Bus Stop Optimization Policy (Pilot)

Bus Network Improvement Project - Phase One Plan

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PREPARED WITH ASSISTANCE BY:
Foursquare Integrated Transportation Planning & Jacobs Engineering

MTA Maryland

1 Introduction & Purpose

MTA has over 6,000 bus stops serving its local bus operations in Baltimore City and the surrounding suburbs. The spacing of bus stops has an important impact on the quality of service. In 2012, the average travel speed of MTA bus service was only 11.52 miles per hour, comparable to the speed of a cyclist. A 2012 study of bus transit speeds in the Washington DC region found that average bus speeds in the DC region were considerably higher, at 16.8 miles per hour[1]. Stops across the MTA network are spaced at an average interval of less than 500 feet, much closer than best practices in peer cities. Placing stops too close together can negatively impact bus service; while riders have a shorter walk to stops, closely placed stops increase the travel time aboard the bus. Too many bus stops can lead to bus routes that are slow and unreliable. Optimizing bus stop spacing is important for the efficient operations of a transit system. Improving the spacing of bus stops is a low-cost but potentially high impact way to achieve many of the objectives of the Bus Network Improvement Plan.

Before implementing new bus stop spacing standards system-wide, MTA plans to test bus stop spacing through a small-scale pilot effecting the following bus lines: 50, 53, 56, and 59. MTA will monitor performance along these lines during implementation to determine the impact of the proposed stop spacing standards. This document outlines in greater detail:

- The purpose of bus stop optimization
- MTA's proposed new spacing standards
- MTA's proposed process for optimizing stop spacing

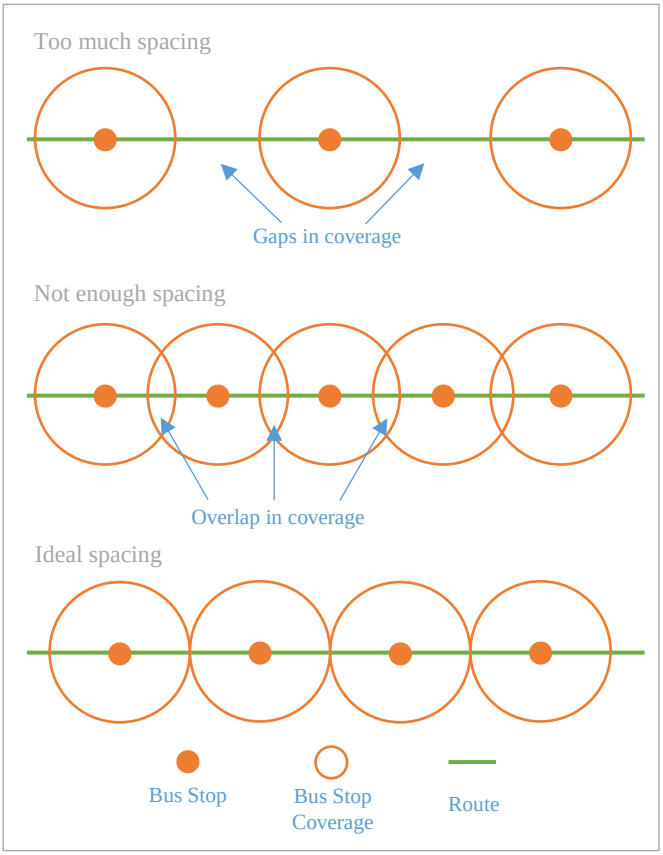
WHY OPTIMIZE BUS STOPS?

Simply put, increasing bus stop spacing when stops are too close can make bus trips quicker and more reliable. There is no consensus or standard for what denotes an optimal stop spacing. The MTA study team researched stop spacing by examining both theoretical studies and industry best practices. For many transit agencies, the existing stop spacing is not based on formal guidelines but instead historical practice that may extend as far back as the spacing on now defunct streetcar lines. Moreover, empirical evidence suggest existing bus stop spacing practices do not achieve the most optimal outcome for passengers.

