DESIGN GUIDELINES FOR BUS AND LIGHT RAIL FACILITIES

SACRAMENTO REGIONAL TRANSIT DISTRICT

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ACKNOWLEDGEMENT

Sacramento Regional Transit District wishes to acknowledge the various agencies and organizations for their invaluable assistance in providing sources of information and constructive criticism to finalize the Design Guidelines for Bus and Light Rail Facilities.

The District wishes to express special appreciation to the Orange County Transit District, Alameda–Contra Costa Transit District, Southeastern Michigan Transportation Authority, City of Sacramento Planning Department, City of Sacramento Public Works Department, City of West Sacramento Public Works Department, and the County of Sacramento Public Works Agency (Department of Transportation).

PREFACE

The preparation of the Design Guidelines for Bus and Light Rail Facilities was originally financed in part through grants from the U.S. Department of Transportation, Federal Transit Administration (FTA) under the Urban Mass Transportation Act of 1964, as amended. The contents of the Design Guidelines reflect the views of the Sacramento Regional Transit District (SacRT), which is solely responsible for the facts and accuracy of the data presented herein.

The contents do not necessarily reflect the official views or policy of the U.S. Department of Transportation. The Design Guidelines do not establish a legal standard or specification or constitute a regulation, and are not intended to supersede or replace municipal and County requirements.

These guidelines are to be used for new construction, and retrofitting or modification of existing facilities. Some existing facilities are inconsistent with the guidelines presented in this document. In these cases, application of the guidelines may be limited by a variety of factors including lack of right of way, physical constraints, or because policies and standards of the local jurisdiction.

Existing facilities are “grandfathered in” and are not required to be modified to meet the requirements set forth in these guidelines. This “grandfather” clause does not however exempt a facility or proposed improvement from complying with Americans with Disabilities Act (ADA) and other Federal, State or Local Agency regulations and requirements.

In all cases, it is imperative that these guidelines be used in conjunction with sound evaluation of facts and site conditions, and engineering judgement. Each site must be thoroughly examined and each project must be evaluated from the aspect of safety, operational requirements, and cost-effectiveness, and design solutions may need to be adjusted accordingly to satisfy site specific constraints and applicable local ordinances.

Final approval of a development plan rests with the City or County authority having jurisdiction. Approval pertaining to all street and intersection improvements rests with the City and/or County Public Works Department. Final approval of off-street transit facilities rests with SacRT.

This document provides only planning-level guidelines for SacRT’s light rail facilities. These guidelines do not provide specific design standards or criteria to be used for the design of light rail facilities. Please refer to the latest edition of the SacRT Light Rail Design Criteria.

These Guidelines should be considered a working document that adapts to changing times, changing environments, and new policies. It is recommended that the Guidelines be kept in a three-ring binder to allow for easy insertion of updated pages as changes are made in the future.

For further information about Design Guidelines for Bus and Light Rail Facilities or additional copies, please contact:

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SECTION 1. INTRODUCTION

1.1. PURPOSE OF GUIDELINES

The purpose of the Design Guidelines for Bus and Light Rail Facilities (Guidelines) is to promote convenient, comfortable, and safe bus and light rail facilities for transit users. These design guidelines will assist Sacramento Regional Transit District (SacRT) in providing consistent, high-quality facilities that the public deserves and will translate into increased ridership and public support for mass transit. Land use patterns and street networks should be designed to encourage rather than inhibit efficient public transit operation.

The Guidelines have been prepared by SacRT to assist with the selection, design and placement of various bus and light rail facilities and amenities, in areas where new bus and/or light rail service is proposed, or where modifications or improvements to existing service are necessary to facilitate safe and efficient transit operations. Installation of a bus or light rail–related facility does not ensure that transit service will be provided. SacRT's Planning Department will furnish, upon request, information on the likelihood of the provision of transit service to a particular area or development.

The Guidelines can be used by developers and public agencies responsible for the planning, design, approval, and/or construction of transit facilities and other public improvements related to bus and light rail facilities. It can also be used as the basis for defining conditions of development approvals and assist in the preparation of environmental documents.

The Guidelines provide a general framework for project development and design, and can be especially useful to planners, architects, and engineers as a working guide during the project planning and design phases. It does not specify the complete engineering design of each element of a bus/light rail facility since all contingent design issues cannot be practically addressed in a general document such as this. Design solutions may need to be adjusted to satisfy site-specific conditions and applicable local codes and regulations. These guidelines do not provide specific design standards and criteria for the design of light rail facilities. Attention is directed to the SacRT Light Rail Design Criteria.

Information in these Guidelines is the result of extensive research and surveys. Similar documents were reviewed from transit agencies throughout the country. Past local practices were reviewed, field exercises were conducted, passenger complaints concerning existing facilities were studied, and bus/light rail operator feedback was analyzed. The current Americans with Disabilities Act (ADA) regulations, adopted in 2006 by the United States Department Transportation (USDOT) and adopted in 2009 by the United States Department of Justice

(USDOJ) were reviewed to include or exceed the requirements for persons with disabilities.

The Guidelines are inherently an evolving set of guidelines. As new information becomes available, new regulations are approved, and methods are improved, this can be added to the Guidelines. Updates to these Guidelines will be available upon request from the SacRT Planning Department or on the SacRT web site at www.sacrt.com.

1.2. METHOD OF PRESENTATION

The Guidelines are presented in the following format:

Planning

- Section 2 deals with planning recommendations for development projects, and elements of design relating to accessibility, safety and security to ensure an efficient, user-friendly and cost-effective transit service.

Roadway

- Sections 3 and 4 provide information regarding bus turning radii and roadway grades.

Bus Rapid Transit (BRT)

- Sections 5 and 6 provide details regarding exclusive bus lanes and bus priority signals.

Bus Stops

- Sections 7 through 12 and Section 14 provide guidelines for bus stops, bus turnouts, bus shelters and benches, bus layover areas, bus turnarounds and bus berths.

Transit Centers

- Sections 13 and 15 discuss details for transit centers and park-and-ride facilities.

Light Rail

- Section 16 gives planning-level guidelines for light rail stations.

Site Elements

- Sections 17 through 20 provide details regarding bike parking facilities, signage, lighting and landscaping.

Appendices

- Appendix A deals with specific vehicle characteristics and technical data for vehicles operated by SacRT.
- Appendix B includes a list of plants commonly used on SacRT projects.
- Appendix C includes photographs of existing facilities.

- Appendix D contains a glossary of terms used in the Guidelines and in the design of bus and light rail facilities.
- Appendix E lists the references used in developing these Guidelines.

SECTION 2. PROJECT DESIGN

2.1. GENERAL DESIGN CONSIDERATIONS

The provision of an effective transit service to a development depends upon two major considerations:

(1) Availability of resources to provide the service, and

(2) Design of the development.

An effective transit service may assist a developer in promoting a new development to the City, County and prospective property owners. A transit service located within close proximity to a development will provide owners and/or residents an alternative means of transportation and be beneficial to the local agency by reducing traffic impacts and assist in achieving air quality requirements.

This chapter deals with the design of ~~a~~ developments focusing on aspects to be considered during design that are conducive to promoting transit service, Transit-Oriented Development (TOD), the concept of Universal Design, and safety and security aspects of design.

2.2. ASPECTS OF DESIGN

Design considerations that have a significant impact on whether a development can be efficiently served by transit are:

(3) Access between transit corridors and the development.

(4) Relative location of (a) the project within the overall transit service area, and (b) the land uses and buildings within a development.

(5) Size and density of development as it relates to the development's potential to generate transit trips.

Early considerations of transit facilities and design concepts that are conducive to efficient transit operation, enables easy integration into the overall development concept and avoids the need for costly changes later to accommodate transit.

2.2.1. Access

For successful transit service to a particular development, it is essential that

(6) the components of the development, i.e., the homes or the employment centers of major traffic generators, have easy access to the transit stops or station near or within it, and

(7) the transit service has direct and operationally safe access to the development.

Certain forms of subdivision design impede access to transit service and the provision of transit service. Examples of such impediments include walled subdivisions, excessive use of cul-de-sacs and circuitous street patterns, undulations/speed bumps along arterials, etc. Normally, SacRT will not provide transit service to subdivisions that include these impediments because it is inefficient and unfeasible to do so.

For appropriate access to, and from, transit service, SacRT recommends the following:

(1) The street pattern of a subdivision or development should include at least one arterial street in a location that will maximize access to it from all parts of the development.

(2) Arterials with more than two lanes or speed limits greater than 30 miles per hour should have not more than 0.25 mile spacing between marked crossings.

(8) The arterials within a subdivision should serve as the collector streets for it.

(9) All parts of the development should have easy pedestrian access to the arterial(s).

(10) Where a development or subdivision is walled or fenced off, and the arterial along which transit service is likely to be provided is outside the walls or fence, or located on a cul-de-sac with no direct access to the arterial, steps should be taken to allow easy pedestrian access to the arterial. These could include the following:

(a) Providing pedestrian access paths, not suitable for vehicular traffic, linking various sections of the development to the arterial, especially near the transit stop.

Security measures incorporated into the development should not preclude these linkages. For example, gates may be provided across these paths at access points to the development.

(b) Replacing the walls or fence around the development near the transit stop(s) along the arterial(s), with a system of offset walls and berms which allow pedestrian passage and provide the sound reducing qualities of walls, but restrict vehicular access.

2.2.2. Location

The provision of transit service to a given development is directly impacted by:

(1) Location of the project in the overall transit service area.

(2) Location of land uses within the project.

(3) Location of specific buildings within a land use designation.

A project can ensure the provision of transit service by locating along or within 1/4-mile of an established or potential transit corridor.

Transportation corridors, (i.e., roadways linking high density residential areas) non-residential buildings with a minimum building size equivalent to 50 employees, and high-volume traffic generators such as shopping centers, educational institutions, etc., represent effective and efficient transit corridors as well. Transit service along such corridors can reach desired productivity levels that sustain its continued provision.

In order to create an effective transit corridor within a major development project, or to enhance the likelihood of a roadway along which a development is proposed to be located to serve as a transit corridor, or to increase the likelihood of a smaller development project being served by transit, SacRT recommends the following:

(1) Locating medium-density (10+ dwelling units per acre) residential uses adjacent to, or at least no more than, 1/4-mile away from the proposed transit corridor.

(2) Sizing employment centers for a minimum building size equivalent to 50 employees and locating those adjacent to, or at least no more than, 1/4-mile from a transit corridor.

(3) Locating all major traffic generators, other than high-density residential uses and significant employment centers, adjacent to the proposed transit corridor.

Examples of major traffic generators are:

(a) Shopping Centers

(b) Educational Institutions (Junior High through Colleges and Universities)

(c) Offices and other places of employment density

(d) Courthouses, jails, and legal services; medical facilities, including hospitals and clinics; social service offices, including welfare offices and job training centers

(e) Major event centers (e.g., Stadiums, Arenas, entertainment complexes, concert venues, etc.)

(f) Transportation Terminals (i.e., airports, bus and train depots, etc.)

Location of a specific building within a development has a significant impact on the potential for transit use. It is, therefore, an important consideration in the development of site plans since greater transit use ensures continued provision of transit service.

Site plans which orient building access to light rail stations or bus stops along transit corridors, and maximize their proximity, facilitate and encourage transit use. SacRT, therefore, recommends:

(1) The distance between buildings within a particular site and the transit corridor along which they are located should be minimized.

(2) Access points to the building should be oriented towards the bus stops/rail stations along the transit corridor.

(3) Locations of parking lots between the buildings and the transit corridor should be avoided.

(4) Sidewalks, plazas, or other means of pedestrian access within the site should be placed to provide a direct path to the transit corridor.

(5) Site development plans should accommodate bus stops at intersections (most convenient to pedestrians); see Section 7. Developments should avoid locating driveways and right-turn pockets near intersections that would displace bus stops from these preferred locations.

Figures 2-1 to 2-3 illustrate these concepts for various development types.

2.3. TRANSIT-ORIENTED DEVELOPMENT

Transit-Oriented Development (TOD) is distinguished from other high-density development by their focus on convenience for transit users and other pedestrians over automobiles. A TOD is a mixed-use community within an average 1/4 mile walking distance of a transit stop and core commercial area. The design, configuration, and mix of uses emphasize a pedestrian-oriented environment and reinforce the use of public transportation. TOD's mix residential, retail, office, open space, and public uses within comfortable walking distance, making it convenient for residents and employees to travel by transit, bicycle, or foot, rather than by car.

In 2005 the Sacramento Area Council of Governments (SACOG) approved the Blueprint Scenario for 2050, which strongly suggests TOD as a way to direct future growth to existing infrastructure, with an expectation of 41% of new jobs and 38% of new housing within walking distance of transit.

As part of the long-range Transit Action Plan, SacRT is developing a TOD guide (dated 04/13/2009) to promote TOD as an important tool in delivering the goals of the Blueprint plan: to increase transit ridership; and widen transportation choices in the Sacramento region.

The TOD Guidelines offer principles and guidelines that will be refined and adopted by each municipality and their various departments. Implementing the Transit Action Plan requires a new means of integrating land use and transportation within the Sacramento Region.

The guidelines identify and organize these many considerations into three elements of city building: Land Use and Community Character; Mobility and Access; and Open Space and Civic Amenities.

Land Use and Community Character

Land use and the character of the built environment are vitally important considerations to TOD and are often the focus of TOD policy. Guidelines in this section include questions of density, building height and disposition, parking ratios, block sizes, and the appropriate mix and types of land use for transit.

It is tempting to be prescriptive in expectations in this category, however many outcomes of the built environment are ultimately influenced by market forces. High quality development is promoted. Architectural styles and residential and commercial product types are subject to fundamental policies such as setting a minimum density expectation, regulating for walkable block sizes and managing parking ratios. The recommendations in this section provide a framework for development that promotes walkability.

Transportation: Mobility and Access

The quality of the design for sidewalks, roadways and transit infrastructure influences the development possibilities of adjacent land use. High-speed roadways designed without on-street parking and provisions for sidewalks with minimum dimensions will not encourage a "Main Street" retailer to locate on that facility. Similarly, if light rail transit requires street separation is within transit station areas the development opportunities around the station will be limited by the lack of interconnectivity and proximity to adjacent development.

However, transit typically operates more efficiently in exclusive guideways with traffic signal priority and grade separations.

Transportation facilities can no longer be designed for the movement of goods and service as if nothing else matters. The surrounding and desired land use context should inform the quality of the transportation system's design even if it means transportation efficiency is compromised because of adjacent development opportunities.

Open Space and Civic Amenities

Like the private development industry, local governments are developers, creating parks and civic infrastructure and these community investments have a profound impact on adjoining land uses. The policies and actions of local government in the development of this civic infrastructure need to be incorporated into the Integrated Transit and Land Use Framework.

Several entities manage parkland throughout the region. For example, the City of Sacramento has four park categories: Pocket Park/Urban Plaza; Neighborhood Park; Community Park; and Regional Park. These categories are familiar enough to use as a baseline for the framework recommendations.

2.4. UNIVERSAL DESIGN

Universal Design is defined as "The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design."

People with disabilities (including mobility impairments, sensory impairments, and other physical and mental disabilities) rely on public transportation to a greater extent than most people. However, the concept of Universal Design should be applied to the design of all transit developments, improvements, and facilities to consider and accommodate the wide range of potential users, including those with disabilities and other special needs. Universal Design shifts more emphasis to the environment and, therefore, the designer to consider more than just the minimum standards or the average conditions.

Although Universal Design standards generally address the needs of people with disabilities, it is a comprehensive concept that can benefit all users. Increased walkway, ramp, and platform widths; trains with level boarding and low-floor buses; smooth walking surfaces; direct access; increased lighting; and improved signage all improve convenience for all travelers, not just those with disabilities. Curb ramps are important for people using handcarts, scooters, strollers, and bicycles, as well as wheelchair users. Automatic door openers are another example of Universal Design features that can benefit many types of users.

Universal Design should result in simple, easy mobility options from origin to destination for the greatest possible range of potential users. It should consider all possible obstacles that may exist in buildings, transit facilities, and vehicles, sidewalks, paths, roads, and traffic.

Designers will be encouraged by SacRT to propose new concepts and technologies that would enhance the image of the transit system, provide greater comfort and convenience to the transit users and public, and would promote the goals of SacRT.

Attention is directed to Section 7.6, “Accessibility” for bus stops and Section 15.2, “Design Guidelines” for Park-and-Ride facilities for specific accessibility guidelines.

2.5. SAFETY AND SECURITY

The design of transit-related developments and facilities should consider and implement the elements of safety and security. Crime Prevention through Environmental Design (CPTED) is based on the principle that effective design that uses the built environment can result in a deterrent for, and a reduction in, the incidence of crime and an improvement in the quality of life.

CPTED is based on four elements:

1. Natural Surveillance
2. Natural Access Control
3. Territorial Reinforcement
4. Maintenance

1. Natural Surveillance - encourages design to increase visibility by effective placement of windows, lighting, landscaping, and avoidance of creating areas that cannot be easily observed all the time.

2. Natural Access Control - involves the use of landscaping, fences, doors, and gates, in addition to mechanical elements such as locks and alarms, and security devices to deter crime and create a perception of risk.

3. Territorial Reinforcement - uses aspects of design, such as sidewalks, landscaping, small fences, and other means to help define “ownership” and provide a sphere of territorial influence of a facility or property owner.

4. Maintenance - is essential to uphold the image of the facility or property and indicate concern and control by the owner.

SECTION 3. BUS TURNING RADII

Adequate roadway clearances are required for buses to safely execute turning movements without crossing more than one traffic lane or striking the street curb. These clearances are based upon bus turning radii. Bus turning radii refer to an outside and inside turning arc, both of which must be allowed for in designing intersection and driveway turns.

3.1. PLACEMENT GUIDELINES

Public or private intersections, driveways, or other roadway sections with curves traveled by buses, should be designed to accommodate minimum bus turning radii.

3.2. DESIGN GUIDELINES

3.2.1. Bus Turning Radii

The bus turning radii to be considered in designing safe intersection and driveway turns are shown in Table 3-1 below.

TABLE 3-1: BUS TURNING RADII

Bus Type		**Minimum**	**Recommended**
Standard 40’	Outside Corner	50’ min	55’ min
	Inner Wheel	28’ max	30’ max
Articulated 60’	Outside Corner	45’ min	50’ min
	Inner Wheel	22’ max	25’ max
Commuter	Outside Corner	31’ max	35’ max
	Inner Wheel	14’ max	16’ max

Note: Outside corner = R1 on Figure. Inner Wheel = R2 on Figure.

While minimum dimensions are given, facility design should be based on the recommended dimensions, especially in new developments, to allow for proper vehicle movement and driver reaction while the bus is in motion. Use of minimum dimensions will be approved by SacRT only where site constraints prevent the use of the recommended dimensions.

Additional allowances should be considered when special circumstances exist, such as reverse turns, or speeds greater than 10 miles per hour.

Figures 3-1 to 3-3 illustrate turn templates which includes movement tracings for 30, 60, 90, 120, 150 and 180-degree turns for a standard 40’ long bus, a 60’ long articulated bus, and a commuter bus.

3.2.2. Curb Radius Design

The following factors should be considered in designing the curb radius for intersections:

- Bus-turning radius.
- Angle of intersection.
- Width and number of lanes on the intersecting streets.
- Allowable bus encroachment.
- Operating speed and speed reductions.
- Parking at the intersection.
- Pedestrian traffic.

Intersection design guidelines for one-center curbs, and for four different radius conditions, are illustrated in Figure 3-4. Larger curb radii are acceptable, if desired. If larger radii are used, they should be provided with a “pork chop” island to provide a refuge area for pedestrians.

The guidelines assume buses are not allowed to cross street centerlines.

Where there are curb lanes on both intersecting streets, it is advisable to restrict parking thereon for some distance from the corner, since the extra lane width provided serves to increase the effective radius.

Figure 3-5 illustrates the relocation of an intersection stop line on a cross street to allow buses significant clearance to complete the turn.

Driveways used by buses operate very similar to low-volume intersections. Therefore, the design of their turning radii is like that of street intersections, except a greater degree of encroachment is allowed due to lower traffic volumes.

Figure 3-6 illustrates the SacRT recommended driveway radii for various conditions of driveway operation.

3.2.3. Current Standards

These guidelines for specifics related to bus characteristics and dimensions should be verified with SacRT Engineering staff prior to use to confirm the applicability of the design standards. SacRT is continuously updating the bus fleet and operations; therefore, the performance specs and physical characteristics of the buses change.

SECTION 4. ROADWAY GRADES

Vehicle roadway grades are normally based upon vehicle performance characteristics for grade ascents or descents under fully loaded conditions.

4.1. DESIGN GUIDELINES

The design guidelines for grades on roadways designed for bus service are:

(1) Maximum sustained grade:

(a) 6% in uphill direction.

(b) 12% in downhill direction.

Where uphill grades approach 6%, a climbing lane may be considered. In general, a climbing lane is more likely to be required for trucks than for buses. To determine whether a climbing lane is required, refer to Chapter 3, “Elements of Design,” Vertical Alignment (Climbing Lanes) of the AASHTO publication “A Policy on Geometric Design for Highways and Streets,” latest edition.

(2) The grade should allow for uniform operation.

(3) Abrupt changes in grade should be avoided. They result in “bus overhang” and ground clearance problems. Vertical curves must be installed at all locations where a grade break occurs. The minimum length of a vertical curve should be 50’. Vertical curves may be omitted where the algebraic difference in grades does not exceed 2.0% for facilities with design speeds of 25 mph or less, or does not exceed 1.0% for facilities with design speeds between 25 mph and 40 mph. If the local agency having jurisdiction over the facility maintains design standards that exceed these standards, then the local agency standards will apply.

(4) The approach or departure angle between the pavement and the bus should not exceed 5 degrees. Angles greater than 5 degrees can result in bus “bottoming out.”

(5) “Drainage dips” and “speed bumps” must be avoided. SacRT will not provide service where these roadway conditions exist. Besides the potential for buses to bottom out, these features reduce bus travel speeds and cause discomfort to bus passengers.

SECTION 5. BUS RAPID TRANSIT SYSTEMS AND EXCLUSIVE BUS LANES

Several concepts and technologies are available to improve bus service and reduce travel times. These measures are an essential component of Express Bus and Bus Rapid Transit (BRT) systems.

5.1. BUS RAPID TRANSIT SYSTEMS

These systems are different from other modes of bus service by its service model which gives bus operations priority over general traffic. BRT and Express buses make fewer stops, generally operating from point-to-point rather than along a corridor. Routes are also typically longer than local bus routes, and nonstop segments are often located along major arterial streets and highways. These routes can take advantage of managed lanes on freeways. BRT is a bus service where portions of the line may operate in a separated right-of-way dedicated for public transportation use during peak periods and includes features that emulate services provided by light rail fixed guideway public transportation systems. These may include defined stations, transit signal priority, high-frequency bi-directional services for a substantial part of weekdays and weekend days, pre-board ticketing, platform level boarding, and separate branding.

5.2. TRANSIT PRIORITY MEASURES

These systems effectively utilize a toolbox of improvements and transit priority measures applied to vehicles, stops, rights-of-way, and operating plans to provide better service. Transit priority measures seek to improve bus service by reducing the in-vehicle component of travel time by giving buses priority over other types of vehicles including reserved bus lanes and priority treatment for buses at traffic signals. The planning and implementation of bus priority measures works best in urban areas with a high concentration of bus services, high levels of traffic congestion, and good community support for transit service. To be successful, transit priority measures must be coordinated with the local jurisdictions responsible for traffic control and roadway planning and operations.

Some of the most common tools and measures are described below:

5.2.1 Vehicles – Vehicles used in BRT systems have characteristics to distinguish them from other buses in the fleet, including the following features:

- Kneeling (i.e., ability to lower the floor of the bus so it is closer to level with the boarding platform)
- Multiple-door boarding and alighting
- “Branded” exteriors that are distinctive and consistent with appearance of stations

- Larger size (e.g., 60-foot articulated buses)

5.2.2 Limited Stop Spacing – Express bus and BRT routes typically feature longer stop spacing than traditional local bus service. Shorter-distance BRT routes typically have stop spacing of 1/4 to 1/2-mile. Longer-distance BRT routes may have longer stop spacing, more like that of light rail e.g., a half-mile or mile apart. This allows for faster and more reliable service. Placing stops at the busiest locations (including transfer points), can keep most riders close to their bus stop.

