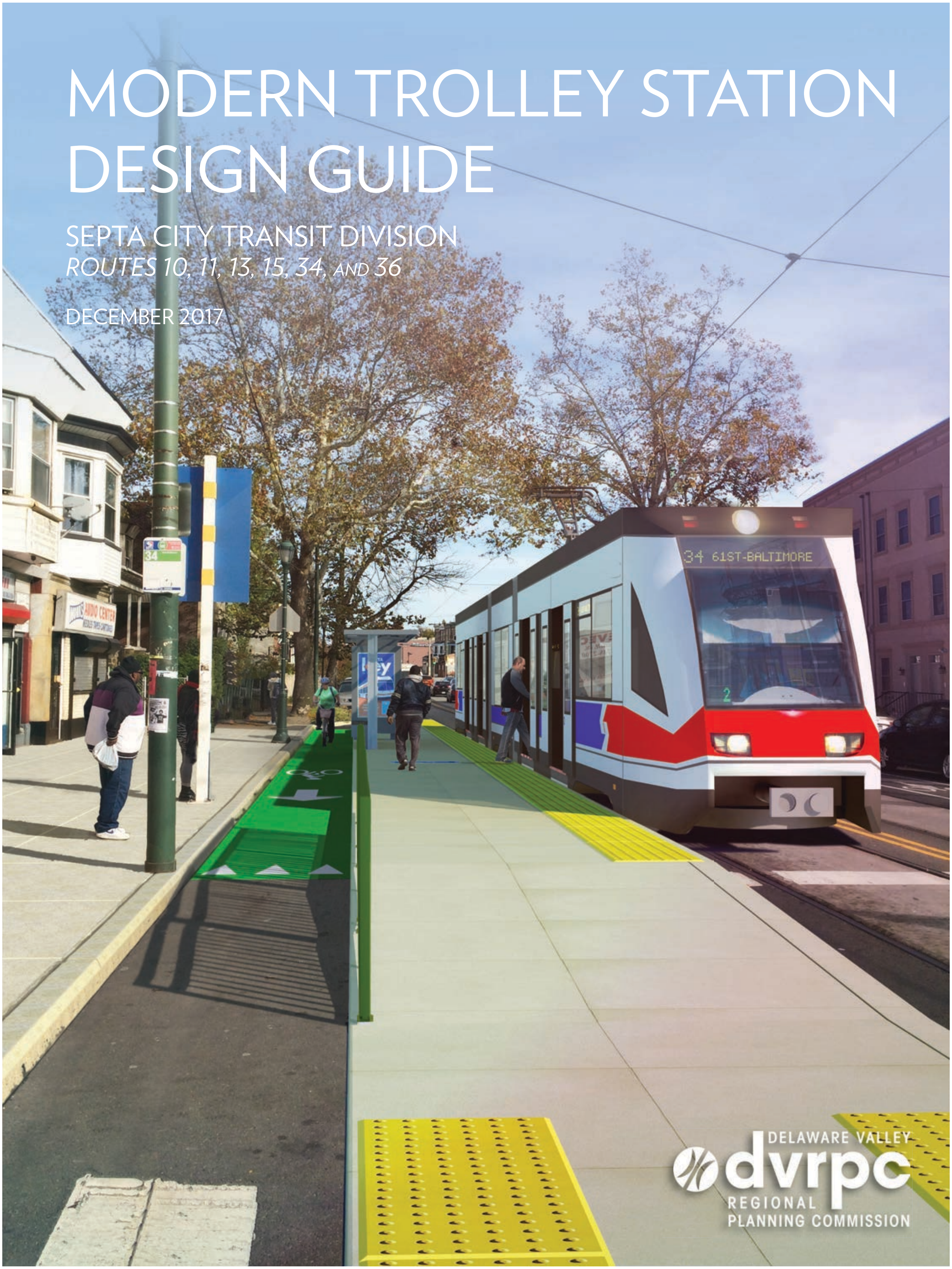
MODERN TROLLEY STATION DESIGN GUIDE

SEPTA CITY TRANSIT DIVISION

ROUTES 10, 11, 13, 15, 34, AND 36

DECEMBER 2017



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STATION DESIGNS

STATION DESIGNS

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SEPTA'S TROLLEY MODERNIZATION PROGRAM

SEPTA's city trolley system serves almost 100,000 people on weekdays and is one of the longest operating streetcar systems in North America. Since 1906 the system has benefited from an off-street tunnel that offers rail-only access directly to Center City for the West Philadelphia trolley lines. This system now requires new vehicles to replace its aging trolley fleet. These state-of-the-art vehicles will offer new opportunities to move passengers quickly, comfortably, and accessibly.

A "modern" accessible trolley system for the future will require changes to the operations, policy, facilities, and design of the corridors the trolleys have relied on in the past. Modernizing the trolley system will be challenging, but rewarding. It will be expensive and include extensive coordination between SEPTA, the City of Philadelphia, stakeholder agencies, and communities along trolley corridors. But, once implemented, Trolley Modernization will breathe new life into Philadelphia's trolley service.

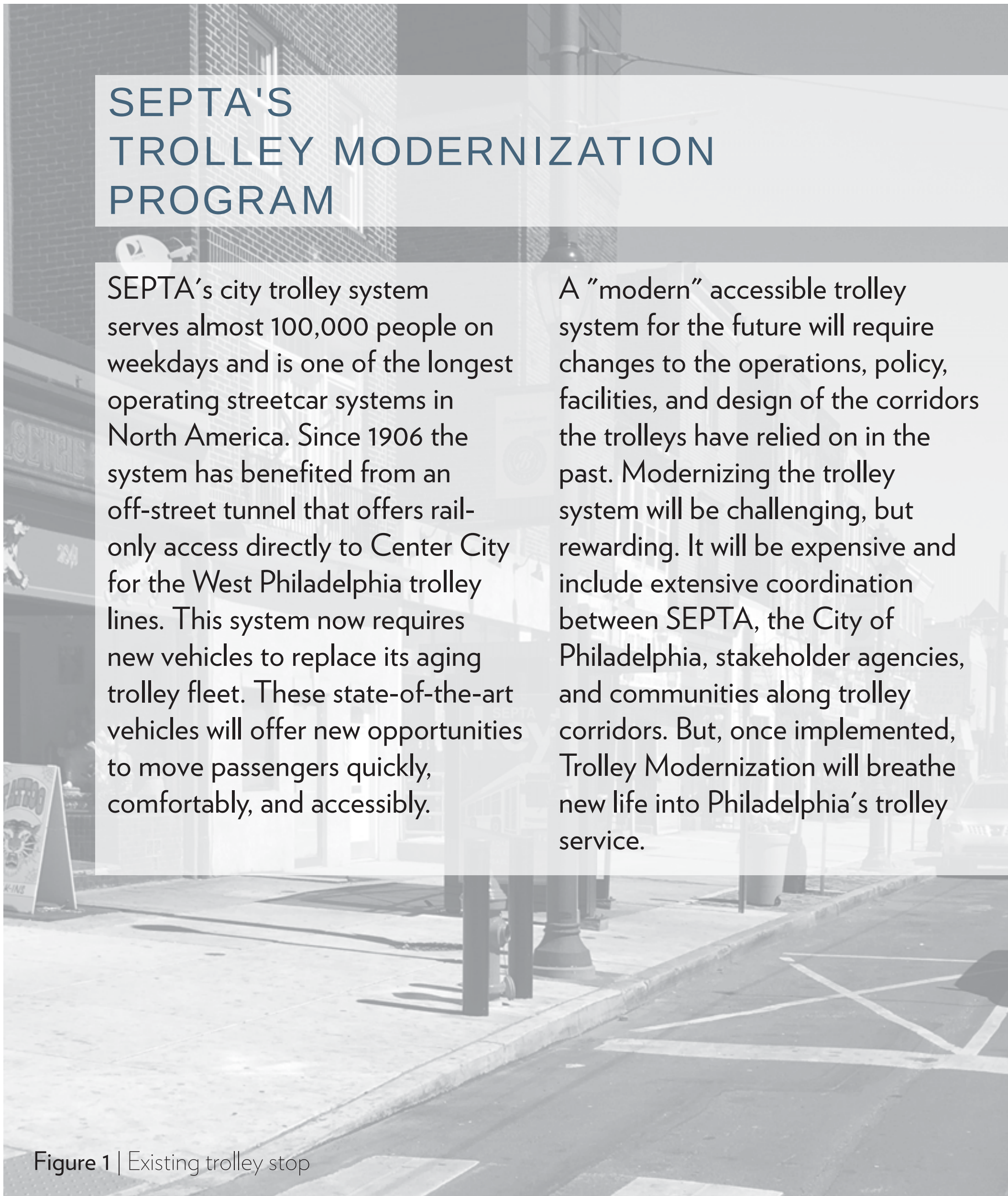


Figure 1 | Existing trolley stop

MODERN STATIONS

Modern trolleys will perform much differently than today's trolleys. New vehicles will require new, ADA-compliant stations, which will offer new amenities for passengers.

At existing trolley stops, passengers board from the street at each intersection, but modern trolley *stations* will be ADA-compliant, and be spaced efficiently—approximately every quarter mile—to provide faster service to passengers.

Trolley stations will be the first, and most visible way SEPTA customers will interact with the modern system. The MODERN TROLLEY STATION DESIGN GUIDE outlines the technical requirements for these new stations and the reasoning behind their design.

SEPTA AND PARTNER AGENCIES WILL NEED:

- Sufficient funding.
- Approaches that consider the once-in-a-lifetime opportunity to reimagine how streets with active rail function.
- Sound strategies to balance the safety and mobility needs of pedestrians, bicyclists, drivers, and transit riders.
- Flexibility in design and construction standards.
- A coordinated, realistic, and flexible plan to roll out modern stations.
- Frequent and clear communication with the public about the opportunities and limitations of modern stations.
- To adapt to new fare payment methods.

NEXT STOP:
MODERN TROLLEYS

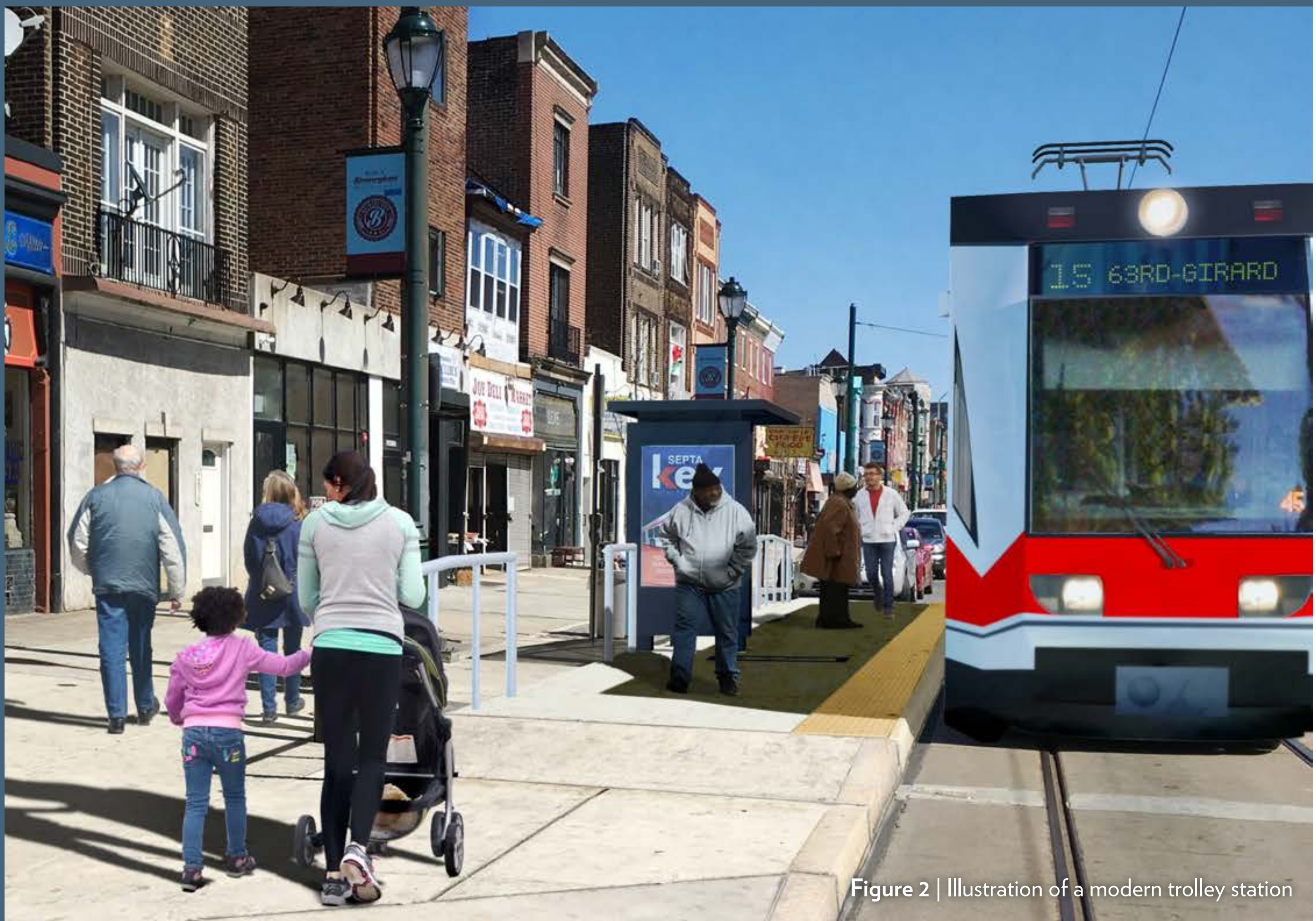


Figure 2 | Illustration of a modern trolley station

PASSENGERS & NEIGHBORS CAN EXPECT TO:

- Board or alight faster, more safely, and with less physical effort.
- Board the trolley via a raised, dedicated boarding area (platform).
- Enter and exit the trolley through any of the vehicle's four doors (multidoor boarding).
- Pay fares on a machine that is on the vehicle, or at the station, without interaction with the on-board operator.
- Activate a quick-deploying boarding ramp when needed.
- Enjoy a flexible seating arrangement so as to easily tote strollers, bulky packages, and bikes on board.
- Lose about 2-3 on-street parking spots where stations are created (approximately every quarter mile); gain parking spaces where trolley stops have been consolidated.
- Bicycle around raised boarding platforms on corridors with bicycle lanes.
- See additional streetscape improvements, such as shelters, railings, and lighting, at some new trolley stations.

INTRODUCTION

Figure 3 | Graphic rendering: Exclusive right-of-way station

SEPTA is preparing for a once-in-a-generation replacement of its trolley fleet. This vehicle replacement, Trolley Modernization, presents a tremendous opportunity to transform Philadelphia's trolley system into a state-of-the-art light rail system. SEPTA's six City trolley lines (Routes 10, 11, 13, 15, 34, and 36) rank within the top 20 highest ridership of City transit lines. A new vehicle, and requisite transformations to the streetscape, will elevate the type of service and convenience that trolleys provide, and will leave a distinct mark along the region's trolley corridors.

Trolley Modernization will convert a bus-like service into a modern, accessible system through many of Philadelphia's neighborhoods. Station improvements will begin to transform streetscapes and be compatible with existing vehicles even before new vehicles are in service. The Modern Trolley Station Design Guide provides practitioners with guidance on the design parameters needed for modern trolley stations along trolley corridors in SEPTA's City Transit Division. A separate Guide will describe modern stations along Routes 101 and 102 in Delaware County.

New Vehicles, New Streets

SEPTA's thirty-six-year-old trolleys are nearing the end of their useful life, causing expensive and inconvenient stresses on the system. Vehicle replacement is necessary to maintain the transit capacity afforded by the trolley tunnel which offers direct, off-street access between University City and Center City for trolleys only. To maintain this essential transit service, SEPTA will procure a new, state-of-the-art trolley fleet. To comply with accessibility laws, SEPTA will purchase accessible vehicles and build accessible stations.

Best practices in the transit industry and vehicle technology have advanced the accessibility and efficiency of trolley and streetcar[1] systems. Figure 4 illustrates how newer light rail vehicles will open trolley service to disabled passengers for the first time and ease boarding for all passengers. Trolley Modernization will do this through:

- **Lower vehicle floors** that remove the barrier of steps inside the vehicle,
- **Passenger-activated ramp deployment** that allows passengers to wheel on or off the vehicle and eases boarding and alighting for passengers who have difficulty walking,
- **New on- or off-board fare payment** allows passengers to board and alight through multiple doors, without the need to interact with operators, and
- **Open seating arrangements** inside the vehicle offer greater flexibility for loading passengers, particularly with wheelchairs, strollers, or bicycles, efficiently.

The vehicles procured will meet today's best practices as well as federal standards. Some characteristics of modern vehicles that represent significant changes from SEPTA's existing fleet are highlighted in Table 1.

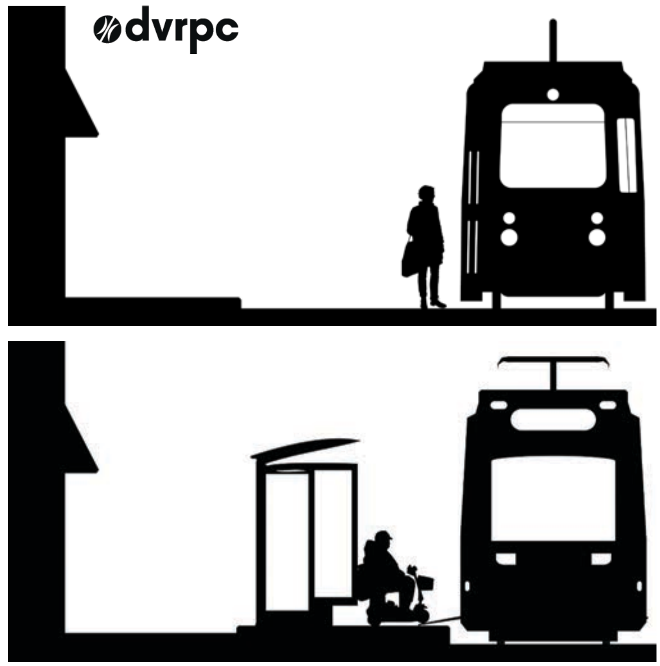


Figure 4 | Existing passenger boarding (top) and modern passenger boarding (bottom)

	Existing Fleet:	Modern City System Vehicles:
Vehicle floor	High, typically 3′	Low, typically 14″
Vehicle length	53′ - 0″	80′ - 0″
Fare payment	Fare box at front door	On- or off-board fare payment that does not involve an operator
Accessible boarding	None, except for operator-activated mechanical lifts, on Route 15 vehicles	Directly from platform (level), or with automatically deployed ramp (near-level)
Number of doors	1 for boarding and alighting (front), 1 for alighting only (rear)	2–4 for both boarding and alighting
Full, not "crush" load, passenger capacity	51 seats, 24 standees	60 seats, 55 standees

Table 1 | Comparison of existing SEPTA trolley fleet and industry standards

Source: SEPTA, 2016

1 The terms "trolley" and "streetcar" both refer to rail cars that draw electric power from an overhead wire. Historically, the two terms have been used interchangeably. "Streetcar" is used more widely, but "trolley" is regionally preferred in Philadelphia.

The distinction between the terms "light rail" and "trolley" can also cause confusion. There is no absolute difference between the two, but a light rail system generally features more exclusive right-of-way and wider stop spacing, while a trolley or streetcar system involves more mixed-traffic travel and closer stop spacing. Many streetcar systems contain elements of light rail systems, and vice versa.

Figure 5 | A passenger boarding SEPTA Route 34 from the roadway

Figure 6 | Passengers boarding the Portland Streetcar from a raised boarding platform

Modern vehicles will compel changes to the street to meet accessibility requirements of the Americans with Disabilities Act of 1990 (ADA). Currently passengers step off the curb, cross some portion of the cartway (the roadway portion between curbs intended for vehicular use), usually the parking lane, and step up inside the vehicle (see Figure 5). In a modern system, passengers board the vehicle via a raised boarding platform that bridges the space between the existing sidewalk and the vehicle floor. This raised boarding platform provides level boarding with the vehicle floor, or near-level boarding through the use of an automatically deployed ramp.

Currently passengers board through a front door with a farebox overseen by a driver, and alight via a back (preferred) or front door. A modern system will allow for passengers to board and alight via multiple doors, requiring long platforms to access those doors. Modern trolley stations therefore require curb "bumpouts" to extend the sidewalk horizontally towards the trolley vehicle edge, vertically to meet the vehicle's low floor, and must be long enough to accommodate multidoor boarding (see Figure 6). This raised, rectangular area where passengers immediately board and alight is referred to as the *raised boarding platform*. The entire area encompassing the raised boarding platform and the transition areas between it and the sidewalk is referred to as the *station*.

Modern stations will be costly and may not be able to be constructed in some existing stop locations due to conflicts with existing driveways, turn lanes, inlets, or fire hydrants. They will also require removing some on-street parking, typically 2-3 parking spaces per station. Because of these impacts, existing stops will need to be consolidated, with new stations sited to:

- Allow for flexibility in locating stations where there are few constructability conflicts,
- Increase passenger boarding efficiency,
- Reduce the cost of modern station infrastructure, and
- Limit the elimination of on-street parking spaces.

PROGRAM OVERVIEW

In addition to streetscape changes at trolley stations, service speed is expected to improve with modern vehicles. DVRPC's Analysis of Modernization Scenarios for SEPTA Route 34 found that modern transit improvements like all-door boarding, transit signal priority (TSP), and stop consolidation could significantly improve service speeds when used in combination (see Figure 7).

Trolley Modernization will bring changes to trolley corridors and the neighborhoods around them, including accessibility for unserved populations, and faster, more reliable service for all.

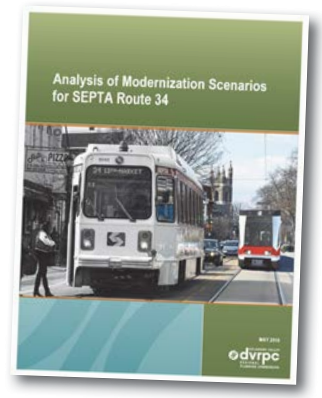


Figure 7 | Operations report

DVRPC's 2016 *Analysis of Modernization Scenarios for SEPTA Route 34* used microsimulation software to test travel time and delay outcomes of Trolley Modernization scenarios for the street running portions of Route 34.

Full report: www.dvrpc.org/Reports/15005.pdf

Trolley Modernization Program Principles

Vehicle procurement is a long and complex process that balances operational needs and infrastructure with fiscal constraints. Modern vehicles will have implications on operations, fare collection, maintenance practices, clearance, tunnel capacity, maintenance facilities, power, communications, signals, and boarding.

At the same time, infrastructure will inform modern trolley operations, such as fare payment, vehicle and track interface, and maintenance. These changes, taken together, make up the Trolley Modernization program. SEPTA's four initial goals for Trolley Modernization are shown in Table 2. These goals informed this design guide's work from the earliest project phases. As Trolley Modernization progresses, SEPTA expects to adapt these principles in response to partner and stakeholder feedback.

SEPTA'S INITIAL TROLLEY MODERNIZATION PROGRAM PRINCIPLES
Accessible System: Provide a completely accessible system that is in full compliance with the Americans with Disabilities Act (ADA).
Safe & Improved Customer Experience: Use modern standards and technologies to provide faster, more reliable transit service.
Control Vehicle Acquisition Costs: Provide the right-sized trolley fleet that will also provide faster, higher-capacity service.
Reduce Annual Operating Costs: Improve reliability and operating speeds to reduce the number of vehicles required based on faster, higher-capacity service.

Table 2 | Trolley Modernization initial program principles

Source: SEPTA, 2015

Collaboration

Trolley Modernization requires balancing the changes that new vehicles will require with the needs of all street users. The majority of SEPTA's trolleys run in mixed traffic, often alongside cyclists and pedestrians. The safety, facility design, and speed of each mode will inform design and policy decisions of Trolley Modernization.

Trolley Modernization's most prominent streetscape impact will be at stations, where curb extensions are needed to make the system accessible. Curb extensions will affect mobility along the entire runningway as the various road users abut, go around, or go through trolley stations. The Trolley Modernization program includes collaboration between SEPTA and many of its stakeholders such as the Pennsylvania Department of Transportation (PennDOT), City of Philadelphia, Delaware County, DVRPC, passengers, bicycle advocates, and business/neighborhood districts. Safety and mobility goals for trolleys, cars, bicyclists, and pedestrians are balanced with utility, maintenance, economic, and aesthetic goals for the corridor. Trade-offs for each goal and mode will be needed at times to reach overall corridor completeness so that all goals, and all modes, can thrive.

Beyond transit, the City of Philadelphia's *Complete Streets Handbook* sets forth policy that safeguards Philadelphia streets to accommodate all modes—transit, personal vehicles, bicyclists, and pedestrians—in a way that is context sensitive. More than half of SEPTA's on-street trolley corridors include bicycle lanes. SEPTA's Trolley Modernization program will need to adhere to the policies set forth in the City of Philadelphia's *Complete Streets Handbook*.

Delaware County is presently developing a Transportation Plan to guide transportation enhancements within the county. The 2035 transportation component to the county's comprehensive plan, *Delaware County 2035*, will consider a unified vision for all transportation modes, including trolleys, within the county. Trolley Modernization will also need to support, and be supported by, *Delaware County 2035*.

Jurisdiction Within and Around Stations

The Modern Trolley Station Design Guide includes station designs for various trolley corridors—both the platform requirements as well as streetscape recommendations that address supplementary objectives like stormwater management or bicycle safety. Future corridor planning and engineering will determine the construction and maintenance limits and requirements for participating agencies. In general, SEPTA's responsibility is to provide ADA access to their vehicles. Streetscape recommendations that extend outside that purpose may be at the discretion of, or in partnership with, other implementing agencies.

What is the Modern Trolley Station Design Guide?

The Modern Trolley Station Design Guide is a reference for planners, engineers and community members to understand the goals behind modernizing trolley corridors within the City. It outlines the design elements and explains their intent and parameters at a conceptual level. The Modern Trolley Station Design Guide is the foundation for station design, corridor design, and engineering strategies that support SEPTA's Trolley Modernization program principles, as well as City of Philadelphia Complete Streets policies.

Subsequent sections are separated into the following topics:

Existing Conditions provides an overview of the current system-wide trolley operating context.

Design Assumptions introduces the main assumptions about how the modern system will operate. These assumptions will dictate the design, dimensions, and spacing of stations.

Station Designs illustrates the station layout options for the system's various right-of-way contexts. These station designs should function as a designer's toolbox, and provide a concept-level introduction to providing accessibility to trolley vehicles and best practices for station, and corridor, design.

A separate design guide will outline station design for routes 101 and 102 which operate in Delaware County and in different operating contexts.

Other Guidance

In addition to the Modern Trolley Station Design Guide, several other references provide relevant guidance for Modern Trolley station design and engineering, including:

- National Association of City Transportation Officials (NACTO) *Transit Street Design Guide*
- NACTO *Urban Bikeway Design Guide*
- Philadelphia *Complete Streets Design Handbook*
- Philadelphia Water Department *Green Streets Design Manual*
- *Philadelphia 2035: Citywide Vision* and *District Plans*
- SEPTA *Bus Stop Design Guidelines*
- PennDOT *Pub13M Design Manual Part 2: Highway Design*
- PennDOT 2013 *ADA Reference Guide*
- NJDOT and PennDOT 2008 *Smart Transportation Guidebook*
- Federal Highway Administration (FHWA) *Manual on Uniform Traffic Control Devices (MUTCD)*
- FHWA *Separated Bike Lane Planning and Design Guide*
- American Association of State Highway and Transportation Officials *Guide for Geometric Design of Transit Facilities on Highways and Streets*
- *American Public Transportation Association (APTA) Modern Streetcar Vehicle Guideline*

Design Process

Over the next decade, SEPTA will oversee modern trolley planning and execution. The engineering requirements, coordination, project requirements, and transitional phases will be managed by both in-house and consultant-led program managers. As part of the transition, SEPTA will initiate the design of portions, or entire routes, of modern trolley corridors with new stations. In some instances, other agencies like the Commerce Department, or PennDOT may initiate streetscape design along corridors, in which case they would act as project sponsors. All modernization projects will require design review and approvals from necessary agencies. In Delaware County, design review and community engagement should coordinate at both the County and municipal level.

