A BETTER CITY

REPORT | MAY 2020

GOING THE DISTANCE TO REOPEN BOSTON:

GUIDANCE ON HOW THE MBTA CAN PROVIDE PHYSICAL DISTANCING TO HELP RIDERS STAY APART

ACKNOWLEDGEMENTS:

A special thank you to the various individuals, advocates, other stakeholders for their participation, with particular recognition to the important contributions of Noah Hodgetts.

The author also wishes to acknowledge the ongoing collaboration for this report from many colleagues, including Tom Nally, Caitlin Allen-Connelly, Tom Ryan, Kate Dineen and Rick Dimino.

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A Better City is a diverse group of business leaders united around a common goal—to enhance Boston and the region's economic health, competitiveness, vibrancy, sustainability and quality of life. By amplifying the voice of the business community through collaboration and consensus across a broad range of stakeholders, A Better City develops solutions and influences policy in three critical areas central to the Boston region's economic competitiveness and growth: transportation and infrastructure, land use and development, and energy and environment.

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PROLOGUE

The MBTA has faced many difficulties over the last 50 years: The Blizzard of 1978, the winter of 2015, and the pandemic of 2020 are the most challenging. The winter of 2015 exposed a broken MBTA, revealing not only failures of infrastructure and inadequate investment, but deep-seated and fundamental deficiencies in management and leadership. The COVID-19 crisis paints a different picture of an agency with strong leadership and resilient employees that ensured continuity of vital transit services to healthcare and emergency workers.

A Better City welcomes two recent steps taken by Governor Charlie Baker and his Administration. Both are consistent with the report's recommendations:

- **MANDATORY USE OF MASKS OR FACE COVERINGS ON THE MBTA.** Governor Baker's Executive Order of May 1, 2020, that read in relevant part: "All persons are...required to wear masks or face coverings when...using...any means of public transit, or while within an enclosed or semi-enclosed transit stop or waiting area."[1] A Better City supports this Order and strongly recommends that the MBTA take assisted compliance measures to offer and oblige passengers to wear face masks and coverings.

- **IMPLEMENTATION OF "SOCIAL DISTANCING" ON THE MBTA SYSTEM.** The MBTA FY21 Revised Operating Budget Presentation at the FMCB meeting on May 4, 2020: "Overall objective for FY21 is for budget to support return to full FY20 service levels even while assuming substantially lower ridership and fares, thus ensuring that that ***social distancing*** [emphasis added] can be sustained."[2]

This report spotlights the "social distancing" objective that was discussed and adopted by the FMCB at its May 4 meeting. Please note that this report uses the term "physical distancing" as recommended by the World Health Organization (WHO)[3].

1. https://www.mass.gov/doc/may-1-2020-masks-and-face-coverings/download

2. MBTA FY21 Revised Operating Budget, Slide pp. 3. https://cdn.mbta.com/sites/default/files/2020-05/2020-05-04-fmcb-E-planning-fy21-budget.pdf

3. Author's note: World Health Organization recommends usage of "physical distancing" instead of "social distancing", as of March 20, 2020. https://www.who.int/docs/default-source/coronaviruse/transcripts/who-audio-emergencies-coronavirus-press-conference-full-20mar2020.pdf?sfvrsn=1eafbff_0

EXECUTIVE SUMMARY

CONTEXT

As COVID-19 infection, hospitalization, and death rates begin to decline, public officials across the nation are focused on facilitating the gradual reopening of regional economies, while preventing future waves of infection. In the Commonwealth of Massachusetts, Governor Baker appointed the 17-member Reopening Advisory Board consisting of business executives, public health officials, and municipal leaders to guide his administration with strategies for reopening the economy amid the COVID-19 pandemic. The Reopening Advisory Board has identified the safety and availability of public transportation as an enabler of the broader reopening—and A Better City has participated in a special subgroup to advise the Governor's Reopening Advisory Board on public transportation considerations. It should be noted that the MBTA is already implementing and considering a number of safety initiatives—and they have demonstrated the ability to flexibly adjust service levels when necessary. We appreciate and admire the MBTA's frontline workers who remain focused on making our transit system work for the people, even in the midst of an unprecedented crisis.

On public transportation, safety is the number one priority—and a safe public transportation system is essential to reopening our regional economy. As key objectives, the MBTA must take strong, immediate, well-publicized actions to protect its workforce and riders in order to build trust and confidence in the system, gradually increasing ridership to enhance mobility, facilitate economic spending, reduce emissions, and ensure equitable access. Such actions should include frequent and robust sanitization, compliance with face covering mandates, and, as this report will further explore, increased service levels and associated measures to support physical distancing. In short, the MBTA must do everything in its power to ensure that public transit is not the source of future community spread.

Based on an assessment of global best practices, A Better City believes that a successful approach to ensuring public health on public transit must be built upon the following foundational components: (a) disinfection; (b) face coverings; and (c) physical distancing. This report assumes that the MBTA will continue vigorous

system-wide disinfection and ensure compliance with the Governor's Executive Order requiring the use of face coverings on public transit. Therefore, this report will focus predominantly on potential strategies for ensuring physical distancing across the MBTA fleet and system.

Transit agencies across the globe are testing a spectrum of techniques for encouraging some degree of physical distancing on trains, buses, and ferries. These strategies range from passive (e.g. working with area employers to reduce demand for transit) to active (e.g. enforcing capacity limits on buses). There are of course serious operational considerations associated with the more active interventions, including fleet capacity, staffing capacity, and other resource constraints. Additionally, there are legitimate civil rights and equity concerns associated with certain enforcement strategies. However, the pursuit of physical distancing is a worthy one—and transit systems around the world are making noteworthy progress. Domestically, several systems have already implemented physical distancing programs on buses, including Chicago, Seattle, Portland (Oregon), and Milwaukee. Abroad, major systems like Moscow, Singapore, Rome, and Paris have implemented significant physical distancing programs on rapid transit services, including subway systems. Numerous systems have also announced plans to initiate substantial physical distancing programs on subways, including London, New York City, Sydney, and San Francisco.

ASSUMPTIONS

On the demand side, this report assumes that the region's major employers continue working with the Commonwealth to implement a robust, coordinated suite of strategies to reduce employee demand for public transit, including but not limited to continued telecommuting to limit the total number of workers using public transit, as well as the adoption of alternative work schedules like staggered hours, longer days, and longer weeks to flatten rush hour peaks. Biking, walking, and other forms of active transportation will also play a critical role in demand management. Additionally, this report assumes that traditional transportation demand management (TDM) approaches, like private shuttles and van pools, are retooled and strengthened to ensure rider and operator safety.

On the supply side, this report assumes that the MBTA moves to full service as quickly as possible and continues to adjust commuter rail and scheduling to support needs in the core system. The MBTA must adopt a flexible, agile approach to service delivery and fleet operations that is continuously informed by the best available public health data and guidance, and ready to adapt to specific mode demand fluctuations in real time. Efforts to ensure supply must be coupled with proactive efforts to recruit operators on an ongoing basis. Additionally, the MBTA should seek opportunities to work with municipalities to expand bus rapid transit (BRT) through exclusive bus lanes and signal priority.

CONCEPTUALIZING PHYSICAL DISTANCING ON THE MBTA

This report takes two physical distancing standards—the WHO standard of 1 meter and the CDC standard of 6 feet—and assesses how these standards could be applied to the MBTA's fleet and operations. More specifically, this report provides a conceptual analysis of how to implement these standards on each of the MBTA's main modes: bus, rapid transit, and commuter rail. Archetypal floor plans for the MBTA's three main vehicle modes were used as the basis to undertake a conceptual engineering analysis to calculate new vehicle capacities that would temporarily exist under the two physical distancing alternatives. Vehicle capacities under the old and new approaches are presented and compared.

- **PHYSICAL DISTANCING ALTERNATIVE 1:** provides for 6-feet of separation between riders and frontline MBTA employees in accordance with "general" U.S. CDC guidelines (note: On May 14, 2020, the CDC released new guidance for reopening mass transit, including the recommendation that systems "Encourage social distancing by increasing spacing of passengers and employees, closing every other row of seats and using bus rear door entry/exit, if feasible")

- **PHYSICAL DISTANCING ALTERNATIVE 2:** provides for 1 meter (or 3.3 feet) of separation in accordance with World Health Organization guidelines that have been recently deployed at peer and smaller-sized agencies throughout the globe, including the Russian Federation, European Union, and Asia.

While robust demand-side management strategies continue to limit ridership in the early phases of the reopening, the MBTA could consider testing a mix of Alternatives 1 and 2 across modes. In any strategy, the MBTA should consider mode-specific approaches and exercise the ability to surge capacity on specific routes and lines, as necessitated by shifts in rider demand and the latest public health data and guidance.

IMPLEMENTING PHYSICAL DISTANCING ON THE MBTA

This report suggests that the MBTA undertake a suite a near-term actions to support physical distancing across the system, including: 1) limiting demand for public transit by establishing the "Going the Distance Collaborative," a long-term advisory partnership with public officials, business leaders, and other stakeholders to maximize work from home and minimize transit usage during peak hours; 2) setting and implementing capacity targets; 3) deploying seat markers and signage; 4) instituting a dynamic monitoring, assisted compliance, and enhanced customer service initiative; 5) launching a comprehensive communication and education campaign; 6) actively coordinating with testing and tracing efforts to identify potential hotspots; 7) pursuing a flexible service delivery approach that is continuously informed by the best available public health data and guidance; and 8) ramping up employee recruitment to ensure ongoing operations and safety. The MBTA is well-positioned to quickly pilot many of these recommendations, including setting capacity targets and deploying seat markers and signage, on replacement bus services already planned to mitigate construction-related service disruptions on portions of the Green Line, Blue Line, and Lowell Commuter Rail Line scheduled to begin in May.

I. CONTEXT

MBTA AND PEER AGENCY RIDERSHIP DECLINES AND SERVICE CUTBACKS DUE TO COVID-19

On March 10, Governor Baker by Executive Order proclaimed the Commonwealth of Massachusetts under a state of emergency. In the weeks leading up to that announcement, as cases of COVID-19 in the state had been confirmed and began to rise, the daily volume of MBTA ridership had started to dip. On March 4, MBTA ridership was down 7% as compared to normal for the same period, even as the MBTA announced expanded efforts to sanitize its public transit vehicles and spaces.[5]

Governor Baker's state of emergency proclamation included an "advisory" that non-essential employees were to stay-at-home and avoid unnecessary travel. Unlike governors in many other states, he did not "order" anyone to do so. "I do not believe I…should order [Massachusetts] citizens to keep confined to their homes for days on end", Governor Baker said.[6] As of March 10, on the day of governor's "advisory" announcement, MBTA ridership was down about 14% as compared to normal levels. MBTA ridership data indicates the Governor's word choice may have been a distinction with a difference, as it took two more weeks—until March 24—for MBTA ridership to plummet down to below a 70% decline from normal levels, near to the 85% average drop that MBTA ridership had stabilized at.

Other peer transit agencies in the U.S. have also experienced similar ridership decreases. At the onset of the COVID-19 emergency, the MBTA and peer agencies were faced with a two-fold crisis: (1) dramatic reductions in ridership and related revenues, and (2) unprecedented workforce and rider health and safety challenges. With the exception of two peer agencies reviewed, all operators responded in a similar way: swift and widespread service cutbacks. These ridership and service changes are summarized in Table 1.

TABLE 1:

REVIEW OF PEER AGENCY SERVICE CUTBACKS: DATA SOURCE: TRANSIT APP EXCEPT WHERE NOTED AS OF MAY 14, 2020

AGENCY	CURRENT RIDERSHIP COMPARED TO NORMAL (%)	EXTENT OF WEEKDAY SERVICE CUTBACKS	NOTES
MBTA (BOSTON)	-85%	Major	Current ridership % sourced from MBTA. Saturday Schedule, "modified"
MTA (NYC)	-73%	Low	Running on its "Essential Service Plan," which preserves most peak service and eliminates some lines on weekdays
SEPTA (PHILADELPHIA)	-72%	Medium	
WMATA (WASHINGTON D.C.)	-77%	Major	
BART (SAN FRANCISCO)	-89%	Major	
CTA (CHICAGO)	-80%	Low	Normal service on five of its eight rail lines

SOURCES:
https://transit.app

https://www.rtands.com/rail-news/updated-april-11-rail-group-staff-report-global-railway-industry-response-and-impacts-to-covid-19-pandemic/

https://www.mbtabackontrack.com/blog/blog/117-covid-19-and-mbta-ridership-part4

5. Agency ridership statistics mentioned in this report were sourced from Transit app, unless otherwise noted. See: https://transit.app/coronavirus

6. "By most measures, Mass. Is a virus hot spot", Boston Globe, April 19, 2020, page A1

Chicago Transit Agency (CTA) and New York City (MTA) are the two exceptions in the peer group, as described in the "Notes" column in Table 1. Despite the dramatic service reductions, to their credit the MBTA and many peers have taken targeted steps to tweak services, however some complaints of overcrowding continue.

The transit industry has developed a long-standing conventional way of thinking about how to make decisions in change to service delivery, including how to define an acceptable level of passenger crowding in vehicles. The decision to cutback services in response to a steep falloff in ridership and revenues is consistent with the conventional normative approach to service delivery and vehicle crowding.

Given the steep falloff in ridership and revenues, the decision of the peer agency group to implement deep service cutbacks was nearly universal. On the other hand, these service cutbacks—taken at the onset of the COVID-19 crisis—would decrease the frequency between vehicles. That would increase the total interval of time for customers to accumulate and wait for the next vehicle. As riders waited and assembled, more people would likely climb onboard each arriving vehicle. With separation of people the main tool to prevent the spread of COVID-19 and infection, any increase in the level of vehicle "crowding" may seem counterintuitive, if not illogical. This counterintuitive outcome can raise questions about whether the normal approach to service levels is most appropriate going forward in light of the paramount need for physical distancing on public transit systems to make riders both feel and be safe from COVID-19 infection.

THE NORMAL APPROACH TO SERVICE LEVELS AND VEHICLE CROWDING

Typically, most transit agencies use a similar policymaking approach to the management decisions regarding frequency of service ("service levels"). In normal times, public transit agencies strive to balance a complex array of social, technical, operational, and financial objectives. As transit agencies strive to strike that balance, policymakers typically use a two-factor analytical standard approach:

1. The delivery of accessible, reliable, and safe public transit services should always be done in the most cost-effective manner; and

2. In support of that cost-effectiveness, transit agencies create service delivery (frequency of service) plans that predictably and purposefully produce crowded vehicles during the peak hour. Said another way, in normal times: a half-empty bus is bad; a full—but not packed—bus is good.

The normal approach to vehicle crowding assumes during peak periods every seat is occupied and that a substantial number of passengers will stand in the aisle areas. When the number of standees reach a maximum acceptable level, the vehicle is considered to be operating at "Acceptable-Crowding" capacity.

