On the Curb, Off the Curb:

Redefining Curb use in South Boston

Report by,
Boston University MET UA 703

BOSTON UNIVERSITY

ABOUT THIS REPORT

This report is a product of student work in Boston University's Urban Research Methods course taught by Professor Yesim Sungu-Eryilmaz in Fall 2021.

OUR PROJECT PARTNERS

The Mayor's Office of New Urban Mechanics: New Urban Mechanics is a department in the City of Boston which "work[s] across departments and communities to explore, experiment, and evaluate new approaches to government and civic life." (https://www.boston.gov/departments/new-urban-mechanics)

BU METROBRIDGE

MetroBridge empowers students across Boston University to tackle urban issues, and at the same time, helps city leaders confront key challenges. MetroBridge connects with local governments to understand their priorities and then collaborates with Boston University faculty to translate each city's unique needs into course projects. Students in undergraduate and graduate classes engage in city projects as class assignments while working directly with local government leaders during the semester. The goal of MetroBridge is to mutually benefit both the Boston University community and local governments by expanding access to experiential learning and providing tailored support to under-resourced cities. MetroBridge is funded by the College of Arts and Sciences and housed at Boston University's Initiative on Cities.

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INTRODUCTION

In partnership with the Mayor's Office of New Urban Mechanics (MONUM), this study seeks to make recommendations for future curb zone regulations in the City of Boston. Positioned as a civic innovation lab, MONUM charged the research team with rethinking how the city can manage the evolving demands for curb space. Some of these demands include growth in Transportation Network Company (TNC) trips, which now total more than 50 million per year in Boston, as well as the city's overall population growth, now up 9% since 2010 (U.S. Census, QuickFacts). Additionally, with the explosive growth of online shopping, there are as many as 1.6 million deliveries every day in Boston (Warfield, 2021). Increased vehicle traffic resulting from these disruptive technologies must compete for finite curb space with residents' private vehicles, commercial delivery vehicles, buses and other public-sector vehicles such as USPS trucks, and an increasing diversity of curb zone uses including bike share stands, parklets, and outdoor restaurant seating.

Overall, Boston has seen an increase in demand for short-term parking. Building trades vehicles, USPS trucks, and delivery vehicles have always used the curb zone for short-term parking; in many places, cities have accommodated this demand by establishing designated short-term loading zones. Yet in recent years, the growth of online shopping and the advent of TNCs for rideshare and food delivery has dramatically reshaped demand for short-term parking. In addition, accommodations made for different modes of transportation (i.e. the increasing prevalence of bus and bike lanes, the advent of micromobility modes such as e-scooters, etc.) is also changing where and how the curb can be accessed by drivers in a way that is safe for other road users and does not disrupt the flow of buses, bikes, and other vehicles. The lack of short-term loading zones in many areas can provoke drivers to double park in these new lanes, causing issues of safety and transit delays to persist (Warfield, 2021).

Many parking violations result in tickets: over 1 million tickets were issued in Boston in 2019 alone (Warfield, 2021). Yet despite being the main enforcement mechanism against illegal parking, tickets are not necessarily seen as a deterrent by many violators. Many fines do not outweigh the need for commercial vehicles and TNCs to make brief stops as close as possible to their destinations, which tends to lead to double parking and other violations. Tickets therefore cannot be used as a sole method of enforcing regulations during this time of rapid change in curb usage patterns in Boston, and innovative ideas on how to bolster this common enforcement tactic are necessary.

Curb uses and regulations impact our daily lives in a variety of ways, with external factors, such as the COVID-19 pandemic, facilitating constant, rapid change. The COVID-19 pandemic has provided a significant opportunity to reevaluate curb usage, as cities across the world have embraced the vast potential of streets as shared public spaces, rather than the exclusive domain of vehicles. In their guide to Streets for Pandemic Response & Recovery (2020), the National Association of City Transportation Officials outlines potential and emerging uses for street space. Several of these suggestions call for reclaiming the entire street from vehicles to enable events and to provide additional space for civic institutions such as markets and schools. The lessons

learned from widespread experimentation and rapid prototyping of dynamic curb zone uses during the pandemic should be used to shape curb zone regulation in the future. These lessons can be implemented not only through direct curb zone regulation, but also through Boston's Article 80 review process. Article 80 provides an opportunity for the city government to influence private development projects and consider curb use in relation to land use; it can also harness developers' resources to transform the public realm surrounding new construction.

Through this project, we sought to answer three questions: (1) how is the curb used, (2) how is the curb currently regulated, and (3) what is the disconnect between current curb usage and regulation? Although our study was conducted in the West Broadway corridor of South Boston, we believe the findings of our research may be applicable to streets with similar land-use mixes throughout the city. For this project, we measured curb usage by collecting observational data and further analyzing it with secondary data. By observing de facto curb usage throughout the day, we intended to increase our understanding of the effectiveness of existing de jure policies. This allowed us to make recommendations that accommodate de facto usage while prioritizing efficiency, safety, and convenience for all modes.

The research team was composed of 26 students in Dr. Yesim Sungu-Eryilmaz's graduate-level UA703 Urban Research Methods course at Boston University. Teaching assistant Arya Alizadeh also contributed to this project. The work took place throughout the Fall semester of 2021. Students worked in three groups to compile existing research, develop the methodology, and analyze the data collected, respectively.

This study employs an observational methodology. Our approach was informed by prior research on curb regulations which also used observational techniques (Marsden, Docherty & Dowling, 2020; Girón-Valderrama, del, Machado-León, & Goodchild, 2019; Weinberger, 2012) and an analysis of existing statistics (Manville & Pinksi 2021). We also examined curb usage issues identified by public agencies and the type of interventions agencies have deployed to relieve the tension between movement (i.e. throughput) and place (i.e. the streetscape) (Marsden, G. Docherty I., Dowling, R. 2020) and the causes and consequences of curb parking management (Manville, M. & Pinksi, M. 2021). Additionally, studies conducted in Seattle and New York City influenced our focus on loading and unloading, dynamic regulations, and the need for a combination of policies to close the gap in curb usage and curb regulation.

LITERATURE REVIEW

The curb is defined as “the physical interface between the public highway and the footway or sidewalk” (Marsden, 2020). In other words, the curb zone is a liminal space where vehicles stop and road users transition between vehicular movement and pedestrian activity. Here, the word “vehicles” does not refer exclusively to motor vehicles operated by businesses and private citizens, but also to public transit vehicles, bicycles, micromobility, etc. In recent years—especially during the COVID-19 pandemic—city planners, municipal governments, and the public have begun to embrace the curb zone as an under-used public space rife with possibility; curb zones across the world have been re imagined as parklets, restaurant seating, bike share stations, and so on. At the same time, the imperative to decarbonize transportation and the advent of disruptive technologies such as TNC rideshare/food delivery and electric micromobility vehicles have dramatically reshaped the mix of users on our streets. This means that regulating the curb zone is perhaps more complicated than ever before. However, early on in the development of this project, it became clear that motor vehicles (predominantly TNCs and those owned by private citizens, though also commercial delivery vehicles and public-sector vehicles such as USPS trucks) were the greatest source of traffic disruption within the study area. Unmet demand for curb space for motor vehicles led to frequent double-parking and other violations that caused unsafe conditions and traffic that impeded all road users, including bus riders and cyclists. Thus, the decision was made to focus on parking violations committed by motor vehicle operators as a proxy for unmet demand for curb space (see section D. I.). What follows is a review of the existing literature on curb zone parking regulations and their effectiveness at optimizing curb zone usage for the benefit of all users.

EXISTING CURB REGULATION TACTICS AND THEIR EFFECTIVENESS

In examining the literature on curb use and regulation, we identified the following key themes: dynamic versus static regulations, uneven enforcement of regulations, misallocation of curb space, and the use of designated pick up and/or loading zones.

The literature on dynamic versus static curb regulation focused on specific policies. Dynamic curb zones change regulation based on time of day. Ranjbari et al. (2021) found that a dynamic curb space allocation policy which changed metered parking spaces to designated pick-up/drop-off zones for TNCs, taxis, and private vehicles reduced the number of travel lane pick-ups/drop-offs, reduced dwell times, and increased curb use compliance. This approach was also shown to allow for smoother traffic flow in and out of the pick-up/drop-off area, mitigating the effects of TNCs on other road users. The findings of Dey et al. (2019) also support the deployment of dynamic curb zone regulation for improved traffic flows in commercial freight loading and unloading zones. The research team collected data from time-lapse cameras and through direct observation for one week before and after implementing a price increase in the study area. They determined that disincentives for commercial zone violations,

additional enforcement, and data-driven program modifications would aid in relieving the district's congestion, which is largely caused by commercial loading and unloading that blocks travel lane throughput (Dey et al., 2019, p. 324).

In contrast to Dey et al., a recent presentation shared by the City of Boston discussed current violation costs using a fee-per-violation model, lamenting that "enforcement is complicated by a variety of curb rules and fines, some of which may encourage behavior such as double parking, [for] a lower cost fine" (Warfield, 2021). Table 1 outlines the fee associated with each type of violation:

Violation	Fine
Stop in Bus/Bike Lane	$100
Beyond Loading Zone Time Limit	$90
No Stopping	$90
No Parking	$55 - $90
Double Parking	$35 - $55
Unpaid or beyond meter time limit	$40

Although these penalties apply to both private and commercial vehicles, existing city regulations tend to give more leeway to the latter. A potent example of this is the stipulation that commercial vehicles, when dropping off or loading cargo, are permitted to park in a residential permit area for up to three hours. Underlying these preferential policies is the simple fact that parking tickets are considered a necessary cost of doing business by logistics companies. Commercial vehicle drivers (those employed directly by businesses such as FedEx or Amazon) "do not pay the tickets they incur—those enrolled in the City of Boston's Fleet Program, for example, are billed the total of their violations monthly, or the cost of the fines are passed on through the cost of service" (Warfield, 2021). The fleets of logistics companies such as FedEx and UPS received millions of dollars in fines for illegal parking in 2018 alone (Yu & Bayram, 2021). Double parking is of particular concern with commercial vehicles, as they are liable to reduce sightlines and impede access to bus lanes, bicycle facilities, crosswalks, etc. (Yu & Bayram, 2021).

Parking violations cause logistical issues in the public realm and can create safety concerns. A study of curb management in downtowns and their surrounding neighborhoods in Australia and the UK found that most violations were committed by commercial delivery vehicles, public-sector vehicles, and bicycles (Marsden et al., 2020). Other studies on TNCs noted frequent violations in no-parking zones or bus lanes to meet pick-up and drop-off points, creating conflict between modes (Ranjbari et al., 2021). The study cited ignorance or a deliberate decision to ignore the regulations as the main motives behind these violations, while the underlying cause was a mismatch between the land uses along the street and the allocation of available curb

space (Marsden et al., 2020). It also argues that at this time, public agencies need to gain a better understanding of de facto curb use in order to develop regulation that matches the realities of supply and demand and strengthens the capacity and rigor of enforcement.

