SAN FRANCISCO CURB STUDY

Uber

FEHR PEERS

San Francisco Curb Study

Prepared for:
Uber Technologies

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FEHR PEERS

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Executive Summary

This study, in which Fehr & Peers served as a transportation consultant to Uber Technologies, was conducted to observe several locations with moderate to high passenger loading activity and a mixture of adjacent land uses/neighborhoods and roadway characteristics. Observations were used to identify common trends and behaviors, and to develop broad strategies to improve curb space productivity for a variety of roadway typologies.

What We Did

Fehr & Peers collected, observed, and analyzed a combination of traffic count data, video, photography, and Uber activity data, to quantify the interactions between passenger loading and other modes (e.g., private auto, bus, bicycles) at each case study location. The data were used to quantify passenger loading demand by mode for each location. We combined these findings with knowledge of transportation planning, engineering best practices, and current research efforts on curb space management in order to develop a set of strategies that could be implemented to improve curb space productivity. We then applied these strategies to each of the five study locations in a way that would also help address the multimodal interactions, or "friction" related to passenger loading in areas where curb space for this use is insufficient for meeting current levels of demand. The strategies outlined are not specific to San Francisco and could be useful to other cities with comparable land use and streetscape contexts to improve curb space productivity.

What We Found

None of the case study locations had adequate curb space to accommodate our observed passenger loading demand. Therefore, passenger loading activity was found to occur at the curb and in the travel way. The disruption this activity had on surrounding modes (e.g., buses, private vehicles, bicyclists, etc.) varied from location to location. While each case study location has a unique blend of roadway characteristics, surrounding land uses, and community priorities, providing additional opportunities for passenger loading to occur curbside would improve traffic flow, reduce pedestrian exposure to traffic, and bring people to and from these areas in a more efficient manner.

What We Recommend

This study documents the methodology, findings, and overall framework for agencies to evaluate the curb space to move people more safely and efficiently. For each case study, we identified several strategies to consider and quantifiable metrics to illustrate the potential effectiveness of providing better curbside opportunities for passenger loading activity.

Background

As the adoption of ridesharing via Transportation Network Companies ("TNC"s such as Uber, Lyft, etc.) increases, ridesharing pickups and drop-offs are adding to the many use cases for safe and efficient curbside access for passengers and drivers.[1] This is most evident in urban areas, where the demand for curbside access competes with the largest variety of other uses such as vehicle parking and commercial loading,. In response to the growing competition for space, some cities are calling the curbside "flex" space and starting to be more intentional about defining curbside uses.

Source: Seattle DOT

Curb productivity, a term that will be used throughout the document, refers to the efficiency with which a given section of curb space facilitates the arrival and departure of people, including those arriving by TNC, taxi, transit, private car drop-off, parked car, or another mode that requires curbside access (e.g., bikeshare, motorcycle, etc.). As noted in the following section, the curb serves an array of functions and users, including commercial loading which, particularly in urban environments, comes up as being important to users as often as passenger loading. While this report generally considers all curb users, it focuses on curb access for passenger loading. Curbside activity along five different blocks in San Francisco ("case study locations") was observed for this study.

Many cities / agencies are developing policies and frameworks in response to the changing needs and uses of curb space. This study contributes to a growing body of policy, planning, and engineering studies on this topic. However, it is somewhat distinct from the larger group in that a) it is a result of working directly with a TNC, and b) it benefits from data that can only be supplied by a TNC.

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[1] The curbside is typically the space between the pedestrian realm and the travel way, serving various uses including parking, bus stops, commercial loading, passenger loading, and landscaping.

Best Practices

Fehr & Peers is currently in partnership with the Institute of Traffic Engineers (ITE) and North American City Transportation Officials (NACTO) to develop a "Practitioner's Guide" to document the various policies, studies, and guidelines that some cities are developing with respect to curb space management. This Guide is not yet finalized, but is anticipated to be published in October 2018.

One theme to emerge from this Guide is the new way that cities are defining the functions or uses of the public right-of-way and most notably curb space. Seattle's framework is a good example; it categorizes curb space under six primary functions:

1. **Mobility** (general purpose travel lanes, bike lanes, bus lanes) – The movement of people and goods, including sidewalks, bicycle lanes and protected bikeways, dedicated bus or light rail/streetcar lanes, and general purpose vehicular travel lanes.
2. **Access for People** (bus stops, bike parking, passenger loading zones) – People arriving at their destination or transferring between different modes of transportation. This includes transit stops, passenger loading zones, taxi zones, short-term parking, bicycle parking, and curb extensions.
3. **Access for Commerce** (delivery/goods loading) – Goods and services reaching their customers and markets primarily through commercial vehicle or truck loading zones.
4. **Activation** (parklets, food trucks, public art) – Provision of vibrant social spaces that encourage people to interact and congregate. Uses that drive activation include food trucks, restaurant patios, parklets, public art installations, seating, and street festivals (including farmers markets).
5. **Greening** (plantings, rain gardens, bio-swales) – Enhancements to aesthetics and environmental health such as planted boulevard strips, streets trees, planter boxes, rain gardens, and bio-swales.
6. **Storage** (parking, bus layovers, construction) – Provision of storage for vehicles and equipment, including bus layover spaces, reserved spaces for specific uses such as police or government vehicles, longer-term on-street parking, and construction vehicles.

Additionally, the International Transport Forum (ITF)[2] recently released a report presenting an overview of curb management challenges that cities around the world are increasingly faced with, as new shared mobility services and urban goods deliveries increase. Through quantitative modeling and experts' input, ITF analyzed the relative efficiency, contribution to city policy objectives, and implications on city revenues of shifting curb space use away from parking towards passenger and commercial loading. The study recommends that cities allocate curb space for shared mobility services, though this should be based on an

[2] International Transport Forum (2018). The Shared-Use City: Managing the Curb (Rep.). Retrieved https://www.itf-oecd.org/sites/default/files/docs/shared-use-city-managing-curb_3.pdf

overall strategic re-assessment of the priorities regarding curb access and use by different modes. Additionally, the report states that cities should consider pricing the curb to retain current revenues from paid on-street parking. The report also suggest that curb space should be flexible and dynamic to adapt to different uses and users, including new mobility services such as TNCs, over the course of the day. Finally, the model showed that, when shared mobility services have better access to the curb, pressure on traffic could decrease as the percentage of shared rides increases.

San Francisco Context

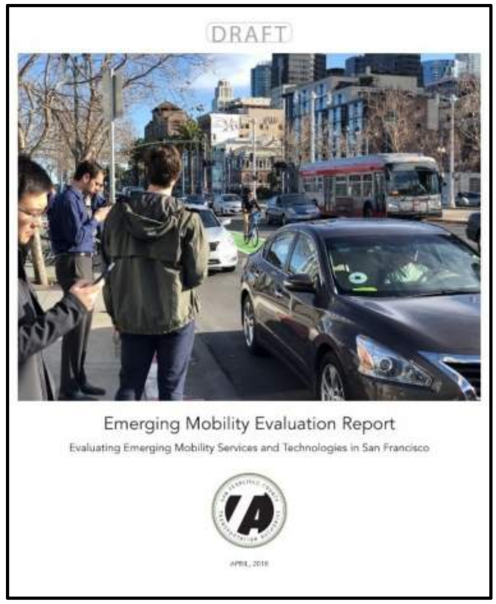
Fehr & Peers prepared a detailed technical memorandum summarizing a subset of San Francisco's on-street parking and loading policies (Appendix A). This memo focuses on how the San Francisco Metropolitan Transit Authority (SFMTA) generates revenue from vehicles parking at the curb, property owners applying for specific curbside uses adjacent to their properties, and from citations due to improper use of the curbside. It also presents some considerations with respect to parking pricing and potential conversion to other uses, and provides some high-level next steps the city could consider in re-envisioning its approach to curb space.

City and County agencies are also engaging in separate studies of and recommendations for managing curb space. Three key initiatives currently underway include the update of the Travel Demand and Loading Guidelines, under the Planning Department, the creation of a Curbspace Management Team within the SFMTA, as well as the development of an Emerging Mobility Strategy from the San Francisco County Transportation Agency.

Two typical on-street loading facilities, included in SF Planning Department Travel Demand and Loading Update study. Left: yellow curb (commercial loading); right: white curb (passenger loading). Source: Google Street View, 2018.

The San Francisco Planning Department is currently updating its guidance for preparation of transportation impact analysis associated with new development. This guidance includes the City's preferred methodology for calculating travel demand, or the number of people traveling to or from a given site, as well as calculating loading demand, or the number and duration of instances unloading goods or people at the site. Fehr &

Peers assisted in data collection and analysis as part of this effort, which included observations of curbside locations throughout San Francisco. This included collecting curb space occupancy data at designated loading zones related to a variety of land uses. Overall, curbside loading tended to be more heavily utilized than off-street loading, particularly in the mid-day and evening hours. This effort also included intercept surveys of people arriving at 64 study sites throughout the City; individuals who were making deliveries, or who arrived by taxi or TNC, were assumed to be involved in a loading instance. At some locations, up to one in five person-trips included loading of some sort, indicating that demand for curb space may be significantly higher than is assumed under current methods.



The question of how curb space use is shifting in San Francisco is further addressed through SFCTA's emerging mobilities report (*see excerpt below*), which begins to raise potential policy changes to address curb space management. This report specifically calls for a concerted effort to inventory and manage existing curbside uses in San Francisco; while there have been minimal specific recommendations, likely next steps for pilot programs include time-of-day parking and loading restrictions and potential increased enforcement of loading related violations such as double-parking or use of bus facilities by private vehicles.

Manage Congestion at Curbs and on City Roadways

The SFMTA and the Transportation Authority should prioritize developing a curb management strategy that allocates and prices curb access appropriately. Such a strategy should be supported by curb management pilots with emerging mobility services and through a curb management prioritization study. The SFMTA should also develop and implement an emerging mobility streets design guide to reduce modal conflicts. Finally, based on current congestion levels on San Francisco roadways, San Francisco should move toward implementing a decongestion pricing and incentives system, whether through cordons or roadway user fees, to manage roadway congestion.

Move towards implementation of a Decongestion Pricing and Incentives Program

The Transportation Authority should move toward implementation of a decongestion pricing and incentives program to prioritize the movement of people and manage congestion. This strategy could be implemented either through a cordon system around the most congested areas of the city or through VMT pricing strategies, paired with improvements to the transit network and incentives to use transit at the places and times when the streets are most congested. State authorizing legislation is required before San Francisco would be able to implement such a program.

Develop a Curb Management Strategy

The SFMTA and the Transportation Authority should develop an inventory of curb space and curb use throughout

Congestion Pricing and San Francisco

Congestion pricing is a type of demand-based pricing, in which we charge more for a resource during times of peak demand, in order to shift demand and allocate the resource more efficiently. This approach has historically been used for phone service and electricity, among other sectors. In the transportation sector, pricing strategies may be used to manage parking availability, encourage off-peak transit ridership, or reduce peak-period traffic in an area or along a corridor. Here, "congestion pricing" refers to relieving traffic congestion through peak-period road pricing. Under a congestion pricing program, private vehicles are assessed a charge when accessing congested areas (a certain point on the road network or enter a certain area of a city) during the most congested times of day. Pricing can be dynamic or set at a fixed rate.

The San Francisco Municipal Transportation Agency (SFMTA) is working on a city-wide curb space management strategy and has begun taking a more proactive approach towards managing the curb space as part of streetscape projects and other area planning efforts. Efforts to date have focused on increasing passenger and commercial loading curb space and short-term parking (typically used for longer loading instances). The SFMTA uses several strategies to achieve that: relocating loading zones to more convenient spaces and/or to be adjacent to each other to increase effective length, establishing flexible curb space by time-of-day (commercial loading during the day and passenger loading in the evening), and establishing "active loading only" zones in existing "no parking" zones that can be used for both for commercial and passenger loading. In November 2017, the City of San Francisco began discussions with several local technology companies, including Uber, to stand up a curb space pilot program aimed at reducing double parking, ensuring safe curbside access for all users, and mitigating traffic congestion.

Preparing for Autonomous Vehicles

Although this report is centered on existing levels of passenger loading, including TNC activity, it is important to note that autonomous vehicle (AV) technology has the potential to make vehicle travel more convenient and less costly, with resultant impacts on TNC use and vehicle use generally[3]. Questions remain as to how AVs should be regulated to maximize their potential benefits, including improved safety performance, increased access to mobility for the young, elderly, and disabled, increased productivity, and improved land use, while mitigating potential risks, such as increased vehicle usage and related emissions, switching from more efficient modes, and impacts on the design and functioning of cities.

Automobile, TNC, and technology companies are currently testing AVs on public roads across the US. As of April 2018, developers in the state of California can obtain permits to test AVs without a driver behind the wheel[4]. Rather, the AV need only be connected to a remote monitoring station to allow a monitor to take over if required.

However, the expected timelines for AV market adoption are uncertain. The same can be said with respect to the legal and policy landscapes in which they will operate. It is likely that fully autonomous vehicles will first be used in TNCs fleets and/or in special zones.

Since fully autonomous vehicles are expected to be capable of autonomous driving, parking, and dropping and picking up passengers at the curb, the introduction of AVs may increase curbside demand and reduce

[3] Johnson, C., and Walker, J. (2017). "Peak Car Ownership: The Market Opportunity of Electric Automated Mobility Services." *Rocky Mountain Institute*. Accessed at https://www.rmi.org/wp-content/uploads/2017/03/Mobility_PeakCarOwnership_Report2017.pdf

[4] California DMV (2017). "Testing of Autonomous Vehicles." Accessed at https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing

parking demand. Unlike TNCs today, AVs may require curbside meeting points at specific locations, which could introduce additional pressure for more effective curb space management. The introduction of AVs may make different passenger loading operations possible, such as dedicated, orderly, or centralized pickup and drop-off locations.

Today, drivers pay a premium to park close to their destination. In the future, more people may use TNC-like services which will not require parking. Parking could also become more tightly packed as due to automated parking technology, better vehicle maneuverability, not having to open doors, and potentially smaller vehicles. In these ways, increased AV use may reduce parking demand and could motivate the conversion of existing parking facilities to other uses, including passenger loading facilities to accommodate increased demand.

While travel demand and mode choice with AV is difficult to estimate, AVs will require space at the curb to conduct safe and efficient passenger pickups and drop-offs. Therefore, the need to investigate technology-enabled and data-driven measures to mitigate the increased demand for curb space will only increase over time.

Site Selection

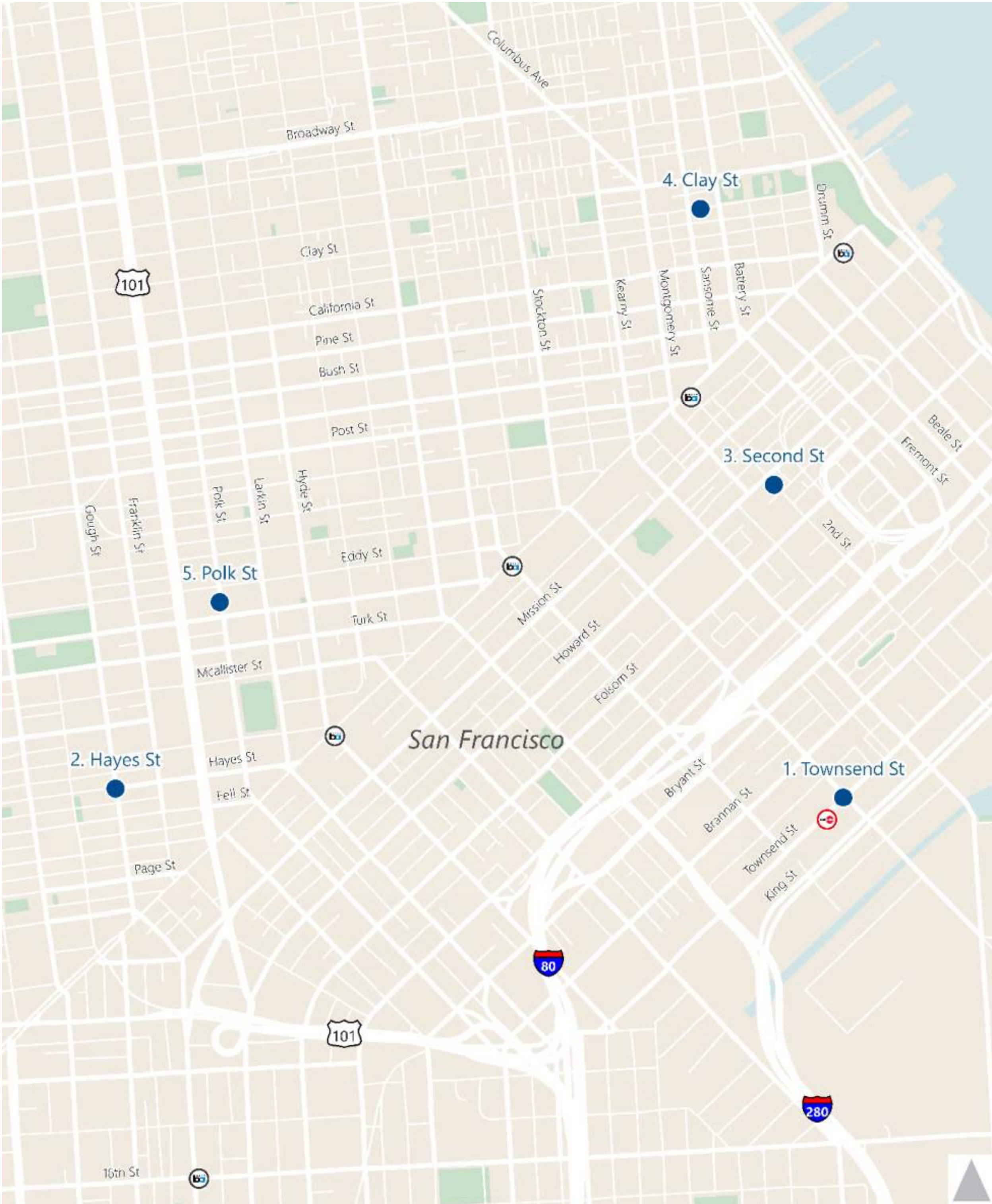
Five case study locations were identified for this study. All five locations are in San Francisco and represent a range of different land use mixes, street characters, and functional roadway classifications. The common element at all five locations was moderate to high levels of ridesharing passenger loading activity relative to other parts of the City (based on data provided by Uber).

Our first goal was to identify a set of case study locations with specific characteristics that were unique when compared to each other, but comparable to other sites in San Francisco or a similar urban environment.

