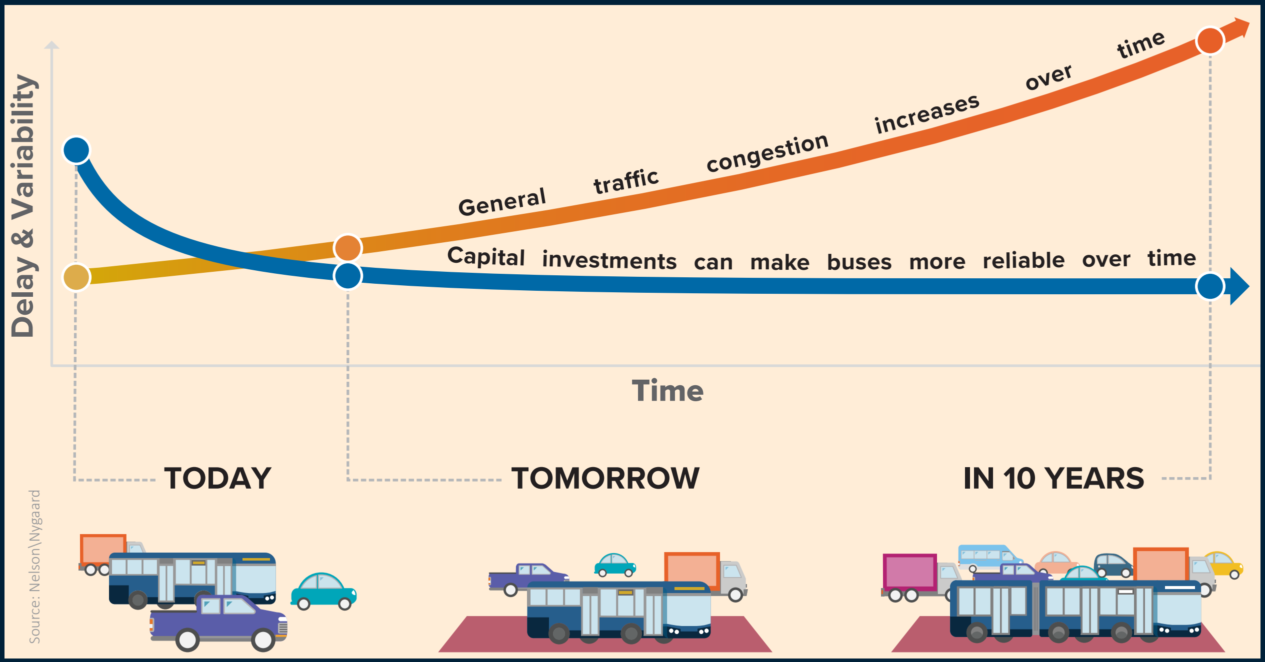
Metro Local buses in downtown Los Angeles, CA.

CHAPTER 4

Speed and Reliability Operations and Technology

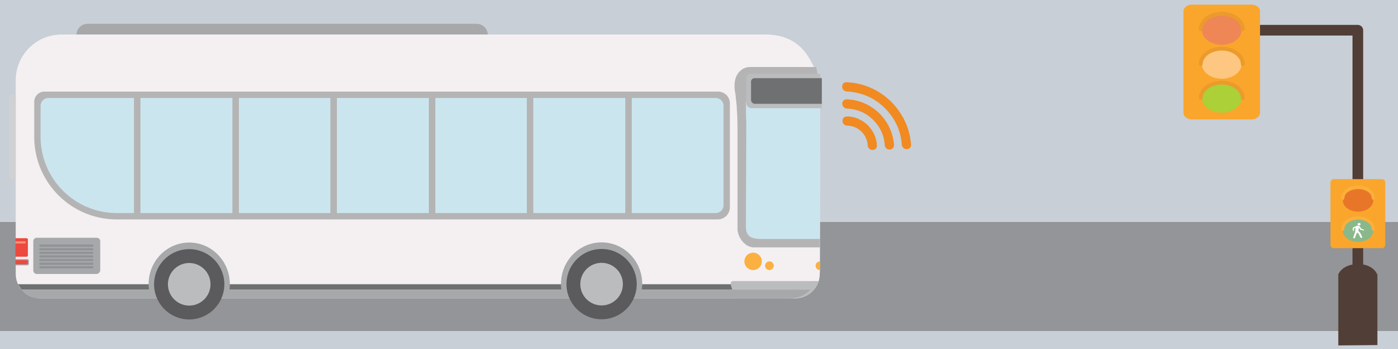
Operational and technology strategies that complement design treatments to make service faster and more reliable.

Design of streets and congestion on those streets is one part of why transit becomes delayed. Another factor, how service is operated, can also be optimized to provide fast, reliable transit. This chapter focuses on design treatments that can improve speed and reliability, and which require interagency coordination.



TRANSIT SIGNAL PRIORITY (TSP)

Cost	$$-$$$$	Coordination	High



What Is It?

TSP is a technology that allows buses to move through traffic signals without delay. There are multiple variations in how TSP can be implemented. At the basic level, TSP allows transit vehicles to communicate with signals to extend green lights, end red lights early, and/or add a bus-only signal phase.

What Are The Benefits?

- **Travel Time:** TSP can reduce travel times by 10% and reduce delay by up to 50% at target intersections (NACTO).
- **Reliability:** Travel time variability can be reduced by up to 40% (TransLink).
- **Safety:** TSP reduces conflicts at intersections between transit vehicles and cyclists, pedestrians, and motorists.

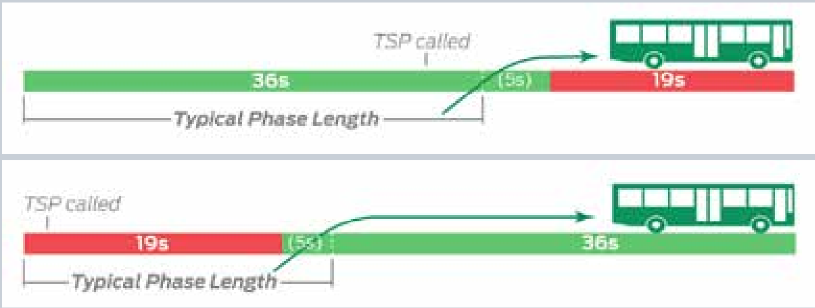
How Does It Work?

TSP applied along a stretch of transit corridor allows the bus to take advantage of coordinated signal progression.

- **Signal Priority (green extension)** prolongs the green light so the bus can clear the intersection.
- **Signal Pre-Emption (early green)** provides a green signal phase earlier than otherwise programmed to prevent the bus from dwelling by the red light. (Typically reserved for emergency vehicles).
- **Bus-Only Phases and sequence changes** triggers a special bus-only green 'through' signal phases (paired with queue jump lanes); or bus-only turn phase at intersections where left turns are made (turn lane may be shared with autos or may be bus-only).

When Is It Used?

- Signalized intersections with a far-side stop or no transit stop, allowing the bus to clear the intersection without waiting at a signal.
- The usefulness of TSP depends on both geometric and operational factors, including roadway facility type, general traffic volume and capacity, signal spacing, and cycle length.



Examples of green extension (top) and red truncation (bottom).
Source: NACTO

TRANSIT SIGNAL PRIORITY (TSP)

Design Elements

- Multiple types of TSP communication technology are commonly available (including line-of-sight, GPS, and microwave), each having relative benefits and tradeoffs.
- TSP requires new or upgraded technology in the signal controller cabinet, on board transit vehicles, or both.

Complementary Treatments

- **Far Side Bus Stops:** TSP is optimized when stops are far side.
- **Bus Stop Balancing:** Bus stop locations should be optimized to reduce delays caused by unnecessary or excessive stopping.
- **Queue Jumps:** TSP works well at signalized intersections where existing infrastructure, traffic conditions, and stop location supports queue jump implementation.

Other Considerations

- Requires a high degree of coordination between the agencies responsible for signals and transit operations.
- Transit corridor improvements may span across multiple jurisdictions, traffic signal systems, and support operation by multiple service providers, requiring interagency agreements.
- May not be effective where traffic congestion is so severe that the bus is unable to communicate effectively with TSP receivers.
- A traffic study may be needed for each intersection to determine the potential impacts of implementing TSP.
- Potential for additional capital investments in new and/or upgrades to existing signal infrastructure (signal mast arm, controller cabinets, etc.).

Transit signal priority in Seattle, WA.

QUEUE JUMP/BYPASS

Cost	$$-$$$	Coordination	High

What Is It?