Planners and engineers working on modernizing trolley corridors should rely on this guide to understand the principles and set the parameters around design solutions. Philadelphia's trolley corridors are complicated. They can be narrow, accommodate multiple modes of transportation, and have a slew of signs and underground utilities around which to design. Designing modern trolley stations will require creative solutions. Flexibility is encouraged.

Creativity should be exercised during the planning of projects so that the opportunity to realize a more far-reaching vision for trolley corridors can be accomplished. For example, modernizing stations may be the impetus to imagine changing lane configurations, rerouting bicycle facilities, or rearranging rights-of-way. Design preferences may evolve with time and experience.

Trolley station design must be an iterative process. SEPTA is encouraged to pilot temporary or one-off station designs, and measure outcomes before committing to a more permanent strategy.

Trolley Modernization fits under best practices of Transit First, an interagency initiative between SEPTA and the City of Philadelphia that supports policies that allow transit to run more efficiently on high volume corridors. SEPTA and the City of Philadelphia have spent decades assuring that transit is prioritized in transportation planning through the Transit First Committee. The Transit First Committee will serve as a forum for collaboration, ensuring that SEPTA riders and Philadelphia residents share in the benefits of Trolley Modernization, and that trade-offs and conflicts can be managed fairly.

Trolley Modernization design work will include active participation from community members and elected officials in addition to standard design review and approval. Community collaboration should include persistent education and outreach on the requirements needed to accommodate ADA and operational goals of modern trolleys while balancing the safety and mobility goals of motorists, pedestrians, and bicyclists. At the same time, community outreach should take into account the goals and concerns of residents and businesses along the corridors so that they are vested and active participants in design decisions when possible. Outreach will need to continue once projects have been implemented to educate those traveling by trolley, foot, bicycle, or auto, on how to safely navigate the new system. For example, bicyclists may need specialized programming in order to know how to navigate around a trolley station or where to stop at intersections. (See Figure 100 for an example of Seattle's bicycling around streetcar educational materials.)

SEPTA is not the first transit agency to implement a modern trolley system on existing urban streets; many cities have undergone a modernization program to their existing systems, while others are establishing new streetcar lines. Each city addresses policy and design decisions that impact operations in a different way. These peer cities provide insight on how to balance modern trolley systems' needs with demands of street users.

In this introductory chapter, six peer cities are listed, with a brief description of their relevance to SEPTA's system. Later, in the Station Designs section, specific design techniques used in these peer cities, as well as some others, are cited to share lessons learned with designers contemplating similar design interventions in Philadelphia. Noted peer cities in both chapters should serve as sources for planners and engineers advancing Trolley Modernization to further analyze during future work.

Toronto:

In Toronto, Ontario, Canada, the Toronto Transit Commission (TTC) is in the process of modernizing their existing streetcar system through the procurement of new low-floor vehicles. TTC's transition to modern vehicles, and the design and operations changes they require, is comparable to what SEPTA will experience through modernization. Along some corridors, new vehicles have already been rolled out, offering a view of how implementation phasing might work for SEPTA.

Boston:

The Massachusetts Bay Transportation Authority (MBTA) is purchasing a partial new fleet of vehicles which will go toward a new Green Line extension and be used together with older vehicles on the rest of the system. This partial replacement demonstrates the resulting inconsistences in accessibility, fare payment, and number of doors used for boarding and alighting over the system.

Washington, DC:

DC Streetcar opened a new, 2-mile long, modern streetcar system in 2016 along H Street and Benning Street with transfers to Union Station. The line operates in mixed traffic, switching from a center lane to outside lane alignment. DC Streetcar demonstrates the design and policy decisions associated with trying to build ridership on a brand new streetcar system.

Portland, OR:

The Portland Streetcar, operated and maintained by TriMet and owned by the City of Portland, has gone to great lengths to accommodate bicycle facilities along its streetcar system. Portland's streetcar system is a seasoned modern system in that it is a newer system that continues to expand and evolve design approaches, particularly as they experiment with providing accessibility and define how bicyclists navigate curbside stations.

San Francisco:

San Francisco's streetcar system is operated by the San Francisco Municipal Railway (Muni) and owned by the City and County of San Francisco. San Francisco's system affords SEPTA and the City of Philadelphia lessons in improving existing streetcar performance with a focus on balancing complete streets policies through their city-wide policy—"Better Streets." The policy encourages adding community space, landscaping, and seating areas along streets to enhance the environment for all people along the street, regardless of mode.

Seattle:

The Seattle Streetcar system is operated by King County Metro and owned by the Seattle Department of Transportation. Seattle's streetcar system is an example of a decade or younger system, considering expansion, that is fully committed to modern approaches to fare payment and accessibility and is leading the way in station design that balances the needs of all modes on streetcar corridors.

EXISTING CONDITIONS

Figure 8 | Graphic rendering: Modern trolley in mixed traffic

The following chapter identifies and explores typical operating conditions for the street-running portions of SEPTA's six City Transit Division trolley routes. The routes are divided into seven cross-sections that are broadly representative of rights-of-way throughout the City trolley system, which will be used in subsequent chapters to identify appropriate trolley station designs for various streetscape contexts.

Route and Generalized Cross-Sections Map:

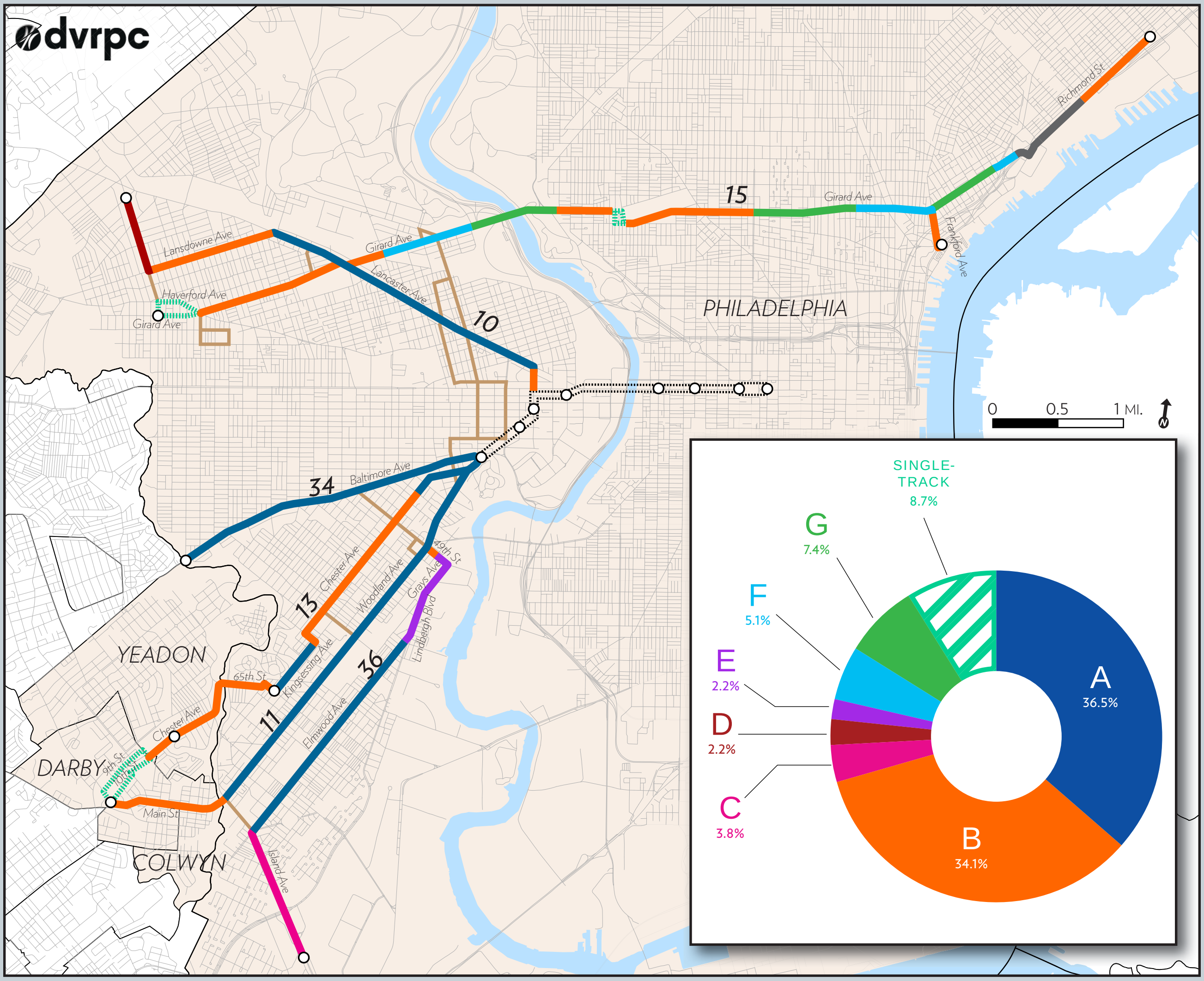


Figure 9 | Route and generalized cross-sections map

System Routes:

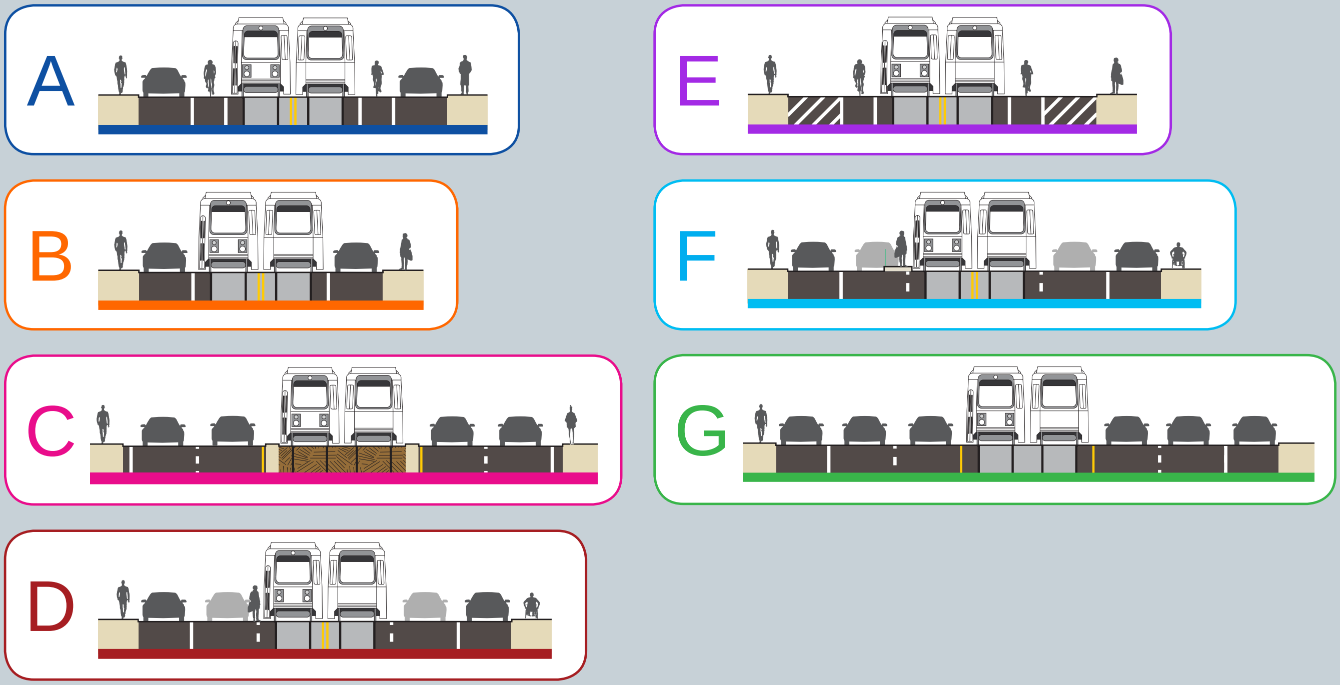
SEPTA operates six trolley lines within its City Transit division, Routes 10, 11, 13, 15, 34, and 36 (see Figure 9). These six routes are the remnants of a more robust trolley system that reached its peak in the mid-20th century, when trolley tracks were features of most major streets in urban Philadelphia.

After World War Two, the vast majority of streetcar routes nationwide were replaced by bus routes. SEPTA preserved a significant portion of its system and today remains one of the largest streetcar networks in the United States. Unlike other cities' entirely street-running systems, SEPTA's trolley system takes advantage of a tunnel linking West Philadelphia and Center City. The tunnel provides a direct and exclusive right-of-way that cannot be replicated on-street, a core reason that SEPTA's "legacy" system remains among the largest in North America.

Five of SEPTA's six City Transit trolley routes (10, 11, 13, 34, and 36) are known as "subway-surface" routes because they run, in part, through the trolley tunnel, making subway stops in Center City and University City. Traveling west, routes 11, 13, 34, and 36 emerge from the tunnel at the 40th Street Portal, and continue above ground to termini in West and Southwest Philadelphia (routes 34 and 36), and termini in Darby Borough (routes 11 and 13).

Generalized Cross-Section Types:

Cross-sections represent corridors with revenue service track only.



TUNNEL

Trolley routes in the tunnel

SINGLE TRACK

Trolley route segment on a one-way street, or in a single lane of a two-way street.

NON-REVENUE

Trolley tracks used for diversion service or when there are no passengers on board.

IN DESIGN

Trolley service temporarily suspended, and corridor currently in design, on portions of E. Girard Ave. and Richmond St. due to PennDOT's I-95 reconstruction.

Route 10 surfaces at the 36th Street Portal and travels northwest to its terminus near Lancaster & Malvern Avenues.

The subway-surface trolley routes are served by Kawasaki Light Rail Vehicles (LRVs), introduced in 1981 and 1982.

The sixth, Route 15, is a crosstown route more reminiscent of Philadelphia's historic trolley system, running entirely on-street in a variety of contexts. Route 15 is served by President's Conference Committee-II trolleys (PCC-II), originally built in the 1940s, but completely rebuilt in 2005.

The cross-sections of trolley streets are mostly generalizable into the seven typical cross-sections presented in Figure 9 and on subsequent pages. Cross-sections vary throughout the system, especially at major intersections, but they are simplified to organize concept-level station designs that will serve the existing SEPTA trolley system. Applying these station design concepts will require designers to take a closer, site specific look at trolley corridors, and be aware of any proposed changes to these cross sections so as to adapt accordingly.

TYPICAL CROSS-SECTIONS DIAGRAMS

A

9.4 mi.

Routes:
10, 11, 13,
34, 36

Configuration:
2 drive/trolley lanes
2 bicycle lanes
2 parking lanes
Boarding from bicycle lane

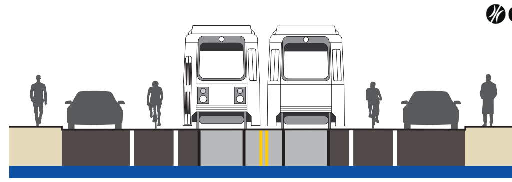


Figure 10 | Baltimore Avenue & 43rd Street

Figure 11 | Woodland Avenue & 49th Street

B

8.8 mi.

Routes:
10, 11, 13,
15, 34, 36

Configuration:
2 drive/trolley lanes
2 parking lanes
Boarding from parking lane

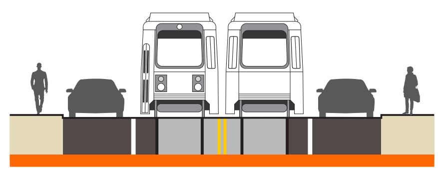


Figure 12 | Main Street & Mill Street, Darby

Figure 13 | Lansdowne Avenue & Conestoga Street

C

1.0 mi.

Route: 36

Dedicated trolley right-of-way
4+ travel lanes
Boarding from island platforms

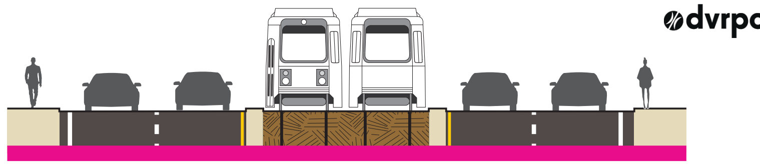


Figure 14 | Island Avenue near 76th Street

Figure 15 | Island Avenue & Lindbergh Boulevard

D

0.6 mi.

Route: 10

2 drive/trolley lanes
2 drive lanes
2 parking lanes
Boarding from travel lane

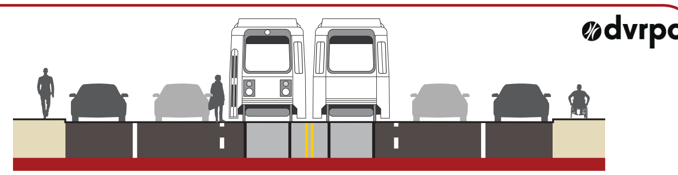


Figure 16 | 63rd Street & Jefferson Street

Figure 17 | 63rd Street & Lebanon Avenue

E

0.6 mi.

Route: 36

2 drive/trolley lanes
2 bicycle lanes
Shoulders signed for no parking

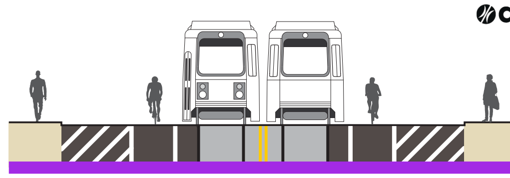


Figure 18 | Grays Avenue & 51st Street (looking northeast)

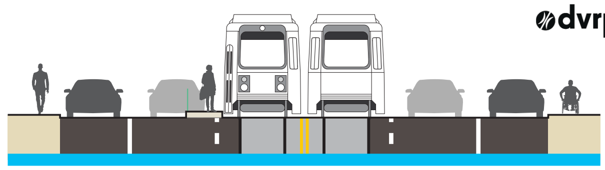
Figure 19 | Grays Avenue & 51st Street (looking southwest)

F

1.3 mi.

Route: 15

2 drive/trolley lanes
2 drive lanes
2 parking lanes
Boarding from island platforms



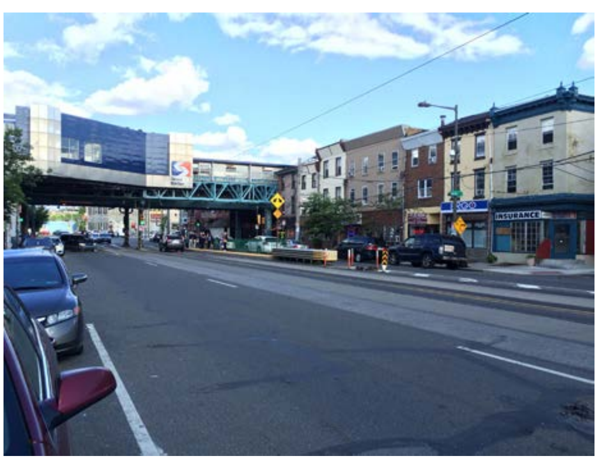


Figure 20 | Girard Avenue & Hope Street

Figure 21 | Girard Avenue looking west from the Market-Frankford Line

G

1.9 mi.

Route: 15

2 trolley/left turn lanes
4 drive lanes
2 parking lanes
Boarding from island platforms

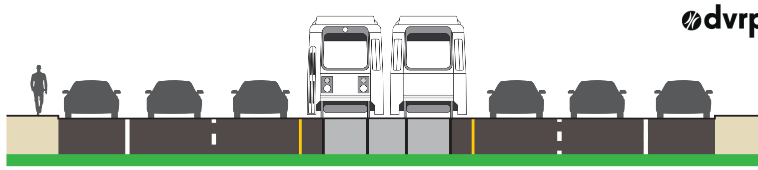


Figure 22 | Girard Avenue & 7th Street

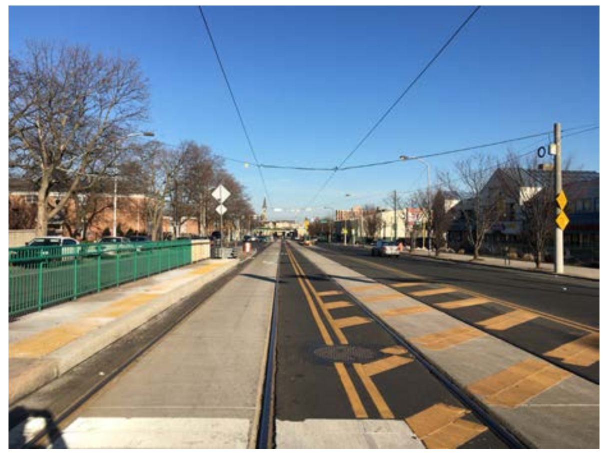


Figure 23 | Girard Avenue & 12th Street

TYPICAL CROSS-SECTION DIMENSIONS

System Overview:

Table 3 provides summaries of the common cross-sections, by route. The tables provide generalized dimensions for the right-of-way in each section type along the route. It is provided as a quick reference for design engineers to begin to conceptualize station designs in relation to the existing right-of-way. Designers will need to verify exact dimensions and unique cross-sections before beginning design work.

Route 10:

		WESTBOUND ⇩	⇩	⇩	EASTBOUND ⇧	⇧	⇧
Street	Cartway Width	Parking Lane	Bicycle Lane	Trolley/ Travel Lane	Trolley/ Travel Lane	Bicycle Lane	Parking Lane
36th Street	40′	8′		12′	12′		8′
Lancaster Avenue	48′	8′	5′	11′	11′	5′	8′
Lansdowne Avenue	36′	8′		10′	10′		8′
63rd Street	60′	8′		11′ 11′	11′ 11′		8′

Route 11:

		WESTBOUND ⇩	⇩	⇩	EASTBOUND ⇧	⇧	⇧
Street	Cartway Width	Parking Lane	Bicycle Lane	Trolley/ Travel Lane	Trolley/ Travel Lane	Bicycle Lane	Parking Lane
Woodland Avenue (between 40th & Chester)	44′		5′	14′	14′	5′	
Woodland Avenue (between Chester & Cobbs Creek)	44′	7′	5′	10′	10′	5′	7′
Main Street*	34′	7′		10′	10′		7′

* *Main Street's westbound parking lane becomes angle parking between Ridge Avenue and Powell Street.*

Route 13:

		WESTBOUND ⇩	⇩	⇩	EASTBOUND ⇧	⇧	⇧
Street	Cartway Width	Parking Lane	Bicycle Lane	Trolley/ Travel Lane	Trolley/ Travel Lane	Bicycle Lane	Parking Lane
Woodland Avenue	44′		5′	14′	14′	5′	
Chester Avenue (between Woodland & 46th)	44′	7′	5′	10′	10′	5′	7′
Chester Avenue (between 46th & 60th)	44′	8′		14′	14′		8′
65th Street (between Kingsessing & Chester)	40′	8′		12′	12′		8′
65th Street (between Chester & Cobbs Creek)	36′	7′		11′	11′		7′
Chester Avenue (between Cobbs Creek & Cedar)	36′	7′		11′	11′		7′

Street	Cartway Width	Parking Lane	Trolley/ Travel Lane	Parking Lane
Westbound: 10th Street	24′	7′	10′	7′
Eastbound: 9th Street	26′	8′	10′	8′

Table 3 | Typical cross-section dimensions by route

Sources: City of Philadelphia Aerial Imagery, 2015; Google Maps, 2016

Route 15:

Street	Cartway Width	Parking Lane (Westbound)	Bicycle Lane (Westbound)	Trolley/ Travel Lane (Westbound)	Trolley ROW	Trolley/ Travel Lane (Eastbound)	Bicycle Lane (Eastbound)	Parking Lane (Eastbound)
Frankford Avenue	36′	8′		10′		10′		8′
Girard Avenue (between Frankford & 6th)	72′	8′		14′ 14′		14′ 14′		8′
Girard Avenue (between 6th & Broad)	84′	8′		11′ 11′	12′ 12′	11′ 11′		8′
Girard Avenue/College Avenue (between Broad & 25th)	40′	8′		12′		12′		8′
Girard Avenue (between 26th & 31st)	40′	8′		12′		12′		8′
Girard Avenue Bridge	72′			12′ 12′	12′ 12′	12′ 12′		
Girard Avenue (between 38th & 40th)	68′	8′		13′ 13′		13′ 13′		8′
Girard Avenue (between 40th & Belmont)	68′	8′		12′	14′ 14′	12′		8′
Girard Avenue (between Belmont & Lancaster)	50′	9′	5′	11′		11′	5′	9′
Girard Avenue (between Lancaster & 60th)	40′	8′		12′		12′		8′

Street	Cartway Width	Parking Lane	Bicycle Lane	Trolley/ Travel Lane	Trolley/ Travel Lane	Bicycle Lane	Parking Lane
Westbound: College/Girard Avenue (between Poplar & 26th)	44′	8′		14′	14′		8′
Eastbound: Poplar Street (between College & 26th)	30′			12′	10′		8′
Eastbound: 26th Street (between Girard & Poplar)	27′	8′			11′		8′
Westbound: Haverford Avenue (between Girard & 63rd)	44′	7′	5′	10′	10′	5′	7′
Westbound: 63rd Street (between Haverford & Girard)	60′	8′		11′ 11′	11′ 11′		8′
Eastbound: Girard Avenue (between 63rd & 60th)	36′	8′		10′	10′		8′

Route 34:

Street	Cartway Width	Parking Lane (Westbound)	Bicycle Lane (Westbound)	Trolley/ Travel Lane (Westbound)	Trolley/ Travel Lane (Eastbound)	Bicycle Lane (Eastbound)	Parking Lane (Eastbound)
Baltimore Avenue	44′	7′	5′	10′	10′	5′	7′

Route 36:

Street	Cartway Width	Parking Lane (Westbound)	Bicycle Lane (Westbound)	Trolley/ Travel Lane (Westbound)	Trolley ROW	Trolley/ Travel Lane (Eastbound)	Bicycle Lane (Eastbound)	Parking Lane (Eastbound)
Woodland Avenue	44′		5′	14′		14′	5′	
49th Street (between Woodland & Paschall)	40′	8′		12′		12′		8′
49th Street (between Paschall & Grays)	52′	9′	6′	11′		11′	6′	9′
Grays Avenue	52′	9′ *	6′	11′		11′	6′	9′ *
Lindbergh Boulevard	44′	7′	5′	10′		10′	5′	7′
Elmwood Avenue	44′	7′	5′	10′		10′	5′	7′
Island Avenue	Varies	Varies			30′	Varies		

** Grays Avenue parking lane is signed "No Stopping Any Time"*

TROLLEY VEHICLES

Trolley Vehicles:

SEPTA uses two types of vehicles on its City Transit division routes, 112 Kawasaki LRVs and 18 PCC-IIs (see Tables 4 and 5). These vehicles predate the Americans with Disabilities Act of 1990 (ADA), the modern approach to accessibility. Vehicles have high floors, steps, and single-channel boarding, often from street-level. Only the retrofitted PCC-II cars in service on Route 15 comply with the ADA, and only do so via time-consuming, driver-operated wheelchair lifts and connect to platforms that are not ADA compliant due to their narrow depth.