The MBTA's DataBlog published in May 2016 discussed the issue of capacity and crowding: "A key component of capacity is how readily riders accept crowded conditions. Different people perceive and react to crowding differently." For example, recent (pre-pandemic) MBTA focus group studies show that an individuals' comfort with crowded vehicles vary by gender.[7]

"Acceptable-Crowding" is calculated using one of two methods: (1) A percentage multiple of the number of seated passengers; or (2) Providing each standing passenger ("standee") with a share of aisle space. As shown in Table 2 below, the amount of presumed space that is normally allocated to each standee passenger varies by mode.

TABLE 2:

FACTORS USED TO CALCULATE TOTAL STANDEES PER VEHICLE: NORMAL APPROACH

ENTITY	MODE	"ACCEPTABLE- CROWDING" CONSIDERATIONS
FMCB/MBTA	Bus	140% of seated capacity
	Rapid Transit: Light Rail	3.76 ft^2 per standee
	Rapid Transit: Heavy Rail	3.48 ft^2 per standee
	Commuter Rail	110% of seated capacity

SOURCES:
MBTA Service Delivery Policy Workshop, October 20, 2016, Office of Performance Management and Innovation, Planning and Scheduling Department, Office of Transportation Planning. https://www.google.com/url?sa=t&rct=-j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwigqa_c743pAhUFVt8KHV8_A5c-QFjAAegQIBBAB&url=https%3A%2F%2Farchives.lib.state.ma.us%2Fbit-stream%2Fhandle%2F2452%2F432868%2Focn949066298-2016-10-20a.pdf%3Fsequence%3D2%26isAllowed%3Dy&usg=AOvVaw2jthVDQWhKNk_pfcQvfWKv

7. https://www.mbtabackontrack.com/blog/48-at-what-level-does-crowding-become-unacceptable

NORMAL PASSENGER CAPACITIES PER VEHICLE

Using the factors in Table 2 to calculate the total number of standees, the normal passenger carrying capacity on each of the MBTA's main modes: bus, rapid transit, and commuter rail is shown in Table 3. The archetypal MBTA vehicle for each mode was used to determine these normal capacities per vehicle[8].

TABLE 3:

PASSENGER CAPACITIES PER TYPICLE VEHICLE: NORMAL "ACCEPTABLY-FULL" DENSITY: (FOR "ARCHETYPICAL" MBTA VEHICLE BY MODE; NOT TOTAL FOR EACH TRAIN CONSIST)

MBTA MODE	# OF SEATS	"ACCEPTABLY-FULL" CAPACITY FACTOR	"ACCEPTABLY-FULL" # OF STANDEES	"ACCEPTABLE-FULL" CAPACITY PER VEHICLE
BUS (40-FOOT)	36	140% # of seated capacity	14	50
RAPID TRANSIT: LIGHT RAIL (GREEN LINE)	45	3.76 sq. ft. per passenger	55	100
RAPID TRANSIT: HEAVY RAIL (RED LINE)	57	3.48 sq. ft per passenger	85	142
COMMUTER RAIL (BI-LEVEL)	173	110% of seated capacity	17	190

SOURCES:

Rapid Transit, Heavy Rail: Red Line listed as example. Orange Line and Blue Line quantities are lower.

Light Rail (Green Line): total aisle = 208 ft2

Heavy Rail (Red Line): total aisle = 296 ft2

CTPS/MPO. Core-Capacity Constraints. 2016 https://www.ctps.org/data/pdf/studies/other/core_capacity/Core_Capacity_Constraints.pdf

https://cssh.northeastern.edu/dukakiscenter/publication/hub-and-spoke-core-transit-congestion-and-the-future-of-transit-and-development-in-greater-boston/

https://mikethemadbiologist.com/2012/06/20/so-how-many-people-can-you-cram-into-an-mbta-train/

MBTA Blue Book, Ridership and Service Statistics, Fourteenth Edition, 2014. https://old.

mbta.com/uploadedfiles/documents/2014%20BLUEBOOK%2014th%20Edition(1).pdf

8, The MBTA operates its bus, rapid transit, and commuter rail services using a variety of rolling stock purchased over many decades from differing manufacturers. The capacity analysis presented in this report is meant to be a representative sampling of vehicle capacities, not an exact measurement.

OVERVIEW OF PHYSICAL DISTANCING ON TRANSIT IN U.S.: NEW CDC SPECIFIC GUIDANCE ISSUED ON MAY 14, 2020 TO URGE "SOCIAL DISTANCING" ON MASS TRANSIT

Transit agencies both domestic and across the globe are testing a spectrum of techniques for encouraging some degree of physical distancing on trains, buses, and ferries. These strategies range from passive (e.g. working with area employers to reduce demand for transit) to active (e.g. enforcing capacity limits on busses). There are of course serious operational considerations associated with the more active interventions, including fleet capacity, staffing capacity, and other resource constraints. Additionally, there are legitimate civil rights and equity concerns associated with certain enforcement strategies. However, the pursuit of physical distancing is a worthy one—and transit systems around the world are making noteworthy progress.

Before May 14, 2020, domestic mass transit physical distancing programs were based on the general physical distancing standard of 6 feet as established by the U.S. Centers for Disease Control and Prevention (CDC) at the onset of the COVID-19 pandemic[9]. Of even greater weight to this report, on May 14, 2020, the CDC published new guidance specifically targeted at mass transit systems to provide direction, for instance, to ***"encourage social distancing [stay at least 6 feet (about 2 arms' length) from other people[10]] by increasing spacing of passengers and employees, closing every other row of seats*** (emphasis added) and using bus rear door entry/exit, if feasible".[11]

Domestically, several systems have already implemented physical distancing programs on buses, including Chicago, Seattle, Portland (Oregon), and Milwaukee. On May 13, 2020, the MBTA announced plans to undertake a physical distancing pilot project on a bus shuttle replacement service to support a 7-day closure for construction on the Lowell Commuter Rail Line. Numerous systems have also announced plans to initiate substantial physical distancing programs on subways, including New York City and San Francisco. Table 4 provides a summary of domestic existing physical distancing programs and planned initiatives.

9. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html

10, This definition of "social distancing" is from the link embedded in the CDC guidance cited in Footnote 10. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html

11. "CDC, Public Health Considerations for Reopening Mass Transit During The Covid-19 Pandemic. Issued May 14, 2020. https://www.cdc.gov/coronavirus/2019-ncov/community/pdf/MassTransit-DecisionTree.pdf

TABLE 4:

U.S. PHYSICAL DISTANCING TRANSIT PROGRAMS: EXISTING AND PLANNED, EXAMPLES: (PROGRAM IS EXISTING UNLESS OTHERWISE NOTED) (AS OF MAY 14, 2020)				
	PHYSICAL DISTANCING MEASURES			
ENTITY	**40-FOOT BUS**	**60-FOOT BUS**	**SUBWAY**	**NOTES:**
SEATTLE: KING COUNTY METRO	12 riders	18 riders		• Once those limits are reached, drivers should pass up other customers and the digital signs on the front of buses will read "Coach Full, Sorry." • Cap is illusory. If a bus has fewer passengers than the limit when a driver opens the door, the driver should allow everyone at the stop to board, even if that exceeds the limit.
PORTLAND: TRI-MET	10 or 15		See notes	• Higher limit of 15 people if there are couples or riders with children. See Attachment B for photos. • Additionally, Tri-Met is posting signs on some seats that say "Don't sit here" in order to encourage riders to distance themselves from one another, and from the bus driver. • Planned: Signs will be posted on MAX and WES trains encouraging riders to keep their distance from others.
CHICAGO: CHICAGO TRANSIT AUTHORITY (CTA)	15	22		• "Bus crowding management" program gives drivers the authority to run as "drop-off only" and bypass certain bus stops if their bus is becoming crowded • Driver is allowed to let passengers onboard and exceed limits
MILWAUKEE: COUNTY DOT	10			• A maximum of 10 passengers will be allowed on a bus at any given time.
MBTA BUS REPLACEMENT SHUTTLE FOR LOWELL COMMUTER RAIL CLOSURE[A]	TBD	TBD		From MBTA press release: • "MBTA's bus shuttle plan includes measures to promote social distancing that protect MBTA workers and riders, and the MBTA will carefully monitor ridership levels on the shuttle buses, adjusting service levels if needed. • "In compliance with the Executive Order that went into effect on May 6, MBTA customers must wear face coverings while onboard shuttle buses. Additionally, to promote social distancing efforts and protect the health and safety of MBTA riders and bus operators, ridership on shuttle buses will limited. The MBTA will also keep a robust fleet of shuttles on standby to accommodate ridership demands as needed
NEW YORK: MTA			See notes	• Pilot markers at subway stations include: Lexington Avenue/53rd Street station on the Queens-bound E/M platform and at the 51st Street station on the 6 line to indicate where riders can stand to maintain proper 6 foot distancing.[B] • Planned: Signs will be posted on MAX and WES trains encouraging riders to keep their distance from others. • Under discussion for subway: "MTA has cameras on almost every station. Those cameras can be used together with analytics to determine the level of passengers on a platform, passengers on mezzanine. MTA is going to be look at ways – in the interest of the safety of our customers and our employees – to control the number of passengers."[C] • Planned: "everything is on the table, including the possibility of reserving spots on trains or buses and social distancing on subway platforms."[C]
SAN FRANCISCO: BART			See notes	• Planned: Signage at each station entrance of BART facilities will be posted to inform all employees and customers that they should: avoid entering the facility if they have a cough or fever; maintain a minimum six-foot distance from one another.[D] • Planned: Downtown BART stations to provide extra masks for riders. BART police will also hand masks out. BART police may be posted at station entrances to enforce mask rules by refusing entry to those who refuse to wear one. But first police and agency's ambassadors will attempt to get people to use some type of covering.[E, F]

SOURCES:

This Table includes research and work product of Caitlin Allen-Connelly, Project Manager, A Better City

A. https://www.mbta.com/news/2020-05-11/building-better-t-7-day-lowell-commuter-rail-line-closure-begins-may-18

B. https://abc7ny.com/traffic/mta-adds-social-distancing-markers-floats-idea-of-reservations/6178657/

C. Quote from MTA Chairman and CEO Pat Foye. https://newyork.cbslocal.com/2020/05/14/mta-on-future-of-social-distancing/

D. https://www.bart.gov/sites/default/files/docs/BART%20Social%20Distancing%20Protocol%20completed.pdf

E. https://www.sfchronicle.com/bayarea/philmatier/article/To-begin-to-come-back-from-coronavirus-BART-15265788.php

F. https://www.officer.com/covid-19/news/21135632/bart-police-looking-how-to-best-to-protect-officers-and-riders-amid-coronavirus-pandemic

OVERVIEW OF PHYSICAL DISTANCING ON SUBWAY SYSTEMS ABROAD

Abroad, most major systems apply the WHO prevailing guidance of 1 meter in their development of physical distancing programs. As shown in Table 5, numerous peer rapid transit system physical distancing programs exist or are underway in other parts of the world. Systems in Moscow, Singapore, Rome, and Paris have implemented significant physical distancing programs on their subways. Several systems have also announced plans to initiate substantial physical distancing programs on subways, including London, Auckland, and Sydney.

TABLE 5:

INTERNATIONAL RAPID TRANSIT PHYSICAL DISTANCING PROGRAMS: EXISTING AND PLANNED: (PROGRAM IS EXISTING AND ALL PRORGAMS BASED ON WHO 1 METER STANDARD UNLESS OTHERWISE NOTED.) (AS OF MAY 14, 2020)		
ENTITY	**PHYSICAL DISTANCING MEASURES**	**NOTES**
MOSCOW: METRO	Seat markers placed on every other seat to encourage physical distancing.	Please see Attachment B for photos
SINGAPORE: LTA[A]	All rapid transit trains and platforms are being progressively marked with safe distancing stickers. Standing spaces and seats that should be avoided on subway vehicles are marked out. Transport ambassadors and bus captains, together with agency enforcement officers, will help to see to that passengers appreciate distancing markers. They will limit the number of passengers entering train stations.	Please see Attachment B for photos
ROME: METRO[B]	All rapid transit trains and platforms are being progressively marked with safe distancing stickers. Standing spaces and seats that should be avoided on subway vehicles are marked out.	
PARIS[C]	All rapid transit trains and platforms are being progressively marked with safe distancing stickers. Standing spaces and seats that should be avoided on subway vehicles are marked out.	
LONDON[D]	Planned: Appears to be developing physical distancing plans based on 2 meter separation.	
SYDNEY[E]	Planned: Appears to be developing passive physical distancing plans founded on demand management measures. Goal is to keep transit demand at or below 30% of normal levels to enable "social distancing" on vehicles.	

SOURCES:

This Table includes research and work product of Caitlin Allen-Connelly, Project Manager, A Better City

A. https://www.straitstimes.com/singapore/transport/coronavirus-safe-distancing-measures-to-be-rolled-out-across-public-transport

B. Correspondence between Nilar Chit Tun and Caitlin Allen-Connelly of A Better City, dated May 14, 2020.

C. Mobitelex 294. La révélation, la lettre, la reprise, la sécurité, les milliards, la drôle de priorité (May 5)

C. https://www.washingtonpost.com/graphics/world/2020/05/11/scenes-paris-metro-france-lifts-its-coronavirus-lockdown/

D. https://www.bbc.com/news/business-52394835

E. https://www.9news.com.au/national/coronavirus-public-transport-social-distancing-challenge-as-covid19-restrictions-ease/ae6c79e2-cfba-4d0b-af75-01cc6d4f645f

II. CONCEPTUALIZING PHYSICAL DISTANCING ON THE MBTA

This report takes two physical distancing standards—the CDC standard of 6 feet and the WHO standard of 1 meter—and assesses how these standards could be applied to the MBTA's fleet and operations. More specifically, this report provides a conceptual analysis of how to implement these standards on each of the MBTA's main modes: bus, rapid transit, and commuter rail. Archetypal floor plans for the MBTA's three main vehicle modes were used as the basis to undertake a conceptual engineering analysis to calculate new vehicle capacities that would temporarily exist under the two physical distancing alternatives. Vehicle capacities under the old and new approaches are presented and compared.

- **PHYSICAL DISTANCING ALTERNATIVE I:** provides for 6-feet of separation between riders and frontline MBTA employees in accordance with "general" U.S. CDC guidelines (note: as of publication, the CDC has not issued any formal guidance to public transit agencies like the MBTA with respect to physical distancing of passengers); and

- **PHYSICAL DISTANCING ALTERNATIVE 2:** provides for 1 meter (or 3.3 feet) of separation in accordance with World Health Organization guidelines that have been recently deployed at peer and smaller-sized agencies throughout the globe, including the Russian Federation, European Union, and Asia.