Appropriate space allocation is crucial to improving overall traffic flow and increasing safety when vehicles are loading/unloading passengers and cargo (Cao et al., 2017). In Girón-Valderrama (2019), the use of Passenger Load Zones (PLZs) and Commercial Vehicle Load Zones (CVLZs) were expected to mitigate these safety concerns when initially introduced; however, the study observed that even though PLZs and CVLZs were specifically designated to accommodate pick-up and drop-off areas for their respective vehicle types, passenger vehicle traffic often impeded the use of CVLZs for actual commercial vehicles (Girón-Valderrama, 2019). This is another example of how existing curb regulation and enforcement proves ineffective. Yet despite these regulations not achieving their stated aims—in this case safety and improved traffic flow—there remains potential for further introduction of evidence-based regulatory and enforcement mechanisms that make incremental progress toward these worthy policy goals.

Finally, a report released by the Seattle Department of Transportation in 2020 notes the importance of data sharing and annual reporting of various metrics related to curb use, including parking fines, parking usage, instances of non-commercial vehicles occupying commercial vehicle space, etc. Reliable, consistent data collection methods paired with investment in data management personnel and software were key in the development of new curb management strategies for the city. Among the authors' recommendations: a particular focus on car share operations, conducting annual parking studies and rate reviews, developing data analytics partnerships, promoting innovative urban goods delivery (using cameras to track which type of vehicles are utilizing load zones), conducting a ride hail zone pilot project, and deploying shared mobility hubs (Seattle Department of Transportation, 2020).

THE DISCONNECT BETWEEN CURRENT CURB ZONE REGULATION AND DEMAND

Our review of the literature revealed four key usages of the curb zone: parking (Weinberger, 2012), pick-up/drop-off zones (Yu & Bayram, 2021), loading/unloading zones (Yu & Bayram, 2021), and outdoor dining (City of Boston, 2021). That being said, demand for curb space is constantly evolving. Across the literature, authors observed several key trends in recent curb zone use and regulation, including the increase in ride-sharing and food delivery services, the fragmentation of the freight industry, and the shift from sole parking zones to dynamic zones that accomodate novel uses such as TNCs. In our review, we emphasized the importance of research based on real-time data and statistical modeling. Through simulation models, Yu & Bayram (2018, 2021) discovered that increasing demand for online shopping, although hypothesized to reduce traffic by decreasing the number of consumer trips to brick-and-mortar stores, actually resulted in an explosion of trips by delivery trucks (Yu & Bayram, 2021). Furthermore, they find, the shift to online shopping has not correlated with decreased curb activity. Although both

articles confirmed the need for dynamic curb space allocation policy, they did not make specific recommendations for curb zone redesign. Girón-Valderrama (2019) uses the “Gap Acceptance Model” to describe the relationship between traffic volume in various travel lanes and the “acceptable gap” that exists based on this volume to allow for or hinder traffic flow.

Like Boston, Seattle has also experienced an explosion of TNC trips in recent years, with the figure increasing fivefold between 2015 and 2019 (Goodchild et al., 2019). As noted by both Goodchild, et al. (2019) and Yu & Bayram (2021), TNC vehicles are more likely to stop in non-loading zone spaces or in travel lanes, which can cause traffic congestion, transit delays, and unsafe conditions for cyclists. In response to this recurring problem, Seattle introduced additional Passenger Load Zones (PLZs) and geofencing, which was intended to encourage fewer travel lane stops (Goodchild et al., 2019). Geofencing uses a mobile phone application to send push notifications to TNC drivers, notifying them of nearby available loading zones. Although PLZs and geofencing did increase the number of TNC drivers who stopped at the curb instead of in travel lanes, “between 7 percent and 10 percent of drivers still stopped in the travel lane even when PLZs were empty” (Goodchild et al., 2019). Thus, the implementation of PLZs and geofencing, while effective, is not a panacea for the misuse of curb space.

West Broadway, South Boston

SITE DESCRIPTION & DEMOGRAPHICS

Observation was conducted on two separate blocks of West Broadway in South Boston: (1) between Dorchester Avenue and A Street (known as “Block 1”) and (2) between D Street and E Street (known as “Block 5”).

BLOCK 1: DORCHESTER AVE TO A STREET

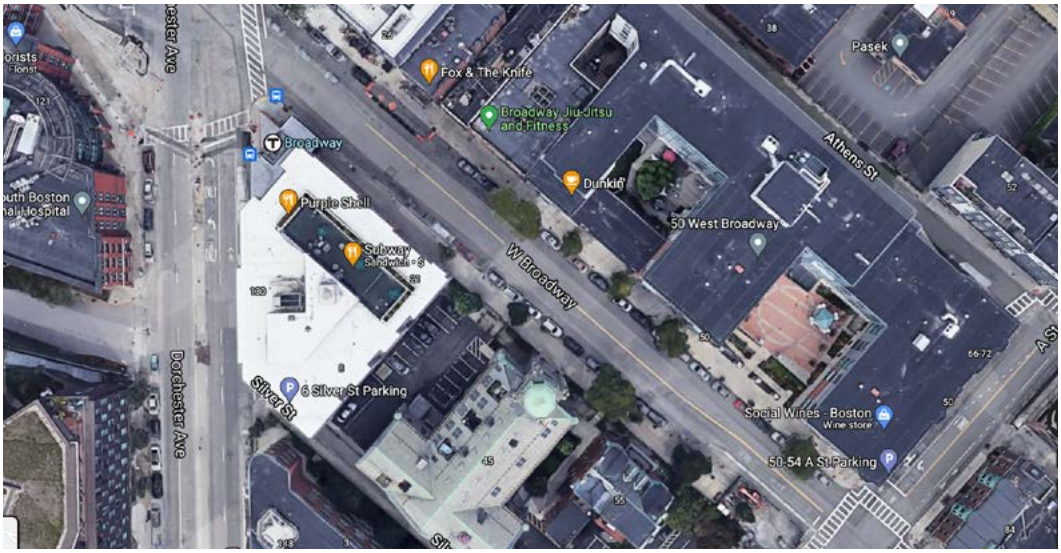


Figure 1. Block 1 Aerial View

Dorchester Avenue is an arterial road leading to points south, while Broadway forms the main commercial thoroughfare of South Boston. Westbound across Dorchester Ave, West Broadway becomes Traveler Street, a critical chokepoint that connects South Boston to Interstate-93, the South End, and Downtown Boston. The intersection of Dorchester Ave and West Broadway is also the location of the Broadway stop of the MBTA’s Red Line.

The block is home to a wide variety of uses, with seven restaurants, various other ground-floor retail establishments, and hundreds of units of housing. The restaurants reflect a variety of cuisines, price points, and opening hours. There are fast food options including Starbucks, Dunkin Donuts, and Subway, along with takeout-oriented independent restaurants and higher-end establishments like Fox & the Knife. Although there are a number of proposed development projects in the immediate vicinity of West Broadway, the BPDA currently has no proposals on file for the Dorchester Ave to A Street block.

Broadway Station ranked 15th among the MBTA’s 22 Red Line stations in terms of average weekday boardings with 6,020 (MassDOT, 2020, p. 8). The station also acts as a stop of the MBTA’s number 9, 11, and 47 buses. According to the U.S. Census, only 22% of Block 1 area residents use public transit to commute, which is 11% lower than the city as a whole, while over 24% walk to work, nearly 10% higher than Boston

overall. 43% commute by car—exactly in line with the city at large. Notably, 4.2% of area residents cycle to work, a much higher proportion than the city's 2.3%. There are no dedicated cycle or bus lanes anywhere in the study area.

There is also no metered parking anywhere in the study area. The large majority of parking on both blocks is regulated as two-hour, Monday through Friday, 8AM - 6PM. Most of these zones exempt resident sticker holders from this time limit. There are tow zones on both sides of the street on both blocks that prohibit parking during snow emergencies and street cleaning. On the Dorchester Ave end of Block 1, there is a bus stop zone on the south side and a restaurant seating zone on the north side. On the A Street side of the block, there is a short "no stopping any time" zone at the northern corner and a 15-minute loading zone immediately to its west, presumably in service of the wine retail store at that corner. There is one fire hydrant on the block, located in front of the Teriyaki House restaurant. There are no curb cuts or rights-of-way that intersect the sidewalk within Block 1.

BLOCK 5: D STREET TO E STREET

Figure 2. Block 5 Aerial View

Block 5 is approximately half a mile from the Broadway T station, but there is an inbound stop for the number 9 bus at its Southeast corner. This segment of West Broadway also features a diverse array of land uses, with mixed-use buildings housing apartments (predominantly with less than 10 units) above ground-floor commercial. There is a bar and restaurant (Shenanigans Bar), a juice bar, a bakery, two florists, two barbershops, a hairdresser, an American Legion post, a cabinetmaker, an Edible Arrangements store, a dog groomer, a bank, a locksmith, and a gym. These uses represent a diversity of business-related traffic at various times of the day.

There are four curb cuts for driveways, parking lots, and alleys on the north side of the block and one on the south side of the block. There are two handicap/disabled veteran parking zones on the south side of the block. The remainder of the block is regulated as two-hour parking.

DIVERSITY

We analyzed the demographic makeup of the observed areas of West Broadway and compared it to Boston as a whole. The characteristics we examined were median age of population, median household income, and diversity index (U.S. Census Bureau, 2021).

Residents of Block 1's U.S. Census block group are whiter (75% non-Hispanic white) and wealthier (median household income $193,068) than the city as a whole (44.5% non-Hispanic white, median household income $79,018). Vehicle ownership stands at 1.1 per household in the block group, on par with the Boston average of 1.0.

Residents of Block 5 are similar to those of Block 1. Block 5 has a population which is 90% non-Hispanic white and a median household income of $136,198. Vehicle ownership for this block group is 0.9 on the North side and 1.0 on the South side, also on par with the Boston average.

A diversity index is used to describe the diversity of a population based on multiple demographic traits. A value of 0% indicates little diversity, whereas a value of 100% indicates high diversity. West Broadway's diversity index ranges from 25.66 to 42.09%. Similar indices can be found on both sides of Block 1 and the north side of Block 5. However, the south side of Block 5 has a lower diversity index, falling in the 10.87 to 26.65% range.

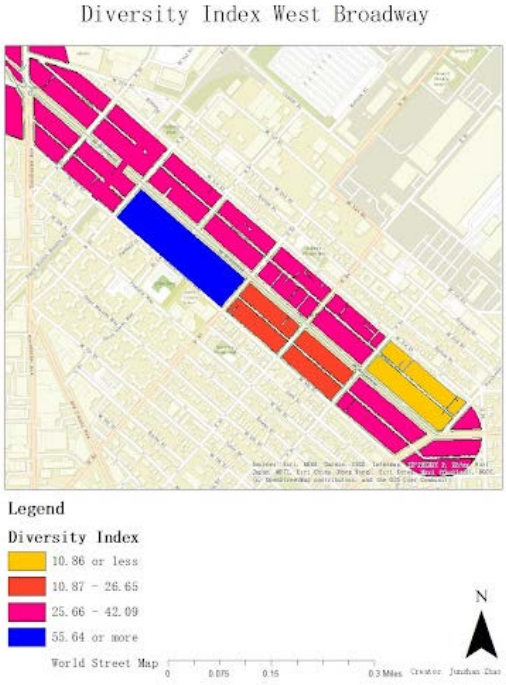


Figure 3. Diversity Index of West Broadway Street, Boston

DATA COLLECTION METHOD

Data was collected via direct observation of illegal parking activity. One observer was stationed on the north side and one on the south side of each block to ensure adequate capacity to record simultaneous violations. Observation was conducted on Wednesdays and Fridays in November of 2021, between the hours of 7 to 9AM and 4 to 8PM.