[1] National Capital Region Transportation Planning Board *Multimodal Coordination of Bus Priority Hotspots – Task 2 Technical Memo,* January 2012

There is a relationship between the number of stops along a route and the effective travel time for users; bus routes with a higher frequency of stops allow riders to quickly reach a stop, but increase travel time once aboard a bus. Placing stops too far apart or too close together increases transit journey times for customers; too many bus stops increases travel times on the bus, while too few bus stops increase the time it takes to walk to a stop. Optimal stop spacing balances the need for quick walk times to a bus stop and efficient bus operations (see **Figure 1**).

Figure 1 – Spacing Impacts on Bus Stop Coverage



This basic relationship between vehicle speed and access time to a stop help drive stop spacing. One seminal study on optimizing transit stop spacing found that as transit speeds decrease, stop spacing must increase in order to minimize riders' travel times[2]. In another study, researchers simulated trip travel times in a number of Dutch cities, finding that the optimal stop spacing (from a purely travel time-focused standpoint) ranges from 600 meters (1,968 feet) in small cities to 800 meters (2,625 feet) in larger ones[3]. In the real-world stop spacing is impacted by a number of factors ranging from vehicle speeds to the special needs of users, especially seniors and passengers with disabilities.

The best empirical data on the effectiveness of bus stop removal comes from a group of researchers at Portland State University, who produced a set of papers analyzing the impacts of bus stop removal by TriMet[4]. Their main result was that stop consolidation efforts improved running times and did not negatively impact ridership. Specifically, the researchers found that the removal of approximately 9 percent of stops along a route reduced average run times by approximately 6 percent, while not negatively impacting ridership or reliability.

PEER STANDARDS

A number of other agencies' practices were examined in this study, including:

[2] El-Geneidy, A.M., et al *Effects of Bus Stop Consolidation on Passenger Activity and Transit Operations*. Transportation Research Record No. 1971, 2006

[3] Ibid

[4] El-Geneidy, Ahmed M., Strathman, James G., Kimpel, Thomas J., and Crout, David T. "Effects of Bus Stop Consolidation on Passenger Activity and Transit Operations." Transportation Research Record. 1970, pp. 32-41, 2006; Li, Huan and Bertini, Robert L. "Assessment of an optimal bus stop spacing model using high resolution archived stop-level data." 88th Annual Meeting of the Transportation Research Board, 2009; Bertini, Robert L., and El-Geneidy, Ahmed M. "Modeling Transit Trip Time Using Archived Bus Dispatch System Data." Journal of Transportation Engineering, 130:1. pp 56-69. 2004

- New York City Transit (NYCT) – New York City, NY
- Washington Metropolitan Area Transit Authority (WMATA) – Washington, DC
- Southeastern Pennsylvania Transportation Authority (SEPTA) – Philadelphia, PA
- Massachusetts Bay Transportation Authority (MBTA) – Boston, MA
- Tri-County Metropolitan Transportation District of Oregon (TriMet) – Portland, OR
- San Francisco Municipal Transportation Agency (SFMTA) – San Francisco, CA
- Hampton Roads Transit (HRT) – Norfolk/Virginia Beach, VA

Also reviewed were the Maryland Transit Guidelines report (MD Transit Guidelines), produced in May 2002 in a multi-agency effort; and MTA's current Local Bus Service Standards, revised in 2011.

Five of the agencies reviewed had official stop spacing standards, while SFMTA and MBTA are currently developing spacing standards (draft or informal standards are presented here). The MD Transit Guidelines and the MTA Local Bus Service Standards Policy also provided draft spacing standards. Agencies based spacing standards on either land use or service type. Land use based categorization is the most common way to group spacing standards (see **Table 1**). At its most basic, land-use based standards set different spacing standards for bus routes in urban areas vs. suburban areas. Many of the guidelines expanded past those two categories to include spacing standards for downtowns and rural areas. Agencies base spacing standards by land use because, as population density increases, so do the number of potential riders and destinations along a bus route.