Please see Attachment B for examples of physical distancing Alternative 1 and Alternative 2 that have been implemented at peer and smaller-sized agencies around the world, including in the European Union, the Russian Federation, and Asia.

Larger-sized drawings of conceptual engineering studies for both Alternative 1 and Alternative 2 for each mode by archetypical vehicle are contained in Attachment D. Summaries of those engineering studies with revised passenger capacities per vehicle for each mode under both approaches are provided in the following tables:

- **TABLE 6A:** Bus, 40-foot (Silver Line is shown in Attachment D)
- **TABLE 6B:** Rapid Transit, Light Rail, Green Line (Mattapan Trolley not studied)
- **TABLE 6C:** Rapid Transit, Heavy Rail, Red Line (as proxy for Blue Line and Orange Line)
- **TABLE 6D:** : Commuter Rail coach, Bi-level

A Better City may complement this report with supplementary study briefs on several additional aspects we believe important to help the MBTA achieve physical distancing program objectives. These may include:

- What is the responsibility of customers as they enter/exit the MBTA system?
- What is the responsibility of passengers as they board, ride, and alight vehicles?
- What internal/external practices may best help sustain physical distancing program objectives whenever an on-route vehicle is already full?
- How can a multi-modal methodology to service levels best support a physical distancing program? For example, Commuter Rail services may have excess capacities that could help support ridership demand on parallel or nearby bus routes.
- What kinds of high-tech PPE techniques normally deployed outside the transit industry can be brought onboard MBTA vehicles to enhance safety of frontline employees and also make more space available on each vehicle to support physical distancing program objectives.

TABLE 6A:

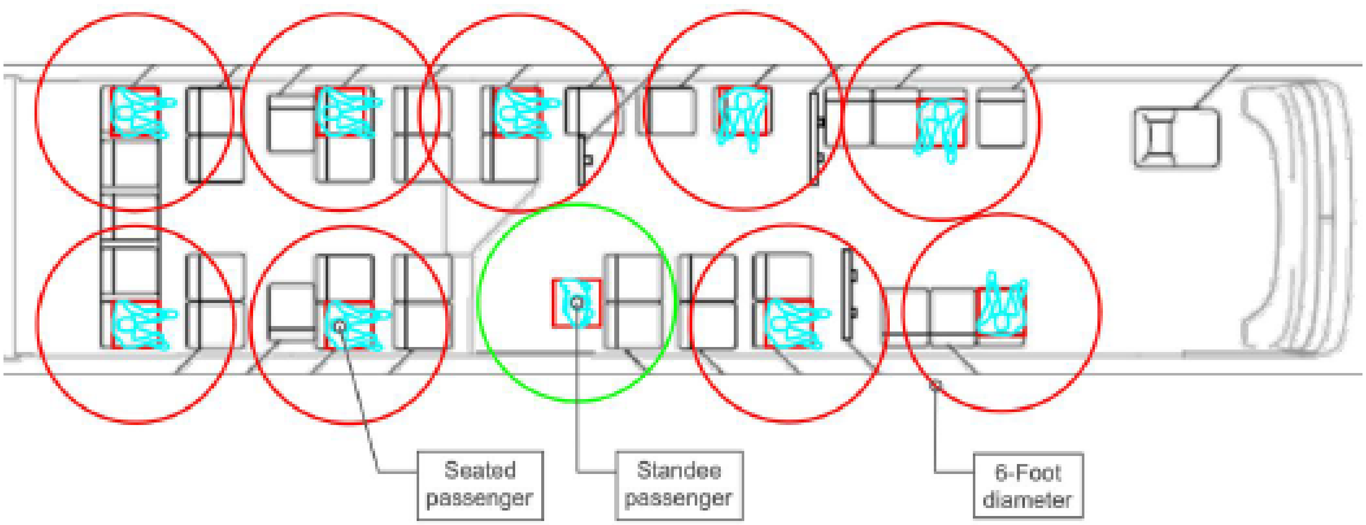
GOING THE DISTANCE: VEHICLE CAPACITY FOR ALTERNATIVE 1 & ALTERNATIVE 2: MBTA 40-FOOT BUS

		ALTERNATIVE 1: 6-FEET OF SEPARATION			ALTERNATIVE 2: 1 METER OF SEPARATION		
MODE	SEATS	SEATS OCCUPIED	STANDEES	TOTAL	SEATS OCCUPIED	STANDEES	TOTAL
Bus (40-foot)	36	9	1	10	15	7	22

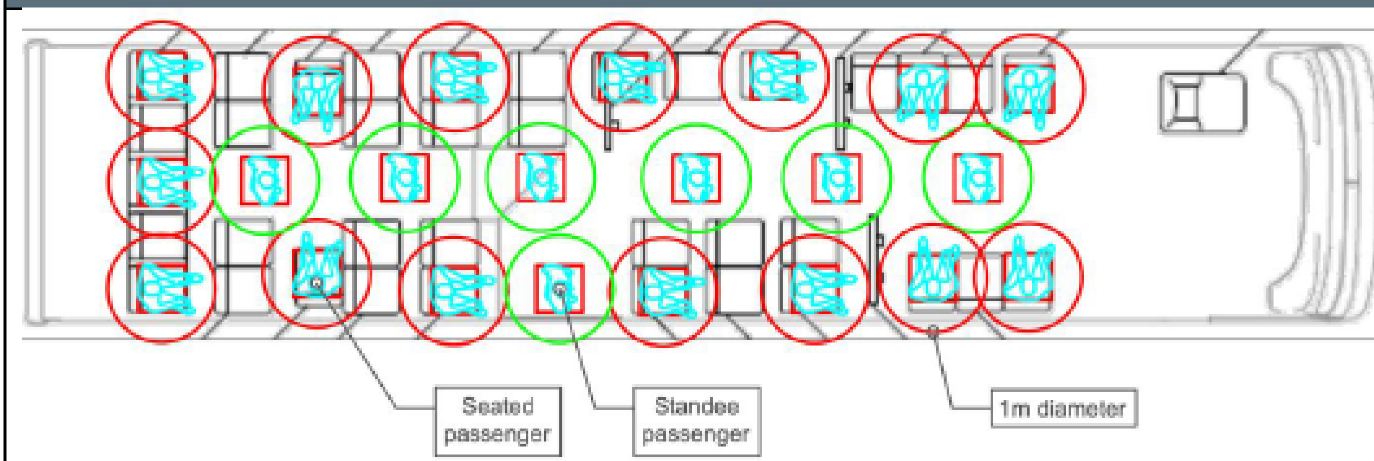
Key to graphic below:

- Riders: depicted in "Blue" symbol outline
- Seated Riders: located in center of "Red" Circle
- Standee Riders: located in center of "Green" Circle

ALTERNATIVE 1:



ALTERNATIVE 2:



See Attachment D: For larger-sized drawings

TABLE 6B:

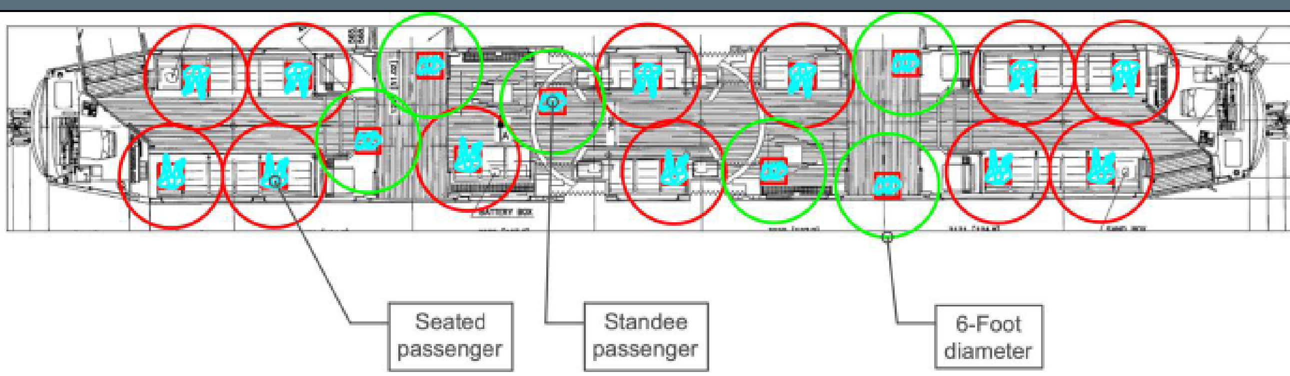
GOING THE DISTANCE: VEHICLE CAPACITY FOR ALTERNATIVE 1 & ALTERNATIVE 2: MBTA LIGHT RAIL, GREEN LINE

		ALTERNATIVE 1: 6-FEET OF SEPARATION			ALTERNATIVE 2: 1 METER OF SEPARATION		
MODE	SEATS	SEATS OCCUPIED	STANDEES	TOTAL	SEATS OCCUPIED	STANDEES	TOTAL
Green Line	46	12	6	18	24	21	45

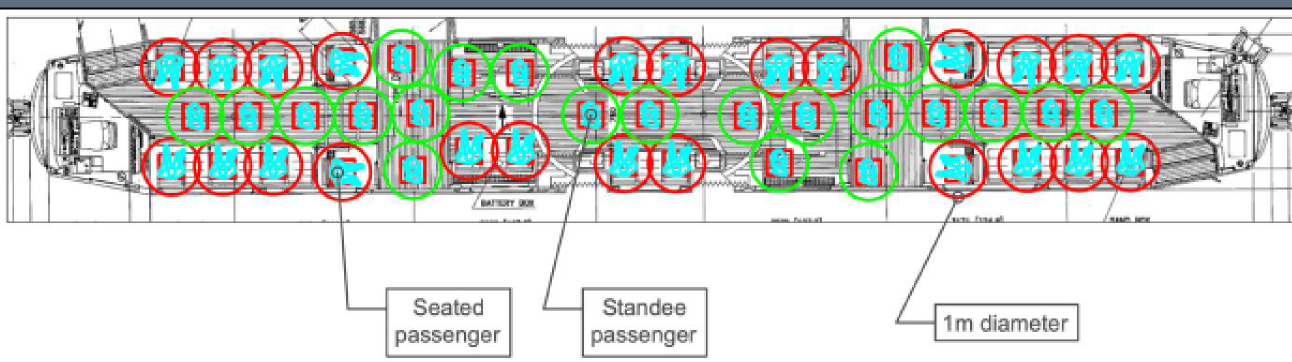
Key to graphic below:

- Riders: depicted in "Blue" symbol outline
- Seated Riders: located in center of "Red" Circle
- Standee Riders: located in center of "Green" Circle

ALTERNATIVE 1:



ALTERNATIVE 2:



See Attachment D: For larger-sized drawings

TABLE 6C:

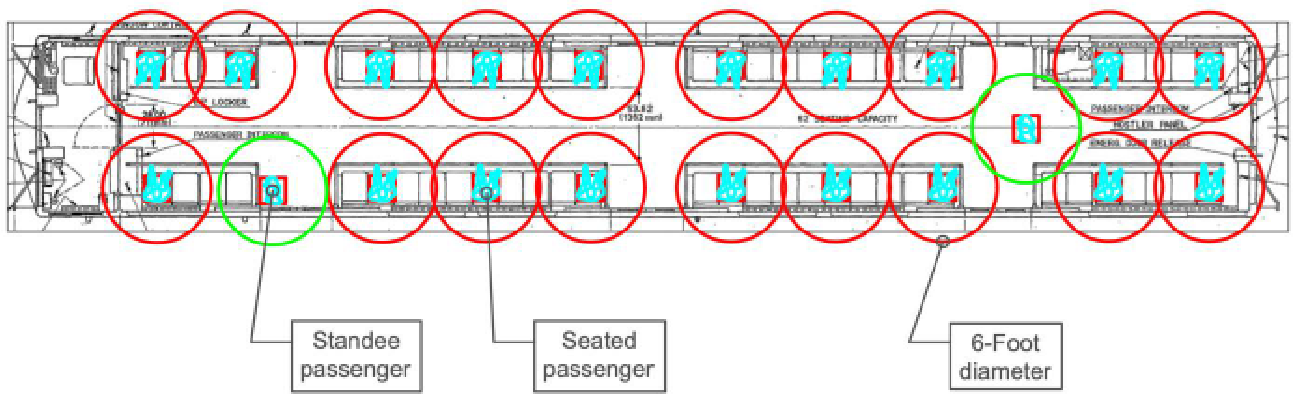
GOING THE DISTANCE: VEHICLE CAPACITY FOR ALTERNATIVE 1 & ALTERNATIVE 2: MBTA HEAVY RAIL, RED LINE

		ALTERNATIVE 1: 6-FEET OF SEPARATION			ALTERNATIVE 2: 1 METER OF SEPARATION		
MODE	SEATS	SEATS OCCUPIED	STANDEES	TOTAL	SEATS OCCUPIED	STANDEES	TOTAL
Red Line	62	19	2	21	32	25	57

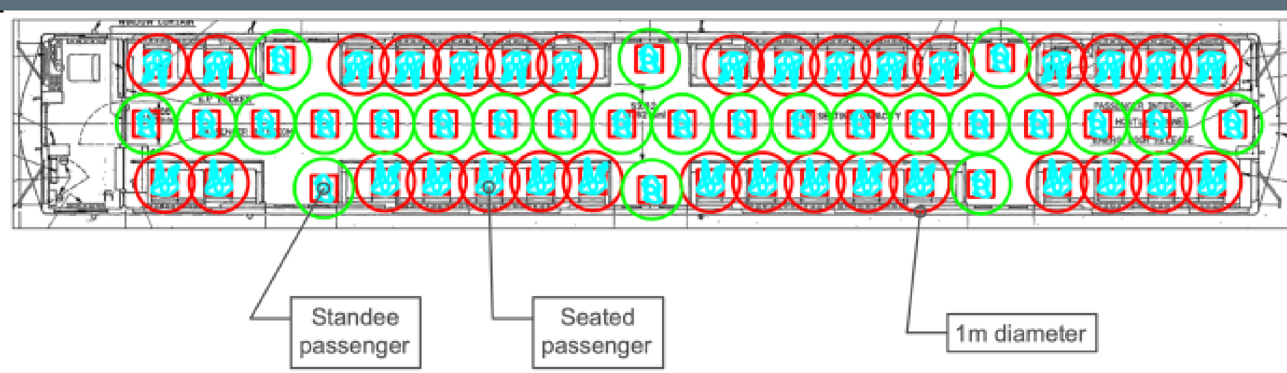
Key to graphic below:

- Riders: depicted in "Blue" symbol outline
- Seated Riders: located in center of "Red" Circle
- Standee Riders: located in center of "Green" Circle

ALTERNATIVE 1:



ALTERNATIVE 2:



See Attachment D: For larger-sized drawings

TABLE 6D:

