2.9 Strategy 9: Bus Stop Location Planning and Bus Stop Design

Bus stop location planning and bus stop design applications include selecting a proper location for a stop, relocating a bus stop, designing the bus stop zone, and monitoring stops. The location and design of a bus stop play a role in improving the safety of passengers boarding and alighting buses. A bus stop with insufficient room to accommodate passenger loads may cause a passenger to inadvertently step into the path of an approaching bus. The location of bus stops and the related curb treatments and amenities contribute to bus operations and the safety of passengers.

Bus stops should be designed to minimize crowding and to protect passengers from passing traffic. As bus stops are typically controlled by the local municipality, the placement of—or improvements to—the stops must be coordinated with the appropriate municipal department.

Cost associated with bus stop location planning and bus stop design range from moderately low to high. Relocating a bus stop may incur a series of costs, depending on the location and stop amenities: moving the bus stop sign and shelter (if applicable) and accessibility improvements such as curb cuts and concrete pads for mobility devices. While each of these costs may be

Table 2-10. Applications of bus design/modification.

Application	Purpose	Description	Stakeholder Subjective Ratings and Comments on Effectiveness*
Increased number of side marker lamps	To provide warning to pedestrians and other drivers that the bus is turning or about to turn	Added three side marker lamps on the right and left side of the bus (one between the doors and front bumper, one midway down the bus, and one near the rear of the bus). Marker lamps are activated by the turn signal and hazards. Replaced the incandescent lights (only allow 5 candlepower) to LED (effective light is about 20 candlepower) so that it can be seen in the daytime.	Use of LEDs greatly increases illumination of each light over single incandescent bulb while staying within regulation LEDs last longer than incandescent lights
Blinking chevrons on side mirrors	To provide warning to pedestrians and other drivers that the bus is turning or about to turn	Added a blinking chevron on the side mirrors, which is activated by the turn signal and hazards.	Do not know effectiveness as only about 12% of fleet has new lights
Audible turn signals	To provide warning to pedestrians and other drivers that the bus is turning or about to turn	Agency tested a version about 5 or 6 years ago that used a backup beeper. Now they are looking at a right-turn voice warning system similar to "bus turning right... bus turning right" that would be activated when the turn signal is activated and when the bus hits a certain degree of turning on the wheel. About 60 decibels is heard. The problem is getting someone to come forward with an audible chip and speaker. Another agency wired a small noise-emitting device on all buses. Noise was about 70 decibels.	Back-up beeper warning was not effective—people thought the bus was backing up and it was too loud Public forced them to take them off as they objected to hearing it go off at 1:00 A.M.
Safety warning strobe light atop buses (see Figure 2-14)	To help pedestrians and other motorists spot buses operating along city streets and to provide additional lighting for early morning and evening bus users	Flashing yellow strobe light on top of buses. See further details in Section 3.1.3.6.	Not implemented due to the following: Did not conform to state motor vehicle regulations Residents complained of light being too bright It was not evident to people where the light was coming from
LED light strip on front-top of bus (see Figure 2-15)	To get the attention of pedestrians and ultimately to improve safety	A LED strip of flashing lights across the front (top) of bus. Unlike the one single strobe light atop buses (as noted in previous application), these lights move back and forth and are meant to increase awareness about the presence of buses when it's dark. See further details in Section 3.1.3.6.	Currently being tested
Side strobe lights (see Figure 2-16)	To indicate to motorists and pedestrians that a bus is making a turn	Two lights are placed on each side of 40-foot buses. Three lights are placed on each side of the articulated buses. Lights are controlled by the turn signal and flash at a higher frequency than a typical turn signal. The articulated buses also have an audible signal during right turns, which is the same beep signal that is used to indicate that the ramp is being deployed. The 40-foot buses are not equipped with audible signals to avoid unwanted noises in residential areas and where pedestrian traffic is low.	Not reported
Bus curb lights (see Figure 2-17)	To increase operators' view of pedestrians running alongside the bus at night	Several lights along the lower right side of the bus activated by opening the bus door. To give the bus enough time to pull away from the curb, the lights stay on for about 16–20 seconds after the door has closed. See further details in Section 3.1.5.	Rated a 5 in reducing collisions involving pedestrians falling under the bus at night (since curb light installation, nighttime collisions of this type have been nearly eliminated)
Video clips as a forensic tool for accident investigation	To use clips of accidents as a training aid for operators To do accident investigations To make recommendations on how to avoid accidents in the future	Six cameras are mounted on the buses. They are allowed to review 5 minutes of video prior to the incident occurrence.	Very successful. Much more able to defend themselves in law suits. Ratings: 4 for reducing collisions 3 for reducing severity 1 for reducing close calls 5 for reducing claims 3 on operator acceptance 4 on public acceptance
S1-GARD	To reduce the severity of injuries resulting from accidents involving pedestrians coming in contact with the rear right wheels of transit buses	Flexible plastic shield placed at the rear duals to deflect a person away from the path of the right rear dual.	Unknown