Table 2 – Typical Stop Spacing by Land Use

Stop Type	MTA Local Bus Service Standards	MD Transit Guidelines	SEPTA	TriMet	SFMTA	MBTA[5]	HRT
Downtown	500 – 750 ft	440 – 528 ft		780 ft††		1,000 – 1,300 ft	
Urban	600 – 1,200 ft	750 ft	500/1,000 ft† (existing/new routes)	1,000ft	800 – 1,360 ft	750 – 1,300 ft	750 ft
Suburban	1,000 – 1,500 ft	1,000 ft	1,000 ft†	As needed		1,000 – 1,300 ft	1,050 – 1,760 ft (1/3 mi)
Rural		As needed	As needed				

† Minimum Stop Spacing Standard
†† Downtown / Regional Activity Centers

NYCT, WMATA, and MBTA (draft guidelines) chose to develop standards around the type of service (see **Table 2**). Service standards help to create more clarity among riders because they are more likely to comprehend the spacing differences between service types than between land use categories.

Table 3 – Stop Standards by Service Type

Service Type	WMATA	NYCT	MBTA[5]
Local Service	1,050 – 1,320 ft	750 ft†	(see Table 1)
Limited Stop Service	1,760 – 2,640 ft (1/3 - 1/2 mi)	1,300 ft†	1,300 – 2,600 ft

† Minimum Stop Spacing Standard

[5] Draft spacing guidelines

There is a great deal of variation among the spacing standards reviewed. Recommended spacing ranged from 500 feet to as much as 1,320 feet for local service in urban areas. Recently released spacing standards tend to recommend wider stop spacing than seen at MTA, with a number of agencies settling on spacing standards of 1,000 feet or greater. Even newly adopted wider spacing standards may be conservative as spacing standards are still well below typical spacing among European transit systems.[6]