5.2.3 Exclusive Bus Lanes and Bus Only Rights-of-Way - In a full BRT system, buses are partially or fully separated from traffic to improve speed and reliability through dedicated running ways and exclusive bus lanes. Refer to Section 5.2: Exclusive Bus Lanes for further guidance on Exclusive Bus Lanes. These dedicated lanes can be signed and include distinctive pavement treatment.

5.2.4 Traffic Signal Priority and Queue Jumpers – Preferential treatment of buses at intersections can involve the extension of green-light time or actuation of the green light at signalized intersections upon detection of an approaching bus.

5.2.5 Enhanced stops - Full BRT stops include amenities such as real-time arrival information, maps, and ticket vending machines for prepaid boarding. Stops may also have raised platforms to enable level or near-level boarding. Together, prepaid boarding and level boarding can greatly speed up the loading and unloading process, further improving speed and reliability.

5.3. EXCLUSIVE BUS LANES

An exclusive bus lane, also referred to as a dedicated bus lane, is one lane of a roadway reserved for the use of buses, usually during peak hours, though it may also be reserved all day.

The advantage of an exclusive lane is that it segregates the bus from, and permits it to bypass, heavily congested traffic on roadways. This results in significant time savings for the bus patron, which increases the attractiveness of public transit when compared to a private automobile. The effectiveness of an exclusive bus lane, however, depends on the level of enforcement.

By reducing operating time per route, exclusive bus lanes also decrease bus operating costs and may allow for increased service frequency, further improving the attractiveness of transit.

5.3.1. Placement Guidelines

Exclusive bus lanes are typically applied on major routes with frequent headways or where traffic congestion may significantly affect reliability of service.

Exclusive bus lanes can be created on existing roadways or incorporated into new roadways. This can be accomplished by any one of the following:

- Eliminating the curb parking lane and reserving it for buses.
- Reserving an existing traffic lane on multi-lane, one-way arterials.
- Reserving an entire street for exclusive bus operations.

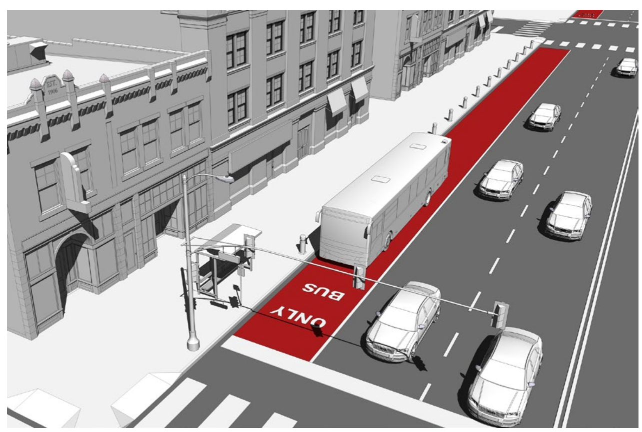
Exclusive bus lanes are warranted under the conditions listed below:

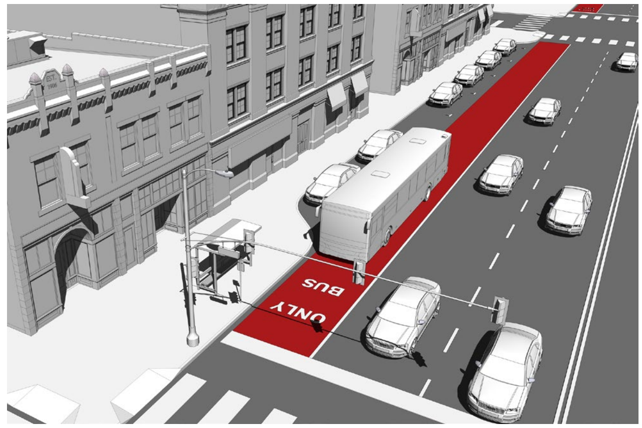
Where volumes are at least 15 buses per hour per direction
On BRT routes or similar lines where SacRT has determined to make major investments

Exclusive bus streets may be considered when there are at least 30 buses per hour in the peak period along the street. They are particularly suited for streets along buildings with commercially oriented frontage.

Exclusive bus lanes may be in various locations within a street. Examples of exclusive bus lanes include the following:

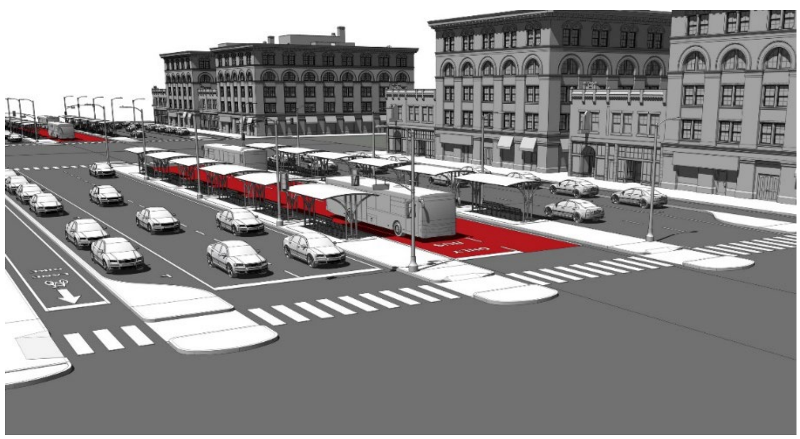
- Curbside bus lanes - Typically used on major routes and arterials with frequent headways or where traffic congestion may significantly affect reliability. Curbside lanes run along the existing curb. "Bus Only" pavement markings should be used to emphasize the lane and deter other drivers from using it. Strict enforcement is required for curbside bus lanes to prevent encroachment of the lane through double parking, delivery vehicles and drop offs. The minimum width of a curbside bus lane is 11'.





- Offset bus lanes - Typically used on major routes and arterials with frequent headways or where traffic congestion may significantly affect reliability. Offset lanes replace the rightmost lane on a street that allows parking. Strict enforcement is required for curbside bus lanes to prevent encroachment of the lane through double parking, delivery vehicles and drop offs. Bus bulbs should be installed to provide access directly to the bus. The minimum width of an off-set bus lane is 10’.

- Median bus lanes - Typically used on major routes and arterials with frequent headways or where traffic congestion may significantly affect reliability. Median bus lanes are applied in the center of the roadway and paired with accessible transit stops in the median. The minimum width for a median bus is 11’. Median boarding islands are required at each bus stop. These stops must be fully accessible and lead to safe, controlled crosswalks or crossings.



- Contra-flow bus lanes - Typically applied to bus routes to create strategic, efficient connections rather than as a continuous application along a corridor. A 2-lane wide section of 22’-24’ is preferred. Contra-flow bus lanes should include “One-Way Except Buses” sign. A double yellow centerline marking or a 3’-minimum buffer marking should be applied to separate contra-flow bus traffic from opposing traffic. “Bus Only” markings should be applied, and traffic signal modifications are required to reflect two-way bus flow.

5.3.2. Design Guidelines

5.3.2.1. Lane Width

On urban streets:

- Recommended width: 12’
- Minimum width: 11’

Independent of normal roadway facilities:

- For one-way operation: 18’ (to allow one bus to pass another)
- For two-way operation: 25’

The gutter section adjacent to the pavement should not be considered as part of the bus lane.

Figure 5-1 illustrates recommended bus lane widths for curbside bus lanes.

5.3.3. Pavement Design

In designing the pavement for an exclusive bus lane, the following factors should be considered:

- Soil conditions.
- Pavement material strengths.
- Bus axle weights.
- Anticipated bus volumes.
- Bus operating speeds.

It is recommended that a dowel jointed concrete pavement be used for exclusive bus lanes. As a minimum, the pavement structural section will be as specified in Section 7.4.4, “Bus Stop Pavement.”

The standard pavement design guidelines as set forth in the Caltrans Highway Design Manual are recommended by SacRT for the design of pavement sections involving bus operations.

5.3.4. Signage and Delineation

All signing and striping must be in accordance with the latest edition of the California Manual of Uniform Traffic Control Devices (MUTCD).

Bus lanes should be delineated by:

- Use of solid white 8”–10” wide, thermo-plastic striping. Other materials with similar wear-resistant properties may be used.

- Use of painted pavement may be applicable to fully exclusive bus lanes. Discussion with the local jurisdictional agency should be held to confirm the use of colored pavement.
- Portable cones when the lane is exclusive for only a short period during the day (e.g., the peak period only).

Overhead signing should be used over bus lanes to indicate to other traffic that it should yield to buses.

Figure 5-2 illustrates recommended signing for exclusive bus lanes.

5.4. AUTOMATIC VEHICLE LOCATING SYSTEMS

One of the advanced technologies used in BRT and sometimes in conventional bus operations is Automatic Vehicle Location systems (AVL). These systems track transit vehicles against their designated route schedules. AVL is often integrated with other systems including:

- Computer Aided Dispatch (CAD)
- Automatic Voice Annunciation (AVA) of key bus stops
- Automatic Passenger Counters (APCs)
- Real-time bus location, e.g., through the General Transit Feed Specification Real-Time extension (GTFS-rt)
- Electronic fare collection, such as smart cards (e.g., the Connect Card system)
- Transit Signal Priority (TSP)
- Local jurisdiction’s central traffic control center, capable of adjusting signal timing to maintain route schedules

5.5. PASSENGER/CUSTOMER INFORMATION

In addition to the standard amenities associated with other bus stop locations including basic signs, route maps, and schedules, another technology SacRT implements is real time bus arrival information. This information utilizes AVL systems to notify passengers when the next bus will arrive. Real time displays are typically only installed at bus stops with shelters or at transit centers.

SECTION 6. BUS PRIORITY TRAFFIC CONTROLS

Bus priority traffic controls include Queue Jumps and Transit Signal Priority (TSP). TSP involves alterations to a normal traffic signal cycle to permit buses to progress through an intersection with reduced delay by either extending an existing green light or terminating an existing red light.

Bus priority traffic controls have the potential to significantly reduce bus operating time on corridors where signal delay is a large fraction of total delay and variation in running times.

6.1. PLACEMENT GUIDELINES

Bus priority traffic controls should generally be considered wherever they are not constrained by pedestrian clearance or signal network constraints.

Bus priority traffic controls are recommended as follows:

(11) On roadways with bus traffic volumes of 5 or more buses per hour during peak periods.

(12) To allow bus ingress and egress to exclusive bus lanes, park-and-ride facilities, transit centers, and light rail stations.

(13) To accommodate special bus turning movements, such as:

- (a) At nearside stops where traffic lane is dropped on the other side of the intersection.
- (b) When a lane change must be made in a short distance (i.e., from a nearside bus stop to a left-turn lane).
- (c) When emerging from a bus turnout.
- (d) When buses are permitted to make right or left turns where such are normally prohibited.

6.2. DESIGN GUIDELINES

Bus priority traffic controls should adhere to standard traffic control device design criteria. In addition, a bus priority traffic control system should:

- Be coordinated with the design guidelines of the facility, movements to and from which it is installed to assist (e.g., exclusive bus lanes, queue jumpers, shared right turn lanes, ingress and egress points to transit centers, park-and-ride lots, etc.).

- Be considered when high-frequency bus routes have an average headway of 15 minutes or less.
- Be considered when forecasted traffic volumes exceed 500 vehicles per hour in the curb lane during peak periods and right turn volumes exceed 250 vehicles per hour during peak periods.
- Be considered when the intersection operates at an unacceptable level of service (defined by local jurisdiction).

6.2.1 Bus Priority Treatment - Queue Jumpers

Queue jumpers consist of nearside right turn lane and far-side bus stop and/or acceleration lane. Buses can use the right turn lane to bypass traffic congestion and proceed through the intersection. Additional enhancements to queue jumpers could include an exclusive bus only lane upstream from the traffic signal, an extension of the right turn lane to bypass traffic queued at the intersection, or an advanced green light indication allowing the bus to pass through the intersection before general traffic does. Figures 6-1 and 6-2 illustrate several options for queue jumpers.

a) Queue Jumper with Acceleration Lane
This option includes a nearside right turn lane (buses excepted), a nearside bus stop, and an acceleration lane for buses with a taper back to the general purpose lanes (Figure 6-1). The length of the acceleration lane is based on speed and should be designed by an experienced engineer.

b) Queue Jumper with Farside Bus Stop
This option may be used when there is a heavy directional transfer to an intersecting transit route. Buses can bypass queues either using a right turn lane (buses excepted) or an exclusive bus queue-jump lane. Since the bus stop is located farside, a standard transition can be used for buses to re-enter the traffic lane (Figure 6-2).

c) Queue Jumper with Continuous Bus Lane
This option includes a nearside right turn lane or an exclusive bus queue-jump lane, a farside bus stop and a continuous bus lane extending to the next block or further, depending on bus circulation patterns. Right turns are allowable by general traffic from the bus lane (Figure 6-2).

Consider an exclusive nearside bus-only lane in addition to the nearside right turn lane when the right turn volumes exceed 400 vehicles per hour during peak periods. It is recommended that travel time and cost/benefit analyses be conducted during the planning stages of queue jumper implementation.

6.2.2 Traffic Signal Priority

Traffic Signal Priority (TSP) is a system designed to reduce delays in bus service due to excessive waits at intersection signals. There are two general types of systems.

a) Device-Based TSP - Depending on the program algorithm, a bus approaching a downstream traffic signal extends the green light or advances the cycle to green, either through transponders or other electronic communications means, to proceed through the intersection. The bus operator determines when signal priority is needed to maintain the bus schedule.
b) Software-Based TSP - A bus system equipped with an automatic vehicle location (AVL) system and/or with a real-time location feed (e.g., GTFS-rt) and advanced radio communications gives signal priority control to the operations center, where typically a computerized system determines bus adherence to schedule and automatically triggers traffic signals when needed).

6.3. TECHNOLOGICAL GUIDELINES

Municipalities planning traffic signal pre-emption projects should contact SacRT Systems Design Department for guidelines to ensure system compatibility.

SECTION 7. BUS STOPS

A bus stop is a curbside area specially designated for passenger loading and unloading. Bus stops are commonly identified by a bus stop sign, a red curb, and/or pavement markings. Complementary stops for both route directions are usually provided and connected by crosswalks to provide safe pedestrian connections to the stops in each direction. For off-street bus transfer facilities refer to Section 13: Transit Centers.

7.1. BUS STOP TYPES

The different types of bus stops and the specific conditions under which they are recommended are described below.

The following factors should be considered when selecting the type of bus stop:

- Adjacent land use and activities
- Passenger origins and destinations
- Pedestrian access, including accessibility for disabled patrons and their mobility device(s) (See Section 7.4.2)
- Bus route (e.g, bus turning movements at the intersection)
- Bus signal priority (e.g., extended green light suggests far side placement)
- Impact on intersection operations
- Intersecting transit routes and the potential for convenient transfers between routes, including routes of other transit operators
- Intersection geometry
- Parking restrictions and requirements
- Physical roadside conditions (trees, poles, driveways, etc.)
- Whether there is space for a turnout (if a turnout is required)
- Traffic control devices
- Location and presence of bicycle facilities (including bike share stations and corrals, bikeways and bike lanes)
- Type of service – BRT or Express Bus systems may include enhanced bus stops

Figure 7-1 illustrates the layout and dimensions for each of the bus stop types.

7.1.1. Far-side Stops

Farside stops are located beyond street intersections. Farside stops should be used wherever practical because they have several advantages over mid-block and nearside stops.

The advantages of far-side stops are:

(1) Creates shorter deceleration distances for buses since buses can begin their approach into the stop from the intersection.

(2) At signalized intersections, buses can take advantage of the red-phase in the traffic signal cycle time to pull out of the stop and reenter the traffic stream.

(3) Minimize interference by buses with traffic making right turns.

(4) Superior to mid-block and nearside stops for buses making left turns at intersections.

(5) Minimizes sight distance problems on approaches to intersection.

(6) Encourages pedestrians to cross the street behind the bus instead of in front of it.

7.1.2. Mid-Block Stops

Mid-block stops are located between roadway intersections. Mid-block stops must be accompanied by a pedestrian crosswalk. Mid-block is typically the least desirable location for a stop, because it takes the most curb space, and is the least operationally preferable.

Mid-block stops may be used when:

(1) Changes in route direction require a right turn and the curb radius is short.

(2) It is necessary to eliminate or reduce pedestrian street crossings at the intersections.

(3) Large numbers of passengers assemble at the bus stop, and it is necessary to avoid overcrowding at or near intersections.

(4) Right-turn pockets or driveways at the corner prevent a near-side stop.

(5) The bus needs to make a left turn, and would be unable to do so from a near-side stop.

7.1.3. Nearside Stops

Nearside stops are located immediately preceding street intersections.

Nearside stops are typically preferred over mid-block stops, but less desirable than far-side stops because they present less than desirable conditions for

(a) traffic making right turns; (b) pedestrians crossing in front of buses into traffic; and (c) buses waiting in travel lanes to enter the stop.

Nearside stops are more acceptable at stop sign-controlled intersections because the bus will always have to come to a stop for the stop sign, and by serving customers nearside the intersection, the bus avoids having to make a second stop farside the intersection.

At signalized intersections, far-side stops are much preferred, because near-side stops can cause a bus to miss a green light. Also, at stops where the bus pulls out of traffic to serve the bus stop, re-entry is much easier farside a signalized intersection, where a bus can take advantage of a red phase, than nearside.

Nearside stops may also be preferable to farside stops in settings (typically urban) with in-lane bus stops (i.e., where the bus stops in traffic). Stopping the bus in-lane far-side of an intersection can cause intersection gridlock. Whereas stopping the bus in-lane nearside an intersection may delay traffic behind the bus, but does not obstruct the intersection, and is an effective way for the bus to avoid delay re-entering traffic in lower-speed, higher-volume urban corridors.

In urban areas with street parking, nearside in-lane stops can be particularly attractive, if the sidewalk is widened to the width of the parking lane. This is the design solution that consumes the least amount of street parking, in areas where parking is typically at a premium. At the same time, it provides a larger dedicated waiting area for transit customers in areas that often have high ridership, and separates them from passersby on the sidewalk.

7.1.4 Temporary Bus Stops

Where bus stops are located at an existing undeveloped location (no existing sidewalk, curb and/or gutter) a temporary bus stop loading/unloading area must be constructed with an accessible pathway installed to connect pedestrians to an existing sidewalk or intersection. Additional safety means (including but not limited to: lighting, high visibility markings or reflectors, etc.) and signage must be installed.

Figure 7-2 illustrates the layout and dimensions for a typical unimproved temporary bus stop location.

7.2. PLACEMENT GUIDELINES

Bus stops should be located in the curb lane on roadways. They may also be located in parking lanes and bicycle lanes.

7.2.1. Bus Stop Spacing

For local bus service, it is important to space bus stops close enough for accessibility, especially when the connecting sidewalk network is poor, but sufficiently far apart to avoid stopping more frequently than needed. Stopping frequently increases passenger travel time and bus trip time, involves more wear and tear on the buses, and contributes to traffic congestion. Recommended bus stop placements are shown in Table 7.1.

TABLE 7.1: LOCAL STOP SPACING

Environment	Spacing Range	Typical Spacing
Rural	1,000’ to 2,640’	1,250’ (0.25 miles)
Suburban	800’ to 1,320’	1,000’ (0.2 miles)
Urban (Central City)	400’ to 1,260’ (1-3 blocks)	800’ (2 blocks)

Extreme placement distances may be considered on a case-by-case basis depending on the density of the market area served.

In many suburban and rural industrial settings, where streets are wide, speeds are high, and/or traffic volumes are high, stop spacing will often be longer than desired due to lack of marked crossings.

Bus Rapid Transit (BRT) and limited stop service will have longer stop spacing, as discussed in Section 5.

Longer-distance BRT and/or freeway-oriented express bus service may be designed less around on-street bus stops and more around Park-and-Ride lots, regional transit centers, regional bus and light rail transit stations, etc.. Please consult the APTA Recommended Practice “Bus Rapid Transit Service Design” for further information on station/stop spacing.

As a general guideline, at the beginning of routes, when most activity is customer pick-up, and the bus is not yet full, there is less to be gained from longer stop spacing, because there are fewer riders on the bus who are disadvantaged by the delay from additional stops. The max load point and middle sections of a route, where passenger loads are highest, are where more riders are delayed from excessive stops, and where it is therefore more advantageous to have longer stop spacing. At the end of the route, as loads decrease, closer stop spacing ceases to be a detriment to as many riders (because there are fewer through-riders remaining on the bus) and increasingly is of value to customers, who individually prefer to be dropped off closer to their own destinations. Therefore, it is the middle sections of routes that tend to benefit most from longer stop spacing, and closer stop spacing tends to be more appropriate at the ends of routes (often in the central downtown and in suburban residential neighborhoods).

7.3. GENERAL CONSIDERATIONS

Two of the most critical factors in bus stop placements are safety and avoidance of conflicts that would otherwise impede bus, car, bicycle or pedestrian flows.

The ability to comply with ADA guidelines is typically the first consideration in bus stop site selection. In selecting a site for placement of a bus stop, the need for future passenger amenities is an important consideration. If possible, the bus stop should be located in an area where typical improvements, such as a bench or a passenger shelter, can be accommodated in the public right-of-way. The final decision on bus stop location is dependent on several safety and operating considerations that require on-site evaluation, including the following:

Safety and Accessibility

Passenger protection from passing traffic and bicyclists
Access for people with disabilities
All-weather surface to step from/to the bus
Proximity to crosswalks and curb ramps
Convenient passenger transfers to routes with nearby stops (preferably same-stop, around-the-corner, or at least in line-of-sight, with minimal street crossings required, and minimum walking distance from the corner)
Proximity of stop for the same route in the opposite direction (i.e., stops are preferably built as pairs)
Physical comfort of the waiting environment, including lighting (see Section 19), noise levels, shade from nearby trees or buildings, places to sit, and clear space near the stop
Visibility of the waiting customer
Appropriateness of adjacent land use (i.e., preferred sites include in front of retail establishments, offices, apartments, public buildings or parks, and religious establishments; SacRT tries to avoid siting bus stops and especially vertical amenities in front of outdoor dining, and historic or highly ornamented building frontages)
Park-lets, bike corrals, etc. will require same clearance requirements as for parking lanes

Operations:

Adequate curb space
Interaction of a stopped or moving bus with other motorists, especially other motorists pulling into or out of nearby driveways and buses exiting or re-entering traffic
Interaction of a stopped or moving bus with bicycles, especially weaving movements when a bus moves from the travel lane to the curbside, crossing or sharing space with a bicycle lane
On-street parking and delivery zones
Bus routing patterns (e.g., left or right turns near the bus stop)

Directions (i.e., one-way) and widths of intersection streets
Types of traffic controls (signal, stop, or yield)
Volumes, speeds, and turning movements of other traffic
Width of sidewalks and sidewalk alignment (separated from or attached to curb)
Pedestrian activities through intersections
Proximity and traffic volumes of nearby driveways

7.4. DESIGN GUIDELINES FOR BUS STOPS

7.4.1. Bus Stop Length

Number of Berths

The curb space required for an on-street bus stop normally includes not only the curb adjacent to the stopped bus, but clear space in front and behind the bus, which altogether, comprises a bus stop zone. Where street parking is present, the boundaries of a bus stop zone will typically be marked by No Parking signs.

The amount of curb space needed for a bus stop zone depends on the number of buses to accommodate as well as whether the stop is near-side, far-side, or mid-block.

Most on-street bus stops need to accommodate only one bus at a time. Multiple spaces are needed when it is likely that there will be multiple buses present at the same time, e.g., due to multiple routes, higher frequency, or longer dwell times. Longer dwell times at non-terminal stops can occur due to frequent wheelchair boardings, heavy school or commuter loads, single-door buses, time points (where the bus will have to wait, if it is ahead of schedule), and transfer points (where the bus often waits for transferring customers).