Queue jumps and queue bypasses designate spaces that allow buses to proceed through a signalized intersection ahead of general traffic.

What Are The Benefits?

Queue jumps can reduce bus delay at congested intersections where buses may experience delays due to traffic queues spanning multiple signal phases.

Queue Jump Case Studies

- **West Valley City, UT** installed queue jumps at 13 intersections and saw bus travel times decrease by 13-22% per location.
- **Calgary Transit** implemented queue jump lanes along a high-volume corridor, resulting in travel time savings of 25%-30% in the corridor and 1.5 to 2 minutes off of trip times.
- **The MTA** implemented queue jumps In 2015 for the M86 route which reduced time stopped in traffic by 7% in the westbound direction and 30% in the eastbound direction.

What Does It Look Like?

- Queue jump/right turn except bus lanes allow buses to utilize right-turn only lanes with autos to bypass the queue at a traffic signal and receive a transit signal phase to merge back into through traffic lanes.
- Queue bypass/transit approach lanes are bus-only lanes to the left of right turn pockets.
- A transit signal phase can be used with either queue jumps or queue bypasses. It gives the bus a green light while general traffic waits at the red light; on the far side of the intersection the bus can merge into the travel lane seamlessly while traffic is still stopped.

When Is It Used?

- Can be used along a corridor with existing lane geometry that supports installation, at spot locations with high delay or nearside bus stops.
- When a dedicated right turn lane is present and volumes are high.

Source: Nelson\Nygaard

A queue jump /right turn except bus.

QUEUE JUMP/BYPASS

Design Elements

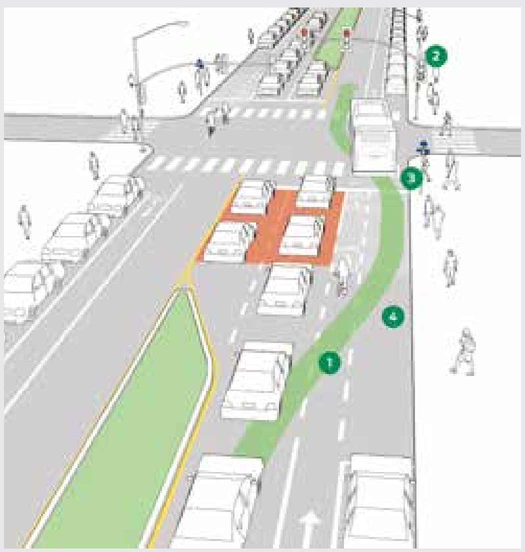
- Queue jump/bypass lanes are indicated with signage and pavement markings.
- A receiving lane for the bus on the far side of the intersection is preferred; if there is no receiving lane a bus-only signal phase is required.
- Queue jump efficiency decreases if right turn volumes are greater than 150 during peak hours.
- Installation may require roadway modifications such as widening or repaving, as well as modifications to existing traffic signals and controllers.

Complementary Treatments

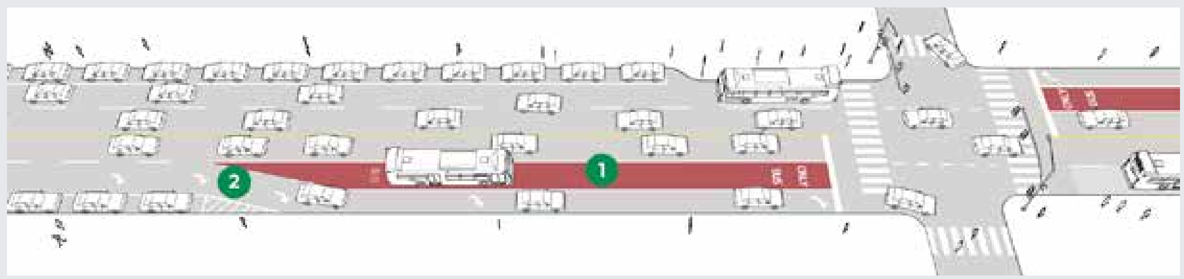
- Queue jumps are more effective when buses are equipped with **Transit signal priority (TSP)** to provide transit-only signal phase for buses to advance through the intersection and merge back into travel lanes ahead of autos.
- **Bus pullout lanes** may be constructed at near-side bus stops in conjunction with queue jump and TSP.
- **Queue jumps in advance of far-side bus stops** may mitigate potential auto queuing behind stopped buses during passenger loading and unloading.

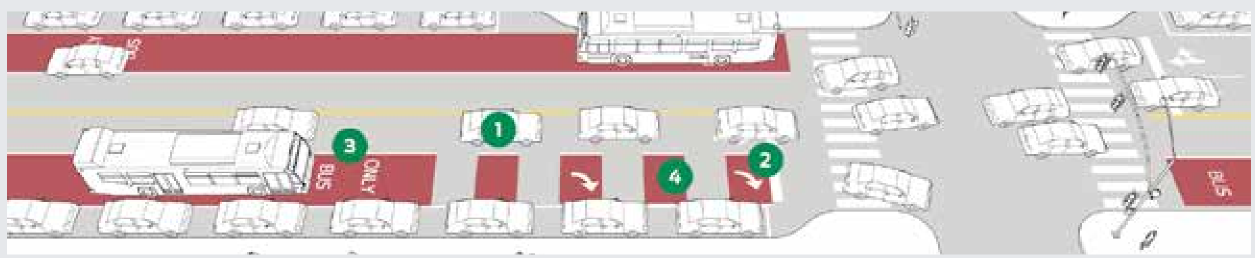
Other Considerations

- Analyses of auto turning movement and other traffic operating conditions should be conducted to assess potential impacts to traffic delay, signal timing and cycles.
- In some cases, opportunities for queue jumps may be identified along major corridors where ROW was preserved for potential widening.
- TSP detection equipment can increase the cost of implementation.



Queue Jump may be made from a shared transit/turn lane or a short exclusive transit lane.
Source: NACTO; https://nacto.org/publication/transit-street-design-guide/intersections/intersection-design/queue-jump-lanes/

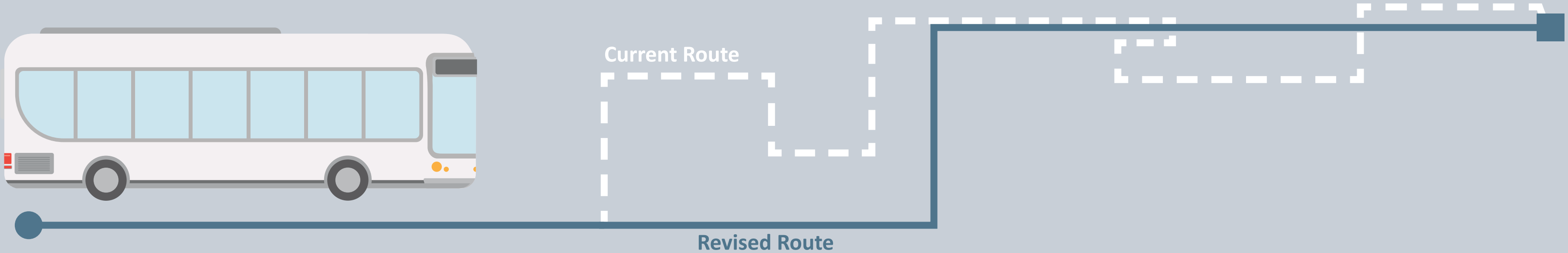




Transit Approach Lane (top) and Queue Bypass (bottom); green numbers highlight pavement marking features.
Source: NACTO
Top: https://nacto.org/publication/transit-street-design-guide/intersections/intersection-design/transit-approach-lane/
Bottom: https://nacto.org/publication/transit-street-design-guide/intersections/intersection-design/shared-right-turn-lane/

SERVICE ADJUSTMENTS

Cost $$-$$ **Coordination** Moderate



What Is It?

Bus service on direct paths is readily understood to customers and makes the most efficient use of transit resources. Over time, bus routes can become circuitous as routes are modified due to changing land uses, passenger needs, or political requests. Investment in transit priority affords opportunity to modify bus routing to provide the most direct path possible. Service adjustments include strategic changes to a bus route's alignment and/or underlying service operations.

What Are The Benefits?

- **Faster service:** A 2013 survey of 41 transit agencies found that route design changes were the second most successful strategy for improving bus speeds.[1]
- **Eliminates circuitous route deviations and branching** for more reliable, simplified service and scheduling for users and trip planning.
- **Reduced cost:** Can reduce the number of vehicles needed to operate the route due to faster end-to-end travel times.