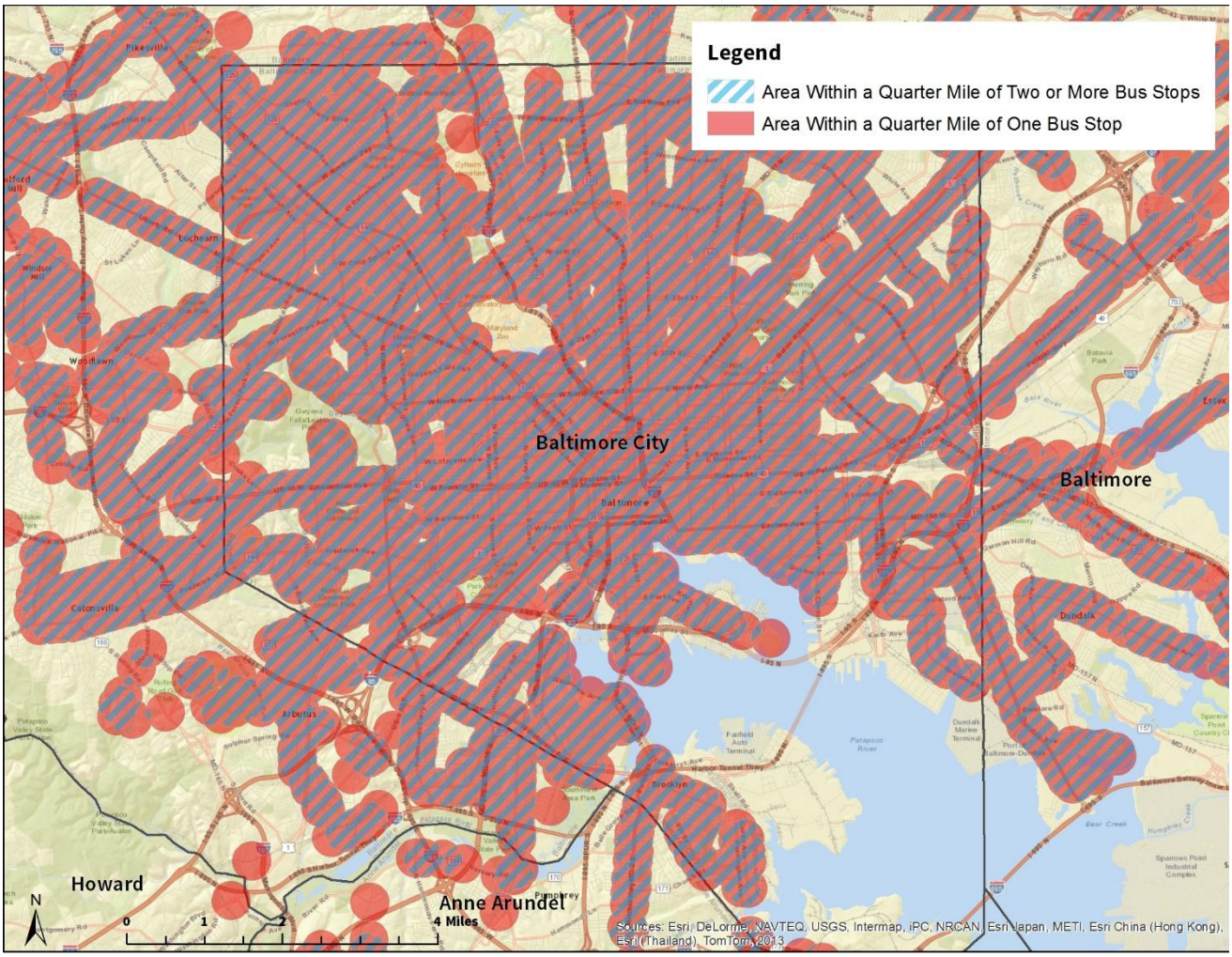
2 Bus Stop Spacing Guidelines for MTA

Draft bus stop spacing recommendations have been developed based on both best practices among other agencies and sensitivity to the local context in Baltimore. Stops along MTA's Core Bus service are approximately 500 feet apart on average, closer than any of the standards reviewed. A bus stop's service area is typically defined as a quarter mile radius around a stop, roughly equivalent to a five minute walk; given the close stop spacing, 80% of the area within walking distance of a MTA bus stop is also within walking distance to at least one other bus stop (see **Figure 2**).

Increasing the average spacing between bus stops can benefit both MTA operations and rider experience. For the customer, larger distances between stops would increase the time it takes to access MTA service but reduce travel times aboard buses. Faster travel times and less stop and go would also improve MTA's operational efficiencies by increasing an operator's ability to adhere to published schedule while also decreasing the everyday wear and tear on vehicles. Finally, fewer stops system-wide would allow MTA to better maintain bus stop assets, including reducing the logistical complications around providing improvements like better schedule and route information at stops.

[6] Europe's HiTrans guidelines recommend a typical stop spacing of 600m (1,960 ft), with 400m (1,312 ft) in city centers, and 1000 meters (3280 ft) for express/BRT style services.

Figure 2 – Bus Stop Coverage Within the City of Baltimore



RECOMMENDED SPACING GUIDELINES FOR LOCAL BUS SERVICE

The overriding principle of these guidelines is that stop placement decisions for a route should first take into consideration the need to provide transfer opportunities between routes, siting stops as appropriate to provide safe and efficient transfers. After siting stops to provide transfer opportunities, the remaining portions of routes where transfers are not available should utilize minimum and maximum spacing distances developed for each of four service areas (Downtown, Urban Areas, Suburban Areas, and Suburban Activity Centers) to govern the placement of stops.

Transfer Considerations

Transfer opportunities should be provided for all routes that either cross or run concurrently on the same right of way. Where routes cross, the basic principle to be followed is that a stop should be located at the intersection where the routes cross, or if necessary up to a half-block away at a mid-block stop location. Stop placement should take all location factors into account, and be decided on a case-by-case basis, but effort should be made to allow for 100% of potential transfer opportunities with two or fewer street crossings required whenever possible. When routes run concurrently, spacing guidelines should dictate the placement of

stops to be shared by those routes, with the caveat that when routes run concurrently for very short distances that may be less than the minimum spacing guideline for the service area in question (one or two blocks, for instance), at least one stop should be shared between the two routes if possible. If a shared stop is not possible in such a situation, stop locations requiring two or fewer street crossings, as with crossing routes, should be utilized.