Linear, on-street bus stops function less effectively when they are multiple- space stops due to (1) difficulty for customers to predict where the desired bus will stop, (2) buses obstructing one another due to random arrival times, (3) underuse of space during lower-volume off-peak hours.

If more than three spaces or berths are needed at a single on-street bus stop, an entire-block bus stop, with designated berths, is preferable. Designated berths typically require at least 150 feet of curb space per berth (like a mid-block stop) so each route can reach its berth even if other buses are present upstream and downstream.

If more than three berths are needed at several stops in a row, it may be preferable to move to a skip-stop regime (i.e., where routes stop only at every other stop along a corridor) or to simply realign some of the routes to a parallel street.

End-of-route (i.e., terminal) bus stops typically have scheduled wait time. When headways are thirty minutes or more, end-of-route wait time will usually be less than the headway between buses, so one berth per route will usually be sufficient. But when frequency is every fifteen minutes or better, scheduled wait times at the end-of-route may often exceed the headway between buses, so a single bus route may need multiple spaces.

(Also see Bus Berth, Section 14).

Table 7.2 presents suggested bus stop capacity requirements based on peak-hour bus volumes. Exceptions can be made based on the circumstances described above.

TABLE 7.2: BUS BERTH REQUIREMENTS FOR ON-STREET NON-TERMINAL BUS STOPS	
Peak-Hour Bus Volume	Required Berths Per Bus Stop
1 to 20	1
21 to 40	2
41 to 60	3
More than 60	Skip-Stop or Realign Route

Bus Stop Length

Minimum bus stop lengths for specific bus stop types are provided on the following page and are illustrated in Figure 7-1. The dimensions illustrated in the figure assume parking prohibitions are in place and are enforced the entire length of the bus stop.

For standard transit buses, 40 feet is needed for the bus itself, plus clear space upstream and downstream. For re-entry to traffic, on higher-speed rural and suburban roads, 50 feet of downstream clear space is required, measured from the sign post (i.e., front of stopped bus). For pulling out of traffic and up to the curb, 60 feet of clear space is preferred, measured from the tail of the bus. Altogether, this amounts to 150 feet of curb space, all of which will need to have parking removed for the bus stop zone for a mid-block stop.

For nearside and farside stops, clear space for pulling to the curb or re-entering traffic is not needed downstream or upstream, respectively (since the intersection can be used for the bus's lateral movement). Low-volume driveways at either end of the bus stop zone can also be used as effective clear space. High-volume driveways should typically be avoided , especially downstream of the bus stop, due to line-of-sight issues. Nearside and farside stops both add 5 feet of clear space requirement between the bus and the crosswalk.

Other modifiers to curb space requirements include:

- On lower speed streets, the clear space needed downstream of the signpost on a far-side or mid-block stop can be reduced from 50 to 25 feet.

- Farside bus stops require an additional 25 feet of curb space, from the crosswalk to the tail of the stopped bus, if (a) receiving a bus making a right turn (so the bus can pull squarely to the curb), (b) far side a high-volume or high-speed right turn (to reduce rear-end collisions), or (c) if on a higher speed suburban or rural corridor (for bus deceleration).

When, the bus stop sign post and pad cannot be positioned optimally close to the intersection (e.g., because of trees or other obstacles) adjust all dimensions accordingly. Parking removal will typically have to be rounded up or down to the length of a parking stall, which is around 25 feet.

Curb space in front of and behind the bus may also be rounded up or down to the nearest street parking stall, which typically measures around 25 feet long.

TABLE 7.3: MINIMUM BUS STOP LENGTHS FOR ON-STREET BUS STOPS WITH STREET PARKING[1]

Bus Stop Type	Minimum Bus Stop Length (Urban)	Recommended Bus Stop Length (Suburban or Rural)
Farside Stops: buses make right turn	90’	115’
Farside Stops: buses do not make right turn	70’	120’
Mid-block Stops	125’	150’
Nearside Stops	105’	105’
Notes: 1. For each additional bus berthadd 50’ for a standard 40’ long bus, or 70’ for a 60’ articulated bus.		

The bus stop dimensions allow SacRT buses to leave the stop without passing over the centerline of the street. In situations where stopping in travel lanes is prohibited, or where speeds or bus volumes are high, a bus turnout may be necessary (see Section 8, Bus Turnouts).

Bus stop length should assume that buses have front bicycle racks deployed, which extend past the front of a bus by 3’ and requires an additional 2’ to 3’ clear for the patron to load the bicycle from the front of the bus.

Protected Bicycle Lanes

Buffered bicycle lanes, parking-protected bicycle lanes, and other similar treatments can result in the bus having to make a greater lateral movement from the #1 lane to the curb, and back to the #1 lane from the curb. This results in the need for more curb space at the bus stop.

Example:
A parking-protected bicycle lane may result in the #1 lane being 16 feet from the curb face. Compared to a standard 8-foot wide parking lane, the bus has to make twice as long a lateral movement. For a near-side stop that typically requires 60 feet of clear space from the tail of the bus, the requirement would double to 120 feet, for a total requirement of 165 feet (40 feet for the bus, 120 feet for taper, and 5 feet of clear space to the crosswalk). For a far-side stop with 50 feet of downstream clear space typically needed from the signpost, the requirement would double to 100 feet for a total of 145 feet (40 feet for the bus, 100 feet for the taper, and 5 feet of clear space to the crosswalk).

7.4.2. Bus Stop Width

The minimum width of the bus stop is dependent on the type of facility provided, location, and extent of adjacent facilities. At a minimum the following must apply:

- All pathways and sidewalks should be a minimum of 5’ wide (’ is preferred), and a minimum of 8’ wide in areas of heavier pedestrian traffic.
- A concrete pad (minimum 6’ parallel to curb by 8’ perpendicular to curb, or 5’ parallel by 9’ perpendicular (10’-3” preferred)) must be provided at every bus stop (see Figure 7-6). Concrete pad must be clear of all obstacles.
- Where bus stops are located in areas with planter strips, the planters must be interrupted for a concrete pedestrian pad 8’ wide (which may overlap sidewalk) by 26’ long; 30’ long is preferred; at a minimum provide the 5’ or 6’ pad length parallel to the curb with a second pad measured 26’ from the first, outside to outside). Concrete pad must be clear of all obstacles.

7.4.3. Bus Stop Curbs

Curbs at bus stops must be minimum 4” and maximum 7½” high to facilitate passenger boarding and alighting (see Appendix A-1, Bus Vehicle Specifications: First Step Distance to Ground). If the curb is too high, it will interfere with the operation of the wheelchair lift or ramp and front kneel feature of buses. Curbs must have a near vertical face and must not be mountable by traffic.

7.4.4. Bus Stop Signing and Striping

Bus stop zones must have street parking removed with signs indicating “No Parking” or “No Stopping Except for Buses.” All bus stops will have "No Smoking" signage located in the bus shelter.

Bus stops must have a paved area at the point of loading from the sidewalk for accessibility, and be adjacent to street lighting. Sidewalks at all bus stops should also be provided with wheelchair-access ramps at crosswalk locations.

Figure 7-3 illustrates typical bus stop signing and striping requirements.

The following are general guidelines for bus stop signs, sign locations and clearances (see also Section 18 – Signage for detailed sign information):

- In no case should any part of the post or the sign be located closer than 24” from the curb face.
- The bus stop sign should be located at the front of the bus stopping area opposite the detectable warning tile guide strip.
- A detectable warning tile guide strip (4” wide) must be placed from the back of the sidewalk to the back of the curb opposite the bus access point.
- Where bus stop posts do not have tactile route plaques the bus stop signs should be mounted on square unistrut posts. This is useful for visually impaired patrons to locate the exact location where the bus will stop.
- All bus stop signs include a Caltrans Type R-26 “No Parking” sign mounted on the same pole facing the street.
- The bottom of the sign should be 7’ above grade (6’-8” minimum), and the top of the sign must be no higher than 10’ above grade.

7.4.5. Bus Stop Pavement

The pavement structural section at bus stops must be of sufficient strength to accommodate repetitive bus axle loads and turning action forces exerted by buses. Exact pavement designs will depend on site-specific conditions, the traffic index and in-situ subgrade support.

Where the bus stop falls within the jurisdiction of a local agency and that agency maintains standards that exceed those stated below, then the local agency’s standards will apply.

SacRT recommends using concrete pavement for bus stops where the volume of bus traffic is high (>10 buses per day), or where the general traffic composition comprises a high percentage of heavy vehicles and for all bus turnouts.

The *minimum* concrete pavement section will be as follows (see Figure 7-4)

- 9” PCC dowel jointed fiber reinforced concrete pavement
- 12” Class 2 AB (depending on subgrade support)
- Transverse and Longitudinal joints must be constructed per the latest approved Caltrans Standard Plans and Specifications

Where the number of buses is lower (≤10 buses per day), the minimum asphalt concrete pavement section will be as follows (see Figure 7-5):

- 6” AC Type B
- 8”–14” Class 2 AB (depending on subgrade support) and traffic index.

7.4.6. Bus Stops with Bicycle Facilities

Ideally, bike lanes will not operate along the same side of the roadway as high-frequency bus routes, and will use different sides of the street or different streets. However, on many corridors, this division between buses and bicycles is not possible. In these cases, bus stops present a challenge among interactions with cyclists, buses, and those accessing bus stops.

Along streets where Class II Bike Lanes occur and there are not parking lanes, if bus and bicycle volumes are low, and visibility is sufficient, the bus may stop in the bicycle lane and partly in the #1 lane. Bus turnouts may be used when necessary (e.g., if speeds or visibility do not allow the bus to stop partially in-lane). Where buses stop in bicycle lanes, pavement markings and signage should be provided to alert bus drivers and cyclists of the potential conflicts.

For Class IV Bikeways (also referred to as Separated Bike Lanes or Cycle Track) where feasible, separation of bicycle and bus traffic should occur at bus stops by use of island bus stops, where space permits, such that bicyclists are channeled between the sidewalk and the bus boarding island. This design eliminates weaving movements or “leapfrogging” of buses and bicycles, thus improving cyclist comfort and bus operating speeds. This type of design reduces bus-bicycle conflicts but does create potential pedestrian-bicycle conflicts for pedestrians who must cross from the sidewalk, across the separated bike lane, to access the island bus stop. This potential pedestrian conflict can be mitigated through design and the provision of discrete crossing locations. Visually impaired pedestrians accessing the bus stop should be directed to the crosswalk(s) using detectable warnings and guidance strips.

The following scenarios of bus and bike lane interactions commonly occur (see Figures 7-7 through 7-15):

- Scenario A: Island Platform within Travel Lane and Bike Lane (Bike Lane Alignment Shift)
- Scenario B: Island Platform within Travel Lane Separated Bike Lane (No Separated Bike Lane Alignment Shift)
- Scenario C: Island Platform within Parking Lane or Shoulder (Separated Bike Lane Alignment Shift)
- Scenario D: Island Platform (Separated Bike Lane Alignment Shift)
- Scenario E: Sidewalk Boarding (No Island Platform, Bus Stop adjacent to Separated Bike Lane)
- Scenario F: Near Side Bulb-Out within Parking Lane
- Scenario G: Near Side Island Platform within Parking Lane and Bike Lane (Bike Lane Alignment Shift)

- Scenario H: Far Side Bulb-Out within Parking Lane
- Scenario I: Far Side Island Platform within Parking Lane and Bike Lane (Bike Lane Alignment Shift)

Scenario A: Island Platform within Travel Lane and Bike Lane Shift

In this alignment the island occupies the parking lane width and bike lane width, the bus stops in the travel lane, and the bike lane alignment is moved behind the transit island, however the curb line does not shift. This is typically used when lower volumes occur within the travel lanes and/or where insufficient space is available outside the roadway. The advantages include no removal of sidewalk space and minimal impacts to on-street parking.

Figures 7-7(a) and 7-7(b) shows typical mid-block layouts for this application. Key design elements include:

- The front end of the platform needs 6’ x 8’ minimum clear space to accommodate deployment of an accessible ramp from equipped buses.
- In circumstances without on-street parking, a narrower transit platform may be used so long as a 6’ x 8’ level space can be maintained.
- Minimum crosswalk width of 6’, consider a wider crosswalk dependent on transit boardings. Ideally, the crosswalk is placed at both ends of the boarding island, or alternatively at the transit vehicle exit point. If this transit stop is at a far side street crossing, the bike lane crosswalk should be placed at the start (upstream) end of the platform and included with the full street crossing. If at a near side crossing, the crosswalk should be at both ends if possible, or at least at the downstream end.
- Use of raised crosswalks should be discussed with the local agency with jurisdiction at this location. A raised crosswalk with 1:10-1:25 slopes is preferred to eliminate the need for curb ramps and to act as a warning for cyclists of pedestrian crossing. Drainage should be evaluated either side of the raised crosswalk.
- If a raised crosswalk is not selected, curb ramps with a marked crosswalk should be used. Use of green colored surface treatment should be confirmed with the local agency.
- Each end of each crosswalk should have a detectable warning surface.
- A guidance strip should be placed guiding passengers from the bus accessible boarding space to the crosswalk and from the sidewalk to the bus boarding area.

Scenario B: Island Platform within Travel Lane and Separated Bike Lane

In this alignment the island occupies the parking lane width, the bus stops in the travel lane, and the separated bike lane and curb line do not shift. This is typically used when lower volumes occur within the travel lanes and/or where insufficient space is available outside the roadway. The advantages include no removal of sidewalk , and minimal impacts to on-street parking.

Figures 7-8(a) and 7-8(b) shows typical mid-block layouts for this application. Key design elements include:

- The front end of the platform needs 6' x 8' minimum clear space to accommodate deployment of an accessible ramp from equipped buses.
- In circumstances without on-street parking, a narrower transit platform may be used so long as a 6' x 8' level space can be maintained.
- Minimum crosswalk width of 6', consider a wider crosswalk dependent on transit boardings. Ideally, the crosswalk is placed at both ends of the boarding island, or alternatively at the transit vehicle exit point. If this transit stop is at a far side street crossing, the bike lane crosswalk should be placed at the start (upstream) end of the platform and included with the full street crossing. If at a near side crossing, the crosswalk should be at both ends if possible, or at least at the downstream end.
- Use of raised crosswalks should be discussed with the local agency with jurisdiction at this location. A raised crosswalk with 1:10-1:25 slopes is preferred to eliminate the need for curb ramps and to act as a warning for cyclists of pedestrian crossing. Drainage should be evaluated either side of the raised crosswalk.
- If a raised crosswalk is not selected, curb ramps with a marked crosswalk should be used. Use of green colored surface treatment should be confirmed with the local agency.
- Each end of each crosswalk should have a detectable warning surface.
- A guidance strip should be placed guiding passengers from the bus accessible boarding space to the crosswalk and from the sidewalk to the bus boarding area.

<u>Scenario C:</u> Island Platform within Parking Lane or Shoulder (Separated Bike Lane Alignment Shift)

At locations where it is desired to have the bus move out of the flow of traffic, a separated bike lane may need to bend around the bus island/platform. In this alignment the bus moves out of the travel lane and occupies the parking lane width, the separated bike lane and curb line are shifted into the sidewalk area. This is typically used when higher volumes occur within the travel lanes and where sufficient space is available outside the roadway. The advantage of this is that the bus is not stationary within a travel lane however the separated bike lane shift uses sidewalk space and there are additional impacts to parking.

Figures 7-9(a) and 7-9(b) shows typical mid-block layouts for this application. Key design elements include:

- The lateral shift of the separated bike lane must be designed based on the offset distance and bicycle design speed.
- Front end of platform needs 6’ x 8’ minimum clear space to accommodate deployment of accessible ramp from equipped vehicles.
- In circumstances without on-street parking or limited sidewalk space, a narrower transit platform may be used so long as a 6’ x 8’ level space can be maintained.
- Minimum crosswalk width is 6’, consider a wider crosswalk dependent on transit boardings. Ideally, the crosswalk is placed at both ends of the boarding island, or alternatively at the transit vehicle exit point. If this transit stop is at a far side street crossing, the bike lane crosswalk should be placed at the start (upstream) end of the platform and included with the full street crossing. If at a near side crossing, the crosswalk should be at both ends if possible, or at least at the downstream end.
- Use of raised crosswalks should be discussed with the local agency with jurisdiction at this location. A raised crosswalk with 1:10-1:25 slopes is preferred to eliminate the need for curb ramps and to act as a warning for cyclists of pedestrian crossing. Drainage should be evaluated either side of the raised crosswalk.
- If a raised crosswalk is not selected, curb ramps with a marked crosswalk should be used.
- Each end of each crosswalk should have a detectable warning surface.
- A guidance strip should be placed guiding passengers from the bus accessible boarding space to the crosswalk and from the sidewalk to the bus boarding area.

<u>Scenario D:</u> Island Platform (Separated Bike Lane Alignment Shift)

At locations where it is desired to have the bus move out of the flow of traffic, a separated bike lane may need to bend around the bus island/platform. In this alignment the bus moves out of the travel lane and occupies a “Bus Only” lane width, the separated bike lane and curb line are shifted into the sidewalk area. This is typically used when higher volumes occur within the travel lanes and where sufficient space is available outside the roadway. The advantage of this is that the bus is not stationary within a travel lane however the separated bike lane shift uses sidewalk space and additional right-of-way.

Figures 7-10(a) and 7-10(b) shows typical mid-block layouts for this application. Key design elements include:

- The lateral shift of the separated bike lane must be designed based on the offset distance and bicycle design speed.
- Front end of platform needs 6’ x 8’ minimum clear space to accommodate deployment of accessible ramp from equipped vehicles.
- In circumstances with limited sidewalk space, a narrower transit platform may be used so long as a 6’ x 8’ level space can be maintained.

- Minimum crosswalk width is 6’, consider a wider crosswalk dependent on transit boardings. Ideally, the crosswalk is placed at both ends of the boarding island, or alternatively at the transit vehicle exit point. If this transit stop is at a far side street crossing, the bike lane crosswalk should be placed at the start (upstream) end of the platform and included with the full street crossing. If at a near side crossing, the crosswalk should be at both ends if possible, or at least at the downstream end.
- Use of raised crosswalks should be discussed with the local agency with jurisdiction at this location. A raised crosswalk with 1:10-1:25 slopes is preferred to eliminate the need for curb ramps and to act as a warning for cyclists of pedestrian crossing. Drainage should be evaluated either side of the raised crosswalk.
- If a raised crosswalk is not selected, curb ramps with a marked crosswalk should be used.
- Each end of each crosswalk should have a detectable warning surface.
- A guidance strip should be placed guiding passengers from the bus accessible boarding space to the crosswalk and from the sidewalk to the bus boarding area.

<u>Scenario E:</u> No Island Platform (Bus Stop adjacent to Separated Bike Lane)

Where bus service is sufficiently infrequent (about four buses per hour or fewer) and/or where roadway width is constrained, bus stops may be designed to stop within the separated bike lane. When buses are present, cyclists merge left and pass buses boarding and alighting passengers. In this alignment there is no island/platform. The passengers board and alight from the sidewalk.

Figures 7-11(a) and 7-11(b) shows typical mid-block layouts for this application. Key design elements include:

- Buses pull up to stops along the curb, across the separated bike lane. Bus vehicles yield to through bicyclists.
- Additional pavement markings should be used within the conflict area to alert bus drivers, passengers and cyclists.
- Front end of platform needs 6’ x 8’ minimum clear space to accommodate deployment of accessible ramp from equipped vehicles.

<u>Scenario F:</u> Near Side Bulb-Out within Parking Lane; and <u>Scenario H:</u> Far Side Bulb-Out within Parking Lane

In this alignment the sidewalk tapers out and occupies the parking lane width, and the bus stops in the travel lane. This is typically used when lower volumes occur within the travel lanes and/or where insufficient space is available outside the roadway. The advantages include no removal of sidewalk space , and minimal impacts to on-street parking.

Figures 12 and 14 show typical near-side and far-side layouts respectively for this application. Key design elements include:

- Curb and gutter are transitioned over 10’. Drainage should be evaluated at taper to ensure no ponding is caused.
- Bulbed-out sidewalk should seamlessly tie back into existing sidewalk with the minimum back of walk radius of 18’ diameter.

Scenario G: Near Side Island Platform within Parking Lane and Bike Lane (Bike Lane Alignment Shift); and Scenario I: Far Side Island Platform within Parking Lane and Bike Lane (Bike Lane Alignment Shift)

In this alignment the island occupies the parking lane width and bike lane width, the bus stops in the travel lane, and the bike lane alignment is moved behind the transit island, with the curb line shifting. This is typically used when lower volumes occur within the travel lanes and/or where insufficient space is available outside the roadway. The advantages include no removal of sidewalk space and minimal impacts to on-street parking.

Figures 13 and 15 show typical near-side and far-side layouts respectively for this application. Key design elements include:

- The front end of the platform needs 6’ x 8’ minimum clear space to accommodate deployment of an accessible ramp from equipped buses.
- In circumstances without on-street parking, a narrower transit platform may be used so long as a 6’ x 8’ level space can be maintained.
- Minimum crosswalk width of 6’, consider a wider crosswalk dependent on transit boardings. Ideally, the crosswalk is placed at both ends of the boarding island, or alternatively at the transit vehicle exit point. If this transit stop is at a far side street crossing, the bike lane crosswalk should be placed at the start (upstream) end of the platform and included with the full street crossing. If at a near side crossing, the crosswalk should be at both ends if possible, or at least at the downstream end.
- Use of raised crosswalks should be discussed with the local agency with jurisdiction at this location. A raised crosswalk with 1:10-1:25 slopes is preferred to eliminate the need for curb ramps and to act as a warning for cyclists of pedestrian crossing. Drainage should be evaluated either side of the raised crosswalk.
- If a raised crosswalk is not selected, curb ramps with a marked crosswalk should be used. Use of green colored surface treatment should be confirmed with the local agency.
- Each end of each crosswalk should have a detectable warning surface.
- A guidance strip should be placed guiding passengers from the bus accessible boarding space to the crosswalk and from the sidewalk to the bus boarding area.

- Marked crosswalk for bicyclists as well as pedestrians through the intersection should be provided. Use of green colored surface treatment should be confirmed with the local agency.

7.4.7. Bus Stop Amenities

Several amenities should be provided depending on the usage of the bus stop and other factors. Table 7-4 below are suggested amenities based on the number of average daily boardings.

TABLE 7-4: RECOMMENDED AMENITIES BY DAILY BOARDINGS[1]

	Daily Boardings				
Feature	**<20**	**20-50**	**50-100**	**100-250**	**>250**
Public roadway/street	S	S	S	S	
Non-public roadway/street					O
Expanded sidewalk (>6')	O	O	S	S	S
Seating[2] (# benches)	O (1)	S (1)	S (1)	S (2)	S (>2)
Passenger shelter structure[3]		S	S	S	S
Electronic dynamic message		O	O	O	O
Timetable		O	O	S	S
Route map		O	S	S	S
System map		O	O	O	S
Braille signage	O	O	S	S	S
Trash receptacle			S	S	S
Emergency telephone			O	O	O
Individual bus bays					O
Park and ride			O	O	O
Red curbs	S	S	S	S	O
Bike racks			O	O	O
Bike lockers/parking facilities				O	O
SCR/FVM				O	O
Security Camera			O	O	O

Notes:

1. Bus stop signing and lighting are required at all stops. Refer to Sections 18 and 19 respectively for placement and design requirements.
2. Refer to Section 10 "Bus Benches" for placement and design guidelines.
3. Refer to Section 9 "Bus Shelters" for placemen and design guidelines.

S - Standard
O - Optional

Off-Street Facilities

Most bus stops should be situated on-street. This avoids time-consuming turning movements into and out of off-street facilities and avoids the cost of ownership, maintenance inherent with private facilities, as well as the loss of property tax revenue to local jurisdictions. When ridership at a stop is low, and passenger loads on the bus are high, the time penalty for detouring off-street is unattractive to riders. But as ridership at a stop grows, and especially if typical passenger loads on the bus are low (e.g., at the beginning or end of a route) the case for an off-street facility becomes greater. When daily boardings at a bus stop exceed 250, an off-street facility should be considered. In addition to providing a more comfortable waiting area for transit customers, an off-street facility also separates waiting transit customers from pedestrian traffic on the sidewalk, which may be desirable when both volumes are high. Note, however, that an off-street facility will typically result in buses frequently traversing a city sidewalk (to enter and exit the facility). In areas with heavy pedestrian activity on city sidewalks, this may be a considerable drawback.