1 DDOT Bus Priority Toolbox.

What Does It Look Like?

- Route re-alignment may remove unnecessary turns, cut service to a low-ridership location, avoid a particularly congested area, or take advantage of a faster parallel route.

When Is It Used?

- Adjustments should be considered anywhere that land use, traffic volumes, or passenger needs have changed recently.

OCTA Bravo service improved travel speeds with limited-stop service.

SERVICE ADJUSTMENTS

Other Considerations

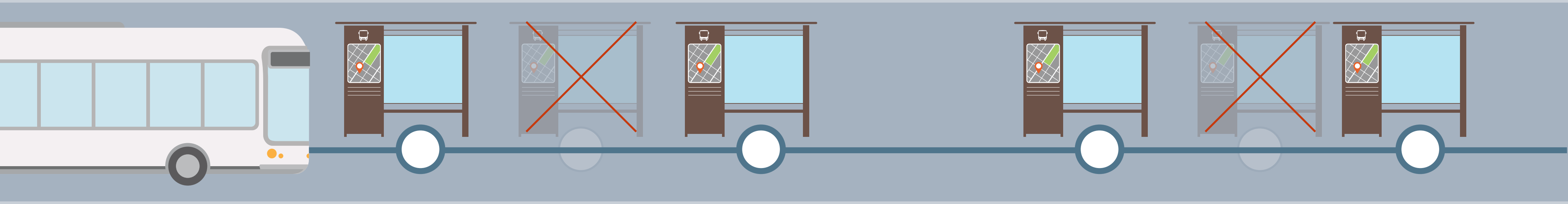
- A data-based study and public outreach process to evaluate how route adjustments will impact existing riders should be carried out prior to making changes, with emphasis on how low-income and other transit-dependent populations will be affected.
- Consider potential Title VI impacts to ADA riders and paratransit service accessibility.
- Many agencies are using first mile/last mile strategies (TNC, microtransit, etc.) to serve lower density areas where fixed-route is not the most effective service delivery option.

Microtransit service in Seattle, WA.

Accessibility must be taken into consideration when making service adjustments.

BUS STOP BALANCING

Cost $$-$$ | **Coordination** Moderate



What Is It?

The distance between bus stops has a direct effect on bus speeds due to the frequency of bus deceleration, stopping, and acceleration. Determining stop spacing and stop location requires a balance between transit speed and customer access. For high-quality transit service, many agencies aim for half-mile stop spacing. Strategic changes to a bus route's spacing and location of stops increases bus speeds by reducing stop-and-go operations.

What Are The Benefits?

- **Faster service:** Eliminating one bus stop typically saves 10 to 15 seconds.[1]
- **Reduced cost:** Faster service due to less stops means lower operating costs and capital costs to maintain target frequencies.
- **Better amenities:** Fewer stops allow agencies to channel passenger amenity resources into a smaller number of locations.

1 DDOT Bus Priority Toolbox.

What Does It Look Like?

- Stop balancing optimizes the spacing between stops. It can involve removing, redesigning, or relocating stops along a route or corridor.
- Factors influencing stop placement and spacing include:
  - Population and employment density around each stop
  - Location of trip generators, or major destinations
  - Stop amenities and transfer activity
  - Community-specific conditions
  - Topography, built environment, and schedule time points

When Is It Used?

- Stop balancing can be implemented in any land use context, but urban areas with shorter blocks, denser land uses, and multiple parallel route options are more likely to have closely spaced stops and routes that make many turns.

Source: SDOT

The RapidRide H Line project consolidated some bus stops on Delridge Way in Seattle.

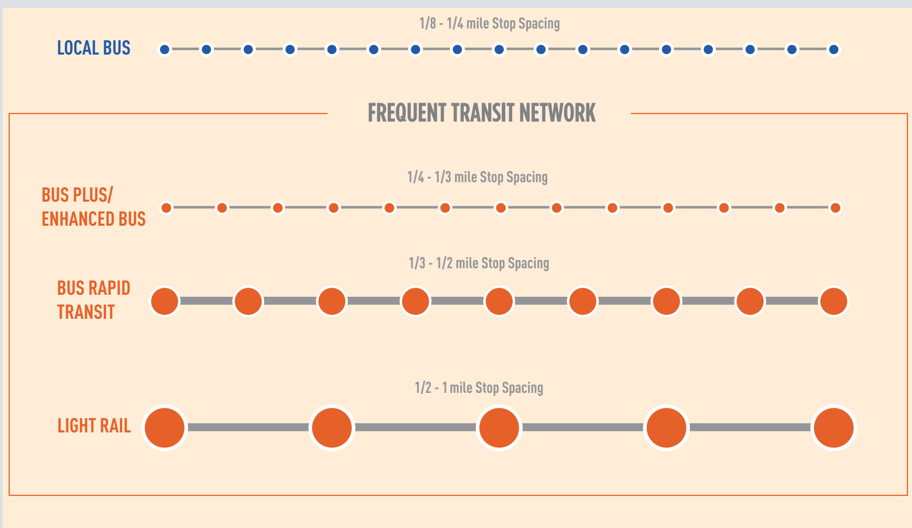
BUS STOP BALANCING

Design Elements

- Consolidated stops will likely need to be enhanced with amenities such as additional shelters, seating, and trash cans, to accommodate more passengers who waited at different stops in the past.
- Safety and accessibility, including continuous sidewalks, curb ramps, and enhanced crossing treatments such as crosswalks and beacons or signals should already be present or should be a priority for installation within ¼-mile of stops.
- Removal is more common on mid-block and near-side stops, stops serving only one route, stops with little or no infrastructure.

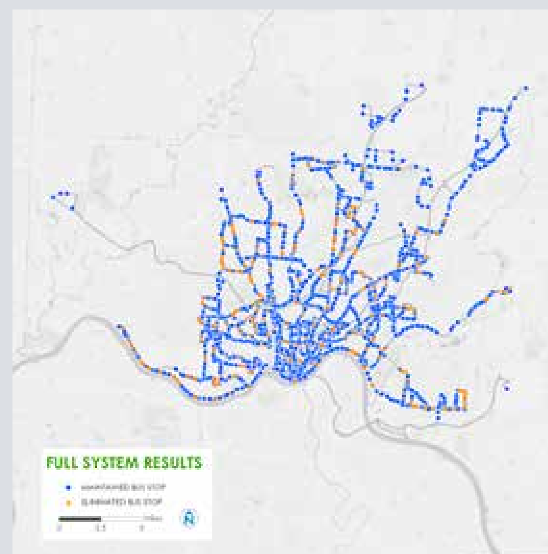
Other Considerations

- Transit agencies should develop a policy around stop spacing for different levels of transit service (ex – 5 or fewer stops per mile for local service) or service types (BRT, local, express, etc.) or by key factors listed above.
- A data-based study and public outreach process to evaluate how stop adjustments will impact existing riders should be carried out prior to making changes, with emphasis on how low-income and other transit-dependent populations will be affected.
- Moving stops farther apart can place a particular burden on people with disabilities, older adults, and others with mobility challenges. It's important to assess the needs of these transit riders, and to make sure the transit access and pedestrian infrastructure in new or relocated stop areas is sufficient to support their access.
- Bus operator interviews are a valuable source of information about how inline bus stop conditions impacting travel times and reliability. Results of any bus stop balancing model or analysis tool require detailed QA/QC review with agency operations and scheduling staff as well as community vetting for as needed adjustments.



Source: SORTA-FASTops bus stop optimization project

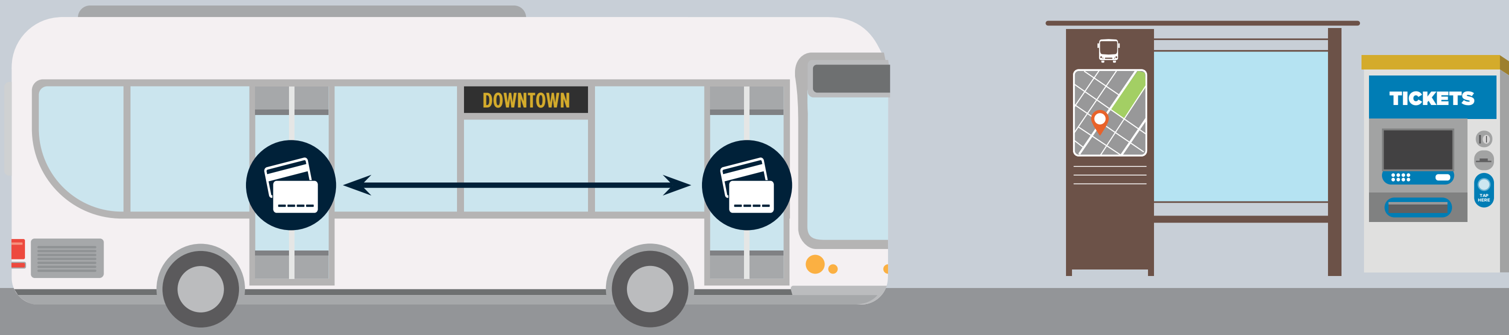
Example stop spacing guidelines for different types of transit service



Source: Nelson\Nygaard

ALL-DOOR BOARDING AND OFF-BOARD FARE COLLECTION

Cost	$$-$$	Coordination	Moderate



What Is It?