Observers were instructed to record several types of parking violations, including double-parking, blocking fire hydrants, parking/stopping in bus lanes or marked bus stop zones, and stopping in 'No Stopping' zones. Observations were recorded on standardized paper forms that included data points for type of violation, vehicle type, time of violation, duration of violation, and location. This form also included a blank space for observers to take notes or record supplemental, subjective observations. Following their assigned observation periods, observers entered their data into a custom ArcGIS form created by our data analysis group.

RATIONALE

This project's research question seeks to analyze the gap between demand for curb space and existing curb space regulation. Because our brief from the City of Boston requested a curb study rather than a parking or traffic study, data collection strategies such as parking inventories and traffic counts were determined to be inappropriate. Therefore, illegal uses of curb and street space are the best and most relevant metric to measure unmet demand for curb space in the study area.

Possible violations were determined via an inventory of existing street assets and parking regulations. Observers were also provided with a set of definitions to clarify what constituted each violation type. However, they were also instructed that the given violation types were not an exhaustive list, therefore a field for "other" violations was provided. Table X provides a list of violations used in this study.

Table 2. Description of Violations

Violation	Description
Bus Zone	Parked within a zone designated only for buses
Double Parked	Parked alongside another car already parked on the side of the road
Hydrant	Parked in front of a fire hydrant
No Parking	Parked in an area marked as "no parking"
Other	Includes illegal U-turns or parking ticket citations

For each violation, observers recorded the time, vehicle type, location, and duration of the violation. We believed that recording the vehicle type would provide insight for our later recommendations for future curb regulation in the study area. Location was recorded by noting the local landmark (for example, the name of the nearest business) closest to the violation. Other, more precise methods of recording location were considered, but we found that using highly-visible landmarks provided a relatively high degree of precision while avoiding the introduction of further complexity (such as geotagging) to the data recording process.

Table 3. Motor Vehicle Descriptions

Vehicle Type	Description
Private Vehicle	Any four-wheeled vehicle not clearly marked as commercial by company livery (logos, etc.) or commercial plates; including TNCs (Uber, Lyft, etc.) marked by TNC stickers or other identifying marks
Commercial Van	Small delivery vehicle with enclosed storage space, clearly marked as commercial by company livery (logos, etc.) and/or commercial license plates
Commercial Truck	Large delivery or trade vehicle of any kind (box truck, flat bed, 18-wheeler, etc.), clearly marked as commercial by company livery (logos, etc.) and/or commercial license plates
Other	Anything not described in the above list; this includes, but is not limited to, motorcycles, motor scooters, and public sector vehicles such as USPS trucks, police cars, and MBTA auxiliary/service vehicles

Another data point collected was the apparent cause of the violation, listed under “Doing What?” on the field sheet. Observers recorded whether the vehicle appeared to be dropping off or picking up, then noted whether the driver was serving passengers, parcels, or food. “Cannot determine” was an option for both columns if the driver’s purpose was unclear. These questions will help inform policy decisions about curb regulation because they can potentially help to quantify the impact of TNCs and third-party food delivery apps. They can also help the city to quantify violations committed by commercial and private vehicles. This will provide the City of Boston with a thoughtful overview of how the curb is used at peak times, and how that use relates to various land uses.

Although there is a column provided on the data sheet for “vehicle features,” these features were limited to general descriptions and observers were explicitly instructed not to record identifying information such as license plate numbers. Therefore the observations do not include private information and did not constitute human subjects research; consequently, this research was not subject to Boston University’s Institutional Review Board (IRB).

The data collection process was piloted on Thursday October 21st from 3:30 PM - 4:30 PM on the North side of Block 1. This was done in order to test the data collection process and to make adjustments to the data collection form before observers were sent into the field. After the pilot, two major improvements were made to the data collection form: (1) Moving the violation length to the right side of the form (as this is typically the last field to be filled out) and (2) adding a “vehicle features” column to keep track of color or vehicle type (in instances when multiple violations were taking place simultaneously). Over the course of the hour-long pilot, 17 violations were recorded.

OBSERVATIONS DAYS & TIMES

In choosing specific time frames for our observation, we consulted the methodologies of existing curb usage studies. Cao et al. (2016) observed on Tuesdays and Thursdays during peak morning and evening commuting hours (7AM - 9AM and 4PM - 6PM). Cao et al. and Girón-Valderrama both note the importance of multiple observation periods on different days and times in order to get a broader scope of the use and or misuse of intended loading space. We ultimately chose to observe on Wednesdays and Fridays, because we hypothesized that illegal parking activity would center around commercial uses, especially restaurants. Wednesday would serve as a “typical weekday” baseline against which to compare an expected surge in restaurant-related traffic on Fridays.

Travel patterns and demand for curb space was deemed too unpredictable on Saturdays and Sundays to make for meaningful recommendations, especially since resident-only parking restrictions are suspended on weekends. Mondays, Tuesdays, and Thursdays were not considered due to regularly-scheduled garbage collection and street sweeping on West Broadway, which had the potential to skew our perception of typical curb usage.

Our strategy for observation times centered around morning (7AM - 9AM) and evening (4AM - 8PM) peak travel periods. These windows, we believed, would represent the most dynamic times for traffic and curb usage. During these times, commuters using all modes (public transit, private vehicles, bikes, walking, micromobility), commercial deliveries, trade vehicles, and TNCs driven by surges of mealtime ordering would all be forced to compete for finite curb and road space. The two blocks selected for observation feature a variety of land uses, retail establishments, and food service locations, which suggested that a variety of patrons would be drawn to the vicinity throughout the day. By observing during AM and PM peak hours, we could record demand for curb space at its most competitive and most dynamic.

RECORDING & UPLOADING DATA

Observers used a paper Field Observation Sheet (Appendix A) to record their data. Other data recording tactics were discussed, including various mobile applications, such as ArcGIS. In theory, mobile applications could help streamline data collection and therefore minimize the need for later data entering . However, we decided that the use of an app would be too restrictive due to the potential for batteries to die, cell service to falter, or for multiple violations to occur at once, forcing observers to keep multiple web pages open and thus increasing the risk or error. This issue was of particular concern, since none of the considered applications had the ability to enter multiple data points at the same time.

Observers were asked to enter their data into a custom ArcGIS form as soon as possible following their observations to ensure that the paper forms would not be lost. The ArcGIS form captured observer data and also included space to record any subjective observations or supplemental information that could help to inform our data analysis group's decisions.

LIMITATIONS

One functional limitation of our methodology is that we relied entirely on human observations. Using human observers restricted both the spatial and temporal coverage of our observations. Another was the possibility of human error. Despite several group sessions to train observers on the methodology, there was always the potential for missed, incorrect, or incomplete observations. Capturing video imagery of the observation sites would have allowed for a greater degree of precision in this regard, however, this option should be carefully implemented due to obvious ethical concerns.

The use of relatively short observation windows (2 - 4 hours) was another limitation, because it was not possible to keep track of extended-length parking violations (i.e. violations of 2-hour parking limits, etc.). Therefore, conclusions about 2-hour parking regulations cannot be drawn.

Inclement weather was also a limitation because of our decision to record observations on paper. One observation day, the afternoon portion of November 12, was postponed a week due to heavy rain.

Finally, this study was limited by the inability to interview violators to determine their intent. Supplemental interviews were not feasible given our methodology for two reasons: (1) individual human observers would not have the capacity to conduct interviews on top of their observations and (2) violators would be unlikely to consent to an interview given time and privacy concerns.

HOW IS THE CURB REGULATED?

Current curb regulations on West Broadway were captured two ways: (1) manually by the study's observers and (2) using an augmented-reality mobile application called COORD, which takes advantage of a smartphone's camera and GPS functionality to detect signage and uses it to create a digital map of regulatory zones. Figure 4 shows the curb asset locations collected through the COORD app, while Figure 5 shows those collected by observers. Block 1 contained the following assets: three bus stop signs (south side only), one fire hydrant (north side), 13 parking signs (both sides), and two crosswalks (one on each end of the block).

Figure 4. Block 1 - COORD Curb Asset Locations

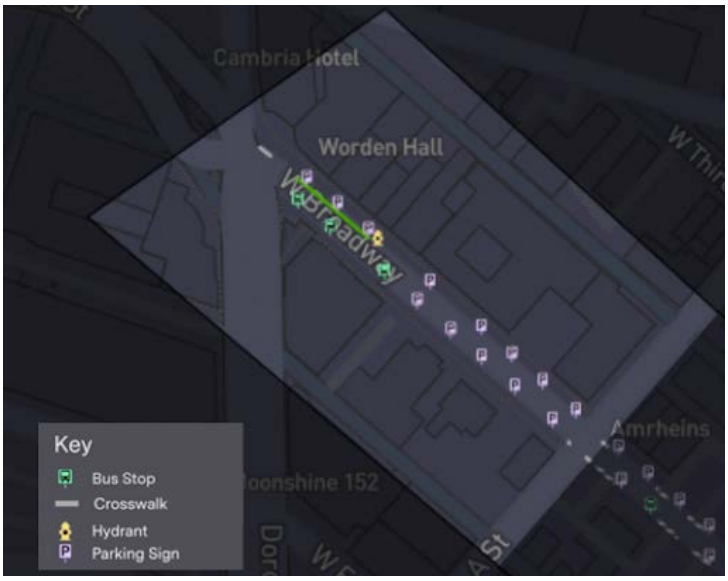
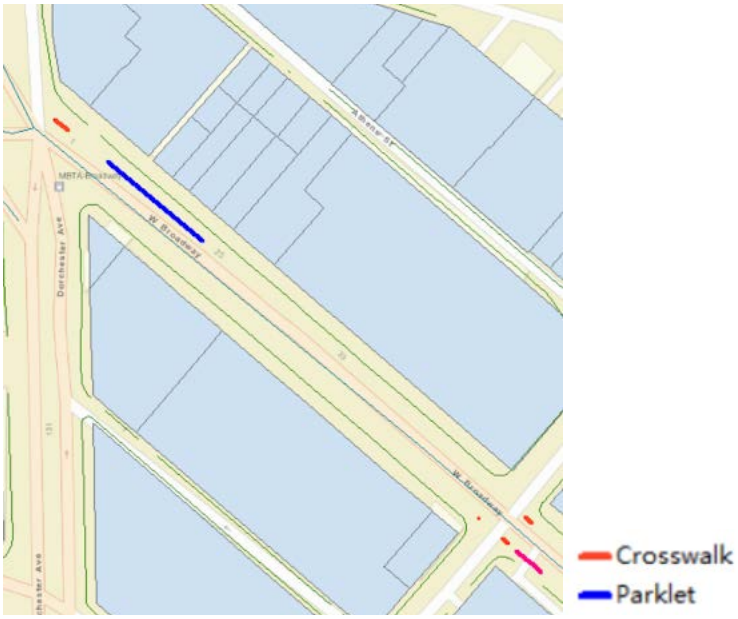


Figure 5. Block 1 - MET UA703 Curb Asset Locations

The COORD app was able to produce a precise map of curb assets and regulations, but the observers were able to provide additional observations that were not detected by the app. For example, the observers recorded the existence of a restaurant seating zone on the north side of Block 1, as depicted in Figure 7. Since this is a temporary feature of the street, it was not detected by the COORD app. Curb regulations on Block 1 included time-limited parking (both sides), time-limited parking except by permit (south side), no parking (both sides), and a bus stop zone (south side).