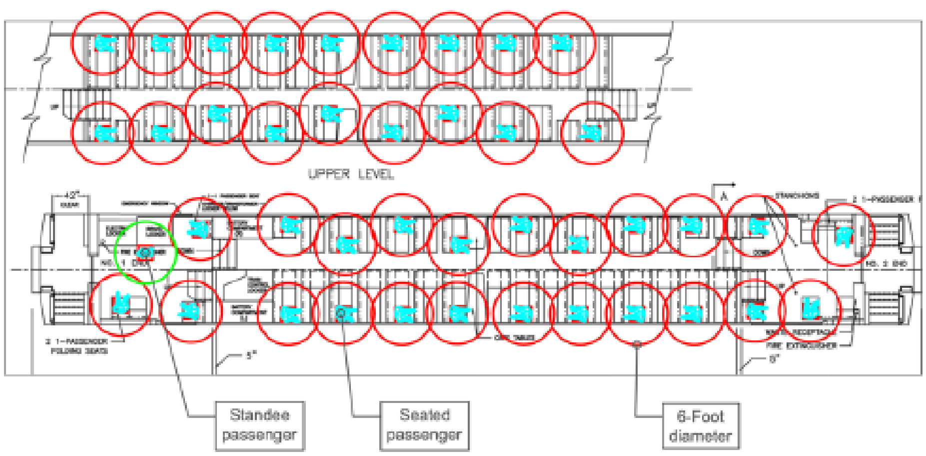
GOING THE DIANCE: VEHICLE CAPACITY FOR ALTERNATIVE 1 & ALTERNATIVE 2: MBTA COMMUTER RAIL, BI-LEVEL COACH

MODE	SEATS	ALTERNATIVE 1: 6-FEET OF SEPARATION			ALTERNATIVE 2: 1 METER OF SEPARATION		
		SEATS OCCUPIED	STANDEES	TOTAL	SEATS OCCUPIED	STANDEES	TOTAL
Com. Rail (Bi-level)	173	41	1	42	78	13	91

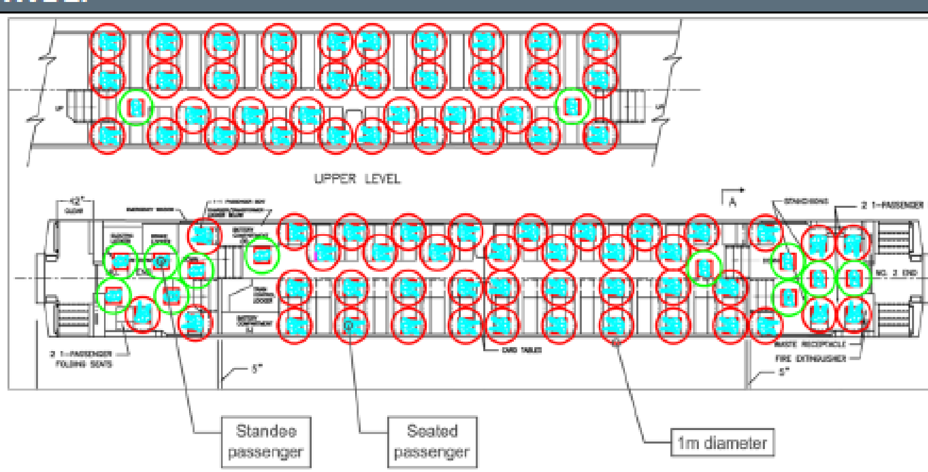
Key to graphic below:

- Riders: depicted in "Blue" symbol outline
- Seated Riders: located in center of "Red" Circle
- Standee Riders: located in center of "Green" Circle

ALTERNATIVE 1:



ALTERNATIVE 2:



MAXIMUM VEHICLE CAPACITIES UNDER NEW APPROACHES COMPARED

The engineering study presented in the previous section provides a conceptual analysis of how to implement both physical distancing standards on each of the MBTA's main modes: bus, rapid transit, and commuter rail. That analysis allowed the maximum number of seated and standee passengers for each mode and for each the CDC's 6-foot and WHO's 1 meter standards to be quantified. Table 7 provides a summary of analysis.

TABLE 7:

VEHICLE CAPACITIES FOR ALTERNATIVE 1 & ALTERNATIVE 2:							
		ALTERNATIVE 1: 6-FEET OF SEPARATION			ALTERNATIVE 2: 1 METER OF SEPARATION		
MODE	SEATS	SEATS OCCUPIED	STANDEES	TOTAL	SEATS OCCUPIED	STANDEES	TOTAL
BUS (40-FOOT)	36	9	1	10	15	7	22
GREEN LINE	46	12	6	18	24	21	45
RED LINE	62	19	2	21	32	25	57
COM. RAIL (BI-LEVEL)	173	41	1	42	78	13	91

SOURCES:

Rapid Transit, Heavy Rail, Red Line used as representative for all three service lines (Red, Orange, and Blue)

6 ft. = 1.83m = 4,072 sq. in. = 28.28 sq. ft. per standee

1m = 39.37" = 1,217 sq. in. = 8.45 sq. ft. per standee

Heavy Rail (Red Line): total aisle sq. ft. = 296

MBTA Blue Book, Ridership and Service Statistics, Fourteenth Edition, 2014, https://old.mbta.com/uploadedfiles/documents/2014%20BLUEBOOK%2014th%20Edition(1).pdf

MAXIMUM VEHICLE CAPACITIES UNDER THE OLD AND NEW APPROACHES PRESENTED & COMPARED

The passenger capacity limit for each vehicle by mode under the old and new approaches are presented and compared in Table 8. Since the objective of physical distancing is to keep riders apart, the density of riders on each vehicle will be reduced as will the capacity of each vehicle as compared to normal "Adequately-Full" normal crowding levels. The maximum capacity of each vehicle for Alternative 1 ranges between 15%–22% or an average of 19% fleetwide of normal. The maximum vehicle capacity for Alternative 2 is higher, with a range of 40%–48% or an average of 44% fleetwide as compared to "normal".

TABLE 8:

MAXIMUM ACCEPTABLE RIDERSHIP CAPACITIES PER VEHICLE: "NORMAL" DENSITY V. "GOING THE DISTANCE" DENSITIES					
	PASSENGER SEPARATION GOALS: MINIMUM DISTANCE BETWEEN RIDERS				
	NORMAL	"GOING THE DISTANCE"			
	NONE[A]	ALTERNATIVE 1: 6.0 FEET APART[B]		ALTERNATIVE 2: 1 METER APART[C]	
MODE	"NORMAL" # OF RIDERS	# OF RIDERS	COMPARED TO "NORMAL"	# OF RIDERS	COMPARED TO "NORMAL"
BUS (40-FOOT)	50	10	20%	22	44%
GREEN LINE	100	18	18%	45	45%
RED LINE	142	21	15%	57	40%
COMMUTER RAIL (BI-LEVEL)	190	42	22%	91	48%
AVERAGE %[D]			19%		44%

SOURCES:

A. "None" = Normally. The MBTA and agency peers traditionally do not have passenger minimum distancing goals. They do use density goals. Seats (and seated passengers) on MBTA Buses and Rapid Transit vehicles are typically 17" or 1.42 feet apart. This report calculates that "normally", for standee passengers, 1.9 feet apart is the distance each standee would be apart based on the MBTA and industry standard AW2 (Assigned Weight classification system) area of 3.5 sq. ft. per standee as shown in Table 4 above. 1.9 feet apart = 397 sq. in. = 2.76 sq. ft. (if circle) or 3.5 sq. ft (if circle) per standee.

B. 6.0 feet Apart = 1.83m = 4,072 sq. in. = 28.28 sq. ft. per standee (if circle as drawn in report)

C. 1m Apart = 3.3 feet = 39.37" = 1,217 sq. in. = 8.45 sq. ft. per standee (if circle as drawn in report)

D. "Average %" listed here, Weighted Averages based on Normal ridership volume modal shares are within 1% of percentages listed here.

For the purposes of this report, "normal" is a proxy for a comparison to what the MBTA would carry at the highest of the normal peak capacity, when vehicles are both running at the highest service levels and are each full of passengers taking up the entire 100% of the normal "Acceptably-Full" densities that were discussed back in Table 3 on pp. 9. The MBTA runs its highest service levels during the so-called Weekday AM Peak, a 3-hour window between 6:00–9:00 AM, typically. If the Weekday AM Peak window had every vehicle running at 100% full density at every moment during that 3-hour window, then Alternative 1 would only provide 19% of that capacity and Alternative 2 would only provide 44% of that capacity. But as discussed below, MBTA vehicles do not run at 100% of "normal" maximum or full capacity for every time increment—traditionally studied in 15-minute intervals—during the entirety of the 3-hour Weekday AM Peak window. As a result, the net effective capacity for the two physical distancing alternatives as compared to normal is higher than the 19% and 44% shown in Table 8.

WEEKDAY AM PEAK AND WEEKDAY 24-HOUR CAPACITY CALCULATIONS

Using over half a million discrete raw data pieces available from the MBTA Open Data Portal, a data analytics analysis for each of the MBTA's three primary modes: bus, rapid transit, and commuter rail was undertaken for this report to ascertain how many riders the MBTA typically carried during the Weekday AM Peak. Pre-pandemic ridership volumes by mode for the Weekday AM Peak period (three-hours) using MBTA-sourced data that is publicly available were prepared.[12] See Appendix C for details of the consultant's methodology in the undertaking of this data analysis. In order to confirm the methodology used for the report's Weekday AM Peak period data analysis, Weekday 24-hour daily ridership totals were also calculated. Those totals were then compared to baseline 24-hour volumes that the MBTA publishes. The results of the pre-pandemic ridership calculations for the Weekday AM Peak period and Weekday 24-Hour totals are reviewed in Table 9.

As shown in Table 9, the normal (pre-pandemic) Weekday AM Peak period (three-hour window between 6:00 AM and 9:00 AM) ridership for the main MBTA modes studied is 324,240 in total. The normal (pre-pandemic) Weekday 24-Hour total was 1,206,426.

MBTA EFFECTIVE SYSTEMWIDE WEEKDAY AM PEAK CAPACITY IN 15-MINUTE INTERVALS

For each day of 2018, the total number of people boarding the MBTA during each 15-minute period between 5:00 AM and 10:00 AM was calculated. This analysis purposely extended the 6:00 AM–9:00 AM out one-hour on either side in contemplation of further analysis of the benefits of robust Flextime efforts to flatten the peak of transit usage in the rush hour window. This consisted of data obtained from the MBTA DataPortal for each station on each day during each 15-minute period, or 1,844,411 records.

The "100% capacity" for the ridership was then set to the highest ridership period, between 8:15 and 8:30 AM. This data was "scaled up" to match the dataset used to calculate the total Weekday AM Peak total systemwide capacity of 324,240 as shown in Table 9. This, however, does not change any of the calculations since all data is normalized for the final output.

The effective system capacity can then be calculated based on a desired percentage of normal peak capacity, which for the purposes of this study is the 19% and 44% totals of normal capacity provided by Alternative 1 and Alternative 2 as shown in Table 8. Using those two distancing alternatives percentages of peak capacity, the number of passengers accommodated during each time period is calculated. If this is less than the 2018 demand, it is counted as "surplus capacity" and if it is lower than the 2018 demand it is counted as a "capacity deficit" or "excess demand." The proportion of passengers accommodated for each 15-minute window were calculated both without and with full peak spreading over the extended five-hour Weekday AM Peak window. That analysis presumes: (a) a portion of riders can Flex earlier or later into the workplace; and (b) the MBTA would run at full-service levels throughout that extended five-hour peak window. The results of this analysis are shown in Figures 1a & 1b, respectively, for Alternative 1 and Alternative 2.

TABLE 9:

WEEKDAY MAXIMUM SYSTEMWIDE CAPACITY BASED ON ACCEPTABLE RIDERSHIP CAPACITIES PER MODE (BASED ON "NORMAL" WEEKDAY SERVICE LEVELS [A])

MODE	ACTUAL[A] "NORMAL" OR "ACCEPTABLY-FULL" CROWDING & FULL WEEKDAY SERVICE LEVELS[B] NO MINIMUM DISTANCING — AM PEAK	24-HOUR
BUS	112,336	408,478
LIGHT RAIL (GREEN LINE)	27,432	143,474
HEAVY RAIL (BLUE, ORANGE & RED LINE)	134,652	527,367
COMMUTER RAIL (BI-LEVEL)	49,820	127,107
TOTALS	324,240	1,206,426

SOURCES:
A. Actual ridership counts based on extensive ridership data analysis undertaken for this report using data sets available at the MBTA's DataBlog web portal. See Attachment A for detailed description of that data analysis.