To help identify case study locations, Uber provided one month of data illustrating density of Uber pick-ups and drop-offs during key peak periods, shown in what is referred to as a "heat map."

These heat maps were combined with knowledge of local neighborhoods, land use contexts, and street characteristics (e.g., number of lanes, presence of bus or bike facilities, etc.) to develop a set of distinct street types to study, each having a high level of passenger loading activity compared to streets of similar size and configuration. We acknowledge that there are other TNC services, such as Lyft, as well as private passenger loading activity. Since similar data from Lyft and private auto are not readily available, we assumed that the Uber-provided data/heat maps served as a reasonable proxy for all passenger loading activity.

We selected five case study locations as part of this study, each of which is noted in the following map.


Columbus Ave
Broadway St
4. Clay St
Drumm St
Clay St
101
California St
Pine St
Bush St
Stockton St
Kearny St
Montgomery St
Sansome St
Battery St
Post St
3. Second St
Beale St
Fremont St
2nd St
Gough St
Franklin St
Polk St
Larkin St
Hyde St
Eddy St
5. Polk St
Mission St
Turk St
Howard St
Mcallister St
Folsom St
San Francisco
2. Hayes St
Hayes St
Fell St
Bryant St
1. Townsend St
Brannan St
Townsend St
King St
Page St
80
101
280
16th St

Data Collection

A variety of data collection methods were used to gather data for this study. Observable streetscape and activity information collected at each of the five locations was supplemented by data provided by Uber. The data collection workflow is summarized as follows:

- **Initial Data Gathering** – Reviewed readily available data (i.e., Google Maps) and completed field visits to determine roadway characteristics and curb space designation.
- **Traffic & Parking Data Collection** – Performed vehicle classification counts and parking surveys, using a combination of pneumatic tubes and video.
- **Video & Photo Documentation** – Installed video cameras on each block to record block activity, and standard cameras to take photos intermittently for higher resolution photos throughout the analysis period.[5]
- **Activity-Based Data Processing** – Reviewed video and photographic data to document the quantity, duration, and effects of passenger loading activity during the peak periods for each case study location.
- **Uber-Provided Data** – Uber provided graphs showing daily variations of pick up and drop off activity for each case study location, and a database of pick-up and drop-off activities. This information was provided only for the five cases study locations and for the dates that the video and photo documentation occurred.

Initial Data Gathering

The following data was gathered using readily available means and supplemented through field visits. The following information was gathered at each study location:

- Number of travel lanes in each direction
- Presence and type of bicycle facility
- Bus stop location and length, if applicable
- Presence of dedicated bus lane
- Median separation type (i.e., dashed stripe, solid stripe, raised curb)
- Curb space use allocation (e.g., parking, commercial loading, passenger loading, bus stop, etc.)
- On-street parking conditions (i.e., supply, type, day/time restrictions)

[5] Although high resolution photo and video was recorded, no personally identifiable data (or faces) were recorded.

Traffic & Parking Data Collection

We collected segment traffic counts via pneumatic hoses placed on the pavement to detect quantity, speed, and vehicle classification (i.e., passenger vehicle, truck, motorcycle, bus) at one location for each case study.

We also conducted a detailed on-street parking occupancy survey to determine the utilization and turnover rate (average duration of stay for on-street parking) along the case study location. This was assessed using video footage.

Activity-Based Data Collection & Processing

To capture the nuances of curbside activity, unknowable through tube counts alone, we installed multiple video cameras and still, photographic cameras around each study location. Video cameras recorded all activity for approximately 12 hours on a typical weekday. The standard cameras took higher quality photos intermittently that supplemented the video recordings.

Once recorded, we reviewed the videos and photographs and quantified certain activity to understand corridor characteristics related to loading/unloading activity. The following information was summarized from the video and photo recordings:

- Type of vehicle (i.e., TNC, bus, commercial, taxi, private vehicle, shuttle)
- Type of loading (i.e., drop-off, pick-up, commercial)
- Side of the street of the loading event
- Location of the loading event (in-street vs. curbside)
- Availability of loading zone at the time of the loading event, including available space (in feet)
- Duration of the loading event (in seconds)
- Number of people loading/unloading
- Effect of the loading event on traffic flow/operations (e.g., did event result in blocked traffic? blocked bicyclist? Etc.)

Uber provided graphs showing daily variations of pick up and drop off activity for each case study location, which we used as a proxy to determine peak periods of all passenger loading activity. Approximately four hours of video were summarized for each site corresponding with the peak activity periods at that site[6]. The table below presents a breakdown of time frames summarized and number of cameras used at each location:

[6] Study periods were limited to daylight hours since the videos/cameras do not perform well in low-light conditions.

	Townsend	Hayes	Second	Clay	Polk
Video Time Used	7AM-9:30AM 3:30PM-7PM	3PM-7PM	8AM-10AM 4:30PM-6:30PM	3PM-7PM	3PM-7PM
Number of Cameras	3	2	2	2	2

To ensure the highest quality data processing, we worked with a data collection firm to define the different characteristics involved with loading/unloading activity. The following is a list of key metrics recorded for each loading event and a description of how we used them for further analysis:

- **Camera Number & Video Time Stamp** – Because multiple cameras were used along each corridor, the camera number in which an event was observed and the video time stamp of when that event occurred were noted for tracking and quality control purposes.
- **Type of Vehicle** – For each event, we categorized the vehicle into one of the following types: TNC, taxi, private vehicle, commercial, shuttle, or bus. TNCs were identified by the Uber or Lyft trade dress on the front and/or back of each vehicle. If no TNC trade dress was visible, we marked the event as a private vehicle. Using this information along with Uber-provided data, we were able to verify whether an event was Uber-specific or not.[7]
- **Pick-Up or Drop-Off** – Each event was logged as a pick-up or drop-off event. Uber also provided us data distinguishing the two types of events.
- **In-Street or Curbside?** – Each event was recorded as either occurring in the street or along the curb. Although the information was not used in later analysis, we did also specify if an event took place in a designated loading zone (a subset of events that occurred at the curb).
    - **Is a Loading Zone Available at the Time of the Event?** – As a follow-up question, we recorded whether loading space was available at the time of the event. If loading space was available at the time of the event, a rough estimate of the amount of space (in feet) was also recorded. One car-length of available loading space was estimated to be equivalent to 20 feet.
- **Duration of Event (Dwell Time)** – A key quantitative metric was the amount of time each event took. We analyzed our recorded dwell times to gather an average range of dwell times for both pick-up events and drop-off events.

[7] However, our method was not 100% accurate in identifying every TNC event. As stated in this Study, our recommendations are for general passenger loading activities, which includes TNCs as well as private passenger loading activity.

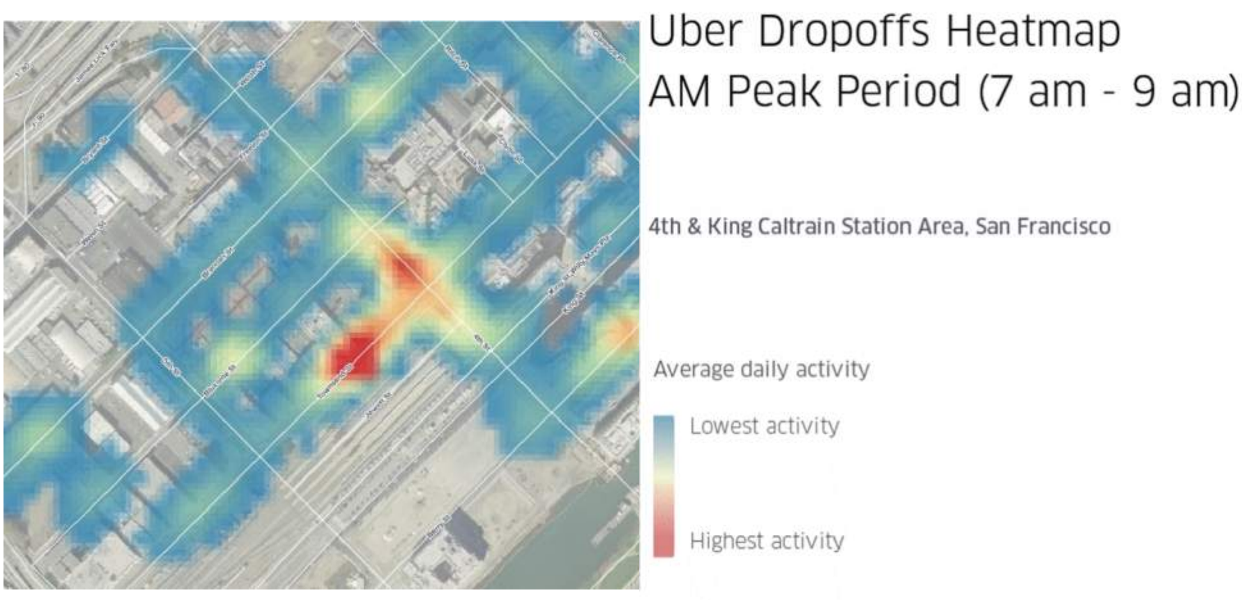
- **Number of People In/Out** – The number of people entering and exiting each vehicle was used to develop an average number per vehicle type and to ultimately yield a 'productivity' factor per vehicle type.
- **Effect on Other Roadway Users** – Another key characteristic to observe with loading events was whether or not the event had an effect on traffic flow and operations. Operational impact of each loading event was determined by asking if the event involved negotiated travel or a completely blocked passage:
    - **Affected?** – Any loading event that altered behavior of surrounding road users was designated as affecting traffic. If it was determined that an event did not affect traffic, no further detail was needed. However, if it was determined that an event did affect traffic, more detailed questions followed.
    - **Negotiated Travel?** – Negotiated travel describes an event in which another road user (e.g., bike, car, bus, pedestrian) needs to navigate its way around a loading/unloading vehicle. In other words, travel was not impeded entirely, but the path or speed of travel was altered by the loading event. Negotiated travel was not limited to vehicles and specification was made when as to which type of road user (bike, pedestrian, vehicle, etc.) the event caused to change course.
    - **Completely Blocked?** – Completely blocked describes an event in which the loading/unloading vehicle impedes travel entirely for another road user; i.e., the loading/unloading vehicle blocks the path of another road user to the point that this other road user cannot continue his/her course even by altering their path or speed.

All additional metrics (e.g., TNC productivity, etc.) are derived from analysis performed with these initial metrics. Descriptions of secondary or output metrics are described alongside results in the subsequent chapters.

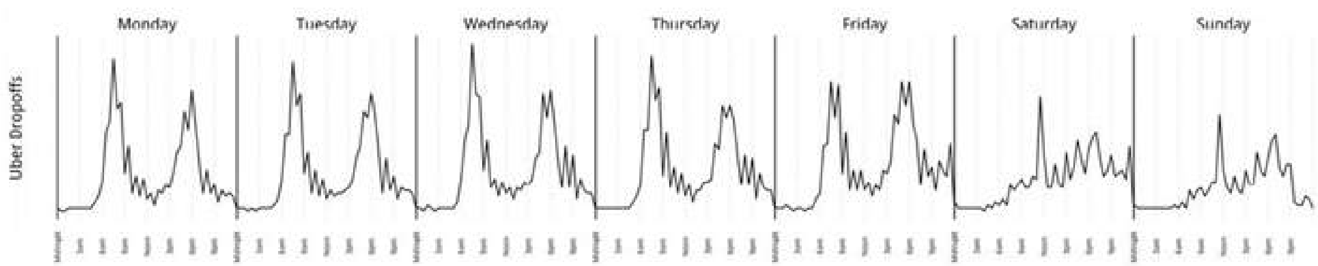
Uber-Provided Data

A key component of our data collection strategy was to leverage Uber data to both inform our other data collection, and to provide supplemental data to inform our analysis and recommendations. The specific data requested and provided by Uber, and how it was used in the study, is as follows:

- **Peak period density of pick-up and drop-off activity** – This was used to determine where the highest concentration of Uber activity occurs. Moderate to high-activity locations became candidates for case studies and this information, along with our understanding of local context and land uses, allowed us to identify the five case study sites.



- **Daily charts of hourly Uber activity for a typical week** – This was used to determine what the peak periods of passenger loading were for each case study location, which then informed what hours of video to reduce for passenger loading activity.



- **Case study location maps** – This was used to understand the parameters of Uber provided data for each location. Using this, we were able to install cameras for data collection to match the same corridor ranges.

In addition to using Uber data to inform case study locations, we used this data to supplement our data collection results and to aid in our quality control of the data reduction process.

Curb Productivity

This study defines curb productivity as the **importance, worth, or usefulness of a specific curbside designation in delivering people to/from the curb via a vehicle**. This chapter seeks to define concepts necessary to understand, evaluate and improve curb productivity.

Concepts & Metrics

The following describes concepts and metrics that are used for each case study to quantify curb activity and serve as the basis for developing data-supported findings and recommendations for each case study location.

Passenger Loading Activity

Passenger loading activity is the *measurable, objective* results of our observations related to each mode, such as the number of vehicles travelling along the corridor, or the number of passenger loading events that occur on this block. These are facts based on the video and photo documentation collected at each Case Study, not requiring any interpretation or engineering judgment to infer the results.

Passenger Loading Impact

Passenger loading impact describes how the passenger loading activity affects travel conditions or other modes. This includes additional details of the above activity with additional context, such as where the activity occurred (i.e., in the travel lane, at the curb, or in between), or how the activity affected traffic flow (i.e., could cars pass the stopped vehicles or not). These impacts are measurable but are more subjective in that they require human review to determine whether passenger loading activity was the main cause of any traffic flow or congestion, or if other factors, such as motorists stopped due to traffic signals or pedestrians, was more of a factor. This section presents several metrics calculated to illustrate the relative friction that can occur between passenger loading activity and general traffic, such as percent of time that passenger loading activity directly affected traffic flow.

Curb Productivity Index

To quantify curb productivity, we developed a metric, referred to as the **Curb Productivity Index**, which represents the productivity of a specific curbside designation based on its primary use. This may be commercial loading, passenger loading, bus stop, or parking.

The calculation includes the following input variables:

- **Activity** – Number of passengers arriving or departing by a specific mode, whether it be by bus, passenger vehicle pick-up/drop-off, or parked vehicle

- **Time** – Dwell time at the curb (i.e., how long are those people/that mode present at the curb)

- **Space** – Curb space occupied by that mode (i.e., passenger vehicle = 20 feet, bus = 60 feet)

The Curb Productivity Index was calculated based on amount of **activity** (i.e., number of people arriving or departing) observed per unit of **time** (i.e., total dwell time from all activity by that mode) and normalized over the amount of **space** typically occupied by that vehicle. Put in equation form, it looks like this:

$$\frac{Activity}{Time\ x\ Space}$$

For example, if in two hours a bus drops off and picks up 100 passengers, all bus loading events combined take 12.5 minutes (i.e. 30 buses each dwelling for an average of 25 seconds), and the bus is 60 feet long, the curb productivity would be:

$$\frac{100\ passengers}{12.5\ minutes\left(\frac{1\ hour}{60\ minutes}\right)\ x\ 60\ feet} = 8\ \frac{passengers}{hour-feet}$$

To put this into units that are more applicable to street configuration, the space unit was converted to the number of people per hour that would be served for every 20 feet of space. This results in a factor that relates the amount of activity that occurs in one hour for a space equivalent to a *typical on-street parking space*. For instance, the above example would result in:

$$8\ \frac{passengers}{hours-feet}\ x\ 20\ feet = \mathbf{160\ passengers\ served\ per\ hour\ per\ 20\ feet\ of\ curb}$$

To put this in perspective, if a car carrying two people is parked in an on-street parking space for those same two hours, that space served 2 passengers in 2 hours for those 20 feet, or in equation form:

$$\frac{2\ passengers}{2\ hours\ x\ 20\ feet} = 0.05\ \frac{passengers}{hour-feet}$$

or

$$0.05\ \frac{passengers}{hours-feet}\ x\ 20\ feet = \mathbf{1\ passenger\ served\ per\ hour\ per\ 20\ feet\ of\ curb}$$

Therefore, in this example, designating curb space for a bus stop would be about 160 times more productive in terms of passenger delivery than if curb space were designated for on-street parking. Since the number of events for each mode varies throughout the day, the Curb Productivity Index for each mode also varies throughout the day. As such, the Curb Productivity Indices presented in this report could be thought of as snapshots in time based on the level of activity observed during the data collection phase of this study.

The Curb Productivity Index for each of the five case study locations was calculated using the above methodology. The results and relative productivity of curbside uses on each case study was then used to evaluate how curb space could be reconfigured to meet the demand for passenger loading activity.

Passenger Loading Curb Demand

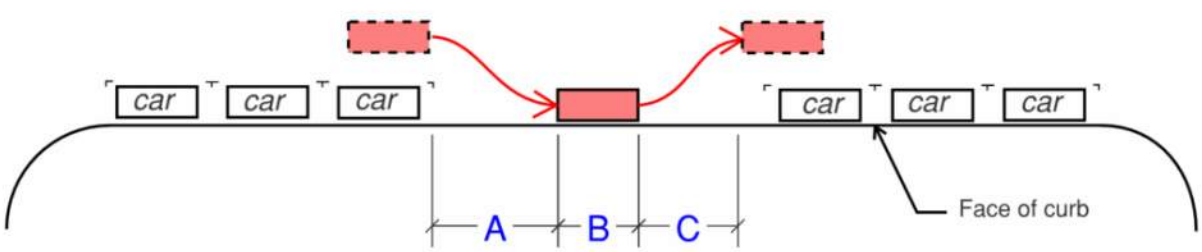
An important measure developed for each location is the **passenger loading curb demand**. This value is an important step to identify appropriate curb space reconfiguration options and to determine how much space would fully accommodate passenger loading pick-ups and drop-offs in a given area. The two elements needed are a) **the number of vehicles** to accommodate, and b) the **space needed per vehicle** (in linear feet).

Peak Curb Demand – Number of Vehicles

Our video data was used to document all passenger loading activity, including when the loading activity occurred and how long it lasted. We documented the proportion of the time that was observed where multiple passenger loading events occurred. This data is used to assess how often during the analysis period a certain number of passenger loading events occurred simultaneously.