The contemporary vehicles that SEPTA plans to purchase have features, such as low vehicle floors, multi-door boarding, and passenger information systems, that represent a major leap forward in terms of accessibility, passenger experience, and service speed. These advances (detailed in the following chapter, "Design Assumptions") will determine the form and function of modern trolley stations.

Kawasaki LRV:

Dimension	Measurement
Vehicle length	50′
Vehicle width	8′ - 6″
Floor height (from top-of-rail)	3′ - 0″
Practical passenger capacity	77
Routes served	10, 11, 13, 34, 36
Year built	1981
ADA accessibility	None

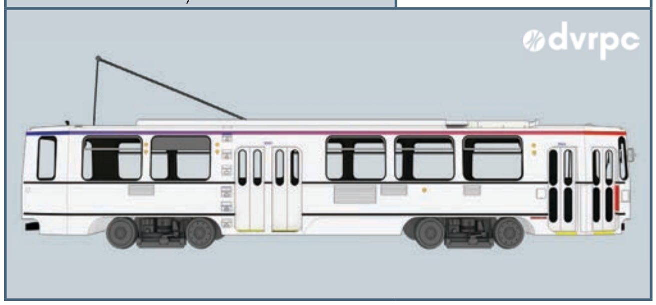


Table 4 | Kawasaki LRV vehicle specifications

PCC-II:

Dimension	Measurement
Vehicle length	46′-6″
Vehicle width	8′ - 6″
Floor height (from top-of-rail)	3′ - 0″
Practical passenger capacity	56
Route served	15
Year built	1947 (overhauled and put back into service in 2005)
ADA accessibility	Driver-operated lift

Table 5 | PCC-II vehicle specifications

DESIGN ASSUMPTIONS

Figure 24 | Graphic rendering: Curb extension station + bicycle lane

The following chapter introduces some of the key assumptions that are known about Trolley Modernization. Modern vehicles, station spacing, universal design, and complete street balancing between modes each play an important role in shaping the design, dimensions, and spacing of modern trolley stations.

VEHICLE

The basic designs of SEPTA's existing trolley fleet predates the Americans with Disabilities Act of 1990 (ADA). Manufacturers have since made significant improvements in performance, accessibility, and passenger experience—many of which are common enough to have become industry standards. These changes reflect both advances in technology, and compliance with regulations (such as ADA). Because of these advances, and to keep SEPTA's costs manageable, SEPTA will procure a vehicle fleet as close to existing supplier stock as possible, and with features that meet SEPTA's system requirements, rather than a made-to-order, or custom vehicle which would unnecessarily, and considerably, increase costs. Key vehicle features are presented here along with some of their most important effects on station design.

Low Vehicle Floors:

Modern low-floor light rail vehicles like that shown in Figure 25 typically have between half and all of their floor area at a low height, approximately fourteen inches above top-of-rail (TOR). The vehicles with less than 100 percent of the floor at a low height are typically referred to as partial low-floor, regardless of the actual percentage of low floor. Both low-, and partial low-floor vehicles are ADA compliant and compatible with the designs in this Guide. It is unknown whether SEPTA will procure low- or partial low-floor vehicles.

Figure 25 | Portland Streetcar: Low-floor vehicle

Automatically Deployed Ramp:

To allow passengers with mobility challenges to board, modern low-floor trolleys feature small bridgeplate ramps. These ramps bridge the horizontal and vertical gap between platform edge and vehicle, and create an accessible slope between the vehicle floor height and the platform height—which may differ by several inches.

These ramps deploy automatically when activated by a passenger using a button located on either the inside or outside of the vehicle (see Figure 26). This differs from earlier iterations of ADA-compliant boarding, which often required a transit agency staff person, typically the operator, to manually operate a lift, a time-consuming endeavor.

Figure 26 | Portland Streetcar: Automatically deployed ramp

Source: Steve Morgan via Wikimedia Commons (CC BY-SA 3.0)

Figure 27 | Metro Transit (Minneapolis): Multidoor boarding

Source: Metro Transit

Multidoor Boarding:

Modern streetcars are constructed with 2 to 4 passenger doors, which speed boarding and alighting (see Figure 27). Vehicles vary by manufacturer in the number and location of doors.

Numerous analyses, including DVRPC's *Analysis of Modernization Scenarios for SEPTA Route 34* (Pub. No. 15005, Published May 2016) have identified multidoor boarding as a significant reducer of dwell times at trolley stations.

Figure 28 | MTA Select Bus Service (New York): Off-board fare payment machines

Source: MTA

"Low-Friction" Fare Payment:

Modern streetcars are built under the assumption of low-friction fare payment, a scenario in which boarding passengers no longer pay their fare single-file at an entry door. Rather, fares are collected either through off-board collection, or on-board fare collection at multiple doors.

On Select Bus Service routes, running in New York City since 2008, for example, off-board fare payment machines (see Figure 28) allow passengers to pay before boarding buses, keeping a receipt as proof of payment. Metropolitan Transit Authority (MTA) officials have reported 30–40 percent dwell time savings since introducing off-board fare payment[2,3].

Another "low-friction" fare payment strategy that may be pertinent for SEPTA's trolley routes includes gated stations within the trolley tunnel (where approximately 80 percent of trolley passengers' trips begin or end, depending on the time of day), or introducing self-serve fare boxes on trolleys.

2 *Sustainable Streets Index 2009.* (New York: MTA, 2009), 37.
3 *34th Street Select Bus Service Newsletter 1.* (New York: MTA, 2011), 3.

VEHICLE

Specifications:

This Guide relies on industry standards, as implemented in other North American transit systems; SEPTA's 2015 Expression of Interest to potential trolley manufacturers; and manufacturers' responses to that Expression of Interest to define Trolley Modernization's design vehicle. These sources set a range of dimensions for modern trolley vehicles to use in designing stations (see Table 6 and Figure 29). Since the 1990's, all transit vehicles are equipped with low floors or ramps in order to be ADA compliant. Because these dimensions match SEPTA's Expression of Interest requirements, they meet system-wide specifications to meet SEPTA's unique operating and spatial context like required turning radii, tunnel clearances, and existing track spacing. Vehicle-borne ramp ADA requirements dictate the height, lateral gap, and clear space of the platform designs.

When there was no consensus among the sources as to a particular dimension, the project team selected the measurements that would allow for the most flexibility in conceptual designs.

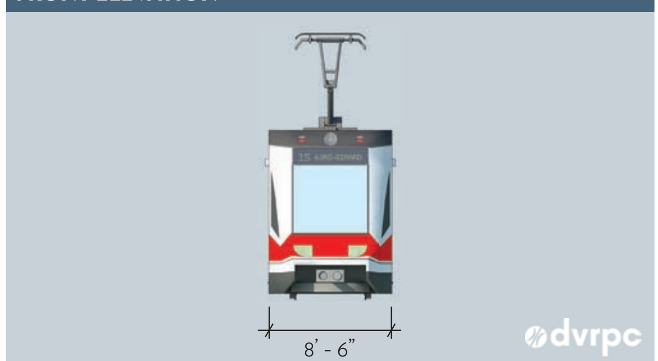
The assumed dimensions do not represent a selected or favored manufacturer, rather, they are generalizations that represent an "off-the-shelf" vehicle as much as possible that minimizes costly customizations, keeping SEPTA's procurement costs more manageable. These vehicle generalizations allow stakeholders to plan for a range of manufacturers.

Dimension	Measurement
Vehicle length	80' - 0"
Vehicle width (includes any appurtenances)	8' - 6"
Minimum turning radius	34'-0"
Floor height (from TOR)	1' - 2"
Distance from front of vehicle to outer edge of first door	15' - 0"
Distance between outer edges of outermost doors	50' - 0"
Car configuration	Articulated
Directional configuration	Single-ended

Table 6 | Vehicle dimensional assumptions

Sources: SEPTA, 2016; APTA Streetcar Subcommittee, 2015

FRONT ELEVATION



SIDE ELEVATION

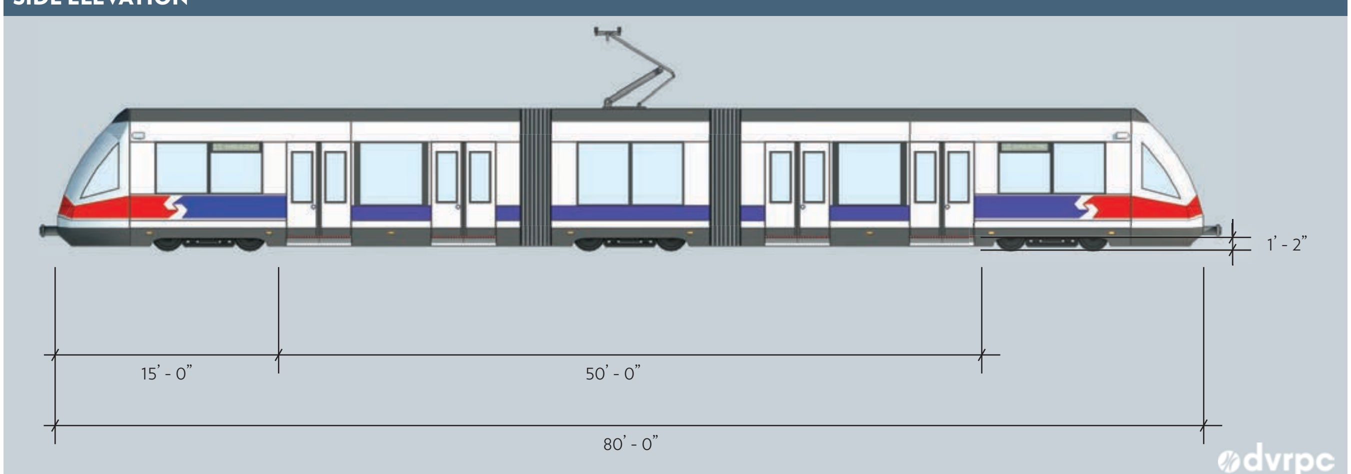


Figure 29 | Vehicle dimensional assumptions

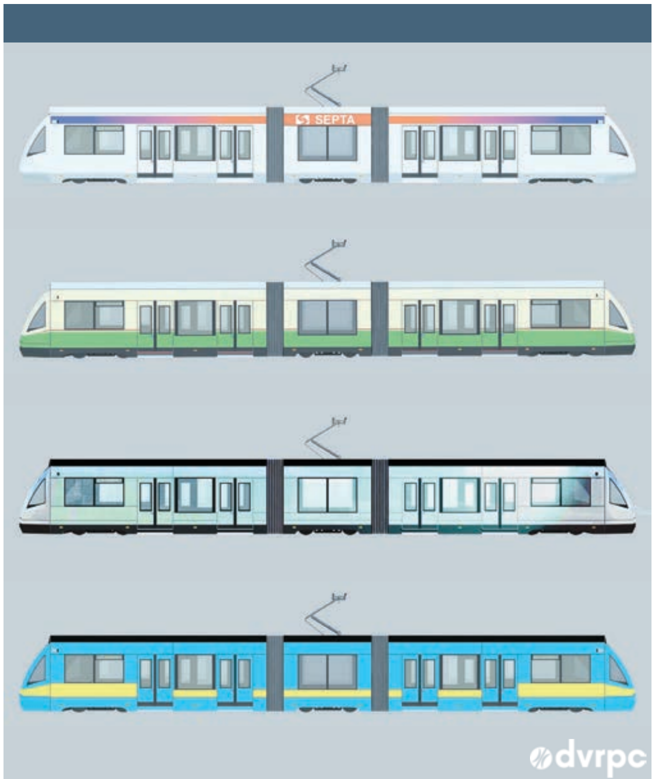


Figure 30 | Design vehicle example color palettes

Figure 31 | Toronto: 1970s-era TTC streetcar

Sources: Peter Broster via Wikimedia Commons (CC BY 2.0)

Visual Identity:

Many features of a contemporary trolley vehicle, such as its length or the number of doors are determined by legal requirements and industry standards. But a vehicle's appearance is a key area of design flexibility. The look and aesthetic finishes of new trolleys will be an important first impression for riders and neighbors. SEPTA should strive to collaborate with these stakeholders to ensure that new trolleys reflect the communities they serve.

Figure 30 shows how SEPTA could customize a new vehicle fleet. These images, like the vehicle presented throughout this report, are used as examples, not design proposals.

Peer Practice:

One approach SEPTA may consider is selecting a vehicle aesthetic that is meant to bridge the gap between old and new. The Toronto Transit Commission (TTC) began rolling out a modernization of their streetcar system in 2014 that shares many characteristics with SEPTA's Trolley Modernization. TTC's existing streetcars, most of which were made in the 1970s, have a distinct red and white color scheme. TTC's new vehicles, made by Bombardier, maintain consistency by reusing the existing palette, but iterate on that theme with sleeker lines and less visible hardware.

Alternatively, Trolley Modernization's look and feel may take SEPTA in a very new direction that nonetheless reflects Philadelphia. Marseille, France's new streetcars entered service in 2007 with a ship's bow-like body design evoking that city's maritime heritage. According to Bombardier, the vehicles are customized with larger windows, wooden seats, and a blue interior palette to accentuate Marseille's Mediterranean setting.

Incidentally, the same model of vehicle is used in both Toronto and Marseille, highlighting the level of customization possible, even with the same vehicle.

Figure 32 | Toronto: contemporary TTC streetcar

Sources: Robert Taylor via Wikimedia Commons (CC BY 2.0)

Figure 33 | Marseille: contemporary tram

Source: Ingolf via Flickr (CC BY-SA 2.0)

STOP CONSOLIDATION

As noted throughout this Guide, Trolley Modernization will require numerous trade-offs, both operationally and physically. In order to operate as an effective system reflective of modern transit standards, SEPTA must develop a sensible, cost-effective strategy to consolidate a number of existing trolley stops. It is critical that SEPTA develop this stop consolidation strategy through collaborative public outreach, working with its passengers, neighborhood groups, advocates for the disabled, political leaders, property owners, and other stakeholders.

Four key technical factors contribute to stop consolidation: the *constructability* at a station location; the *ridership* of a given station; a station's place in the broader transit *network*; and the overall *station spacing*.

Constructability:

The physical challenges of modernizing trolley stations will be an important constraint. In many cases, existing stops will not have adequate curb space to accommodate the footprint of a modern trolley station, generally 80–120 feet long by 8.5–12 feet wide. (See pp. 32-35, Station Elements in the station designs section, an overview of key trolley station dimensions.) This may be the result of nearby cross streets, driveways, or other obstructions—both publicly and privately owned.

Figure 34 shows Woodland Avenue at 52nd Street, an example of a challenging station from a constructability standpoint owing to numerous curb cuts (marked in red.)

In addressing constructability challenges, designers should consider options for relocating stations to the far side of an intersection, or mid-block, if either option can be accomplished safely.

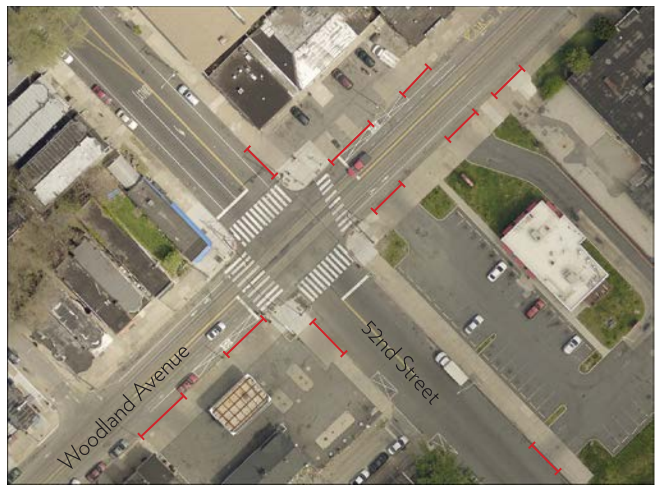


Figure 34 | 52nd Street & Woodland Avenue aerial image with curb cuts shown in red

Source: City of Philadelphia, 2015; DVRPC, 2016

Ridership:

Comparing average daily ridership at trolley stops is a helpful way to identify the strongest candidate stations to remain during stop consolidation. Higher ridership stops should be preserved, while lower ridership stops should be candidates for elimination.

SEPTA currently uses the ratio of total daily riders per scheduled daily trip as a station performance measurement (Boards + alights in both directions / scheduled daily trips in both directions). This metric offers a useful ridership comparison between stops regardless of how frequently they are served.

Network:

Care should be taken to preserve convenient access to important destinations (such as schools, employment centers, etc.), and to locations where passengers may need to transfer to another transit route. In some cases where stations are not able to be constructed exactly where local bus services intersect, SEPTA may consider altering bus routes to connect to modern trolley stations, facilitating bus-trolley transfers. Generally, stations should be located at intersections where the greatest connectivity is provided by the existing street grid.

SEPTA Route	Average Stop Spacing (ft.)
10	657
11	546
13	573
15	768
34	541
36	558
Systemwide average	*642*

Table 7 | Average stop spacing, surface portions of SEPTA trolley routes

Sources: SEPTA, 2012; DVRPC, 2015

City: Transit System (year built)	Average Stop Spacing (ft.)
New Orleans, LA: Streetcar routes* (1835)	712
Toronto, ON: TTC streetcar routes (1892)	820
Boston, MA: Green Line† (1894)	1,036
San Francisco, CA: Muni Metro‡ (1912)	938
"first-generation" system average	*877*
Portland, OR: Portland Streetcar (2001)	1,021
Seattle, WA: Seattle Streetcar (2007)	1,056
Tucson, AZ: Sun Link (2014)	936
Atlanta, GA: Atlanta Streetcar (2014)	1,188
Washington, DC: DC Streetcar (2016)	1,584
Modern system average	*1,157*

Table 8 | Average stop spacing, surface-running portions of select North American streetcar routes

Sources: Google Maps, 2015; Toronto Transit Commission, 2014; APTA Streetcar Subcommittee, 2011

**Includes St. Charles Line and Canal Street Line*

†Includes segments of MBTA Green Line routes "B" Branch, "C" Branch, and "E" Branch that operate in mixed traffic and in dedicated rights-of-way, but excludes segments in grade-separated rights-of-way.

‡Includes segments of Muni Metro routes J, K, L, M, N, and T that operate in mixed traffic and in dedicated rights-of-way, but excludes segments in grade-separated rights-of-way.

Station Spacing:

Stop consolidation reveals an essential trade-off in service planning: more stations along a route make it more convenient for passengers to access that station, but inconveniences other passengers by slowing down service, as the transit vehicle must stop more frequently. Fortunately, there is robust data on this trade-off that can inform SEPTA as it sites modern trolley stations.

A pertinent local example of research into the effects of stop consolidation on trolley service speed is DVRPC's 2016 *Analysis of Modernization Scenarios for SEPTA Route 34* (www.dvrpc.org/Reports/15005.pdf). That study used VISSIM microsimulation software to test the travel time and delay outcomes of various Trolley Modernization scenarios for the street running portions of Route 34, including stop consolidation. When paired with other modernization elements, stop consolidation was estimated to reduce on-street running times by up to 19.8 percent during the A.M. peak period in the peak direction (eastbound).

Passengers who previously used eliminated stops, however, would need to travel approximately 1 or 2 blocks further to arrive at a trolley station. A reasonable stop consolidation scenario would improve service speed without unduly burdening passengers. To achieve this, SEPTA should develop internal standards for station spacing, based on the experience of peer transit systems.

Comparing Tables 7 and 8 reveals that stops on the surface portions of SEPTA's trolley routes are mostly spaced closer than peer streetcar systems. Even fellow "first-generation" streetcar systems (i.e., systems that predate the post-WWII decline of streetcar transit) mostly feature greater average stop spacing.

Stop spacing on surface trolley routes also tend toward the minimum of SEPTA's current published standards: 500 feet minimum for established routes, and 1,000 feet minimum for new routes.

SEPTA should rely heavily on peer practice as it determines appropriate stop spacing on a modern trolley system. Systems with similar passenger capacity on vehicles and similar ridership may be particularly instructive.

COMPLETE STREETS

Today, SEPTA's trolley system shares public right-of-way space with bicycle lanes, parking spaces, sidewalks, cars, trucks, utility lines, green infrastructure, street furniture, and more. Even minor changes to the trolley system are likely to upset the existing balance of street functions. A major change such as Trolley Modernization requires thoughtful balancing of the needs of users and the demands of infrastructure. With careful planning, trolley streets can continue to grow as safe, multimodal transportation corridors, social spaces, and conduits for economic development.

The Guide seeks to balance the diverse needs of all street users, relying on the *Philadelphia Complete Streets Design Handbook*, adopted in 2013, as primary guidance. In particular, special attention is devoted to the interactions described in this section.

Automobile/Trolley Station Interaction:

Accessible trolley boarding requires building platforms that meet trolley vehicle doors. Depending on the size of the travel lane on a trolley street, this may require some encroachment of the boarding platform into the existing travel lane. In these cases, measures may need to be taken to protect the safety of drivers and trolley passengers, and to ensure that trolley stations are not damaged by automobiles.

In many cases, the travel lane may need to shift away from the boarding platform, and/or may need to be narrowed to accommodate a modern trolley station. Figure 35 shows one such treatment at a Portland Streetcar station, shifting the lane line demarcating the parking and travel lanes by about 18 inches.

Other measures, such as bright paint, can help warn drivers of upcoming trolley stations, as shown in Figure 35. In Seattle, for example, streetcar stations feature reflectors at locations where drivers are at risk of driving into a curb or other piece of streetcar infrastructure (see Figure 36).

In cases where a trolley stop exists as an island between two vehicular travel lanes, not only would existing travel lanes need to shift to accommodate a wider trolley station, but additional safety measures may be necessary to protect waiting passengers.

On Girard Avenue, for example, existing between-lane trolley stops use metal crash attenuators to protect passengers from vehicular traffic (see Figure 37). With modern trolley service, the existing 4' to 5' wide platforms will need to be widened to 8' - 6" to achieve ADA compliance, which may offer opportunities for different, more aesthetically pleasing strategies for protecting trolley stations and their passengers.

Figure 35 | Portland Streetcar: Shifting lane line

Figure 36 | Seattle Streetcar: Reflectors

Figure 37 | A crash attenuator at a Route 15 trolley stop

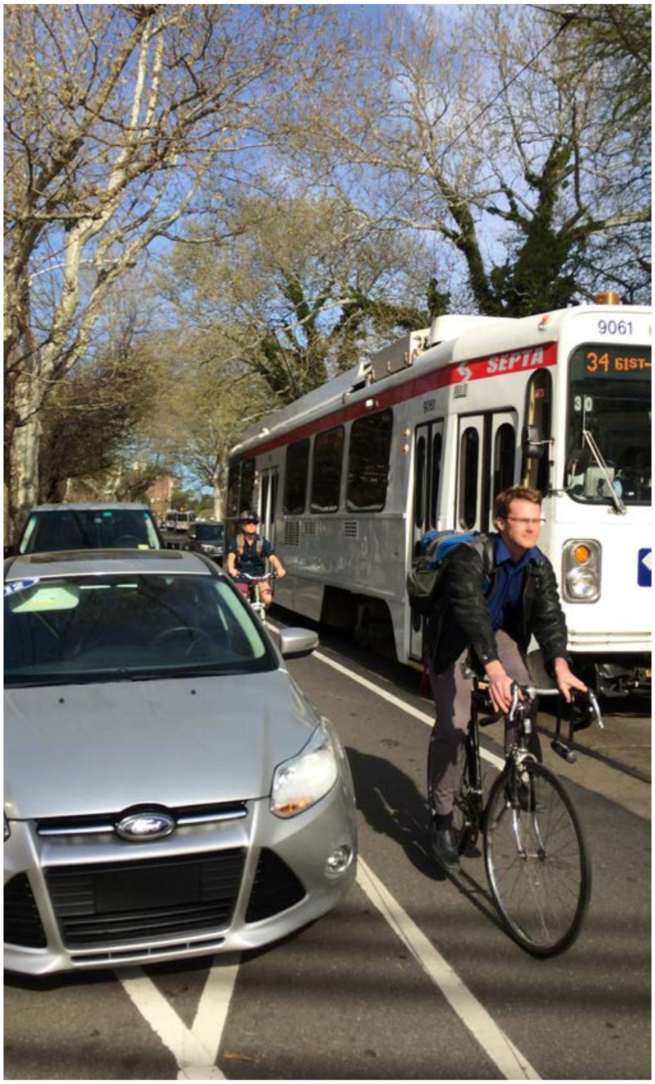


Figure 38 | Bicycle traffic alongside a Route 34 trolley on Baltimore Avenue

Bicycle/Trolley Interaction:

Cycling is not only a vital transportation option in its own right, but also works as an effective complement to the trolley system. Cyclists have been shown to travel longer distances to reach transit than pedestrians, expanding the reach of transit stations.

Approximately 40 percent of Philadelphia's trolley streets feature a dedicated bicycle facility—typically a conventional bicycle lane (see Figure 38). Some trolley corridors are among the most popular bicycle routes in the region. Safe coexistence of cyclists, drivers, pedestrians, and trolley passengers is one of the key design challenges of this guide.

Based on the project team's review of research and peer practice, there are three fundamental strategies for integrating bicycles and streetcars:

Strategy 1: Designing bicycle facilities and trolley stations that safely and functionally interact with each other;

Strategy 2: Building truly separated bicycle facilities (such as a physically-separated bicycle lane or sidepath) on existing trolley streets; and

Strategy 3: Developing a bicycle facility of equal or better quality on a nearby parallel street.

Strategies 1 and 2 would require implementation partnerships with municipal and community stakeholders because they go beyond the budget, jurisdiction, and legal requirements of SEPTA's Trolley Modernization program. Strategy 2 is limited by the narrow width of existing trolley corridors. It will often be the most expensive option, but also the most impactful in limiting bicycle/trolley conflicts. Strategy 3 would reduce bicycle/trolley conflicts, but will only be feasible for small portions of trolley routes, as many of the system's trolley corridors lack an obvious parallel street. The trade-offs associated with this transition would make it difficult to satisfy nearby residents and bicyclists who use the existing facilities. Nevertheless, SEPTA should collaborate with stakeholders to consider each of these options on a systemwide basis.

As a station design guide, this document focuses on the first strategy as it is within the purview of SEPTA's modernization efforts. For detailed discussion on accommodating cyclists at trolley stations, see the Station Designs section, pp. 40–49.

On Street Parking/Trolley Station Interaction:

On most trolley corridors, a modern trolley station will use space from an existing on-street parking lane (see Figure 39). At existing bus and trolley stops, a portion of the parking lane is typically striped for a transit loading zone, where parking is prohibited. SEPTA's current standard for transit loading zone size on existing routes is 60 feet long for standard vehicles, such as existing trolleys, and 90 feet long for articulated vehicles.

Modern trolley station designs will occupy about 100 feet of linear space, including the 60-foot transit zone, and 40 feet of the parking lane. Assuming 20 linear feet for an on-street parking space, a typical modern trolley station would require reducing the supply of on-street parking by two spaces per trolley station.

However, where stops have been consolidated, transit loading zones can be replaced with new on-street parking spaces. Trolley Modernization's parking implications systemwide will vary based on the degree to which stops are consolidated because each discontinued trolley stop would remove a transit loading zone, returning 60 linear feet of parking lane, or three parking spaces, to the right-of-way.

For example, Route 34 currently has 20 in-street surface stops in each direction. If half of those stops were eliminated, and the remaining stops were outfitted with modern platforms, the Baltimore Avenue corridor would actually *gain* parking spaces. For each loss of two parking spaces at a modern trolley station, three parking spaces would be created by removing the transit loading zone at an eliminated stop.