Street Furniture
To keep maintenance costs reasonable, bus shelters are non-standard unless daily boardings are at least 20. Trash receptacles requires at least 50 daily boardings, otherwise, non-transit users of the trash receptacle will tend to be the majority users. For benches, there is no minimum required number of daily boardings; however, in all cases, physical space is usually a limiting factor.

Electronic Dynamic Message Signs
Digital signs with real-time bus arrivals and other info require at least 25 daily boardings. They are also typically installed only where a bus shelter already exists, providing a consistent mounting location and power supply. Other criteria for locating digital signs include the presence of multiple routes and higher-frequency service.

Other factors that should be considered when evaluating amenities at bus stops include:

- space available
- maintenance of facility
- availability of power and cell phone service
- visibility of stop
- requirements specific to the location where stop is located (local regulations, by-laws and ordinances)
- location of stop relative to adjacent properties
- location of environmentally sensitive areas in the vicinity
- equity in distribution of shelters and benches (Title 6 Requirements)

7.5. <u>BUS STOP FOR BRT SYSTEMS</u>

Bus stops for BRT systems or similar express bus systems should be enhanced or full station stops. BRT stops should be attractive, convey permanence and provide more substantial passenger amenities than those found in standard bus stops. They also offer higher capacity and are easy for passengers to identify and locate in a street environment. In addition, they may have enhanced security features.

Examples of branding at BRT stops: (Ontario-Canada, Los Angeles-CA, Kansas City-MO)

The decision of the type of facility will depend on anticipated usage, costs, right of way, and physical constraints. BRT stops typically have enhanced bus stop amenities and include the following:

- Raised boarding and alighting platform
- Shelter
- Fare collection facilities (optional)
- “Branded,” consistent with appearance of BRT vehicles
- Route maps and schedules
- Monument signage
- Security cameras
- Electronic Dynamic Message Signs
- High-quality, attractive, functional amenities
- Amenities consistent with high boarding volumes (>100/day) as shown in Table 7-4 above.

7.6. ACCESSIBILITY

Bus stops must have a paved area at the point of loading from the sidewalk for accessibility, should be adequately lighted, and must comply with the latest Title 24 and Americans with Disabilities Act (ADA) regulations in effect at the time the stop is constructed or most recently modified.

In addition to the length and width dimensions listed, the following minimum guidelines should be considered to provide safe and convenient pedestrian access to bus stops:

- Maximum slopes of all pathways, ramps must not exceed 5% (1' vertical over 20' horizontal).
- Maximum cross slopes of all pathways and ramps must not exceed 2% (1.5% to 1.75% recommended).
- Maximum slopes of all boarding areas must not exceed 2% (1.5% to 1.75% recommended) in any direction.
- A minimum horizontal clearance of 36" should be maintained in the boarding area between all obstructions.
- Curb ramps are needed at crossings where grade level change occurs.
- Curbs should maintain a constant height at bus loading areas to avoid stumbling.
- Bus passengers should cross a minimum number of streets at high-volume transfer locations.
- At bus stops where the potential for "jaywalking" exists, "No Pedestrian Crossing—Use Sidewalk" or "Use Crosswalk" signs should be placed if possible. However, where pedestrian volumes are high and the distance to the nearest crosswalk exceeds 200', a pedestrian crosswalk may be warranted. The designer should confirm the need for this with the SacRT Engineering Department. For specific site locations, installation of a median barrier or fence may be required to prevent unauthorized crossing of the street.
- For future development, sidewalks should be 8' wide where possible to provide pedestrian separation from automobile traffic. Sidewalks separated from traffic or on collector or local streets may be narrower but not less than 6' or as required by the local agency under whose jurisdiction the sidewalk lies, whichever is the greater.
- Adequacy of available street lighting should be assessed at bus stops for patron convenience and safety. Additional lighting may be warranted. A minimum illumination of 1.5 footcandles is required at all stops; see Section 19 - Lighting.
- New residential developments should consider breaks in walls between properties to allow pedestrian passageway to bus stops. A patron should not have to walk more than 1/4 mile to reach a bus stop.

7.7. LANDSCAPING

Landscaping at bus stops, bus turnouts and bus facilities should follow the guidelines set forth in Section 20 of these Guidelines. The planting of shade trees at bus stops is encouraged. The trees and landscaping must not cause a physical or visual obstruction for the transit users, pedestrians, bus operators, or other traffic.

SECTION 8. BUS TURNOUTS

A bus turnout is a bus stop located in a recessed curb area on a roadway, separated from moving lanes of traffic. Bus turnouts reduce automobile/bus conflict at stops; provide greater separation between traffic and pedestrians waiting for the bus; and may allow the bus to regain its travel speed in its reentry into traffic. It is identified similarly as a bus stop, with a red curb marking, pavement markings, and/or a "No Parking" sign.

Bus turnouts are disadvantageous to transit speed and reliability, compared to stopping in a curb-side travel lane, because turnouts require buses to wait for a break in traffic before resuming travel after a stop.

8.1. PLACEMENT GUIDELINES

Bus turnouts are preferred at the far side of an intersection although mid-block turnouts may be warranted at specific locations. Near side turnouts are discouraged because they tend to be used as right turn lanes by non-transit vehicles.

Bus turnouts should be considered after a case-by-case review when one or more of the following conditions are met:

- Typical traffic speeds are 40 miles per hour or greater.
- Typical dwell times are longer (e.g. 10 seconds or more) due to student loads, regular wheelchair boardings, schedule time points, or frequent transfers between routes.
- Bus stops in the curb lane are prohibited.
- Right-of-way width is adequate to allow constructing the turnout without adversely affecting sidewalk pedestrian flow.
- The stop location has a history of repeated traffic and/or pedestrian accidents associated with either automobiles or buses, and it is determined that a bus turnout could reduce the number of accidents.
- Bus stop is in an area where passenger demographics support a bus turnout (e.g. near an elderly care center)

In some cases, the local agency under whose jurisdiction the facility occurs may require bus turnouts at intersections for reasons other than transit (i.e., general intersection widening, lengthening of turn lanes, acceleration lanes, etc.).

8.2. DESIGN GUIDELINES FOR BUS TURNOUTS

8.2.1. Bus Turnout Dimensions

Figures 8-1 and 8-2 detail the design guidelines for bus turnoutsfor farside and mid-block bus stops. The taper rates are dependent on the design speed of the roadway. The intent is to provide sufficient acceleration/deceleration length to allow the bus to leave and enter traffic lanes at about the average traffic speed of the roadway.

Bus turnouts at stops where several bus routes converge and interface should be sized to accommodate more than one bus. Specific information with respect to the number and type of buses (i.e., standard, articulated, etc.) may be obtained from the SacRT Planning Department prior to design. The design guidelines for Bus Layover Areas (see Section 11) should also be considered in such cases.

Bus turnouts must be designed to provide safe conditions for passenger activity and entry and exit movements for buses (e.g., good visibility, adequate lighting, pavement in good repair, etc.).

The loading area, sidewalks, pathways, and ramps at bus turnouts must meet the requirements of Title 24 and ADA and at a minimum follow the guidelines as stated in Section 7.5, “Accessibility,” of these Guidelines.

8.2.2. Bus Turnout Pavement

All bus turnouts must be dowel-jointed concrete pavement in compliance with the latest approved Caltrans standard plans and specifications. Section 7.4.4, “Bus Stop Pavement,” of these Guidelines gives the minimum structural section to be used for concrete pavement within a bus turnout. Figure 8-3 illustrates the pavement and curb detail for a bus turnout.

SacRT recommends using concrete for bus turnout pavement construction. Concrete is stronger, more resistant to wheel rutting, and reduces maintenance costs.

The use of asphalt concrete pavement may be considered on a case-by-case basis. Major projects should consider the use of analysis by a soils engineer or review available City/County/State soils reports. Pavement design should be based on these reports.

SECTION 9. BUS SHELTERS

Bus shelters are covered, semi-enclosed waiting areas with benches at bus stops. Bus shelters offer protection from inclement weather conditions, provide for passenger comfort, and establish a transit presence within a local area.

9.1. PLACEMENT GUIDELINES

To avoid excessive maintenance costs, bus shelters are standard only where ridership is 20 boardings per day or greater, with exceptions:

Bus shelters should be installed where bus stops occur at the following locations:

In or near areas where medical facilities exist
In or near areas where there exists a high proportion of senior citizens
In or near areas where there exist a high proportion of disabled or visually impaired persons
In or near areas where education facilities exist, such as schools
In or near areas where a high number of potential users occur, such as sporting facilities, convention halls, and arenas

Bus shelters may be installed based on the average number of boardings using the guidelines in Table 9-1 below.

TABLE 9.1: GUIDELINES FOR INSTALLATION OF BUS SHELTERS AT BUS STOPS	
Location	**Boardings per Day**
Rural	≥20
Suburban	≥20
Urban	≥20

Bus shelters may also be installed at existing or proposed bus stops adjacent to specific developments by the developer/owner as a transit amenity, by advertising contractors based on advertising potential, or where funded by others or by grants. Such installations must be coordinated with SacRT. These structures are to be maintained by the above listed entities.

Bus shelters should meet the following minimum placement guidelines:

(1) Shelters located adjacent to buildings should be placed a minimum of 12” away from the building, wall or other obstructions to allow for cleaning.

(2) Shelters should not be placed where they obstruct sidewalks or access to and from transit vehicles.

(3) Shelters should not be placed where they obstruct visibility at street intersections or where vehicles exit onto an arterial from a private roadway or driveway.

Figures 9-1 illustrates standard bus stop designs with shelter placement for sidewalk and separated pedestrian pathway conditions respectively.

9.2. DESIGN GUIDELINES

Bus shelter designs can vary considerably, from a single, standardized structure, to a fully integrated design treatment when provided by developers or other sources (i.e., property owners, City, County, etc.). Bus shelters should, however, be easily recognizable as a bus stop and be consistent with the standard design specifications provided by SacRT, especially if SacRT is responsible for their maintenance.

Where architectural concerns inhibit this consistency, specific designs must be submitted to SacRT and will be reviewed on a case-by-case basis. All bus shelters, regardless of design, should meet the minimum guidelines given below:

(1) Bus shelters should be constructed of tough, weather-and-vandal-resistant materials (i.e., brick, metal, tempered glass, etc.) that do not require any special cleaning solvents, painting, repair tools, etc. Components requiring routine, time-based replacement should not be included. All components should be easily removable and replaceable to facilitate maintenance.

(2) Bus shelters must be constructed so as not to pose safety hazards to passengers or to other individuals.

(3) Free-standing shelters should be placed on a non-slip concrete pad sloped 2% max. (1’ vertical to 50’ horizontal) toward the roadway for drainage purposes. The minimum dimensions of the pad will be 12' x 10’.

(4) The concrete pad will consist of a minimum of 4” of PCC concrete on 6” Class 2 AB.

(5) Curb cuts and ramps should be provided for wheelchair access at all crosswalks and as required due to elevation changes in the vicinity of the bus stop.

(6) Minimum clearance of 4’ from the curb is recommended (8’ is desirable) for the front, sides, and rear for free-standing shelters to provide for wheelchair access. Where less than 8’ exists between

the face curb and any part of the shelter, a minimum accessible boarding area (6’ parallel to curb and 8’ perpendicular to curb, or 5’ parallel to curb and 9’ minimum (10’-3” preferred) perpendicular to curb) must be provided to the side of the shelter opposite the bus stop location or where the wheelchair-accessible door is located. See Figure 9-2 for details. Shelters should have an opening from grade to the bottom of the wall panel of at least 6” for ventilation, prevention of trash accumulation, and drainage.

(7) Roof and support structure of the shelter should be designed to hold a load of 40 pounds per square foot, and designed so that drainage is sloped away from the street side of the shelter.

(8) Benches installed in bus shelters must be of the size, style and materials specified in Section 10, Bus Benches of these guidelines. A companion wheelchair location must be provided within the shelter and with the wheelchair back in line with the bench back.

(9) Bus shelters may have bike racks (minimum Class III) which should be placed at the rear and should have a minimum allowance of 4’ on the sides and a minimum maneuvering space allowance of 9.5’. (See Bicycle Parking Facilities, Section 17).

(10) All bus shelters must have a minimum area of 2.5’ wide by 4’ deep (4’-4” recommended) accessible by a disabled person.

(11) All bus shelters should have at least one light inside the shelter for passenger safety, security, and convenience, see Section 19. SacRT recommends that bus shelters be provided with lighting where the existing outdoor lighting level is inadequate. The minimum illumination within the bus shelter is 15 footcandles. Lighting fixtures must be easily maintained, vandal-resistant, and placed to maximize passenger illumination.

(12) All bus shelters must have provisions for electrical hook-up for lighting and/or digital amenities.

(13) All shelters must have trash receptacles. Trash receptacles should be aesthetically compatible (using similar materials and color) with other bus stop components and should be anchored.

(14) All shelters must have route and schedule information. Schedule information contained within the shelter must be accessible to visually impaired passengers and not conflict with the designated wheelchair area.

(15) All shelters must contain a "No Smoking" decal placed within the shelter.

(16) Public telephones, bicycle racks and/or lockers, and mailboxes and newspaper racks may be incorporated into bus shelter design.

(17) All obstructions and amenities must not impede the access for the users, general public, disabled, or visually impaired. They should also not obstruct emergency routes or maintenance operations.

(18) See Section 7-4-6 for list of amenities that should be considered at bus stops. (Additional input required from SacRT regarding amenities including IT dynamic messaging signage and other smart phone based technology)

A building overhang or awning may substitute for a bus shelter. In many instances, this may be more aesthetic than a free-standing shelter and improve pedestrian access to the bus stop.

9.3. <u>BUS SHELTER MAINTENANCE</u>

Well maintained bus stops, shelters and amenities are crucial to the image of the transit system. Damaged furniture (including graffiti) and trash build-up should be tended to immediately to create a positive impression for transit patrons and the general public, and to deter criminal activity.

SacRT's standard bus shelters are installed and maintained by an advertising company under contract to SacRT; however, not all shelters or benches are owned nor maintained by SacRT or its contractor. The owners of the street furniture have the obligation to maintain said furniture, and the political jurisdiction should be responsible for monitoring these items for compliance. Maintenance frequency of no less than once per week should include:

- Full wash down of shelter and accessories
- Removal or all dirt, graffiti, and pasted material
- Wipe down of glass surfaces
- Removal and replacement of trash bags
- Litter pick-up around stop or shelter/accessories within a distance of 10'
- Manual or chemical removal of weeds
- Pruning of obstructing foliage
- Touch up of marred paint
- Verify shelter lighting levels and replace bad bulbs and ballasts

Repair of items that pose a safety problem should be performed promptly or at least within 24 hours of notification. Repairs that do not pose safety problems should be completed within three days.

SECTION 10. BUS BENCHES

Bus benches are a convenience amenity provided for passenger comfort and should be provided at all bus stops unless specifically approved by SacRT.

10.1. PLACEMENT GUIDELINES

Bus benches should meet the following placement guidelines:

(1) Bus benches should be placed no closer than 5’ and no farther than 12’ from the forward end of any bus stop, to remove it from passenger loading and unloading areas.

(2) Bus benches should be placed facing the street.

(3) No bus bench may be closer than 4’ from the street curb to adequately allow for pedestrian and wheelchair movement in front of the bus bench. The preferred distance is 5’.

(4) When placed on a sidewalk, a bus bench should have a minimum clearance of 4’ (5’ is desirable) at the side, and either front or rear, to allow for wheelchair access at the bus stop.

Where sidewalks are narrow (less than 7’ wide), benches should be placed behind the sidewalk so that adequate width exists for pedestrians and wheelchair users. In this case, the bench should be installed at a location, and on a “bench pad,” previously approved by SacRT. Currently, SacRT does not assume the cost of constructing the bench pad. Such costs must be borne by the entity desiring to install the bench.

Figures 10-1 and 10-2 illustrates bus bench placement at a standard design bus stop with bench only.

10.2. DESIGN GUIDELINES

Bus bench designs can be varied but should meet the following design guidelines:

(1) Bus benches should be comfortable, constructed of durable weather- and vandal-resistant materials (e.g. no wooden benches), and be pleasing in appearance.

(2) Bus benches will be constructed of a material, or in such a manner, that resists heat absorption by direct sunlight.

(3) Bus benches must be light in color to discourage heat build-up. The color of the bench must require approval by SacRT. Pre-approved colors include light gray (RAL 7004) and Ultramarine blue (RAL 5002) or equal.

(4) Bus benches must be perforated or constructed with slots to allow rainwater to drain through.

(5) Bus benches should include an upright back support and be able to seat 3 to 4 people. Recommended dimensions: 6’ long and with seat height 17”-19” above grade.

(6) Seat dividers (i.e., end and intermediate arm rests) are required.

(7) Benches should be integrated into the landscape and architectural style of the project site and facility design.

(8) All bus stops and benches must be visible and have adequate lighting as described in Section 19 of these guidelines.

(9) Benches must be anchored and will be constructed to allow easy relocation if required.

(10) Local jurisdictions may have special standards for physical clearance that must be satisfied.

(11) The concrete pad supporting the bench must consist of a minimum of 4” of PCC concrete on 6” Class 2 AB.

(12) Bus benches must not be the “flip down” seat type.

(13) Advertising benches may be used if in accordance with the prescribed guidelines.

SacRT encourages developers to provide bus benches at all bus stops. However, SacRT should be contacted before installation to address maintenance requirements, since SacRT currently has an agreement with a private vendor to install and maintain advertising bus benches within its service area.

SECTION 11. BUS LAYOVER AREAS

A bus layover area is a designated area denoting the end of a route, where buses may be parked between trips to allow the drivers a rest period before resuming service in the reverse direction. Such areas occur at each end of a bus route and may be so indicated by a posted sign.

11.1. PLACEMENT GUIDELINES

(1) Bus layover areas should be placed at specially designated locations such as transit centers, light rail stations, and park-and-ride lots.

(2) Bus layover areas should be located at bus stops for efficient use of curb space, to minimize deadhead (non-revenue travel) time and because patrons will naturally try to board at a parked bus. However, they may be located remotely with SacRT permission on a case-by-case basis.

(3) Bus layover areas at bus turnouts should only be located at farside or mid-block turnouts designed specifically to accommodate parked buses.

11.2. DESIGN GUIDELINES

(1) The minimum for any bus layover area is the same for a standard farside stop to allow sufficient area for parking, ingress, egress, and turnaround. Figure 7-1 illustrates farside stop dimensions.

(2) Bus layover area pavement should always be concrete. See Section 7.4.4, “Bus Stop Pavement,” for material specifications.

(3) Based on the number of buses and operators, restrooms may be required for bus operators. The SacRT Planning Department should be contacted to determine whether there is a need for restroom facilities. SacRT will not maintain public restrooms.

(4) Additional facilities for bus operators and maintenance needs including, but not limited to, drinking fountains with water bottle fillers, and water hook-ups for pressure washers.

(5) Parking for service vehicles.

(6) As a minimum, all bus layover areas must have a bus shelter and bus bench.

(7) Curbside stops are to be avoided as bus layover stops unless they are in an area where a bus parked for 10 minutes or more will not impair traffic, obscure storefronts, or disturb residents. All routes must have designated bus berths. Standard scheduled break time is at least 12 minutes. Terminal capacity analysis should assume layovers of 20 minutes and that bus operators are not required to move their buses during layovers. Routes with headways of 20 minutes or less therefore require multiple berths (due to the possibility of two buses on the same route laying over at the same time).

(a) Each route should always board passengers from its own fixed and designated location. Ideally, each route should also drop off passengers at its own fixed and designated location as well.

(b) To meet standards, frequent routes will typically require layover space be separate from passenger loading and unloading areas and that the terminal have a convenient internal circulation route.

- *Example*: Route X arrives at the terminal, drops its customers at the Route X bus stop, pulls forward to a non-passenger serving layover space, and then after the operator’s break, circles the facility to the Route X bus stop, where it picks up waiting passengers.

(c) The number of required layover spaces is determined by dividing 20 minutes (i.e., maximum break time) by the minimum headway of the route and rounding up.

- *Example*: Route Y has peak headways of 5 minutes. With 20-minute breaks, a fifth bus will arrive right when the first bus is scheduled to leave. A minimum of four layover spaces are needed (plus at least one passenger stop, for five total spaces).

- *Example*: Route Z has peak headways of 15 minutes. Bus 1 arrives at Time 0. Bus 2 arrives at Time 15 and needs a second space. At Time 20, Bus 1 departs, freeing the first layover space for Bus 3, which will arrive at Time 30. Two layover spaces are needed (plus at least one passenger stop, for three total spaces).

SECTION 12. BUS TURNAROUNDS

Bus Turnarounds are provided in major transit facilities (i.e., park-and-ride lots, transit centers, and light rail stations) to allow buses to re-enter revenue service in the opposite direction after a stop or layover.

Bus turnarounds may be either clockwise or counter-clockwise. Counter-clockwise turnarounds are preferred as they have fewer conflicting movements.

Clockwise turnarounds will only be considered when site constraints prohibit the use of counter-clockwise turnarounds.

12.1. PLACEMENT GUIDELINES

A bus turnaround should be provided when:

(1) A bus terminus is within a facility (i.e., shopping center parking lot, employment center, park-and-ride lot, etc.) and not at a roadway bus stop.

(2) A major trip attractor is located off the roadway and is to be served by bus service.

(3) There is no convenient way to go “around the block” at the terminus of a bus route.

Bus turnarounds should be signed “bus only” or located to minimize conflicts with pedestrians and other vehicles.

12.2. DESIGN GUIDELINES

Bus turnarounds must be designed to make the turnaround maneuver a simple and safe procedure. The following design criteria should be considered during design:

- Concrete pavement is preferred for bus turnaround areas due to the shear forces exerted by bus turning movements.
- All curbs within the bus turnaround must be non-mountable curbs. Curbs will be poured monolithically with the sidewalk and pavement or will be dowelled to the concrete pavement per Caltrans Std Plans A35B. Curbs will be painted red.
- Landscaping must be designed so as not to reduce the sight distance of the bus operators.
- Signage must prohibit stopping or parking within the turnaround.

Figures 12-1 and 12-2 illustrate various types of bus turnarounds and dimensions for each type, based on the minimum turning radius of a standard 40’ long bus.

SECTION 13. TRANSIT CENTERS

Transit centers are major transit facilities that are designed to accommodate transfer between buses and often other modes of transit at a single facility. These transit functions may include passenger loading and unloading areas, driver breaks and reliefs, bus layovers, park-and-ride, etc. Transit centers may serve a single mode or they may be multi-modal. They may also serve as transfer points between different regional and local bus operators.

Transit centers formally denote a permanent transit presence in the area and, therefore, should be designed to conform with adjacent land uses. Joint development, such as use of “air space” above the center, space for small vendor carts, or shared passenger waiting areas with other transportation providers (e.g., private carriers, taxis, etc.) may be considered to maximize space utilization.

13.1. PLACEMENT GUIDELINES

Transit centers serve as the focal point for transit service to a given area. As such, they should be centrally located within an area preferably at or near a major transit destination.

A transit center may be an exclusive transit facility that serves either buses and light rail or buses only, or it may be a joint-use facility. Appropriate joint use locations for transit centers are regional shopping centers, large office and commercial developments, universities, and similar high activity centers. At these locations, the transit center is generally incorporated into the parking area associated with the facility and its circulation system.

Where the transit center provides light rail service, or is planned adjacent to a proposed light rail line, SacRT should be consulted to determine appropriate location on a case-by-case basis.

Where the transit center provides only bus service, it should, under joint-use conditions, be located adjacent to the public roadway serving the facility or one of its major interior streets. The purpose of this recommendation is to:

- Reduce bus/automobile circulation conflicts within the facility.
- Reduce bus travel time by eliminating circuitous routing through the facility.
- Reduce the extent of reinforcement of parking lot circulation streets needed to withstand the heavy axle loads of buses.