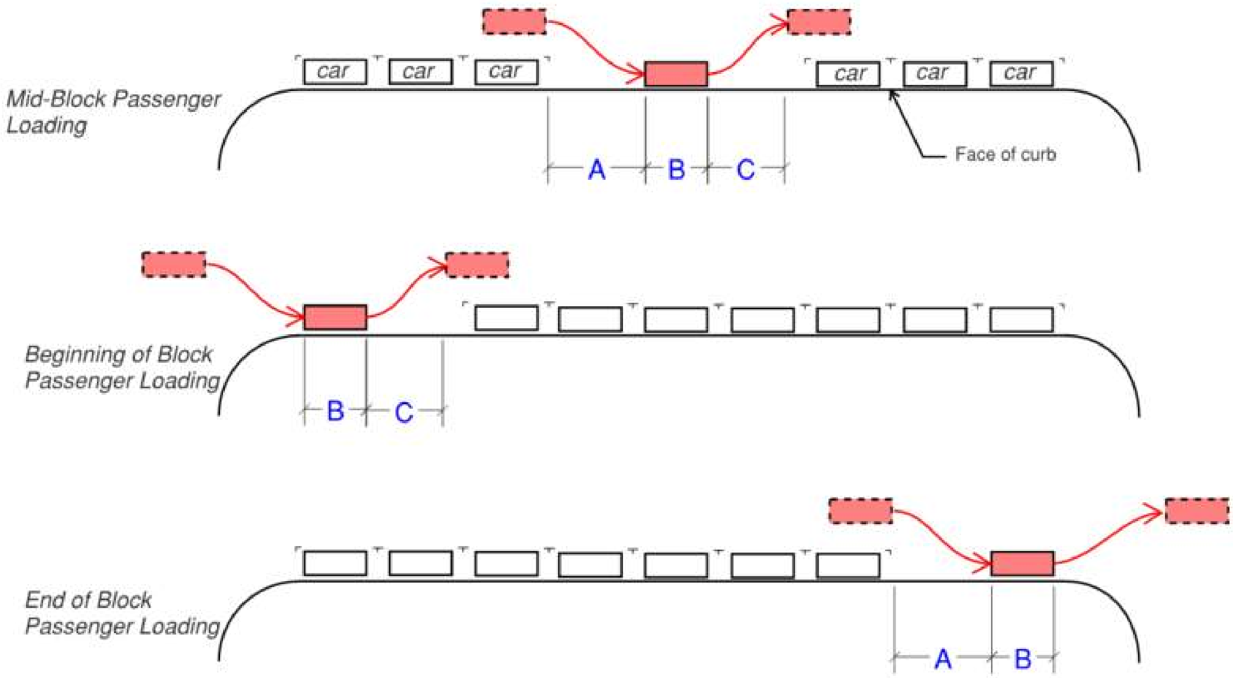
Peak Curb Demand – Amount of Space

Once the frequency and quantity of simultaneous passenger loading events is documented, it needs to be determined how much space is needed to accommodate the vehicle demand. A standard passenger vehicle is about 15-17 feet long. The space required for a standard 15-17-foot passenger vehicle to pull over from a travel lane to the curb is about 50 to 60 feet. The vehicle path from travel lane to curb and back to the travel lane is depicted in the following diagram:



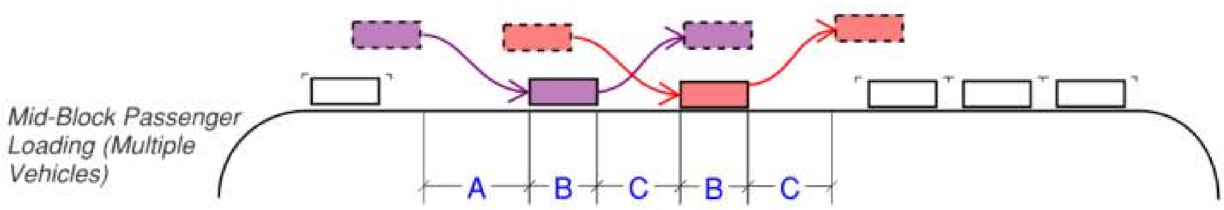
Key: A = the "entry distance", B = the vehicle length, and C = the "exit distance"

Using engineering software and field tests, the total distance A+B+C is about 50 to 60 feet in many circumstances. As such, to accommodate a single passenger loading space would require 50 to 60 feet if placed in between other parked vehicles or obstructions. There is some opportunity to accommodate passenger loading maneuvers while providing less than 50 to 60 feet per vehicle. By placing the zones before or after driveways or intersections the entry and exit distances can be through zones where parked vehicle would not be expected. The following diagrams show the same maneuver in less space by using the intersection as part of the passenger loading maneuver space.



Therefore, the amount of space needed to accommodate a passenger loading space depends on where that space is provided.

Furthermore, when multiple vehicles are maneuvering to the curb for passenger pick up and drop off, each event does not necessarily need the entire 50 to 60 feet. The following diagram illustrates when two vehicles are accessing a combined passenger loading zone one right after another.



In the above example, the red vehicle arrives first, stopping close enough to the parked vehicle ahead to provide enough space to re-enter the travel way, When the second vehicle (in purple) enters the passenger loading zone, the purple vehicle's motorist will stop behind the red vehicle and try to leave enough space for it to re-enter the travel way.

If A, B, and C in the figures above are each 20 feet, the amount of space required is:

- One Passenger Loading Zone (midblock) = **60 feet**
- One Passenger Loading Zone (next to driveway, intersection, bus stop) = **40 feet**
- Two Passenger Loading Zone (midblock) = **100 feet** *(~50 feet per vehicle)*
- Three Passenger Loading Zone (midblock) = **140 feet** *(~43 feet per vehicle)*

This methodology determines how much curb space should be allocated to passenger loading given a certain number of simultaneous events.

Limitations Acknowledgement

Like any methodology meant to simplify a complex phenomenon there are limitations to consider before application. With respect to the methodologies presented above and deployed in the following sections, there are four main reasons behind this; the first having to do with passenger loading demand and the remaining ones having to do with how to account for and allocate curb space based on that demand, which may be peaked rather than constant throughout the day.

1. The methodology necessarily simplifies arrival patterns and, particularly for multiple simultaneous passenger loading activities, idealizes driver behavior (e.g., assumes vehicles would pull to the front of the available curb space). Thus, the complexity of many simultaneous passenger loading events (i.e., three or more) at one curb is not captured and limits the applicability of this methodology to locations with lower levels of passenger loading demand. As such, use of this methodology in scenarios with high simultaneous passenger loading demand at the same curb would not represent a suggested practice.

2. The methodology determines the passenger loading curb space demand based on the peak number of simultaneous vehicles observed (i.e., the amount of curb space to be allocated to passenger loading is determined based on the highest level of activity observed). However, this peak demand may occur one to a few times a day and/or for a limited time throughout the day.

3. When deployed in the following sections, we identify what changes to the case study areas would allow accommodation of the peak passenger loading demand at the curb. As noted above, the curb

changes required are based on the observed number of simultaneous passenger loading vehicles and the curb space required for different levels of vehicle demand. However, while the peak passenger loading curb space demand (in feet) identified for each case study would ensure all activity is accommodated at the curb, there is some variability in the total curb space needed based on how many zones are provided and/or where these are on the block.

4. The recommendations presented for each case study location focus only on the observed block. However, curbside management decisions may require looking at a broader area to best allocate curb space for each use and, thus, other opportunities beyond those identified in this report may exist to allocate passenger loading (or other curb uses) on adjacent blocks.

With respect to the second and third points above, a city may not desire to design the curb space based on the highest absolute demand, but rather, like other traffic engineering decisions, identify a threshold or heuristic to determine the optimal curb space allocation (e.g., allocate enough curb space to passenger loading demand based on the 85^{th} percentile number of simultaneous vehicles). This would allow a city to balance passenger loading with other curb space demands and the desire to ensure efficient street operations.

In scenarios where passenger loading demand is very high for a peak(s) and/or sustained over an extended period, measures in addition to re-envisioning curb space allocation may be required in order to ensure efficient passenger loading and street operations. These measures include active management, enforcement, and/or geofencing. The Transportation Hub-Townsend Street case study is the case study location with both the highest and most sustained peaks of passenger loading demand and could potentially benefit from these additional measures.

Strategies to Improve Curb Productivity

Based on the observations and curb productivity indices for each study location, we developed **three basic strategies to improve curb productivity**. By accommodating a greater proportion of passenger loading demand at the curb and thereby reducing the frequency of double parking, these strategies aim to reducing friction and increase safety in the travel lane.

Where modifications to curb space are evaluated to address local or systemic issues along a corridor or in a neighborhood, understanding the objectives and priorities of the local agency and affected community is paramount. Modifying the street character, whether it is by removing or converting on-street parking, adding commercial/freight loading spaces, or converting curb space from one use to another, requires substantial political and community support. Agency policy, staff involvement and resources, public outreach and input, and support from local business and property owners is necessary for any major changes to public streets. Every city and neighborhood are unique, and there is no formula for the perfect process or solution. This section seeks to identify some basic strategies that can help explain, justify, and clarify potential curb productivity solutions.

The following strategies were developed as basic types of curb space modifications, each with their own opportunities and challenges, benefits, and obstacles. These strategies are not mutually exclusive – Using all three in one block or in an area is reasonable and would probably increase the overall effectiveness of curb space reconfiguration, allowing an agency a maximum number of options to consider to address the needs and objectives of the various stakeholders.

Following these strategies are infographics illustrating them with examples of how they might apply to a typical street. The strategies are then recommended, where appropriate, for each of the five case study locations.

Relocation

This strategy consists of relocating curb space along a block while keeping the overall amount of space dedicated to each use as a constant. No net removal of parking, nor increase or decrease of loading zones is required. This strategy would be expected to be easier to implement from a public or political perspective since the overall inventory of curb space doesn't change. However, this strategy also has the lowest likelihood of addressing common problems related to passenger and commercial loading occurring in the street, such as disruption of traffic flow.

However, this strategy can be used to improve curb productivity when used appropriately. For example, assume you have a street with an observed level of double-parking as a result of commercial and passenger loading activities. Commercial delivery vehicles (trucks) vary in size, from small (less than 20 feet) to large (40 feet long or more) often with goods loaded and unloading from the back, extending the vehicle footprint. At locations where the loading zones are about the size of a single on-street parking space (20 to 25 feet), trucks over 20 feet cannot easily access or use these spaces. However, relocating these 20 to 25 feet loading spaces adjacent to curb spaces where fixed objects (i.e., parked vehicles) are not expected, such as a driveway or curb extension, would allow more space for a truck to access that space. The result of this relocation could reduce the likelihood of double parked commercial vehicles. Another example would be consolidating multiple small loading zones (each 30 feet or less) into one large loading zone could allow for multiple small trucks or the occasional large truck.

Conversion

This strategy consists of converting curb space along a block in a way that adjusts the amount of curb space dedicated to various uses. This strategy would typically include some reduction of on-street parking. Although this can be a challenge in some neighborhoods, our data and other industry research shows that on-street parking, while a convenience to many, doesn't result in the same productivity as a zone dedicated to passenger loading (i.e., a bus stop or passenger loading zone).

This strategy can be used to improve curb productivity when demand for a particular mode is shown to be underserved by the existing curb space allocation. For example, assume you have a street with an observed level of double-parking of passenger loading activities occurring in the street. Removing a parking space adjacent to a driveway or the intersection would be easier and more efficient to access for a passenger pick-up or drop-off activity compared to a mid-block location where there are fixed objects (i.e., parked cars) on either side of the passenger loading zone, as illustrated in the Passenger Loading Curb Demand section of the report.

Effective curb space conversion should take into account various factors, including safety (line of sight) for all modes

Flexibility

This strategy consists of converting curb space, implementing technology, and modifying infrastructure to change the curb use as demand for that space fluctuates throughout the course of a day. This strategy has the potential to serve more people over a typical day when implemented and monitored to maximize its effectiveness.

A flexible system would be effective where you have a mix of land uses with overlapping demand for curb space. Commercial loading demand is typically highest in the morning and afternoon, while passenger loading in an area with employment centers and commercial uses would be expected in the commute hours and evening hours. And daytime loading space could even be flexed into overnight on-street parking to serve nearby residents. This strategy requires technology and other infrastructure for adequate implementation. Curbside meters, signage, paint, and markings would likely need to be installed to adequately enforce the time-of-day permissions. Agencies may decide to partner with transportation providers and private companies - to educate users. Additional resources may be needed to enforce the restrictions. This is where pricing for the curb space for all users (not just parking), while not studied as part of this project could potentially improve the ability to implement this strategy.

Considerations Discussion

The above strategies focus on changes to the streetscape and existing curb allocations. While those strategies are the most direct way to address curb demand and productivity, there are numerous additional considerations when reconfiguring the curb, as shown on the following figures.

Since this study focuses on passenger loading activity, it does not examine these additional considerations in detail. For example, the time periods observed in this study generally reflect peak times for passenger loading activity during daylight hours, which is different from peak periods for commercial loading activity. Thus, the commercial activity that occurred during the observation periods does not represent the highest level of activity for each corridor. However, the need for commercial loading was taken into consideration at a qualitative level based on the assumed needs from the surrounding land uses, and existing curb space for commercial loading was recommended to be maintained accordingly, when possible. In many instances, passenger loading and commercial loading are compatible in one same space by implementing flexible loading spaces, taking advantage of the different peak periods for these two curb uses[8].

Similarly, other considerations such as existing infrastructure, city policies, and safety were taken into account at a broad level when identifying potential opportunities. These policy issues, as well as public input, will likely be key topics for discussions and negotiations in implementing physical changes to the curb and the roadway. The implementation of these changes would largely be driven by agency staff rather than through partnerships with transportation operators. Before any of the recommendations presented in this study are implemented, further analysis based on City review and comment, community engagement, and other detailed design may be required.

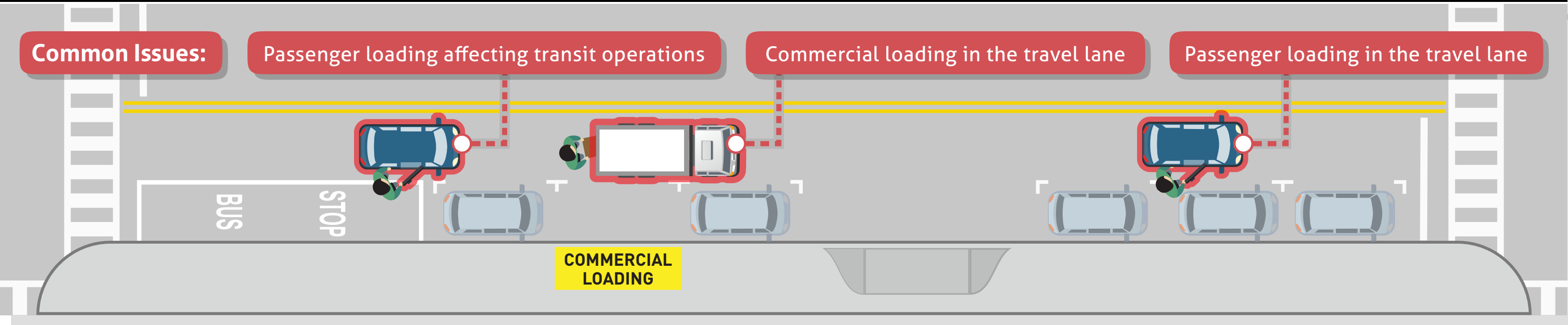
In addition to the physical changes to the curb or street configuration, other strategies to consider to improve passenger loading conditions are active management or enforcement by the appropriate personnel, and potentially, geofencing. Active management or enforcement, often associated with event centers and airports, can ensure that traffic keeps moving to avoid backups as well as provide more eyes on the street and curb in order to prioritize safety. Geofencing is a proactive measure that TNCs can take to help riders and drivers find loading zones and steer clear of challenging situations, particularly at large events and airports.

[8] A recent report developed for the San Francisco Planning Department; San Francisco Travel Demand Update: Data Collection and Analysis (Fehr & Peers, June 2018), found that demand for commercial loading activity at the curb peaks between 10 AM and 12 PM on average weekdays.

3 Strategies to Increase

Curb Productivity

Uber
FEHR PEERS



Relocation

Relocate curb spaces to better utilize the curb zone.

Conversion

Convert curb space to different uses to better utilize the curb zone.

Flexibility

Convert curb spaces to ***flexible time of day zones*** to meet demand-based uses throughout the day.

Methodology

Recognize ***common issues***

↓

Identify **Strategies**

↓

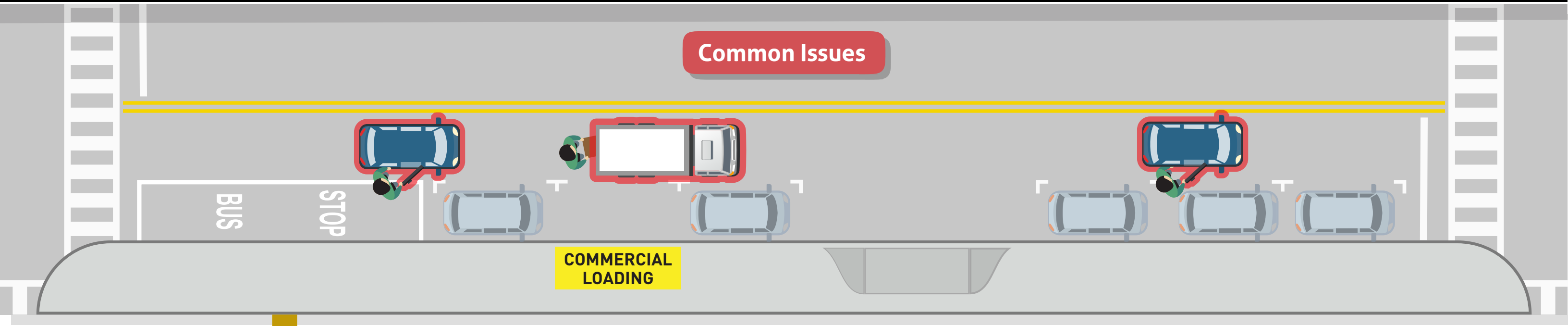
Develop ***solutions*** given other considerations

Other Considerations

- Safety
- Geofencing
- Agency policies
- Land use
- Infrastructure
- Community Values

Strategy:

Relocation

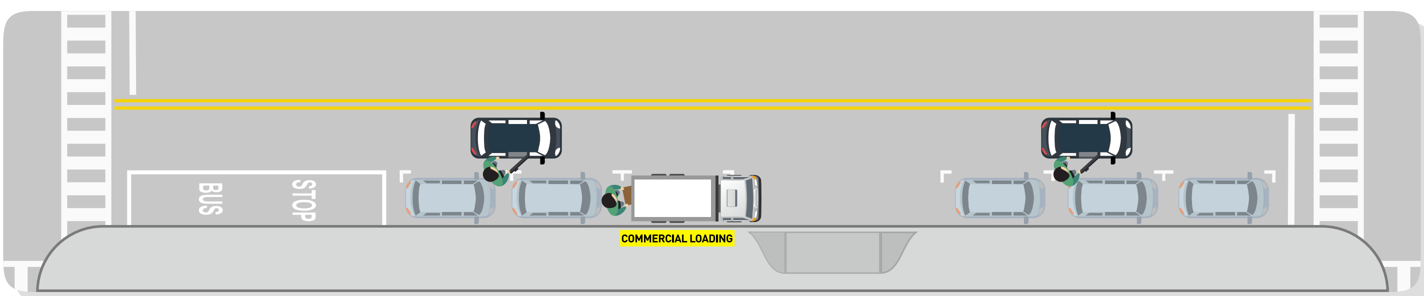


Relocation

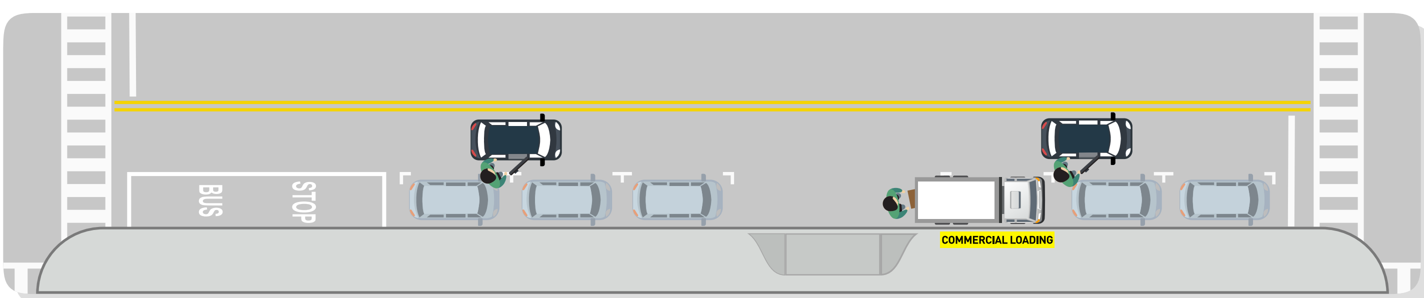
Conversion

Flexibility

Possible Solution Relocate COMMERCIAL LOADING to allow trucks to ***back into zone***.