B. "Normal" = Pre-pandemic Weekday Service Levels, in-use prior to March 17, 2020

12. https://mbta-massdot.opendata.arcgis.com

FIGURE 1A:

MBTA EFFECTIVE SYSTEMWIDE WEEKDAY AM PEAK CAPACITY: ALTERNATIVE 1

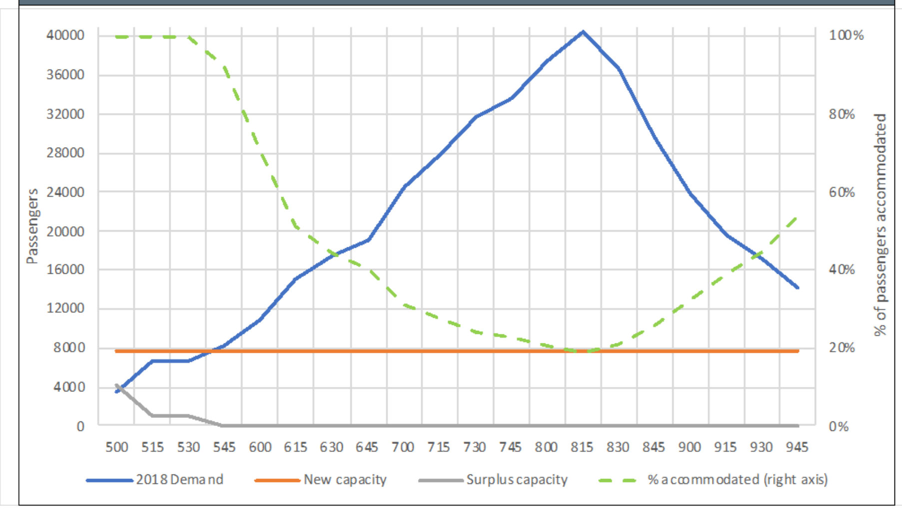
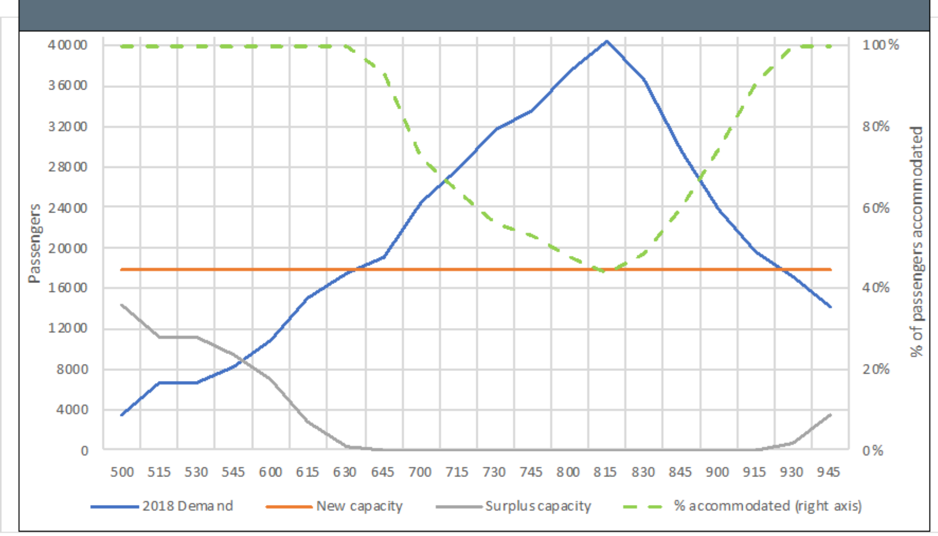


FIGURE 1B:

MBTA EFFECTIVE SYSTEMWIDE WEEKDAY AM PEAK CAPACITY: ALTERNATIVE 2



EFFECTIVE MBTA SYSTEM CAPACITY & BENEFITS OF ROBUST EMPLOYEE FLEX-TIME PROGRAM TO FLATTEN THE PEAK FOR BOTH ALTERNATIVES

The analysis used to create Figures 1A & 1B allows for the following findings:

1. If the system was already running at the maximum 15-minute interval demand of 40,428 for every increment of the AM Peak window, then Alternate 1 would only provide 19% of normal maximum capacity. But since the system carries only about 50% of maximum capacity on average for the time window, the percentage of riders that can be accommodated under Alternative 1 is higher than 19%. Based on preliminary results from our analysis that is still under development, it appears that Alternative 1 can accommodate more than 25% of normal demand without any effort to spread the peak and rises to between 30%–35% with a purposeful peak spread.

2. With respect to Alternative 2, if the system was already running at the maximum 15-minute interval demand of 40,428 for every increment of the AM Peak window, then Alternate 2 would only provide 44% of normal maximum capacity. As already mentioned, the system carries about half of maximum capacity on average for the extended Weekday AM Peak period. Again, based on preliminary results from our analysis that is still under development, it looks like the percentage of riders that can be accommodated under Alternative 2 is above 50% without any effort to spread the peak and rises above 60% with a purposeful peak spread. Because Alternative 2 has a much higher capacity than Alternative 1, it can gain a much greater benefit from a robust program of Flextime to take advantage of the larger surplus systemwide capacities that exist between 5:00–6:00 AM and 9:00–10:00 AM.

3. In both approaches to physical distancing, the significant increases in accommodating additional ridership from efforts to take advantage of excess system capacities speaks to the importance of robust efforts to help “spread the peak” or “flatten the curve” in the morning and evening peak periods.

4. When looking at the normal Weekday AM Peak window that spans from 6:00 AM to 9:00 AM, the peak 15-minute interval for overall systemwide capacity is 8:15–8:30 AM, when the system carried 40,428 riders.

5. Presuming that 3-hour window is expanded on either side to run from 5:00 AM to 10:00 AM and that full weekday service is similarly extended, the average ridership or capacity for each portion of the 5-hour window is 21,204 or almost half as much as the peak 15-minute peak interval of 40,428. That means that on average the system over that window is
carrying about half the ridership it has the capacity to handle.

6. There are some indications that the MBTA is currently carrying about 15% of normal ridership in aggregate system-wide. Based on preliminary results from our analysis that is still under development, and speaking to potentials that should be confirmed and refined by a larger itemized (mode by mode) analysis that could most likely only be undertaken by the MBTA itself:

A. Alternative 1 can accommodate a rise to 25% of normal ridership (without Flextime) and up to 30%–35% with Flextime.

B. Alternative 2 can accommodate an increase of over 50% of normal ridership (without Flextime) and over 60% with a very robust set of Flextime measures.

•

III. IMPLEMENTING PHYSICAL DISTANCING ON THE MBTA

RECOMMENDATIONS

This report recommends that the MBTA undertake the following suite of near-term actions to support physical distancing across the system.

I. The MBTA should help limit demand for public transit by establishing the "Going the Distance Collaborative," a long-term advisory partnership with public officials, business leaders, and other stakeholders to maximize work from home and minimize transit usage during peak hours. This collaborative can help deploy and amend demand management strategies, including telecommuting and alternative work schedules, to help reduce overall demand for public transit and to help "spread the peak" or "flatten the curve" of morning and evening rush hours.

2. The MBTA should set capacity targets across its fleet and system. This report can provide capacity targets aligned with national and global standards. Mode-specific capacity targets are key operations and monitoring tools for implementing a successful physical distancing program. Capacity targets can help operators make real time decisions and help MBTA leadership make service delivery adjustments.

3. The MBTA should deploy seat markers and signage across its fleet, stations, and stops to help riders maintain physical distance. For example, the MBTA will need to convey to riders which seats to occupy and where standees should position themselves on vehicles so that physical distancing objectives can be achieved.

4. The MBTA should institute a dynamic monitoring, assisted compliance, and enhanced customer service initiative to help riders maintain physical distance. The campaign should also reinforce other complementary health and safety measures, including Governor Baker's Executive Order of May 1st requiring all passengers to wear face coverings on the MBTA system.

5. The MBTA should launch a comprehensive communication and education campaign to help riders understand physical distancing objectives and related health and safety measures, including disinfection efforts and face covering requirements. This campaign should be multimedia and multilingual.

6. The MBTA should pursue ways to participate in the Commonwealth's innovative contact tracing program to identify potential transit-related hotspots. The MBTA should also pursue additional diagnostic testing and antibody testing efforts to understand the full scope of infection in its workforce.

7. The MBTA should pursue a flexible approach to service delivery that is continuously informed by the best available public health data and guidance and ready to adapt to specific mode demand fluctuations in real time. Certain modes and routes will experience differences in ridership demand. The MBTA will need to continue and strengthen its ability to be nimble in its service delivery. Scheduling changes are already happening with a quick turnaround and this will need to continue. Additionally, intermodal links, such as bus routes directed toward commuter rail stations possibly fed with urban rail services, may need to be considered.

8. The MBTA should ramp up employee recruitment to ensure ongoing operations and safety. Ongoing recruitment and onboarding of operators will be necessary to backfill both preexisting and COVID-related staffing capacity constraints.

Furthermore, the MBTA is well-positioned to quickly pilot many of these recommendations, including setting capacity targets and de-ploying seat markers and signage, on replacement bus services already planned to mitigate construction-related service disruptions on portions of the Green Line, Blue Line, and Lowell Commuter Rail Line scheduled to begin in May.

IV. CONCLUSION

In the coming weeks and months, the widespread deployment of demand management strategies, including continued telecommuting and alternative work schedules, is expected to significantly limit demand for public transit. However, there will be essential workers continuing to staff the frontlines and non-essential workers returning to the work-place—how will they choose to commute? Will they take public transit, drive, carpool, grab an Uber/Lyft, hop on a private shuttle, bike or walk? If potential riders choose to forsake public transit in droves, there will be serious ramifications for roadway congestion, air quality, and the solvency of the MBTA itself. It would be difficult to overstate the importance of these initial individual commute choices, as they could collectively influence the ability for the Boston economy to rebound, which could then impact the region's long-term economic resilience and environmental sustainability.

A Better City puts forth this report to help the MBTA consider physical distancing strategies to protect the health and safety of the MBTA workforce and ridership. By taking clear, decisive actions to safeguard public health, the MBTA will build trust and confidence in the system and gradually increase ridership—ultimately enhancing mobility, facilitating economic spending, reducing emissions, and ensuring equitable access. We are optimistic that by going the distance, the MBTA, public officials, the business community, and other stakeholders can work together to help riders stay apart.

A Better City is grateful for the MBTA's steadfast leadership and herculean efforts to keep our region running throughout this unprecedented crisis. The MBTA's frontline workers are essential and heroic. We look forward to continuing to work together to enhance and expand ac-cess to public transit throughout the region—now and in the years to come.

V. ATTACHMENTS

ATTACHMENT A: ANALYSIS OF MBTA RIDERSHIP DATA BY MODE METHODOLOGY

MBTA RIDERSHIP DATA BY MODE METHODOLOGY
APRIL 28, 2020

Research Question: How many people does the MBTA carry on average on heavy rail, light rail, commuter rail, and buses during the AM peak rush hour period (6M–9 AM) compared to a 24-hour period

1. Data was retrieved from the MBTA Open Data Portal.

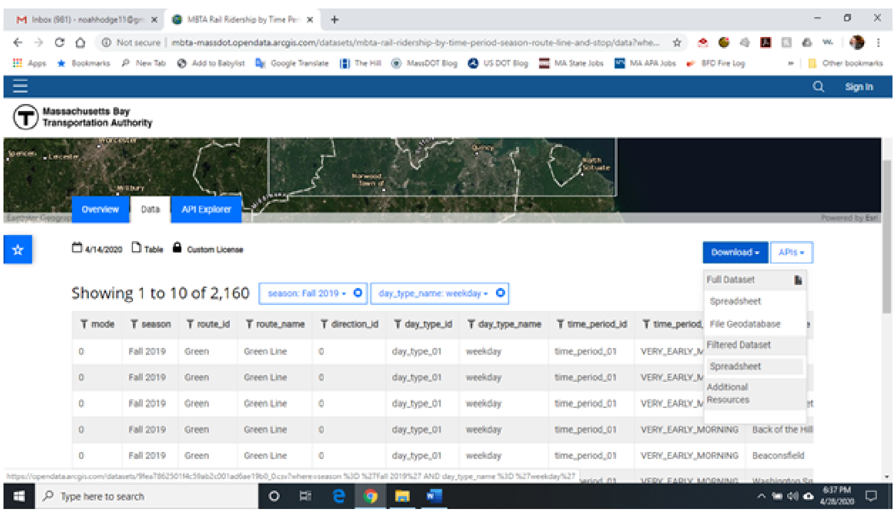
2. The follow tables on the MBTA Open Data Portal were utilized for this analysis. All tables can be found in the "Ridership" category under the "Data by category" field

   A. MBTA Bus Ridership by Trip, Season, Route/Line, and Stop (Bus Ridership)

   B. MBTA Rail Ridership by Time Period, Season, Route/Line, and Stop (Rail Ridership)

   C. MBTA Commuter Rail Ridership by Trip, Season, Route/Line, and Stop (Commuter Rail Ridership)

3. For each dataset, data was filtered on the MBTA Data Portal to only show the most recent time period for which data was available and weekday data only. This was done by clicking on the "Data" tab and filtering by "season", selecting the most recent time period and then filtering by "day_type_name". An example of this is shown below for the Rail Ridership data:



4. Filtered Spreadsheets were downloaded in .csv format as follows for each of the following datasets:
   - Bus Ridership – Fall 2018, weekday
   - Rail Ridership – Fall 2019, weekday
   - Commuter Rail Ridership– Spring 2018, weekday

5. Each of the three downloaded spreadsheets were then duplicated so that the 6 – 9 AM data could be extracted.

6. 6- 9 AM bus ridership data was extracted by sorting all data in the Bus Ridership dataset by "trip_start_time" and then deleting all records except for those with a time stamp between "6:00:00" and "9:00:00".

7. The 6-9 AM average bus boarding number of 112, 336 was obtained by inserting a pivot table in the Bus Ridership dataset, which summed the number in the "boardings" field at each stop in the remaining 100,762 records.

8. The 24-hour average bus boarding number of 408,478 was obtained by inserting a pivot table in the copy of the Bus Ridership data set, that was not manipulated, which summed the number in the "boardings" field at each stop in the total 418,802 records.

9. 6- 9 AM rail ridership data was extracted by sorting all data in the Rail Ridership dataset by "time_period_name" and then deleting all records except for those with a time period name of "EARLY_AM" and "AM_PEAK". EARLY AM as defined in the MBTA Service Delivery Policy, January 23, 2017; pp. 9 consists of the period of 6:00 – 6:59 AM. AM PEAK contains the period of 7:00 AM – 8:59 AM.

10. The 6-9 AM average heavy rail and light rail boarding numbers (134,652 and 27,432 respectively) was obtained by inserting a pivot table in the Rail Ridership dataset which summed the number in the "average_ons" field by "route_id" (i.e. Blue, Green, Orange, Red) in the remaining 480 records.

11. The total "average_ons" for the Blue, Orange, and Red Lines were then summed to net the 6-9 AM average heavy rail boarding number of 134,652.

12. The total "average_ons" for the Green Line was used for the 6-9 AM average light rail board number of 27,432.

13. The process in steps 10- 13 was utilized to produce the 24-hour heavy and light rail boarding numbers of 527,367 and 143,474 in the copy of the Rail Ridership dataset that was not manipulated, which summed the number in the "average_ons" field by "route_id" in the total 2,160 records.

14. 6- 9 AM commuter rail ridership data was extracted by sorting all data in the Commuter Rail Ridership dataset by "stop time" and then deleting all records except for those with a time stamp between "11:00:00" and "14:00:00". This time range was utilized as it was determined that when the data was downloaded it was converted to Greenwich Mean Time, which is 5 hours ahead of Eastern Standard Time.

15. The 6-9 AM average commuter rail boarding number of 49,827 was obtained by inserting a pivot table in the Commuter Rail dataset which summed the number in the "average_ons" field at each stop in the remaining 1,162 records.

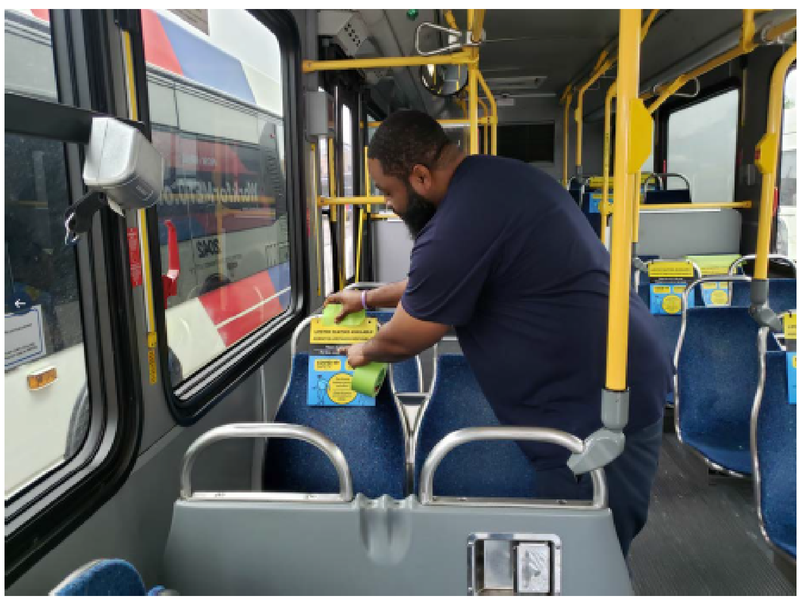
16. The 24-hour average commuter rail boarding number of 127,107 was obtained by inserting a pivot table in the copy of the Commuter Rail Ridership dataset that was not manipulated, which summed the number in the "average_ons" field at each stop in the total 5,432 records.