Location of the transit center should also consider future expansion of the transit center and the facility within which it is located to allow buses to continue operating without interfering with the functions of the facility.

13.2. DESIGN GUIDELINES

Although transit needs and functions may vary from one transit center location to another, SacRT recommends the following general design guidelines for a transit center:

- Bus access into the transit center should be separated from automobile access.
- Bus access routes to and from the transit center should meet all standard dimensional guidelines for bus turning radii, bus turnouts and bus turnarounds, as recommended by SacRT. (See Sections 3, 8, 11, and 12.)
- Bus berths should be designed as layovers so that boarding passengers do not interfere with de-boarding passengers. Consideration should be given to future expansion needs wherever possible. (See Section 12.)
- Bus berths should be arranged to minimize pedestrian travel distances between buses or from the primary use of a joint use facility.
- Where pedestrians must cross bus traffic (e.g. between two rows of bus berths) the back side of the pedestrian waiting area should be fenced and crossings channeled at specific locations to minimize pedestrian/bus conflicts.
- Passenger waiting areas should:
    - Provide shelter from the elements.
    - Provide opportunities for passengers to sit and rest.
    - Meet local safety and security standards.
    - Be well lit and landscaped.
    - Have good visibility of oncoming buses.
    - Be located away from building entrances.
    - Provide transit route and system information maps together with local street maps identifying bus stop locations in their local context.
- Ancillary facilities, including public telephones, trash receptacles, mailboxes and newspaper racks may be incorporated into the transit center design for passenger convenience.
- If Transit Centers are on roadways, traffic signals be considered at main driveways for large park-and-ride lots, and if applicable, at separate bus driveways. When located within a specific development, transit center structures should not block the visibility of the development from nearby streets.

SECTION 14. BUS BERTHS

Bus berths are designated areas for buses to pull over and load and unload passengers in major transit facilities such as park-and-ride lots, transit centers, airports, or rail stations.

14.1. PLACEMENT GUIDELINES

14.1.1. If the bus berths are co-located with an important traffic generator such as an airport, civic building, hospital, school, shopping center, sports arena etc., then the bus boarding area should be as close as possible to the “front door”. (See also Section 2, Project Design of these Design Guidelines)

14.1.2. Bus berths may be located in the parking lot of the transit facility served in one of the following two general alternatives:

- At the periphery of the parking lot
- Within the parking lot

The specific advantages of each of these alternatives are given below. These should be considered when selecting the appropriate location.

Peripheral Location

(1) Reduces automobile/bus conflicts.

(2) Reduces bus operating time.

(3) May reduce pavement area required to accommodate buses.

(4) May reduce pavement maintenance cost.

(5) May reduce land requirements

(6) May provide more attractive pedestrian only waiting area.

Within-Lot Location

(1) Reduces walking distances for passengers transferring from auto-to-bus or vice versa.

(2) May reduce curb frontage requirements.

14.2. DESIGN GUIDELINES

The bus berthing area should be designed to make the most efficient use of the land on which it is to be located. Factors to be considered in developing the design are:

- Size and shape of parcel
- Available curb frontage
- Local traffic characteristics

Sawtooth Berths

Sawtooth berths are recommended for major, off-street boarding locations. They are most suitable for sites that do not have adequate length for parallel berths.

The minimum length for a sawtooth berth is 48’.

Figure 14-1 illustrates the sawtooth berth guidance for a standard, 40’-long bus. Figure 14-3 illustrates the sawtooth berth guidance for a 60’-long articulated bus.

Parallel Berths

Required roadway widths and berth lengths for parallel berthing are provided in the table below. These dimensions are given for selected pull-out and pull-in distances for a standard 40’ long bus. They are based on the assumption that the bus will pull out from, and pull in to, the berth around a parked bus.

TABLE 14-1: GUIDELINES FOR PARALLEL BERTHS
Required Pull-In and Pull-Out Dimensions for Parallel Berthing

Road Width (Ft)	Pull-In Distance[1] (Ft)	Pull-Out Distance[1] (Ft)	Berth Length[2] (Ft)	Tail Out (Ft)
24	52	10	102	1
23	40	15	95	2
22	26	20	86	3
21	20	30	90	4

Notes:
1. For a standard 40’ long bus.
2. Berth length = Pull-In-Distance + Pull-Out Distance + Bus Length

(Source: Transit Facilities Standards Manual, Alameda–Contra Costa Transit District, March 1983.)

Figure 14-2 illustrates the parallel berth guidance for a standard, 40’-long bus. Figure 14-4 illustrates the parallel berth guidance for a 60’-long articulated bus.

SECTION 15. PARK-AND-RIDE FACILITIES

Park-and-Ride (PNR) facilities are areas provided for transit users who wish to park their automobiles or cycles and transfer to a bus or light rail vehicle to complete their trip.

PNR facilities have the potential to increase the transit market since they serve a local collection and distribution function in areas where population densities are too low to generate significant amounts of walk-on bus patronage, i.e., less than 5 dwelling units per residential acre (see Density, Section 2.3), and are, therefore, not likely to receive fixed-route transit service. The use of a PNR lot provides access to such service.

PNR facilities typically attract trips from within an area that extends about 1 mile towards the activity center served by the transit service from the lot (e.g., downtown) and about 5 miles away from it.

PNR facilities can be provided as “exclusive” facilities or in conjunction with other development as “joint-use” facilities.

Exclusive PNR Facilities

Exclusive PNR facilities are facilities built for the exclusive use of transit patrons and transit vehicles. They provide parking for passengers using the transit service provided from the facility.

Exclusive PNR facilities are recommended when the parking demand at the facility exceeds 50 spaces. They may be considered for parking demands of less than 50 spaces, on a case-by-case basis, after consultation with SacRT. “Joint-use” PNR lots are preferred, and encouraged, in such cases. Typically, an exclusive PNR lot provides anywhere from 500 parking spaces (bus service) to 1,000 parking spaces (light rail service). Exclusive PNR lots may be owned by SacRT or by another public agency.

Joint-Use PNR Facilities

Joint-use PNR facilities represent those parking locations where transit patrons can utilize the parking available in a private parking lot (e.g. church, cinema, government office, or shopping center) as they continue their trip by transit. Normally, the parking made available for this purpose is restricted to a specific number of spaces and a specific location within the parking area. In some cases, transit vehicles may have access to the facility, but normally the transit service is provided along the adjacent roadway.

15.1. PLACEMENT GUIDELINES

A PNR facility should be located so that:

(14) Passenger and transit traffic has direct and safe access to freeways/expressways and local arterials.

(15) Passenger trips are intercepted before they approach:

(a) The activity center; or

(b) Points of traffic congestion; or

(c) Freeway/expressway entrances.

(16) Traffic to the facility is discouraged from filtering through residential neighborhoods.

(17) Location with respect to user demand, and major traffic congestion areas.

Placement of the PNR should also consider:

(18) Proximity to other park-and-ride facilities.

(19) Site visibility.

(20) Land use compatibility.

(21) Availability of sufficient land to provide the flexibility to expand.

(22) Construction requirements.

(23) Commuter driver distances.

(24) Location of bicycle routes.

(25) Security.

(26) Location with respect to a bus route. For express buses the ideal location is just before the bus gets onto the freeway or expressway.

Joint-use PNR lots should be considered in conjunction with the parking lots of the facilities listed below. These typically have low parking demand during the day on weekdays, making them suitable for this purpose.

- Community and neighborhood shopping centers.
- Churches/Temples, etc.
- Movie theaters, including drive-in theaters.

- Light industrial centers.
- Sports arenas.
- Parks and recreational facilities.

15.2. DESIGN GUIDELINES

A PNR facility is used by various modes, i.e., buses, automobiles, vans, motorcycles, and bicycles. Automobiles can be differentiated further as serving the disabled, serving carpools/vanpools, “compact” automobiles, taxis and accessing the facility only to pick up or drop off passengers (Kiss-and-Ride). Internal site design including entrance/exit design, should give priority consideration to these various modes in the order indicated below:

(27) Rail transit (light rail or other forms of transit) platforms

(28) Express buses.

(29) Non-express buses.

(30) Microtransit (on-demand) buses.

(31) Taxis and ride-hailing services (Uber, Lyft)

(32) Kiss-and-Ride

- (a) Drop-off
- (b) Pick-up

(33) Bicycles

(34) Motorcycles

(35) Automobiles/Vans

- (a) Serving the disabled
- (b) Serving carpools
- (c) “Compact” automobiles
- (d) Single occupant
- (e) Electric vehicle charging

Similar functions, such as taxi loading and unloading, and Kiss-and-Ride drop-off and pick-up, or bicycles and motorcycles, may be grouped in the same place.

The design guidelines that follow have been developed for exclusive-use PNR facilities. They may be used for joint-use PNR facilities wherever practical. In the case of joint-use PNR facilities, SacRT specifically recommends appropriate signage to indicate (a) availability of parking for PNR purposes, and (b) location of this parking.

15.2.1. Lot Size: Parking Space Requirements:

The size of a PNR lot is primarily dependent on the land available for this purpose. This factor may sometimes require the construction of multiple small lots (50 spaces or less) dispersed throughout an area, or, in other cases, fewer mid-size (50–500 spaces) and large lots (500–1,000 spaces) located where the space is available within an area.

Preferably, the size of the PNR facility should be determined by transportation modeling or other objective methods that is tied to demand as well as supply of parking.

The combined parking capacity of all PNR lots within a community should equal the demand within the community plus up to 10% additional capacity to allow for usage by neighboring communities or changes in vehicle occupancy rates or commuting patterns.

Parking space demand generated by a specific development is normally determined by a methodology that considers:

(36) Work trips originating in the development destined for an activity center six (6) or more miles away.

(37) Ratio of automobile travel time to transit travel time from the development to the activity center.

(38) Share of the work trips likely to be PNR trips based on the above two factors.

This methodology can be obtained, upon request, from SacRT. SacRT will also be glad to assist, upon request, in determining PNR demand.

15.2.2. Access

In general, traffic signals and turn lanes should be provided along roadways adjacent to a PNR lot to facilitate access for vehicles using the lot. The guidelines below are lot-specific and address entrance/exit design and driveway design.

(a) Entrance/Exit Design

Entrances and exits should be designed to:

(39) Minimize automobile/bus conflicts. Exclusive bus entrance and exit lanes are preferred. They are essential if:

(a) 12 or more buses serve the facility per hour during the peak period; or

(b) The PNR lot has 500 or more parking spaces.

(40) Provide adequate separation between the entrance/exit and the nearest intersections per local road standards.

(41) Provide adequate traffic sight distances.

(42) Provide an entrance and exit at each roadway where the facility is bounded by more than one roadway. This provides faster and more flexible access.

(43) Provide an adequate number of traffic lanes at entrances and exits.

Since the capacity of entrance/exit lanes to PNR lots average 300 vehicles/lane/hour, PNR lots with fewer than 300 spaces only require one entrance and one exit.

SacRT, however, recommends that the following factors be considered before determining the number of entrance/exit lanes to be provided:

- Number of vehicles using the facility.
- Local traffic conditions.
- Driveway operational characteristics (i.e., one-way or two-way traffic).
- Facility security.

(44) <u>Minimize pedestrian/bus conflicts.</u>

<u>(b) Driveway Design</u>

SacRT recommends that driveways to PNR lots conform to the following guidelines:

(45) Main entrance to major PNR lots (> 500 stalls) should be designed to local standards and in accordance with the criteria in (a) above.

(46) Minor or secondary driveways should not be located near intersections. This serves to avoid disruption of traffic on PNR facility access streets and to minimize safety problems.

(47) Driveways should be located to facilitate inbound traffic to the PNR facility. Traffic within the facility tends to move slowly and can easily negotiate the turns required to reach the exits.

(48) Driveways to medium (> 50 stalls) or large PNR lots should include a "throat" to allow for exiting vehicles to stack within the lot without blocking other on-site circulation.

(49) Minimum dimensions for driveway width, length, and curb radii for right turn movements are given in the table below.

TABLE 15-1: MINIMUM DRIVEWAY DIMENSIONS

Element	Minimum Dimension
Width	
– One-Way	15’
– Two-Way	25’
Length	20’
Right-Turn Radius	
– Inside	15’
– Outside	55’

(50) The design for two-way driveways should include:

(a) A low ground-cover planter or striping separating the entrance and exit lanes.

(b) Signs denoting "Enter Only" and "Exit Only" appropriately placed to not obstruct traffic sighting.

(c) Stenciled markings indicated "Enter Only" and "Exit Only" on the appropriate lanes.

(d) Stop signs and stencils, as necessary.

(51) The structural pavement section for driveways to be used by buses should be designed in accordance with the local agency (under whose jurisdiction the facility falls) standards for commercial driveways, in conformance with the design guidelines given under "Bus Stops," Section 7.4., and "Exclusive Bus Lanes," Section 5.2.

(52) Traffic signals be considered at main driveways for large PNR lots, and at separate bus driveways, if applicable.

(c) Pedestrian Access

Pedestrian access within a PNR facility must provide direct, safe, and logical pathways between key points within the facility. The pathways must meet the requirements for persons with disabilities and/or visual impairments. The following guidelines should be followed as a minimum requirement:

- All pathways must generally be a minimum of 5’ wide.
- Pathways must be a paved, slip-resistant surface void of any patterning that may interfere with the operation of a wheelchair.
- The maximum cross-slope of a pathway is 2% (1:50). (1.5% to 1.75% is recommended.)
- Any elevation change of 1/2” or more, or grade steeper than 5% (1:20), requires a ramp. SacRT recommends limiting grade changes to less than 5% slope.
- All crosswalks must be clearly delineated with pavement marking, signage, and curb ramps.
- All curb ramps must have truncated domes along the full width of the ramp and 3’ deep regardless of slope.
- Pathways from disabled parking areas must provide the most direct route to key elements within the PNR facilities, including platforms, bus stops, shelters, Fare Vending Machines, kiosks and vendors, restrooms, and information signs and booths. Such pathways will be demonstrated with signage and a 4” detectable warning tile strip.
- The path of travel for mobility-impaired patrons should be the same path of travel as the general public.
- All locations where changes of grades, stairs, or potential hazards occur must be marked with a tactile strip or paint of contrasting colors.
- Pathways must be well lit in accordance with the lighting requirements defined in Section 19 of these Guidelines.
- Obstacles within the pathways must be avoided. The minimum width of pathway must be 3’ wherever there is an obstacle within the pathway.
- Where a pathway crosses light rail tracks, freight tracks or a roadway without curb ramps, a detectable warning tile (36” wide) is required.

15.2.3. Parking Layout

SacRT prefers 90° parking with aisles oriented so people walk along the aisle to get to their bus or train. In some circumstances, due to small or irregular shaped sites, SacRT will allow perpendicular aisles of 60°, 45°, or parallel stalls. The size and shape of the site are the principal determinants in designing the most effective parking layout.

Typically, 350–400 square feet should be allowed per automobile parking space in a PNR lot. This translates to approximately 100 spaces per acre. Additional space should be provided for non-automobile uses, i.e., bus berthing and cycle parking, etc. This dimension includes modest landscaping and an allocation for normal movements and parking clearances. Adjustments should be made to accommodate local landscaping requirements, where necessary.

SacRT's recommended minimum parking layout dimensions are given in the table below and illustrated in Figures 15-1 to 15-4. Disabled parking layout dimensions are shown in Figures 15-5 and 15-6. Where the parking lot lies within the jurisdiction of a local agency that maintains design standards that exceed these standards, then the local agency standards will apply. Shade tree requirements, as discussed in Section 20 Landscaping, should be coordinated during the parking lot design.

TABLE 15-2: MINIMUM PARKING LAYOUT DIMENSIONS

	Minimum Dimensions		
Parking Angle	**45 degrees**	**60 degrees**	**90 degrees**
Parking Space			
–Width[1]	8'–9'	8'–9'	8'–9'
–Depth (to curb)[2]	17'–20.5'	18'–22'	17'–19'
Curb Length per Space	12'	10'	9'
Circulation Aisle Width[3]	14'-20'	14'-20'	25'

Notes:
1. 8' for "compact" automobiles; 9' for standard size automobiles. Additional width should be allocated for disabled parking space markings.
2. 17'-18' for "compact" automobiles; 19' for standard size automobiles at 90°.
3. Where buses are routed through the park-and-ride facility, a minimum of 22' is recommended for circulation aisle width to allow buses to bypass each other.

(a) Aisles

Aisles within a PNR lot provide circulation paths within the facility and access to parking spaces. Aisles should conform to the following guidelines:

(53) Aisles should connect directly with entrance and exit points.

(54) Aisles should be laid out to be parallel to:

(a) The direction of pedestrian traffic.

(b) The longest site dimension; and

(55) Pavement for aisles anticipated to be used for bus circulation should be reinforced to accommodate bus axle loads. (See "Bus Stops," Section 7.4.4 for pavement specifications.)

(b) Allocation of Specifically Assigned Spaces

Allocation of parking spaces within a PNR lot is determined by the type of use (i.e., parking for the disabled, carpools, cycles, etc.) and the potential for use. SacRT recommends the following:

(56) Parking proximity to the bus berthing area should be provided in the following priority order:

(a) Disabled parking

(b) Bicycles and motorcycles

(c) Carpools/vanpools

(d) ”Compact” automobiles

(e) Standard automobiles

(f) Electric vehicle (EV) charging stalls should be farthest from the destination, to avoid having charging infrastructure blocked by general parking

(57) Special parking areas should be reserved for the disabled, cycles, carpools/vanpools, and “compact” automobiles.

(58) SacRT recommends that 5% of the total parking spaces should be reserved for carpools/vanpools.

(59) Approximately 20% of the total parking spaces should be reserved for “compact” automobiles.

(60) Short-term parking for passenger drop-off and pick-up (Kiss-and-Ride) should be provided close to the bus loading and unloading area. The duration of this parking need not exceed 10 minutes.

The maximum number of such spaces to be provided is to be determined by the following formula:

$$\frac{\text{Estimated Evening Peak Hour Kiss-and-Ride Passengers}}{6} = \text{Maximum number of short-term parking spaces needed}$$

Space availability may constrain the provision of the maximum number of spaces. Adjustments may be discussed with SacRT on a case-by-case basis.

15.2.4. Bus Interface

It is desirable to route buses serving a large PNR facility (500–1,000 spaces) into the facility, and to do so with a minimal increase in running time. When this is not practical, for reasons such as liability limitations, space availability, pavement strength, local traffic conditions, etc., buses may load and unload passengers at the roadway adjacent to the facility. In this case, guidelines for Bus Stops (Section 7) and Bus Turnouts (Section 8) should be considered.

SacRT also recommends that the curb loading area or bus turnout should be located on the farside of the entrance(s) to the PNR lot. This reduces a potential safety problem of a late PNR patron turning right into the site in front of a bus pulling away from the curb.

Where buses can be routed into the PNR facility, refer to design guidelines for Bus Berths (Section 14) and Bus Turning Radii (Section 3)

15.2.5. Barriers

In addition to the Access and Parking Layout guidelines described above, SacRT recommends provision of a ~~boundary~~ barrier ~~or control~~ where the PNR lot abuts a public roadway or sidewalk. Such a barrier can help reduce theft and vandalism of parked vehicles.

The barrier may be provided as a low wall or fencing with or without landscaping that does not exceed its height.

Barriers along streets with exit driveways or near intersections should not be higher than 2'. Higher barriers may be considered under these conditions if they are set back enough to ensure visibility of on-coming traffic and pedestrians.

15.2.6 Other

For signage, lighting and electrical, and landscaping guidelines see Sections 18, 19 and 20, respectively. For other design issues not addressed above, standard parking lot design criteria included in the Traffic Engineering Handbook of the Institute of Transportation Engineers should be used.

SECTION 16. LIGHT RAIL TRANSIT STATION DESIGN

16.1. GENERAL

16.1.1. Role of Stations

This section establishes specific guidelines and standards for the design of Light Rail Transit (LRT) stations. The elements addressed include Location and Site Layout, Station Amenities, Park-and-Ride Facilities, Accessibility Requirements, and Materials and Finishes. Overall, these are general guidelines that are meant to be prescriptive rather than restrictive.

Three broad principles guide the design of the stations:

- The station is an integral part of the LRT System. As such, it must facilitate the movement of passengers to and from the LRT vehicle in the most convenient and cost-effective manner.

- The location of the station within or adjacent to a community will increase accessibility to that community. The station must be designed to carefully relate to the adjacent movement and land use patterns. Where adjacent areas are subject to redevelopment, it will assist in structuring the form of that development.

- The station amenities are a community resource. Each day passengers will spend a period of time in the station ranging from several minutes during peak hours, to 10-15 minutes during off-peak hours. The total time spent in the station environment is a considerable amount. It should be both enjoyable and informative. It will become a place where neighbors meet on their way to and from work and where information regarding community events can be posted. It will become, over time, an important element in the community fabric.

In achieving the above broad design principal, the station designs must also seek to maximize passenger safety and convenience, neighborhood value, and minimize design and construction costs and maintenance requirements. Long-term maintenance costs must also be weighed against short-term capital costs.

16.1.2. Codes and Standards

LRT stations must be designed in accordance with SacRT's Light Rail Design Criteria.

16.1.3. Influence of System Operations on Design

The station platforms allow for free movement of pedestrians to enter and exit. There are no gates or separate areas for patrons with fare. Station areas will, however, be signed as SacRT property. Fare vending equipment is provided on station platforms for the purchase of fares. Patrons with a fare can board the light rail vehicle (LRV) through any of the doors. Patrons on board the LRV are checked by a Transit Ambassador to ensure that a fare has been purchased.

16.2. LOCATION AND SITE LAYOUT

16.2.1. General

A light rail station is a place designated for the purpose of loading and unloading passengers from LRVs. The station may range from a simple sidewalk stop for pedestrian walk-on access, to trackside platforms, to a more elaborate facility that includes bus transfer and park-and-ride facilities (see Sections 13 and 15 of these guidelines). To facilitate passenger access, light rail stations may be incorporated into large commercial and office developments through a joint development project.

Light rail transit stations may be divided into two general classes:

- Urban stations.
- Suburban stations.

An urban station is located within urban land uses and is usually the ultimate destination point of the trip. Little or no parking is provided at an urban station to encourage patrons to walk or take transit. Occasionally, an urban station may be served by a bus route (e.g., crosstown route or route from an area not served by rail).

A suburban station is located in outlying areas that are primarily residential in nature. As joint development takes place, some target suburban stations may become employment centers. While passengers are encouraged to walk to and from the station by providing appropriate pedestrian access, the station may provide for bus transfers, layovers and turnarounds, and parking for park-and-ride/"kiss-and-ride" patrons (See Figure 16-1).

16.2.2. Location

Selection of the location of light rail stations should be based on:

- Availability of space.
- Proximity to other stations.
- Relationship to feeder bus routes.
- Relationship to major destinations (e.g., office parks, civic facilities, shopping centers, colleges, etc.) and high-density residential land uses.

- Compatibility with the immediate environment.

The general location of the stations should be determined early in the light rail system design phase. The appropriate governmental entity (local, state, federal) with land use authority over the selected sites should be requested to include these locations on the applicable Land Use Maps and Community Plans.

SacRT specifically recommends:

(1) Light rail stations should be spaced no closer than one-half to one mile in urban areas and one to two miles in suburban areas; however, each location should be evaluated within the context of its surroundings. Adjustments to this recommendation may be made to accommodate the need for more closely spaced stations in the downtown area, or stations that are spaced farther apart in outlying suburban areas.

(2) Light rail stations should be incorporated with the design of major employment centers (i.e., 1,000 employees or more) to provide safe and convenient pedestrian access between the station and the buildings within the center.

(3) Within residential developments, light rail stations should be located (a) closer to the high-density users, and (b) to allow safe and convenient pedestrian access from the development.

(4) Within designated transit centers, light rail stations should be located to provide:

- Safe and convenient access to passengers arriving by various modes (i.e., bus, park-and-ride, cycle, on foot, and "kiss-and-ride").

- Safe and efficient access by all other modes serving it (i.e., buses, park-and-ride vehicles, passenger drop-off vehicles, etc.).