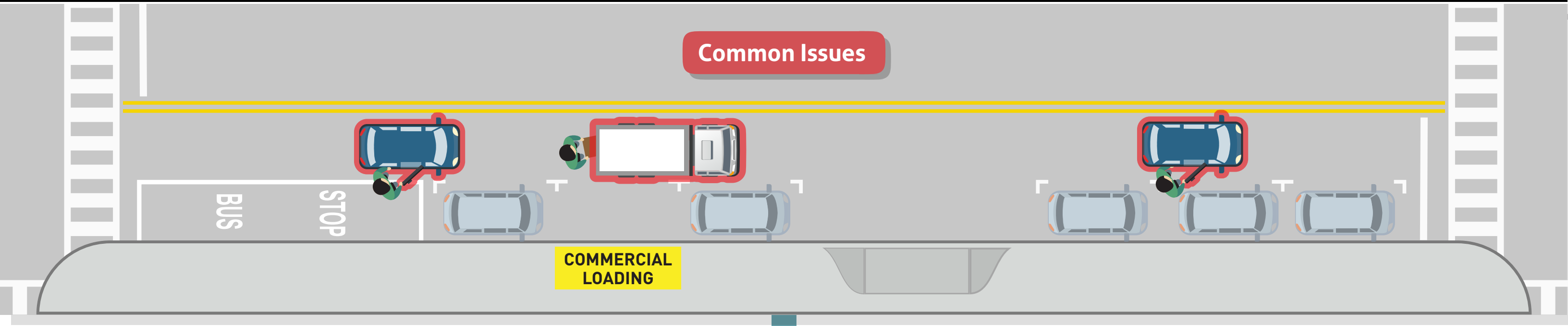


Possible Solution Relocate COMMERCIAL LOADING to allow trucks to ***drive into zone***.

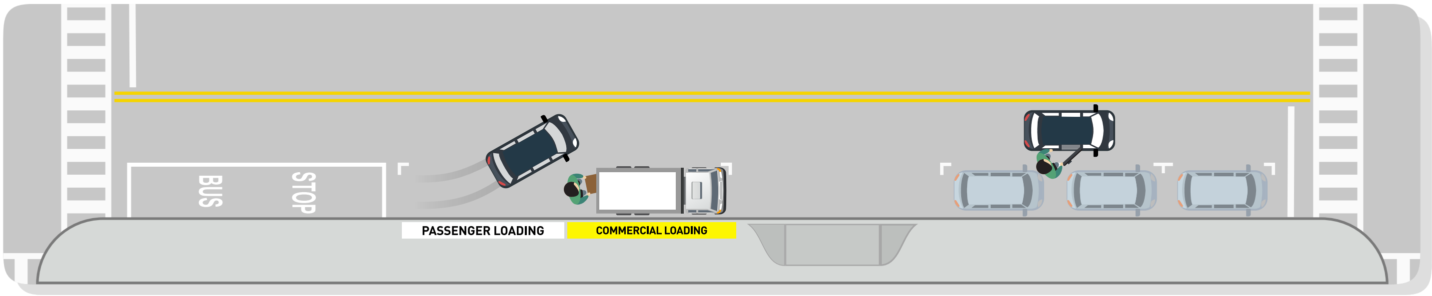


Strategy:

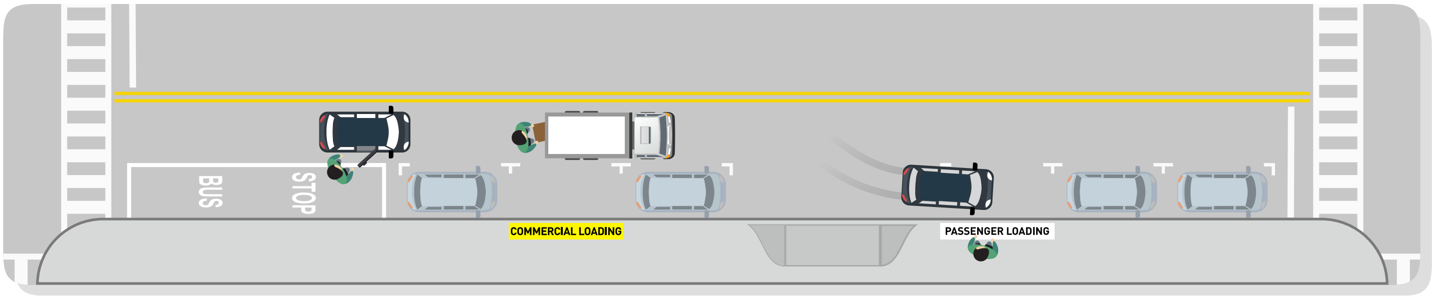
Conversion



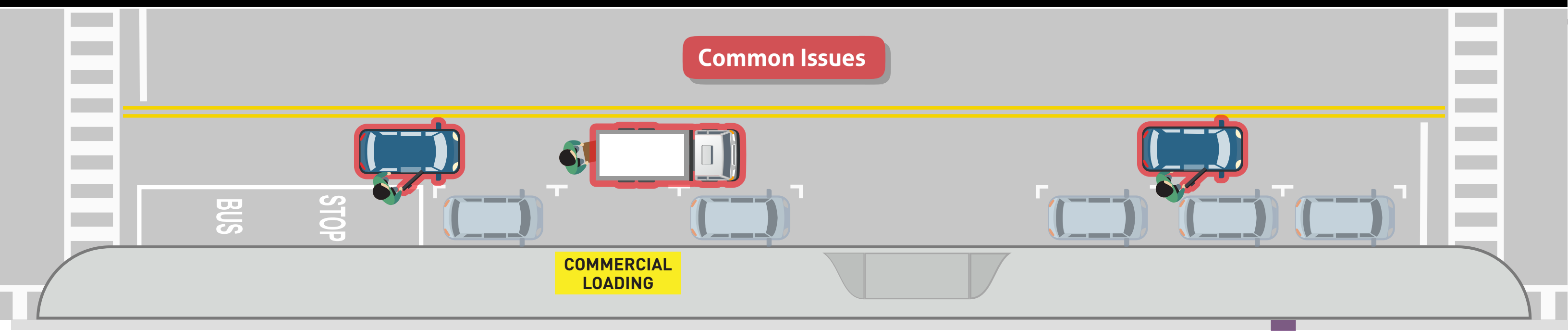
Possible Solution Convert 2 parking spaces and commercial loading to a ***larger*** PASSENGER LOADING and COMMERCIAL LOADING zone.



Possible Solution Convert parking space to a PASSENGER LOADING zone.



Strategy:
Flexibility

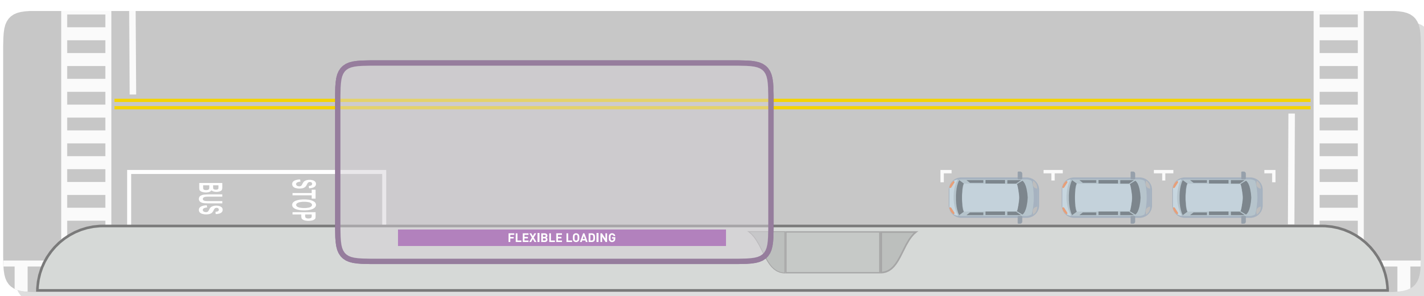


Relocation

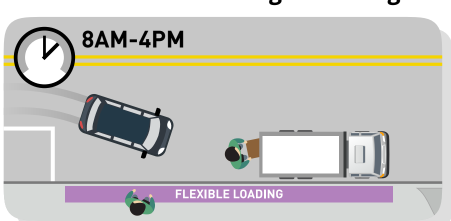
Conversion

Flexibility

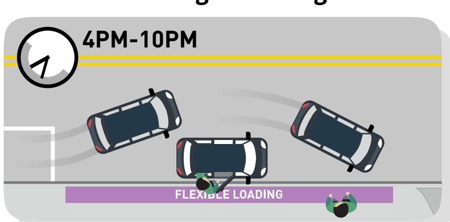
Possible Solution Convert parking and commercial loading to a FLEXIBLE LOADING zone.



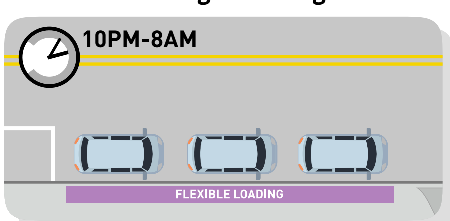
Commercial/Passenger Loading



Passenger Loading



Overnight Parking



Case Studies

This chapter includes a detailed evaluation of each case study location using the data, concepts, and metrics described in the previous sections of this report. For each case study location, we include the following sections:

Transportation Context – This includes a description of the existing street typology, surrounding land uses, and an overview of the operational conditions. A depiction of the street is also included to provide a visual representation of the character of the street and existing curb space allocation.

Observations & Findings – This includes a summary of our observations and key findings as they relate to passenger loading activity and its effects on general traffic conditions. We also included the calculated curb productivity index and passenger loading demand for each location that was used to inform the development of potential recommendations for each case study.

Recommendations – This includes a description of the potential improvements that could be made to the street to accommodate the passenger loading demand using the aforementioned strategies to accommodate the observed peak passenger loading demand at the curb. However, it is not necessarily required that the peak curb space demand be accommodated. There are many considerations and tradeoffs that a city needs to weigh when it comes to how curb space should be allocated. As such, it may not be feasible to provide the peak passenger loading curb space demand.

The graphics developed for each case study illustrate a summary of our findings and present a set of potential opportunities for how curb space could be reconfigured to improve the productivity of the curbside (in terms of passenger loading) for each case study. This is achieved by accommodating a greater proportion of the passenger loading demand at the curb, thus reducing adverse passenger loading impacts to traffic operations. For each location, we identified a recommended strategy based on engineering judgement that generally considers the location of the observed demand, the competing demands for curb space in that area, the land use context, and potential conflicts with other modes in the right of way, among others. The strategies outlined are not specific to San Francisco, though, and could be useful to other cities with comparable land use and streetscape contexts.

Transportation Hub: Townsend Street

Transportation Context

Townsend Street was chosen to represent an arterial adjacent to a major transit center. The 4th/King Caltrain station is a major hub of activity, providing regional transit service to/from the peninsula and south bay. The high frequency bus/transit service, private bike and bikeshare activity, and passenger loading activity (i.e., taxi, TNC, private vehicle) adjacent to the station causes major congestion during peak commute periods. This location was chosen as a response to anecdotal evidence and observations that passenger activity often occurs in the street, impacting other modes. *An illustration of the physical street layout, including curb space allocation by use type is shown below.*

Caltrain station in SoMa neighborhood, surrounded by mixed use office and light industrial

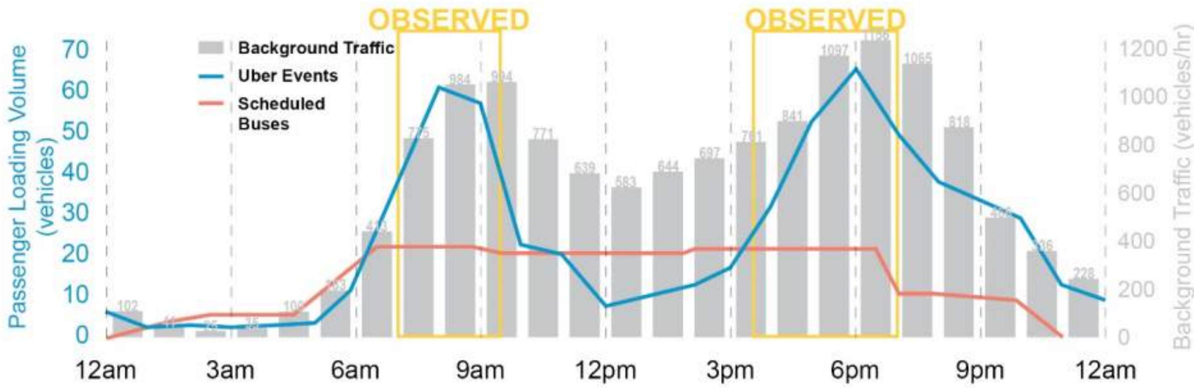
Observations & Findings

Summary

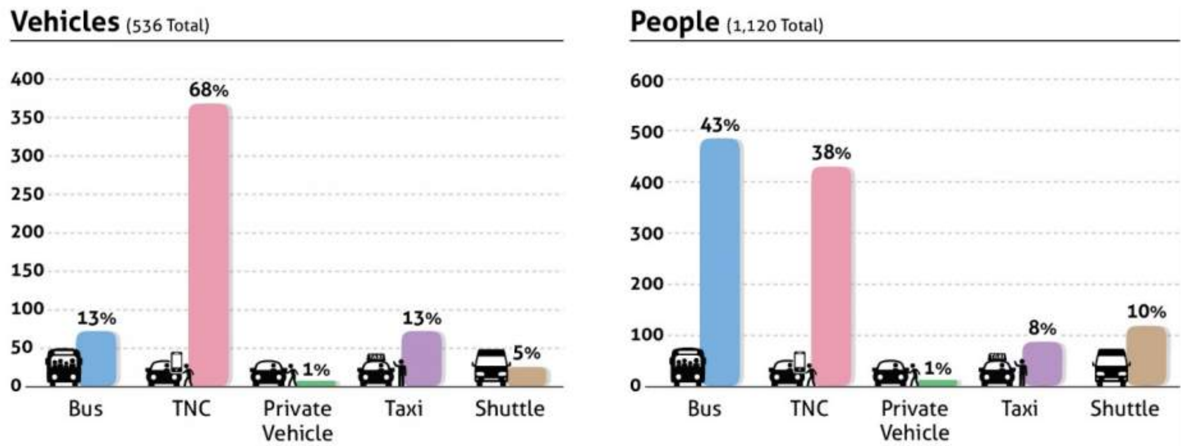
- Bus passenger loading has the highest curb productivity. Scheduled activity and allocated space are well-matched.
- Passenger loading activity for other modes is higher than the existing curb space designation can accommodate during peak passenger loading demand times.
- The largest amount of curb space is dedicated to parking, which limits passenger throughput by other modes by way of the curb.

Passenger Loading Activity

Peak activity at this location corresponds with peak Caltrain service hours and observations were summarized from 7AM-9:30AM and 3:30PM-7PM of a typical weekday to capture these peaks. Background traffic volumes on this block peaked at around 1,000 vehicles per hour in the AM peak and 1,150 vehicles per hour in the PM peak. Outside of commute hours, Townsend was not a heavily trafficked corridor and volumes dip as low as 500-600 vehicles per hour during the midday period. During the study period, Uber activity was highest at around 60 loading events per hour at 8AM and then again at 6PM. A consistent stream of around 20 buses per hour serves this block from 6AM to 6:30 PM. As many as seven Muni routes stop on this block during peak commute hours with headways ranging from eight to 20 minutes. When combined with intra-regional bus services that stop on this block (e.g., Megabus), the result was at least one bus loading event every two minutes during the observation periods. The following chart illustrates the various traffic patterns over the course of the weekday our data was collected.