All-Door Boarding and Off-Board Fare Collection are operational policies that allow customers to board a transit vehicle at any open door and pay fares before boarding.

What Are The Benefits?

- **Reliability:** All-Door Boarding can lead to up to 10% improvement in on-time performance by reducing dwell times at stops.
- **Travel Time:** Off-Board fare collection can significantly reduce passenger boarding times, with dwell per passenger falling from about 4 seconds to 2–2.5 seconds (NACTO).

Travel Time Case Studies

- **TransLink**- All-Door Boarding reduced overall travel time by 3%.
- **SFMTA**- In San Francisco, dwell times decreased 38% per customer on average and bus speeds increased by 2% as ridership increased 2%.

What Does It Look Like?

- Ticket vending machines at stops and/or smartphone applications to enable Off-Board Fare Payment and All-Door Boarding.
- Account-based (reloadable) smart cards.

When Is It Used?

- Curbside fare machines are costly to install and maintain; use on high-frequency or high-volume corridors where reduced dwell time is a priority.

Source: NACTO

Example of all-door boarding on LA Metro Rapid Line in Los Angeles, CA.

BUS-BICYCLE TREATMENTS

Design Elements

- Install an adequate number of machines to handle the expected number of passengers purchasing tickets during peak hours, especially if all customers must collect Proof of Payment tickets to board.
- Off-Board payment purchase instructions should be clear, simple, and well communicated, potentially in multiple languages.
- Off-Board payment and ticket vending machines require connections to electrical utilities as well as communications network.
- Requires the use of either off-board payment systems or all-door proof-of-payment systems (such as cash and card front door payment and rear-door card readers).
- Timeline can be a few months, to use existing infrastructure and develop a mobile app, or a few years, with new equipment and fare media.

Complementary Treatments

- **Bus Stop Placement:** Bus stops should be located at optimal locations to maximize the benefits of All-Door Boarding throughout a bus route.
- **Level Boarding:** Facilitates faster and more reliable boarding, further reducing dwell times and variability.

Source: Nelson\Nygaard

Platform fare reader in Puget Sound Region, WA.

Other Considerations

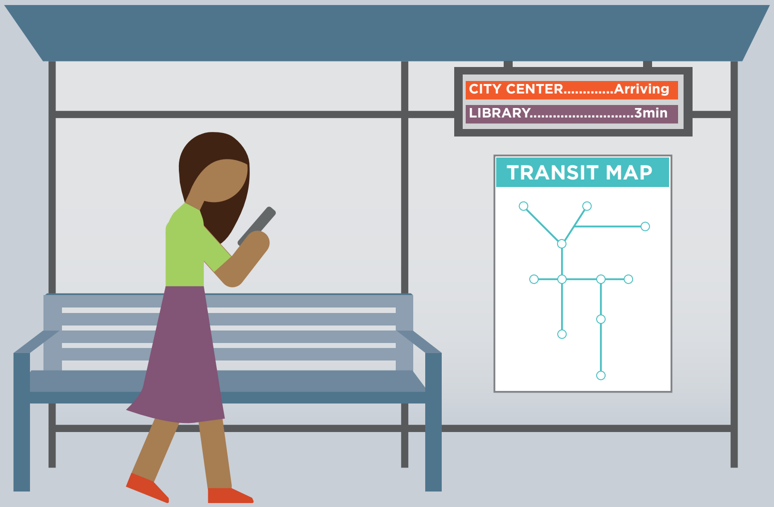
- Implementing Off-Board ticketing machines may be expensive at scale, and locations should be strategically selected at high ridership and transfer locations.
- Potentially requires implementation of fare inspections by dedicated staff but reduces fare validation done by bus drivers.
- Most effective when implemented across an entire system, which requires greater up front capital than a phased approach, and reduces confusion for transit customers about which routes in a system have All-Door Boarding and which do not.
- Gather information before and after implementation; invest in automatic passenger counters or employ short-term counting staff, to assess boarding times, volumes, and improvements.
- Interagency agreements may be required to standardized fare structures and accommodate reciprocal acceptance of fare payment media at bus stops served by multiple transit operators.

Source: NACTO

Station vending machine in San Bernardino, CA.

REAL TIME INFORMATION

Cost	$$-$$$	Coordination	Moderate



What Is It?

Real Time Information tells transit operators or riders the status of transit vehicles, including approximate locations and predictive travel and arrival times. In most cases, Real Time Information relies on Automatic Vehicle Location (AVL) technology on board buses linked to Global Positioning Systems (GPS).

What Are The Benefits?

- **Customer Experience:** Providing Real Time Information related to schedules, expected travel times, and real-time arrival times can make the system more attractive and simpler to use, reduce uncertainty and wait times, and improve rider satisfaction.
- **Connectivity:** Real Time Information and wayfinding information can enhance the transit stop as a gateway to its surrounding neighborhood or destinations.
- **Travel Time Savings:** Real Time Information allows riders the option to adjust their trip choices to reduce their travel times.

When Is It Used?

- Real Time Information should be prioritized at high-volume, high-activity, or transfer stops.
- Real Time Information systems should include information about relevant transportation connections and services, including regional routes, rideshare and carshare, and micromobility options to expand mobility opportunities.

What Does It Look Like?

Information can be shown on hanging signs or signage integrated into the bus stop shelter. Outside of stations and stops, Real-Time Information wayfinding can inform rider decision making and transit access.

- **Smartphone Technology:** Smartphone technology, such as Short Message Service (SMS), mobile applications, and websites allow riders to access schedule and real-time information.
- **Dynamic Messaging Systems:** Dynamic Messaging Systems at bus stops and stations tell riders when the next bus will arrive and can warn them if a bus is delayed.
- **On-Board Annunciators:** Real Time Information on-board buses can include automated announcements of next stops and upcoming transfer points. This amenity adds to American with Disabilities Act (ADA) compliance and relieves bus drivers from calling out stops.
- **Vehicle Occupancy Information:** On-board automated fare collection (AFC) and/or automated passenger counter data (APC) provides riders an estimate of how crowded a bus or train is, allowing them to evaluate whether to wait for the next bus.

REAL TIME INFORMATION

Complementary Treatments

- **Bus Stop Placement:** Bus stops should be located at optimal locations to maximize the benefits of All Door Boarding throughout a bus route.
- **Level Boarding:** Facilitates faster and more reliable boarding, further reducing dwell times and variability.

Other Considerations

- Level of detail for information displayed should be carefully considered to provide clarity and avoid confusion. Over-signing or cluttering the station or stop area with too much information may be ignored or contribute to information overload for riders.
- Financial costs of implementing Real Time Information can vary depending on the technology and the amenities chosen; as well as the existing infrastructure and site conditions, and time and staff-related costs associated with training and maintenance of the technology.
- For riders with visual disabilities, provide an alternative to visual Real Time Information display boards; audible announcements with Real Time Information are preferred over braille and other methods that require finding the display.

Example of a Real Time Information dynamic messaging system.

Example of a station's Real Time Information messaging system in Boston.

Source: Nelson\Nygaard

BRT design concept for Madison Street BRT in Seattle, WA.

CHAPTER 5

Policies and Enforcement

To advance transit priority, speed, and reliability projects into design and implementation, transit agency sponsors often partner with jurisdictions that have authority over the roadways and with other potential funding partners.

Local, state, and Federal policies provide guidance and a standardized framework for implementation. Policies may establish legal precedence and local approval mechanisms to implement transit priority treatments and supportive changes to operations and infrastructure. Transit supportive policies can also prioritize speed and reliability projects within local and regional capital improvement planning (CIP) process and funding processes. Jurisdictions develop clear and appropriate transit supportive policies through extensive stakeholder engagement and coordination between enforcement agencies, local jurisdictions, transit agencies.