* Stakeholder subjective ratings are based on a scale of 1 to 5, with 1 being "very ineffective" and 5 being "very effective" or with 1 being "very unsuccessful" and 5 being "very successful."

moderately low, the combination of costs could be high. The addition of striping and bollards and other barriers at bus stops are considered to be moderately low (thousands of dollars) in cost, depending on site conditions and the extent of the improvement.

Figure 2-14. Safety warning strobe light atop bus.

2.9.1 Applications of Bus Stop Location Planning and Bus Stop Design

Easter Seals Project Action developed the Toolkit for the Assessment of Bus Stop Accessibility and Safety, which is primarily targeted toward staff at transit agencies and public works departments that are responsible for bus stop design and placement. The Toolkit is intended to be a resource that can be used to enhance the accessibility of specific bus stops or to help in the development of strategic plans to achieve systemwide accessibility. Application of the information and guidance presented in this Toolkit would not only help the disability community, but the general population of pedestrians and bus riders as well. The Toolkit includes good suggestions regarding the design of bus stop areas, landing pads, and lighting (*7*).

Specific applications of bus stop location planning and bus stop design strategies, as reported by agencies and stakeholders, are shown in Table 2-11.

2.9.2 Suggested Applications of Bus Stop Location Planning and Bus Stop Design

Beyond the specific applications of bus stop location planning and bus stop design shown in Table 2-11, stakeholders suggested a number of bus stop location planning and bus stop design applications that might mitigate bus-and-pedestrian collisions. These suggestions included real-time bus arrival information, bus stop supervision, traffic control, bus nubs, painted bus "pads," and better bus stop planning. Each of theses suggestions is discussed in more detail below.

2.9.2.1 Real-time Bus Arrival Information

Providing real-time bus arrival information was suggested by the pedestrian groups, as well as the stakeholder groups that participated in the research. The premise behind real-time bus arrival information as an application for mitigating bus-and-pedestrian collisions is that better information will help pedestrians make better decisions. For example, if riders know that the next bus is only a few minutes away, they may be less inclined to run after the bus that is pulling out of the stop. Conversely, however, if the next bus is known to be more than a few minutes away, it may encourage patrons to run after the bus that is just leaving the stop. The real-time information could be provided on LED signs in the bus shelters or on the exterior of the buses.

Figure 2-15. LED light strip on front-top of bus.

Source: Champaign–Urbana Mass Transit District

Figure 2-16. Side strobe lights.

2.9.2.2 Bus Stop Supervision

Bus stop supervision was suggested by a stakeholder group and a bus operator group. The suggestions included

- Place supervisors at busy stop locations to help with boarding and alighting, and
- Provide supervision through video cameras at busy or problematic stops.

These strategies are meant to monitor pedestrian activity while waiting at stops. Supervision, either in-person or via video, could help mitigate crowding and pushing at busy stops and roughhousing, all of which can lead to pedestrians being pushed into the roadway under the bus.

2.9.2.3 Traffic Control

Traffic control was suggested as a necessary ingredient when locating bus stops: bus stops should not be located where there is no traffic control. The presence of some traffic control might

Figure 2-17. Bus curb lights.