On mixed traffic roadways, especially urban streets, light rail stations should be located on the far side of intersections to minimize interference to light rail operations by other traffic.

16.2.3. Platform Layout

The design of light rail platform should be governed by:

- Passenger volume.

- Integration with bus service.

- Local site considerations (i.e., available space, physical environment, social and neighborhood context, and opportunities for linkages to generators, etc.).

- Pedestrian access.

- Joint development opportunity.

In addition, each station will present unique design considerations that must be addressed to reflect and enhance the characteristics of the particular location. For example, the station may be designed as part of a larger plan to rebuild or revitalize the adjacent area, or to blend with the existing urban environment. At the same time, the station must present a consistent image of the light rail system and conform to system-specific requirements.

There are two basic platform types:

- Side Platform: Provided as a pair, where each platform serves either the inbound or outbound track. The tracks are located between the two platforms.

- Center Platform: Located between the two tracks serving both inbound and outbound trains from the same central area.

Side platforms are generally preferred for passenger convenience and safety, and because they facilitate the design of traction power provision. Center platforms, however, may have to be considered for reasons specific to certain locations.

Assistance in selecting the appropriate station type may be obtained from SacRT upon request.

SacRT recommends the following for all platform types:

(61) The length of the platform will be determined by the site layout and the length of the longest train to be used in service. Trains are up to 336’ long.

(62) The width of the platform from any fixed object on it to its trackside edge should be no less than 10’. It is important to avoid potential crush-points between a fixed object and the moving train cars, and to allow access for service and emergency vehicles.

(63) Avoid leaving areas of concealment around ramps and pockets people can hide in.

(64) All new light rail stations must be designed to accommodate direct boarding for disabled passengers for low-floor vehicles by providing raised boarding platforms 8” above top of rail.

Layout and dimensions of platform shelters are illustrated in Figure 16-2.

Design guidelines for bus layover, bus turnaround facilities, transit centers, and park-and-ride are provided in Sections 11, 12, 13, and 15 of this document. Additional specific design considerations are addressed below.

16.2.4. Passenger Circulation

The following are general criteria and must be supplemented by the latest ADA Guidelines and Title 24 requirements of the California Building Code.

16.2.4.1. General

A major design requirement for light rail stations is the safe and efficient movement of passengers in all those areas of the station to which they routinely have access (See Figures 16-2 to 16-5). These areas should be designed according to the following guidelines:

(65) To improve circulation and convenience for disabled and visually impaired persons, the access routes to the boarding areas and other amenities within the station and from the parking lots or drop off points must be made as short and as direct as possible.

(66) Directional guidance tiles and signage must be placed to direct disabled and visually impaired persons along the shortest accessible route between the various amenities located within the station, the parking or drop-off areas, and the bus or light rail boarding areas.

16.2.4.2. Pedestrian At-Grade Access

Walkways on the station site should be designed to:

(67) Be linked to the pedestrian network in the surrounding community to encourage arrival at, and departure from, the station on foot.

16.2.4.3. Links to Adjacent Uses

Links for pedestrians and bicycles between the station and neighborhood increase the system's usage. Barriers to pedestrian and bicycle access insulate the station by being accessible by motor vehicle only. Crosswalks, pathways, and bridges can serve to increase non-motorized accessibility. Bicycles, however, must be walked through the platform area.

(68) Evaluate need for additional protected crosswalks to improve safe pedestrian access to station area.

(69) Provide pedestrian and bicycle pathways through park-and-ride lots.

(70) Review constraints to pedestrian/bicycle access to development within at least 1,500’ of the station area.

(71) Design pedestrian paths with adequate lighting, visibility, smooth and hazard-free walking surfaces, and protection from weather (where appropriate) to enhance the safety and attractiveness of walking to transit.

(72) New underpasses must be open where feasible and wide enough to avoid security concerns, as well as pass a small vehicle (at least 25’ wide).

(73) Suggest new walkways, structures or gates in walls or fences to improve access.

(74) Bicycle pathways should be designed to connect with adopted City and County bikeways.

SECTION 17. BICYCLE PARKING FACILITIES

Bicycle parking facilities range from simple racks to bike share stations/corrals and lockers. The provision of bicycle parking facilities at transit stops is one method of encouraging transit and bicycle use as an access mode.

17.1. PLACEMENT GUIDELINES

Bicycle parking facilities should be provided in transit trip origination areas, such as park-and-ride facilities, suburban light rail stations, high passenger volume suburban bus stops, etc., to generate maximum rider and transit user potential. Inclusion of bike share stations should be discussed with local operators.

Potential sites for bicycle parking facilities should be at bus stops where two or more bus routes meet, park-and-ride facilities, transit centers, and light rail station loading areas.

Bicycle parking facilities must be located in the public right-of-way, or at sites with an easement license agreement from the property owner(s).

Long-term bicycle parking facilities should be located in areas where security is provided. Where this is not feasible, bicycle parking should be located in areas with a high volume of pedestrian traffic to discourage theft and vandalism.

Bicycle parking areas should be located outside of the primary circulation paths. Parking should include Class 3 facilities (e.g. bike racks) for casual patrons, and Class I facilities (e.g. bike lockers) for lease by regular patrons. Contact SacRT Facilities Department for bike locker rental guidelines.

The following guidelines will be used for bicycle parking facilities at light rail stations:

(75) Bicycle parking facilities should be provided at all light rail stations wherever feasible.

(76) Enclosed bicycle lockers should be placed as follows:

Location	Number of Spaces
Large Park-and-Ride Stations (more than 500 spaces)	40
Small Park-and-Ride Stations and Walk Access Stations	20-40

(77) At all stations, secure bicycle racks should be provided.

(78) Bicycle locker and bicycle rack designs must conform with SacRT's standard plans (available upon request).

(79) Placement of bicycle facilities must be near areas with high volumes of pedestrian activity, which do not interfere with pedestrian circulation, to promote usage and security.

(80) New stations must be designed with space for expansion to at least 40 enclosed bicycle locker spaces to allow for future demand.

17.2. DESIGN GUIDELINES

Bicycle parking facilities can either be open (e.g., bicycle racks) or enclosed (e.g., bicycle lockers).

Bicycle racks require a minimum allowance of 9.5’ for maneuvering space into the rack with an additional 4’ allowance on each side of the bicycle rack.

Figure 17-1 illustrates three commonly applied designs for enclosed bicycle parking facilities or bicycle lockers. Each bicycle locker should allow for a 2’ by 6’ space per bicycle for parking, and 2’ along the width, and 5’ along the length of the locker for maneuvering space.

Bicycle parking should be located on a hard, dust-free surface, such as asphalt or a concrete pad.

A typical automobile parking space can provide sufficient space for six enclosed bicycle lockers where each locker is able to hold two bicycles.

SECTION 18. SIGNAGE

18.1. GENERAL GUIDELINES

The following guidelines will apply to signage for PNR facilities, transit centers, and light rail stations:

(81) Signs should be placed at freeway off-ramps and along arterials accessing the PNR lot, directing potential users to the facility. This is particularly applicable to lots of more than 50 parking spaces. Smaller facilities may be signed only at the site location.

(82) Signs must be placed within the PNR lot directing users to the appropriate parking location or facility (e.g., disabled parking, van accessible parking, carpool/vanpool parking, bicycle parking, kiss-and-ride area, bus drop-off area, bus stop, information).

(83) Signs must be sized according to viewing distance.

(84) Signs must be fabricated from matte or non-glare materials and must have lettering and background colors that have high contrasts.

Information signs provide a variety of transit information, including bus route numbers, maps, and schedules. They are designed not only to make the transit system easier to use for existing patrons, but also to attract new ridership. Signs may range from bus stop flags to elaborate route system information displays within bus shelters at light rail stations or transfer facilities.

Bus stop flags, the simplest form of information signs, are installed at all SacRT bus stops. They provide information on bus routes serving the stop, which may include route numbers, route destinations, stop identification numbers, and a telephone number for obtaining bus schedule information.

Information signs vary in degree of complexity from simple route maps to displays showing items such as the system map, fare information, schedules, etc.

All information signs, schedules, and maps must be available and readable to all users, including disabled and visually impaired persons. Where information is not available in a format identifiable to visually impaired persons, available devices should be considered.

Assistance for sign and display design, and the necessary transit information, may be obtained upon request from SacRT.

18.2. PLACEMENT GUIDELINES

A bus stop flag should be placed at each bus stop.

Information signs should be placed at transit centers, light rail stations, park-and-ride lots, bus layover areas, and heavily used bus stops.

SacRT further recommends that information signs should be:

(85) Grouped closely with other bus stop amenities, such as bus shelters, bus benches, and bicycle parking facilities.

(86) Located near the front of a bus stop and away from passenger loading areas, so the nearest part of any sign is no closer than 2' from the street curb.

(87) Mounted away from trees, buildings, other signs, or obstructions.

(88) Plainly visible, with the front of the sign facing oncoming traffic.

18.3. DESIGN GUIDELINES

(89) All information signs should be made of durable and vandal-resistant materials.

(90) Presentation media should be moisture-proof. This may be achieved by encasing informational material in mar-resistant, clear material.

(91) Information signs should be mounted at eye-level for a normal adult: approximately 5' from the ground to the center of the display. Signs should be lower if children, the disabled, or senior citizens are the predominant bus and light rail patrons within the area.

(92) Bus stop flags should not be less than 7' from the ground and must conform to the requirements listed in Section 7, "Bus Stops," of these Guidelines.

(93) In general, the specifications for sign size, words, or symbols and location are as follows:

(a) Letters, numbers, and designs on signs should be sized according to viewing distance.

(b) For overhead signs, the minimum height over a walkway is 80" and the minimum character height is 3".

(c) The background must contrast well with the letters and designs, either dark on light or light on dark.

(d) The finish on signs must be matte or another non-glare finish.

(e) Signs at ground level must have no obstructions in front so people can stand as close as 3” away to read them.

(f) Some signs at ground level indicating accessible features must include the International Symbol of Accessibility and written information in raised letters:

- Letters and numerals raised 1/32” and accompanied with Grade 2 Braille, and

- Raised characters at least 3/4” high, but not more than 2” high.

(94) Information signs must be manufactured with a photo polymer extension.

Bus stop signs are placed to notify passengers where the bus will stop, to provide reference for bus operators, and to provide information to the passengers. The bus stop sign must be reflectorized and double-faced for visibility from approach in either direction. The bus stop sign:

(95) identifies the location as a bus stop

(96) includes the number of the bus route(s) using the stop

(97) includes the stop number

(98) displays the transit information telephone number, website and TTY

(99) must have a tactile route plaque mounted on the post between 48” and 60” above grade

18.3.1. <u>Additional Signage Guidelines</u>

In addition to the guidelines given above, SacRT recommends the following signage at Park-and- Ride (PNR) facilities:

- Pathfinder signs should be placed at freeway off-ramps and along arterials accessing the PNR lot, directing potential users to the facility. This should particularly be followed in the case of larger lots (more than 100 spaces). Smaller facilities may be signed only at the site.

- Directional signs should be placed within the PNR lot directing users to the appropriate parking locations (i.e., disabled parking, carpool/vanpool parking, cycle parking, etc.), including requirements of ADA and SacRT's signage specifications.

SECTION 19. LIGHTING

19.1. GENERAL

PNR lots, transit centers, and light rail stations should be adequately lit to provide patrons, operators, and the general public a safe and easily visible facility. Poor lighting encourages unintentional use of the facilities and will lower patrons' comfort level.

19.2. PLACEMENT GUIDELINES

(100) Street lighting should be placed at each bus stop (or each bus stop located near street lighting). Illumination should reach pedestrian crosswalks leading to bus stops and along sidewalks leading to bus stops.

(101) Bus stops without street lighting may be considered for solar lighting.

19.3. DESIGN GUIDELINES

Lighting design guidelines include:

(102) Light fixtures and standards must be incorporated into the structural and architectural elements of the stations and illuminate signage, platform edge, shelters, seating, the area around fare vending equipment, ramps and stairs, walls, rail and bus loading areas, pedestrian walkways and crossings, and parking areas.

(103) Lighting equipment chosen and overall design criteria must consider SacRT's lighting system requirements for low, long-term system maintenance and ease of lighting system maintenance.

(104) Lighting designs should minimize glare and light trespass into the adjacent neighborhoods.

(105) If maintained by SacRT, street light poles, luminaires, LED or lamp types, and wattages must conform to SacRT's standard plans (available upon request).

(106) Minimum maintained (mean) footcandles at grade level must be as follows within the designated areas:

TABLE 19-1: ILLUMINATION REQUIREMENTS

Location	Horizontal footcandles (at grade)	Vertical footcandles (5' above grade)	Max:Min Ratio
Fare Vending Machine (within 5' of face, per CA	10.0	10.0	5:1

Financial Code Sec 13041)			
Shelters/Buildings	5.0	5.0	10:1
Platform and Bus Stops	2.0	2.0	10:1
Walkways including stairs	2.0	2.0	10:1
Landscaping at Platform and Walkways	1.0	2.0	10:1
Parking Lots	0.5	2.0	10:1
Bus Lanes/Driveways/Entrances	0.5	1.5	10:1
Landscaping at Parking Lots	0.5	1.0	10:1
Note: The minimum values shown here may be reduced if the area is illuminated by lamps with a CRI of 90 or greater.			

(107) The intent of these levels is to provide the highest illumination levels in the areas of highest activity and/or potential conflict with trains, buses, or automobiles. The lighting plan must also appropriately focus on important signage.

(108) The ratio of maximum illumination to minimum illumination (at grade level) must be within the range of 10:1 and 15:1. The layout of the lights should be such as to avoid dark areas.

(109) Non-standard signage that requires backlighting and non-standard spare parts for maintenance should be avoided.

(110) The lighting plan must coordinate with the signage plan as SacRT typically mounts signs on the light poles. Where practical, the location of the poles should be adjusted to provide uniform placement of station identification signs.

(111) Coordination is required with the local agency within whose jurisdiction the site occurs, to determine any specific illumination standards in that area.

SECTION 20. LANDSCAPING

20.1. GENERAL

This section presents general criteria for landscaping of light rail stations, transit centers, and PNR facilities that are owned and/or maintained by SacRT, as well as for bus stops and other facilities not owned by SacRT but where SacRT operates.

20.2. PLACEMENT GUIDELINES

All landscaping must be designed to require minimum maintenance and avoid conflict with operations.

Landscaping designs must not permit the accumulation of grass, leaves or other plant materials on tracks or near bus stops.

20.3. LANDSCAPING OBJECTIVES

Transit stations and PNR ride lots should be carefully landscaped to:

- Maintain existing neighborhood character. Make all possible attempts will be made to preserve significant site features such as mature trees and incorporate them into the overall landscape design.
- Provide attractive approaches to stations.
- Transition landscaping should be utilized on an approach to a station or SacRT facility.
- Provide continuity between stations and adjacent areas.
- Establish visual screening where necessary.
- Protect and frame views and vistas.
- Supplement and reinforce existing landscapes.
- Introduce shade and human scale to paved areas.
- Establish visual identity along the alignment.
- Reinforce line of vehicular and pedestrian movement.
- Utilize plant materials appropriate to high-density urban areas that are disease resistant, require minimum maintenance, and are drought tolerant.

20.4. DESIGN GUIDELINES

(112) All planting areas must have provisions for after-care irrigation. Automatic irrigation systems must be provided where permanent water is required. Irrigation systems should use parts typical of other systems. Specific material, methods, and equipment will be required to ensure compatibility and standardization with current Rainbird Maxicom computerized central control system. Specific detailing and specifications of installation of planting and irrigation will also be required.

(113) Tree grates allowing for root aeration and watering may be provided where trees are located in areas of paving.

(114) Maximum slopes for planting must be 2:1 (2’ horizontal to 1’ vertical) with a minimum of 3’ flat area at the top and bottom of the slope where space is limited. A slope ratio of 4:1 is preferred. Slope rounding and contour grading should be accomplished where possible. Erosion Control planting and/or planting and irrigation with consideration for slope protection is required.

(115) Tree shading in the parking area must conform to the requirements of the local jurisdiction. Shade tree planting could be included as division between stalls, in the parking row end island, or in stalls especially designed for planting as determined by the designer. Tree wells or planters should be large enough to allow 8’ x 8’ permeable area, if possible, centered on each tree.

(116) At stations with park-and-ride or major bus transfer facilities, mature trees should be located around the perimeter and along the major pedestrian walks leading to the station to achieve the initial large-scale subdivision of the site and emphasize the major pedestrian routes to the station.

(117) Minimum 24” box size trees should be installed where possible, to allow new trees to better resist vandalism.

(118) Entrances to stations may be emphasized by grouping trees in masses. The surrounding ground level must be kept clear to allow good visibility.

(119) Plant material must be selected considering size, native species, continuity, vandal resistance, drought tolerance, and maintenance requirements. Use of rare species, plants requiring specialized care, is prohibited. Very durable plants should be selected particularly around vehicle parking areas where cars overhang

plants and pedestrians get out of cars. Circulation of pedestrians should also be strong design consideration.

(120) Landscape design should be guided by the recommendations of the following codes and standards, as applicable:

- Recommended plant material, City/County of Sacramento and Caltrans.
- American Standard for Nursery Stock ANSI Z60.1, 1973, adopted by the American Association of Nurserymen, Inc.
- Bailey's Standard Encyclopedia of Horticulture.
- Standardized Plant Names, American Joint Committee on Horticulture Nomenclature (AJCHN).
- Allergy-Free Gardening, Thomas Leo Ogren, 10-Speed Press.

20.5. GENERAL DESIGN PARAMETERS

The following general design parameters have been developed for stations/park-and-ride lots:

(121) Sidewalk stations must incorporate a street tree pattern and should match existing patterns or establish one where none exists.

(122) A border providing an adequate area for screening, glare prevention, and general landscape planting should be provided around the periphery of every open station site.

(123) Existing planting must be preserved wherever possible when the plant material is judged appropriate. Native plant materials where appropriate may be specified in landscape designs.

(124) Where possible, groupings of trees should be placed among the parking stalls to further subdivide and contrast with the visual severity of the parking areas.

(125) Landscaping of the LRT right-of-way should be minimized andthe track right-of-way must be kept clear. Considerations must be made during landscape design to avoid plantings adjacent to the tracks where they may contribute to fouling the ballast and clogging drainage systems, be destroyed by periodic herbicide treatment by track maintenance personnel or interfere with the traction power lines. Cut and fill areas requiring erosion protection must be seeded during construction with native grasses and wildflowers.

(126) Do not plant trees under overhead lines or where dripline will overhang into LRT, or railroad right-of-way. Both Utility easements and other public right-of-ways should also be considered. Maintain a minimum distance of 10’ from any pole light. All canopy trees must be placed in a location that does not inhibit the light from the source.

(127) Do not plant trees where limbs will block the bus path of travel (to a height of at least 14’ clear).

(128) Do not plant along the curb length at bus stops, where passengers will be boarding and alighting buses (typically a length of 26’ from the front of a bus).

(129) Do not plant within 5’ of any fire hydrants, post indicator valves or building backflow prevention devices per local code requirements.

(130) Landscaping over underground utilities must be considered.

(131) Design irrigation zones at similar elevations to avoid low-head drainage. Use in-line check valves where unavoidable. Group remote control valves where practical and easily maintainable. Include ball valve, and wye strainer for each manifold. At platform areas, provide 1” quick coupler valves at 50’ on-center and located where a pressure-washing truck may park safely. Provide a gate valve at each side of each track crossing to isolate system in the event of a mainline break. Where pipes cross under paving, provide PVC Schedule 40 sleeves two times the size of the pipe it is carrying. All control wiring must be sleeved in conduit under paving. Run two extra wires from the controller to the last valve in each direction paralleling the pressure mainline. All valve boxes must bolt down with Pentahead bolts (five sided).

(132) Use low-precipitation heads where practical.

(133) Use 12” pop-ups (where allowed) throughout shrub planting areas.

(134) The irrigation systems should be designed to allow a complete cycle within a 6-hour period. The watering cycles should be completed between the hours of 11:00 P.M. and 5:00 A.M. if overhead.

(135) Tree, turf and shrub areas must be irrigated separately as their watering needs differ. Irrigate plants with differing exposures separately.

(136) Use pressure compensating heads or valves where pressures throughout the system vary, particularly if a booster pump is utilized.

(137) All irrigation system must include an automatic rain shutoff switch in a vandal resistant enclosure attached to the controller cabinet.

(138) Where windy conditions prevail, designer should design the overhead irrigation system with this factor in mind.

(139) Watering schedules (Plant Establishment Period and Established Planting). Provide water use requirements for each plant and square footage calculations per County requirements.

(140) Consider local jurisdiction watering standards.

20.6. PLANT MATERIALS

Considerations for the selection of plant material include:

- Mature height and spread
- Growth rate
- Seasonal form and color
- Hardiness
- Sun/shade preferences
- Seed/fruit formation
- Allergen-producing potential
- Soil and drainage conditions
- Tolerance to wind, pollutants, and abuse
- Bird attraction
- Transplant tolerance
- Availability/initial cost
- Maintenance characteristics
- Visibility for pedestrian safety and at intersections for vehicular safety. Visibility is important for surveillance from crime and acts of violence.

20.7. TREES

(141) Existing Trees – Mature existing trees must be preserved where possible. All existing trees on the site must be indicated in the contract documents and appropriate protection during construction must be specified for those that are to remain. In conformance with the County's Oak Tree Preservation Ordinance, special techniques for aeration, grading changes, paving and so forth, may need to be undertaken to ensure continued health. Damage compensation and arborist consultation should be included in specifications concerning preservation of existing trees.

(142) Street Trees – Trees should be part of an existing street tree pattern established by the local governmental authority for adjoining areas. Where no pattern exists, an orderly pattern must be established as determined by the SacRT staff and approved by local jurisdiction. Where tree planting is closer than 5' from an adjacent curb or paving area, tree root barriers must be provided.

(143) Minimum caliper of trees located in paved pedestrian areas should be 2-1/2", with 4" being desirable. Trees must be spaced between 25' and 40' apart depending on the species. In all other areas, a minimum caliper of 1-1/2" is desirable. Remove nursery leader stakes prior to planting. If tree cannot stand in a straight unbending position, this tree is undesirable and should be rejected.

(144) The longitudinal spacing will be adjusted to accommodate LRT vehicle doors and subsurface conditions such as utilities and vaults, as well as special conditions such as existing or proposed sidewalk canopies, awnings, and shelters.

(145) Where applicable, new street trees at stations should relate to existing landscaping. A standard street tree must be approved by the local jurisdictions.

(146) Trees must be pruned so all foliage is at least 7' above grade, to avoid providing hiding places, to discourage vandalism, and to maintain ADA-required clear height for pedestrians. Where adjacent to roadways, limbs and foliage should be trimmed to at least 12' above grade (14' preferred) to prevent buses from striking limbs.

(147) All trees must be placed in prepared planting pits twice the diameter of the plant container.

(148) A list of trees commonly used by SacRT is contained in Appendix B and may be used as a general guideline.

20.8. TREE GRATES

A cast iron grate with minimum area of 16 square feet should be provided where necessary to prevent compaction of the soil surface. Tree grates must be designed to support the weight of one wheel of a service vehicle. Refer to ADA and CBC for maximum grate opening size.

20.9. TREE GUARDS

Tree guards should be considered at locations where tree trunks are likely to receive abuse from service vehicles or pedestrians.

20.10. GUYING AND STAKING

All trees in pedestrian areas must be staked when they are planted. For non-pedestrian areas, trees under 4” in caliper should be staked or guyed as necessary. Trees greater than 4” in caliper must be guyed with a minimum of three guys, if determined to be necessary as trees grow towards maturity. Trees that cannot support their "heads" should not be accepted on the project.

20.11. SOIL PREPARATION

All planter areas throughout the site must be cleared and grubbed and all deleterious material such as rock, debris, concrete, and trash removed prior to placing topsoil or subsoil backfill. Subsoil must be ripped to a depth of 12” prior to placing topsoil.

20.12. SHRUBS AND GROUND COVER

Where shrubs are necessary for accent or screening, they should be selected and grouped in a manner to minimize maintenance. Ground cover or low shrubs may be used in landscaped areas on slopes where pedestrian activity is to be discouraged. Consideration should be given for the duration for plants to get to be a deterrent.