17. The 24-hour ridership data for all modes was then compared to the average number of weekday trips by mode available by month on the MBTA's Performance Dashboard. The 24-hour ridership data for each of the four modes were found to all be within 5% of the ridership data on the MBTA's Performance Dashboard and therefore both the 6-9 AM Peak and 24-hour ridership data by mode yielded in this analysis was deemed accurate for use.

ATTACHMENT B: EXAMPLES OF PHYSICAL DISTANCING ALTERNATIVE 1 & ALTERNATIVE 2

FIGURE B1:

ALTERNATIVE 1, SIX FEET OF SEPARATION: METRO HOUSTON



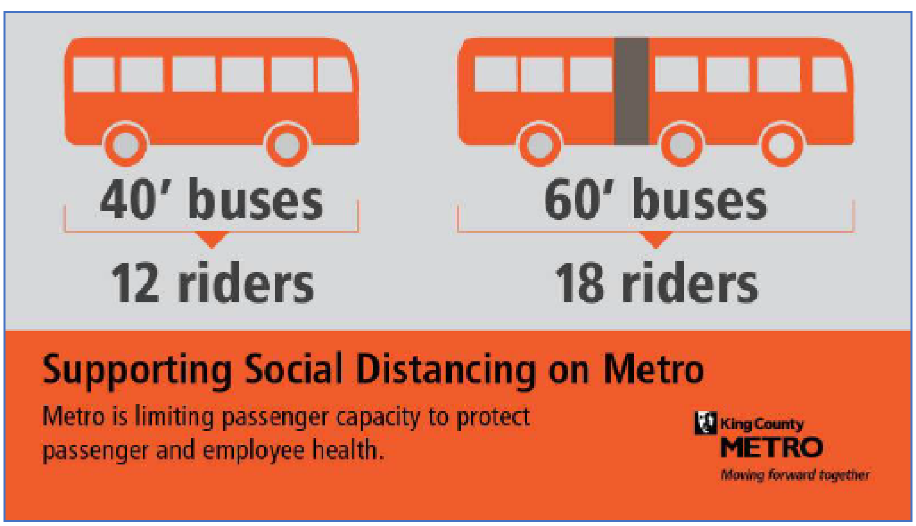
SOURCES:
https://www.ridemetro.org/Pages/Coronavirus.aspx#

https://twitter.com/METROHouston/status/1241892462081310727/photo/2D

https://www.khou.com/article/news/health/coronavirus/metro-houstons-plan-to-stop-coronavirus-spread/285-3931a4ab-251d-4886-9176-ebb5fef66d50

FIGURE B2A:

ALTERNATIVE I, SIX FEET OF SEPARATION: TRI-MET

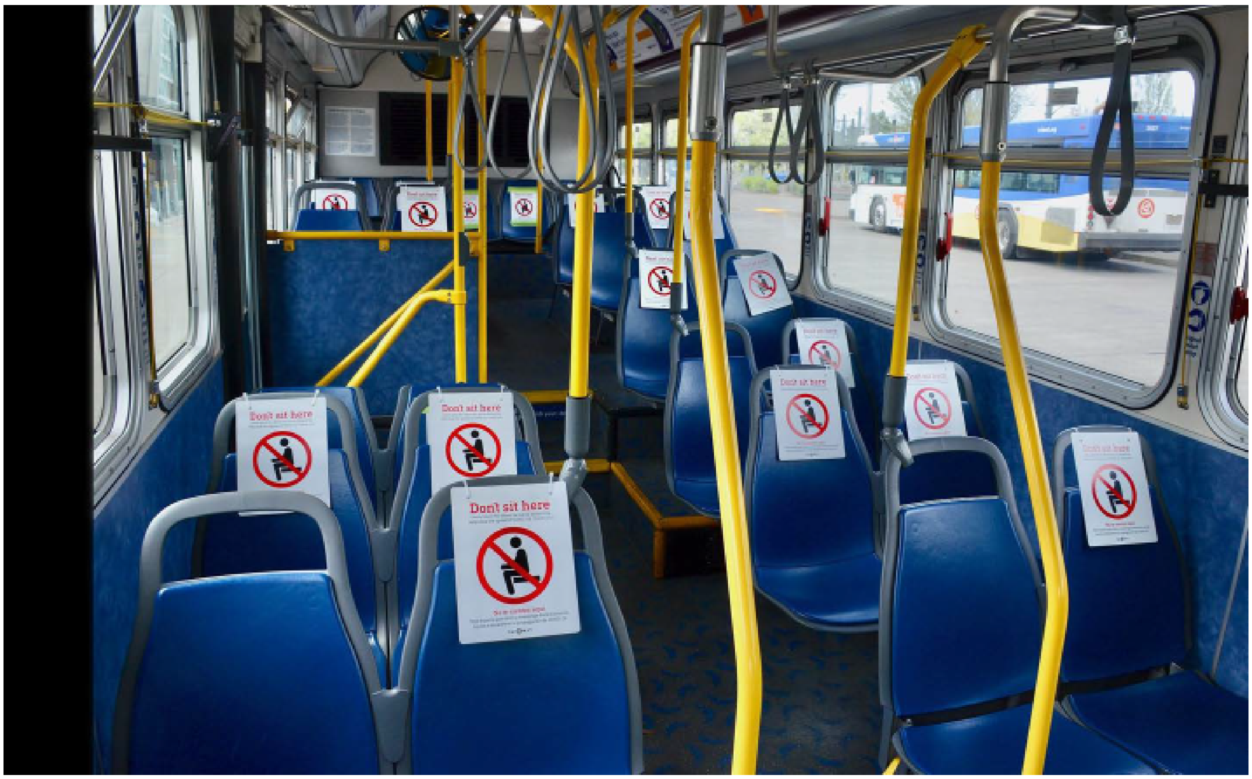


SOURCES:
Official policy: no more than 12–15 riders will be permitted on a 40-foot bus at one time. But research shows operator/drivers instructed to let all waiting to board, even if doing so precludes physical distancing.

https://twitter.com/search?q=tri-met%20bus&src=typed_query&f=live

FIGURE B2B:

ALTERNATIVE I, SIX FEET OF SEPARATION:
TRI-MET: PORTLAND OR

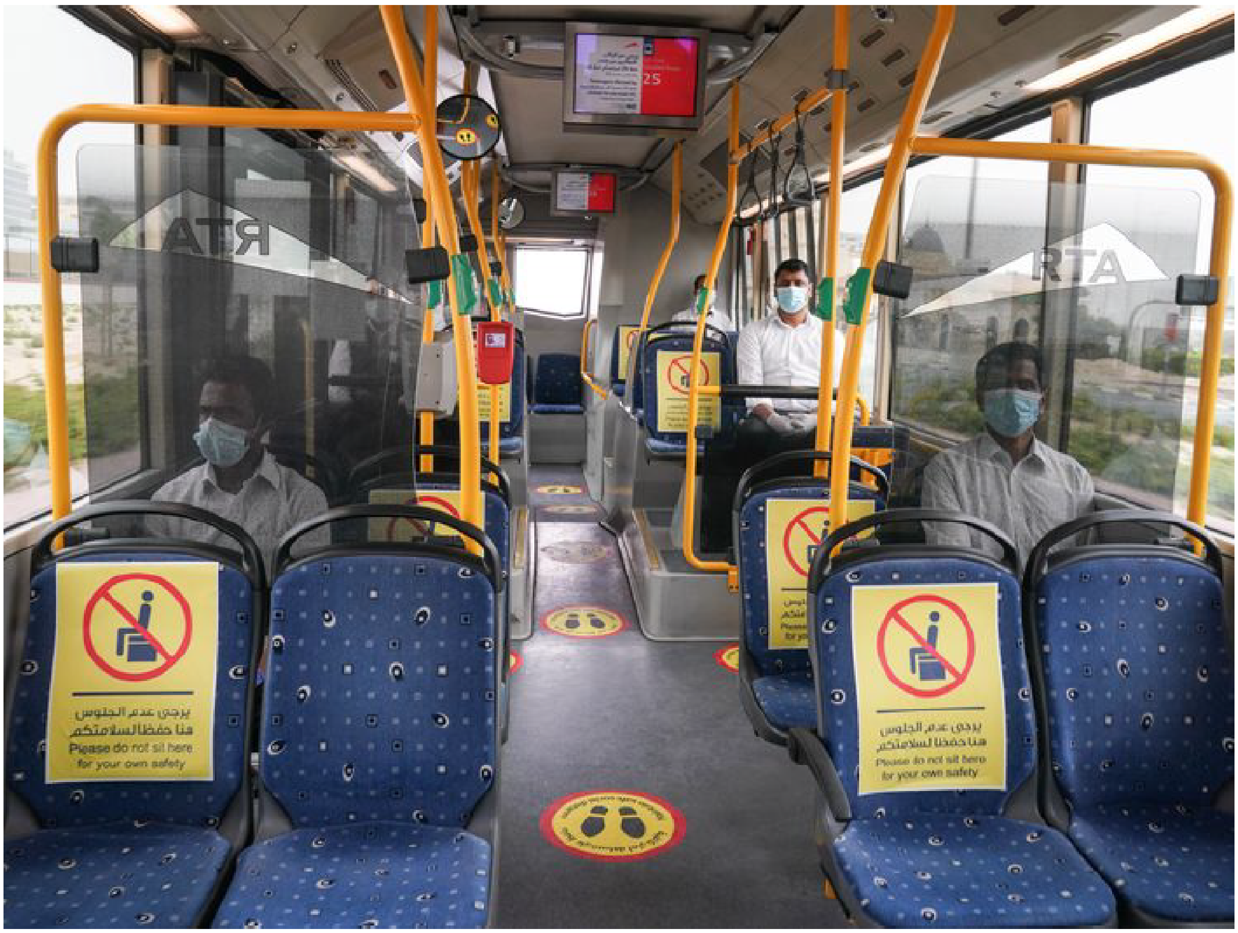


SOURCES:
Official policy: no more than 12–15 riders will be permitted on a 40-foot bus at one time. But research shows operator/drivers instructed to let all waiting to board, even if doing so precludes physical distancing.

https://twitter.com/search?q=tri-met%20bus&src=typed_query&f=live

FIGURE B3:

ALTERNATIVE 2, 1 METER OF SEPARATION: DUBAI RTA



SOURCES:
https://gulfnews.com/uae/coronavirus-dubai-rta-revises-operational-hours-for-public-transport-including-metro-buses-and-taxis-1.70744322

FIGURE B4A:

ALTERNATIVE 2, 1 METER OF SEPARATION: MOSCOW SUBWAY

FIGURE B4B:

ALTERNATIVE 2, 1 METER OF SEPARATION: MOSCOW SUBWAY

FIGURE B5A:

ALTERNATIVE 2, 1 METER OF SEPARATION: SINGAPORE – LAND TRANSPORT AUTHORITY

SOURCES:
https://www.straitstimes.com/singapore/transport/coronavirus-safe-distancing-measures-to-be-rolled-out-across-public-transport

FIGURE B5B:

ALTERNATIVE 2, 1 METER OF SEPARATION: SINGAPORE–LAND TRANSPORT AUTHORITY

SOURCES:
https://www.straitstimes.com/singapore/transport/coronavirus-safe-distancing-measures-to-be-rolled-out-across-public-transport

FIGURE B5C:

ALTERNATIVE 2, 1 METER OF SEPARATION: SINGAPORE–LAND TRANSPORT AUTHORITY

SOURCES:
[Markings on bus station queue area spaced 1m apart](https://www.straitstimes.com/singapore/transport/coronavirus-safe-distancing-measures-to-be-rolled-out-across-public-transport)

https://www.straitstimes.com/singapore/transport/coronavirus-safe-distancing-measures-to-be-rolled-out-across-public-transport

ATTACHMENT C: METHODOLOGY FOR DETERMINING 15-MINUTE AVERAGE RIDERSHIP LEVELS

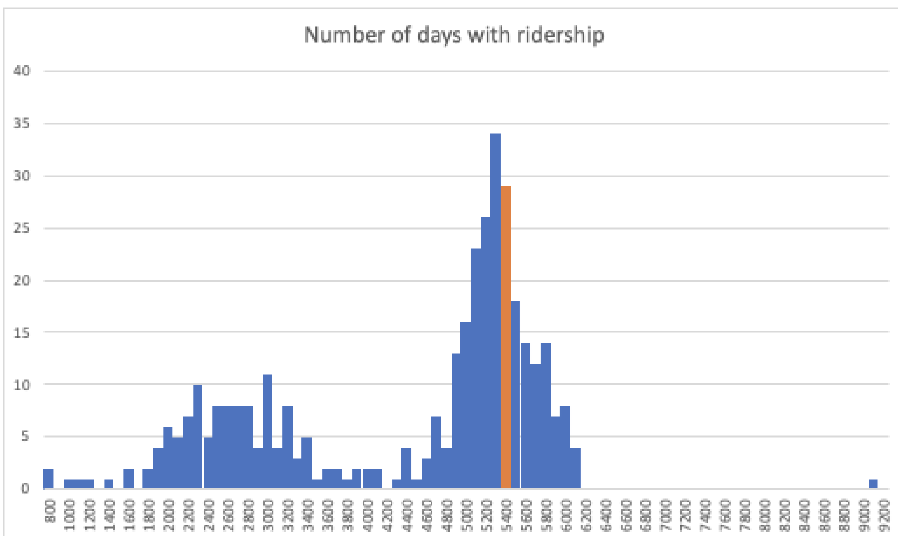
METHODOLOGY FOR DETERMINING 15-MINUTE AVERAGE RIDERSHIP LEVELS

Research question: how many people use or board the MBTA rapid transit in each 15-minute period during Weekday AM Peak?

1. Data was obtained from the MBTA's "gated station entry" portal here. These data are aggregated by station and 15-minute period. The data analyzed is for all boarding's during calendar year 2018.