In other words, Trolley Modernization would hypothetically be "parking neutral" if 40 percent of existing stop pairs were eliminated through stop consolidation.[5]

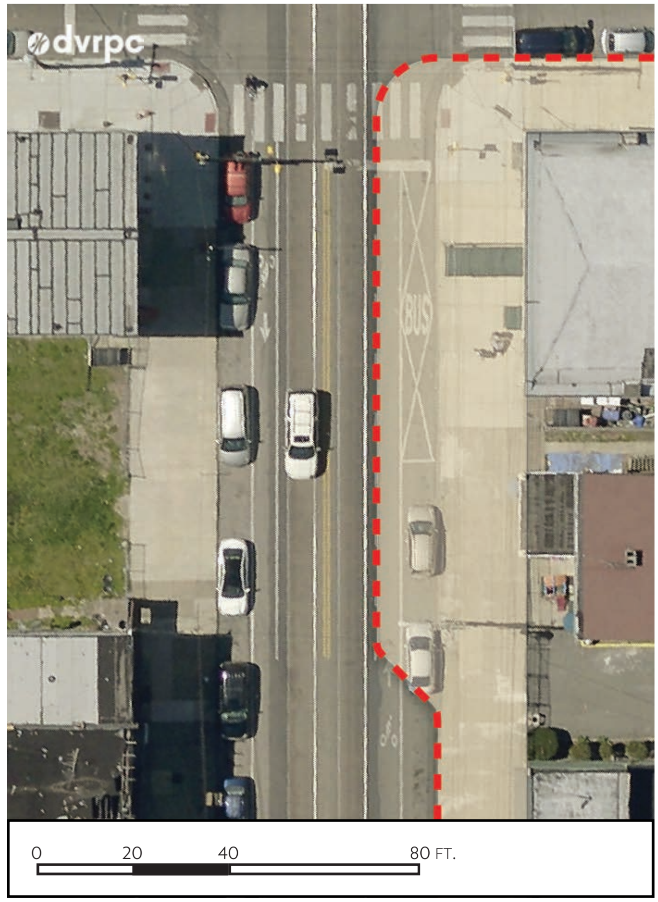


Figure 39 | A modern trolley station's footprint overlaid on a typical existing trolley stop

Source: City of Philadelphia, 2015; DVRPC, 2017

Route	Stop Consolidation Level					
	10%	20%	30%	40%	50%	60%
10	-101	-66	-36	0	34	64
11	-114	-84	-39	0	41	76
13	-143	-93	-48	0	47	92
15	-69	-49	-24	0	26	46
34	-60	-40	-20	0	20	40
36	-92	-62	-32	0	33	63

Table 9 | Net change in on street parking spaces under various stop consolidation scenarios.

Note: Parking calculations apply only to stops in which a modern station would occupy the parking lane.

5 This hypothetical calculation does not account for driveways, streets with both trolley and bus routes, utilities, or other factors that would affect stop consolidation and station siting scenarios. Actual station siting decisions will involve considering many more factors besides parking trade-offs. It is presented here as a rule of thumb.

Coincidentally, a 40 percent stop consolidation rate is just slightly higher than the 35 percent stop consolidation rate recommended in DVRPC's *Transit First Analysis of SEPTA Route 34* (2010). As noted above, the DVRPC *Analysis of Modernization Scenarios for SEPTA Route 34* (2016) found significant time savings when the same consolidation rate was combined with other Trolley Modernization factors, such as multidoor boarding and "low-friction" fare payment.

Figure 40 | Corner stormwater bumpout

Source: Philadelphia Water Department, 2014

Utilities/Trolley Station Interaction:

Trolley corridors in Philadelphia and Delaware County share right-of-way space with various elements of utility infrastructure, including electric, telecommunications, gas, and water facilities—among others.

Stormwater inlets, for instance, are often located within the footprint of trolley stations. With trolley modernization, these stormwater inlets will need to be moved or rebuilt.

Changes to stormwater utilities, on the other hand, may present opportunities to include green stormwater infrastructure (GSI) features as part of modern trolley stations like the stormwater bumpout shown in Figure 40. The Philadelphia Water Department's (PWD) "stormwater bumpouts" are examples of GSI that could be integrated into trolley stations where appropriate. The Stormwater Infrastructure section in the Station Designs section shows suggested locations for GSI features on relevant station designs.

Stop Location:

On today's trolley routes, trolleys typically stop at the near side of intersections to load and unload passengers. When constructing new stations, there may be opportunities to improve operational performance by locating station platforms at the far side of an intersection. Either strategy has pros and cons.

Near-side stops prevent double-stopping (once for a red light, and again for passengers), and prevent queuing behind a stopped trolley for either through-traffic, or of turning traffic from an intersecting street. Near-side stations are generally most effective on streets with one lane in each direction where trolleys operate in mixed traffic. Maintaining near-side stops may also be the least disruptive to on-street parking patterns as transit loading zones currently prevent parking at the near side of intersections.

Far-side stops, when paired with transit signal priority, can facilitate faster trolley service, and may be more effective than near-side stops at intersections with complex turning movements. Far-side stops can be particularly useful on multi-lane cross-sections, allowing turn movements even when a trolley is stopped at a station. They may, however, encourage mid-block pedestrian crossings, depending on how far they are set from the intersection.

The Station Designs section offers guidance on both near-side and far-side stations. Because SEPTA's trolley system is large and complex, this guide cannot offer a blanket preference for near- or far-side stations. SEPTA and its project partners must make stop location decisions on a route- and site-specific basis while considering pedestrian safety, constructability, lane configuration, turn movements, transfer potential, and other critical factors.

Accessibility Standards:

Improved access for passengers with disabilities is one of the primary benefits of Trolley Modernization. When replacing its trolley fleet, SEPTA will be required to comply with ADA in the design of both the vehicle, and the design of stations.

The United States Access Board is the independent federal agency that sets standards for ADA compliance. In this report, the project team relied especially on the Access Board's ADA Standards for Transportation Facilities, which governs facilities such as station buildings and platforms, and ADA Accessibility Guidelines for Transportation Vehicles, which applies to buses, rail cars, and other public transit vehicles. Guidance on vehicle-borne ramp specifications can be found in 49 CFR 38.83 Mobility aid accessibility and 36 CFR 1192.83.

Based on a review of these ADA standards, the project team has used the assumptions in Table 10 to inform its minimum standards for platform access. These ADA standards inform this report's conceptual designs, but are not meant as a substitute for a full ADA-compliance review of stations in the preliminary and final design phases.

Dimension	Measurement
Minimum platform width	8' - 6"
Maximum slope on a platform ramp	1:12 or 8.33%
Maximum running slope on a walking surface	1:20 or 5%
Maximum cross slope on a walking surface	1:48 or ≈2%
Clear landing space at accessible vehicle door	8' × 5'

Table 10 | Platform accessibility dimensional assumptions

Source: U.S. Access Board, 2010

Universal Design:

Trolley Modernization represents a once in a lifetime opportunity to make trolley routes more effective transportation options for people with mobility challenges—not simply ADA-compliant. In that regard, this guide strives to apply the principles of Universal Design to station concepts. Universal Design is an approach that involves designing the built environment to be intuitive and accessible to the broadest spectrum of users possible without the need for adaptation or special design.[4]

Where possible, this design guide seeks to implement these principles. For example, all station designs recommend platforms that are longer than the minimum length required to meet the trolley's doors. This affords trolley drivers a wider margin for error when stopping, and allows passengers to board from a consistent platform height. Likewise, the design guide recommends providing multiple entry/exit points for boarding platforms whenever safety considerations allow.

PRINCIPLES OF UNIVERSAL DESIGN

1. **Equitable Use**: The design is useful and marketable to people with diverse abilities.
2. **Flexibility in Use**: The design accommodates a wide range of individual preferences and abilities.
3. **Simple and Intuitive Use**: Use of the design is easy to understand regardless of the user's experience, knowledge, language skills, or current concentration level.
4. **Perceptible Information**: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
5. **Tolerance for Error**: The design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. **Low Physical Effort**: The design can be used efficiently and comfortably with a minimum of fatigue.
7. **Size and Space for Approach and Use**: Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture or mobility.

4 "The Center for Universal Design [at North Carolina State University] is a national research, information, and technical assistance center that evaluates, develops, and promotes accessible and universal design in housing, buildings, outdoor and urban environments and related products." More information on Universal Design is available at their website, ncsu.edu/ncsu/design/cud/index.htm.

STATION DESIGNS

Figure 41 | Graphic rendering: Road diet station

The following chapter presents ADA-compliant station designs compatible with SEPTA's new trolley vehicles. Designers should use this chapter as a starting place before preliminary engineering. The designs are presented at a conceptual level, and are intended as a "toolbox" for designers as they create detailed, site-specific plans for trolley stations. Flexibility in design standards and coordination with stakeholders is essential as designers adapt these concepts.

The chapter begins with an explanation of the ***station elements*** (pp. 32-35) common to all station types, such as locations for accessible boarding, and desired sidewalk width. Station designs are grouped according to the type of street on which they apply. The matching "typical cross-sections" from SEPTA's trolley system are noted along with each station type.

Curb Extension station types apply on streets where trolleys run adjacent to the parking lane, typically on two-lane, two-way streets. (pp. 36–39)
TYPICAL CROSS-SECTIONS: **B**

Trolley and Bicycle station types apply on streets where trolleys run adjacent to a bicycle lane, also typically on two-lane, two-way streets. (pp. 40–49)
TYPICAL CROSS-SECTIONS: **A**, **E**

Multi-Lane stations apply on streets with multiple travel lanes in each direction, or streets where trolleys have a dedicated right-of-way. (pp. 50–54)
TYPICAL CROSS-SECTIONS: **C**, **D**, **F**, **G**

Next Level station types cannot be easily constructed on today's trolley streets without moving track or changing lane configurations. They are most appropriate on streets undergoing an overhaul, or on new trolley corridors. (pp. 55-63)

Platform:

The preferred size and arrangement of design elements of the platform are consistent across all station types. Their placement allows for the greatest accessibility. Access to the platform and its relationship to the cartway vary outside the platform footprint.

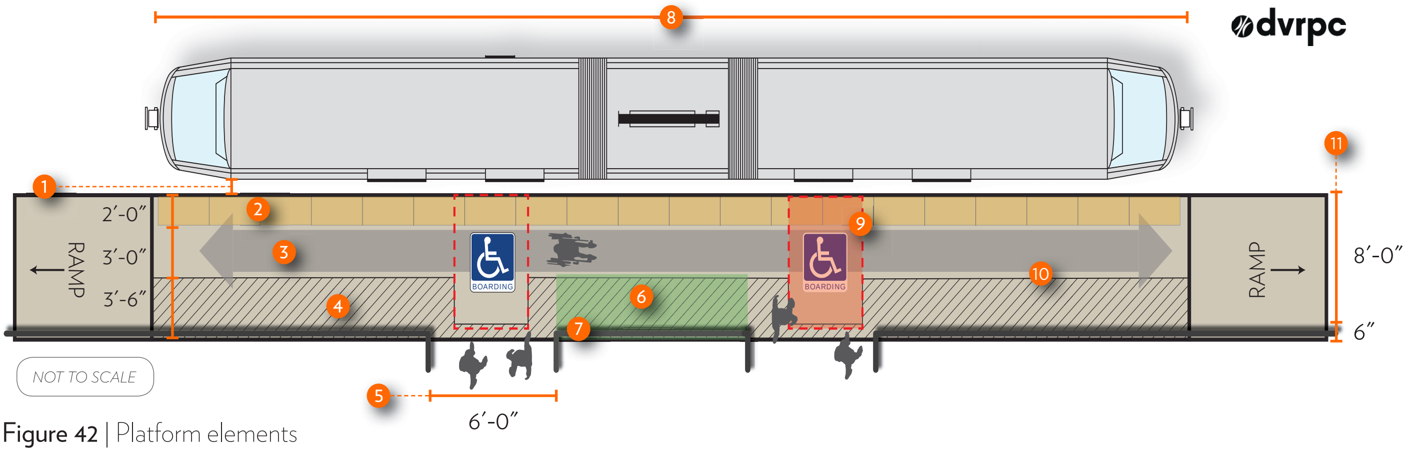


Figure 42 | Platform elements

Design Recommendations:

1. **Lateral Gap**: The distance between the edge of the platform and the edge of the vehicle should be no greater than 6".
2. **Curbside Edge**: A 2'-wide detectable warning strip must be placed along the curbside edge of the platform.
3. **Accessible Route**: A 3'-wide accessible route must be kept clear of all obstructions, and must connect to the accessible boarding locations (see recommendation 9).
4. **Furnishing Zone**: A 3'-6"-wide furnishing zone along the platform's sidewalk edge provides space for furniture, a shelter, or other passenger amenities. These features delineate the platform from the adjacent sidewalk or bicycle lane. The footprint of furnishings may not encroach on minimum platform space (see recommendation 10).
5. **Platform Entrances at Sidewalk Edge**: 6'-wide entrances allows space for two people to pass without requiring a railing. Entrances wider than 6' with stairs require a middle railing.
6. **Shelter**: Include a passenger shelter that meets SEPTA's standards for passenger comfort. Shelters may not encroach on ADA-required spaces. In conjunction with Trolley Modernization, trolley station shelters should be designed and branded to identify trolley service as different from SEPTA's other services.
7. **Railing**: The purposes of railings on platforms are to meet ADA requirements on a ramp, and to protect waiting passengers from a safety hazard, such as traffic, or a vertical drop that could create a trip hazard. When a new station requires rebuilding an entire corner, consider a barrier-free station-and-sidewalk combination, sloping gently from sidewalk to platform height.
8. **Platform Length**: A 80'-long minimum platform (not including access ramps) ensures direct access to all four vehicle doors plus 15' additional length beyond the first and last doors to ensure flexibility in vehicle stop location.
9. **Accessible Boarding Locations**: An 8' x 5' primary accessible boarding location must be marked on the platform where the primary accessible vehicle door is expected to stop. (On the design vehicle, the second door from the front is expected to be the primary accessible door.) A secondary accessible boarding location may be necessary on certain vehicles where in-vehicle barriers prevent passengers in wheelchairs from moving between vehicle sections. Accessible boarding locations must be marked in accordance with SEPTA standards and free of obstructions.
10. **Platform Area**: An 80' x 8'-6" platform should be ample space for boarding and alighting passengers to fit comfortably and safely on the platform at most stations. At high ridership stations, more space may be required. In these cases, the platform should be enlarged to meet a Passenger Platform Level of Service C (LOS C), a rating of average space available to waiting passengers set by the Highway Capacity Manual (HCM Exhibit 11-9). LOS should be calculated based on the station's highest expected daily boardings.
11. **Platform Width**: An 8'-6" platform width provides 8' clear for ADA boarding and alighting from a vehicle-deployed accessible boarding ramp door plus an additional 6" to provide space for a railing or lean bar outside the ADA wheelchair landing areas. This is a minimum standard, and may be enlarged towards the sidewalk where space allows.

Arrangement at Intersection:

The preferred size and arrangement of design elements at the intersection are consistent across all station types. The preferred intersection configuration directs pedestrians and vehicles to maneuver in a consistent, predictable manner and limits conflicts.

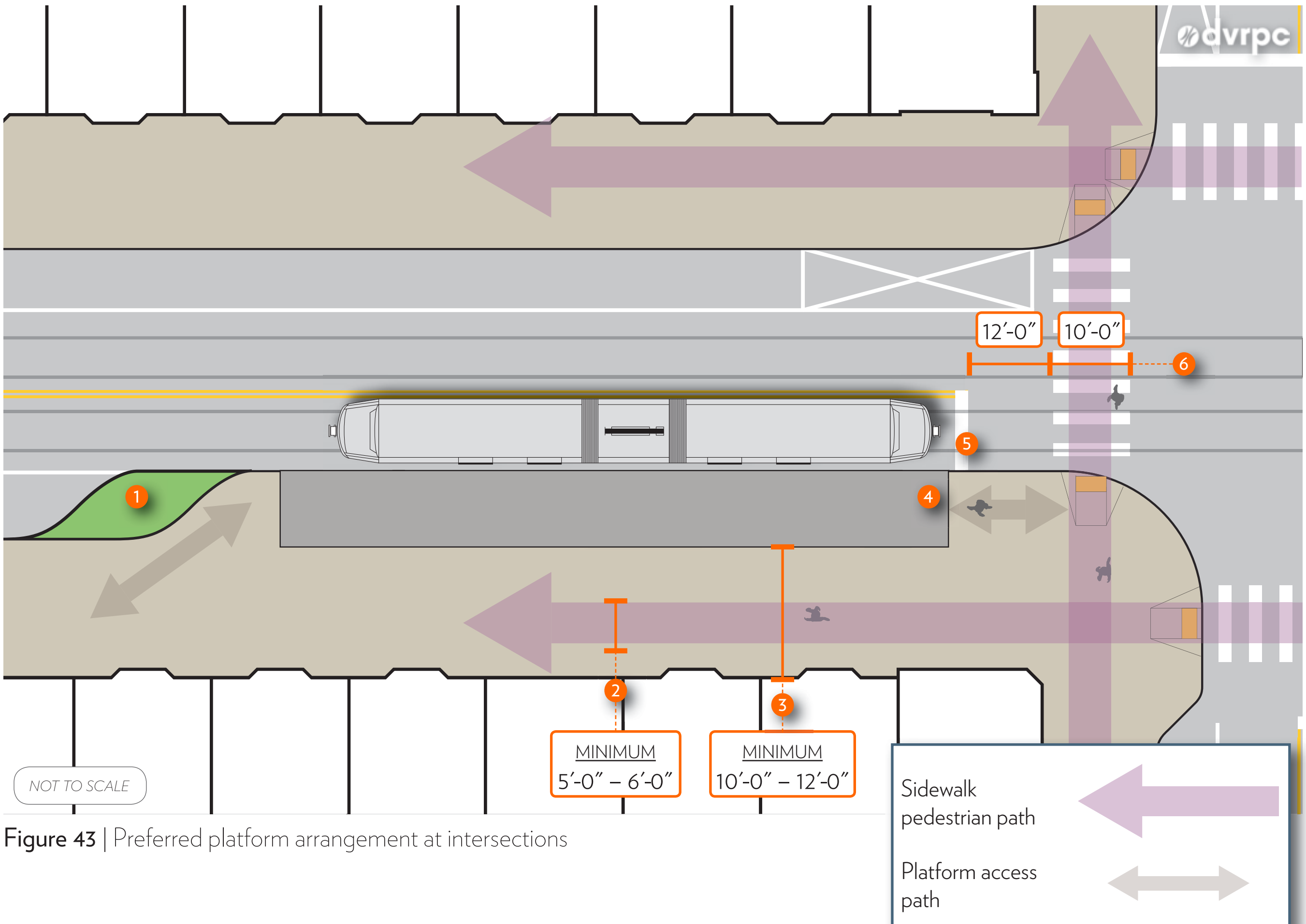


Figure 43 | Preferred platform arrangement at intersections

Design Recommendations:

1. **Furnishing Zone:** A furnishing zone at the rear of the platform provides space for additional furnishings, discourages access into, or across, the street at an unsignalized location and provides opportunities for stormwater infrastructure when space allows.
2. **Walking Zone Width:** The Philadelphia Complete Streets Design Handbook (CSDH) sets standards for sidewalk layout, including minimum width for walking zones. The walking zone of the sidewalk behind trolley platforms is dictated by the street's Street Type classification in the CSDH, §4.3. On existing trolley corridors, the walking zone width must be ≥ 5' on "Lower Density Residential" streets, and ≥ 6' on all other streets.
3. **Sidewalk Width:** Standards for the total sidewalk width can be found in CSDH, §4.3. On existing trolley corridors, total sidewalk width must be ≥ 10' on "Lower Density Residential" streets, and ≥ 12' on all other streets.
4. **Platform Access Ramp:** A primary accessible ramp to the platform will be provided at the platform end closest to the intersection. Another accessible ramp should be provided at the opposite end of the platform whenever space allows.
5. **Trolley Stop Location:** Trolley vehicles will stop directly at the stop bar, with no additional set back. The stop bar is the visual cue for trolley drivers to stop the vehicle so that doors open at the same place along the platform at each station.
6. **Crosswalk and Stop Bar:** Intersection must include a 10'-0"-wide crosswalk and 12'-0" stop bar setback per Streets Department Typical Pavement Markings detail #PM0102.

Platform Height:

Modern light rail and streetcar systems' main way of achieving accessibility is by providing a raised boarding platform to interface with a low vehicle floor. Today, passengers board from street level, stepping up onto a stairway within the trolley (see Figure 44). This severely compromises the vehicle's accessibility. Most obviously, it excludes passengers in wheelchairs. But it also limits access for passengers who cannot easily climb stairs, passengers carrying large items, and passengers with strollers, to name only a few examples.

Stations with near-level boarding feature a raised boarding platform that is higher than a typical sidewalk curb, but lower than the vehicle floor—typically 10 inches above TOR (see Figure 45). To comply with the ADA, these platforms require a vehicle-borne bridgeplate ramp, which allows passengers in wheelchairs to board and alight (see Figure 46).

Near-level platforms are easier to integrate into a streetscape than level platforms. At 10 inches, they can better coexist with adjacent traffic, and require less space for a ramp up from sidewalk height (typically 6 inches). Near-level platforms also allow interoperability with buses, which typically cannot deploy their wheelchair lifts (and sometimes open their doors) on fully level platforms.

Level boarding platforms are meant to be approximately the same height as the trolley's floor at door openings. That means level boarding requires a nominally 14-inch-high platform, but the ADA requires the platform and vehicle floor to match height within $\frac{5}{8}$ inch, requiring precise customization (see Figure 47).

Level boarding requires no bridgeplates, and provides the best boarding experience for passengers. On the other hand, it requires more space to transition to platform height, introduces a much higher-than-typical curb to the streetscape, and leaves little room for flexibility.

As a general rule, near level boarding is preferred when trolleys run in mixed-traffic conditions. Level boarding is more appropriate in exclusive rights-of-way, such as typical cross-section "C," or at stations in the trolley tunnel.

Passenger experience consistency is critical when deciding between boarding heights. SEPTA should not offer level boarding unless it can do so at all off-street stations, and can safely alert passengers to lower platforms at on-street stations.

Figure 44 | Existing boarding

Figure 45 | Near-level boarding without bridgeplate ramp deployed

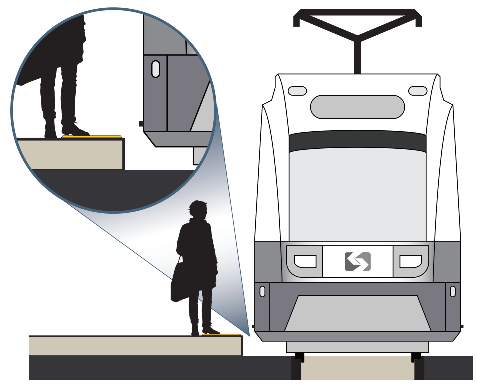


Figure 46 | Near-level boarding with bridgeplate ramp deployed

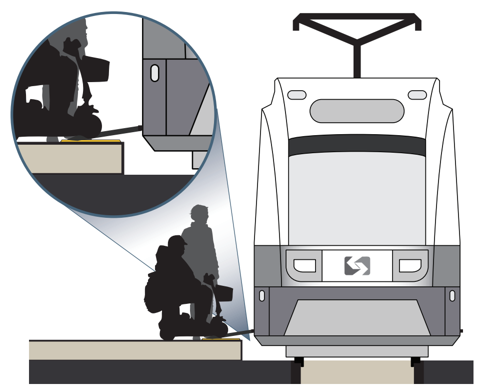
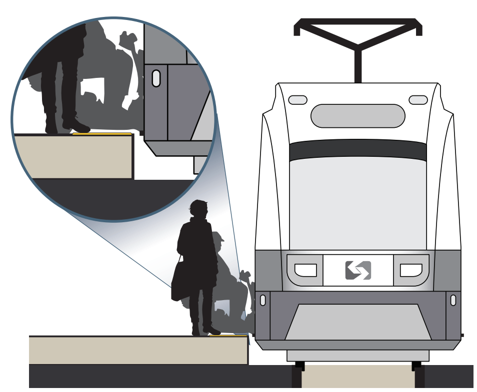


Figure 47 | Level boarding



Stormwater Infrastructure:

Modern trolley stations will inevitably impact stormwater drainage. Moving or adding inlets will be necessary at most stations, and drainage on the platform itself may also require stormwater treatments. Stations may present opportunities for green stormwater infrastructure (GSI). Through its Green City, Clean Waters initiative, the Philadelphia Water Department (PWD) integrates GSI into Philadelphia's streetscape to capture stormwater at its source and mitigate water pollution associated with runoff. The figures below show two typical PWD GSI features that are likely to be adapted to accommodate a modern trolley station.

To be effective, GSI features must be placed appropriately relative to topography and existing infrastructure, which limits the number of modern trolley stations where GSI is appropriate. Designers should use the guidance below as they collaborate with PWD to site and design any GSI features that will be integrated into modern trolley stations. Detailed design guidance on GSI features can be found in PWD's *Green Streets Design Manual*. (GSDM)

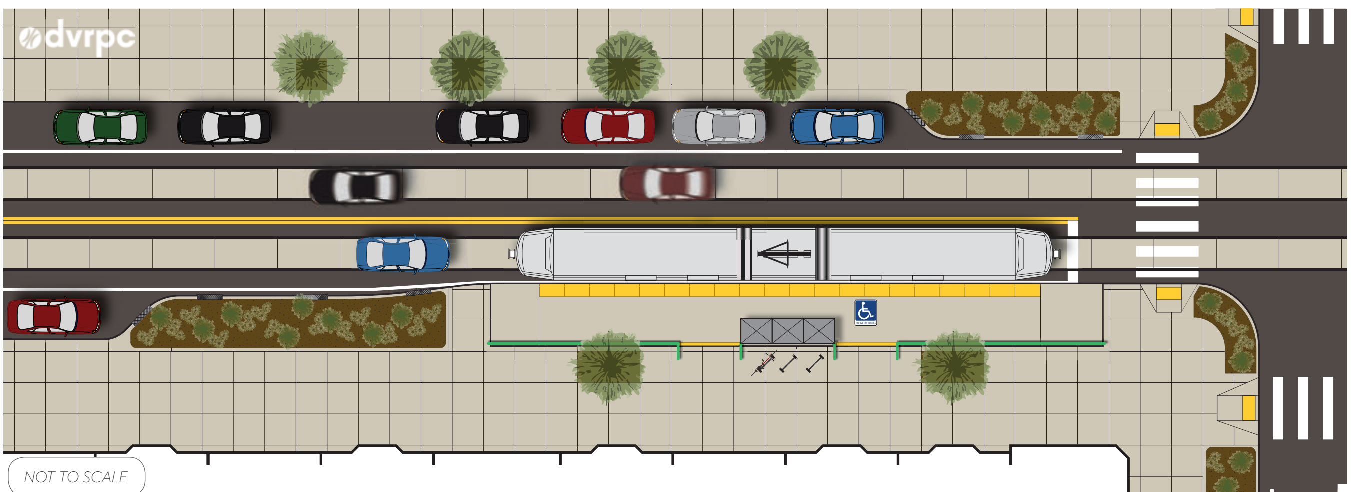


Figure 48 | Corner stormwater bumpout with modern trolley station

Corner Stormwater Bumpout:

Figure 48 shows an adaptation of PWD's typical treatment, a corner stormwater bumpout (GSDM Appendix, detail SB-01), to accommodate a modern trolley station. A stormwater bumpout works by setting a landscaped planter lower than the roadway's gutter elevation, allowing stormwater runoff to infiltrate into the planter.