Table 2-11. Applications of bus stop location planning and bus stop design.

Application	Purpose	Description	Stakeholder Subjective Ratings and Comments on Effectiveness*
Monitoring, relocation, and removal of bus stops	To identify bus stop locations that lead to unsafe behaviors To identify bus stop locations that improve the visibility of pedestrians To relocate or remove stops that are unsafe	Agency monitors bus stops and removes those stops that are creating unsafe pedestrian behaviors. A bus stop committee is composed of safety representatives and police officers. The committee looks at bus stop locations. They look at the place that will allow the bus to get into the stop safely and smoothly. They also (re)locate stops to make pedestrians more visible.	Not reported Not reported
Far-side bus stops (see Figure 2-18)	To reduce collisions between pedestrians who have just alighted the bus and the departing bus	By locating the bus stop on the far side of the intersection, pedestrians who have just alighted the bus cross the street at the intersection behind the bus. This is opposed to a near-side bus stop, where pedestrians who have just alighted the bus cross at the intersection in front of the bus.	Highly recommended by various agencies and groups
Bollards, barriers, and striping	To keep people from being in the bus area	A line of bollards, barriers, or striping.	Not reported
Standee lines at bus stops	To reduce pushing at crowded stops	Multiple buses lined up. Only the leader has doors open and they would have light duty personnel assigned. They help the passengers to board. Monitor pedestrians entering bus. Once bus is loaded, the following bus moves up into lead position and then opens the doors. Passengers form lines to board.	Not reported

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assist pedestrians in understanding when it is safe to cross and in allowing pedestrians to obtain a sufficient gap to cross.

2.9.2.4 Bus Nubs

Bus nubs were suggested by one or more agencies and stakeholders as a possible strategy for mitigating bus-and-pedestrian collisions. A bus nub is essentially an extended version of a bulb-out that allows placement of the entire length of a bus stop adjacent to the travel lane. The primary motivations for installing bus nubs are to improve transit operations through the elimination of bus-weaving maneuvers into and out of a curbside bus stop and to reduce

Figure 2-18. Bus stop located on far-side of intersection.

sidewalk congestion by adding sidewalk space with the bus nub design (*4*). In addition, bus nubs can reduce the crossing distance and time for pedestrians, make it easier for operators to see pedestrians waiting to cross the street or board the bus, slow right-turn movements, and reduce the use of bus pull-out areas for illegal parking. As these goals of nubs hit on several different issues surrounding bus-and-pedestrian collisions, nubs could be an interesting strategy that could mitigate a variety of problems associated with bus-and-pedestrian collisions. Other names used for bus nubs include "curb extensions," "bus bulbs," and "bus bulges."

The cost of constructing nubs can range from $15000 to $55000 depending upon drainage needs, utility relocation, construction materials, and patron amenities (*5*). If street drainage systems need to be reconfigured, there is a steel-fabricated nub with a built-in shelter that can be installed over an existing street, allowing runoff to filter underneath; this system can be used to test a nub before a permanent installation is made (*6*).

2.9.2.5 Painted Bus "Pads"

Two types of bus pad installations were suggested by stakeholders for mitigating bus-and-pedestrian collisions:

1. Install painted bus "pads" on the pavement to delineate to pedestrians where the bus will stop, or
2. Install landing pads to provide pedestrians with a clear, level area with which to maneuver while waiting for, boarding, or alighting buses. Landing pads could reduce the frequency with which a pedestrian might trip or get "pushed" by stationery objects (such as waste receptacles) into the roadway or an oncoming bus.

2.9.2.6 Better Bus Stop Planning

Better bus stop planning, in general, was recommended by many stakeholders. It was reported that, in some instances, bus stop placement is a "second thought" and not part of the overall planning process. Bus stops are sometimes developed as a result of citizen requests and do not include sufficient collaboration or design analysis. Older stops are often not updated to integrate with new roads, traffic volumes, or routes. Additionally, in areas where construction is ongoing or weather is an issue (e.g., flooding, snow), stops are not always accessible or visible, causing pedestrians to make unsafe and unexpected maneuvers.