2. For each day of 2018, the total number of people boarding the MBTA during each 15-minute period between 5:00 AM and 10:00 AM was calculated. This consisted of data for each station on each day during each 15-minute period, or 1,844,411 records.

3. For each of these periods, the 275th lowest value was taken so as to exclude values obtained on weekend days, holidays and other low-ridership periods. This is generally in the middle of the distribution of weekday ridership. For instance, for the 9:45 to 10:00 time frame, the 275th element (75th percentile) falls within the distribution of ridership in the orange bar on the chart below. Other distributions are similar:



4. The python code to analyze these data can be found at the end of this document.

5. The "100% capacity" for the ridership was then set to the highest ridership period, between 8:15 and 8:30 AM.

6. The rail ridership for the 6:00 to 9:00 period was calculated at 124,410, with 15,512 boardings between 8:15 and 8:30. The 6 to 9 figure is 92.5% of the figure calculated based on average ridership from other sources, the differences may be due to farebox non-interaction, holiday data, medians vs averages, etc.

7. It is possible to "scale up" these data to match the full subway+light rail+bus+commuter rail dataset, which counted 2.6 times more passengers on the overall system during this time frame to estimate the overall carrying capacity of the system. This must be done for the peak period as well. This, however, does not change any of the calculations since all data is normalized for the final output.

8. The system capacity can then be calculated based on a desired percentage of normal peak capacity.

9. Using a desired percent of peak capacity, the number of passengers accommodated during each time period is calculated. If this is less than the 2018 demand, it is counted as "surplus capacity" and if it is lower than the 2018 demand it is counted as a "capacity deficit" or "excess demand."

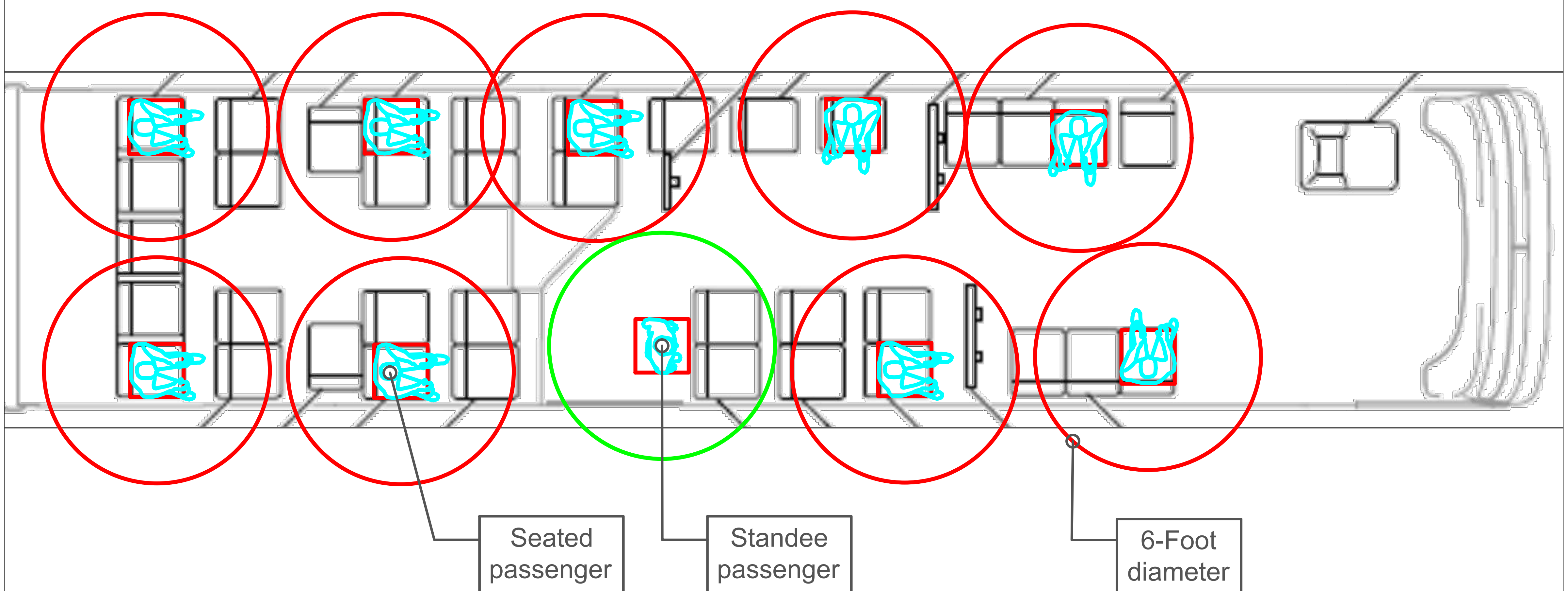
10. The proportion of passengers accommodated is calculated as 1 - (capacity deficit / 2018 demand), and the proportion of passengers accommodated with full peak spreading is calculated as (the total new capacity from 5 to 10 AM / 2018 demand).

These data can be replicated for specific lines or stations if needed.

PYTHON CODE:

```
import csv

csv_file = 'gated_2018.csv'

times =
['500','515','530','545','600','615','630','645','700','715','730',
         '745','800','815','830','845','900','915','930','945']

times_list = []

with open(csv_file, newline='') as csvfile:
    csv = csv.reader(csvfile, delimiter=',', quotechar='|')

    all_lines = []

    for i in csv:

        all_lines.append(i)

date_list = []

for k in all_lines:

    if k[2] not in date_list:

        date_list.append(k[2])

for m in times:

    pax_list = []

    for l in date_list:

        pax_sum = 0

        for j in all_lines:

            if j[3] == m and j[2] == l:

                pax_sum += int(j[4])

        pax_list.append(pax_sum)

    pax_list.sort()

    times_list.append([m, pax_list[275]])

    print(times_list)
```

ATTACHMENT D: FULL SHEET DRAWINGS OF ENGINGEERED CONCEPTS BY VEHICLE MODE FOR PHYSICAL DISTANCING ALTERNATIVE 1 & ALTER-NATIVE 2



GENERAL NOTES

1. Dimensions in inches unless otherwise noted.
2. Presumes all riders are six-feet apart from those in seats and from other standees.
3. Presumes 17" of biacromial breadth for each rider
4. Concept level analysis.
5. Key: (with quantities)

   Blue Outline:
   Each rider six-feet apart

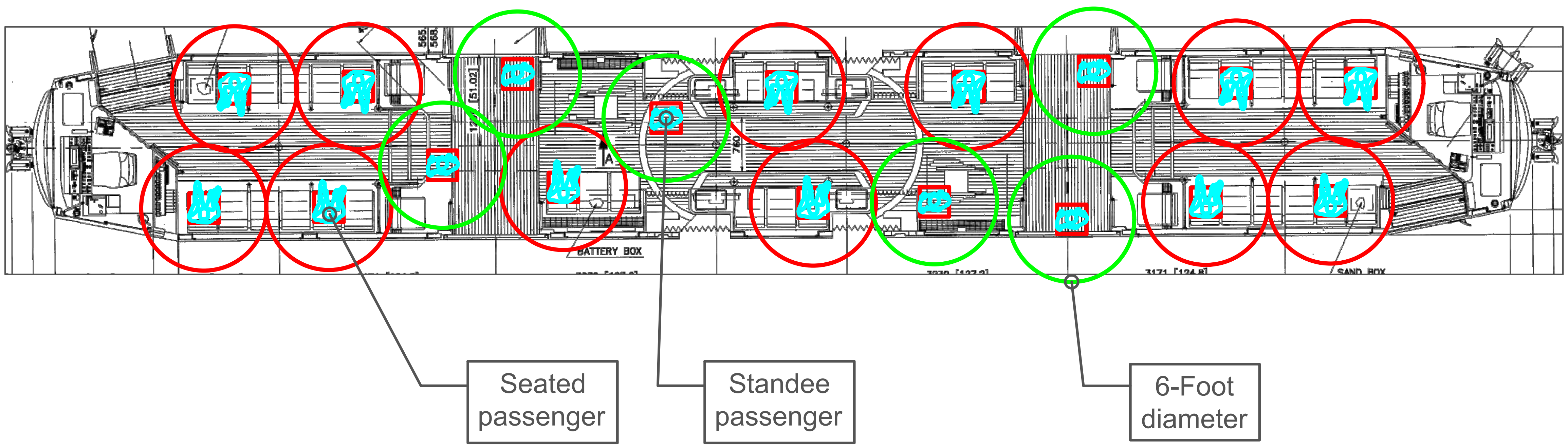
   Red Circle:
   Seated riders: (9)

   Green circle:
   Standee riders: (1)

Sheet Title:

MBTA Going the Distance:
BUS 40-FOOT
Passenger Density:
ALTERNATIVE 1: SIX-FEET APART

Prepared by:	GAB
Drawn by:	GAB
Date:	5/6/20
Scale:	1' = 40'
	Sheet: 0



GENERAL NOTES

1. Dimensions in inches unless otherwise noted.
2. Presumes all riders are six-feet apart from those in seats and from other standees.
3. Presumes 17" of biacromial breadth for each rider
4. Concept level analysis.
5. Key: (with quantities)

   Blue Outline:
   Each rider six-feet apart

   Red Circle:
   Seated riders: (12)

   Green circle:
   Standee riders: (6)

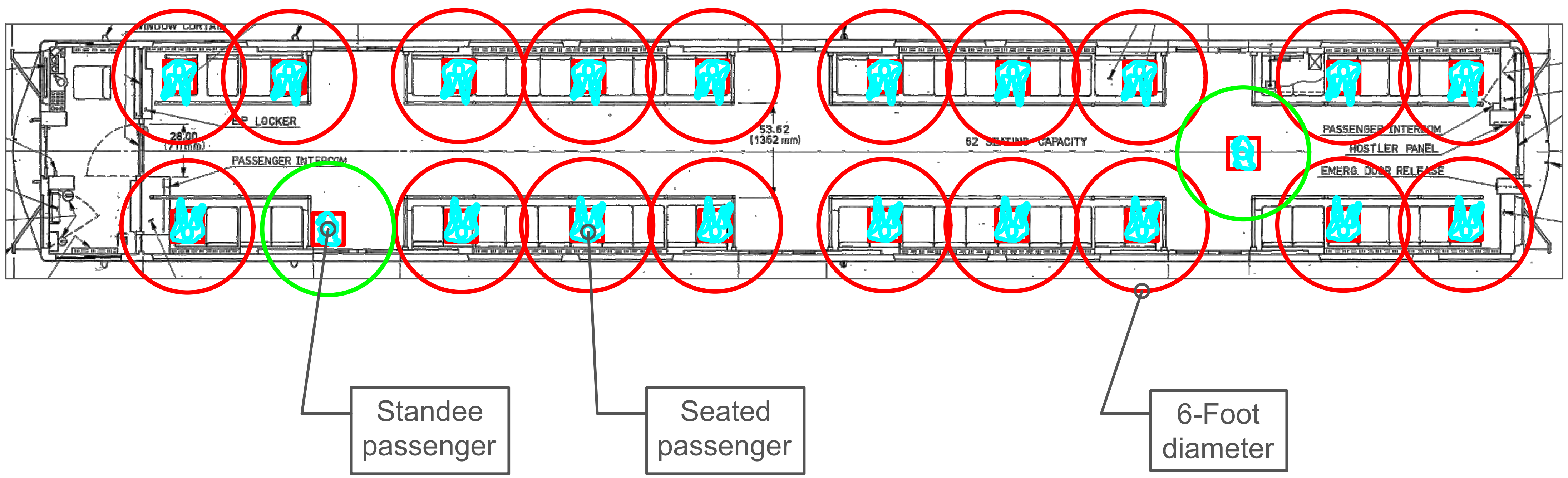
Sheet Title:

MBTA Going the Distance:
LIGHT RAIL, GREEN LINE
Passenger Density:
ALTERNATIVE 1: SIX-FEET APART

Prepared by:	GAB
Drawn by:	GAB
Date:	5/6/20
Scale:	1' = 75'

Sheet:

0



GENERAL NOTES

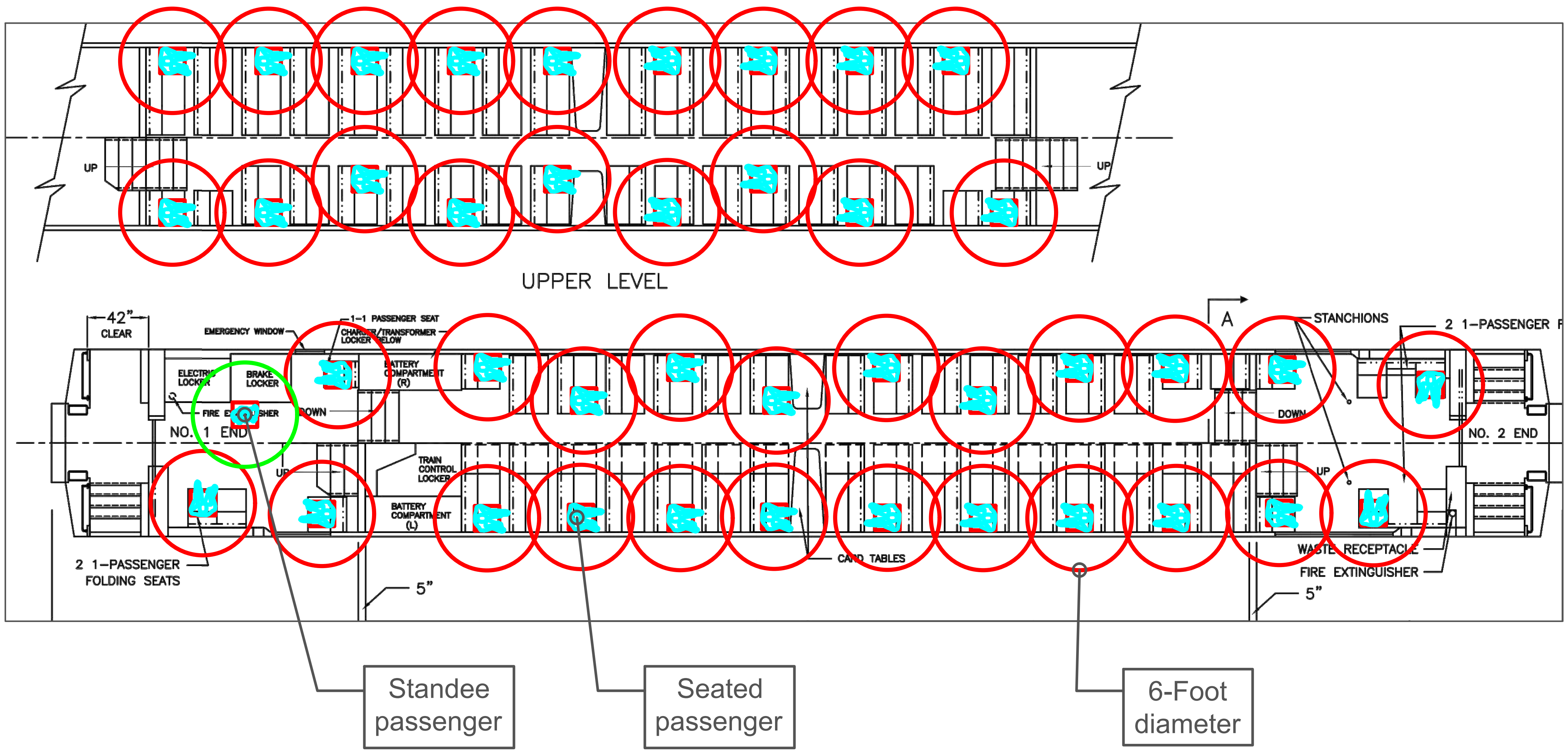
1. Dimensions in inches unless otherwise noted.
2. Presumes all riders are six-feet apart from those in seats and from other standees.
3. Presumes 17" of biacromial breadth for each rider
4. Concept level analysis.
5. Key: (with quantities)