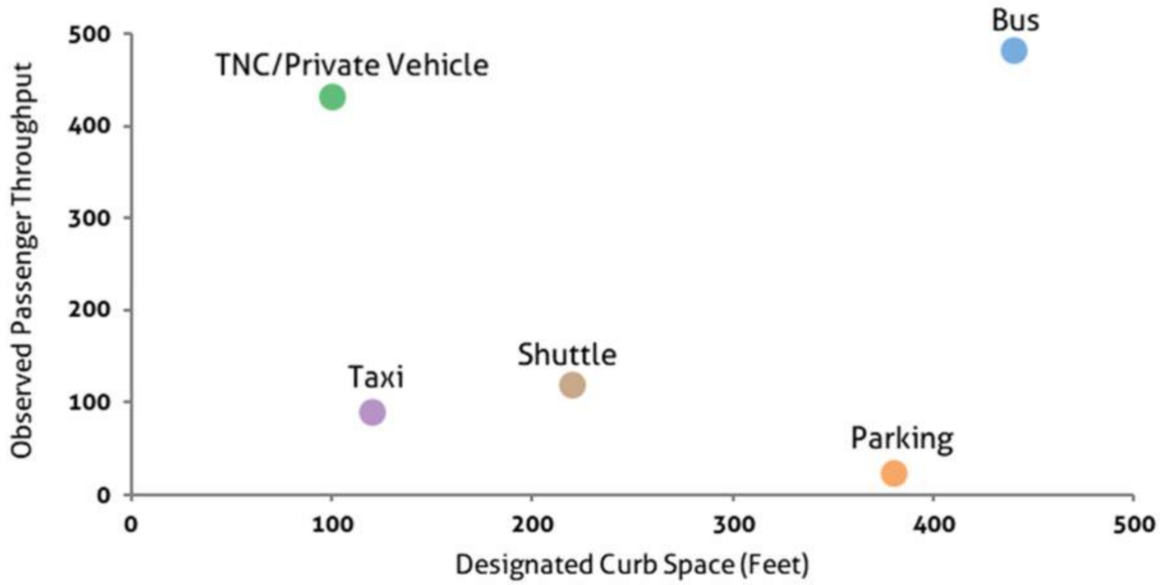


On the observed weekday, passenger vehicles (TNCs and private vehicles) accounted for nearly 70 percent of passenger loading events, and about 40 percent of people loading or unloading along this stretch of Townsend Street. Buses and taxis, each 13 percent of loading vehicles, were the next most common loading vehicle types, serving 43 and five percent, respectively, of the people loading or unloading. In this location, bus boardings and alightings are highly concentrated, which makes for very efficient use of each bus loading event. The observed passenger loading activity by vehicles and people is illustrated below.



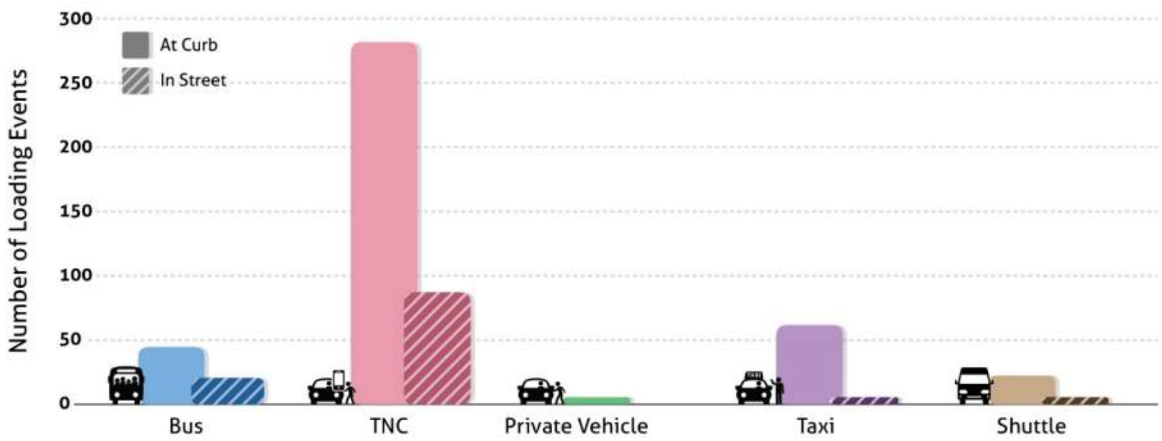
Buses load/off-load, on average, seven people per bus compared to 1-1.2 people per passenger vehicle, 1.3 people per taxi, and 4.5 people per shuttle.

The following graph presents the number of people served by each mode (i.e., observed passenger throughput) with respect to the amount of curb space allocated to that mode. As such, the comparison of how productive each mode (and curb space) is in terms of passenger throughput, and the amount of dedicated curb space to that mode can be made. In this case, there is a curb space allocation/demand mismatch. TNCs and private vehicles serve the second highest number of people (432), but have the smallest portion of curb space allocated (100 feet). Space allocated for taxi passenger loading is better balanced, with 120 feet serving 89 people during the observation period, as well as that of buses, which serve 481 people within 440 feet of designated space. Parked vehicles served 23 people and have 500 feet of curb space, more than any other designation.

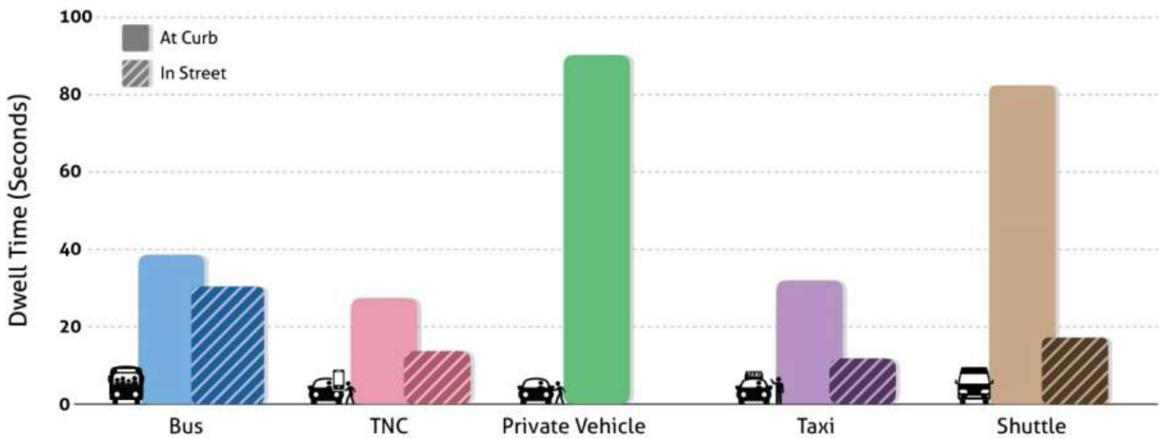


Passenger Loading Impact

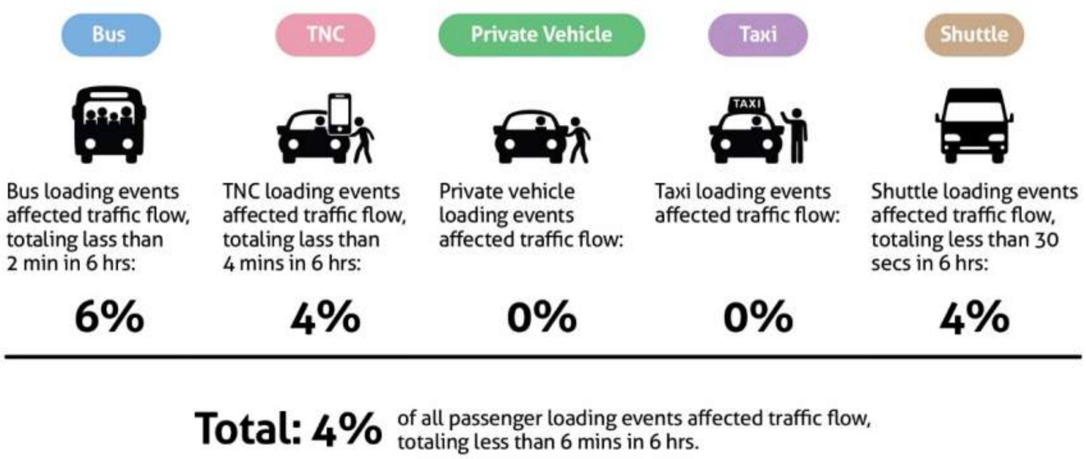
Approximately one-quarter of TNC events occurred in the street. Most of the buses, taxis, and shuttles loaded at the curb in their dedicated stops.



Across all modes, average dwell times are longer curbside than they are in the street. A handful of outlying high dwell times skewed average curbside dwell times higher for private vehicles and shuttles. For the most common modes (buses, TNCs, and taxis), curbside dwell times averaged between 30 and 40 seconds and in-street dwell times averaged between 10 and 30 seconds. TNCs and taxis had the shortest dwell times at this location. Difficulty finding an assigned passenger (for TNCs), difficulty merging back into traffic in the eastbound direction, and time spent assisting passengers with luggage were all factors that contributed to loading events with observed high dwell times.

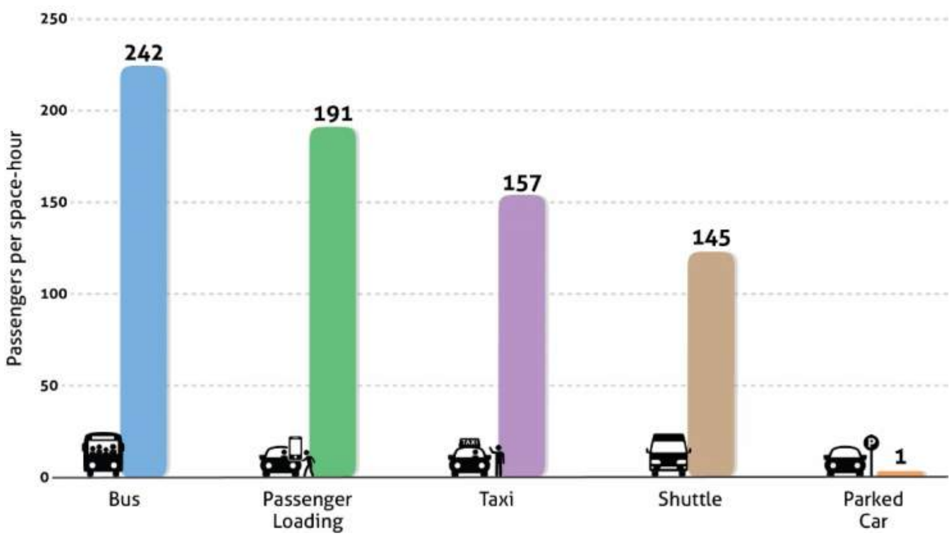


Despite congested peak and multi-modal interactions, only four percent of all loading events affected traffic flow. Effects were defined by instances in which another road user (e.g., bike, car, bus, pedestrian) needed to navigate its way around or was fully blocked by the loading/unloading vehicle. All events that affected traffic flow were caused by buses, shuttles, or TNCs. The full temporal impact of these effects is very small, totaling fewer than six minutes in six hours.



Curb Productivity

The following are the calculated curb productivity indices for the zones dedicated to serving passengers and parked cars along Townsend Street; "passenger loading" includes all vehicles using the passenger loading zone, which in this case were TNCs and private vehicles.



The curb productivity indices for buses, shuttles, taxis, and TNCs/passenger vehicles at this location are at the high end of the range of observed scores for all five sites studied in San Francisco. This points to the importance of high-turnover passenger loading adjacent to a major transit center and supports the recommendation to remove or relocate at a slightly greater distance all nearby on-street parking and repurpose all unused curb space in the vicinity to serve passenger loading.

Passenger Loading Curb Demand

The following table shows the percentage of time during the analysis period when specific numbers of simultaneous passenger loading events by TNC or private vehicle were observed in this case study location.

Simultaneous Passenger Loading Events (by TNC/Private Vehicle)	Amount of Time During Analysis Period
0	10% (36 minutes)
1	20% (72 minute)
2	23% (83 minutes)
3	23% (83 minutes)
4	17% (61 minutes)
5	4% (14 minutes)
6 or more	**3% (11 minutes)**

Notes:
Analysis period duration was six hours for Townsend Street
Bold denotes the percentage of time the maximum number of passenger loading activities were observed

To accommodate the peak passenger loading demand from TNCs and private vehicles, space for six or more simultaneous passenger loading vehicles would be required, which would require approximately 320 to 360 feet of passenger loading space according to the methodology/calculations shown in the 'Peak Curb Demand – Amount of Space' section. However, as presented in that section, and the 'Limitations Acknowledgement' section that follows it, using the methodology to determine demand where three or more simultaneous passenger loading events occur at the same curb does not represent a suggested practice, as the complexities of such a scenario are not accounted for in the methodology.

Recommendations

Passenger loading activity levels are peaked in the AM and PM commute periods of a typical weekday. Video observations found that passenger loading demand was twice as high in the eastbound direction (south side of the street, adjacent to the train station) compared to the westbound direction. The peak passenger loading demand was found to be six vehicles on a typical weekday. Given the higher than average levels of curb space demand and the overall complexity of this area, a more robust analysis than that conducted as part of this study, such as the use of a microsimulation model, would be appropriate to determine a preferred solution. Therefore, we identified potential opportunities to reallocate curb space to passenger loading on both sides of the street, but did not identify a recommended strategy.

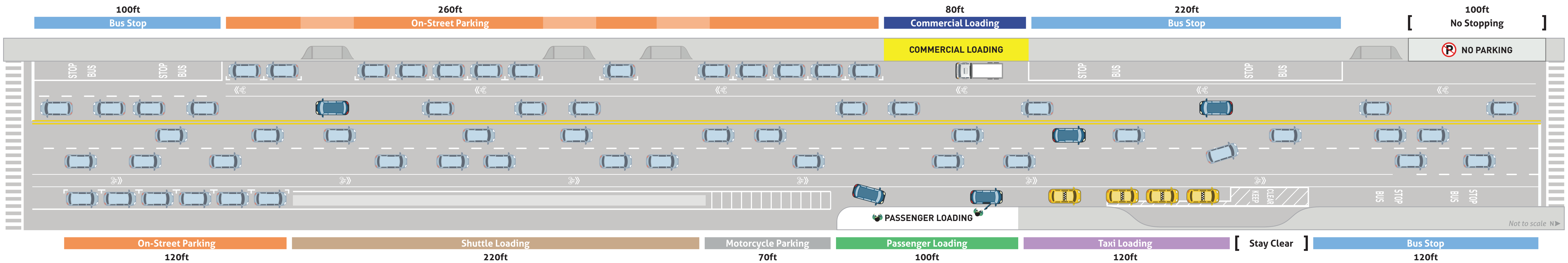
Case Study: **Transportation Hub - Existing Conditions** | Train station surrounded by mixed-use office and light industrial

Based on observations and data collected on Townsend Street in San Francisco, CA

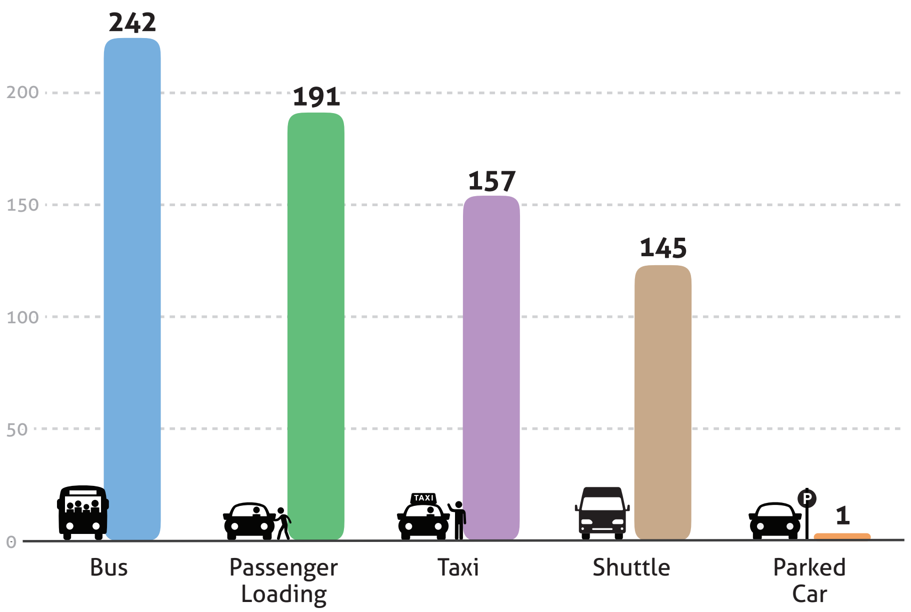
Increasing Curb Productivity

Uber

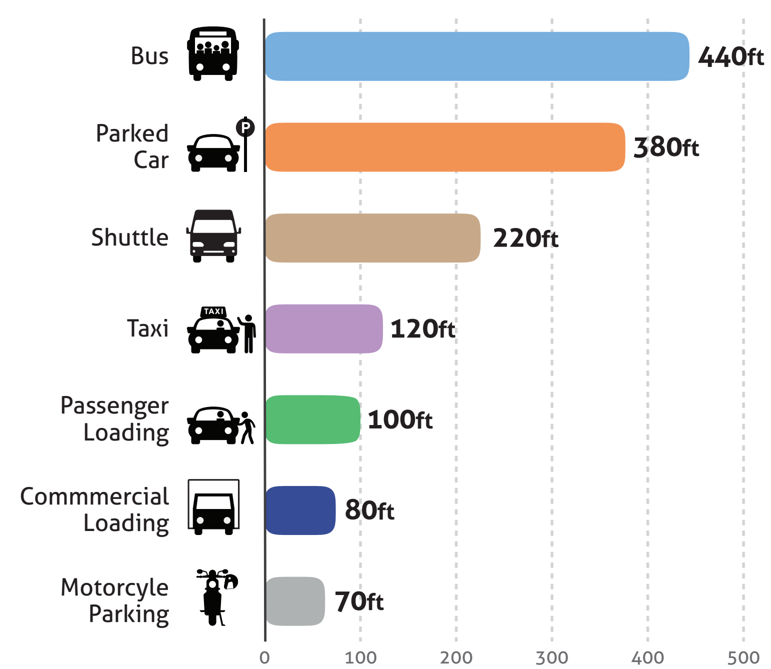
FEHR PEERS



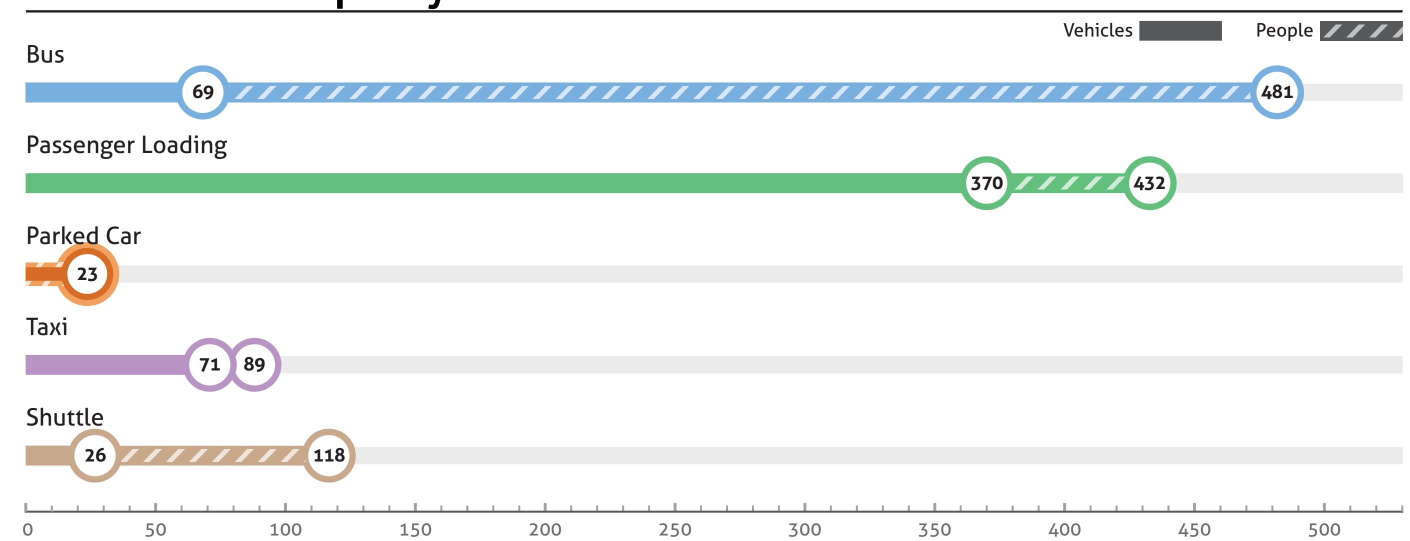
Curb Space Productivity (Passengers per space-hour)