2.10 Strategy 10: Bus Stop Lighting and Illumination

Bus stop lighting and illumination are important issues. The primary concern, as it relates to bus-and-pedestrian collisions, is the visibility of pedestrians waiting at bus stops. This is a frequent concern expressed by pedestrians as well as bus operators and stakeholders. Passengers worry that they will not be seen by operators and, as a result, will be passed by. In an attempt to be seen, they may inadvertently step into the path of an approaching bus trying to "flag down" the operator.

In general, the bus stop lighting and illumination strategy is moderate in cost. For example, the cost of a flashing beacon ranges from $1,200 per bus stop for solar-powered lights to $200–$300 per bus stop for non-solar-powered lighting systems. Similarly, bus stop solar illumination units average around $1,600 per stop location. Although conventional illumination systems are less expensive, they require an immediate power source. Costs rise sharply when power must be brought to the stop, potentially increasing the costs by several thousands of dollars. Non-technology solutions—such as the retro-reflective "paddles" used by one agency ($20 per paddle) and retro-reflective bus stop signs—are low in cost.

2.10.1 Applications of Bus Stop Lighting and Illumination

In response to bus stop lighting concerns, an interesting and unique mix of applications have been employed by several different agencies. These applications include passive and active systems that indicate to an operator that an intending passenger is present at a stop. These systems may be as simple and inexpensive as a flashlight or retro-reflective paddle held by the waiting pedestrian or a pedestrian-activated flashing beacon located atop a pole at a stop. Specific applications of bus stop lighting and illumination, as reported by agencies and stakeholders, are shown in Table 2-12.

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Table 2-12. Applications of bus stop lighting and illumination.

Application	Purpose	Description	Stakeholder Subjective Ratings and Comments on Effectiveness*
Retro-reflective paddles (see Figure 2-19)	To alert the operator of a pedestrian at the stop	A round paddle made of aluminum (1-ft diameter) with retro-reflective tape. The paddles are attached to the shelters with a 6-ft piece of cable that allows patrons to pick it up and move it around when waiting at the stop. The headlights of the bus reflect off the tape alerting the operator that someone is waiting at the stop. Drawback: new riders may not know how to use paddles.	Ratings: 4 for reducing collisions 5 for reducing severity 5 on operator acceptance 5 on public acceptance (if stop does not have them, patrons call and ask for them)
Flashing beacons (see Figure 2-20)	To alert the operator of a pedestrian at the stop	A simple flashing light is mounted on top of the stop and hooked to a user switch. Riders push the button or switch and the light flashes for about 2 minutes. One agency uses the paddles (see above strategy) at stops without power. Beacons can be used at stops with very poor sight lines. Beacons are electric or solar powered.	Operators love it. They report that it makes their job easier and they are more alert to a rider waiting. High public acceptance. Agency has received phone calls from the public saying how much they like it.
Retro-reflective bus stop signs	To increase the visibility of the bus stop	Signs designating the bus stop location that are high in retro-reflectivity.	Rated a 2 or 3 for reducing collisions Reportedly much better than the standard *Manual for Uniform Traffic Control Devices (MUTCD)* bus stop signs in terms of visibility
Solar-powered shelter lights	To provide light for pedestrians and bus operators	The lights put out a subtle glow rather than a glare, just enough to light the shelters. The shelters are solar powered. One drawback is that chemicals used to treat snow and ice on roads interfered with functioning of solar panels and electronics. One agency reported they had to clean them twice a day and eventually stopped using them.	Not reported
Pocket and pen lights (see Figure 2-21)	To allow a bus driver to see more easily a rider waiting at a bus stop	Small hand-held light that pedestrians can activate when walking to and from a stop and standing at the stop. Operators hand them out primarily to riders who catch the bus in dark conditions.	Rated a 5 for bus stops on rural and high-speed roads although difficult to rate because agency rarely has a bus and pedestrian collision. Very high public acceptance—"people love them," according to the director of the transit agency.

* Stakeholder subjective ratings are based on a scale of 1 to 5, with 1 being "very ineffective" and 5 being "very effective" or with 1 being "very unsuccessful" and 5 being "very successful."