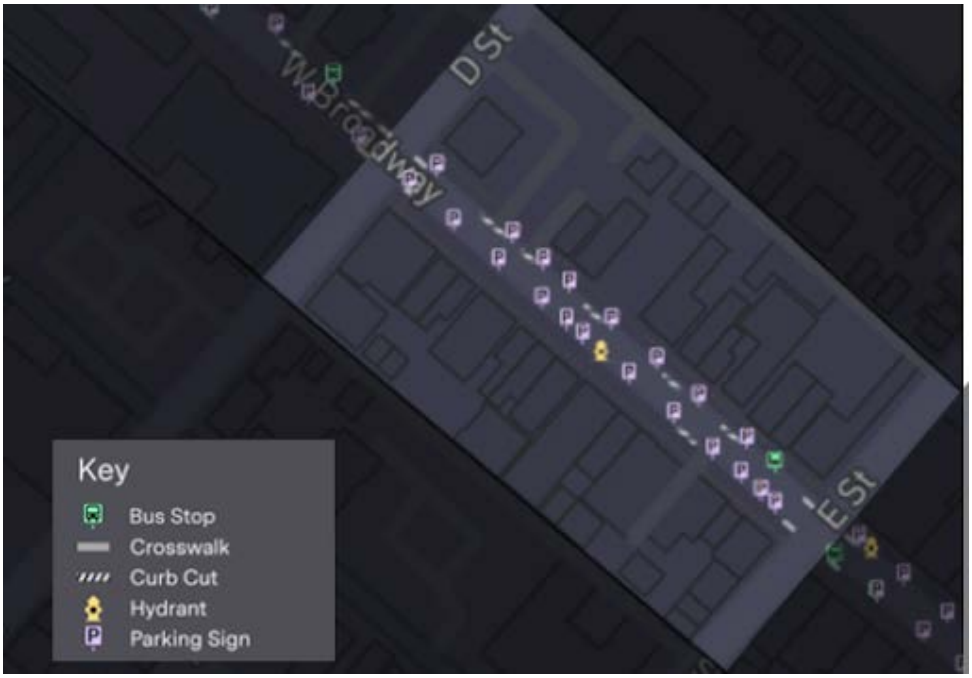
Figure 6. Block 1 - COORD Curb Regulations

Figure 7. Block 1 - MET UA703 Curb Regulations



On Block 5, both COORD and the research group recorded 20 parking signs, one bus stop sign, and one fire hydrant, as shown on Figures 8 and 9.

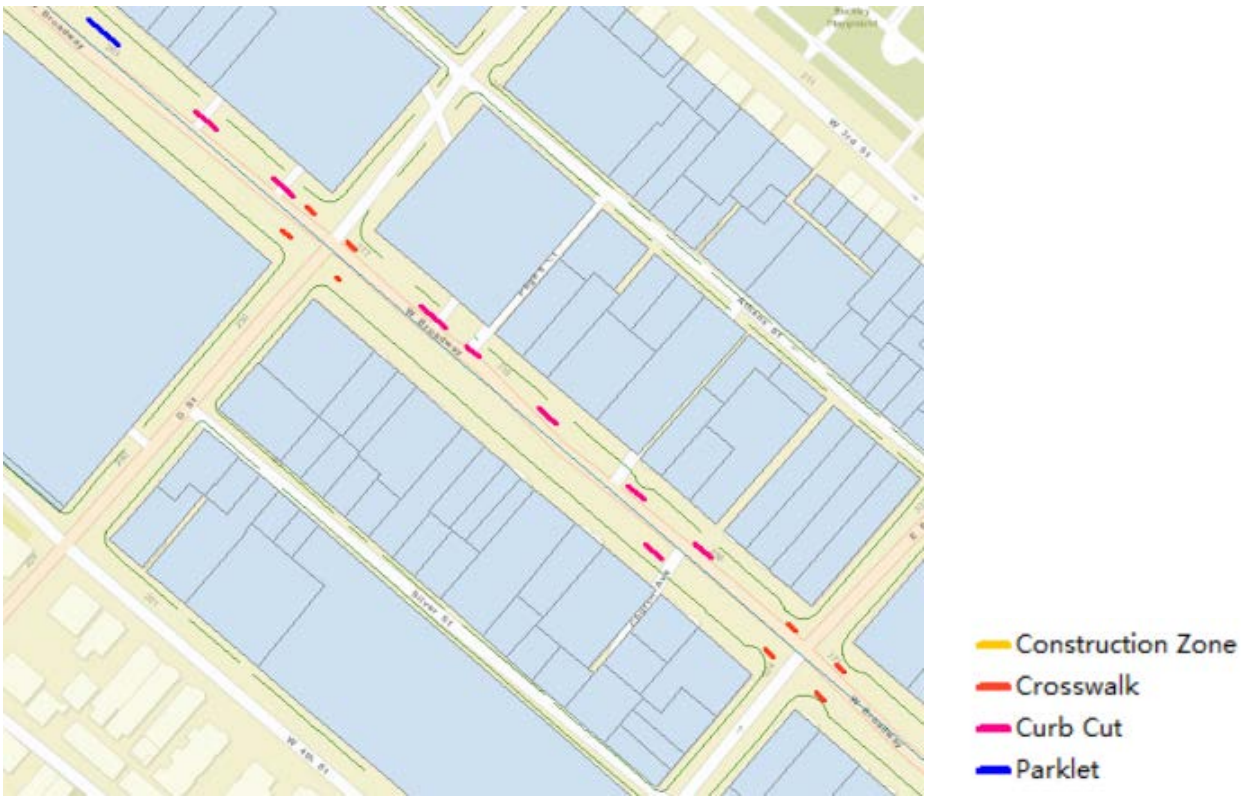
Figure 8. Block 5 - COORD Curb Asset Locations



Curb regulations on Block 5 included time-limited parking (both sides), bus stop zones (north side), handicapped/disbled veteran (HP-DV) parking (south side), and no parking zones (both sides). Note that most of the “no parking” regulations overlap with the hydrant and curb cuts.

Figure 10. Block 5 - COORD Curb Regulations

Figure 11. Block 5 - MET UA703 Curb Regulations



The signage for each block is summarized in Table 4 below.

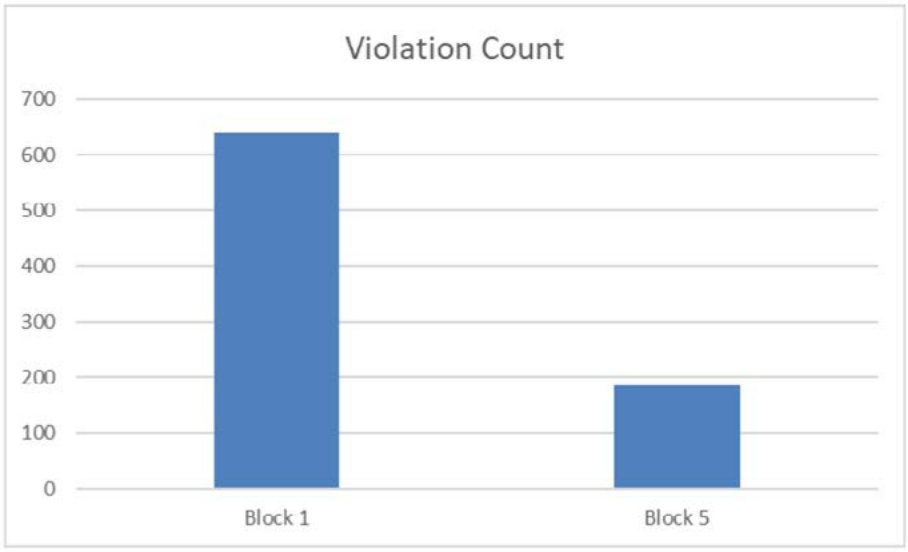
Regulation	Description
HP-DV Parking	Handicapped or Disabled Veteran permit only
Bus Stop	Bus stop zone or extended bus stop zone
No Parking	“No Stopping Any Time” signs; curb cuts; within 10 feet of fire hydrant
Time-Limited Parking	2 hour parking limit
Time-Limited Parking (except by permit)	2 hour parking (except by residential permit)
Unrestricted Parking	No visible regulations

HOW IS THE CURB USED?

OBSERVED VIOLATIONS

Our team observed a total of 821 violations: 635 violations over 24 total hours of observation on Block 1 and 186 violations over 20 total hours of observation on Block 5. Fewer hours of observation were conducted on Block 5, but Block 5 also had a much lower number of violations on a per hour basis. Block 1 had an average of 26.5 violations per hour while Block 5 had just 9.3 violations per hour.

Figure 12. Observed Violation Counts by Block



Double parking was the most common violation across all blocks, accounting for 61.1% of the total. The remaining makeup of violations was 24.0% from parking in bus stop zones, 7.3% from parking in “no parking” zones, 5.4% from parking within 10 feet of a fire hydrant, and 2.2% from other violations. Violations falling under the “other” category include parking in a handicapped/disabled veteran (HP-DV) parking spot, causing a near collision when re-entering traffic, blocking a right-of-way that intersects the street (for example, parking lot entrances, driveways, or alleys), exceeding the time limit in a 15 minute loading zone, and illegal U-turns. Table 5 provides a breakdown of violation type by block.

BLOCK 1

Double parking was the most common violation on Block 1’s north side, comprising 88.3% of the total. “Hydrant,” “no parking,” and “other” violations made up 10.5%, 0.6%, and 0.6% of the total, respectively. In this case, the “other” category included one instance of a vehicle exceeding the limit in a 15 minute zone and one instance of an illegal U-turn.

Bus zone violations were the most common violation on Block 1's south side, making up 67.6% of the total. Other violations included double parking (15.8%), no parking (15.1%), and other (1.4%). All "other" violations observed on the south side were illegal U-turns.

BLOCK 5

Double parking was the most common violation on Block 5's north side, accounting for 81.3% of the total. Bus zone violations accounted for 5.5% of the total, while "no parking" and "other" each accounted for 6.6%. "Other" violations included blocking a parking lot entrance and illegal U-turns.

Double parking was also the most common violation on the south side of Block 5, accounting for 76.8% of the total. Parking in "no parking" zones accounted for the second-largest segment, followed by parking within 10 feet of a fire hydrant (7.4%) and "other" (6.3%). Violations on Block 5 falling under "other" included one instance of parking in an HP-DV spot, one instance of a near collision when a vehicle left a parking space, three instances of blocking a parking lot entrance or driveway, and six instances of illegal U-turns.