Connections with Rail Lines

Although not all bus lines directly connect with a rail line, effort should be made to place stops, if possible, in the location requiring the shortest distance and fewest street crossings to make transfers between bus and rail.

Spacing Targets by Service Area

These draft spacing guidelines developed by MTA are based on geographic location and include separate guidelines for Downtown Baltimore, urban areas (Baltimore City), suburban areas, and finally suburban activity centers (see **Section 3.1** for more information on the geographic definition of these areas). These guidelines provide a minimum and maximum recommended spacing and in some cases prescribe a target average stop spacing.

Downtown

The study team recommends that local service in Downtown Baltimore have shorter stop spacing than elsewhere in the MTA Core Bus network. Stops should be placed between 750 feet and 1,000 feet apart from one another, with a target average spacing of one stop every two blocks. There are a number of reasons to create closer stop spacing guidelines in Downtown Baltimore, including:

- Shorter stop spacing maximizes convenience for MTA customers as a large share of riders begin or end their trips downtown.
- Downtown has a high density of connecting transit routes, all of which require connecting bus stops.
- Optimal stop spacing is partially a function of average bus speeds; in congested places like Downtown Baltimore where bus speeds are going to be low regardless of stop spacing, longer access times to bus stops would increase the overall travel time of bus trips for passengers.
- Due to the volume of passengers boarding MTA buses in Downtown, too few stops may lead to overcrowding at bus stops and boarding delays.

Urban Areas

For urban areas the study team recommends a stop spacing of 750 feet to 1,320 feet (quarter mile), with an average spacing along a route of one stop every 1,000 feet, or approximately every two to three blocks. These guidelines were devised to allow for wider spacing than in Downtown Baltimore but still closer spacing than in suburban areas. A stop spacing of 1,000 feet was the most common spacing standard adopted by the other systems reviewed. Increasing average stop distance to 1,000 feet would reduce the number of stops needed by approximately 50% based on the observed actual stop spacing in Baltimore of 500 feet. While increasing the guideline to 1,000 feet would improve route performance it should have a negligible effect on overall route accessibility. For example, increasing the distance of stops from 500 feet to 1,000 feet should only increase bus stop access times by a maximum of approximately two minutes (assuming the average walking speed of 4 feet/second). The average user will see their access times increase by less than two minutes.

It is recommended that stops be placed closer together, at 750 feet apart, in major activity centers such Johns Hopkins Hospital and Charles Village. In urban areas with less demand or limited ADA compliant access pathways, stop spacing can increase to 1,320 feet.

Suburban Areas

In suburban areas, the study team recommends stop spacing of 1,000 feet to 2,640 feet (half mile), with an average stop spacing of 1,320 feet (quarter mile). Greater stop spacing for suburban areas is recommended because of lower density land uses and the greater weight of onboard travel time to total trip time. Suburban trips typically cover greater distances than urban ones, and passengers are therefore more effected by slower travel speeds than marginal increases in stop distances. Other agencies generally define 1,000 feet as a stop spacing *minimum* for suburban areas, which is equivalent to at least two to three city clocks between bus stops. However, implementing the spacing guideline in suburban areas requires a detailed review of the actual stop spacing to ensure that stops placed far apart do not preclude access due to a likely poorer pedestrian network.

A maximum spacing of 2,640 feet (half-mile) is recommended only for portions of a bus route with no suitable or easily accessible locations for a bus stop. Roadway segments with zero boardings a day and limited destinations within feasible walking distance, are all candidates for the maximum spacing guideline.