Curb Allocation



Vehicles and People by Mode



Average Dwell Times

Peak* Passenger Loading Curb Space Demand:

320-360 feet

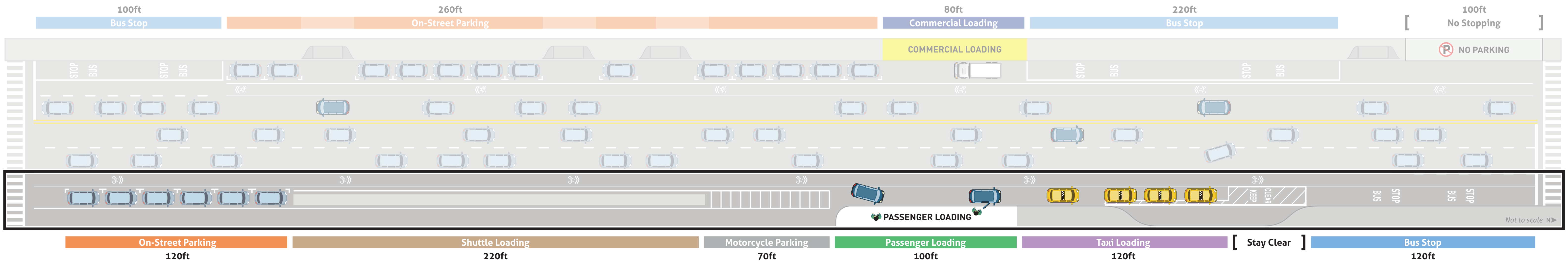
* The peak passenger loading demand observed was six vehicles loading at any one time. This level of demand was seen for 3% of the total observed period and would require 320 to 360 feet of curb space to accommodate loading activity.

Case Study: **Transportation Hub - Potential Opportunities** | **Train station surrounded by mixed-use office and light industrial**

Based on observations and data collected on Townsend Street in San Francisco, CA

Increasing Curb Productivity

Uber
FEHR PEERS



South Side Package of Improvements

Option 1

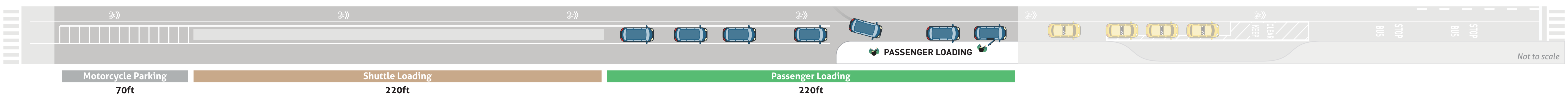
Relocation + **Conversion**

Relocate motorcycle parking.

Convert six parking spaces to a PASSENGER LOADING zone.

Curb Allocation (South Side Only)

	Existing	Change	Total
Passenger Loading	100ft	+120ft	220ft
Parking	120ft	-120ft	0ft



Option 2

Relocation + **Conversion** + **Conversion**

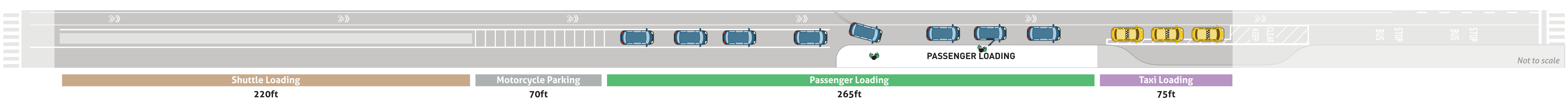
Shift motorcycle parking and shuttle parking to the west

Convert six parking spaces to a PASSENGER LOADING zone.

Convert a portion of the taxi zone to a PASSENGER LOADING zone.

Curb Allocation (South Side Only)

	Existing	Change	Total
Passenger Loading	100ft	+165ft	265ft
Parking	120ft	-120ft	0ft
Taxi Loading	120ft	-45ft	75ft

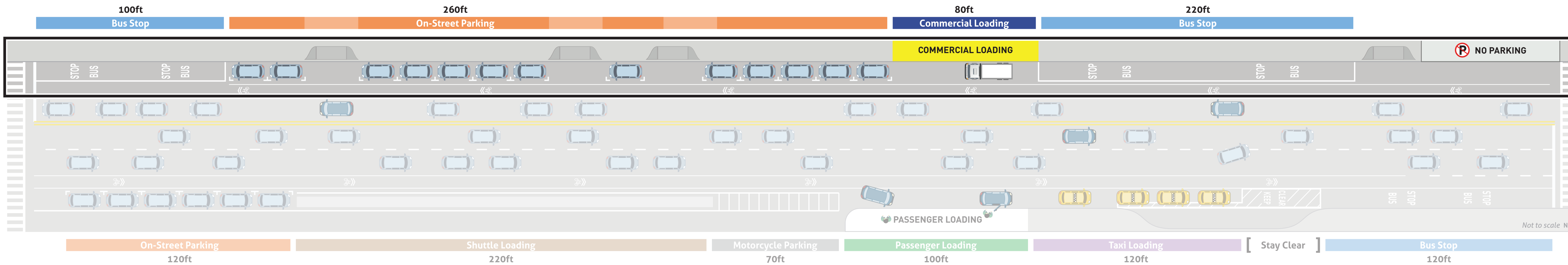


Case Study: **Transportation Hub - Potential Opportunities** | **Train station surrounded by mixed-use office and light industrial**

Based on observations and data collected on Townsend Street in San Francisco, CA

Increasing Curb Productivity

Uber FEHR PEERS



North Side Package of Improvements

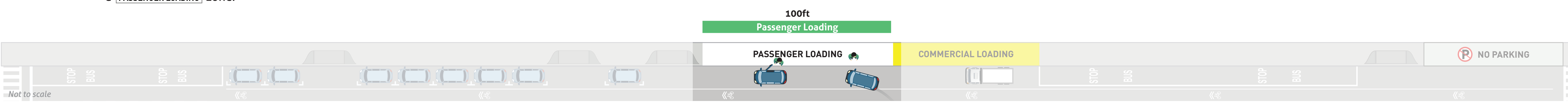
Option 1

Conversion

Convert five parking spaces to a PASSENGER LOADING zone.

Curb Allocation (North Side Only)

	Existing	Change	Total
Passenger Loading	0ft	+100ft	100ft
Parking	260ft	-100ft	160ft



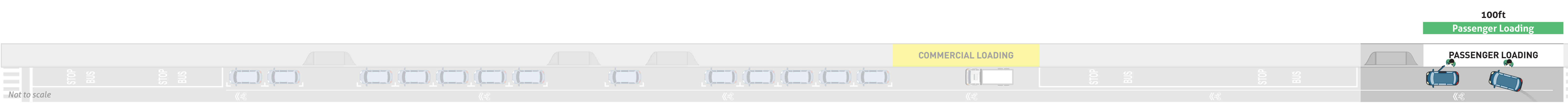
Option 2

Conversion

Convert no parking zone to a PASSENGER LOADING zone.

Curb Allocation (North Side Only)

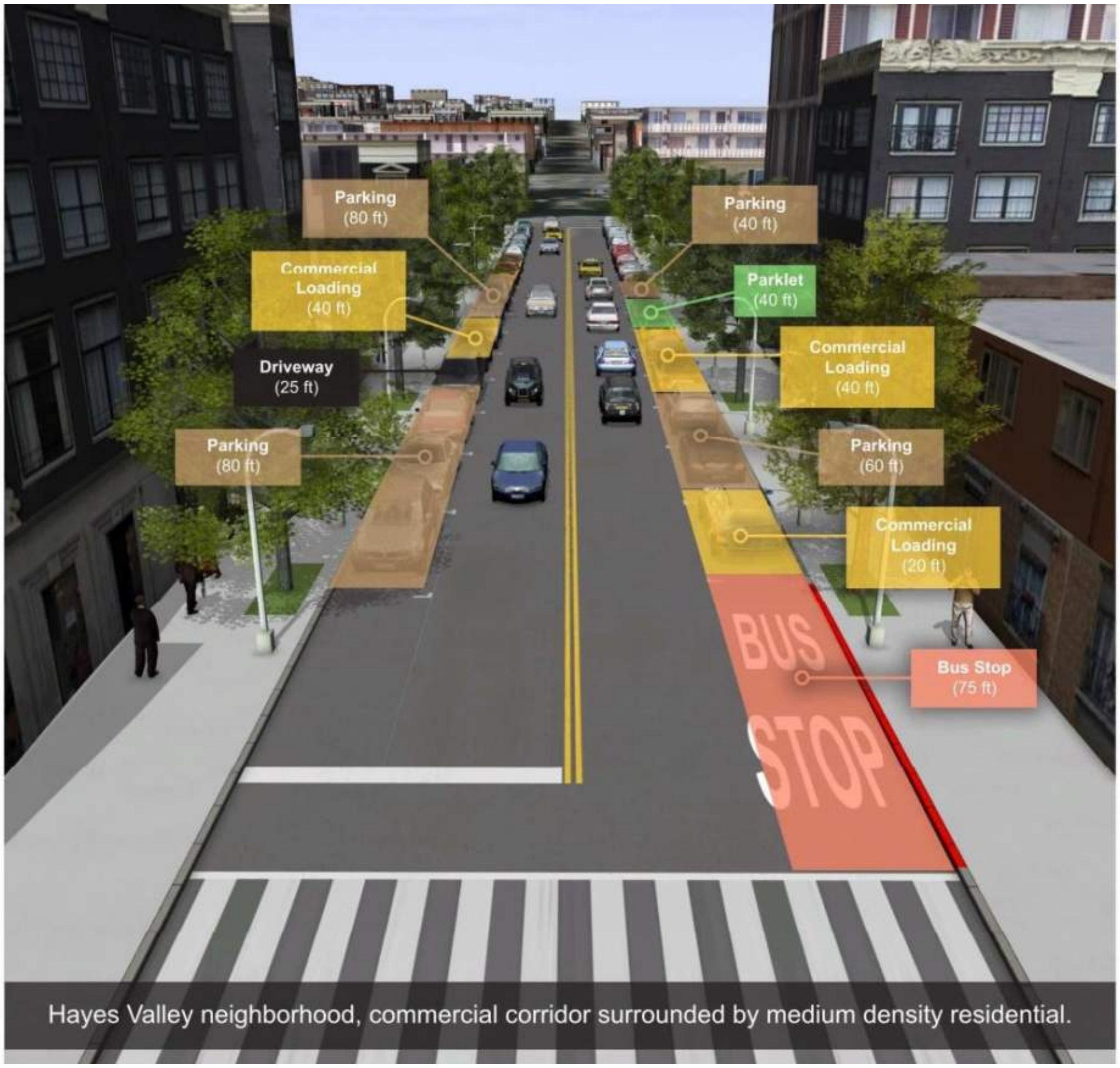
	Existing	Change	Total
Passenger Loading	0ft	+100ft	100ft
No Parking	100ft	-100ft	0ft



Commercial Corridor: Hayes Street

Transportation Context

Hayes Street was chosen to represent a two-lane commercial corridor with moderate pedestrian and bus activity. Located in the Hayes Valley neighborhood, the retail and medium density residential in this corridor serves a variety of residents and visitors to shops and restaurants. Commercial and passenger loading activity peaks at various times of the day, periodically affecting traffic flow to and from the nearby arterials such as Franklin and Gough Streets. *An illustration of the physical street layout, including curb space allocation by use type is shown below.*



Hayes Valley neighborhood, commercial corridor surrounded by medium density residential.

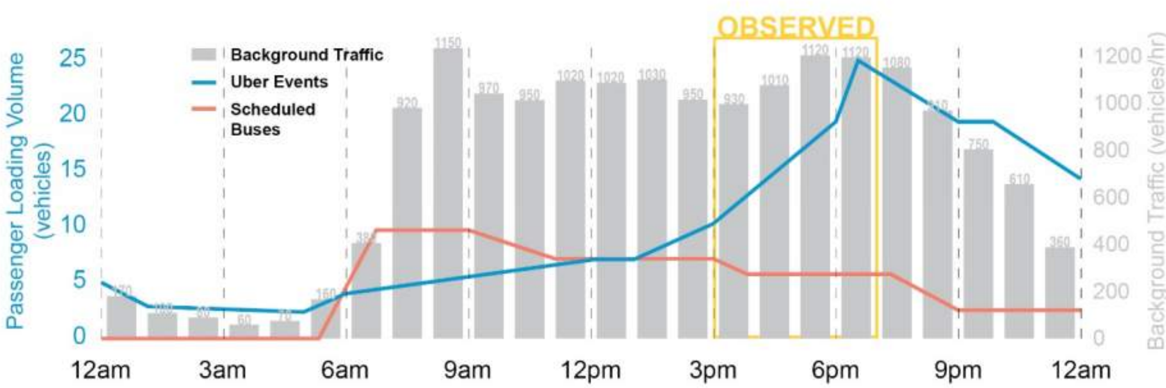
Observations & Findings

Summary

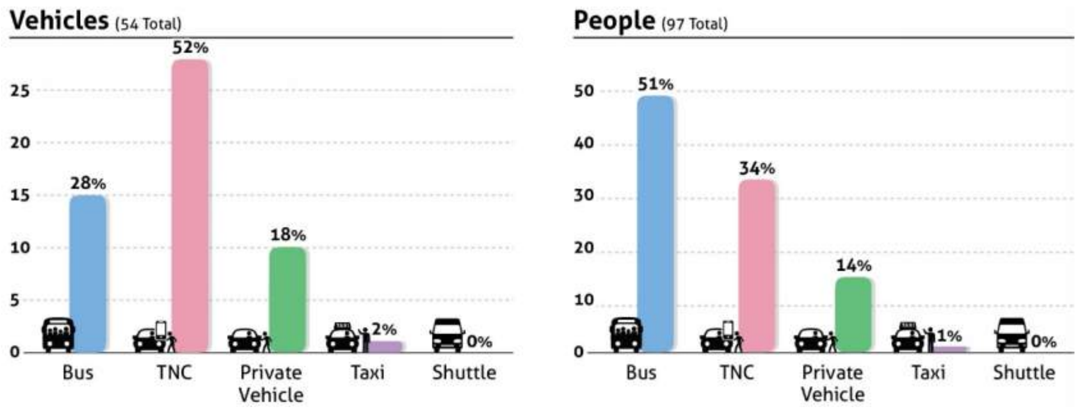
- Bus passenger loading has the highest curb productivity. Scheduled activity and allocated space are well-matched.
- Passenger loading activity by other modes (i.e., taxis, TNCs, and private vehicles) is high, with curb productivity being at par with that of the bus, but there is no curb space designated for that use.
- The largest amount of curb space is dedicated to parking, which limits passenger throughput by other modes by way of the curb.

Passenger Loading Activity

Observations at this location were summarized from 3PM to 7PM of a typical weekday. Typical weekday traffic volumes on this block were consistently above 900 vehicles per hour between 7AM and 9PM with peaks of more than 1100 vehicles per hour during AM and PM commute peaks. Uber activity during the observation period increased steadily from 6AM onwards until peaking at 6:30PM and steadily declined thereafter. Scheduled bus service peaks during AM commute hours and slowly tapers down throughout the day. One Muni line serves this stretch of Hayes Street and, during the observed period, buses are scheduled to stop every 11 minutes. The following chart illustrates the various traffic patterns over the course of the weekday for which our data was collected.



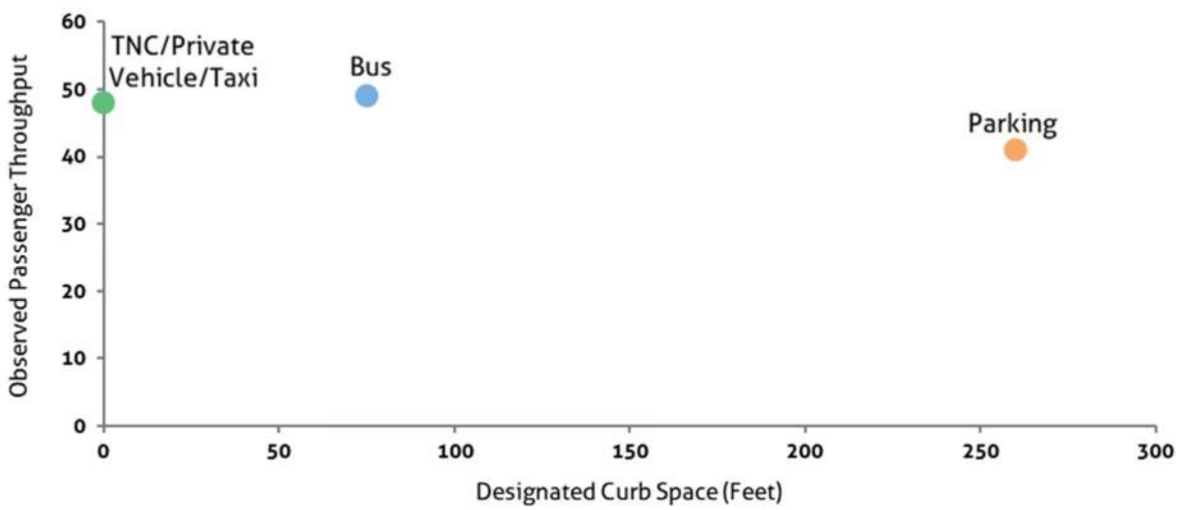
On the observed weekday, TNC[9] vehicles accounted for more than half of passenger loading events by all modes, and 34 percent of *people* loading or unloading along this stretch of Hayes Street. Buses, 28 percent of passenger-loading vehicles, were the next most common passenger-loading vehicle, serving 51 percent of the *people* loading or unloading. As expected, buses are the most efficient mode when it comes to moving large numbers of people. The observed passenger loading activity by vehicles and people is illustrated below.