Table 5. Violation Type Makeup by Block

Violation	Total	Block 1 Total	Block 1 North	Block 1 South	Block 5 Total	Block 5 North	Block 5 South
Bus	24.0%	30.2%	N/A	67.6%	2.7%	5.5%	N/A
Double Parked	61.1%	55.9%	88.3%	15.8%	79.0%	81.3%	76.8%
Hydrant	5.4%	5.8%	10.5%	N/A	3.8%	N/A	7.4%
No Parking	7.3%	7.1%	0.6%	15.1%	8.1%	6.6%	9.5%
Other	2.2%	0.9%	0.6%	1.4%	6.5%	6.6%	6.3%

HOW IS THE CURB USED?

VIOLATIONS AND TIME

While double parking made up the largest portion of violations overall, the number and type of violations varied based on the time of day and day of the week. Table 6 provides an overview of violation types by day. The north side of Block 1 saw a total of 351 violations over two days—183 violations (52.1%) were observed on Wednesday and 168 violations (47.9%) were observed on Friday. Most violations were categorized as double parking, making up 83.1% of Wednesday's violations and 94.0% of Friday's violations. On the south side of Block 1, 284 violations were observed, with 146 violations (51.4%) observed on Wednesday and 138 violations (48.6%) observed on Friday. The south side of Block 1 saw the most violations from cars parking in a bus stop zone, comprising 80.8% of Wednesday's violations and 53.6% of Friday's violations. The north side of Block 5 saw a total of 91 violations over two days—45 violations (49.5%) were observed on Wednesday and 46 violations (50.5%) were observed on Friday. The largest number of violations were due to double parking, making up 77.8% of Wednesday's violations and 82.6% of Friday's violations. Lastly, the south side of Block 5 saw a total of 95 violations over two days—27 violations (28.4%) were observed on Wednesday and 68 violations (71.6%) were observed on Friday. Double parking, the largest contributor to violations, made up 63.0% and 82.4% of violations on Wednesday and Friday, respectively.

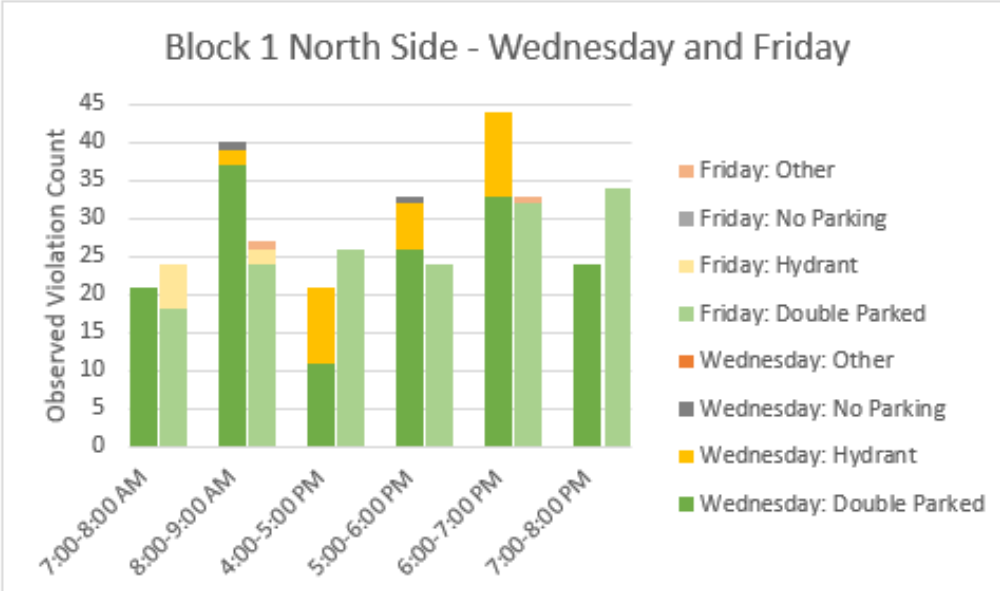
Table 6. Violations by Day of the Week

Violation	Block 1 North Side		Block 1 South Side		Block 5 North Side		Block 5 South Side	
	Wed	Fri	Wed	Fri	Wed	Fri	Wed	Fri
Bus Lane	Not applicable		80.8%	53.6%	6.7%	4.3%	Not applicable	
Double Parked	83.1%	94.0%	14.4%	17.4%	77.8%	82.6%	63.0%	82.4%
Hydrant	15.8%	4.8%	Not applicable		Not applicable		7.4%	7.4%
No Parking	1.1%	0.0%	4.1%	26.8%	4.4%	8.7%	11.1%	8.8%
Other (see text)	0.0%	1.2%	0.7%	2.2%	11.1%	4.3%	18.5%	1.5%

BLOCK 1

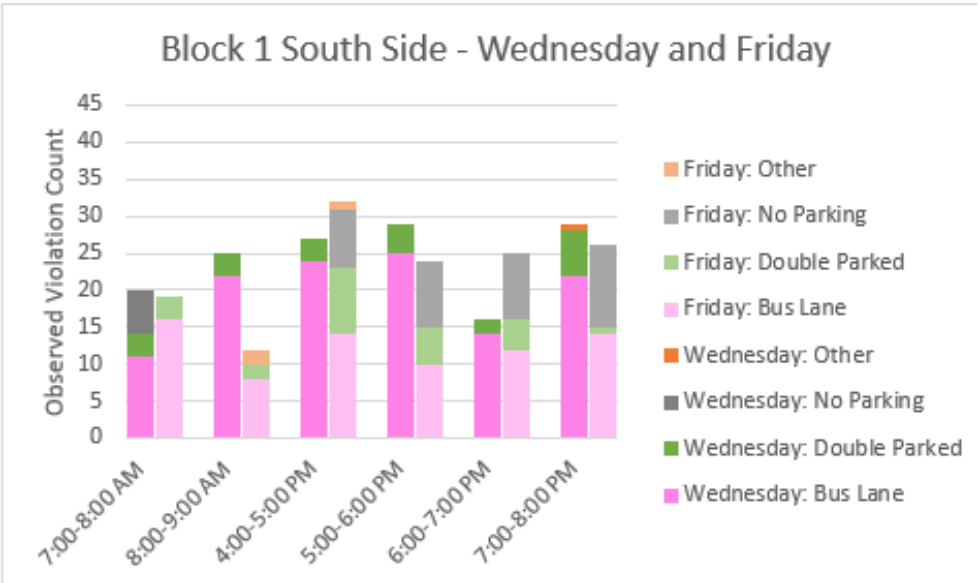
Violations also varied by time of day, as shown in Figures 13 through 16. On the north side of Block 1, the average number of violations per hour was 29.3. The most observations in a single hour was on Wednesday from 6 - 7PM, with 44 total violations. The smallest number of violations within an hour was tied between 7 - 8AM and 4 - 5PM on Wednesday, each with a total of 21 violations.

Figure 13. Violation by time of day on Block 1 - North Side



On the south side of Block 1, the highest number of observations in a single hour occurred on Friday from 4 - 5PM, with 32 total violations. The smallest number of violations within an hour occurred on Wednesday between 6 - 7PM, with a total of 16 violations.

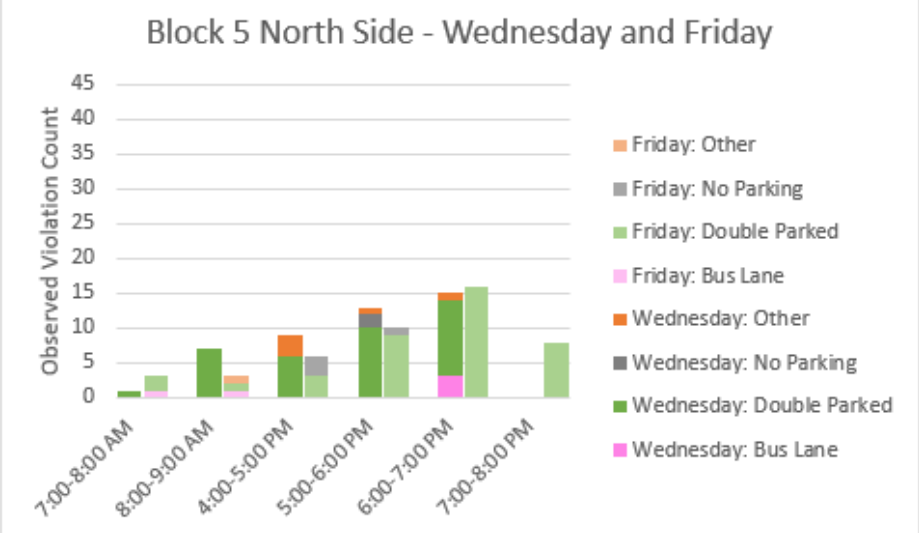
Figure 14. Violation by time of day on Block 1 - South Side



BLOCK 5

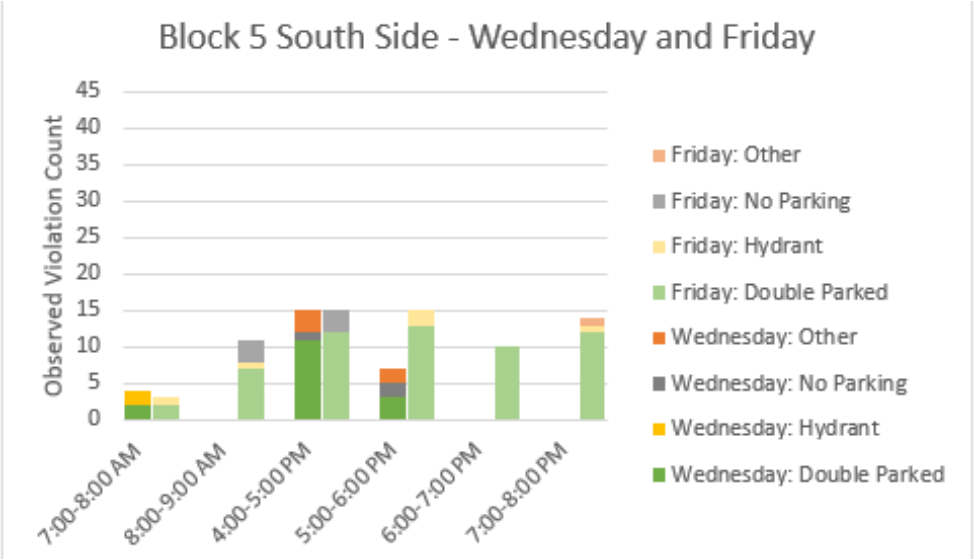
The north side of Block 5 saw an average of 8.3 violations per hour, with the highest number of violations occurring between 6 and 7PM on both Wednesday and Friday, and the fewest number of violations between 7 and 8AM on Wednesday, with a total of one. Violations falling under “other” included three instances of blocking a parking lot entrance or driveway, two instances of illegal U-turns, and one instance of a near collision when a vehicle left a parking space. Generally, more violations occurred in the afternoon than in the morning.