Suburban Activity Centers

While suburban areas overall have a lower density of transit usage than urban areas, there are a number of suburban activity centers with high transit demand such as suburban downtowns (e.g., Towson), major shopping destinations (e.g., Security Square Mall), and mixed-use high density development (e.g., Arundel Mills area). These activity centers warrant a lower minimum stop spacing of 750 feet. Not all suburban activity centers require a stop spacing of 750 feet, however. For example, a large regional mall is a major activity generator but may only have one convenient access point for transit riders. Appropriate spacing should be assessed on a case by case basis.

Rural Areas

No guideline was developed for rural areas as this was not considered applicable to MTA Core Bus service area.

Table 3 – Draft Spacing Guidelines (Local Bus Service)

Land Use Type	Spacing	Target Average	Additional Notes
Downtown	750 – 1,000 ft	2 blocks	Locate stops at every location with intersecting local MTA transit service. Pay special attention to optimizing access to major trip generators.
Urban Areas	750 – 1,320 ft (1/4 mi)	1,000 ft	The minimum spacing is recommended for locations at major activity centers and destinations.
Suburban Areas	1,000 – 2,640 ft (1/2 mi)	1,320 ft (1/4 mi)	Maximum spacing is recommended for locations along a route with little development.
Suburban Activity Centers	750 – 2,640 ft (1/2 mi)	1,320 ft (1/4 mi)	Where warranted in suburban activity centers, the minimum stop spacing is reduced to 750 feet to enable improved access to stops. Maximum spacing is only appropriate in locations with poor accessibility or lack of trip generators.

Exceptions to Spacing Guidelines

Stop spacing closer than the recommended minimum spacing is acceptable in certain circumstances:

- If closer spacing is necessary to provide stops at locations with intersecting bus service.
- If closer spacing is necessary to properly serve identified populations with mobility issues (i.e., seniors and persons with disabilities).
- Existing pedestrian infrastructure does not adequately support the preferred spacing and placement of bus stops (e.g., sidewalk is not large enough for passenger volume).
- Existing infrastructure is not ADA compliant.
- The environment or topography creates barriers to optimal placement. For example, stops on steep grades should, on average, be closer together for up-hill services.

SPACING GUIDELINES FOR QUICKBUS AND EXPRESS SERVICE

QuickBus Service

QuickBus, MTA's limited-stop bus service, operates on busy transit corridors where local bus service is also available, and most QuickBus stops will be shared with local service. Agencies like NYCT and WMATA operate similar types of limited stop service.

Following the spacing set by the agencies reviewed, it is recommended that QuickBus stops typically be located twice as far apart as the recommended spacing for local bus service (with the exception of the Downtown area). QuickBus service should stop at major destinations that generate a disproportionately large share of ridership along a corridor. QuickBus services should also stop at intersecting QuickBus routes and nearby rail lines (within 2-3 blocks). Outside Downtown, buses should stop at all locations along a corridor with 200 or more boardings a day. Maximum stop spacing is appropriate for locations with few major destinations or intersecting transit service.

Table 4 – Draft Spacing Guidelines (QuickBus)

Land Use Type	Spacing	Target Average	Notes
Downtown	1,000 – 1,760 ft (1/3 mi)	1,320 ft (1/4 mi)	Stops should be located at major transfer nodes.
Urban Areas	1,760 – 2,640 ft (1/3 - 1/2 mi)	2,000 ft	Stops should be located at high ridership locations and major destinations. Closer stop spacing is appropriate at locations with 200+ boardings per day or high frequency connecting bus service.
Suburban Areas	1,760 – 5,280 ft (1/3 – 1 mi)	2,640 ft (1/2 mi)	
Suburban Activity Centers	1,760 – 5,280 ft (1/3 – 1 mi)	2,640 ft (1/2 mi)	

Exceptions to minimum spacing:

The spacing guidelines above assume that the QuickBus is operating as a premium service on the same alignment as local service. However, where a QuickBus line is operating on segments without local service in the Surburban service area, the minimum spacing guidelines may be relaxed to match the local service spacing minimum. The maximum distance of 1 mile between stops would not change.