Also critical to the safety and success of transit priority treatments is enforcement authority. Allowing agencies and stakeholders with jurisdictional control over infrastructure, ROW, and services to enforce changes to the roadway network and traffic operations encourages changes in travel behaviors and discourages violators.

STATE AND FEDERAL POLICIES

This section describes relevant state and federal policies in support of transit priority. The Federal Transit Administration (FTA) provides financial and technical assistance to local public transit systems, oversees safety measures, and helps develop next-generation technology research. FTA discretionary funding programs such as the Section 5309 Capital Investment Grants (CIG) Program may support BRT corridor project development and construction. Examples of transit supportive policies enacted by the State of California include, State Bill (SB) 288 and SB 743, SB 9 and 10, SB 998, and Assembly Bill (AB) 917, further descried below.

SB 288
Expediting environmental review requirements for transit priority

SB 288 expands exemptions from California Environmental Quality Act (CEQA) review requirements to projects that institute or increase new bus rapid transit, bus, or light rail services on public rail or highway ROW; as well as those that designate and convert general purpose lanes, high-occupancy toll lanes, high-occupancy vehicle lanes, or highway shoulders.

Recognizing the broader mobility context of transit-oriented corridors and communities, the bill also expedites environmental processes for transit agency sponsored projects that improve customer information and wayfinding or include pedestrian and bicycle facilities, include zero emission vehicle (ZEV) fueling or charging facilities, or strive to shift mode choice away from autos through reduced minimum parking requirements. Projects over $100K require equity analysis and community engagement.

SB 743
Prioritizing projects that reduce vehicle miles traveled

SB 743 is California's initiative to encourage a dramatic shift from managing congestion to reducing vehicle miles traveled (VMT). The law breaks with past policy and national practice; traffic congestion is no longer considered a potentially significant environmental impact under the CEQA. It encourages investment in projects that reduce VMT and shift travel away from single occupancy vehicles.

As a result of SB 743, traditional measures for mitigating congestion (e.g., widening roads, adding turn lanes, and making similar investments in the transportation network) will be replaced with measures that mitigate additional driving, such as increasing transit options, facilitating biking and walking, changing development patterns and charging for parking.

SB 9 and SB 10
Encouraging density around transit

Two bills signed into state law in California in 2021 make it easier for jurisdictions to achieve higher residential density near transit routes. The first, SB 9, eliminates single family zoning, making it possible to build denser housing statewide. The second, SB 10, allows for denser development near public transit corridors by enabling local governments to easily change their zoning rules and allow housing developments with up to ten units in areas that are well-served by transit.

Additional strategies that can be including in local zoning and development code to support transit include but are not limited to requiring:

- Transportation demand management programs for employers or housing developments over a certain size.
- Direct pedestrian connections from new development to main streets, including those that have transit routes.

SB 998
Public transit bus lanes

Current law makes it unlawful for a person to stop or park a motor vehicle in specified places, including an area designated as a fire lane by the fire department or fire district, as specified. A violation of these provisions is an infraction. SB 998 would prohibit a person from operating a motor vehicle, or stopping, parking, or leaving a vehicle standing, on a portion of the highway designated for the exclusive use of transit, subject to specified exceptions. Because a violation of these provisions would be a crime, this bill would impose a state-mandated local program. This bill would also require a public transit agency to place and maintain signs and traffic control devices indicating that a portion of a highway is designated for the exclusive use of transit, as specified.

Bus lane in Denver, CO.

AB 917
Video imaging of parking violations

Current law allows only two jurisdictions, the City and County of San Francisco and the Alameda-Contra Transit District, to use video surveillance to enforce parking violations in designated transit-only lanes. Existing law also requires designated employees or contracted law enforcement agencies to review video image recordings for the purpose of determining whether a parking violation occurred within a transit-only lane and issue citations as necessary. This bill would extend that authorization indefinitely to the City and County of San Francisco indefinitely, and to any public transit operator in the state until January 1, 2027. This bill would also expand the authorization to enforce parking violations to include violations occurring within transit stops.

Bus Lane Enforcement

Enforcement is often needed to ensure that transit-only lanes function as intended. Automated enforcement can be incorporated into transit operations, with video cameras on buses capturing license plates of vehicles that are illegally parked or stopped within a dedicated transit lane. Enforcement encourages motorist behavior change and reduces repeat violators. Considerations include but are not limited to obtaining authorization to utilize automated detection and enforcement systems and programs under state law; as well as staff training and resource capacity to review captured violations and issue citations.

LOCAL AND REGIONAL POLICIES

The following local and regional policies are found across California and nationally.

Vendor Pre-qualification

Consider development of design and construction procurement guidelines for transit corridors spanning multiple jurisdictional boundaries (state, regional, and local). Streamlining procurement of professional services and materials saves time and coordination efforts between smaller jurisdictions who may not have capacity or expertise to oversee and execute transit-specific improvements. Supporting the Boston region's Better Bus Program, MassDOT has a Pre-qualified Vendor procured agreement authorizes contractors to do work across municipalities and under one contract (https://www.mapc.org/public-works-collective-purchasing-program/). Although MBTA is a municipal transit operator for the state, similar pre-qualification agreements and materials lists may be developed at local or regional levels.

Right of Way and Street Design

Local and regional jurisdictions often establish a street typology and hierarchy to set modal priorities, operating standards, special designations, and establish thresholds for implementing changes. These typologies may be tied to a Complete Streets policy that directs the jurisdiction to design and manage the public right-of-way for all modes, with an emphasis on vulnerable users. Street design guidelines and Transit (facility) design guidelines provide technical specifications, methods, and materials required to incorporate desired and appropriate transit priority treatments within design plans and estimates.

Several peers in the Boson and D.C. region have developed right of way and street design standards at the statewide or regional levels to set precedence and lay a critical foundation for local jurisdictions and municipalities to adopt similar standards and policies supporting transit priority treatments and conversions of spaces for bus lanes.

Bus Priority

Local municipalities having jurisdictional control of roadways, signals, and critical supporting infrastructure to BRT or transit priority are following examples set at the State and Regional levels, by incorporating bus lanes and transit priority policies to support improved service and connectivity to their community constituents.

Several communities outside of Boston, including Arlington, Cambridge, and Everett have adopted local policies that enable conversion of travel lanes and spaces within the public right-of-way for transit priority treatments, including dedicated lanes and signal priority. By focusing ordinances to designate eligibility based on places with high delay or high unreliability, the cities can provide flexibility to identify locations that will benefit from various bus priority strategies (https://www.mwcog.org/documents/2011/04/01/bus-priority-treatment-guidelines-bus-bus-priority/).

Land Use and Transportation Demand Management

Land use and transit can be mutually supportive. Population and employment density are major factors in achieving high transit ridership—denser areas and higher ridership support higher frequency of service, which makes transit more convenient and attracts more customers. Transportation demand management supports transit through programming that encourages people to choose travel modes other than driving alone.

Transit-supportive density and affordability

In California, SB 10 provides an opportunity for local and regional jurisdictions to partner with transit agencies to explore transit-oriented development programs and projects. This may include partnering with the private sector to plan, fund, and develop residential and commercial development near transit stations. Jurisdictions should provide incentives or consider legislative requirements for developers and property owners to provide affordable housing near transit.

Parking policy and traffic operations

Local zoning code can support a move from single-occupancy vehicles to transit by reducing or eliminating parking minimums for development on frequent transit lines. Pricing parking is another regulatory tool, particularly in urban and commercial areas, for encouraging transit use.

Multiple transportation modes and functions require curb space, including parking, deliveries, passenger services, bicycle lanes, and transit lanes and stops. Curb management policies and strategies can provide a decision-making framework for jurisdictions to manage their curb space. For example, the City of Seattle established priority uses for the curb based on land use (see Figure 5-1). Seattle's transit, bicycle, pedestrian, and freight master plans are the primary drivers of priorities at the curb in all contexts.

SCAG has been working on curb-related studies and programs in recent years, including the Last Mile Freight Delivery Study (Completed October 2020), the Curb Space Management Study (underway), the Sustainable Communities Program Smart Cities & Mobility Innovations projects (underway) and the Last Mile Freight Program (underway). These studies and programs range from analyzing local city curb management needs at the city block level, to working with public and private stakeholders regarding last mile freight delivery operations and innovative technologies.