Figure 15. Violation by time of day on Block 5 - North Side



The south side of Block 5 had an average of 10.6 violations per hour. Violations falling under “other” included three illegal U-turns between 5 and 6PM on Wednesday, one illegal U-turn and 15-minute zone violation between 6 and 7PM on Wednesday, and one instance of parking in an HP-DV parking spot between 7 and 8PM on Friday. The number of violations per hour ranged from 3 to 15—the smallest range of all block sides. The highest number of violations occurred between the hours of 4 and 5PM on Wednesday and Friday, and between 5 and 6PM on Friday, with a high of 15 violations each hour. The fewest number of violations within an hour occurred on Friday between 7 and 8AM, with a total of three.

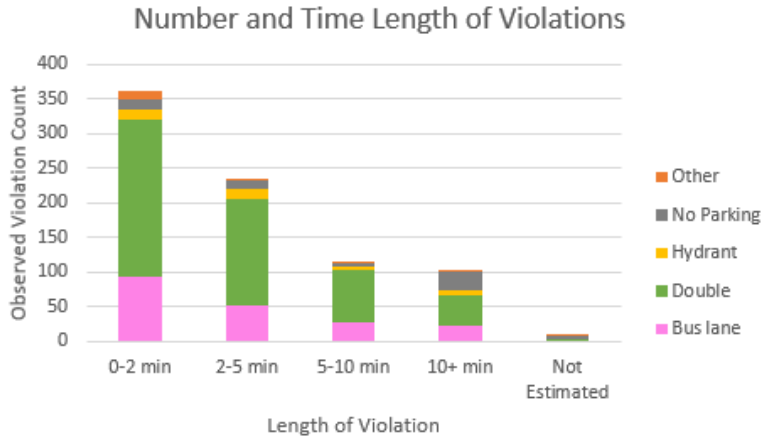
Figure 16. Violation by time of day on Block 5 - South Side



DURATION OF VIOLATIONS

The duration of violations varied slightly by block, but the vast majority lasted for 10 minutes or less. Figure 17 shows the duration of violations broken down by violation type. Across all blocks and days, 86.5% of violations occurred for 10 minutes or less. 44.0% occurred for two minutes or less, 28.6% occurred for 2-5 minutes, 13.9% occurred for 5-10 minutes, 12.5% occurred for over 10 minutes, and 1.0% were not recorded due to observation errors. Double parking violations, the most common violation type, had an above-average proportion of violations occur for 10 minutes or less (91.0%), with 45.2% lasting under two minutes, 30.7% lasting 2-5 minutes, and 15.2% lasting 5-10 minutes. 87.8% of bus stop zone violations, the second most common violation type, occurred for 10 minutes or less (47.7% for under two minutes, 26.4% for 2-5 minutes, and 13.7% for 5-10 minutes).

Figure 17. Count and Length of Violations by Violation Type



BLOCK 1

On the north side of Block 1, as shown on Table 7, 88.9% of violations occurred for10 minutes or less. 37.9% of all violations were for two minutes or less, while 34.2%, 16.8%, and 11.1% of all violations lasted 2-5 minutes, 5-10 minutes, and more than 10 minutes, respectively. 72.3% of double parking violations, the most common violation on this side of the block, lasted 5 minutes or less (38.1% for 0-2 minutes, 34.2% for 2-5 minutes), while 17.7% lasted 5-10 minutes and 10.0% lasted more than 10 minutes.

Table 7. Violation by length of time on Block 1 - North Side

Violation	0-2 minutes		2-5 minutes		5-10 minutes		10+minutes	
	Wed	Fri	Wed	Fri	Wed	Fri	Wed	Fri
Double Parked	52	66	59	47	28	27	13	18
Hydrant	10	4	10	2	2	2	7	0
No Parking	0	0	2	0	0	0	0	0
Other	0	1	0	0	0	0	0	1
Total Violations:	62	71	71	49	30	29	20	19
Percent of Violations	37.9%		34.2%		16.8%		11.1%	

The south side of Block 1 had the lowest percentage of violations lasting 10 minutes or less, at 82.0%. As shown in Table 8, 43.3% of all violations were for 2 minutes or less, while 26.1%, 12.7%, and 16.2% of all violations lasted 2-5 minutes, 5-10 minutes, and more than 10 minutes, respectively. The duration of 1.8% of violations was not recorded due to observation errors. Nearly half (47.4%) of bus stop zone violations, the most common violation on this side of the block, occurred for 2 minutes or less, followed by 2-5 minutes (26.6%), 5-10 minutes (14.1%), and over 10 minutes (10.9%).

Table 8. Violation by length of time on Block 1 - South Side

Violation	0-2 minutes		2-5 minutes		5-10 minutes		10+minutes		Not Estimated	
	Wed	Fri	Wed	Fri	Wed	Fri	Wed	Fri	Wed	Fri
Bus Lane	53	38	37	14	16	11	11	10	1	1
Double Parked	11	10	4	10	3	2	3	2	0	0
No Parking	3	6	3	5	0	3	0	20	0	3
Other	0	2	1	0	0	1	0	0	0	0
Total Violations:	67	56	45	29	19	17	14	32	1	4
Percent of Violations	43.3%		26.1%		12.7%		16.2%		1.8%	

BLOCK 5

The north side of Block 5 had the highest percentage of violations occurring for 10 minutes or less, at 91.2%. As shown in Table 9, 64.8%, 18.7%, and 7.7% occurred for 0-2 minutes, 2-5 minutes, and 5-10 minutes, respectively. 94.5% of double parking violations, the most common violation on this side of the block, occurred for 10 minutes or less, with 66.2% occurring for under 2 minutes, 18.9% occurring for 2-5 minutes, and 9.5% occurring for 5-10 minutes.

Table 9. Violation by length of time on Block 5 - North Side

Violation	0-2 minutes		2-5 minutes		5-10 minutes		10+minutes	
	Wed	Fri	Wed	Fri	Wed	Fri	Wed	Fri
Bus Lane	2	1	0	1	0	0	1	0
Double Parked	20	29	8	6	5	2	2	2
No Parking	1	2	0	1	0	0	1	1
Other	4	0	1	0	0	0	0	1
Total Violations:	27	32	9	8	5	2	4	4
Percent of Violations	64.8%		18.7%		7.7%		8.8%	

On the south side of Block 5, 86.1% of violations occurred for 10 minutes or less. As shown on Table 10, 48.4% of all violations lasted two minutes or less, while 25.3%, 12.6%, and 10.2% of all violations lasted 2-5 minutes, 5-10 minutes, and more than 10 minutes, respectively. The duration of 3.2% of violations was not recorded due to observation errors. 53.4% of double parking violations, the most common type on this side of the block, occurred for 0-2 minutes, 27.4% for 2-5 minutes, 12.3% for 5-10 minutes, and 5.5% for over 10 minutes.

Table 10. Violation by length of time on Block 5 - South Side

Violation	0-2 minutes		2-5 minutes		5-10 minutes		10+minutes		Not Estimated	
	Wed	Fri	Wed	Fri	Wed	Fri	Wed	Fri	Wed	Fri
Double Parked	7	32	5	15	2	7	3	1	0	1
Hydrant	0	1	1	1	0	2	1	1	0	0
No Parking	0	1	0	2	0	1	2	2	1	0
Other	4	1	0	0	0	0	0	0	1	0
Total Violations:	11	35	6	18	2	10	6	4	2	1
Percent of Violations	48.4%		25.3%		12.6%		10.5%		3.2%	

VIOLATION TIME AND LAND USE

The number of violations at locations varied by land use. Figure 19 shows higher numbers of violations occurring near quick service restaurants such as Teriyaki House and Dunkin Donuts on the North Side and Starbucks and Subway on the South Side. Block 5 violations largely occurred at commercial and Food - Sit-in land use types. Figure 20 shows the highest density of violations occurring near Shenannigans and

Clock Tavern on the North Side.Violation counts by land use type varied by time, as shown on Figures 21 and 22.