Express Bus Service

MTA operates a number of Express bus services that operate non-stop between Downtown and outlying areas, typically on highways. Express bus service should follow the same stop spacing as local bus in the portions of its service area where it picks up and drops off passengers, running non-stop between the two service areas at either end of the route. Intermediate stops should be provided in limited instances where the route passes by major activity generators, transit hubs such as Metro and Light Rail stops, or park and ride lots.

PROCESS FOR IMPLEMENTING BUS STOP SPACING RECOMMENDATIONS

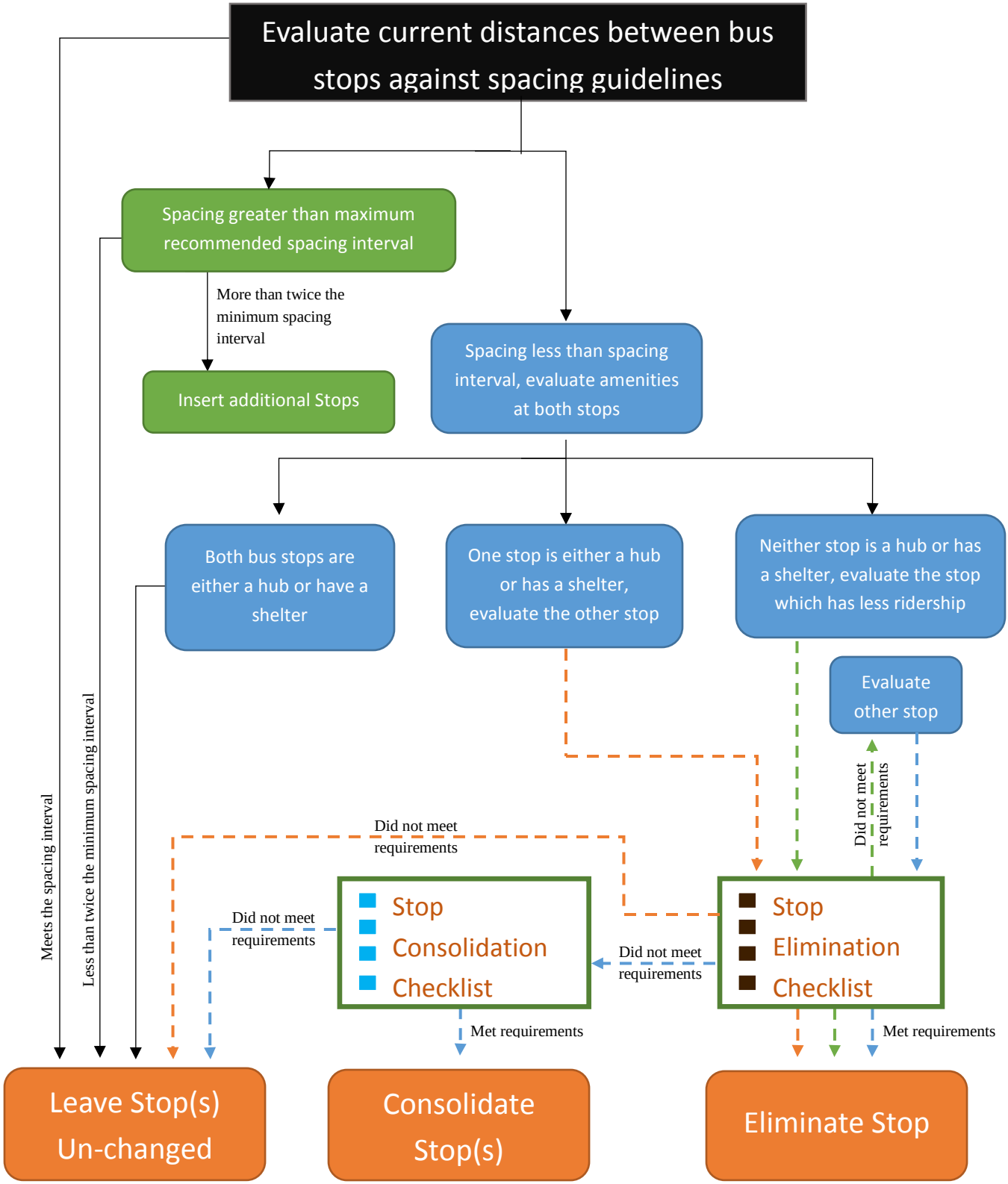
The spacing guidelines outlined above are intended to provide general guidance for stop placement. Implementing stop consolidation will require a nuanced approach that combines spacing guidelines with other more subjective considerations. Every route and stop has its own particular dynamics, and in optimizing bus stop locations MTA must be sensitive to neighborhood demographics, public input, the need for efficient bus operations, pedestrian access, and public safety.