   Blue Outline:
   Each rider six-feet apart

   Red Circle:
   Seated riders: (19)

   Green circle:
   Standee riders: (2)

Sheet Title:	MBTA Going the Distance: HEAVY RAIL, RED LINE Passenger Density: ALTERNATIVE 1: SIX-FEET APART
Prepared by:	GAB
Drawn by:	GAB
Date:	5/6/20
Scale:	1' = 75'
Sheet:	0



GENERAL NOTES

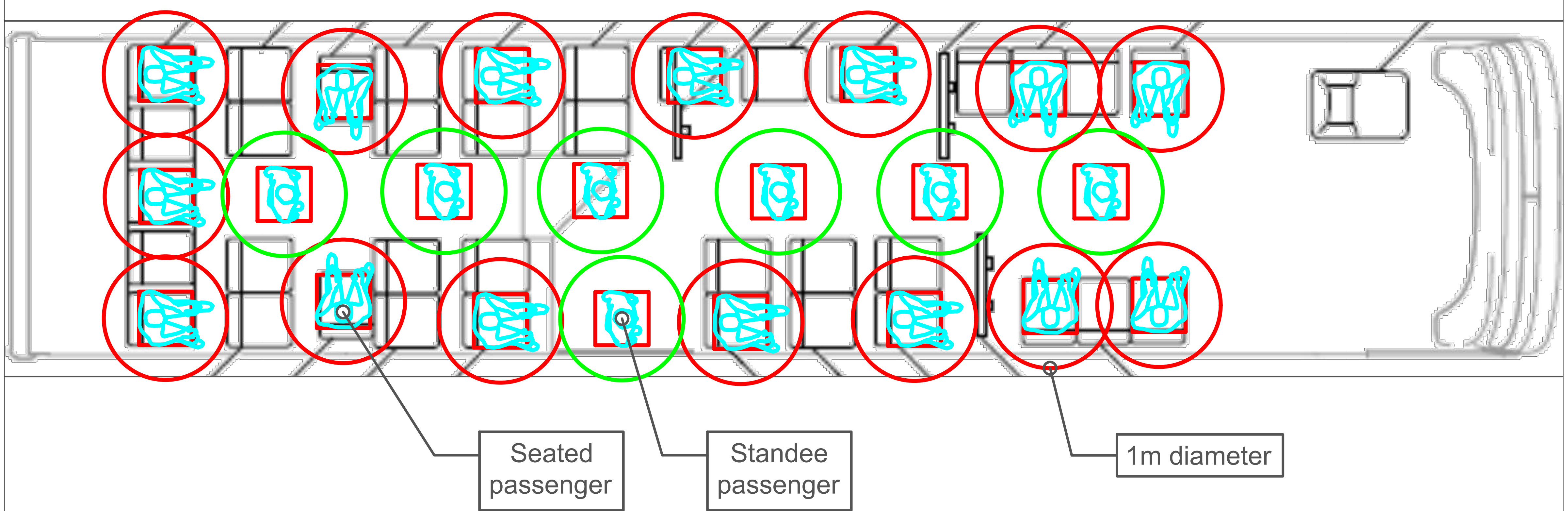
1. Dimensions in inches unless otherwise noted.
2. Presumes all riders are six-feet apart from those in seats and from other standees.
3. Presumes 17" of biacromial breadth for each rider
4. Concept level analysis.
5. Key: (with quantities)

   Blue Outline:
   Each rider six-feet apart

   Red Circle:
   Seated riders: (41)

   Green circle:
   Standee riders: (1)

Sheet Title:	MBTA Going the Distance: COMM. RAIL, BI-LEVEL COACH Passenger Density: ALTERNATIVE 1: SIX-FEET APART
Prepared by:	GAB
Drawn by:	GAB
Date:	5/6/20
Scale:	1' = 90'
	Sheet: 0



GENERAL NOTES

1. Dimensions in inches unless otherwise noted.
2. All riders are 1m apart from those in seats and from other standees.
3. Presumes 17" of biacromial breadth for each rider
4. Concept level analysis.
5. Key: (with quantities)

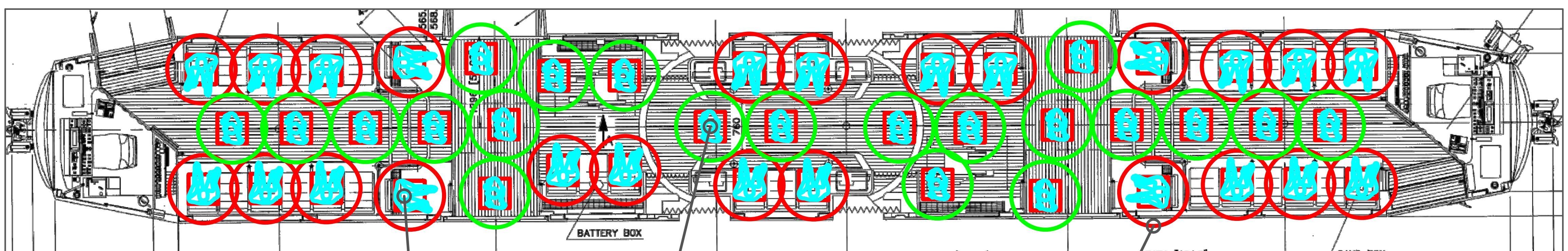
Blue Outline:

a. Each rider 1m apart
b. Face Masks/ Coverings Mandatory

Red Circle:
Seated riders: (15)

Green circle:
Standee riders: (7)

Sheet title:	MBTA Going the Distance: BUS 40-FOOT Passenger Density: ALTERNATIVE 2: 1m APART
Prepared by:	GAB
Drawn by:	GAB
Date:	5/6/20
Scale:	1' = 40'
	Sheet: 0



Seated passenger

Standee passenger

1m diameter

GENERAL NOTES

1. Dimensions in inches unless otherwise noted.
2. All riders are 1m apart from those in seats and from other standees.
3. Presumes 17" of biacromial breadth for each rider
4. Concept level analysis.
5. Key: (with quantities)

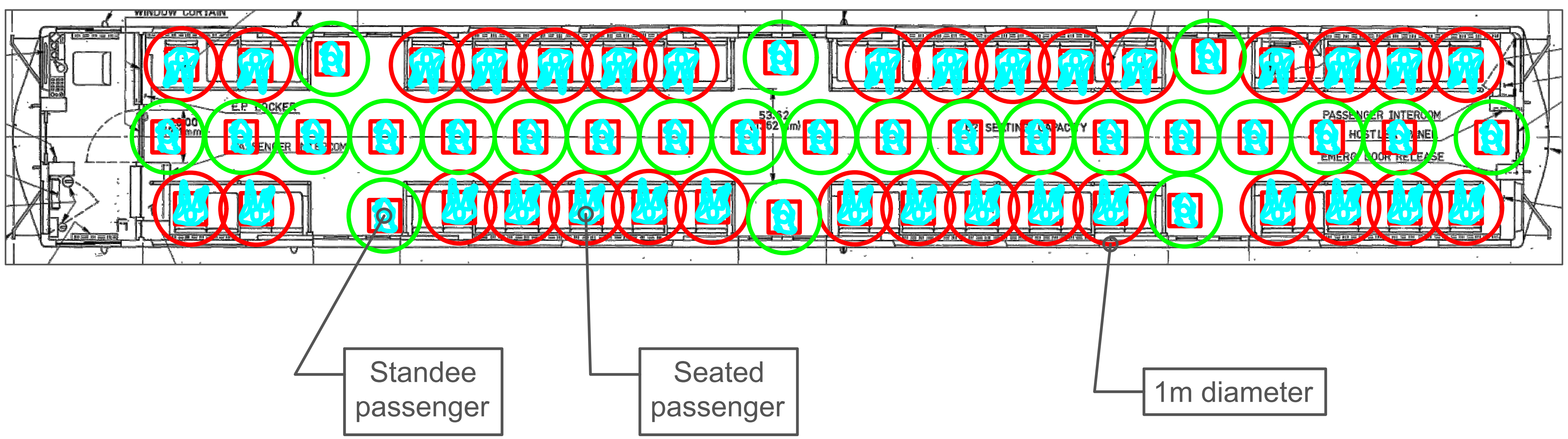
   Blue Outline:

   a. Each rider 1m apart
   b. Face Masks/ Coverings Mandatory

   Red Circle:
   Seated riders: (24)

   Green circle:
   Standee riders: (21)

Sheet title:	MBTA Going the Distance: LIGHT RAIL, GREEN LINE Passenger Density: ALTERNATIVE 2: 1m APART
Prepared by:	GAB
Drawn by:	GAB
Date:	5/6/20
Scale:	1' = 75'
Sheet:	0



GENERAL NOTES

1. Dimensions in inches unless otherwise noted.
2. All riders are 1m apart from those in seats and from other standees.
3. Presumes 17" of biacromial breadth for each rider
4. Concept level analysis.
5. Key: (with quantities)

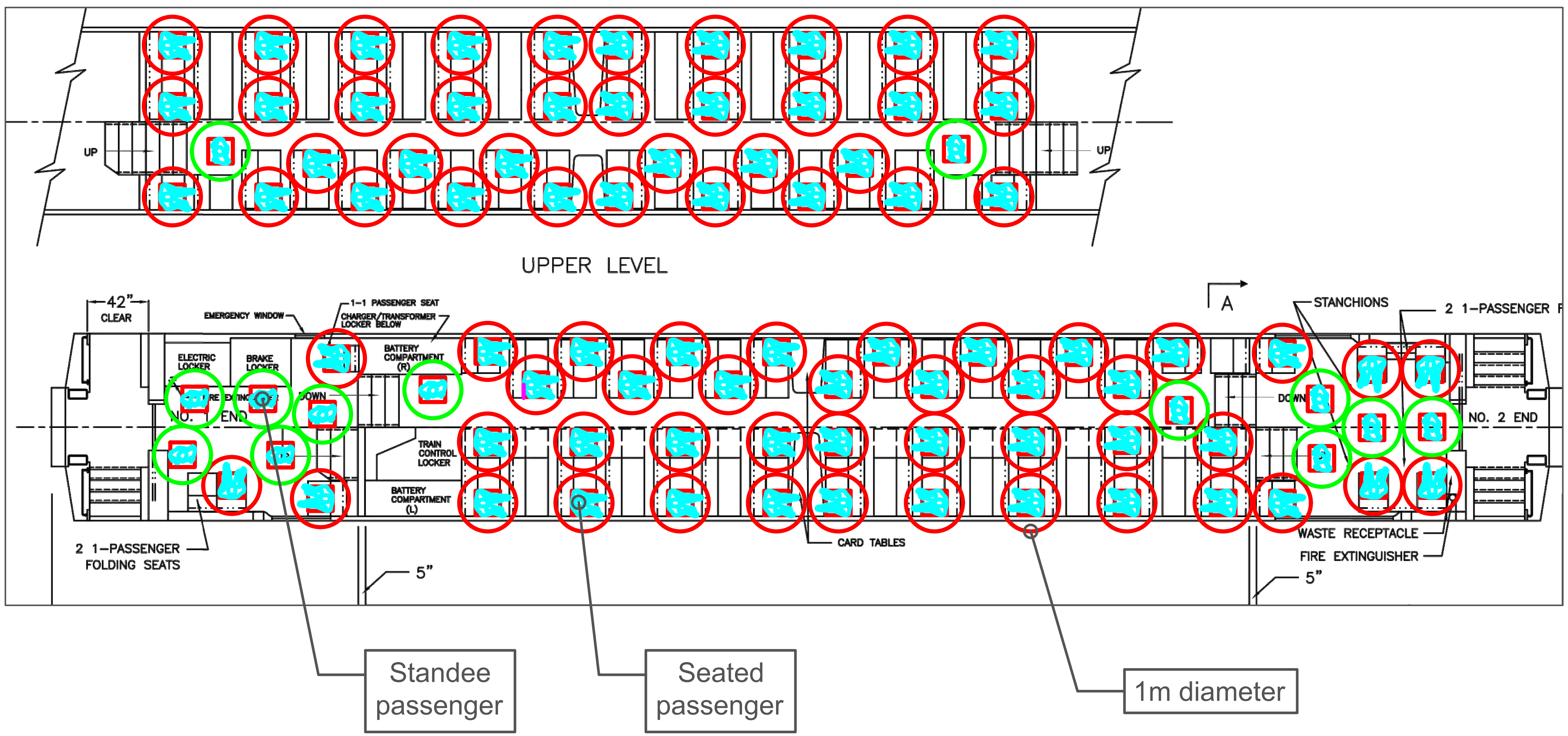
   Blue Outline:

   a. Each rider 1m apart
   b. Face Masks/ Coverings Mandatory

   Red Circle:
   Seated riders: (32)

   Green circle:
   Standee riders: (25)

Sheet title:	MBTA Going the Distance: HEAVY RAIL, RED LINE Passenger Density: ALTERNATIVE 2: 1m APART
Prepared by:	GAB
Drawn by:	GAB
Date:	5/6/20
Scale:	1' = 75'
Sheet:	0



GENERAL NOTES

1. Dimensions in inches unless otherwise noted.
2. All riders are 1m apart from those in seats and from other standees.
3. Presumes 17" of biacromial breadth for each rider
4. Concept level analysis.
5. Key: (with quantities)

   Blue Outline:

   a. Each rider 1m apart
   b. Face Masks/ Coverings Mandatory

   Red Circle:
   Seated riders: (78)

   Green circle:
   Standee riders: (13)

Sheet title:
MBTA Going the Distance:
COMM. RAIL, BI-LEVEL COACH
Passenger Density:
ALTERNATIVE 2: 1m APART

Prepared by:	GAB
Drawn by:	GAB
Date:	5/6/20
Scale:	1' = 90'
	Sheet: 0