Figure 19. Block 1 Violation Heat Map

Figure 20. Block 5 Violation Heat Map

Figure 21. Block 1 Violations over Time Near Certain Land Use Type

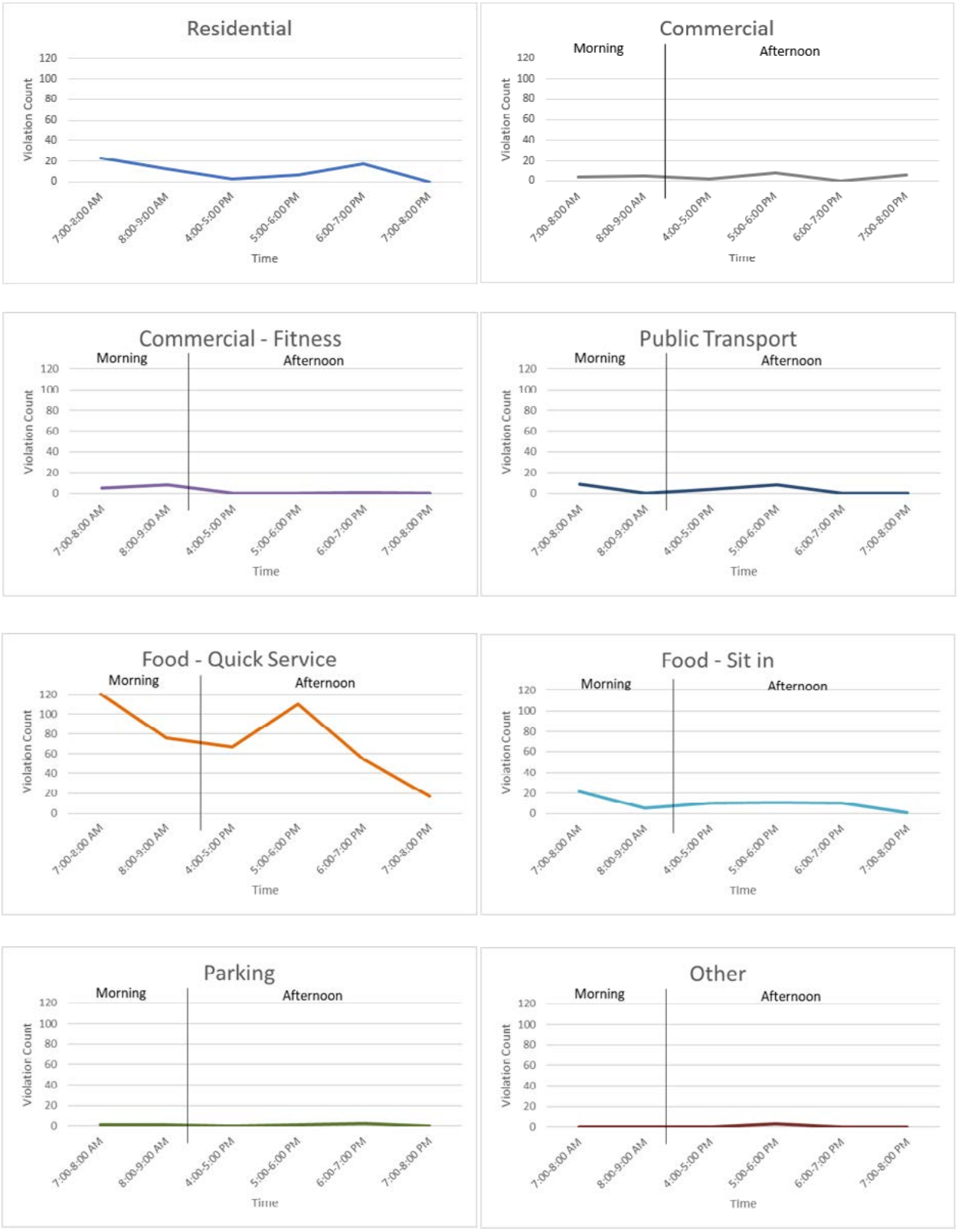
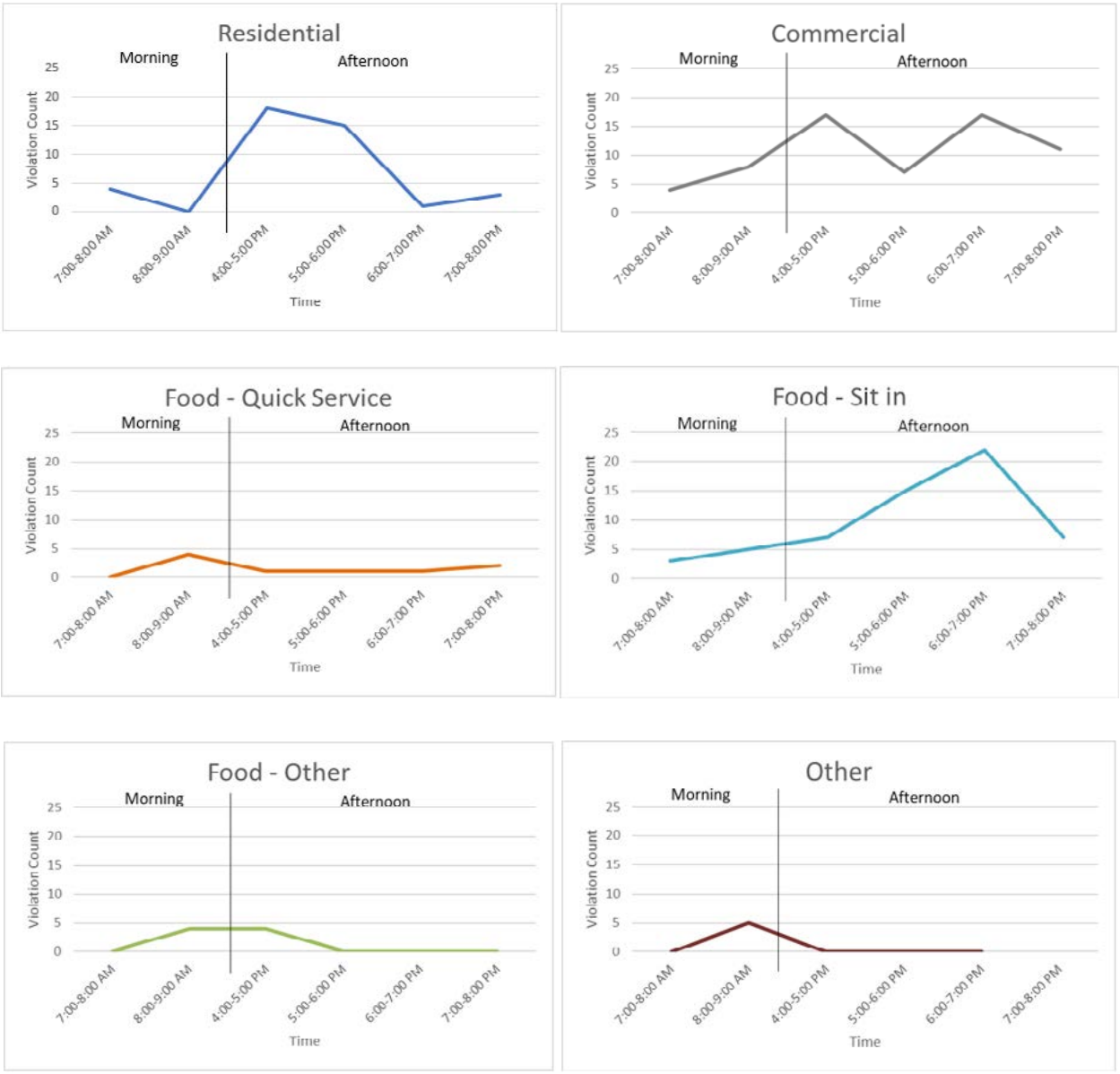


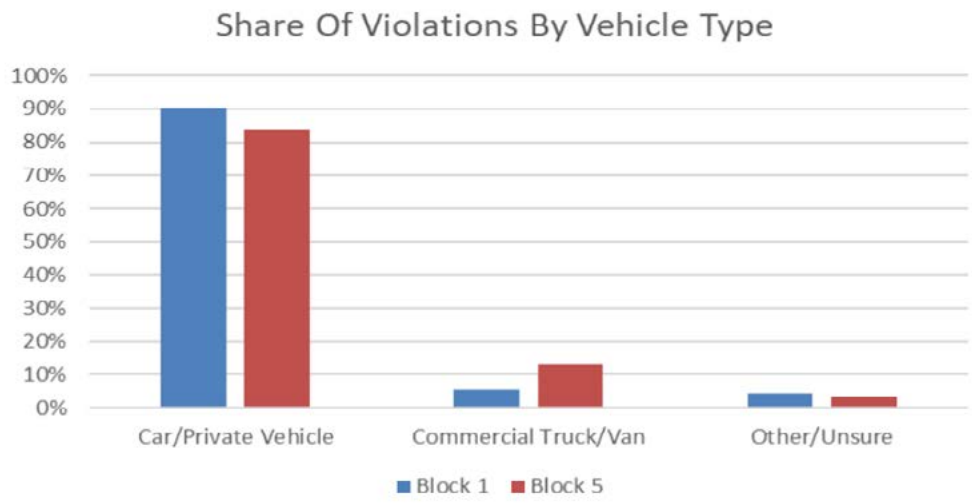
Figure 22. Block 5 Violations over Time Near Certain Land Use Type



OBSERVED VEHICLES

Figure 23 provides an overview of how much each vehicle type contributed to the overall share of violations. Private vehicles committed the most violations on both blocks, accounting for 90% of violations on Block 1 and 82% of violations on Block 5. Note that “other” includes the small number of vehicles that were neither commercial nor privately owned (for example, USPS trucks and MBTA auxiliary vehicles). The “unsure” category captures vehicles that were unable to be identified by their observers.

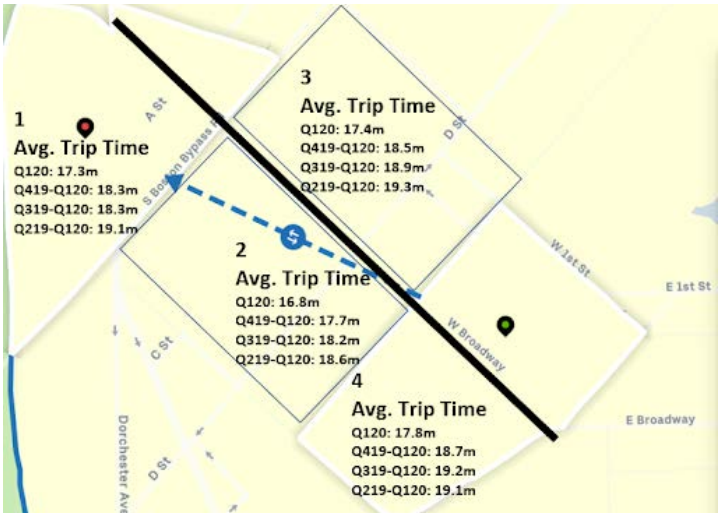
Figure 23. Violation Share by Vehicle Type for Blocks 1 and 5



Rideshare data has an important role to play in analyzing the data collected on West Broadway. With the widespread popularity of TNC rideshare services such as Uber and Lyft, it is important to consider the impact of these services on our results. However, we could not definitively attribute any violations to TNC services in this study, because there was no way to know for sure whether a private vehicle was acting in a TNC capacity. Therefore, all rideshare vehicles were captured under the "private vehicle" category.

Figure 24 shows data compiled from Uber on their average trip times in the West Broadway area of South Boston. The data shows that average trip times in the area range between 16 and 19 minutes.

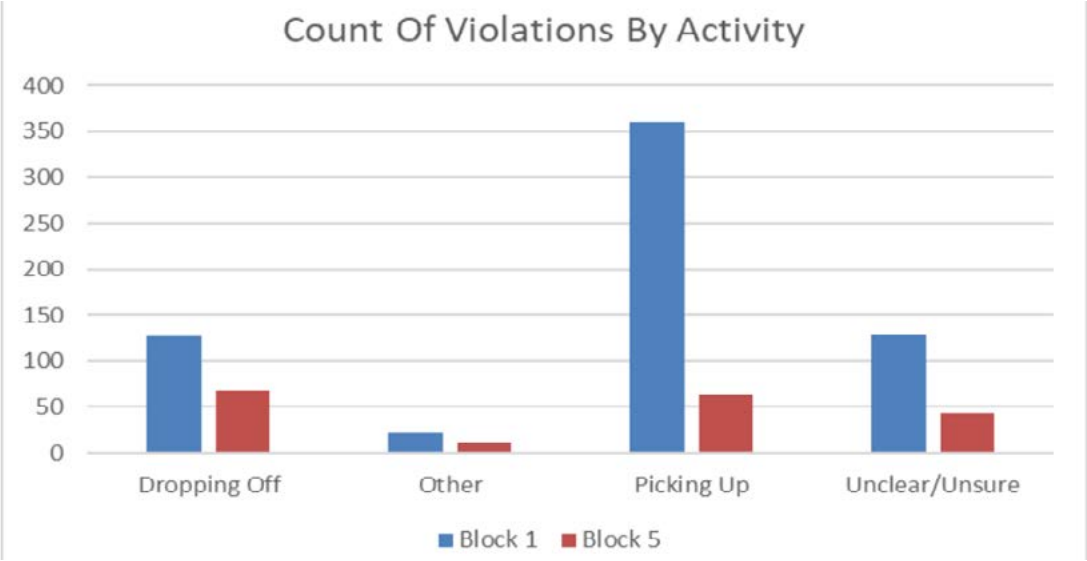
Figure 24. Uber Average Trip Time in South Boston



OBSERVED ACTIVITIES

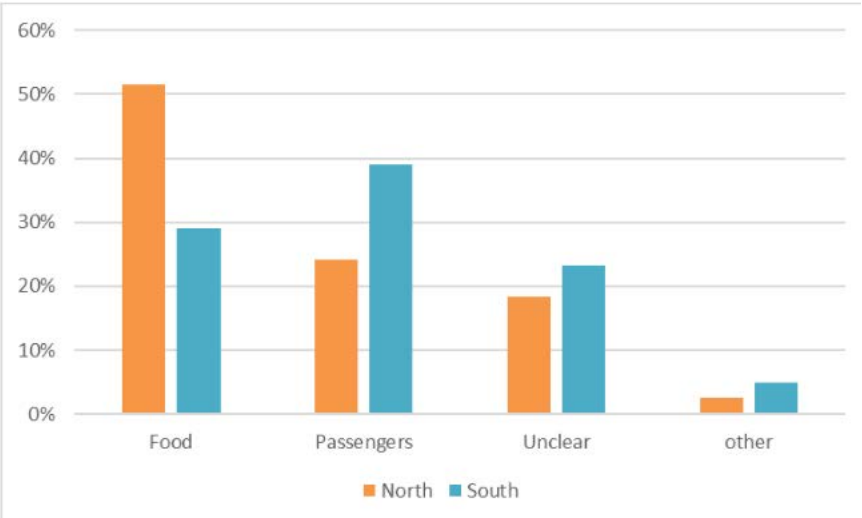
Given that it was impossible to determine with any degree of certainty whether private vehicles were acting as TNCs, we decided to capture violations based on their apparent purpose. Observers were asked to record whether violators were “picking up” or “dropping off” something, then record whether that something was a person/people, a package/packages, or food. Figure 25 shows the breakdown of pick-ups and drop-offs.