All but the planter to the left of the raised platform in Figure 48 are typical to PWD's exiting stormwater bumpouts. The planter at left has been set back from the intersection by approximately 120 feet to allow space for the trolley station.

The size of stormwater planters is variable based on nearby conditions. In general, PWD seeks a 25:1 drainage-area-to-GSI-surface-feature-area ratio. Stormwater features at trolley stations should allow adequate space for pedestrians to use the sidewalk, as well as for pedestrians to reach the station platform.

Stormwater bumpouts must be sited carefully, as they will affect on-street parking more than just a trolley station. GSI features may also be built at other corners at an intersection, as appropriate.

Green Gutter:

Figure 49 shows an adaptation of a green gutter (GSDM Appendix, detail GG-01), used as a buffer in a protected bicycle lane station (see p. 60). A green gutter is a landscaped strip that captures and infiltrates stormwater runoff.

In cases where this configuration is applicable, designers should collaborate with PWD to ensure appropriate sizing and edge treatments.

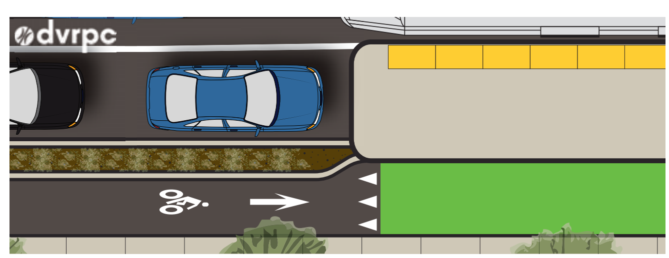


Figure 49 | Green gutter with modern trolley station

CURB EXTENSION STATION

A curb extension station uses the parking lane to create space for a boarding platform. Beyond providing a trolley station, curb extensions improve pedestrian safety by shortening crossing distances at intersections, calming traffic by narrowing the roadway, and making pedestrians more visible to drivers. Curb extensions also offer space for street furniture and other public amenities.

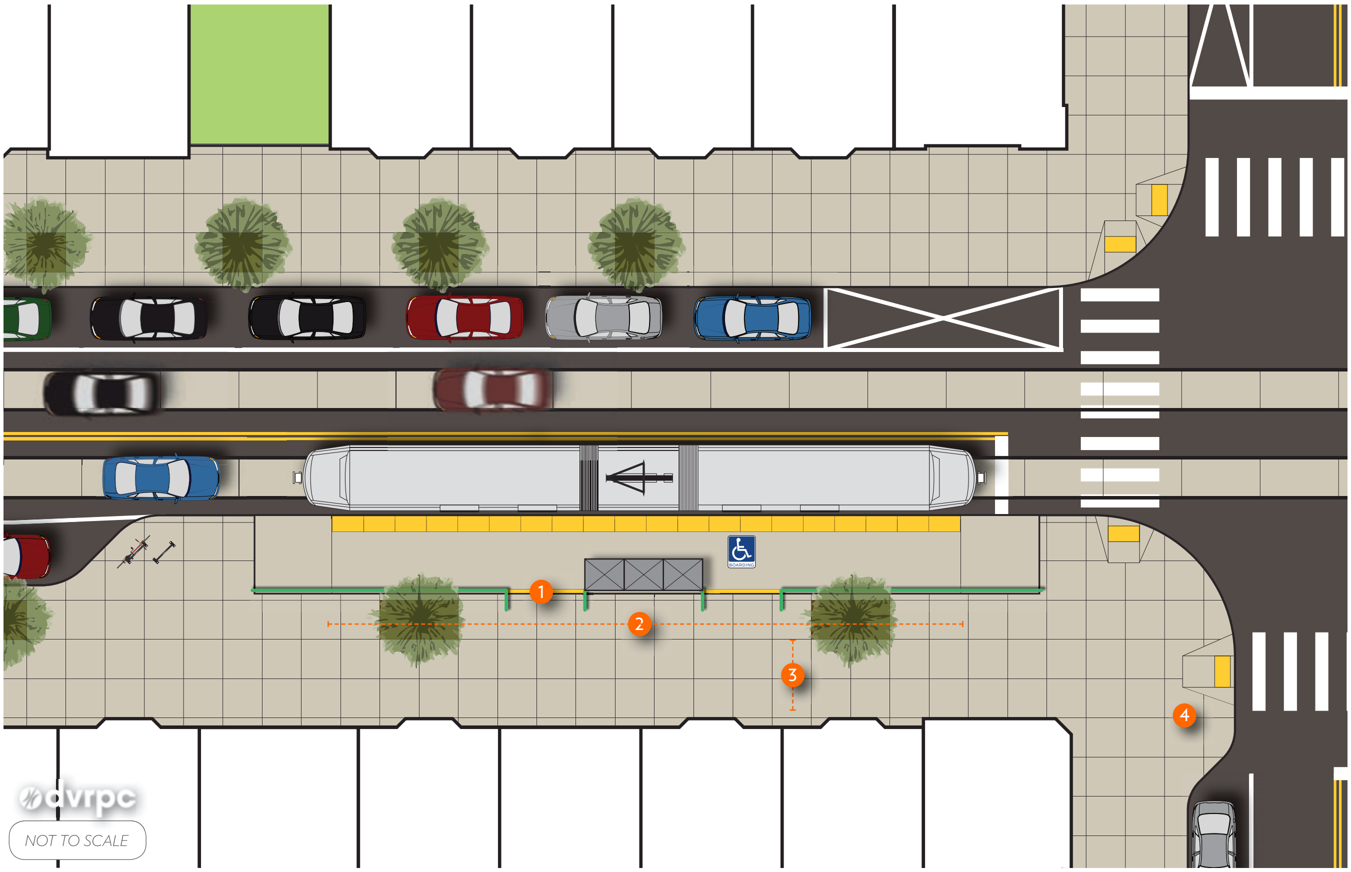


Figure 50 | Curb extension station: Plan view

Design Recommendations:

1. **Additional Platform Entrances**: Steps should be provided to create additional, non-accessible platform entrances. Consider using railings to channelize passenger movement towards vehicle doors.

   At stations with wide sidewalks, consider reconstructing the entire corner to provide a barrier-free transition between sidewalk and platform. (See Figure 57, page 39 for a peer practice example.) This configuration eliminates the need for railings, ramps, and steps, but requires a clear maintenance agreement between SEPTA and the sidewalk's owner.

2. **Street Furniture**: Consider using street furniture, bicycle racks, or landscaping to delineate the platform and sidewalk.

3. **Walk Zone:** Preserve either a 5′-minimum or 6′-minimum walk zone on the sidewalk, depending on the street's classification in the Philadelphia *Complete Streets Handbook*. (See page 33, "Arrangement at Intersection" for further walk zone guidance.)

4. **Cross-street Curb Extension**: Where space allows, continue the curb extension onto cross streets to further increase pedestrian safety.

Figure 51 | Curb extension station: Cross-section

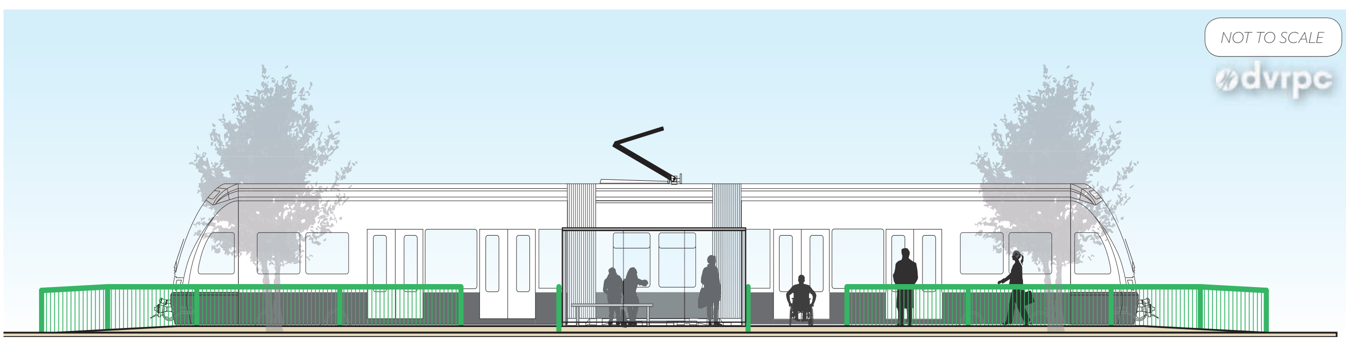
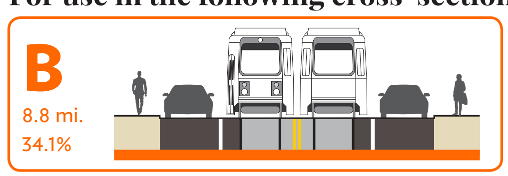


Figure 52 | Curb extension station: Elevation

Key design dimensions:

Dimension	Minimum	Preferred
Platform length	80 ft.	100 ft.
Platform width	8 ft. 6 in.	12 ft.
Platform height	10 in.	10 in.
Station footprint length	100 ft.	120 ft.

For use in the following cross-sections:



Variation: Far-side Station

The curb extension may be located at the far side of an intersection if necessary and safe (see Figure 53). The platform should be located far enough from the intersection that a stopped trolley remains 12' from the crosswalk, as it would at a near side station.

Because trolley vehicles are longer than either standard or articulated buses, far-side stations may cause vehicle queuing within intersections and encourage passengers to cross the street mid-block. If the trolley is not coordinated with transit signal priority (TSP), trolleys may be forced to stop twice (once for the traffic signal, and once for the trolley station), Nevertheless, far-side stations are acceptable where constructability, safety, or other constraints make a near-side station infeasible.

Other station types, especially those with dedicated trolley rights-of-way, may benefit from far-side stop locations without suffering some of the disadvantages of far-side stations in mixed traffic.

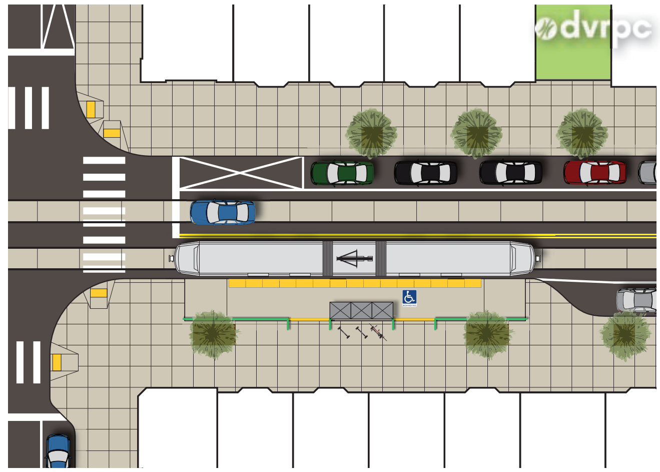


Figure 53 | Curb extension station: far-side variation

Variation: Multi-lane Curb Extension

The same design recommendations could apply to a Multi-lane Curb Extension station as apply to a Standard Curb Extension station. This type of station would apply on trolley corridors where trolley tracks run in the outer travel lanes of a multi-lane cross-section. (See Figure 54).

This condition does not currently exist in SEPTA's system. As a result, this station type would only be possible if the trolley system were expanded onto new streets, or if tracks were relocated on an existing multi-lane street, such as Girard Avenue or 63rd Street. The Next Level Station Designs section (pp. 55–63) discusses this type of intervention in greater detail.

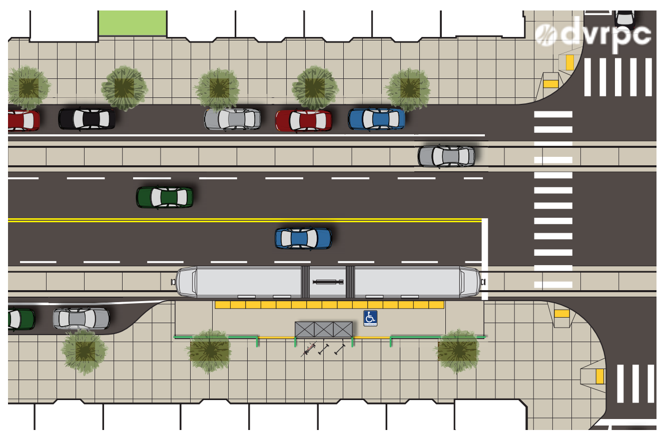


Figure 54 | Curb extension station: Multi-lane variation

Peer Practice: Washington, DC and Portland, OR

Curb Extension Stations are in wide use in streetcar systems both domestically and internationally.

Typically, Curb Extension Stations occupy an existing parking lane, and use railings, transit shelters, plantings, or street furniture to delineate platform space from sidewalk space. This can help to mitigate tripping hazards caused by raised platforms. In cases where a transit operator has agreed to maintain a station, but not an adjacent sidewalk, this configuration can clarify parties' areas of maintenance responsibility.

Figure 55 shows a DC Streetcar station that delineates the station area using a railing and transit shelter at platform level, along with tree planters, pavers, and street furniture at sidewalk level.

The Portland Streetcar station shown in Figure 56, also uses railings to separate station from sidewalk. The grate at left in the photo suggests another benefit to this configuration; conflicts with existing utilities may often be less challenging in the parking lane than on the sidewalk.

The most obvious disadvantage to the clear vertical division between sidewalk and station is that a new barrier is introduced into the streetscape, making the station somewhat less accessible to passengers with mobility challenges. Designers must weigh this trade-off and apply it to the constructability constraints at potential station locations.

Figure 55 | Curb extension: DC Streetcar

Source: BeyondDC via Flickr (CC BY-NC-ND 2.0)

Figure 56 | Curb extension: Portland Streetcar

Peer Practice: Seattle

The Seattle Streetcar station shown in Figure 57 is a good example of a station designed for barrier-free accessibility. The station takes advantage of an ample existing sidewalk and minimal above-ground utilities, providing a gentle slope from sidewalk to platform height.

Figure 57 | Curb extension: Seattle Streetcar

Source: Eric Strathmere via Flickr (CC BY-NC-ND 2.0)

Bicycle-Trolley Integration:

There is one core design challenge for bicycle lanes at modern trolley stations: How to safely route the bicycle lane around a boarding platform. Today on trolley streets with bicycle lanes, cyclists ride straight through a trolley stop location (see Figure 58), sometimes leading to conflicts with boarding or alighting passengers. This configuration is not compatible with an ADA-compliant platform.

Bringing a bicycle lane "behind" a trolley station separates cyclists from a trolley, allowing space for a platform. Figure 59 compares a cyclist's path at a typical existing trolley stop to a cyclist's path at a typical modern trolley station.

This strategy separates cyclists from trolley passengers as they board and alight, but creates new conflicts as passengers enter and exit the station area. To overcome this challenge, trolley station designers must either provide enough width for cyclists and pedestrians to avoid each other in shared space, or separate cyclists and pedestrians vertically using different ground elevations.

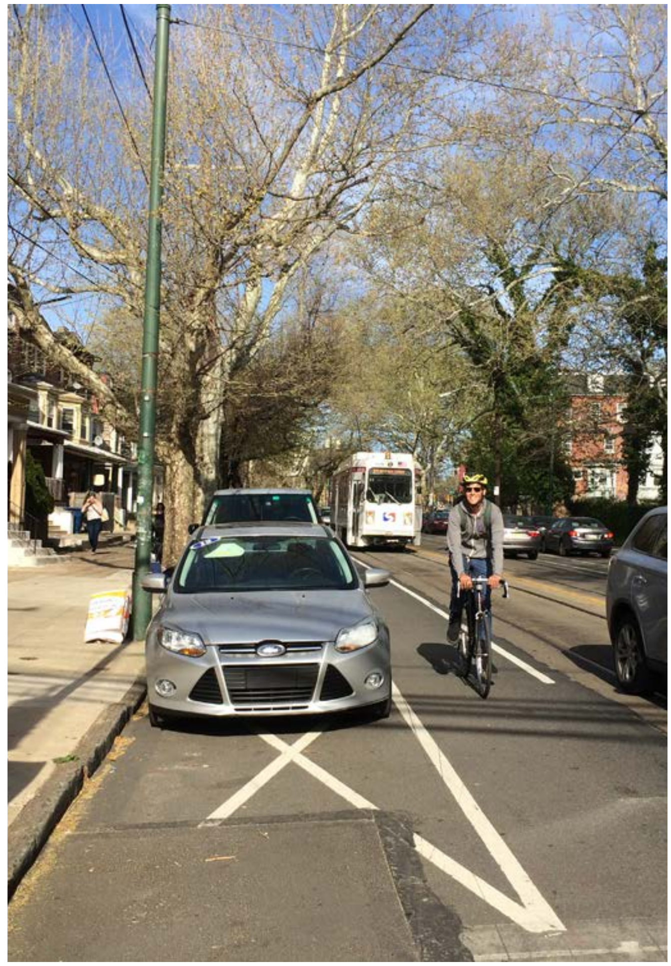


Figure 58 | Bicycle-trolley integration

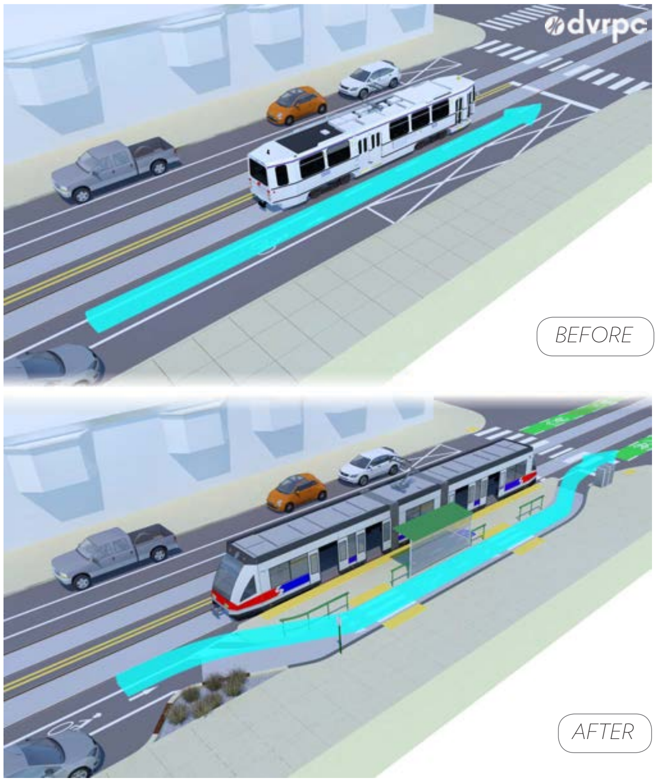


Figure 59 | Bicycle-trolley integration, before and after

The following pages present two station design options for addressing trolley streets with bicycle lanes:

- The **Curb Extension + Bicycle Lane** (pp. 42-45), which brings cyclists up to sidewalk grade. This station type is most appropriate in areas where existing sidewalks are at least 15 feet wide, and free of obstructions (such as utility poles, fire hydrants, etc.) This station would bring cyclists and pedestrians close to each other, but is designed to slow cyclists down.

- The **Floating Trolley Station + Bicycle Lane** (pp. 46-49), which routes cyclists behind the trolley station at street grade. This station type is most appropriate in areas with sidewalks narrower than 15 feet, or where fixed objects (including stormwater infrastructure) cannot be moved from the existing curbline. In this station type, cyclists are likely to travel at somewhat faster speeds, but have fewer conflict points with pedestrians.

Neither of these station types will be appropriate for all trolley stations. Some station locations may, for instance, have wide sidewalks, *and* busy foot traffic. Designers must consider the expected outcomes of each station type, and adapt these conceptual designs on a station-by-station basis. Station variations and peer practice examples presented in the following pages are meant to help designers assess these outcomes as they refine the station designs.

CURB EXTENSION STATION + BICYCLE LANE

The Curb Extension Station + Bicycle Lane modifies a standard curb extension to include a diverted bicycle lane at sidewalk height. Cyclists travel between the sidewalk and boarding platform before reentering the roadway at the intersection. Of the two types of trolley stations with bicycle lanes, this station type is best for locations with wide, unobstructed sidewalks, in areas with infrequent bicycle traffic, or low bicycle speeds. Creating adequate sidewalk space for both a platform and bicycle lane will likely require construction past the existing curbline, into the existing sidewalk.

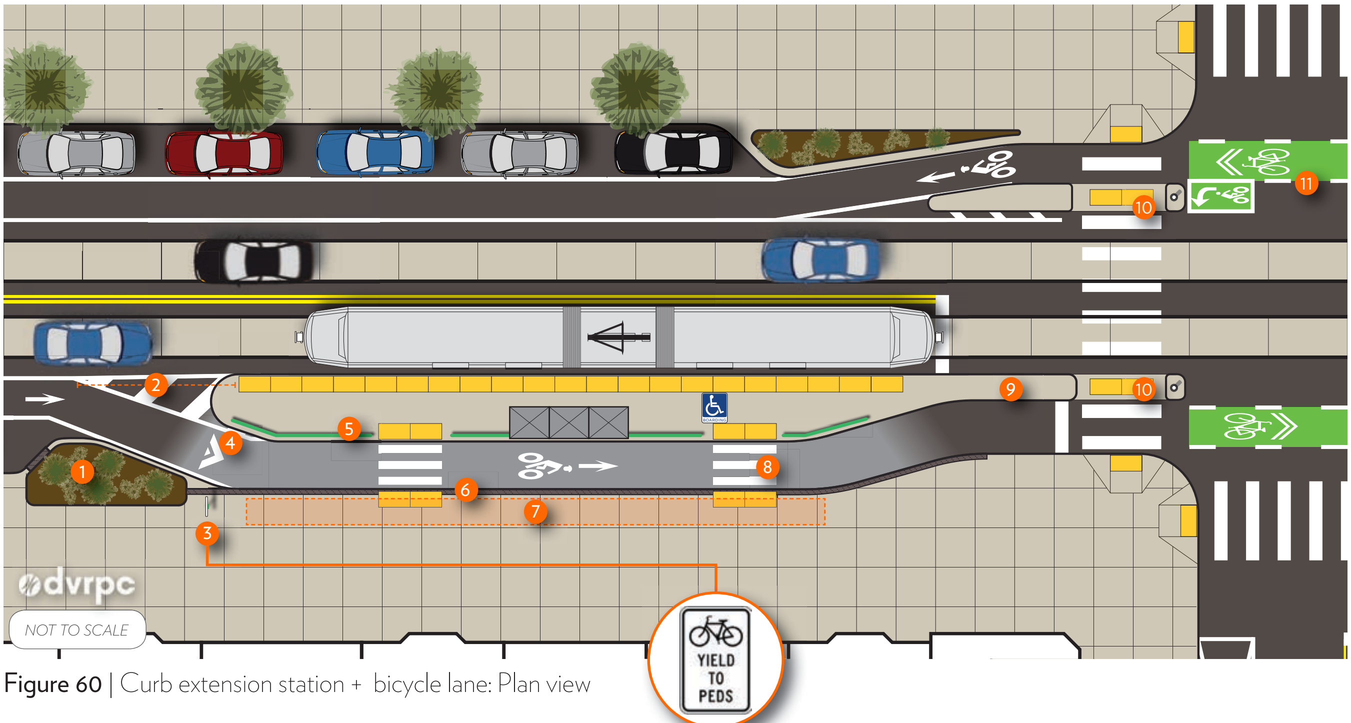


Figure 60 | Curb extension station + bicycle lane: Plan view

Design Recommendations:

1. **Small Curb Extension**: Including a small curb extension prevents parked cars from blocking the bicycle lane's lateral shift. Where possible, enlarge this curb extension to include stormwater infrastructure. (See pg. 35 "Stormwater Infrastructure" for further guidance.)
2. **Bicycle Lane Shift**: The lateral shift of the bicycle lane as it enters the platform area should be 20'-long at minimum so cyclists have time to prepare to safely enter the stop area.
3. **Bicycle Yield Sign**: Where the bicycle lane requires bicyclists to yield to pedestrians at a crosswalk, the "bicycles yield to peds" sign (MUTCD R9-6) must be installed.
4. **Bicycle Ramp-up**: The bicycle lane should ramp up to or down from platform/sidewalk height with a slope no steeper than 1:8. Mark areas where a bicycle lane changes grade with a speed hump symbol (MUTCD 3B-29).
5. **Railings**: Use railings to separate bicycle traffic from the platform area, and to channelize passengers to marked crossings. Railings must be set back 1' from the bicycle lane. *Do not* use railings to separate the bicycle lane and sidewalk, as this creates a "cattle chute" effect, limiting a bicyclist's or pedestrian's ability to evade each other.
6. **Lane Edge/Flowline**: Consider using textured pavers to delineate the bicycle lane from the sidewalk. If necessary, this edge may be used as a covered stormwater flowline.
7. **Clear Zone:** The sidewalk alongside the bicycle lane must be clear of fixed objects and other obstructions for at least five feet, measured from the bicycle lane edge towards the sidewalk.
8. **Platform Access**: Pedestrian crossings of the bicycle lane must be at least 8' wide, and include detectable warning strips at each side. Provide at least two crossings to ensure passenger flow.
9. **Platform Extension**: As the bicycle lane enters the intersection, extend a 3'-wide minimum portion of the platform towards the intersection to protect cyclists from traffic.
10. **Refuge Island:** Include a refuge island where pedestrians cross the bicycle lane. Consider the expected turning traffic volumes and resulting turn radius when designing refuge islands. At station locations with high right-turn volumes, consider a far-side station location (see Figure 63.)
11. **Cyclist Safety in Intersection**: Include intersection crossing markings to guide cyclists and to alert motorists to their presence. Where cyclists may turn left, consider two-stage left turn boxes to help cyclists cross trolley tracks at a 90° angle.