Selection of plant material must consider seasonal appearance, size, and spacing of plants. For example, in no instance will a deciduous ground cover planting be utilized. Plants should be selected from a palette that generally looks good throughout the year. Deciduous plantings should be selected for accent only. Shrubs and ground covers should be kept to 18” maximum height, to avoid creating hiding places.

Shrubs must be placed in prepared panting pits twice the diameter of the root ball. A list of shrubs and groundcovers commonly used by SacRT is contained in Appendix B and may be used as a general guideline.

20.13. MULCH

Prior to installing bark, an application of pre-emergent must be applied to all shrub and ground cover areas. Care should be taken to prevent pre-emergent from over-spraying onto seeded areas, walks and walls causing staining, or death of seeded areas. A minimum 3” layer of shredded bark mulch (not gorilla hair or pebble-type) must be installed in all shrub and ground cover areas to retain soil moisture and minimize weed growth. Gorilla hair mulch has been known to be hazardous as it is very combustible. “Pebble”-type of bark tends to flow readily with runoff from excess irrigation or rains. At the end of maintenance/plant establishment period, the bark mulch must be replenished.

20.14. VINES

Vines may be used selectively to landscape vertical surfaces, such as retaining walls and sound walls. The covering of walls with vines will discourage graffiti application. Coordination of vines with wall design should be considered. The use of vines along light rail corridor soundwalls is discouraged due to the need to post watchers for maintenance access.

20.15. GRASS

The use of grass should be avoided (poor drought resistance and high maintenance) except in drainage swales. If used, grass should be "no-mow" varieties. On slopes greater than 2:1, an erosion control specialist must be consulted. Wildflower seeding, erosion control seeding or ground cover is preferred for landscaping areas of slope less than 3:1. Prior approval by SacRT staff is required.

20.16. SOIL

Existing soil on site should be tested and new soil should be imported as necessary to improve fertility, soil structure and drainage. Planting area preparation and special measures (i.e., aeration tubes, deep water, drainage, etc.) may be necessary to ensure successful plantings and understand if any special tolerances are required (salts, verticillium wilt, poor drainage, slope stabilization, etc.). In many areas of the District, percolation is a concern. A Soils test by a soils laboratory to determine the proper methods and materials required for soil fertility and proper plant establishment is required. Proper soil preparation during construction is critical.

20.17. DRAINAGE

Where possible and practical, drainage should be kept on the surface of the soil as long as possible to allow for absorption into the soil. Efforts should be taken to add retention basins and bioswales and plants that will improve water quality from stormwater runoff from impermeable areas such as parking lots. Attention is directed to Stormwater Quality Improvement Plans for the local agency in whose jurisdiction the facility is located.

20.18. MAINTENANCE/PLANT ESTABLISHMENT PERIOD

Survival of plant material is critical. Plant establishment through the initial 90-days of its growing cycle is equally important to the plant's survival. A minimum 90-day maintenance/plant establishment period must be included in the project. For more intensive plantings, a longer duration is strongly recommended. Maintenance personnel must be experienced in horticulture and landscape maintenance for transportation facilities. Maintenance must be regularly performed on all plantings. Irrigation system must be regularly flushed and operated to ensure proper operation and complete coverage. All walks, walls and flatwork must be regularly cleaned. Graffiti should be abated immediately. All tree pruning must be done by a licensed person or a certified Arborist. Tree stakes and ties should be inspected monthly. Throughout this period, the plants should be vigorously growing and should be flourishing at the end of the plant establishment period. The maintenance period should include watering, weeding, fertilizing, disease and pest control, mowing, trimming, aeration, trash and debris removal, weed and debris removal and all other means and methods that can be inferred as maintenance. The maintenance period during the winter does not effectively serve any purpose towards plant establishment.

SECTION 21. FUTURE TECHNOLOGY AND TRENDS

21.1. GENERAL

Several social, demographic, technological, and transportation trends have recently emerged which may significantly influence the future of transit, both nationally and in the Sacramento region. Details on these trends are provided below.

21.2. CULTURAL TRENDS

The following cultural trends have been evolving over the past couple of decades:

- People driving less overall, particularly seen in younger generations. These trends suggest that, in the future, vehicle ownership and driving may not be as valued as they were in the past.

- Renewed desire to live in urban areas. Millennials (generally speaking, those born between roughly 1980 and 2000) like having the world at their fingertips.

- More single households. Housing preferences and travel patterns associated with traditional nuclear-family households are not as dominant as in previous decades.

- Aging population. While younger generations are driving less, the baby boomer generation are reaching retirement age and driving less as well and will need accessible and convenient transportation options.

- Diversifying population. California is at the forefront of America's racial diversification which historically results in higher rates of transit use.

- Impacts of technology. Smart phone-based ride-hailing services such as Uber and Lyft provide a new set of mobility options.

- Changes to shopping behaviors. As internet shopping grows exponentially, people are making fewer trips to stores.

21.3. TECHNOLOGY

Similarly, the rapid advances of technology will continue to influence lifestyles, how people connect, and where and how they choose to live, work, and travel. Newly developed technologies have changed the expectations of transit riders, and dynamic, flexible, and real-time information now informs travel decisions and behavior.

- Smart Phone Applications. Smart phone apps can be used to look up wait times for buses and trains, figure out where a route goes, and even to pay fares.

- Multimodal mapping services such as Google Maps and Apple Maps provide information on stop locations, routes serving those stops, wait times, and traveltimes. Transit agencies also deploy proprietary apps to distribute system maps, schedules, and rider alerts.

- Websites and Social Media. Before smart phone apps provided real-time travel information, transit agency websites offered custom trip planners, many of which were somewhat difficult to use. Agency websites are now also just one element of larger, multichannel information distribution strategies that exploit social media outlets.
- Real-Time Arrival Information. Research has found that time spent waiting on transit may be perceived as 50 percent or even 100 percent longer than it actually is. Simply letting riders know not just when their buses or trains are scheduled to arrive, but when they will actually arrive can greatly improve the transit-riding experience. Transit agencies can make real-time information on vehicle locations and projected arrival times widely available, for use in platforms ranging from Google Maps to agency-specific smartphone apps.
- Mobile Ticketing. Fare payment options have greatly expanded in the last 15 years. First, stored-value smart cards replaced tokens and eventually paper passes. More recently, smart cards have started to give way to mobile ticketing apps that allow users to pay using their smart phones rather than having to acquire and physically reload smart cards.
- Vehicle Technologies. Several transit operators have recently incorporated new techniques and technologies into their operations, from automated passenger counters aboard vehicles to dispatch software platforms for demand-responsive services. But the most significant advancement may be new methods of vehicle propulsion, most notably the rise of electric and battery-powered buses and streetcars. The enhanced innovation of these types of vehicles has reached a point where they can be a viable, reliable option for everyday operations.

21.4. TRANSPORTATION TRENDS

21.4.1 Shared Mobility

These options generally fall into the category of shared mobility services, or ways of making private vehicles more efficient by ride sharing or car sharing. Many new alternatives blur the line between private and public transportation. Some will likely compete with transit, while others will prove complementary. For example, bike sharing and ride sharing can assist fixed-route transit users with their “first-mile/last-mile” issues of accessing stops.

Below is a summary of both newer and older nontraditional mobility offerings. Most of these options are limited to more urban areas and each have their own potential impact on transit users and operators.

Car Sharing:

- Round-trip (Traditional). Round-trip car-sharing services offer membership-based short-term car rentals that typically charge by the hour and renters must return cars to the pickup location.

- One-way. One-way car-sharing services operate similarly to round-trip car-sharing, but allow members to park and leave cars at most legal parking spots in the service area.

- Peer-to-peer. This system connects car owners with potential renters via an online interface.

- Closed network. This system is a private car-share service for a specific development. The car is managed by a property owner and available only to tenants.

Bike Sharing:

- Dock-based. A dock-based bike-share system allows people to check out a bike from a station using a credit card or membership card. Bicycles can be returned to other docks within the system.

- Dockless. Relying on GPS locators and smartphone technology, this system allows people to reserve a nearby bicycle. Bicycles can be picked up and returned at any ordinary bike rack within a service area.

- Peer-to-peer. This system connects bicycle owners to potential renters via an online interface. Using a special lock, owners can list their bicycle as available for reservation. Bicycles can be picked up and returned at ordinary bicycle racks within a service area.

Ride Hailing:

- Taxis and Limos. Taxis and limousines are the original private shared mobility services. Both provide for-hire vehicles staffed by professional drivers licensed to transport passengers.

- Transportation Network Companies (TNCs). These companies (e.g., Uber, Lyft) use an online or mobile platform to connect passengers to drivers. Drivers use their personal vehicles, and do not need a special license to transport passengers. The speed and smooth user interface for many of these services make them attractive options.

Ride Sharing:

- Carpooling. Carpooling is an arrangement between multiple people to make a trip in a single vehicle. The classic example of carpooling is when co-workers who live near each other organize to share a vehicle to work.

- Vanpooling. Vanpooling services are typically fee-based operations operated by a third party. Driven by one of the commuters, the van travels on an agreed-upon schedule to pick-up and drop-off locations.

21.4.2 Autonomous Vehicles

Development of autonomous vehicles has increased in recent years. As technology continues to evolve rapidly, major benefits such as improved safety, increased mobility, and maximized efficiency may be on the horizon. However, autonomous vehicles will bring new challenges for jurisdictions and transit agencies as technology is slowly integrated with existing infrastructure and human drivers.

Though autonomous vehicles are expected to provide safety improvements, it will take decades for roadways to become fully automated, potentially resulting in friction between autonomous and human drivers.

Additionally, this technology has the potential to increase the capacity of existing roadways through more efficient signal timing and tighter vehicle spacing, reducing congestion concerns and encouraging people to use their own vehicles rather than public transit services. Policies to curtail increased VMT due to autonomous vehicles could play an important role in preventing such concerns from materializing.

Finally, autonomous vehicles could reduce the cost of providing transit service, if driverless buses are used. However, this is unlikely to occur for some time, if ever, as transit agencies such as SacRT employ hundreds of bus operators.

As autonomous technologies begin to emerge, SacRT and other transit operators and agencies in the region will need to update infrastructure to maximize capacity and network safety while simultaneously looking ahead to address the potential challenges of managing new technologies.

APPENDIX A. BUS SPECIFICATIONS AND ELECTRIC BUSES

A.1. EXISTING BUS FLEET CHARACTERISTICS

The SacRT bus fleet as of May 2016 includes 205 buses powered by compressed natural gas (CNG) and 23 shuttle vans. Buses operate daily from 5 a.m. to 11 p.m. every 12 to 60 minutes, depending on the route. Passenger amenities include 32 bus and light rail transfer centers and 22 park-and-ride lots. SacRT also serves over 3,100 bus stops throughout Sacramento County.

RT's entire bus and light rail system is accessible to the disabled community. SacRT also provides a door-to-door transportation service (in accordance with its responsibilities under the Americans with Disabilities Act) for Sacramento area residents who are unable to use fixed-route service. SacRT provides this service through a contract with Paratransit, Inc.

RT's Community Bus program provides smaller circulator "Neighborhood Ride" buses to seven neighborhoods in Sacramento County.

The SacRT bus fleet currently consists of four major vehicle categories. The majority of the bus fleet is 40' CNG buses. Table A-1 shows the bus characteristics.

A.2. ZERO EMISSION VEHICLES

There are several types of zero emission buses that are currently being manufactured. These types differ in fueling types and technologies utilized, which subsequently affect which routes and usages these buses best service.

A.2.1. Battery Electric Buses (BEBs)

Battery electric buses (BEBs) have a battery pack and an electric motor instead of a fuel tank and an engine. This battery is the vehicle's sole source of power and must be recharged, often from the electric grid.

Medium- and heavy-duty BEBs have been predominantly used on urban or suburban routes, characterized by frequent stops and starts, high idle times, lower average speeds, and a daily range of 100 miles or less. As battery technology continues advancing with increased use of electric vehicles, overall costs of BEBs and their batteries are projected to decrease over time.

A.2.2. Hybrid Electric Vehicle Buses

Hybrid electric vehicles (HEV) have both an electric motor and an internal combustion engine, utilizing both electricity and gasoline. While the vehicle can use gasoline for part of its mileage, it can also run emission-free once switching to electric mode.

There are two primary categories of HEVs:

- parallel hybrids use both the electric motor and the engine to move the vehicle,
- series hybrids' engines can generate electricity for the motor as well to move the vehicle. Series hybrids are Hybrid Electric Vehicle Buses also known as extended range vehicles, as the engine can be used to operate the vehicle in the event that the battery is completely depleted.

A.2.3. Fuel Cell Electric Vehicle (FCEV) Buses

Fuel cell electric vehicles (FCEV) contain a fuel cell system powered by hydrogen that generates electricity to operate the vehicle. This electricity used to power the vehicle, along with heat and water vapor, are the only byproducts of fuel cells. Electricity is stored in a battery system.

While fuel cell vehicles have demonstrated comparable performance with conventional vehicles, their capital costs are still high due to low production volumes.

A.3. BATTERY ELECTRIC BUSES

Evaluation of range and charge methods for BEBs is an important step for transit agencies planning to deploy BEBs. Currently more than half of transit agencies use their own agency experience in combination with OEM predictions and bus trials in order to evaluate vehicle range, select suitable routes, and determine what type of charging method would be the best fit for their agency.

A.3.1. Charging Stations

Charging stations for electric buses will be dependent on the bus manufacturer. Overhead fast-chargers, allows on-route charging at chosen locations with fast charge times of 5-13 minutes, enabling 24/7 vehicle operation. Charge stations can be installed at curbside pullouts, transit centers or bus stops. Assisted automatic docking uses wireless communications to govern the speed and stop location of the bus and connects the charger with no input required from the driver, which enhances safety. Plug-in Depot Chargers are another option offered by manufacturers. These involve plugging in the charger into the bus port.

A.3.2. On-route Charging Infrastructure

Transit agencies typically select the location of on-route charging stations in a variety of ways, however locating them at existing transit centers was the most popular choice. Transit centers are ideal infrastructure siting locations because the real estate is already agency owned and maintained, route layovers are typically built in at these locations, the centers are typically at the midway or end of line for routes, and they are typically closed to other vehicle traffic (allowing protection for overhead chargers). Transit centers make future expansion easier as well.

Some transit agencies have also located on-route charging infrastructure at agency owned property, and on the side of public streets, although less common.

In many cases, transit agencies have had to adjust the bus schedules to accommodate the charge times. Irregular charge schedules can sometimes be required due to numerous factors, such as traffic delays, missed charges that need to be made up, and high utility demand rates.

A.3.3. Electricity Rate Structure

BEB operations costs are highly dependent on utility electricity rates, both energy costs and demand charges. These rates vary from utility to utility across the country, and can even vary within a utility price schedule. Transit agencies currently using BEBs believe that there is a need for development of a utility rate specifically suited to the needs of BEB fleets. Communication between the stakeholders (utility, public works, local and state DOTs, OEM, and local planners) was key to having a successful procurement.

TABLE A-3: SacRT ACTIVE BUS FLEET ROSTER VEHICLE SPECIFICATIONS

Please contact SacRT for latest fleet roster and specifications.

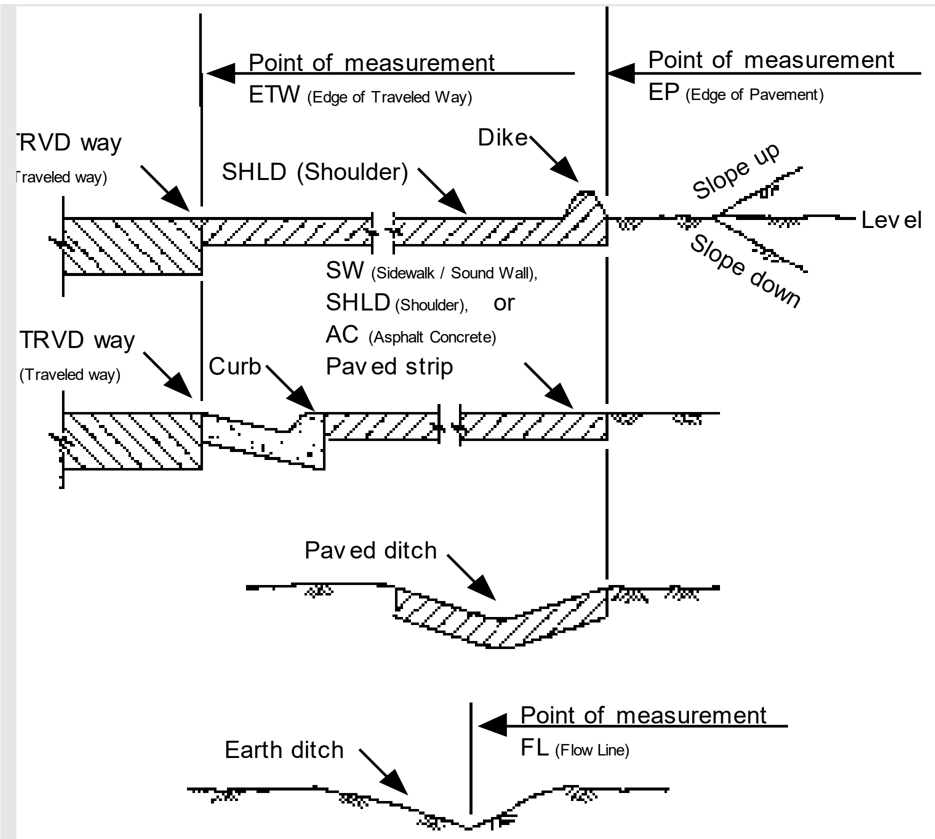
APPENDIX B. PLANT LIST AND SETBACK/SPACING DETAILS

This plant list has been developed as an aid in determining plants acceptable to SacRT and the appropriate setback and spacing for plant material used.

The minimum setbacks should not be reduced unless special circumstances or unusual site conditions warrant adjustment. Tree setbacks should not be reduced. All safety requirements must be met including, but not limited to, those set forth in these guidelines, the Light Rail Design Criteria, and requirements of the local agency jurisdiction.

The on-center spacing of plants is a general recommendation representing distance apart which plants should be spaced when planted. The spacing is based upon the mature growth of the plant material. The distance is set to prevent crowding of plant material the need for pruning when the plants are mature.

This plant list is not intended to represent all acceptable plant materials used on SacRT projects nor does it indicate suitability of plant materials for specific situations. It is only a selection taken from previous projects. When specifying plant material not included in the plant list, use judgment to select spacing and setback consistent with other species of similar mature growth characteristics.



SECTION
POINTS OF MEASUREMENT

TABLE B-1: PLANT LIST AND SETBACK/SPACING DETAILS											
BOTANICAL NAME COMMON NAME		TRAV WAY	PVMT	FENCE	WALL	PAVED DITCH	EARTH DITCH		ON CENTER		DESCRIPTION
Abelia 'Edward Goucher' Goucher Abelia		**-**	**6**	**2**	**2**	**2**	**2.5**		**2**		**SHRUB**
Abelia X grandiflora Glossy Abelia		**-**	**2.5**	**2**	**2**	**2**	**2.5**		**2.5**		**SHRUB**
Acacia melanoxylon Blackwood Acacia		12*	-	4.5	4.5	3	3.5		-		TREE
Acacia pendula Weeping Acacia		6	-	4.5	4.5	4.5	5		-		TREE
Acacia redolens Prostrate Acacia		-	6	6	6	6	7		6		GROUND COVER
Acer macrophyllum Big-Leaf Maple		9	-	6	6	6	7		-		TREE
Aesculus californica California Buckeye		11	-	6	6	3	3.5		-		TREE
Albizia julibrissin Mimosa		12	-	6	6	3	3.5		-		TREE
Arbutus unedo Strawberry Tree		-	4.5	4.5	4.5	3.5	3.5		3		SHRUB
Arbutus unedo 'Compacta' Compact Strawberry Tree		-	2.5	2.5	2.5	2.5	3		2		SHRUB
Arctostaphylos bakeri 'Louis Edmunds' No common name		-	2	2	2	2	2.5		2		SHRUB
Arctostaphylos densiflora 'Howard McMinn' No common name		-	2	2	2	2	2.5		2		SHRUB
Arctostaphylos edmundsii Little Sur Manzanita		-	3	3	3	3	3.5		3		GROUND COVER
Arctostaphylos 'Emerald Carpet' No common name		**-**	**2.5**	**2.5**	**2.5**	**2.5**	**3**		**2.5**		**GROUND COVER**
Arctostaphylos hookeri Hooker Manzanita		-	2	2	2	2	2.5		2		SHRUB
Arctostaphylos hookeri 'Wayside' No common name		-	3	2	2	3	3.5		3		SHRUB
Arctostaphylos 'Pacific Mist' No common name		-	2.5	2.5	2.5	2.5	3		2		SHRUB
Arctostaphylos pajaroensis Pajaro Manzanita		-	2	2	2	2	2.5		-		SHRUB

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS											
BOTANICAL NAME **COMMON NAME**		**TRAV WAY**	**PVMT**	**FENCE**	**WALL**	**PAVED DITCH**	**EARTH DITCH**		**ON CENTER**		**DESCRIPTION**
Arctostaphylos uva-ursi Bearberry		-	2.5	2.5	2.5	2.5	3		2.5		GROUND COVER
Arctostaphylos uva-ursi 'Radiant' No common name		-	2.5	2.5	2.5	2.5	3		2.5		GROUND COVER
Arecastrum romanzoffianum Queen Palm		9	-	2	2	2	2		-		TREE
Berberis thunbergii 'Atropurpurea' Red Barberry		-	2	2	2	3	3		2		SHRUB
Berberis thunbergii 'Crimson Pygmy' Crimson Pygmy Barberry		-	2	2	2	2	2.5		1		SHRUB
Brahea edulis Guadalupe Palm		6	-	3	3	4.5	5		-		PALM
Buddleia davidii Butterflybush		-	3.5	3	3	3	3.5		3		SHRUB
Callistemon citrinus Lemon Bottlebrush		-	4.5	4.5	4.5	4.5	5		3.5		SHRUB
Callistemon viminalis Weeping Bottlebrush		6	-	4.5	4.5	4.5	5		-		TREE
Calocedrus decurrens Incense Cedar		9	-	6	6	6	7		-		TREE
Campsis radicans Common Trumpet Creeper		-	-	-	-	3	3.5		3		VINE
Carpenteria californica Bush Anemone		-	2.5	2.5	2.5	2.5	3		5		SHRUB
Carpobrotus edulis Hottentot Fig		-	2	2	2	2	2.5		0.5		GROUND COVER
Casuarina stricta Mountain She Oak		9	2	4.5	3	3	3.5		-		TREE
Ceanothus 'Concha' No common name		-	3	2.5	2.5	2.5	3		2.5		SHRUB
Ceanothus griseus horizontalis 'Yankee Point'		-	4.5	3	2	3	3.5		2		SHRUB
Ceanothus 'Joyce Coulter' Wild lilac		-	3	2.5	2.5	2.5	3		2.5		SHRUB
Ceanothus 'Ray Hartman' No common name		-	4.5	4.5	3	3	3.5		3		SHRUB