Figure 25. Violation Counts by Activity Category on Blocks 1 and 5



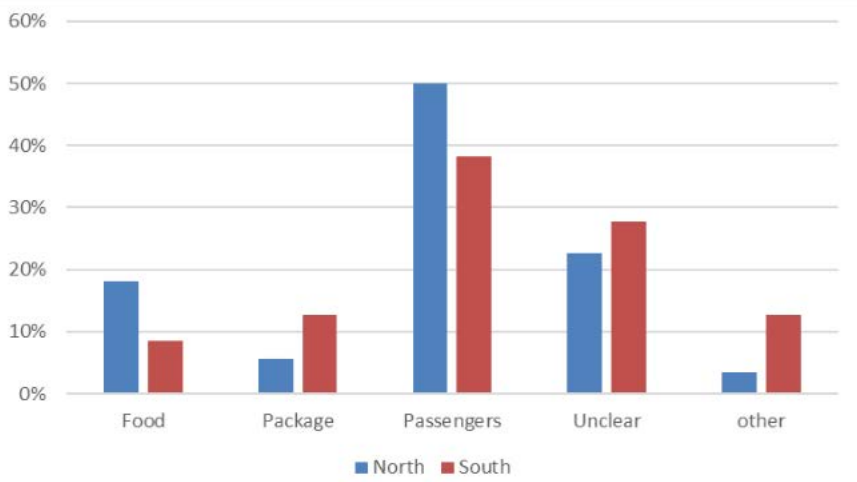
As seen in Figure 26, the majority of violations on the north side of Block 1 were pick-ups. A majority of the vehicles conducting pick-ups were picking up food. The south side saw a greater percentage of drop-offs than the north side and a greater percentage of passenger-related violations.

Figure 26. Block 1 Violations by Actions



As shown in Figure 27, Block 5 showed greater consistency between the north and south sides when it came to pick-ups and drop-offs. A majority of violations on this block were passenger-related. Vehicles generally waited longer to pick up passengers than to pick up food, leading to longer violations. The north side saw a greater share of food-related violations, while the south side had a greater share of package-related violations. Commercial vehicles were most common in package-related violations.

Figure 27. Block 5 Violations by Activity Type



RECOMMENDATIONS

In summary: 57% of violations occurred between 4PM and 7PM; 54 % of violations occurred outside quick-serve restaurants; 61% of violations were double parking; 73% of violations lasted less than 5 minutes. In light of these findings, here are our recommendations for curb management tactics in the City of Boston.

A low-cost, low-technology solution is to implement flexible loading zones (LZs) in areas prone to violations. Signage should establish that any vehicle—including private vehicles, TNCs, commercial, and public-sector vehicles—may use the zones for pick-up/drop-off activity. Time limits could be set at 5, 10, or 15 minutes depending on the anticipated purpose of usage; for example, if TNC food pickups at quick-serve restaurants is the main source of violations in the area of concern, the limit should be set at 5 minutes; if a majority of violations are caused by parcel delivery to a large residential building or commercial facility, a longer time limit may be more appropriate. Ideally, LZs should be clearly marked by signage, curb paint, and/or thermoplastic coating to create a clear visual separation from surrounding curb regulations, such as 2 hour zones.

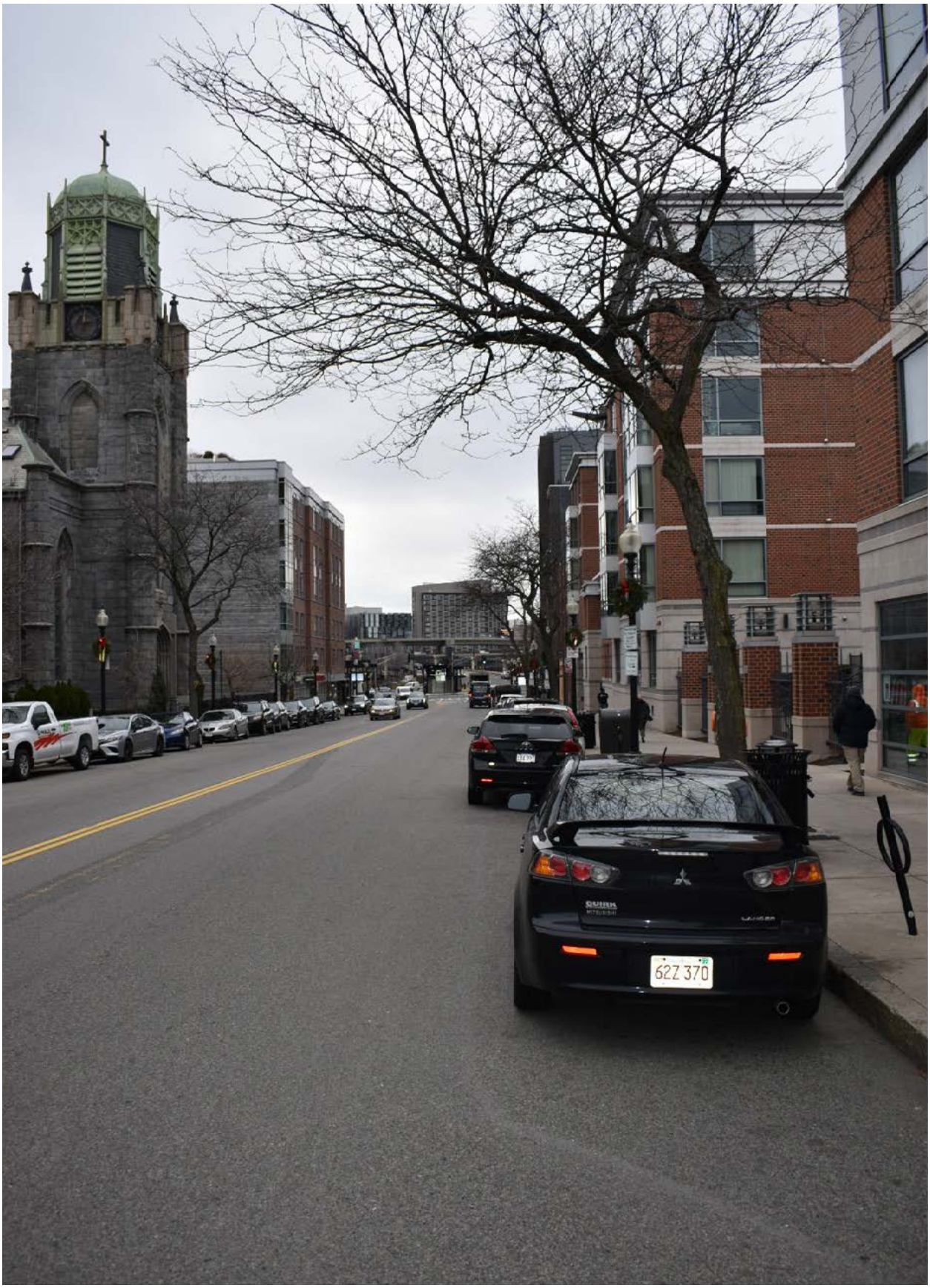
In order to maximize the effectiveness of LZs at reducing violations, they should be located adjacent to the de facto source of those violations, as drivers in our study displayed a clear preference for parking as close as possible to their destinations, ignoring open spaces located farther up the block in favor of double parking closer to their targets. In many places, this will inevitably entail the conversion of parking spaces that are currently regulated as 2 hour and/or resident parking to LZs. While this may raise concerns about equity and the yielding of publicly-owned assets (i.e. the curb zone) to accommodate traffic that may in large part be caused by TNCs, we believe that appropriately-sized LZs would be a more equitable use of curb space than the 2 hour/resident spaces they would replace. For one thing, making no accomodations for the slew of online-enabled pick-ups and deliveries does nothing to change the fact these services exist and will continue to cause major disruptions on our roads. This has become a fact of life in recent years—not only to automobile drivers, but also to other road users like cyclists and bus riders who suffer delays and unsafe conditions as a result of rampant violations. Thus, it is also in their best interests to remove pick-up and delivery traffic from travel lanes and redirect it into the curb zone wherever possible. It is important to point out that this does not constitute the yielding of otherwise public space to corporate interests such as Uber and Lyft, as the entire process of curb zone regulation is an exercise in balancing competing (mainly private) interests who all demand access to finite public space; seen in this light, codifying space for short-term pickups and drop-offs is a much more efficient and equitable use of that space than the handful of resident parking spaces they would replace, which, at present, only benefit the small number of private citizens who use them to park for free indefinitely.

Alternatively, a higher-cost, higher-tech curb management option is to implement geofencing in select areas. Geofencing would require a mobile phone application that sends push notifications to TNC drivers, notifying them of nearby available LZs. As discussed earlier in the literature review section, the City of Seattle tested the

simultaneous deployment of LZs and geofencing. The results demonstrated that LZs and geofencing used together significantly reduced vehicles stopping in traffic lanes. Between 7 and 10 % of drivers still stopped in traffic, but this still represented a significant decrease in violations.

Further research is needed for MONUM to have a holistic view of curb usage and parking violations throughout the city. This study should be replicated during other seasons and in various neighborhoods of Boston, as the time of year and the ongoing effects of the pandemic on travel patterns may have influenced the flow of traffic and demand for curb space on West Broadway. Studies in other areas of the city would also help to establish precedent upon which to base future regulatory decisions.

Lastly, the City of Boston may benefit from additional research on the relationship between curb usage and land use, as some land use types and particular types of commercial uses may correlate with a disproportionate number of violations. Building design, as it relates to curb usage, is also important. For example, some establishments may have secondary entrances that could be used for food pick-up and drop-off, potentially helping to reduce violations and some of the safety concerns, transit delays, traffic, and inter-mode conflicts that come along with them. Design considerations can and should be emphasized in the BPDA's Article 80 review process.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