Buses load/off-load, on average, 3.3 people per bus compared to 1.2 people per TNC and 1.4 people per private vehicle.

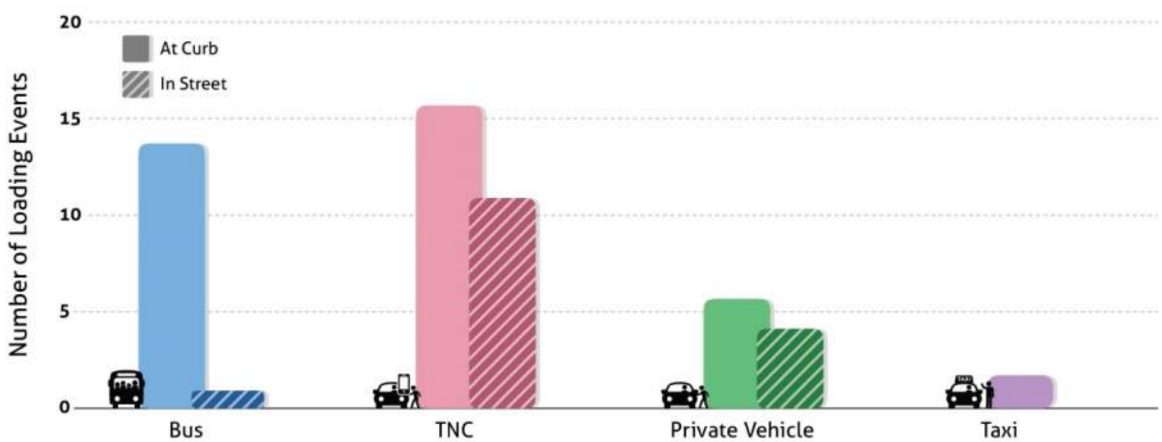
The following graph presents the number of people served by each mode (i.e., observed passenger throughput) with respect to the amount of curb space allocated to that mode. As such, the comparison of how productive each mode (and curb space) is in terms of passenger throughput, and the amount of designated curb space to that mode can be made. TNCs, passenger vehicles, and taxis brought 48 people to the area during the observed period, but have no designated curb space. In contrast, parked cars bring a similar number of people to the area (41) during the observed period, but have 260 feet of curb space allocated to this use. While parked cars spend much longer at the curb than vehicles solely picking up and dropping off passengers, and thus, require more curb space than passenger loading for a similar number of vehicles and people served, this corridor presents a curb space demand/allocation mismatch for these two uses.

[9] It should be noted that we cannot definitively state that all activity that is categorized as TNC is in fact a TNC. We used our judgment when reviewing the video to determine if the activity seemed to be a third-party TNC-like activity or a private vehicle activity (e.g. someone dropping off a friend or family member). As such, we have not made any characterizations related to the differences between private vehicle passenger loading and TNC loading, except for dedicated passenger loading in the TNC loading space on Townsend Street. Any references to specific passenger loading vehicle types (TNC versus Private Vehicle) should not be taken as fact, but more of a broad description of the vehicle classification.

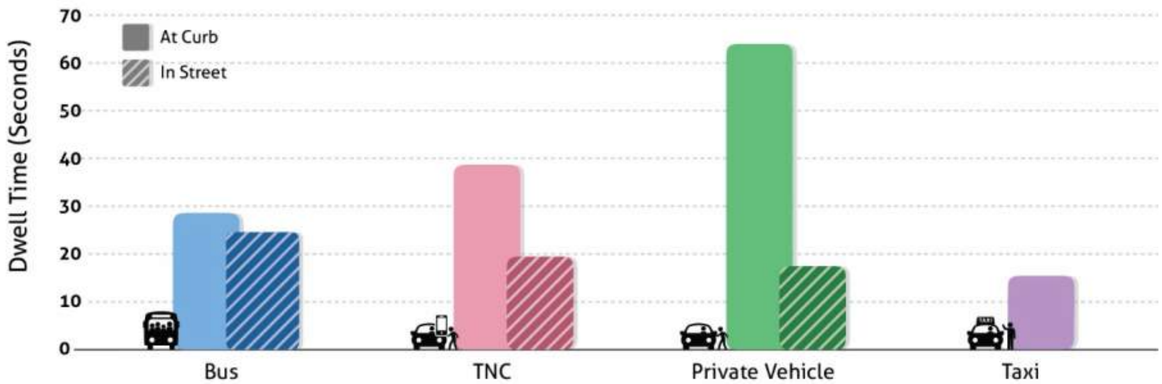


Passenger Loading Impact

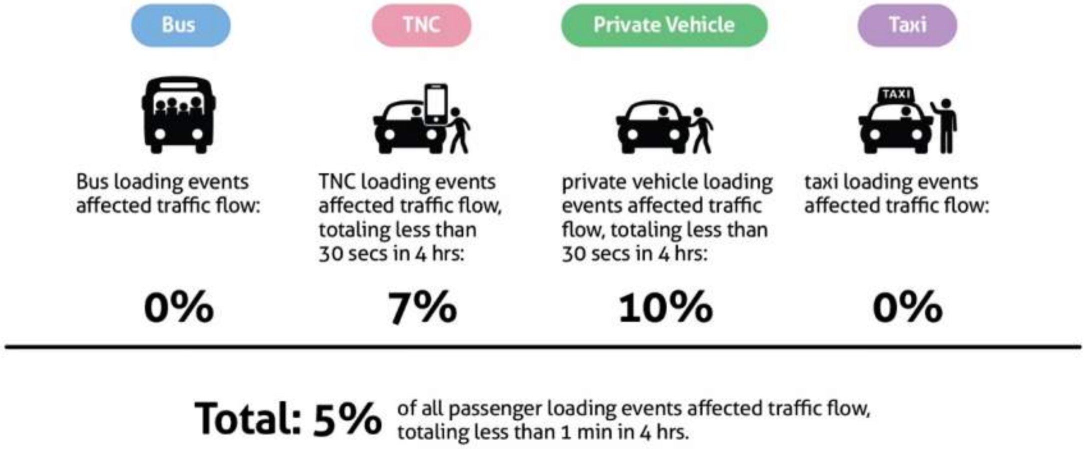
Of the observed events, TNC loading was the most common event type both at the curb and in the street, with a greater proportion occurring curbside despite the lack of dedicated curb space for passenger loading. With one exception, buses loaded passengers at the curb in their dedicated stops.



Across all modes, average dwell times are longer at the curb than they are in the street. The average curbside dwell time for private vehicles (60 seconds) was higher than curbside dwell times for buses or TNCs. Dwell time for TNCs at the curb averaged 40 seconds and buses averaged 30 seconds. Dwell time in the street ranged from 20-30 seconds across these three modes.

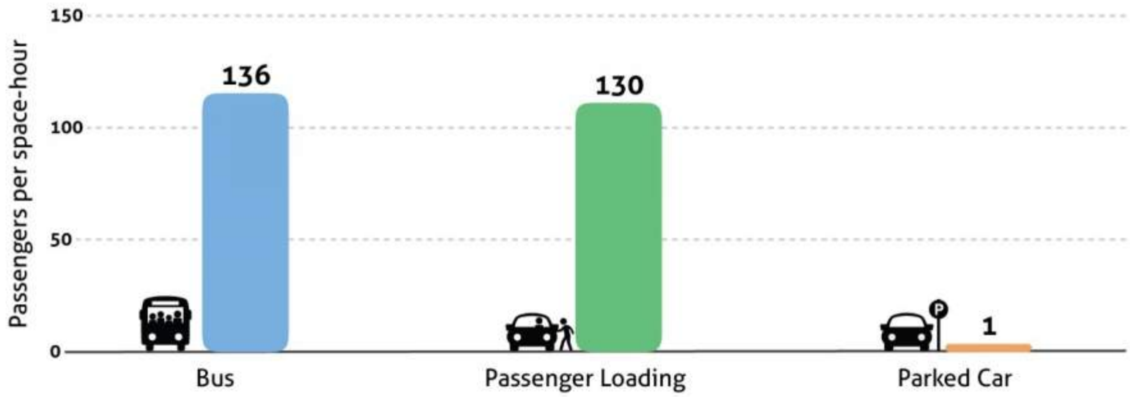


Only five percent of all loading events affected traffic flow. Effects were defined by instances in which vehicles fully blocked travelers (cars, bikes, buses, etc.) behind them or in which trailing modes had to switch lanes to go around the loading event. All events that affected traffic flow were caused by either TNCs or private vehicles. With dwell times of only 20-30 seconds; however, the full temporal impact of these effects is very small, totaling less than a minute in four hours.



Curb Productivity

The following are the calculated curb productivity indices for the zones dedicated to serving passengers along Hayes Street; "passenger loading" at this location includes all vehicles that would use a passenger loading zone, which in this case are taxis, TNCs, and private vehicles.



Passenger Loading Curb Demand

The following table shows the percentage of time during the analysis period when specific numbers of simultaneous passenger loading events by TNC, private vehicle, or taxi were observed in this case study location.

Simultaneous Passenger Loading Events (by TNC/Private Vehicle/Taxi)	Amount of Time During Analysis Period
0	63% (2 hours, 31 minutes)
1	**37% (1 hour, 29 minutes)**
2 or more	0%

Notes:
Analysis period duration was four hours for Hayes Street.
Bold denotes the percentage of time the maximum number of passenger loading activities were observed

To accommodate the observed peak passenger loading demand from taxis, TNCs, and private vehicles, space for one passenger loading vehicle would be required. Approximately 40 to 60 feet of passenger loading space would be necessary to accommodate one passenger loading event, depending on how the passenger loading zone is configured.

Recommendations

Passenger loading activity levels are peaked in the PM commute period and into the evening hours on a typical weekday. Video observations found that providing passenger loading space for one vehicle (40-60 feet) would accommodate peak passenger loading demand for this study area on a typical weekday.

Each opportunity identified would provide adequate space for a passenger vehicle to pull out of the travel lane completely to pick up or drop off a passenger, in some instances by utilizing a no parking zone to pull into and out of the passenger loading zone (e.g. opportunities #2 and #3).

Our observations found that passenger loading demand was twice as high in the eastbound direction compared to the westbound direction. Therefore, opportunities #2 and #4 would be preferred over #1 and #3. Of the two, opportunity #4 would be recommended as it would minimize parking loss, which is typically a concern of local merchants. Establishing this zone as a flexible loading zone would still provide commercial loading during the peak commercial loading periods of the day and the loss of one parking space would be a reasonable trade-off to promote passenger loading to occur at the curb and not disrupt traffic flows during the PM commute and evening periods.

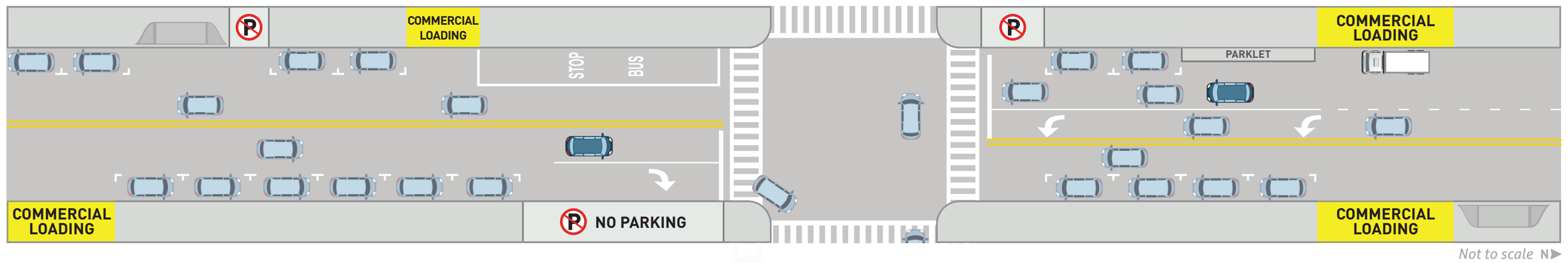
Case Study: **Commercial Corridor** | Mixed-use commercial corridor with medium-density residential

Based on observations and data collected on Hayes Street in San Francisco, CA

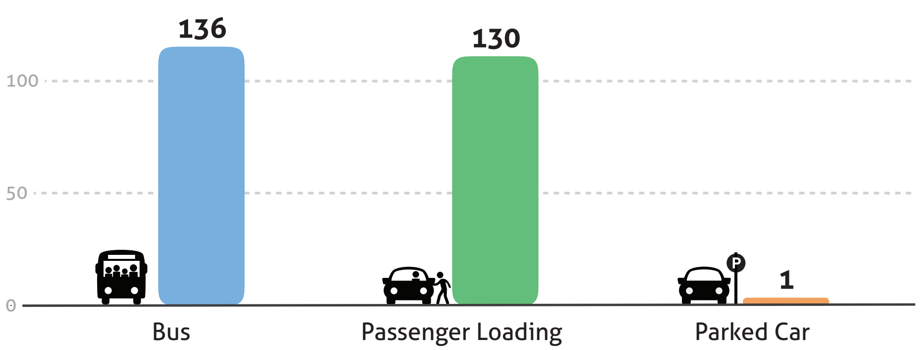
Increasing Curb Productivity

Uber FEHR PEERS

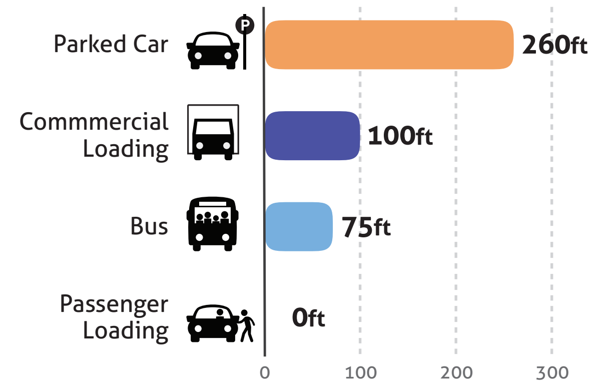
Existing Conditions



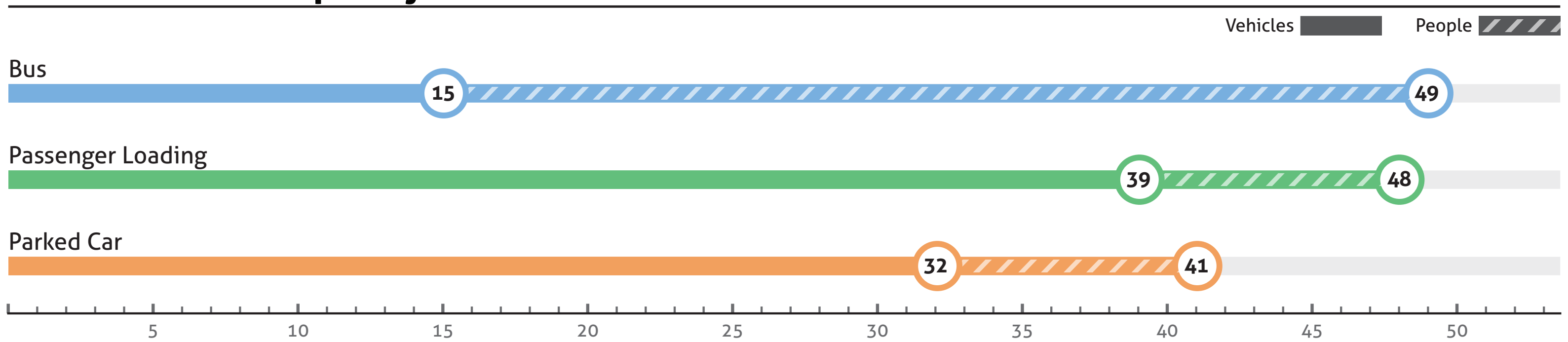
Curb Space Productivity (Passengers per space-hour)



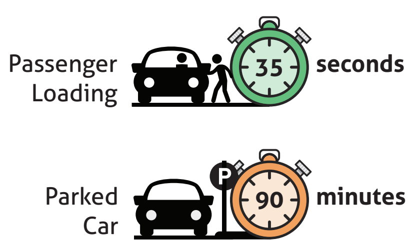
Curb Allocation



Vehicles and People by Mode



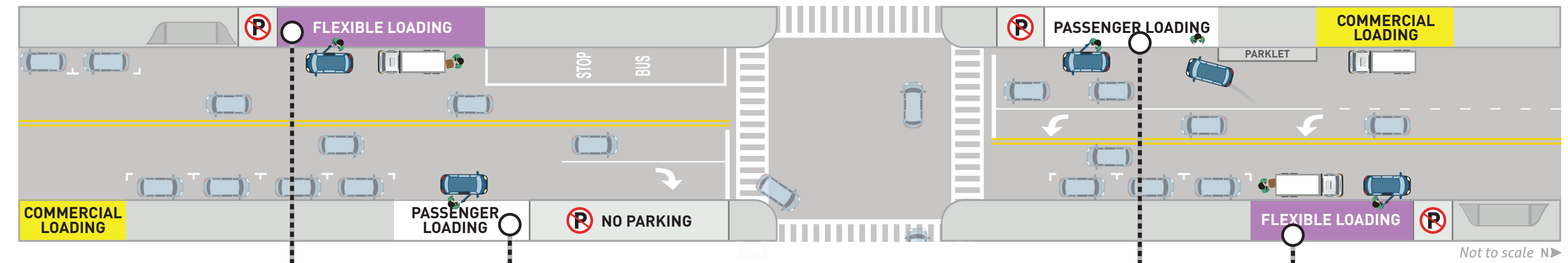
Average Dwell Times



Peak* Passenger Loading Curb Space Demand

40-60 feet

Potential Opportunities



1 Flexibility

Curb Allocation

	Existing	Change	Total
	0ft	+60ft	60ft
	260ft	-40ft	220ft
	100ft	-20ft	80ft + 60ft

Convert two parking spaces and one commercial loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

2 Conversion

Curb Allocation

	Change	Total
	+40ft	40ft
	-40ft	220ft

Convert two parking spaces to a PASSENGER LOADING zone.

3 Conversion

Curb Allocation

	Change	Total
	+40ft	40ft
	-40ft	220ft

Convert two parking spaces and shorten the parklet to implement one PASSENGER LOADING zone.