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS											
BOTANICAL NAME COMMON NAME		**TRAV WAY**	**PVMT**	**FENCE**	**WALL**	**PAVED DITCH**	**EARTH DITCH**		**ON CENTER**		**DESCRIPTION**
Ceanothus thyrsiflorus Blueblossom		-	4.5	4.5	4.5	4.5	5		4.5		SHRUB
Cedrus deodara Deodar Cedar		12.5	-	9	9	9	10		-		TREE
Celtis occidentalis Common Hackberry		9	-	6	6	4.5	5		-		TREE
Celtis sinensis\\ Chinese Hackberry		**9**	**3**	**4.5**	**3**	**3**	**3.5**		**-**		**TREE**
Cercidium floridum Blue Palo Verde		-	4.5	4.5	4.5	4.5	4.5				SHRUB
Cercidium microphyllum Littleleaf Palo Verde		-	4.5	4.5	4.5	4.5	4.5		-		SHRUB
Cercis canadensis Eastern Redbud		9	-	4.5	4.5	4.5	5		-		TREE
Cercis occidentalis Western Redbud		-	4.5	4.5	4.5	4.5	4.5		-		SHRUB
Cercocarpus betuloides Mountain Mahogany		-	3.5	3	3	3	3.5		3		SHRUB
Chaenomeles speciosa Flowering Quince		-	2	2	2	2	2.5		-		SHRUB
Chitalpa tashkentensis No common name		12		6	6	3	3.5				TREE
Cinnamomum camphora Camphor Tree		12.5	-	9	9	6	7		-		TREE
Cistus (All Varieties) Rock Rose		**-**	**2**	**2**	**2**	**2**	**2**		**2**		**SHRUB**
Clytostoma callistegioides Violet Trumpet Vine		-	-	-	-	2.5	3		3		VINE
Coprosma X kirkii No common name		**-**	**2**	**2**	**2**	**2**	**2.5**		**1**		**SHRUB**
Correa pulchella Australian Fuchsia		-	4	4	4	4	4		4		SHRUB
Cotinus coggygria Smoke Tree		-	4.5	4.5	4.5	4.5	5		3		SHRUB
Cotinus coggygria 'Purpureus' No common name		-	4.5	4.5	4.5	4.5	5		3		SHRUB

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS											
BOTANICAL NAME **COMMON NAME**		**TRAV WAY**	**PVMT**	**FENCE**	**WALL**	**PAVE D DITCH**	**EART H DITC**		**ON CENTER**		**DESCRIPTIO N**
Cotoneaster lacteus Parney Cotoneaster		-	3	3	3	3	3.5		3		SHRUB
Cupressus arizonica glabra Smooth Arizona Cypress		9	-	4.5	4.5	4.5	5		-		TREE
Cupressus macrocarpa Monterey Cypress		9	-	6	6	6	7		-		TREE
Delosperma alba White Trailing Iceplant		-	2	2	2	2	2.5		0.3		GROUND COVER
Elaeagnus pungens **Silverberry**		**-**	**4.5**	**3**	**3**	**3**	**3.5**		**3**		**SHRUB**
Escallonia exoniensis No common name		-	3	2.5	2.5	2.5	3		2		SHRUB
Escallonia 'Newport Dwarf' **No common name**		**-**	**1.5***	**1.5***	**1.5***	**1.5***	**1.5***		**1**		**SHRUB**
Escallonia rubra Red Escallonia		-	3	2.5	2.5	2.5	3		2		SHRUB
Euonymus fortunei radicans Trailing Euonymus		-	6	6	6	6	7		4.5		SHRUB
Ficus pumila Creeping Fig		-	-	-	-	3	3.5		3		VINE
Fraxinus uhdei Shamel Ash		12.5*	-	4.5	4.5	4.5	5		-		TREE
Fremontodendron 'California Glory' Flannel Bush		-	4.5	3	3	3	3.5		3		SHRUB
Fremontodendron mexicanum Mexican Flannel Bush		-	4.5	3	3	3	3.5		3		SHRUB
Garrya elliptica Coast Silk-tassel		-	4.5	3	3	3	3.5		3		SHRUB
Garrya elliptica 'James Roof' No common name		-	4.5	3	3	3	3.5		3		SHRUB
Gazania rigens leucolaena 'Sunrise Yellow' Gazania		-	2	2	2	2	2.5		0.3*		GROUND COVER
Geijera parviflora Australian Willow		9	-	3	3	3	3.5		-		TREE
Gelsemium sempervirens Carolina Jessamine		-	-	-	-	3	3.5		3		VINE

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS

BOTANICAL NAME COMMON NAME		TRAV WAY	PVMT	FENCE	WALL	PAVED DITCH	EARTH DITCH		ON CENTER		DESCRIPTION
Ginkgo biloba Ginkgo		9	-	6	4.5	4.5	5		-		TREE MALE ONLY
Gleditsia triacanthos inermis 'Moraine' Moraine Honey Locust		9	4	4.5	4	4	4		-		TREE
Grevillea 'Canberra' No common name		-	3	3	3	2.5	3		3		SHRUB
Grevillea 'Poorinda Constance' No common name		-	3	3	3	2.5	3		3		SHRUB
Grevillea 'Noellii'' No common name		-	2.5	2.5	2.5	2	2.5		2		SHRUB
Grevillea rosmarinifolia Rosemary Grevillea		-	2.5	2	2	2	2.5		1.5		SHRUB
Grewia caffra Lavender Starflower		-	3	3	3	2	2.5		2.5		SHRUB
Hedera canariensis Algerian Ivy		-	2	2	2	2	2.5		0.3*		GROUND COVER
Hedera helix English Ivy		-	2	2	2	2	2.5		0.3*		GROUND COVER
Hemerocallis hybrids Daylily		-	1	1	1	1	5		1		-
Heteromeles arbutifolia Toyon		-	4.5	4.5	3	3	3.5		4.5		SHRUB
Hymenosporum flavum Sweetshade		9	-	4.5	4.5	4.5	5		-		TREE
Jasminum humile Italian Jasmine		-	4.5	4.5	4.5	4.5	5		3		SHRUB
Jasminum mesnyi Primrose Jasmine		-	4.5	4.5	4.5	4.5	5		3		SHRUB
Juniperus chinensis 'Pfitzerana' Pfitzer Juniper		-	2	2	2	2	2.5		2		SHRUB
Juniperus chinensis sargentii Sargent Juniper		-	3	3	2	3	3.5		2		SHRUB
Juniperus horizontalis 'Wiltonii' Wilton Carpet Juniper		**-**	**2**	**2**	**2**	**2**	**2.5**		**2**		**SHRUB**
Juniperus sabina 'Broadmoor' Broadmoor Juniper		-	2	2	2	2	2.5		3		SHRUB

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS											
BOTANICAL NAME COMMON NAME		TRAV WAY	PVMT	FENCE	WALL	PAVED DITCH	EARTH DITCH		ON CENTER		DESCRIPTION
Juniperus sabina 'Scandia' No common name		-	3	3	3	3	3.5		3		SHRUB
Koelreuteria bipinnata Chinese Flame Tree		9	-	3	3	3	3.5		-		TREE
Koelreuteria paniculata Golden Rain Tree		9	-	4.5	4.5	4.5	5		-		TREE
Lagerstroemia indica Crape Myrtle		**9**	**-**	**4.5**	**4.5**	**4.5**	**5**		**-**		**TREE**
Lagerstromia indica 'Dwarf' Crape Myrtle (Dwarf		**-**	**3**	**2**	**2**	**2**	**3**		**2**		**SHRUB**
Leptospermum laevigatum Australian Tea Tree		-	4.5	4.5	4.5	4.5	5		-		SHRUB
Leptospermum scoparium New Zealand Tea Tree		-	4.5	3	3	3	3.5		3		SHRUB
Leucophyllum frutescens Texas Ranger		-	2.5	2	2	2	2.5		2		SHRUB
Liquidambar styraciflua Sweet Gum		9	-	4.5	4.5	4.5	5		-		TREE
Liriodendron tulipifera Tulip Tree		12.5	-	6	4.5	4.5	5		-		TREE
Lonicera japonica 'Halliana' Hall's Honeysuckle		-	-	-	-	2	2.5		2.5		VINE
Lycianthes rantonnei Blue Potato Bush		-	2.5	2.5	2.5	2.5	3		2.5		SHRUB
Lyonothamnus floribundus asplenifolius Fern-Leaf Catalina		9	-	6	6	3	3.5		-		TREE
Macfadyena unguis-cati Cat's-Claw		-	-	-	-	3	3.5		2.5		VINE
Magnolia grandiflora Southern Magnolia		9	-	4.5	4.5	4.5	5		-		TREE
Mahonia aquifolium Oregon Grape		-	2	2	2	2	2.5		2		SHRUB
Mahonia pinnata California Holly-Grape		-	2	2	2	2	2.5		2		SHRUB
Malephora crocea purpureo-crocea (Hymenocyclus) Ice plant		-	2	2	2	2	2.5		0.3*		GROUND COVER

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS											
BOTANICAL NAME COMMON NAME		**TRAV WAY**	**PVMT**	**FENCE**	**WALL**	**PAVED DITCH**	**EARTH DITCH**		**ON CENTER**		**DESCRIPTION**
Melaleuca armillaris Drooping Melaleuca		-	6	6	6	6	7		-		SHRUB
Myoporum laetum No common name		9	-	6	6	6	7		-		TREE
Myoporum 'Pacificum' Prostrate Myoporum		-	6	6	6	6	7		6		SHRUB
Myoporum parvifolium 'Putah Creek' Prostrate Myoporum			6	6	6	6	7		6		GROUND COVER
Myrica californica Pacific Wax Myrtle		-	4.5	3.5	3.5	3.5	4.5		3		SHRUB
Myrtus communis True Myrtle		-	4.5	4.5	4.5	4.5	5		2.5		SHRUB
Nandina domestica Heavenly Bamboo		**-**	**2.5**	**2.5**	**2.5**	**2.5**	**3**		**4**		**SHRUB**
Nandina domestica 'Nana Purpurea' Dwarf Heavenly Bamboo											SHRUB
Nyssa sylvatica Sour Gum		9	-	6	6	6	7		-		TREE
Olea europaea 'Fruitless' Olive		9	-	4.5	4.5	3	3.5		-		TREE
Olea europaea 'Skylark Dwarf' No common name		-	2.5	2.5	2.5	2.5	3		2.5		SHRUB
Parkinsonia aculeata Jerusalem Thorn		9	4.5	4.5	4.5	4.5	5		-		TREE
Parthenocissus tricuspidata Boston Ivy		-	-	-	-	4	4.5		3		VINE
Paulownia tomentosa Empress Tree		12.5	-	6	6	4.5	5.5		-		TREE
Photinia X fraseri Photinia		**-**	**4.5**	**4.5**	**3**	**3**	**3.5**		**3**		**SHRUB**
Photinia serrulata Chinese Photinia		-	6.5	4.5	3	3	3.5		3		SHRUB
Pistacia chinensis Chinese Pistache		**12.5**	**-**	**6**	**6**	**6**	**7**		**-**		**TREE**
Pittosporum crassifolium Black Pittosporum		-	4.5	3	3	2.5	3		3		SHRUB

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS

BOTANICAL NAME COMMON NAME		TRAV WAY	PVMT	FENCE	WALL	PAVED DITCH	EARTH DITCH		ON CENTER		DESCRIPTION
Pittosporum tenuifolium Tawhiwhi		-	4.5	3	3	2.5	3		2.5		SHRUB
Pittosporum tobira Tobira		**-**	**4.5**	**3**	**2**	**2**	**2.5**		**2**		**SHRUB**
Pittosporum tobira 'Variegata' Variegated Tobira		-	3	3	3	3	3.5		3		SHRUB
Pittosporum tobira 'Wheeler's Dwarf'No common name		-	1	1	1	2	2		2.5		SHRUB
Platanus X acerifolia \London Plane		**9**	**-**	**6**	**6**	**3**	**3.5**		**-**		**TREE**
Platanus racemosa California Sycamore		12.5	-	6	6	3	3.5		-		TREE
Plumbago auriculata Cape Plumbago		-	4.5	4.5	4.5	4.5	5		3		SHRUB
Podocarpus henkelii Long-Leafed Yellow-Wood		9	-	4.5	4.5	4.5	5		-		SMALL TREE
Polygonum aubertii Chinese Fleece Vine		-	-	-	-	3	3.5		3		VINE
Populus fremontii Fremont Cottonwood		12.5	-	6	6	6	7		-		TREE
Populus nigra 'Italica' Lombardy Poplar		18*	-	18*	12.5*	18*	12.5*		-		TREE
Prunus caroliniana Carolina Cherry Laurel		-	3.5	3	3	3	3.5		3		SHRUB
Prunus ilicifolia Holly-Leaf Cherry		-	4.5	4.5	4.5	4.5	5		4.5		SHRUB
Prunus ilicifolia 'lyonii' Catalina Cherry		-	4.5	4.5	4.5	4.5	5		4.5		SHRUB
Pseudotsuga menziesii Douglas Fir		9	-	6	6	6	7		-		TREE
Pyrus calleryana Callery Pear		9	-	4.5	4.5	4.5	5		-		TREE
Pyrus kawakamii Evergreen Pear		9	-	4.5	4.5	4.5	5		-		TREE
Quercus agrifolia Coast Live Oak		9	-	6	4.5	4.5	5		-		TREE
Quercus coccinea Scarlet Oak		9	-	4.5	4.5	4.5	5		-		TREE
Quercus douglasii Blue Oak		9	-	6	4.5	4.5	5		-		TREE

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS

BOTANICAL NAME COMMON NAME		TRAV WAY	PVMT	FENCE	WALL	PAVED DITCH	EARTH DITCH		ON CENTER		DESCRIPTION
Quercus engelmannii Engelmann Oak		9	-	6	6	6	7		-		TREE
Quercus kelloggii California Black Oak		9	-	6	6	6	7		-		TREE
Quercus lobata Valley Oak		**9**	**-**	**6**	**6**	**6**	**7**		**-**		**TREE**
Quercus palustris Pin Oak		9	-	6	6	6	7		-		TREE
Quercus wislizenii Interior Live Oak		**9**	**-**	**4.5**	**4.5**	**3**	**3**		**-**		**TREE**
Rhamnus alaternus 'John Edwards' No common name		-	4.5	4.5	3	3	3.5		4.5		SHRUB
Rhamnus californica Coffeeberry		-	4.5	4.5	3	3	3.5		4.5		SHRUB
Rhamnus californica 'Eve Case' No common name		-	2.5	2.5	2.5	2	3		2		SHRUB
Rhamnus californica 'Sea View' No common name		-	3	3	3	3	3.5		2		SHRUB
Rhamnus ilicifolia Hollyleaf Redberry		4.5	4.5		3	3	3.5		4.5		SHRUB
Rhaphiolepis indica Indian Hawthorn		-	2.5	3	3	2.5	3		2		SHRUB
Rhaphiolepis indica 'Ballerina' No common name		**-**	**1**	**1**	**1**	**2**	**2**		**1**		**SHRUB**
Rhaphiolepis indica 'Clara' No common name		-	3	2	2	3	3.5		2		SHRUB
Rhaphiolepis indica 'Jack Evans' No common name		**-**	**2.5**	**3**	**3**	**2.5**	**3**		**2**		**SHRUB**
Rhaphiolepis indica 'Pink Cloud' No common name		-	2.5	3	3	2.5	3		2		SHRUB
Rhaphiolepis indica 'Rosea' No common name		**-**	**2.5**	**3**	**3**	**2.5**	**3**		**2**		**SHRUB**
Rhaphiolepis indica 'Springtime' No common name		-	3	2	2	3	3.5		2		SHRUB
Rhaphiolepis 'Majestic Beauty' No common name		-	3.5*	3	3	3.5*	3		3*		SHRUB

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS											
BOTANICAL NAME COMMON NAME		**TRAV WAY**	**PVMT**	**FENCE**	**WALL**	**PAVED DITCH**	**EARTH DITCH**		**ON CENTER**		**DESCRIPTION**
Rhaphiolepis umbellata Yeddo Hawthorn		-	2.5	2.5	2.5	2.5	2.5		2		SHRUB
Rhus integrifolia Lemonade Berry		-	4.5	3	3	3	3.5		3.5		SHRUB
Rhus lancea African Sumac		-	6	4.5	4.5	4.5	5		3.5		SHRUB
Rhus laurina Laurel Sumac		-	6	4.5	4.5	4.5	5		3.5		SHRUB
Rhus ovata Sugarbush		-	4.5	3	3	3	3.5		3.5		SHRUB
Ribes sanguineum Red Flowering Currant		-	2	4	4	4	4		4		SHRUB
Ribes viburnifolium Evergreen Currant		-	2.5	2.5	2.5	2.5	2.5		2		SHRUB
Robinia X ambigua 'Idahoensis' Idaho Locust		9	4.5	4.5	3	3	3.5		-		TREE
Romneya coulteri Matilija Poppy		-	3.5	3	3	3	3.5		2.5		SHRUB
Rosa banksiae Lady Banks' Rose		-	4.5*	4.5*	-	4*	2.5		3*		VINE
Rosa banksiae 'Lutea' Banks' Yellow Rose		-	4.5*	4.5*	-	4*	2.5		3*		VINE
Rosa 'Meidiland' Rose		**-**	**2.5 to 4***	**2.5**	**2.5**	**2.5**	**3**		**2 to 4**		**SHRUB**
Rosmarinus officinalis Rosemary		-	2	2	2	2	2.5		1		SHRUB
Rosmarinus officinalis 'Prostratus' No common name		**-**	**3**	**2**	**2**	**2.5**	**2.5**		**2**		**GROUND COVER**
Salvia leucophylla 'Point Sal' Point Sal Spreader		-	2.5	2	2	2	2.5		5		SHRUB
Sambucus mexicana Blue Elderberry		-	4.5	4.5	4.5	4.5	5		3		SHRUB
Sapium sebiferum Chinese Tallow Tree		9	-	4.5	4.5	4.5	5		-		TREE
Schinus molle California Pepper Tree		12.5	-	9	7.5	6	7		-		TREE
Schinus terebinthefolius Brazilian Pepper Tree		11	-	6	6	4.5	5		-		TREE

Note: Those plants highlighted are more commonly used by SacRT

TABLE B-1 (CONTINUED): PLANT LIST AND SETBACK/SPACING DETAILS												
BOTANICAL NAME **COMMON NAME**		**TRAV WAY**	**PVMT**	**FENCE**	**WALL**	**PAVED DITCH**	**EARTH DITCH**		**ON CENTER**		**DESCRIPTION**
Senna artemisioides Feather Cassia		-	2	2	2	2	2.5		2		SHRUB
Sequoia sempervirens Coast Redwood		9	-	6	6	6	7		-		TREE
Sollya heterophylla Australian Bluebell Creeper		-	3	2	2	2	2.5		2		SHRUB
Tamarix aphylla Athel Tree		9	-	6	6	6	7		-		TREE
Taxodium mucronatum Montezuma Cypress		9	-	6	6	6	7		-		TREE
Tipuana tipu Tipu Tree		9	-	4.5	4.5	4.5	5		-		TREE
Trachelospermum jasminoides **Star Jasmine**		**-**	**3**	**-**	**-**	**3**	**3.5**		**2**		**GROUND COVER**
Trachycarpus fortunei Windmill palm		9	-	3.5	3.5	3.5	4.5		-		TREE
Umbellularia californica California Bay		12.5	-	9	9	6	7		-		TREE
Vaccinium ovatum Evergreen Huckleberry		-	2.5	2.5	2.5	2.5	3		2.5		SHRUB
Viburnum tinus **Laurustinus**		**-**	**2**	**2**	**2**	**2**	**2.5**		**2**		**SHRUB**
Xylosma congestum **Shiny Xylosma**		**-**	**4.5**	**4.5**	**3**	**3**	**3.5**		**3**		**SHRUB**
Xylosma congestum 'Compactum' **Compact Shiny Xylosma**		**-**	**3**	**3**	**2.5**	**2.5**	**3**		**2**		**SHRUB**

Note: Those plants highlighted are more commonly used by SacRT

APPENDIX C. PHOTOGRAPHS OF EXISTING FACILITIES

PLATE C-1: BUS STOP WITH SHELTER (HIGH VOLUME LOCATION)

PLATE C-2: BUS STOP LOW VOLUME LOCATION

PLATE C-3: BUS STOP AT PNR FACILITY

PLATE C-4: KISS-AND-RIDE CLOSE PROXIMITY TO STATION

PLATE C-5: DIRECT ACCESSIBLE PATH TO STATION

PLATE C-6: HANDICAP PARKING AT PNR FACILITY

PLATE C-7: MINI-HIGH ACCESSIBLE RAMP

PLATE C-8: MINI-HIGH ACCESSIBLE RAMP

PLATE C-9: DEFINED DIRECT ACCESSIBLE PATH

PLATE C-10: ACCESSIBLE SIGNAGE

PLATE C-11: ACCESSIBLE FARE VENDING MACHINES

PLATE C-12: 24” PLATFORM WARNING TILE

PLATE C-13: CLEAR DIRECT ACCESSIBLE PATHWAYS

PLATE C-14: WATER FOUNTAINS, TRASH RECEPTACLES, NEWSPAPER STANDS OFF DIRECT PATHWAY

PLATE C-15: SUB-STATIONS TO RECEIVE AESTHETIC ENHANCEMENT

PLATE C-16: ELECTRICAL OR SIGNALING BUILDING TO RECEIVE AESTHETIC ENHANCEMENT

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APPENDIX D. GLOSSARY

Arterial Street: A major street or high-capacity highway, primarily for through traffic, usually on a continuous route with unlimited access to adjacent streets.

Berm: A landscaped mound or wall of earth.

Bus: A self-propelled, rubber-tired vehicle that is not confined to a fixed guideway and that is designed to transport a large number of persons, specifically to transport more persons than a limousine or van, i.e., designed to transport at least 11 to 15 persons.

- **Standard Bus:** A motor bus designed to accommodate the maximum number of passengers both seated and standing for short-ride, frequent-stop service and to have quick-opening entrance and exit service doors; usually from 35' to 41' in length.
- **Articulated Bus:** An extra-long bus that has the rear portion flexibility but permanently connected to the forward portion with no interior barrier to movement between the two parts, permitting the vehicle to turn within a relatively short turning radius; the passenger capacity is about 60 to 80 persons seated, with room for many standees, and the length is from 60' to 70'.

Bus Terminus: Either end of a bus route with associated passenger facilities that is central to considerable area or serves as a junction at any point with other routes.

CBD: Central Business District. That portion of a municipality in which the dominant land use is for intense business activity. This district is characterized by large numbers of pedestrians, commercial vehicle loadings of goods and people, a heavy demand for parking space, and high parking turnover.

Collector Street: A street that gathers and disperses traffic between the larger arterial streets and local streets, that has intersections at grade, and that is important in providing complete movement to and from first origins and final destinations.

Crime Prevention Through Environmental Design (CPTED): Is based on the principle that effective design that uses the built environment can result in a deterrent for, and a reduction in, the incidence of crime and an improvement in the quality of life.

Demand Response: A transportation service characterized by flexible routing and scheduling of relatively small vehicles to provide door-to-door or point-to-point transportation at the user's demand by using a smart phone application, phone-in reservation system, or a pre-scheduled arrangement.

Dwell Time: The time, in seconds, that a transit vehicle spends waiting to pick up, or drop off, passengers.

Fixed Route: Transit service provided on a repetitive, scheduled basis along a specific route with transit vehicles stopping to pick up and discharge passengers at the same locations each time they traverse the route.

Front-Kneel Feature: Driver-actuated device that lowers the front end of the bus during loading and unloading to reduce the effective first step height, i.e., from ground level.

Light Rail: A type of electric transit vehicle railway with a “light volume” traffic capacity compared to “heavy rail.” Light rail may be on exclusive or shared rights-of-way, high or low platform loading, multi-car trains or single-cars, automated or manually operated. In generic usage, light rail includes “street cars,” “trolly cars,” and “tramways”; in specific usage, light rail refers to very modern and more sophisticated developments of these older rail modes.

Microtransit: A demand-response system using regular transit buses (full-size or smaller) requested via a smart phone app, similar to a ride-sharing service.

Mountable Curbs: A vertical sloping number along the edge of a pavement or shoulder forming part of a gutter, strengthening or protecting the edge, and clearly defining the edge to vehicle operators. Mountable curbs are designed so that a bus can cross them with ease in constricted turnaround areas.

Right-of-Way (ROW): The strip of land owned by or under direct control of a transportation system, occupied by or intended for a transportation facility.

Transit Corridor: A broad geographic band that follows a general directional flow connecting major origins and destinations of trips and that contains a number of streets, highways, and transit route alignments.

Transit-Oriented Development (TOD}: Is a mixed-use community within an average one-fourth mile walking distance of a transit stop or station, and core commercial area.

Undulations: Usually referred to as speed bumps. Speed bumps are installed to mitigate excessive traffic speed on residential streets.

APPENDIX E. REFERENCES USED

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*This list was published during a transitional period for our Board and the membership will change in the next 30 days.