Data Collection and Analyses

Regional entities, such as MPOs or large transit operators, may lead or facilitate performance- or policy-based analyses of the transportation network in order to develop standardized approaches to identification of critical transit delays and hotspots for potential speed and reliability investments. Partnerships are relatively new, however, and roles of different stakeholders may vary from project to project. Minneapolis Metro Transit has partnered with the University of Minnesota to perform several analyses of traffic queues and travel time delays along regional transit corridors. Using the trends identified through internal and partner-conducted analyses as well as lessons learned during pilot implementations, they have developed Municipal Operating Agreements (MOAs) with Cities for signal ops, and some cost sharing.

Figure 5-1 City of Seattle Curb Space Priority Typologies

<table>
<tr><th></th><th>Residential</th><th>Commercial & Mixed Use</th><th>Industrial</th></tr>
<tr><td>1</td><td colspan="3">Support for Modal Plan Priorities</td></tr>
<tr><td>2</td><td>Access for People</td><td colspan="2">Access for Commerce</td></tr>
<tr><td>3</td><td>Access for Commerce</td><td colspan="2">Access for People</td></tr>
<tr><td>4</td><td>Greening</td><td>Activation</td><td>Storage</td></tr>
<tr><td>5</td><td>Storage</td><td>Greening</td><td>Activation</td></tr>
<tr><td>6</td><td>Activation</td><td>Storage</td><td>Greening</td></tr>
</table>

Based on https://www.seattle.gov/transportation/projects-and-programs/programs/parking-program/parking-regulations/flex-zone/curb-use-priorities-in-seattle

Equity and Climate Action

Aligning funding priorities with climate and equity-focused goals established at the Federal, state, regional and local levels may elevate investments for projects in underserved and mobility challenged communities. They identify strategic initiatives and set milestone timelines to cut greenhouse gas (GHG) emissions or improve mobility services to focus area communities with high need and significant mobility barriers. In the Capitol area, Climate change and climate impact are the biggest catalyst for conversion of SOV spaces.

They also reinforce community-driven actions by local leadership emphasize understanding of their populations and their mobility needs, allowing agency to communicate justification for investments that align with Climate goals and equity initiatives.

The Twin Cities' Metropolitan Planning Council (Met Council) adopted Thrive MSP 2040 as the regions long range transportation plan, identifying equity as one of five primary outcomes. Regular updates to the regional Transportation Policy Plan must be consistent with the vision set forth in Thrive MSP 2040. Outside of the Capitol area, MWCOG and Montgomery County DOT function as collectors of data and priorities from respective constituents. They often conduct analysis of key data points and metrics and have commissioned a transit study of equity emphasis areas for job accessibility, disadvantaged community benefits.

Traffic and Congestion Impact Analyses

Stakeholders may refer to SB 743 provisions as they develop local and regional congestion and transportation management policies. While developing Policy documents, agencies and leaders may consider setting goals toward acceptable level of traffic impact associated with multimodal investment projects for land developers and traffic mitigation solutions.

A draft policy threshold for the corridor may consider transportation impacts and benefits at the community or corridor level instead of the intersection level, where traditional auto-centric traffic operations and engineering level of service (LOS) and localized impact thresholds may not align with overall multimodal vision for the transportation network.

Peer regions noted that it has been easier to implement quick build projects in project areas having only a single jurisdictional authority. Projects require less coordination of design standards, treatments, and materials among stakeholders and are often candidates for expedited deployment or pilot demonstrations to observe benefits and impacts to consider future opportunities for expansion.

Traffic Incident Management

Seldom considered in depth prior to implementation, are issues in operating protocols and standards for continued operations and maintenance, including incident management and response. Capitol-area transit providers found that Traffic Incident Management (TIM) coordination was vital to address seemingly small issues that prevented contractors and emergency responders from working efficiently and appropriately across state lines in response to incidents on the roadway or other emergency situations.

Collaborative Purchase and Procurement

Regional entities may also act as facilitators for local jurisdictions to compete for alternative funding opportunities or as clearing house that streamlines development of construction bid documents, as well as procurement of materials and professional services. The Metropolitan Area Planning Council (MAPC), representing 101 local cities and towns in the greater Boston region, facilitated development of the (GBPC) Public Works and Public Safety Cooperative Purchasing Program where jurisdictions can pool quantities for services and materials. MAPC leads the bidding process, manages the contracts and handles any problems with a purchase for member communities. When bus lanes projects travel through multijurisdictional areas (Ex MassDOT, Chelsea, Revere), the agreement authorizes contractors to do work across municipalities and under one contract. This program is not limited to Better Bus Projects and can be used for any roadway infrastructure procurement.

CHAPTER 6

Getting On Board

Transit priority improvements are new to many communities.

Agencies may need to introduce the public and key stakeholders to the metrics that are used to track transit performance, the tools that can be used to improve service, and the benefits that can be seen not just by transit passengers, but by everyone who uses the roads. Agencies and their partners may need to respond to concerns about potential conversion of travel or parking lanes for transit as well.

COMMUNICATION

Key Messaging

When elected leaders, agency staff, and municipal stakeholders use consistent terminology and data points it helps normalize conversations and build support for transit projects. Key messages could include:

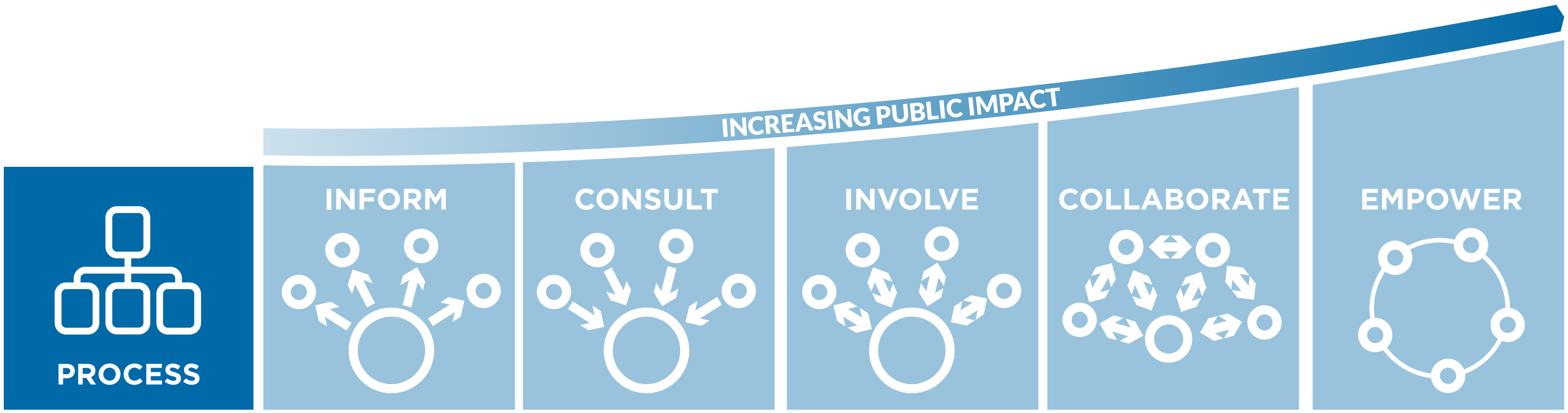
We're taking a people-first approach to providing transportation service that does not have the same business case (ROI) as traditional business models.

We have to find ways to move more people within our existing street space. Our transportation system is unsustainable both environmentally and in its use of the public right-of-way. We can't keep building or expanding roads to accommodate future growth, we need to provide options that move people more efficiently.

Despite having lower carrying capacity than rail, **Regional BRT or rapid transit lanes programs are seen as a more cost-effective solution** to establish high-quality transit service across a diverse region.

Design Outreach Around the People Who Will Be Impacted

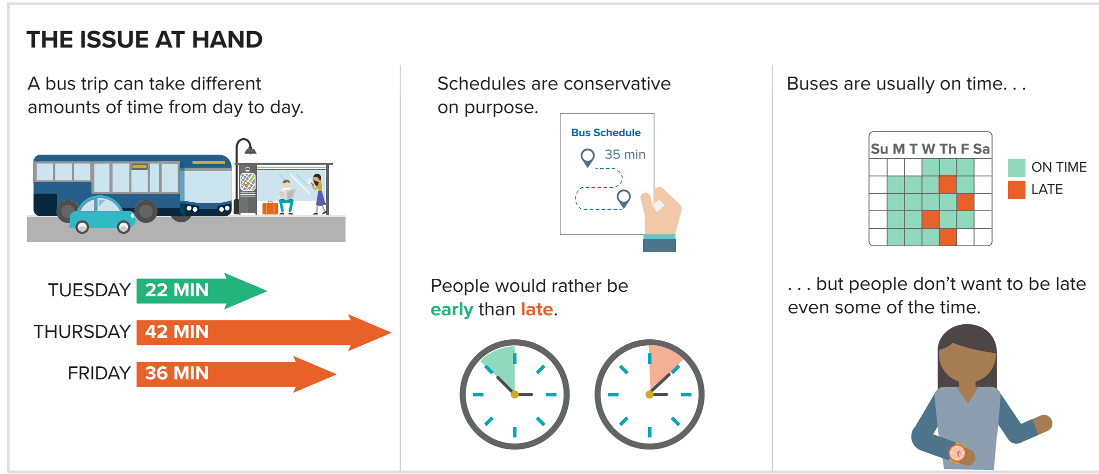
People who depend on transit are most affected by changes to bus service and are often essential workers, low income, and/or people of color. These individuals can often be difficult to reach with traditional engagement methods due to constraints around mobility, childcare needs, etc. However, it is most important to be transparent and up front about whether community outreach will help shape the project or is for informational purposes only. Develop engagement strategies and tactics that engage affected riders where they are, travel, and gather.