On any segment of a bus route MTA can achieve new stop spacing through one of two means. The simpler is removing stops from a route without relocating the remaining stops. This option is preferable in many cases because it impacts fewer riders. However in some instances, removing and relocating stops may be necessary to achieve targeted stop spacing. Relocating stops is recommended where moving the stop will better serve riders along the route. **Figure 1** has been developed to determine whether a location meets the spacing requirements for its service area and is a good candidate for addition, removal and/or relocation.

For all changes, ensure that:

- The community has been properly consulted about the proposed change in stop locations.
- Changes do not disproportionately impact riders with mobility challenges such as seniors and persons with disabilities.
- Changes do not negatively impact traffic and contribute to congestion.
- Title VI and environmental justice populations are not disproportionately impacted by the removal of stops.
- Remaining stops meet ADA guidelines.
- Existing transfer opportunities are maintained within two or fewer street crossings.

Figure 1: Stop Evaluation Flowchart



Stop Elimination Checklist

The following six conditions must be met in order for a bus stop to be considered for elimination:

Criteria to Eliminate	Yes/No
The adjacent stops left unaltered must adhere to the prescribed spacing requirements for their service area.	
Adjacent stops are designed accordingly to absorb additional ridership.	
The stop does not provide direct access to connecting transit services, or if it does there are stops further along the route that will provide the same connection.	
The stop being removed does not meet ADA guidelines, or both the adjacent bus stops meet ADA guidelines.	
The stop being removed will not impact more than 100 riders or 10% of the entire route's daily ridership, whichever is less.	
The stop does not directly serve existing community resources such as schools, hospitals, senior centers, recreation centers, and locations providing public services.	

Below are additional considerations that would not automatically disqualify a stop for elimination but should be considered.

- Does the stop serve a large number of users with mobility issues, including seniors and disabled persons?
- Would removing the stop result in the possibility that the bus would have to continue stopping at the location? For example, if a bus already stops at a corner due to a stop sign, removing the stop may not achieve any travel time savings and may not be worth removing.

Stop Consolidation Checklist

The following eight conditions must be met in order for bus stops to be considered for consolidation:

Criteria to Consolidate	Yes/No
The new stop location has adequate pedestrian access, such as direct sidewalk connections and safe pedestrian crossings.	
The new stop location adheres to the spacing requirements with adjacent stops.	
The new location can be designed to handle 90% of the predicted ridership of the consolidated stops.	
The new location meets ADA guidelines or can be reasonably modified to meet ADA guidelines.	
If either stop being considered for consolidation is a transfer stop, existing transfer opportunities at the new location are possible within two or fewer street crossings or at another stop location along the line.	
The stops being consolidated will not impact more than 20% of the entire route's daily ridership.	
The stops being considered for consolidation do not directly serve existing community resources such as schools, hospitals, senior centers, recreation centers, and locations providing public services.	
The new location will improve or maintain running times.	

Below are additional considerations that would not automatically disqualify stops for consolidation but should be considered.

- Can a new location better serve both expected passengers at the stop and existing passengers from nearby removed stops?
- Will relocating the stop minimize the distance to nearby activity generators?