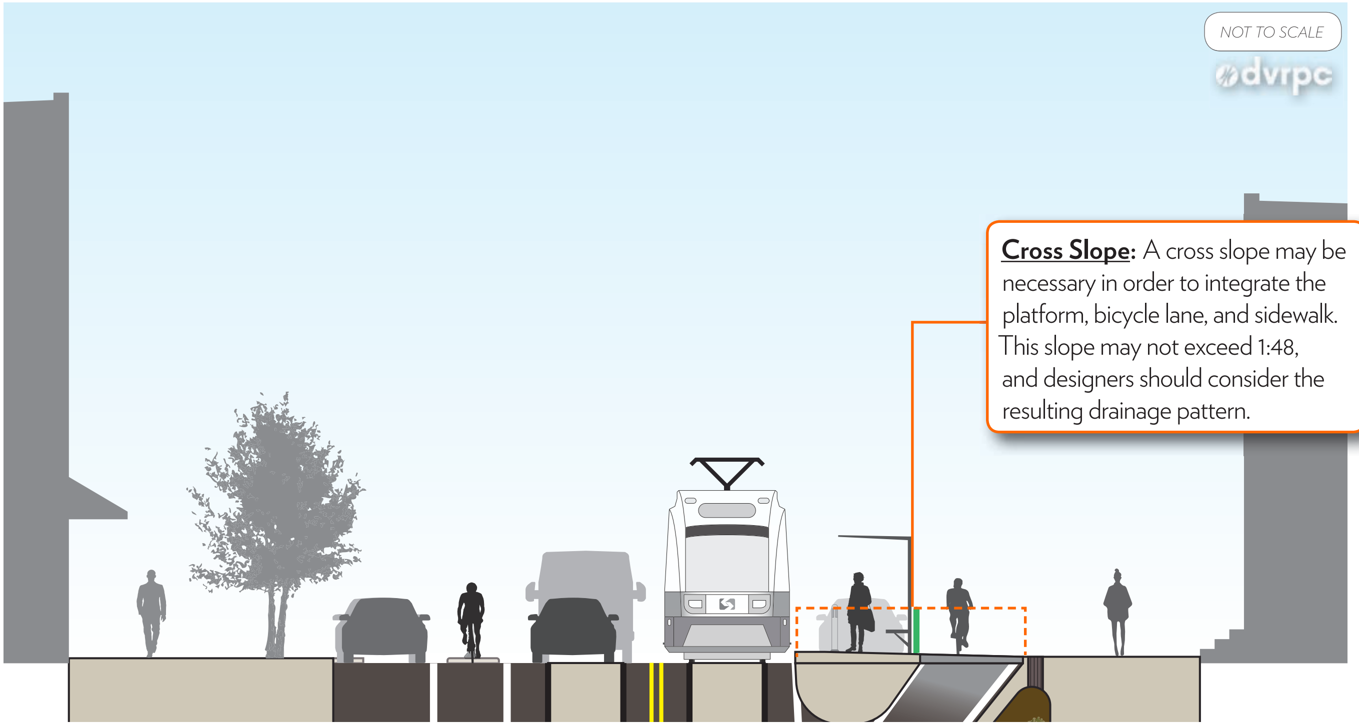


Figure 61 | Curb extension station + bicycle lane: Cross-section

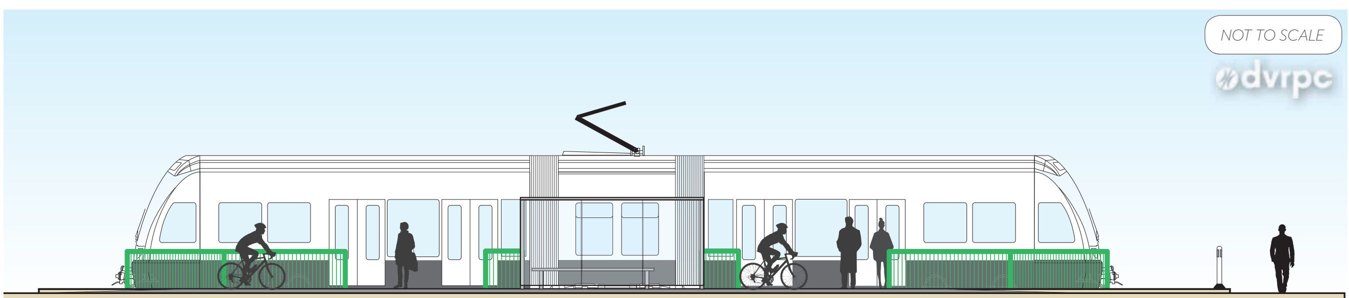


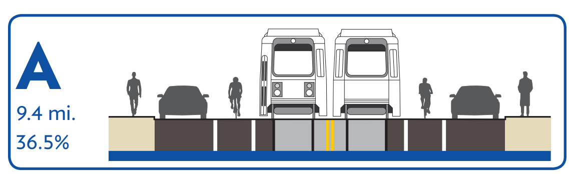
Figure 62 | Curb extension station + bicycle lane: elevation

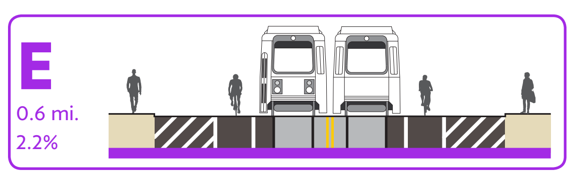
Key design dimensions:

Dimension	Minimum	Preferred
Platform length	80 ft.	100 ft.
Platform width	8 ft. 6 in.	12 ft.
Platform height	10 in.	10 in.
Bicycle lane width*	5 ft.	6 ft.

** Bicycle lane must be set back 1′ (minimum) to 2′ (preferred) from any vertical elements.*

For use in the following cross-sections:





Variation: Far-side Station

Consider locating the Curb Extension Station + Bicycle Lane at the far side of the intersection where right turns are common, or where bicycle traffic volume is high (see Figure 63).

Locating this station type at the far side of an intersection helps protect cyclists from "right hook" collisions with right-turning vehicles because cyclists enter the intersection immediately adjacent to vehicles, increasing their visibility. In locations with high bicycle traffic volume, a far-side station gives pedestrians time to look for cyclists as they cross the intersection, helping to avoid collisions.

This station design suffers from the same trolley service drawbacks as other far-side stations: queuing in the intersection, the potential for multiple stops, and mid-block pedestrian crossings.

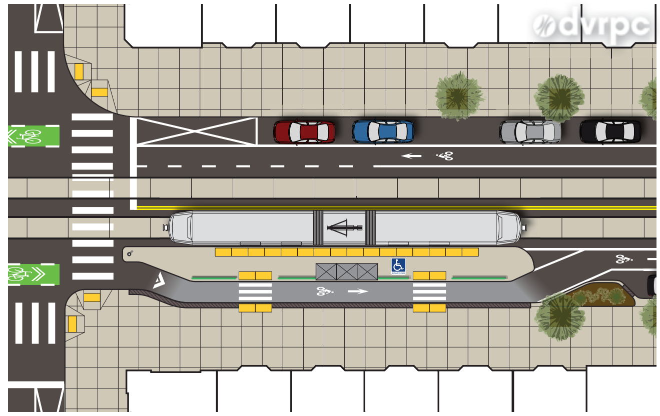


Figure 63 | Curb extension station + bicycle lane: Far-side variation

Peer Practice: Vancouver, BC, Canada

The bus stop in Figure 64 exemplifies a well designed far-side Curb Extension + Bicycle Lane station. The bicycle lane is 2.5 meters wide (8.2 feet), and enters the station area at a gentle slope. The lateral transition is long enough for cyclists to prepare to enter a pedestrian-priority zone. This is all possible because of the ample, unobstructed sidewalk.

Space is clearly delineated between the bus stop, bicycle lane, and sidewalk using only pavement, not fixed objects.

Note also the gentle cross-slope (Canada also uses a maximum 2 percent cross-slope standard) that brings passengers to platform height without compromising the bicycle lane.

Figure 64 | Vancouver: Cornwall Avenue at Cypress Street

Source: Stephen Fesler via The Urbanist (www.theurbanist.org) (CC BY-NC-ND 3.0)

Peer Practice: Cambridge, MA

Cambridge's Western Avenue parking-protected, raised bicycle lane shown in Figure 65 is an example of how to successfully integrate bicycle and transit facilities in a dense, Northeastern city.

The station area is kept clear of nonessential objects, and the transit shelter is safely set back from the bicycle lane.

Figure 65 | Cambridge: Western Avenue at Putnam Avenue

Source: Dylan Passmore via Flickr (CC BY-NC 2.0)

Figure 66 | Seattle: Yesler Way at Broadway

Peer Practice: Seattle

This First Hill Streetcar station in Figure 66 uses green paint to identify areas where cyclists have priority, and standard concrete to identify areas of pedestrian priority, where cyclists must yield.

This station also manages to integrate various public realm features. Note the schedule and wayfinding signs in the foreground, and the public art in the background (and inset), which was commissioned by the Seattle Department of Transportation. The sculpture has counterpart pieces along the streetcar line, providing brand consistency, while also helping to divide the bicycle lane from the curbside sidewalk space.

Figure 67 | Portland: NW Lovejoy Street at NW 13th Street

Source: Steve Boland via Flickr (CC BY-ND-2.0)

Peer Practice: Portland, OR

The Portland Streetcar station in Figure 67—an early U.S. attempt at blending streetcar and bicycle facilities—demonstrates some of the pitfalls of building this type of station in a confined space.

The bicycle lane at this station was officially decommissioned in 2010. Staff in Portland reported learning important design lessons from their experience with this station.

Portland transportation officials relayed the following station treatments that they have taken care to avoid in subsequent station designs:

- The bicycle lane transitions laterally at an abrupt, 45° angle, not allowing cyclists enough time to prepare to enter the station area. This was expected to calm bicycle traffic, but requiring such quick decision-making from cyclists was observed to send them back into the street (in close proximity to the tracks).
- To the right of the bicycle lane, trees prevent cyclists from making evasive maneuvers to avoid collisions, and benches encourage passengers to block the bicycle lane as they sit.
- The bicycle lane is only 5′ wide, ″trapping″ cyclists whenever a pedestrian enters the bicycle lane.

Figure 73 (pg. 49) shows a newer iteration of a Portland Streetcar station with a bicycle lane.

FLOATING STATION + BICYCLE LANE

In the Floating Station + Bicycle Lane, cyclists follow a bicycle lane at street grade between the platform and the sidewalk. The vertical separation between the bicycle lane and the sidewalk is the main safety measure preventing cyclist/pedestrian collisions. Platform access is provided at the intersection, but passengers may also walk across the bicycle lane and step up onto the 10" curb. This station type is most appropriate in areas with narrow sidewalks, high bicycle and pedestrian volume, and/or where existing drainage patterns must be preserved.

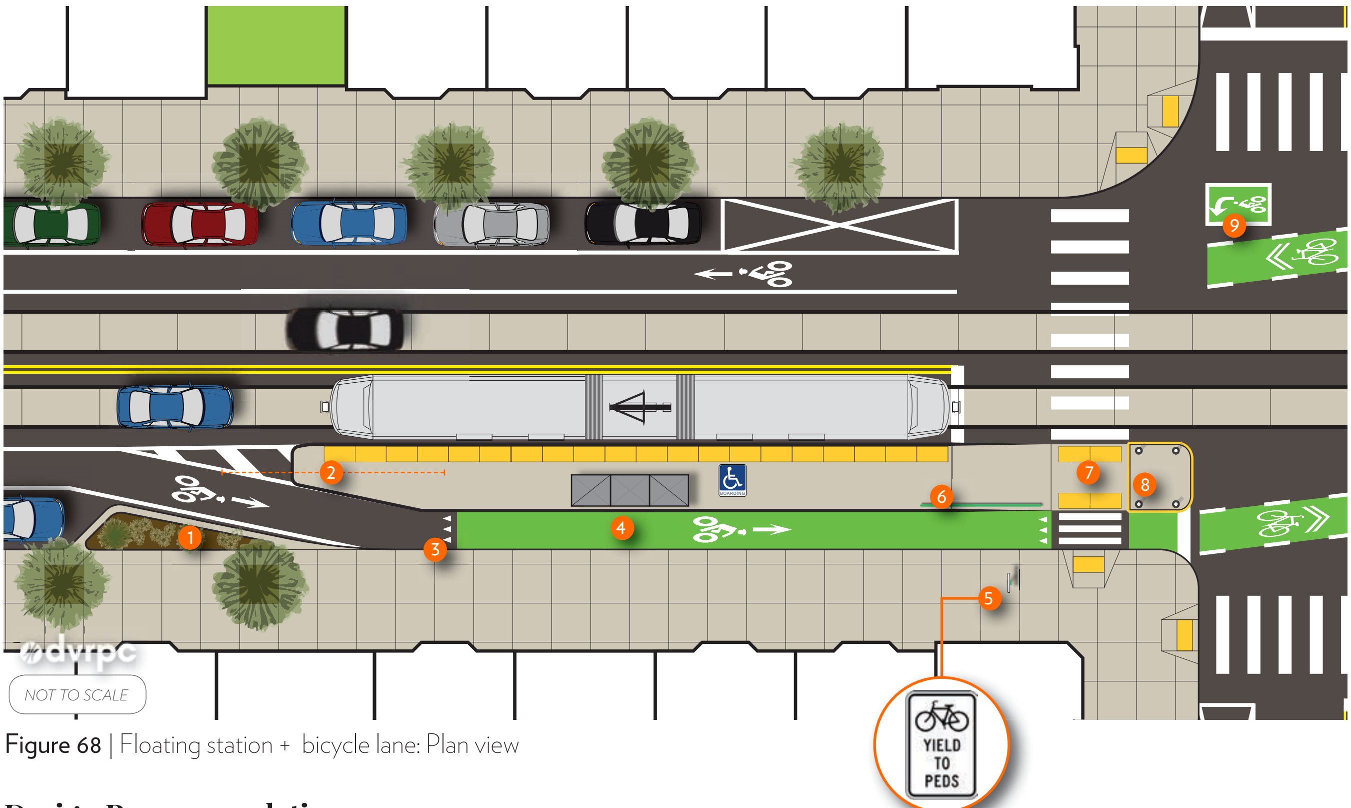


Figure 68 | Floating station + bicycle lane: Plan view

Design Recommendations:

1. **Small Curb Extension**: Consider including a small curb extension to prevent parked cars from blocking the bicycle lane's lateral shift. Where possible, enlarge this curb extension to include stormwater infrastructure. (See pg. 35 "Stormwater Infrastructure" for further guidance.)
2. **Bicycle Lane Shift**: The lateral shift of the bicycle lane as it enters the trolley station must be 20'-long at minimum to ensure cyclists have time to prepare to safely enter the station area, but the shift must be no greater than 1:3 so that cyclists are encouraged to slow down.
3. **Yield Triangles**: Use yield triangles (MUTCD 3B-14) to indicate areas where cyclists must yield to pedestrians.
4. **Green Bicycle Lane Paint**: Include green paint and bicycle lane markings (MUTCD 9C-3) to alert pedestrians walking across the bicycle lane to the presence of cyclists.
5. **Bicycle Yield Sign**: Where the bicycle lane requires bicyclists to yield at a crosswalk from the sidewalk onto the platform, the "bicycles yield to peds" sign (MUTCD R9-6) must be installed.
6. **Railings**: Use railings (in compliance with ADA 405.8) on accessible ramps. At most stations, the 10" curb will safely separate the platform and bicycle lane. At high-ridership stations, or at stations where only the minimum platform width can be provided, consider including a railing to guide pedestrians to formal crossings.
7. **Platform Access Area**: Passengers access the platform area via a ramp located at the crosswalk. This area must include tactile detection strips wherever pedestrians cross a bicycle lane or travel lane, and be connected to an accessible ramp.
8. **Refuge Island Tip**: Include a curbed refuge island with bollards to protect pedestrians and passengers in the platform access area. This refuge island may be modified, but not removed, to facilitate safe vehicular right turns.
9. **Cyclist Safety in Intersection**: Include intersection crossing markings to guide cyclists through the intersection and to alert motorists to their presence. Where cyclists may turn left, consider two-stage left turn queue boxes to encourage cyclists to cross trolley tracks at a 90° angle.

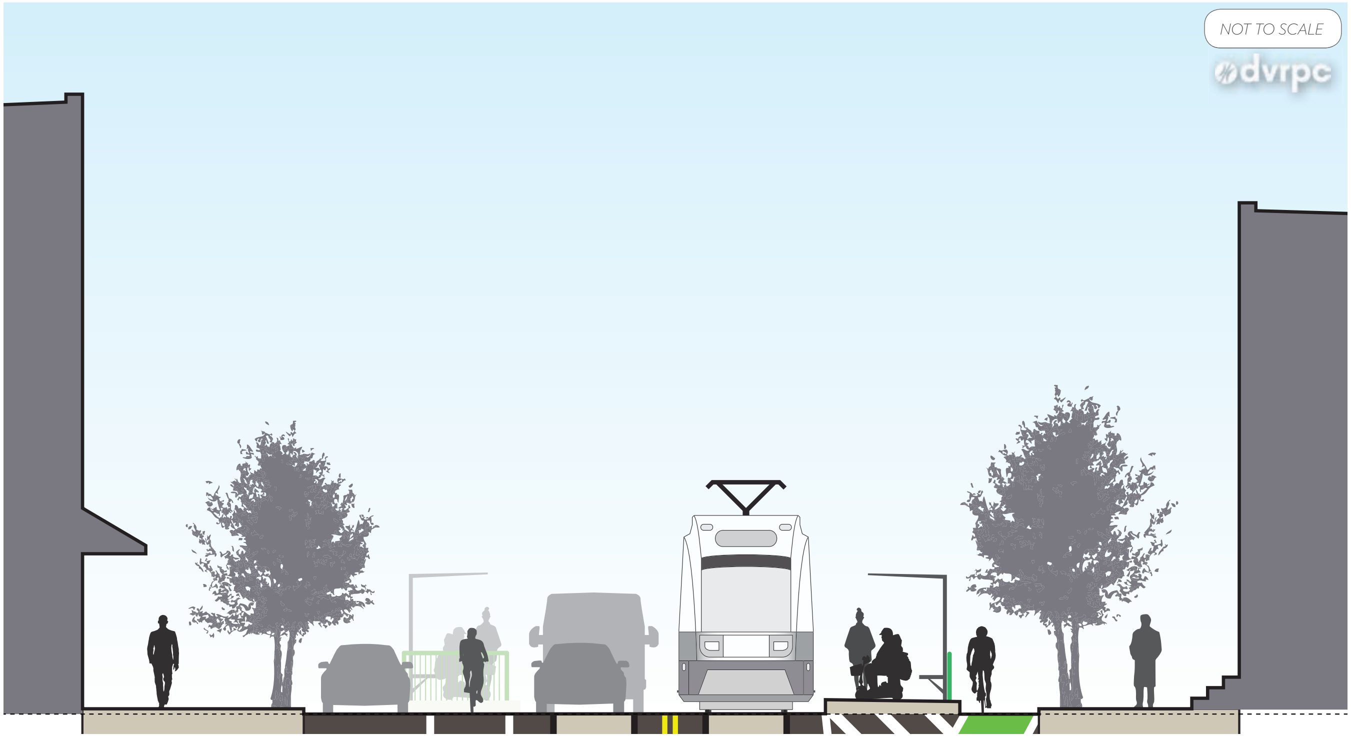


Figure 69 | Floating station + bicycle lane: Cross-section

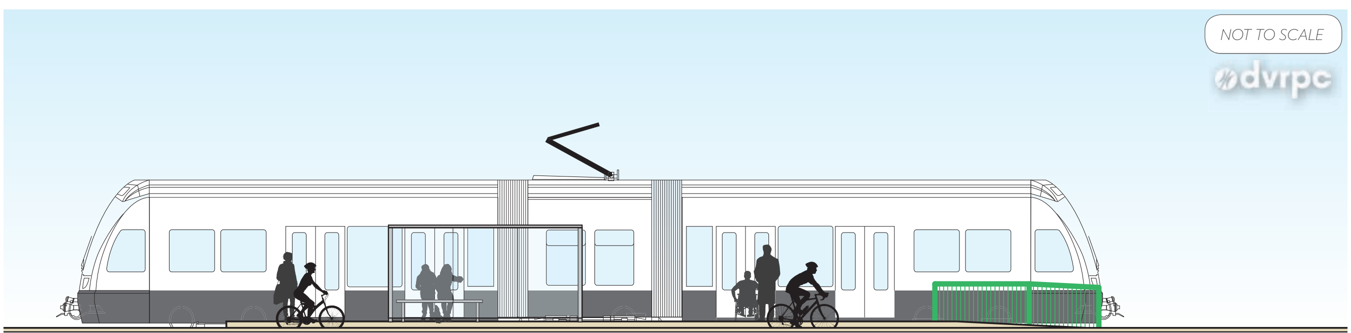
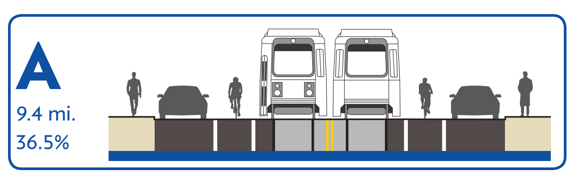


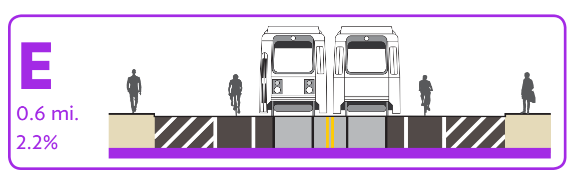
Figure 70 | Floating station + bicycle lane: Elevation

Key design dimensions:

Dimension	Minimum	Preferred
Platform length	80 ft.	100 ft.
Platform width	8 ft. 6 in.	12 ft.
Platform height	10 in.	10 in.
Bicycle lane width	5 ft.	7 ft.

For use in the following cross-sections:





Variation: Far-side Station

Consider locating the Floating Trolley Station + Bicycle Lane at the far side of the intersection in cases where right turns are common, or in locations with high bicycle traffic volume (see Figure 71).

A far-side version of this station helps protect cyclists from "right hook" collisions with right-turning vehicles because cyclists enter the intersection immediately adjacent to vehicles, increasing their visibility. In locations with high bicycle traffic volume, a far-side station gives pedestrians time to look for cyclists as they cross the intersection, helping to avoid collisions.

This station design suffers from the same shortcomings as other far-side stations: intersection queuing, the potential for multiple stops, and mid-block pedestrian crossings.

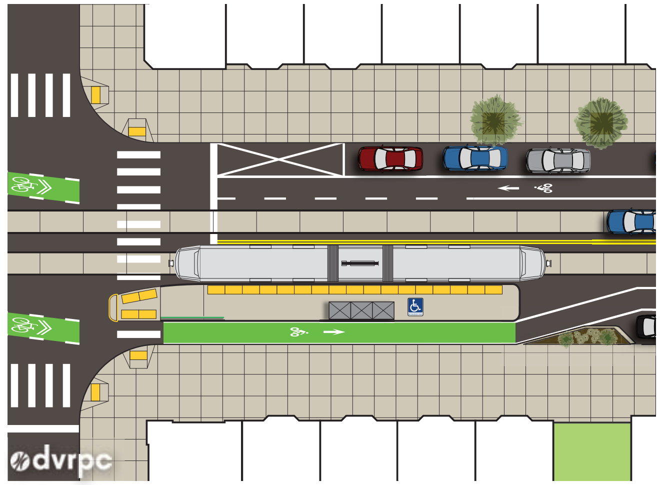


Figure 71 | Floating station + bicycle lane: Far-side variation

Variation: Raised Crosswalk

Consider including a raised crosswalk across the bicycle lane, linking the sidewalk and boarding platform as shown in Figure 72. This hybrid treatment creates a near-seamless access point for passengers with mobility challenges, and guides all passengers to cross at a single location. This variation can be particularly useful when there is insufficient space for a standard accessible ramp. This strategy does, however, somewhat compromise the safety benefits of vertically separating cyclists and pedestrians, and so should only be used when necessary.

Crossings should be 8' wide at minimum, and include detectable warning strips at both sides. Consider a wider crossing for high-ridership stations.

The raised crosswalk may also function as a bicycle traffic calming device. The bicycle lane should ramp to and from crosswalk height with a slope of 1:8–1:25. Mark areas where a bicycle lane changes grade with a speed hump symbol (MUTCD 3B-29).

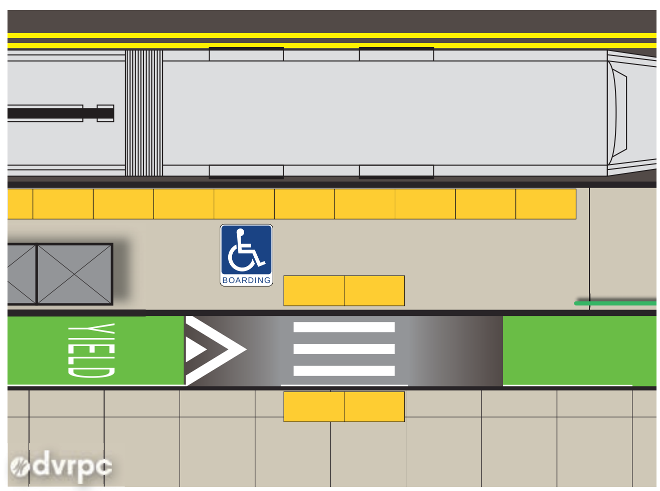


Figure 72 | Floating Trolley Station + Bicycle Lane: raised crosswalk variation

Figure 73 | Portland: Far-side floating station

Figure 74 | Seattle: Dexter Avenue bus stop

Source: Green Lane Project

Figure 75 | San Francisco: Far-side boarding island

Source: People for Bikes (youtu.be/l0qdq36hwSs)

Peer Practice: Portland, OR

The far-side iteration of a Floating Trolley Station + Bicycle Lane shown in Figure 73 highlights several important design details. The station sits alongside a relatively narrow sidewalk, making vertical separation between cyclists and pedestrians critical.

Because this is a far-side station, cyclists use the intersection to transition laterally—making them more visible to drivers. The streetcar platform is narrower than average, so a railing has been provided to keep waiting passengers out of the bicycle lane.

Peer Practice: Seattle

Over the past 5 years, Seattle's Department of Transportation (SDOT) has begun to roll out boarding islands on many of its busiest bicycle/transit corridors. These stops first appeared on Dexter Avenue, a busy transit corridor where cyclists were often in conflict with curbing buses (see Figure 74). Despite increases in both bus boardings, and in vehicle volumes, travel times have held steady, likely because the island stops are spaced efficiently, to encourage faster boarding and avert conflicts with cyclists.

Newer iterations of this stop type have included raised pedestrian crossings and far-side configurations. In conversations with DVRPC staff, SDOT staff reported no known pedestrian-cyclist conflicts.

Peer Practice: San Francisco

This station, at Duboce Avenue and Church Street in San Francisco, demonstrates that pedestrians and cyclists can coexist safely at a floating station—even when the station is very busy.

The platform is 10 feet wide, while the bicycle lane is 6 feet wide—only slightly wider than the minimum standards presented in this guide. Yet, this station accommodates some of San Francisco's most frequent streetcar service (4-minute peak headways) and highest bicycle volumes.[8]

A *short video* produced by the advocacy group People for Bikes (see Figure 75, screenshot) shows how pedestrians and bicyclists navigate at this station.

8 San Francisco Municipal Transportation Agency. *San Francisco Bicycle Count Report 2015.* (San Francisco: SFMTA, 2016).

SPLIT-LANE FLOATING STATION

The Split-Lane Floating Station calls for a platform between two travel lanes. This station type resembles existing island stations on Route 15 along Girard Avenue, with one key difference: the minimum 9′-6″-wide platform is almost twice as wide as existing platforms to enable ADA compliance. This change will provide a safer waiting area, and also impact the parking lane adjacent to stations.