PROCESS	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
GOAL	To provide balanced and objective information in a timely manner.	To obtain feedback or analysis, issues, alternatives, and decisions.	To work with the public to make sure that concerns and aspirations are considered and understood.	To partner with the public in each aspect of the decision-making.	To place final decision-making in the hands of the public.
PROMISE	"We will keep you informed."	"We will listen to and acknowledge your concerns."	"We will work with you to ensure your concerns and aspirations are directly reflected in the decisions made."	"We will look to you for advice and innovation and incorporate this in decisions as much as possible."	"We will implement what you decide."

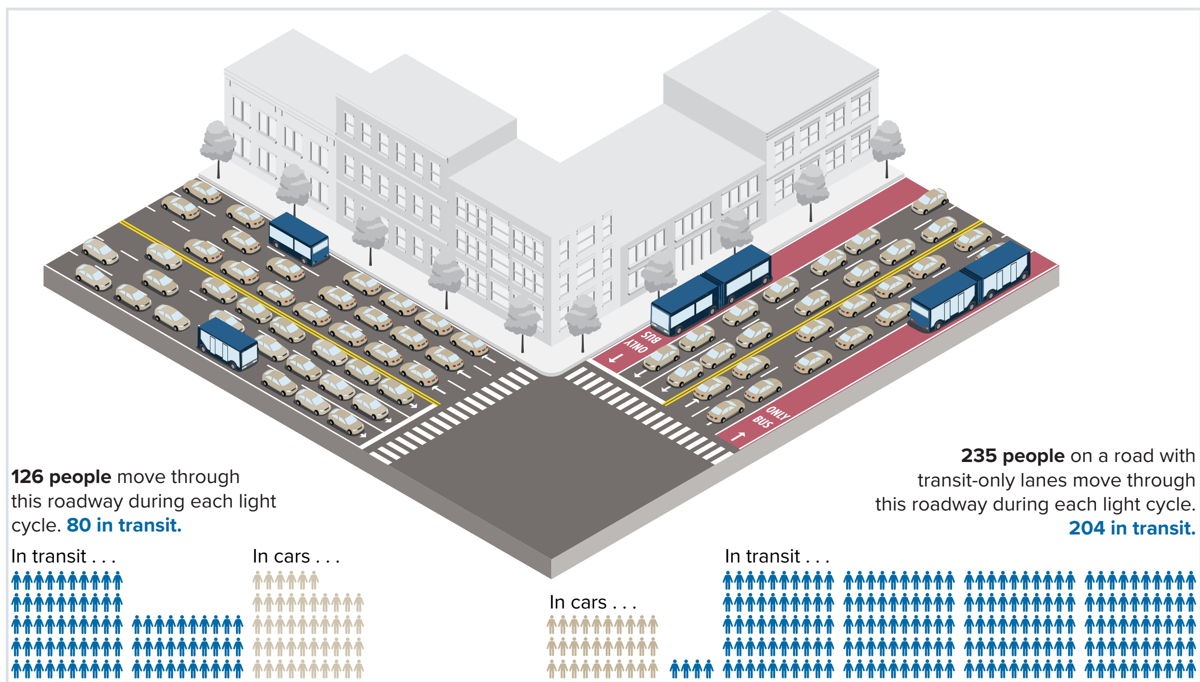
Aim for Clarity Without "Dumbing It Down"

Take the opportunity to define unfamiliar terms and explain their importance (such as reliability and passenger delay). Use talking points that relate with the rider experience, and potential barriers to mobility. Use data to demonstrate how the project will provide direct and indirect benefits to riders and non-riders.



Use Visuals

Everyone processes information differently. Include visuals as well as written and verbal explanations and consider using interactive media to show specific project proposals – an interactive map or simple 3D model gives a better sense of how a corridor will look and feel than a static map or image.



Make It Relatable

Speak to the way individuals experience the transportation system and show how improved transit benefits them, even if they drive. Incorporate storytelling of typical user travel patterns, trip purposes and travel time delay or quality experiences to communicate potential project benefits.

WHO BENEFITS FROM TRANSIT PRIORITY IMPROVEMENTS?

Transit priority projects benefit the entire transportation system and everyone who travels through it.

A bus-only lane in downtown saves the bus time and keeps it running on schedule...

...which means the bus saves time along the entire route. People outside of downtown benefit from an on-time departure too.

As transit travel times become more competitive with driving, more people take the bus, relieving traffic congestion all over the city.

CHAPTER 7

Implementation Lessons Learned

From this review of best practices, counties, local jurisdictions, and transit agencies want to understand the benefits of transit priority, how to communicate the benefits of transit priority, and general implementation guidance.

This section summarizes key findings from review of best practice, case studies and peer conversations.

SCAG REGION STAKEHOLDER INPUT

Understanding Benefits and Challenges of Transit Priority

Most counties in the region are not new to the concept of transit priority treatments, and have had prior discussions about transit priority, in particular transit signal priority (TSP). LA Metro's Bus Rapid Transit Vision and Principles Study has also provided a methodology for selecting BRT corridors that has been leveraged by local agencies across the region.

SCAG counties see benefits of transit priority treatments such as:

- Potential to increase ridership, change travel habits, and improve convenience
- Improved travel times for riders and drivers
- High impact at a relatively low cost

SCAG counties see challenges of transit priority including:

- Resistance to removing parking or potentially slowing vehicular traffic
- Justifying the financial investment
- Coordination across jurisdictions
- Community opposition related to RHNA

LESSONS LEARNED, RECOMMENDATIONS, AND CONSIDERATIONS

This study facilitated one-on-one conversations with peer transportation agency stakeholders in metropolitan areas implementing transit priority programs of improvements. Discussions centered on agency lessons learned through project development and implementation that include but are not limited to components of capital infrastructure selection, design and deployment, transit service and traffic operations, as well as procurement, technology integration, staff resources and training.

Interagency and Interdepartmental Coordination

As previously discussed, transit priority treatments and rapid transit corridor projects often require coordination between the transit operator, local, regional, and/or state transportation stakeholders who control operations and maintenance of or have jurisdictional authority of roadways proposed for bus service.

- Strong leadership from the **state and regional levels** is essential to the successful implementation of bus lanes and transit priority treatments on intercity and intercounty routes that may be high-performing candidates for speed and reliability improvements. Setting enabling policy, funding eligibility, project prioritization, authorizations for use, designation or preservation of transit only rights of way at the top levels of government ensures that projects are appropriately funded, prioritized, and coordinated.
- **Regional authorities** (e.g., county and regional transportation/transit authorities, (sub-regional) metropolitan planning organizations, associations and councils of governments) may have vital roles to play in project development and implementation, including emergency responsibilities and protocols, even though they may not have jurisdictional control over roadways or a direct role in service operations. Authorities provide spaces for facilitation and collate local CIP and information regularly for the TIP/STIP programming identifying and coordinating potentially complementary transit investments with stakeholder agencies and municipalities. They may also coordinate agreements between partner and cooperating stakeholders in support of grant applications, as well as facilitate joint purchasing and procurement of professional services, materials, or other equipment.
- **Local coordination** between potentially affected transit agency and municipal stakeholders at the interdepartmental and agency levels may include but is not limited to capital planning and projects, information technology, service operations, traffic and transportation, public works, economic development, etc.). Local leadership should establish transit as a priority among internal departments that traditionally focus on construction and maintenance of transportation infrastructure Acknowledge contextual expertise of transit and traffic professionals while developing data-driven decision-making thresholds and processes to implement transit priority treatments while mitigating potential impacts acceptable impacts to auto traffic. Consider their own lessons learned from implementation of other multimodal and complete streets improvements. Identify opportunities for local contribution of matching funds or capital improvements to pedestrian and multimodal network enhancement to transit station area connectivity as well as potential joint purchase, shared use, and municipal maintenance agreements.