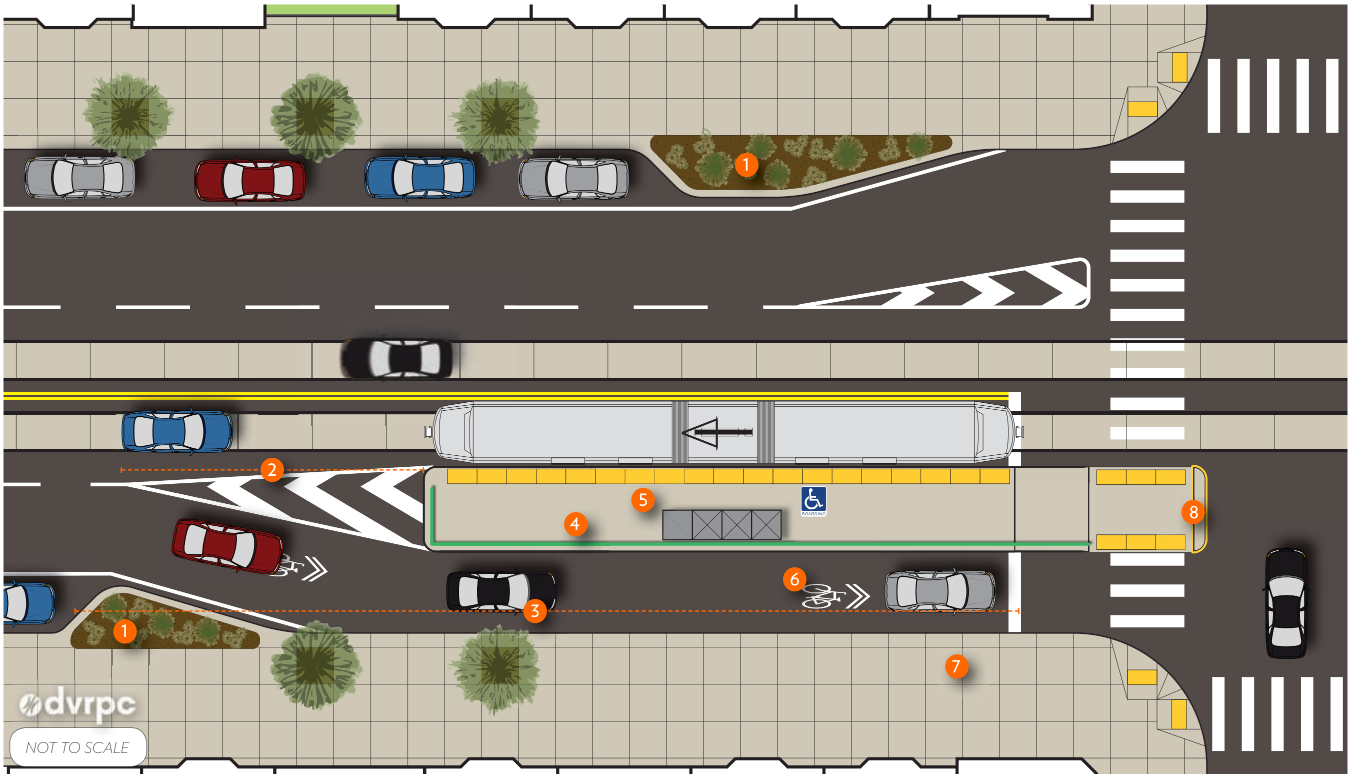


Figure 76 | Split-lane floating station: Plan view

Design Recommendations:

1. **Small Curb Extension**: Include a small curb extension to prevent parked cars from blocking the travel lane's lateral shift. Where possible, enlarge this curb extension to include stormwater infrastructure. (See pg. 35 "Stormwater Infrastructure" for further guidance.)
2. **Travel Lane Split**: The travel lanes should split to either side of the trolley platform. A taper zone—sized to an appropriate design speed—should be marked with white chevrons in accordance with MUTCD 3B-15.
3. **Parking Removal**: Eliminate the parking lane for the length of the trolley station, plus additional length to shift the outside travel lane around the trolley station. This is necessary to accommodate both travel lanes as they pass the trolley station.
4. **Railing/Barrier**: A railing or barrier must be included along the entire length of the trolley station to protect waiting passengers from traffic. Locate the barrier at least 1′ from the outside platform edge so passengers cannot easily lean into the travel lane. This 1′ setback, plus the 6″ space for a railing, plus the 8′ platform width creates the need for a 9′ 6″-wide platform.
5. **Waiting Area Size**: The platform should be large enough to accommodate passengers at Passenger LOS C based on expected peak period ridership. Passenger waiting space is particularly important on this type of station because any overflowing passengers would be forced into a travel lane.
6. **Bicycle Facilities**: While most Split-Lane Floating Stations will apply on streets that are not designated bicycle routes, cyclists will still use these corridors. Direct cyclists to use the outside lanes, where they can safely avoid the trolley tracks, using sharrows (MUTCD 9C-9).
7. **Sidewalk Space**: At constrained and/or high-ridership stations, consider locating additional passenger amenities, such as a shelter or seating, near the crosswalk where passengers access the platform.
8. **Refuge Island**: Include a pedestrian refuge island where the crosswalk meets the trolley station's accessible ramp. This refuge island must include detectable warning strips at either end.

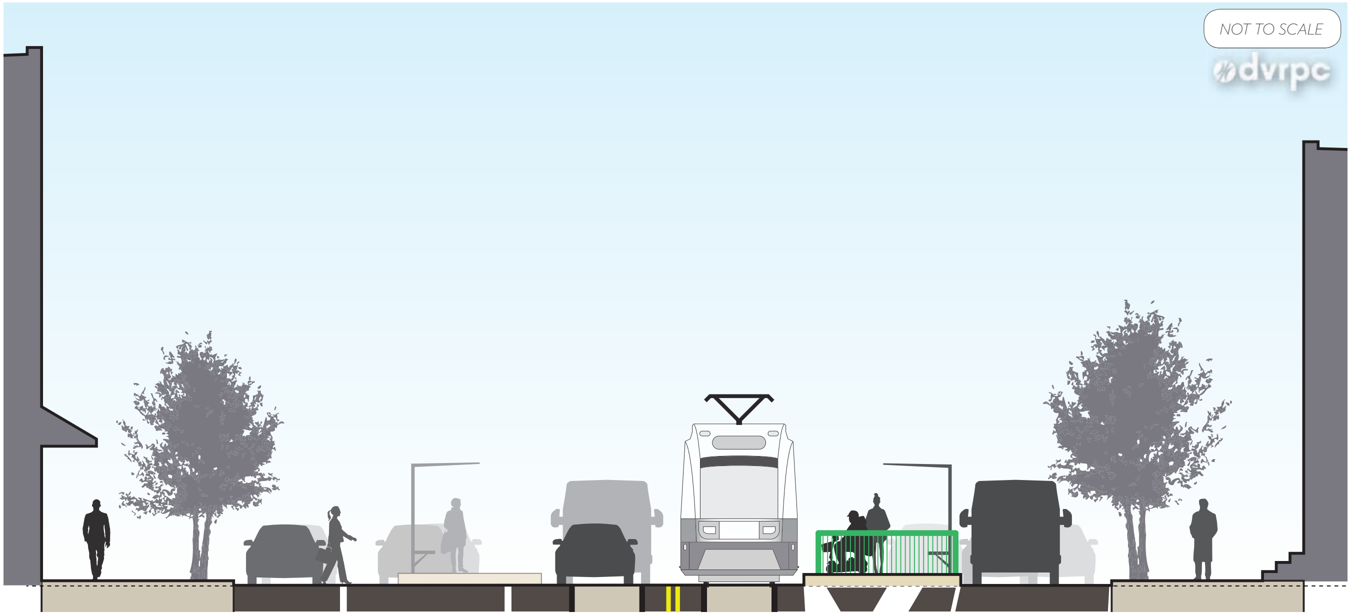


Figure 77 | Split-lane floating station: Cross-section

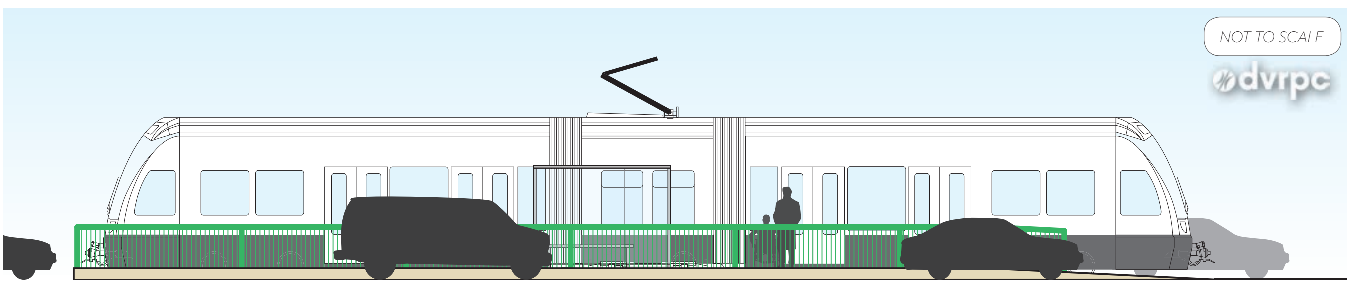
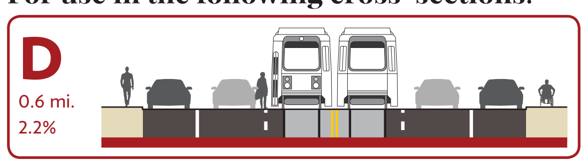


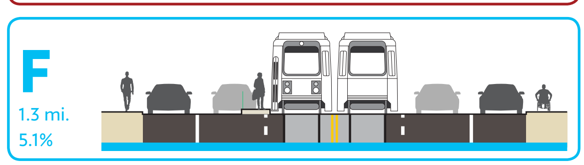
Figure 78 | Split-lane floating station: Elevation

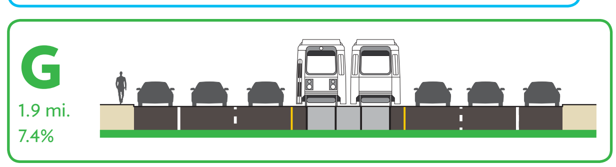
Key design dimensions:

Dimension	Minimum	Preferred
Platform length	80 ft.	100 ft.
Platform width	9 ft. 6 in.	12 ft.
Platform height	10 in.	10 in.

For use in the following cross-sections:







EXCLUSIVE RIGHT-OF-WAY STATION

This station type is a trolley station in a trolley-exclusive right-of-way. While this design presents the minimum standards for this station type, a dedicated right-of-way offers SEPTA an opportunity to expand the platform area, and provide enhanced passenger amenities consistent with best practices at light rail stations. This station is represented in a far-side configuration, but local conditions will ultimately determine platform location.

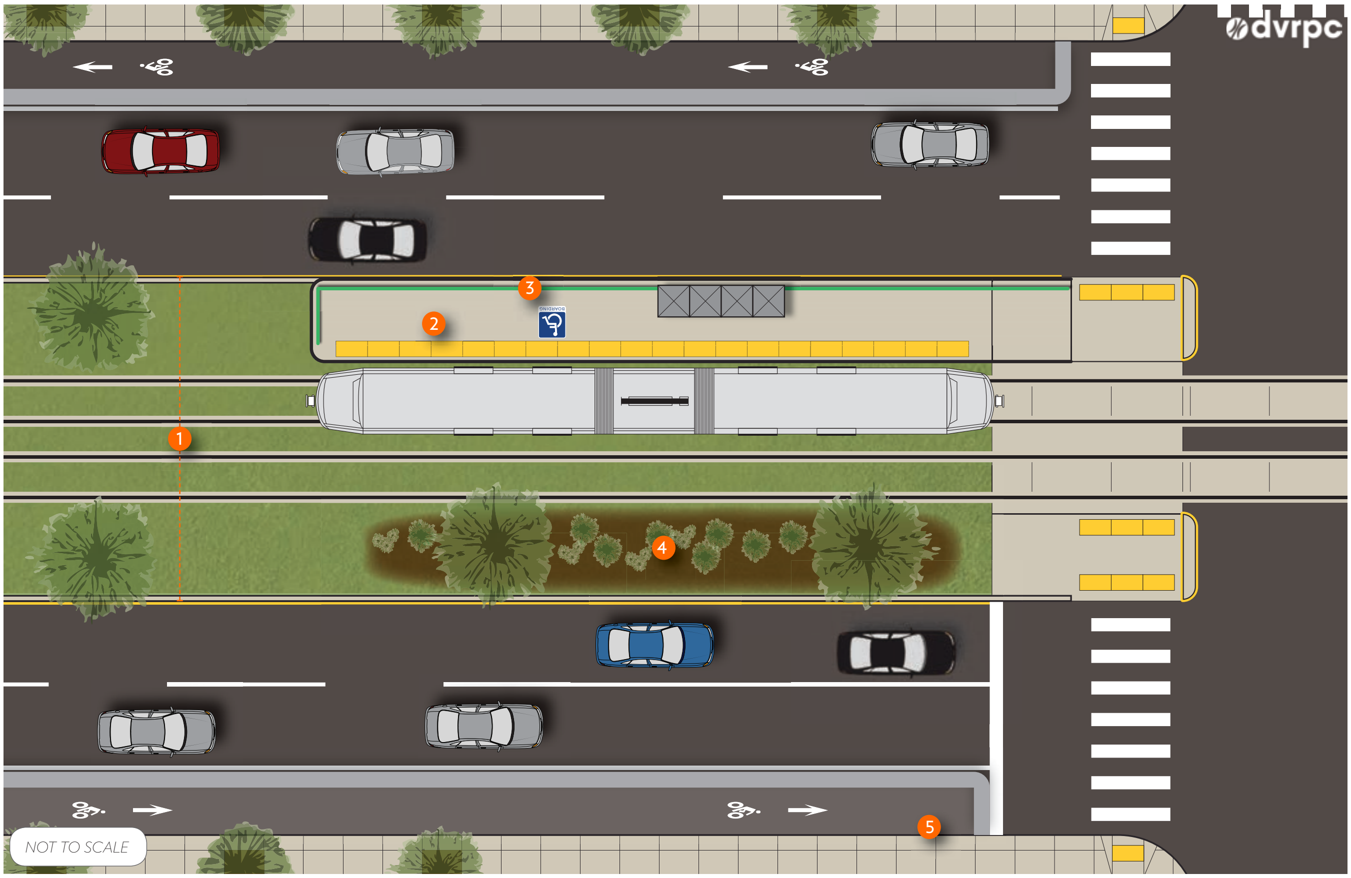


Figure 79 | Exclusive right-of-way station: Plan view

Design Recommendations:

1. **Right-of-Way Width**: The trolley-exclusive right-of-way should be 41'-wide at minimum to accommodate two 11'-wide trolley trackways, and a minimum of 19' of space for two platforms.
2. **Waiting Area Size**: The platform should be large enough to accommodate passengers at Passenger LOS C based on expected peak period ridership. The exclusive right-of-way of this station affords opportunities to increase the station size to accommodate additional passenger amenities like seating.
3. **Railing/Barrier**: A railing or barrier must be included along the entire length of the trolley station to protect waiting passengers from traffic. Locate the barrier at least 1' from the outside platform edge so passengers cannot easily lean into the travel lane.
4. **Right-of-Way Material**: Consider replacing standard railroad ballast in the trolley right-of-way with grass, decorative pavers, or other materials/landscaping that enhance the public realm, and potentially to manage stormwater.
5. **Bicycle Facilities**: Streets with trolley-exclusive rights-of-way will likely be wide enough to accommodate bicycle facilities. Where possible, include a bicycle facility that best applies to the overall roadway design. The facility shown above, based on NACTO's Raised Cycle Track guidance, is applicable on "higher-speed streets with few driveways and cross streets."[7]

7 NACTO. "Raised Cycle Tracks" *Urban Bikeway Design Guide.* (Washington, DC: Island Press, 2014), pp. 35-40.

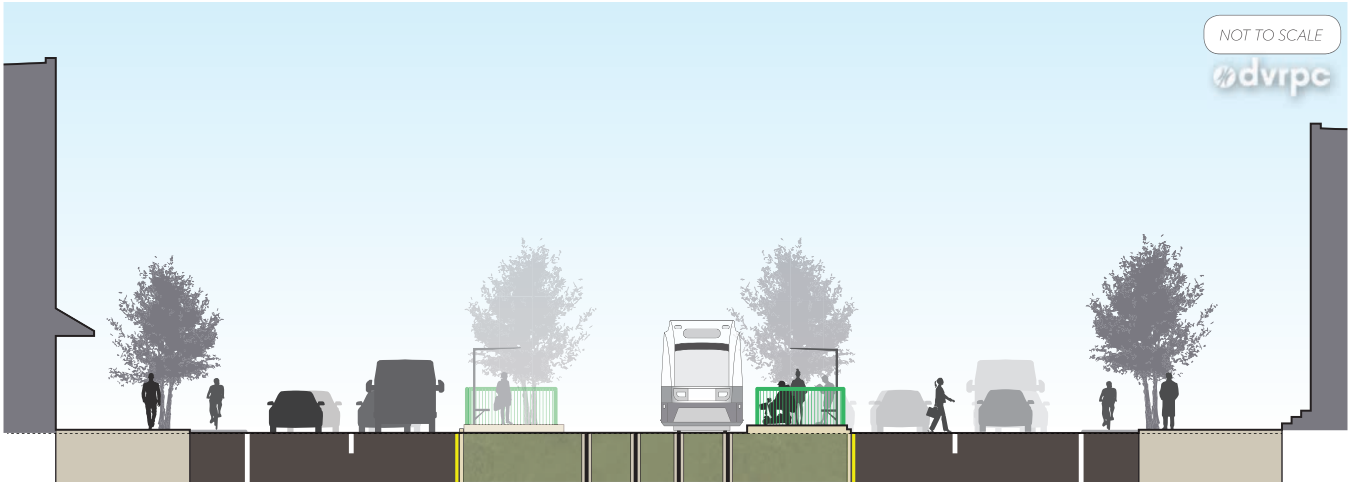


Figure 80 | Exclusive right-of-way station: Cross-section

Figure 81 | Exclusive right-of-way station: Elevation

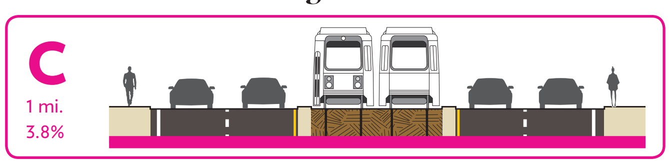
Key design dimensions:

Dimension	Minimum	Preferred
Platform length	80 ft.	100 ft.
Platform width	9 ft. 6 in.	12 ft.
Platform height	10 in.	14 in.*

* *Where possible, consider constructing platforms to allow level boarding (using a nominally 14-inch-high platform) at stations in dedicated rights-of-way.*

In these cases, passengers should be made to understand visually that they are boarding or alighting at a station with level boarding (as opposed to near-level boarding). This may be accomplished by building larger, more enclosed stations, and/or locating level boarding stations along a discrete corridor with greater protection from auto traffic, such as Island Avenue, or in the trolley tunnel.

For use in the following cross-sections:



Peer Practice: San Francisco

Muni Metro operates historic streetcars in a median right-of-way on the Embarcadero, along San Francisco's waterfront (see Figure 82).

Where the roadway is narrower, streetcars run in close proximity to adjacent traffic. Where there is more available space, the median is enlarged and used as a public plaza. In all cases, the right-of-way functions as a pedestrian refuge in the middle of a long street crossing.

Also notable is the use of decorative pavers, which, unlike grass, allow the right of way to be used by emergency vehicles.

Figure 82 | San Francisco: Embarcadero

Peer Practice: New Orleans

In New Orleans, the city uses its streetcar rights-of-way, known locally as the "neutral ground," as a core placemaking feature.

On Canal Street in the Central Business District (see Figure 83), where streetcar service is relatively frequent and traffic congestion a more acute issue, the neutral ground is hardscaped, allowing use by emergency vehicles. The plantings and streetlights are decorative, unifying an important commercial corridor.

St. Charles Avenue (see Figure 84), on the other hand, runs through largely residential districts where the neutral ground serves different urban functions. In addition to streetcar service, space outside the streetcar's envelope provides space for tree canopy. This shared space also fulfills several social functions, with frequent use by joggers and dog walkers.

Figure 83 | New Orleans: Canal Street

Figure 84 | New Orleans: St. Charles Avenue

Figure 85 | Toronto: Queen's Quay, before and after

Source: WATERFRONToronto (www.waterfrontoronto.ca)

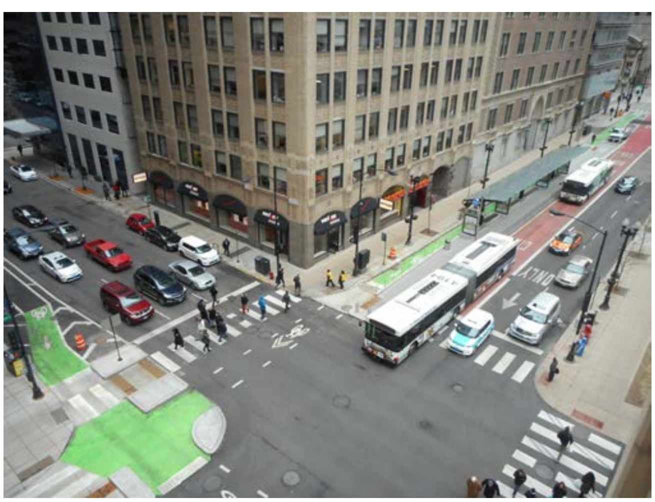


Figure 86 | Chicago: Washington Street & Franklin Street

Source: Nate Roseberry via NACTO

Next Level Station Designs:

By-and-large, the trolley modernization program is intended to *retrofit* SEPTA's trolley system to accommodate advances in vehicle technology, not to completely *replace* it from scratch. With that in mind, this guide takes as a core assumption that much of the existing streetscape along trolley corridors will remain the same, including the location of trolley tracks.

Nevertheless, Trolley Modernization is a once-in-a-lifetime opportunity to plan for the trolley system's long-term future.

This section of the Modern Trolley Station Design Guide explores station types that could not be easily applied to existing trolley corridors. In some cases, these stations require more curb-to-curb width than exists along any of trolley routes. In other cases, a station type would only be possible if a travel lane or parking lane were removed.

Several scenarios are natural decision points for reimagining SEPTA's trolley system:

- **Track renewal:** The expected lifespan of SEPTA's in-street trolley tracks is 25-30 years, after which they must be replaced. Replacing track is an intensive construction process that usually requires temporarily closing all or some of the street. This presents an opportunity to realign trolley tracks, improving safety and mobility for passengers, pedestrians, cyclists, and others.
- **Roadway redesigns:** Existing trolley streets are occasionally the subject of redesigns geared towards safety, congestion mitigation, improving transit service, or other goals. These redesign efforts, such as the ongoing redesign of Island Avenue in Southwest Philadelphia, are appropriate opportunities to design enhanced trolley corridors.
- **System expansion:** Opportunities may arise for SEPTA to expand its trolley system onto new rights-of-way. For example, the Delaware waterfront, the Centennial District in West Philadelphia, and Eastwick in Southwest Philadelphia, are all under early analysis for potential extensions of existing trolley lines.

The following designs would offer major improvements for SEPTA passengers, pedestrians, cyclists, residents, businesses, and in some cases, even drivers. Because they involve major changes to trolley streets, they will require both external collaboration (with City agencies, community groups, etc.), and internal coordination at SEPTA.

ROAD DIET STATION

This station design modifies 4-to-6-lane cross-sections, and dedicates two of the existing lanes exclusively for trolley service. This change would significantly improve speed and reliability for trolley passengers, and offer pedestrians safer crossings. On existing 4-lane cross-sections, this station type would require removing a travel lane in each direction, a significant mobility trade-off that would promote transit and pedestrian safety.

The recommendations for this station design differ from the Exclusive Right-of-Way Station in that they focus on *retrofitting* a mixed-traffic trolley street, rather than making the most of an existing dedicated right-of-way.

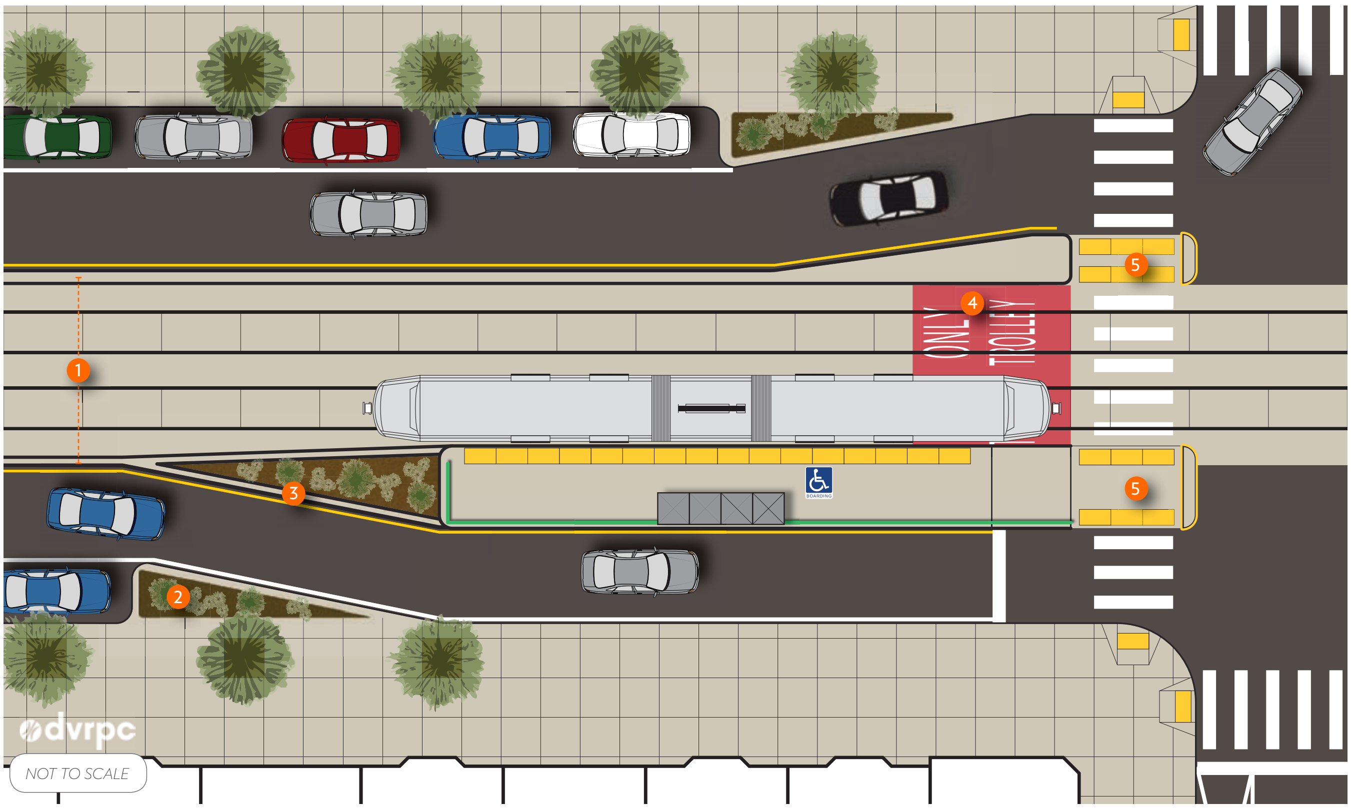


Figure 87 | Road diet station: Plan view

Design Recommendations:

1. **Exclusive Trolley Right-of-Way**: Dedicate an exclusive right-of-way to trolley service. Separate the right-of-way from vehicular traffic using a concrete curb. Where possible, consider an alternate material for the right-of-way such as grass or decorative pavers (see pp. 58-59, peer practice, for examples). Note that some materials would prevent buses and emergency vehicles from using the trolley right-of-way.
2. **Small Curb Extension**: Use a small curb extension to prevent parked cars from blocking the travel lane as it shifts to accommodate the platform. Where possible, enlarge this curb extension to include stormwater infrastructure. (See pg. 35 "Stormwater Infrastructure" for further guidance.)
3. **Travel Lane Shift**: At stations, the travel lane must shift to accommodate the platform at an angle appropriate to the street's design speed. Where possible, use landscaping as a buffer between the end of the platform and the travel lane.
4. **"Trolley Only" Markings**: Use red paint and "Trolley Only" pavement markings at intersections to prevent unauthorized vehicles from entering the trolley-right-of-way.
5. **Refuge Islands**: Include a pedestrian refuge island where the crosswalk meets the trolley station's accessible ramp, and where the crosswalk meets the trolley right-of-way. These refuge islands must include detectable warning strips at either end, and a raised curb closest to the intersection to protect pedestrians from turning vehicles.