Project Identification and Prioritization

When undertaking transportation network and system problems at the local level (e.g. General Plan, SRTP, LRTP, Transportation Action Plan, etc.), coordination across jurisdictions and departments is critical to avoid potentially positioning transit and multimodal goals and projects in competition with one another. Although transit speed and reliability project thresholds and justifications may have typically been applied at the site or location-level, agencies are encouraged to look at mobility investments from a network basis to elevate the conversation about user-based transportation experience. Furthering an understanding of how people move and experience delays or other barriers to mobility are proving helpful to change the conversation about benefits and impacts to autos and traffic, where cumulative benefits of corridor- or network-level improvements.

Other key factors potentially affecting project identification, prioritization, and decision-making between transit operators and agency stakeholders and other peers support transit priority implementation may include but are not limited to:

- As part of the planning process and establishment of mobility goals and objectives, identify performance metrics around **speed, reliability, comfort and connectivity**, to identify priority corridors and hotspots. Incorporate measures that appropriately value the rider experience and community needs for mobility investments.
- Adopt a regional network **long-range plan** that includes identification of transit priority corridors. Understanding a regional BRT network may take a long time to implement, this facilitates inclusion of transit priority treatments within local planning and project development processes to take advantage of potential funding opportunities on near-term speed and reliability investments on priority corridors.
- **Lead with equity and climate impacts** within capital project planning and prioritization. Adoption of (transportation, land use, climate, and equity action plans) at the state and regional level reinforce one another and empower change in decision-making. Include valued, people-focused metrics within regular project prioritization and funding processes.
- Seek **scalable solutions** applicable across geographies and jurisdictions. Coordinate with potential roadway authorities to adopt a sets of applicable transit priority design and service / performance standards for capital improvements and technology. Consistently support efficiency during detailed design and procurement of materials. Be aware of jurisdictional boundaries and potential regulatory differences related to material procurement, enforcement, emergency response, and maintenance.
- Foster a **sense of ownership**, competency and capacity with stakeholders. Involving stakeholders in project planning and scoping activities helps build relationships between neighboring jurisdictions. By establishing clear lines of communication and building a common knowledge of potential transit priority projects you can identify and resolve risks and opportunities early.
- Identify **complementary treatments** and/or projects promoting complete streets, station access, active transportation and connectivity. Transit operators typically do not have large capacity or expertise to implement large capital infrastructure projects beyond a limited range for station shelter, boarding area amenities, and pedestrian improvements for a stop. When possible, align capital improvement planning (CIP) efforts across stakeholders for capital improvements along corridors or at intersections of proposed transit priority treatments and prioritize supportive first/last mile multimodal network and connectivity improvements.
- **Prioritize pilot investments** for bus only lanes where there is high delay and treatments will be highly utilized (volume of buses). Beyond traditional urban core arterials, consider key corridors and segments around regional rail and transit centers providing the most benefits for the most riders.
- **Be opportunistic** for pilot bus lane and transit priority pilot implementation to capitalize on tactical, quick-build techniques (ex – paint, striping, signage, etc.) to modify traffic operations and driver behaviors while traffic volumes are still low.
- Capitalize on **jurisdictional willingness and ability** to implement transit priority treatments to expedite demonstrations of success. Develop a process of analysis justification approval and design of solutions that can be replicated at other priority locations.

Project Development and Implementation

The following summarize agency best practice around overcoming typical barriers to project development and implementation.

- Where possible, **alleviate the burden of proof** for local stakeholders and partners. Larger agencies with resources, capacity, and expertise should conduct up-front data-driven analyses and identification of operational hotspots or assessment of potential traffic benefits/impacts. Develop analyses and thresholds to determine locally acceptable benefits and tradeoffs in relation to transit performance goals versus traditional traffic operations. Build a common base of knowledge with local municipalities who are interested in transit priority, but uncertain on how to justify or under resourced.
- Define roles and responsibilities supporting **interdepartmental, interagency and interjurisdictional coordination**. Depending on affected roadways and project limits, local, regional and state levels transportation agency stakeholders may have a role to play. Facilitate spaces to raise and resolve design and implementation issues and convene regularly at the highest levels to support consistency among projects through planning, design and implementation. Build peer to peer relationships, rapport and capacity among staff.
- **Bring stakeholders along, early.** Don't be afraid of coordinating the details of transit stop improvements and priority treatments across organizational lines during early design phase. Transit priority projects also incorporate capital and technology operational standards that may challenge auto-oriented design and operations. Use potential design and traffic operations issues as opportunities to break down barriers through data sharing, conflict identification and resolution.
- **Leverage design standards and pilots to expedite the process.** Develop design and procurement standards for common capital infrastructure and systems elements to expedite plan reviews, procurement, and implementation. Consolidate procurement of professional services and materials for design and construction under unified contracts structure, where appropriate, for consistent designs, materials, and competitive pricing.
- **Develop project design QA/QC review and decision-making processes** that incorporate input and coordination among municipal departments, as well as appropriate peer staff within stakeholder agencies. Reviews should include compliance with supporting design guidelines and policies including but not limited to complete streets, bus stop design, BRT design, MUTCD, transit oriented corridors or development (TOC/TOD). Conduct internal and interagency debriefs following each phase of project development and implementation.
- **Align schedules** of transit priority projects with planned implementation of complementary infrastructure and land use changes. The extent to which transit priority projects are able to be extend multimodal connectivity and accessibility investments into the surrounding area is often limited. These investments contribute greatly to the service success and should be complementarily coordinated with the capital planning processes of local jurisdictions.
- **Before / after data collection** is essential to building user confidence and making the case for continued investment in transit priority treatments and preservation of ROW, where possible. Collect information on current travel time delay or speed and reliability, as well as supporting equity analyses to focus on access and availability of services to minoritized populations. After implementation, publish reports of delay hotspots, implementation benefits, challenges, community support, and compliance to inform future discussions.

Appendix A

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Multi-door boarding at BRT Station in Eugene, OR.

Appendix B

Peer Case Studies

To supplement the literature review, the project team facilitated informal conversations with transit operators and regional and local stakeholder agencies from peer metropolitan regions who are operating and implementing multijurisdictional transit priority programs across diverse geographies and urban forms. These discussions provided additional best practice insight beyond topics typically documented in transit priority design guidelines and literature reviews, including:

- **Agency Overview and Relevant Project(s)**- Agency roles and responsibilities in planning, development, delivery, and operation of transit speed and reliability treatments.
- **Project Identification and Data Analysis** - Data collection and analysis supporting transit priority project identification, deployment, and measurement of benefits / impacts (including in disadvantaged and equity communities).
- **Implementation Lessons Learned** - Transit lane, speed and reliability implementation lessons learned, including interdepartmental and / or Interagency coordination and supporting policy development
- **COVID-19 Response** - Transit lane deployment and operations during COVID-19.

SCAG and the project team extend special thanks to the agency representatives who contributed to the dialogue summarized in this report:

Boston, MA

- Director of Transit Priority; Massachusetts Bay Transit Authority (MBTA)
- Assistant General Manager of Service Development (MBTA)

Capitol Area, DC/MD/VA

- Mass Transit Branch Manager; District Department of Transportation (DDOT)
- Rapid Transit System Development Manager; Montgomery County Department of Transportation (MCDOT)
- BRT Project Manager (MCDOT)
- Principal Transportation Engineer; Metropolitan Washington Council of Governments (MWCOG)
- Director of Programs and Policy; Northern Virginia Transportation Commission (NVTC)
- Senior Program Manager, Bus Priority; Washington Metropolitan Area Transit Authority (WMATA)

Twin Cities, MN

- Assistant Director, Bus Rapid Transit Projects (Metro Transit)
- Manager of Bus Speed & Reliability (Metro Transit)

Vancouver, BC (Canada)

- Senior Manager, Bus Priority Programs (Translink)

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El Centro, CA 92243
Tel: (213) 236-1967

Orange County
OCTA Building
600 South Main St., Ste. 741
Orange, CA 92868
Tel: (213) 236-1997

Riverside County
3403 10th St., Ste. 805
Riverside, CA 92501
Tel: (951) 784-1513

San Bernardino County
Santa Fe Depot
1170 West 3rd St., Ste. 140
San Bernardino, CA 92418
Tel: (213) 236-1925

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Ventura, CA 93012
Tel: (213) 236-1960

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