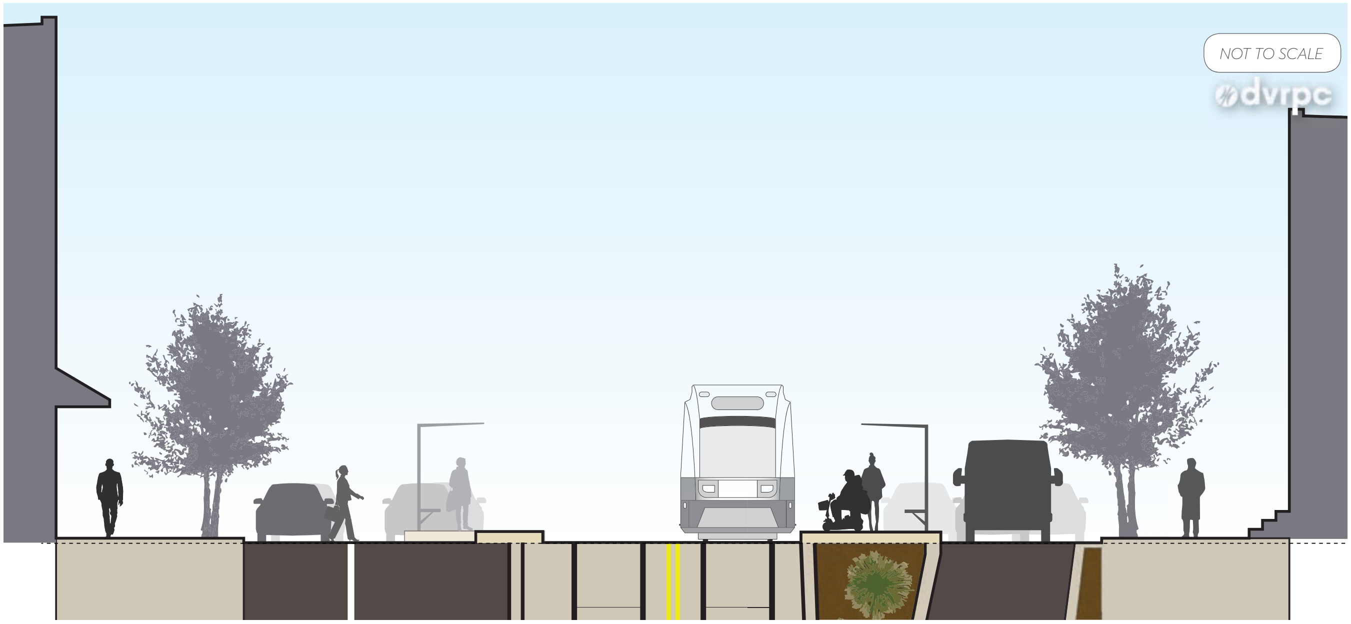


Figure 88 | Road diet station: Cross-section

Figure 89 | Road diet station: Elevation

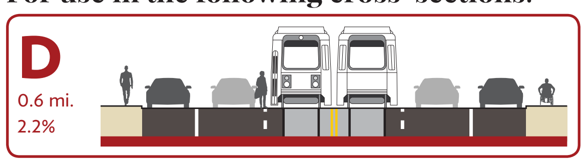
Key design dimensions:

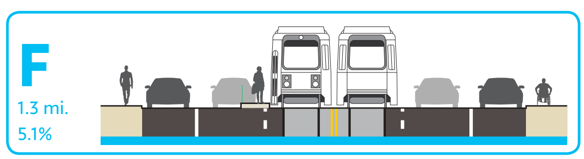
Dimension	Minimum	Preferred
Platform length	80 ft.	100 ft.
Platform width	9 ft. 6 in.	12 ft.
Platform height	10 in.	14 in.*

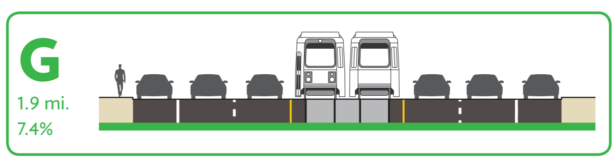
** Where possible, consider constructing platforms to allow level boarding (using a nominally 14-inch-high platform) at stations in dedicated rights-of-way.*

In these cases, passengers should be made to understand visually that they are boarding or alighting at a station with level boarding (as opposed to near-level boarding.) This may be accomplished by building larger, more enclosed stations, and/or locating level boarding stations along a discrete corridor with greater protection from auto traffic, such as Island Avenue, or in the trolley tunnel.

For use in the following cross-sections:







Variation: Far Side Station

Locating the Exclusive Right-of-Way station at the far side of the intersection would often allow a left-turn-only lane. This station configuration would mitigate lost turn lanes that would accompany dedicating an exclusive trolley right-of-way with near side stations (see Figure 90).

Designers should take care to ensure adequate lane widths for both automobiles and trolleys. Dedicated left-turn and trolley signals would likely be required for this station type.

The exclusive right-of-way would help mitigate many of the drawbacks of mixed traffic far-side stations. In particular, intersection queuing and mid-block crossings could be alleviated.

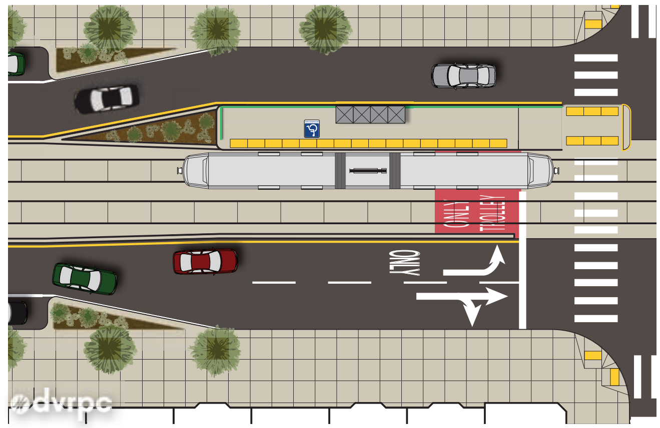


Figure 90 | Road diet station: Far-side variation

Peer Practice: San Francisco

Muni Metro's T Third and N Judah lines show how a dedicated streetcar right-of-way can be integrated into a dense urban environment with varying levels of streetscape impact. Census figures show nearly identical car ownership rates in Philadelphia and San Francisco—respectively, 67.2 percent and 69.1 percent of households have access to a car—suggesting that these streets may also be helpful to understand the mobility trade-offs at play.

In 2013, SFMTA used red paint to limit the center lanes on a 1/3-mile stretch of Church Street to transit vehicles only (Figure 91). A 2015 evaluation of the project found improved speeds for transit and minimal delay for drivers.[8] The report also noted that enforcement of lane violations was a key factor in the project's effectiveness, suggesting that paint alone may not be an effective way to prioritize transit.

Judah Street (Figure 92) features a more visually subtle, but operationally effective, trolley right-of-way. A low curb keeps vehicles off of the median right-of-way, but easily slopes downward to meet the crosswalk at intersections.

Figure 91 | San Francisco: Church Street

Source: NACTO

Figure 92 | San Francisco: Judah Street

8 San Francisco Municipal Transportation Agency. "Church Street Pilot Transit Lanes," *Muni Forward*. June 1, 2015. https://www.sfmta.com/sites/default/files/projects/2015/Church%20Street%20Pilot%20Report%20v5.pdf

Peer Practice: Toronto, ON, Canada

Figure 93 | Toronto: Queen's Quay

Source: WATERFRONToronto (www.waterfrontoronto.ca)

In 2015, Toronto unveiled a major redesign of Queen's Quay, its main waterfront thoroughfare (see Figure 93). The roadway was transformed from a 4-lane, 2-way road with a center streetcar right-of-way, to a 2-lane, 2-way street with a side-running streetcar right-of-way and a 2-way sidepath for cyclists.

Like SEPTA Trolley Modernization, the Queen's Quay redesign has been challenging but rewarding. Early growing pains were reported, with some drivers making erroneous or illegal turns, though media reports suggest this issue has diminished over time. TTC also reported that the side-running streetcar right-of-way has led to slower service because it now crosses more signalized driveways—a strategy SEPTA may want to avoid. Nevertheless, the rewards have been plentiful. Waterfront Toronto, the quasi-governmental agency that oversees Queen's Quay, reported higher pedestrian activity, and recently counted 6,000 bicyclists using the sidepath in a single day, which they described as a "record."[9]

The trade-offs in the Queen's Quay redesign provide insight into how SEPTA might evaluate such a project. Toronto's waterfront is experiencing rapid residential growth, and is a citywide recreational center. This made urban design and public space key factors, helping to explain why lower auto capacity and slower transit service were acceptable trade-offs. If SEPTA began a similarly transformative project, they might pursue different goals than Toronto, such as faster trolley service.

9 Spurr, Ben. "Queens Quay redesign proves popular though 'friction' remains," *Toronto Star*. (Toronto) Aug. 9, 2016.

Peer Practice: Paris

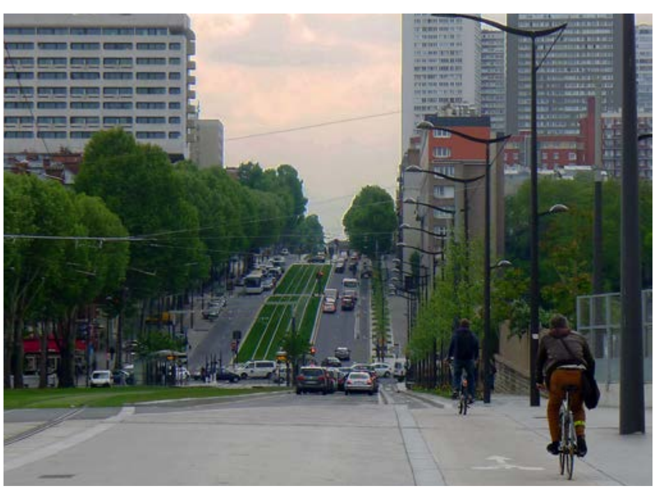


Figure 94 | Paris: Boulevard Masséna

Source: MBZT via Wikimedia Commons (CC BY-SA 3.0)

The nine Paris Tramway lines operate across more than 65 miles at the urban edge of Paris and in its suburbs. Typically, vehicles operate in a median right-of-way with a mix of grass and hardscaping (see Figure 94).

Paris' tramways are especially notable when rethinking SEPTA's trolley lines because they are recent installations, with all nine lines built since the 1990s. In numerous cases, building tramways required removing travel lanes from a congested, multi-lane roadway in auto-dependent sections of Paris. Yet, removing auto capacity paid off in new transit ridership. These lines now carry 900,000 passengers per day—only slightly fewer passengers than the entire SEPTA system.

PROTECTED BICYCLE LANE STATION

This station type pairs a floating trolley station with a parking-protected bicycle lane. Protected bicycle lanes use parked cars plus a buffer to separate cyclists from traffic. This station type offers a safety enhancement over the Floating Station + Bicycle Lane by eliminating the lateral shift before the platform, and by offering greater cyclist and pedestrian protection at intersections.

No existing trolley streets are wide enough to accommodate all the elements of this station type. The protected bicycle lane would therefore apply on new trolley corridors, or on major redesigns of existing trolley corridors.

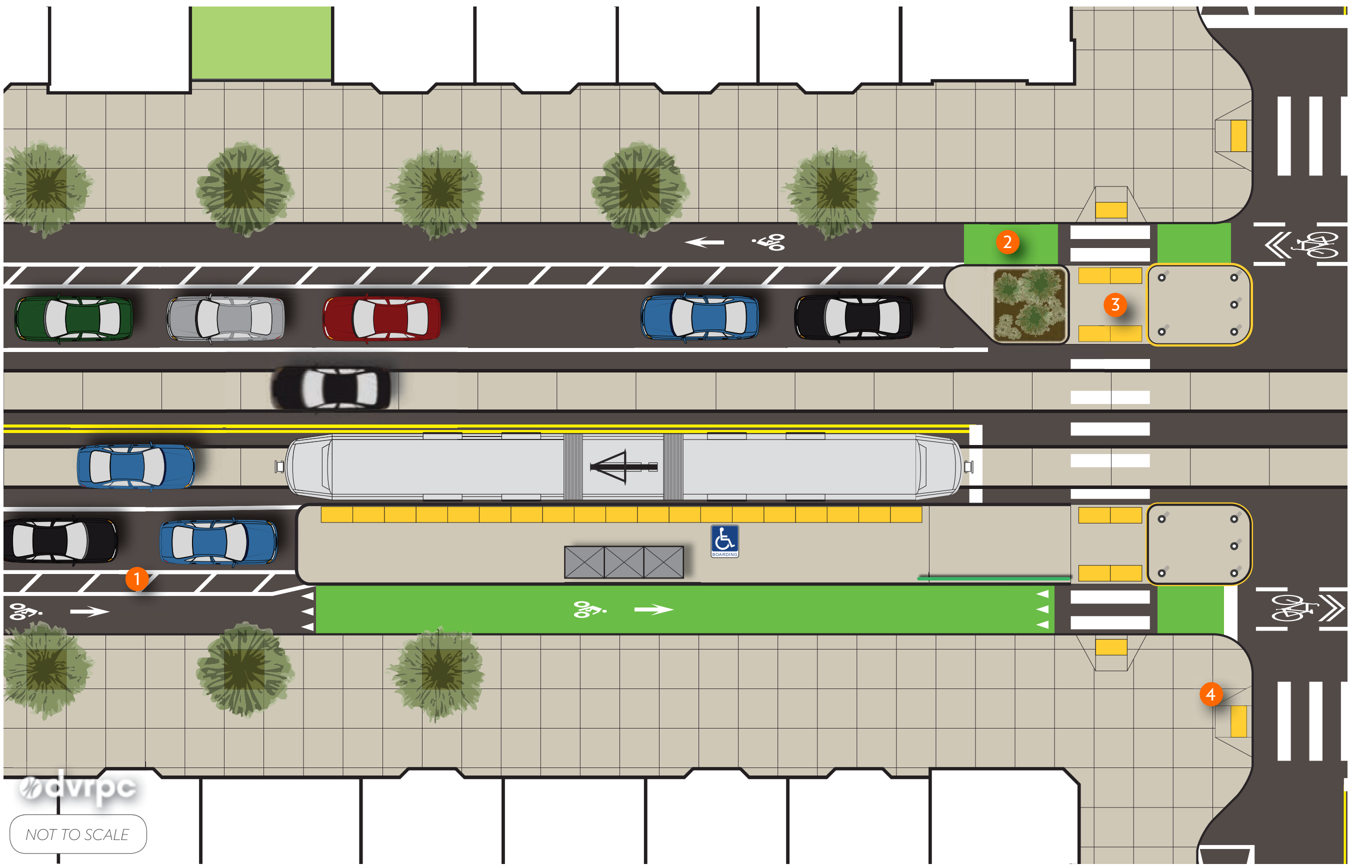


Figure 95 | Protected bicycle lane station: Plan view

Design Recommendations:

1. **Bicycle Lane Buffer**: Separate the bicycle lane from the adjacent parking lane using a 2-or-more foot-wide buffer. The buffer should at minimum include solid white lines with diagonal crosshatching (MUTCD 3B-24). Consider further protecting the bicycle lane using vertical separation elements, including flexible delineators, planters, or a curb. The buffer may also be used to capture and infiltrate stormwater via a green gutter (see pg. 35).
2. **Green Bicycle Lane Paint**: Include green paint and bicycle lane markings (MUTCD 9C-3) to alert pedestrians walking across the bicycle lane to the presence of cyclists.
3. **Refuge Islands**: Include refuge islands with bollards on each side of the intersection. The refuge island protects pedestrians from moving vehicles, and prevents vehicles from parking in the crosswalk. Refuge islands also add protection for the bicycle lane as it enters or exits the intersection. Where possible, consider adding landscaping or other public realm features on these refuge islands.
4. **Full Curb Extension**: Where space allows, consider continuing the curb extension onto cross streets to further increase pedestrian safety. At cross streets with bicycle lanes, a refuge island may be substituted for a curb extension to create a full or partial protected intersection (see Figure 101: Chicago for a recent U.S. example).

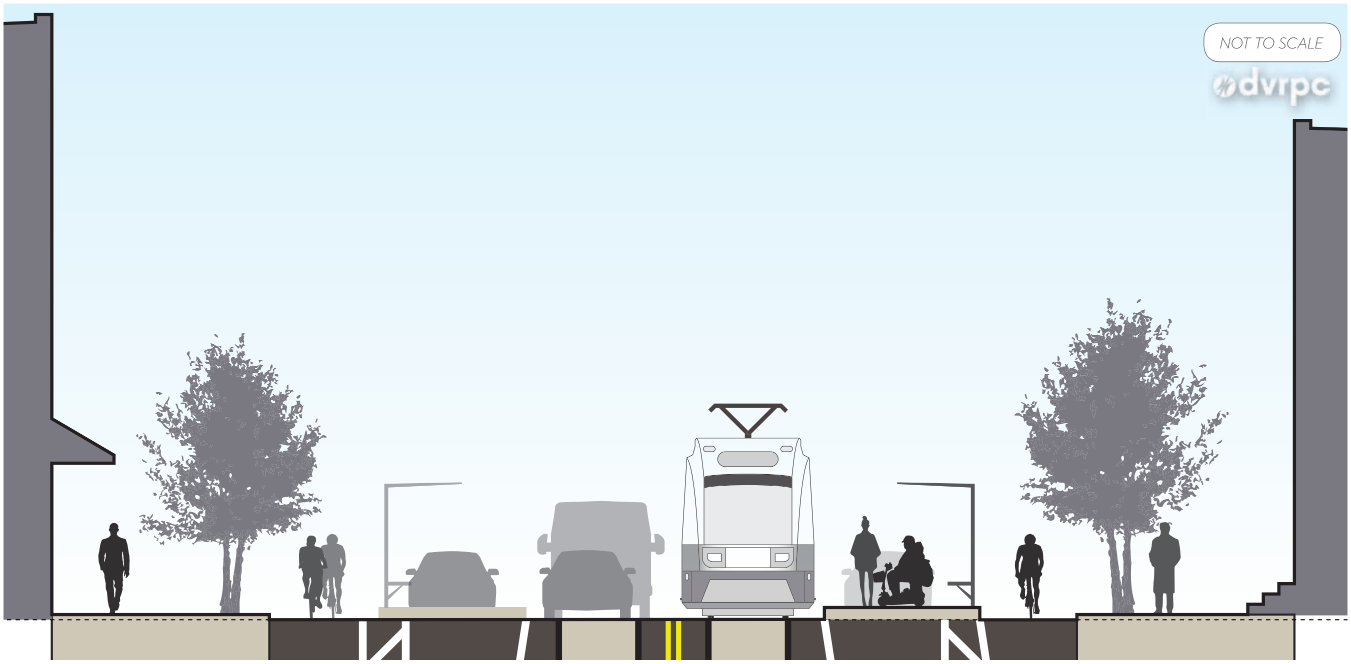


Figure 96 | Protected bicycle lane station: Cross-section

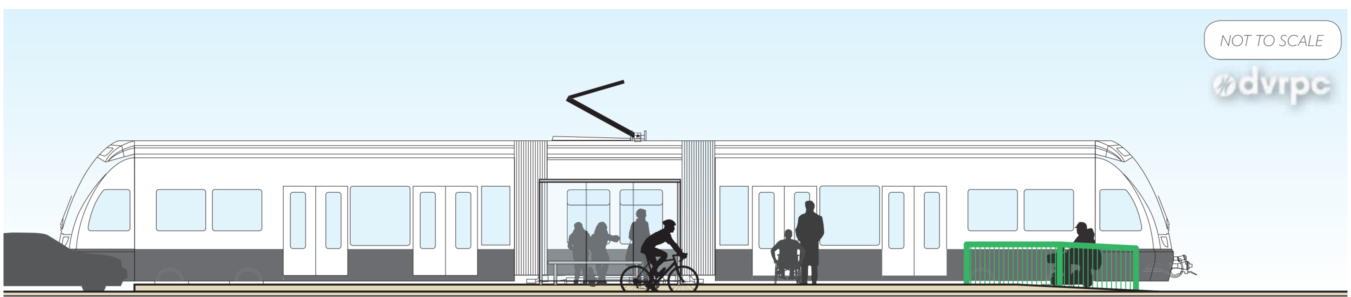
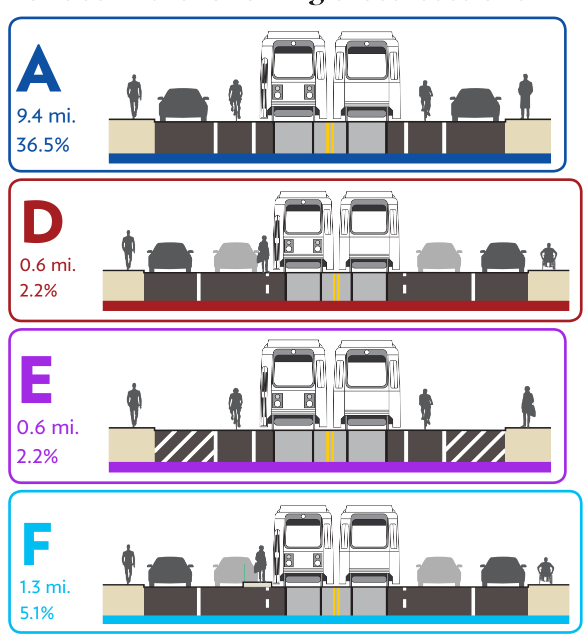


Figure 97 | Protected bicycle lane station: Elevation

Key design dimensions:

Dimension	Minimum	Preferred
Platform length	60 ft.	80 ft.
Platform width	8 ft. 6 in.	12 ft.
Platform height	10 in.	10 in.
Bicycle lane width	5 ft.	7 ft.
Buffer width	2 ft.	3 ft.

For use in the following cross-sections:*



** On existing streets: Applying this station type to cross-section "A" would require widening the cartway. Applying this station to cross-sections "D" or "F" would require reducing the number of travel lanes, or widening the cartway.*

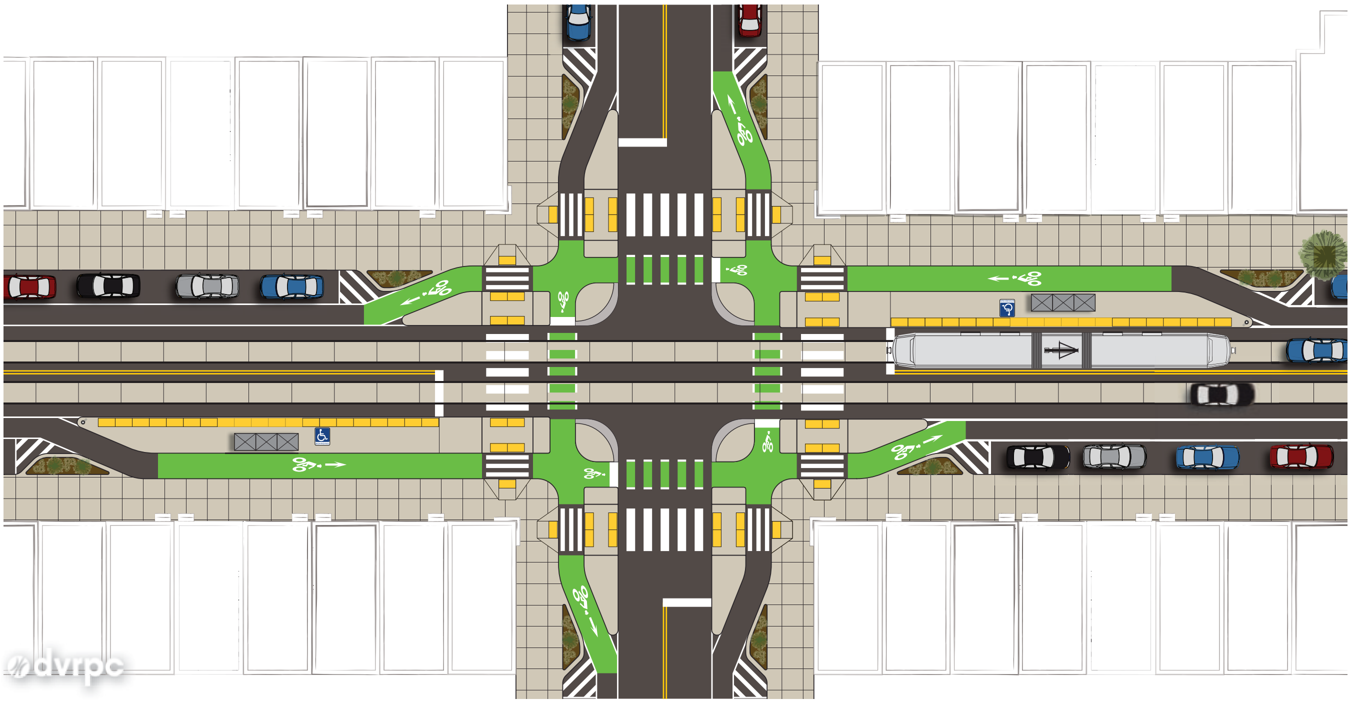


Figure 98 | Protected bicycle lane station: Protected intersection variation

Variation: Protected Intersection

When a trolley corridor intersects with a planned or existing protected bicycle lane, consider building a protected intersection to provide additional safety for both cyclists and pedestrians. A protected intersection should include corner refuge islands, crosswalks set back farther from the intersection, and forward stop bars for bicyclists (See Figure 98).

A protected intersection may require a dedicated signal phase for bicyclists. Designers should pay special attention to street width and expected turn radii when laying out protected intersections.

Figure 99 | Seattle: Broadway

Figure 100 | Seattle: educational signage

Source: SDOT

Peer Practice: Seattle

When the City of Seattle built the First Hill Streetcar line, in part along Broadway, it took the opportunity to transform the street into a safe and accessible corridor for walkers, cyclists, transit riders, and drivers.

Once a 4-lane road with two curbside parking lanes, SDOT removed two travel lanes, and added a center turn lane, leaving ample space for a two-way protected bicycle facility, along with streetcar boarding islands and curb extensions.

The cycle track, which runs behind a parking lane, places cyclists safely away from both auto traffic, and from streetcar tracks. Raised, highly visible crosswalks between the sidewalk and streetcar stations help pedestrians and cyclists negotiate each other in shared space (see Figure 99).

Anticipating what a dramatic overhaul the First Hill project would be, SDOT developed educational literature and signage to help people understand how to drive, park, bicycle, and access streetcar stations on the overhauled street (see Figure 100).

Figure 101 | Chicago: Loop Link station

Peer Practice: Chicago

The Chicago Department of Transportation (CDOT) used a bus service improvement project, Loop Link, to add high-quality bicycle infrastructure in one of the busiest parts of downtown. One lane of several major streets was dedicated for buses only, along with a protected, curbside bicycle lane. Bus passengers now enjoy higher platforms with weather protection and real-time schedule information, while pedestrians benefit from shorter, safer crossings thanks to the bicycle and bus lanes (see Figure 101).

Where the bicycle lane crosses another street with a bicycle lane, CDOT built portions of a Dutch-style "protected intersection" to protect turning bicyclists from cars, and pedestrians from bicyclists (see Figure 86 on page 55 for an aerial view).

The Loop Link project, aside from offering useful design cues, demonstrates how a transit enhancement project may also be used to enhance bicycle infrastructure—especially on roadways with high demand for auto use.

MODERN TROLLEY STATION DESIGN GUIDE

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Geographic Area Covered: Philadelphia, Pennsylvania
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Yeadon, Pennsylvania
Colwyn, Pennsylvania
Delaware County, Pennsylvania

Key Words: Trolley Modernization, SEPTA, accessibility, station design

Abstract: SEPTA's once-in-a-generation replacement of its trolley fleet, or Trolley Modernization, will entail well-spaced trolley stations that are fully accessible. The Modern Trolley Station Design Guide provides practitioners with guidance on the design parameters needed for modern trolley stations along SEPTA's six City Transit Division trolley lines (Routes 10, 11, 13, 15, 34, and 36).

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