4 Flexibility

Curb Allocation

	Change	Total
	+60ft	60ft
	-20ft	240ft
	-40ft	60ft + 60ft

Convert one parking space and freight loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

Recommended for Implementation**

4 Flexibility

Convert one parking space and freight loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

- ☑ Establishes passenger loading zone
- ☑ Minimizes parking loss
- ☑ Accommodates commercial loading
- ☑ Located where passenger loading was observed

* The peak passenger loading demand observed was one vehicle loading at any one time. This level of demand was seen for 37% of the total observed period and would require 40 to 60 feet of curb space to accommodate loading activity.

** Reconfiguring curb space in the public right of way requires stakeholder agency review & approval, which could include community input, additional analysis/design, and/or other considerations to be determined by the owner agency. The above concepts are intended to illustrate some potential reconfigurations and serve as a framework for discussions.

High-Density Office Neighborhood: Second Street

Transportation Context

Second Street was chosen to represent a high-density office neighborhood with high frequency transit and heavily peaked commute period passenger loading demand. Located in the South of Market (SoMa) neighborhood, home of San Francisco's technology employer scene, this block has long bus stops, a commercial loading zone, and motorcycle parking. The high demand for passenger loading by TNCs, and private vehicles during the morning and evening commute hours periodically affects traffic flow and bus access and circulation. *An illustration of the physical street layout, including curb space allocation by use type is shown below.*

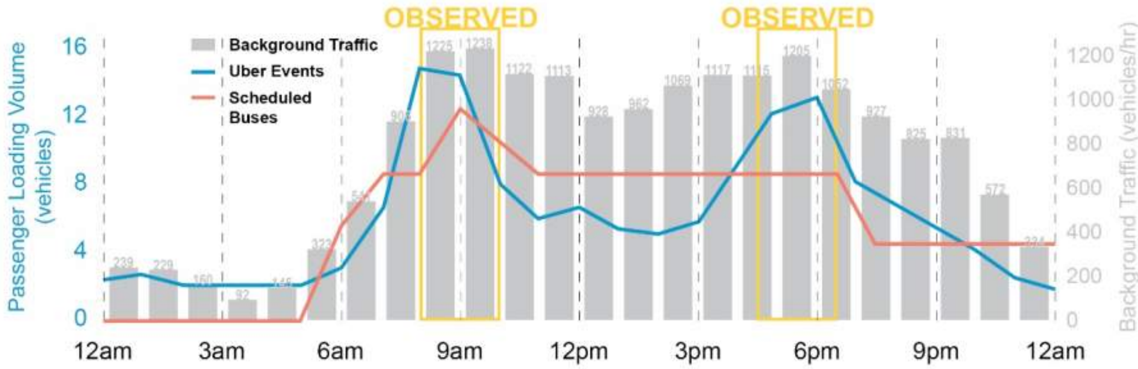
Observations & Findings

Summary

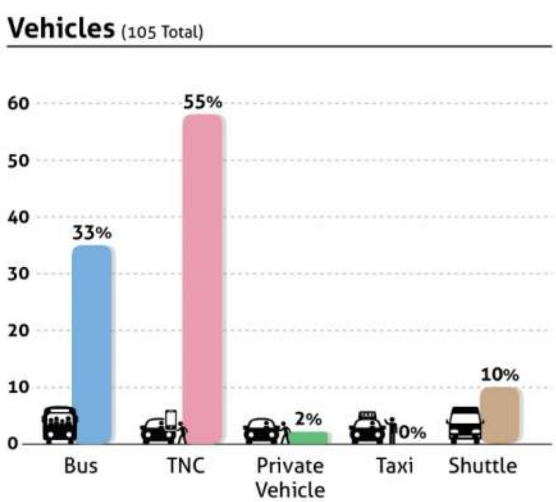
- A large proportion of curb space is allocated to the bus, which has the highest curb productivity. Scheduled activity and allocated space are well-matched.
- Passenger loading activity by TNC and private vehicle is high, with curb productivity being similar to that of the bus, but there is no curb space designated for that use.
- The limited remaining curb space on this block is dedicated to commercial loading and motorcycle parking, both of which are highly valued curb uses in this area. Thus, passenger loading needs and curb space allocation may need to be assessed at a larger scale (e.g. several blocks) due to the competing demand for the curb and limited curb frontage with which to accommodate them. Assessing and planning for needs at a larger scale would help ensure that dedicated curb space is available for a diverse set of uses.

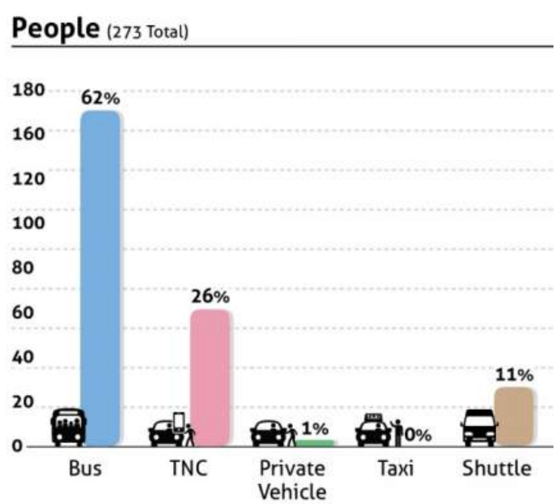
Passenger Loading Activity

Observations at this location were recorded from 8AM to 10AM and 4:30PM to 6:30PM. Typical weekday traffic volumes on this block were consistently above 900 vehicles per hour between 7AM and 8PM with peaks of greater than 1200 vehicles per hour during the morning and evening commutes. Uber activity during the observation period was highest at 8AM (approximately 14 events per hour) and 6PM (approximately 12 events per hour). Scheduled bus service peaks during morning commute hours and slowly tapers throughout the day. Two Muni lines serve this block of Second Street and during the observed time periods both buses are scheduled to run every 15 minutes. The following chart illustrates the various traffic patterns over the course of the weekday our data was collected.



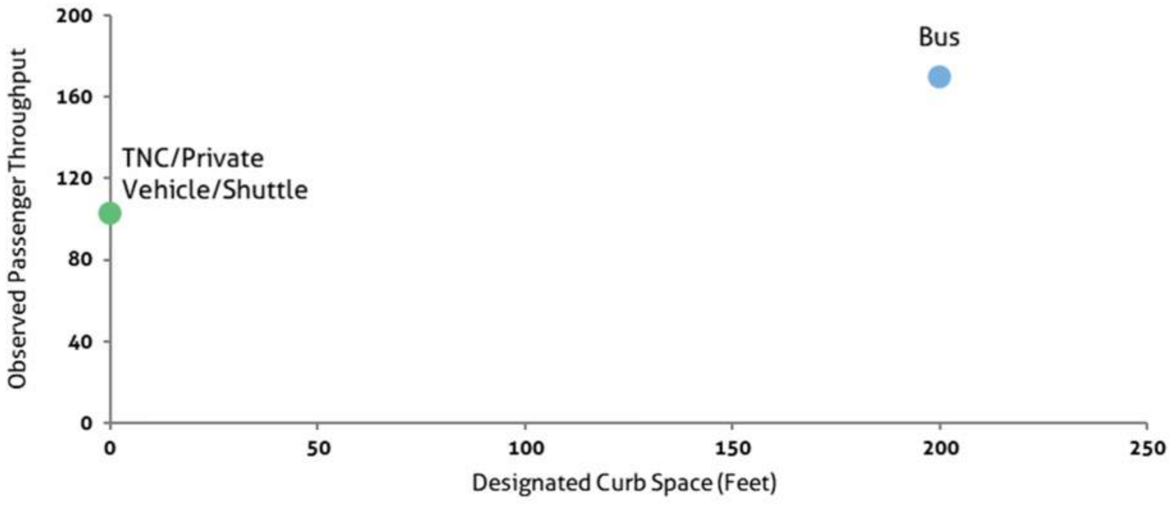
On the observed weekday, TNCs and private vehicles accounted for more than half of passenger loading events, but only 27 percent of people loading or unloading along this stretch of Second Street. Buses, 33 percent of loading vehicles, were the next most common passenger-loading vehicle type, but served 62 percent of the people loading or unloading. This mismatch indicates that in this location, buses are a critical mode for moving large numbers of people. The observed passenger loading activity by vehicles and people is illustrated below.





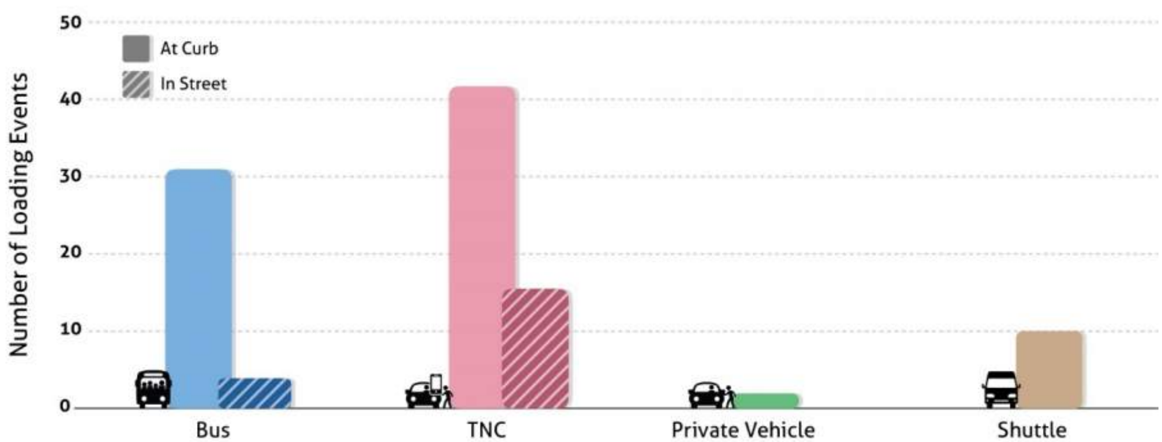
Buses carry, on average, 4.9 people per bus compared to 1-1.2 per passenger vehicle and 3 per shuttle.

The following graph presents the number of people served by each mode (i.e., observed passenger throughput) with respect to the amount of curb space allocated to that mode. Buses brought 170 people to the area during the observed period, making productive use of the 200 feet of curb space designated to buses on this block. Passenger loading (i.e., TNCs, private vehicles, and shuttles) also served 103 people combined, but there is no curb space dedicated to passenger loading on this block.

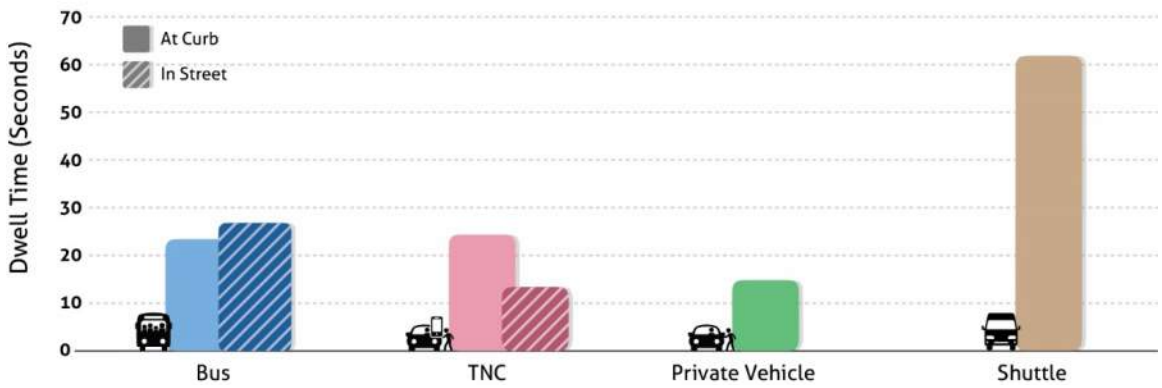


Passenger Loading Impact

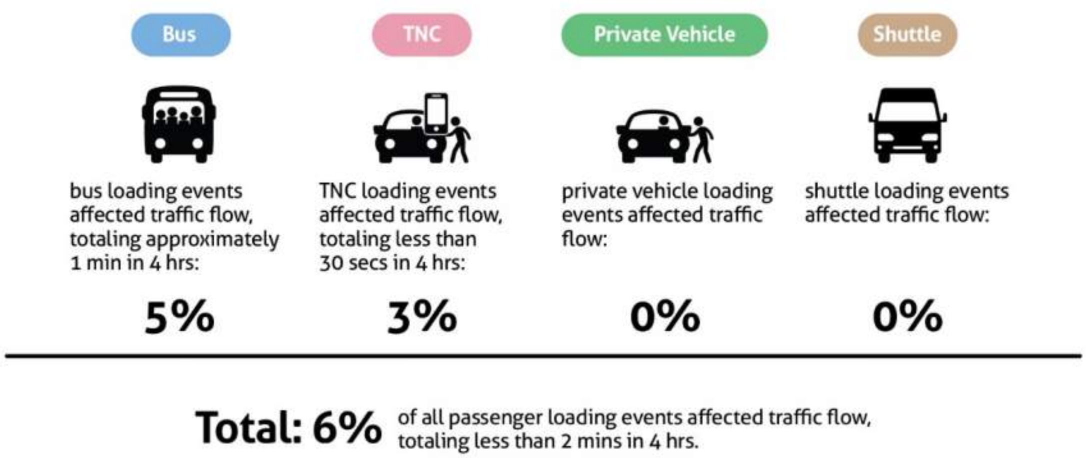
Of the observed events, TNCs accounted for the highest level of passenger loading both at the curb and in the street, with a greater proportion occurring curbside. With a few exceptions, buses loaded passengers at the curb.



With the exception of shuttle events, average dwell times for buses, TNCs, and private vehicles were below 30 seconds, both on and off the curb. The small sample size of shuttle events and in-street bus events meant that a few lengthier dwells exaggerated these averages. The average curbside dwell time for passenger vehicles was only slightly higher than curbside dwell times for buses.

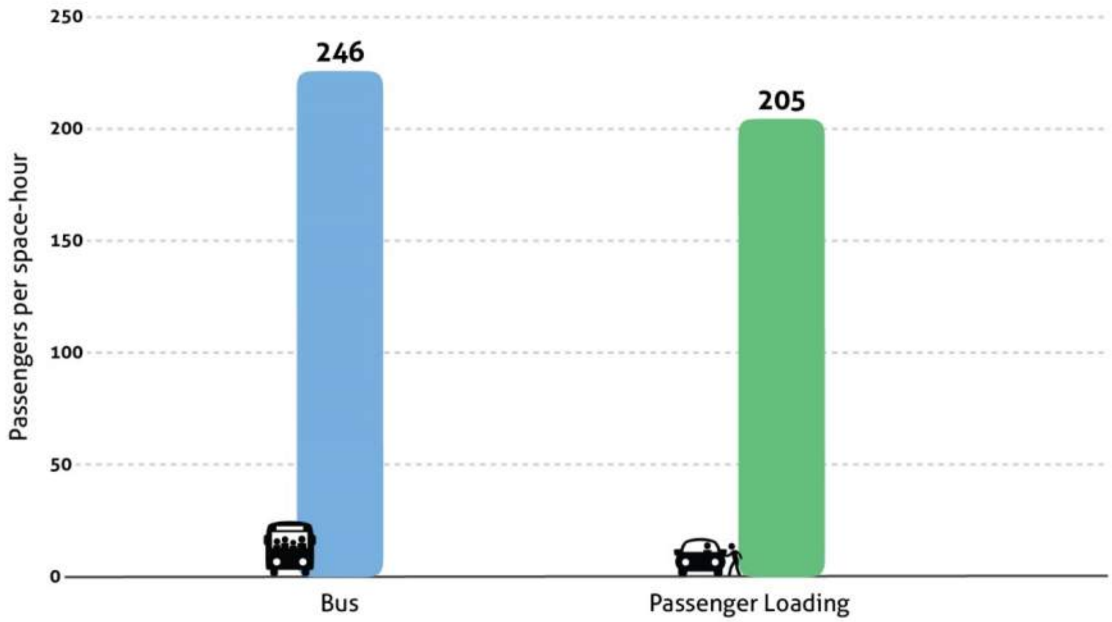


Only six percent of all loading events affected traffic flow. This was part due to the multiple lanes in each direction, which allowed following traffic to change lanes and move around an in-street loading event. All events that affected traffic flow were caused by either buses, TNCs, or private vehicles. With dwell times of only 10-30 seconds, the full temporal impact of these effects is very small, totaling less than two minutes in four hours.



Curb Productivity

The following are the calculated curb productivity indices for the zones dedicated to serving passengers along Second Street; "passenger loading" at this location includes all vehicles that would use a passenger loading zone, which in this case are TNCs and private vehicles.



Passenger Loading Curb Demand

The following table shows the percentage of time during the analysis period when specific numbers of simultaneous passenger loading events by TNC or private vehicle were observed in this case study location.

Simultaneous Passenger Loading Events (by TNC/Private Vehicle)	Amount of Time During Analysis Period
0	70% (2 hours, 48 minutes)
1	23% (55 minutes)
2	4% (10 minutes)
3	**3% (7 minutes)**
4 or more	0%

Notes:
Analysis period duration was four hours for Second Street
Bold denotes the percentage of time the maximum number of passenger loading activities were observed

To accommodate the peak passenger loading demand from TNCs and private vehicles, space for three simultaneous passenger loading events would be required. Approximately 110 to 180 feet of passenger loading space would be necessary to accommodate three simultaneous passenger loading events, depending on how the passenger loading zone is configured.

Recommendations

Passenger loading activity levels are peaked in the AM and PM commute periods of a typical weekday. Video observations found that providing passenger loading space for three vehicles (110-180 feet) would accommodate peak passenger loading demand for this study area on a typical weekday. The current curb space allocation on this block is primarily for bus stops which, given the City's *Transit-First* policy, should remain. The limited remaining curb space on this block is dedicated to commercial loading and motorcycle parking, both of which are highly valued curb uses in this area. Therefore, this location would be one where considering passenger loading needs and curb space allocation at a larger scale (e.g. several blocks) could be beneficial to ensure dedicated curb space is available for a diverse set of uses.

Our observations found that the large majority of passenger loading demand was in the southbound direction (the west side of the street). However, SFMTA is currently planning a lane reduction on this block to accommodate dedicated bicycle facilities along the Second Street corridor, making opportunity #2 infeasible. Therefore, opportunity #1 would be the recommended location and treatment to provide passenger loading curb space in the southbound direction; establishing this space as a flexible loading zone would allow to also continue to serve commercial loading needs at this location.

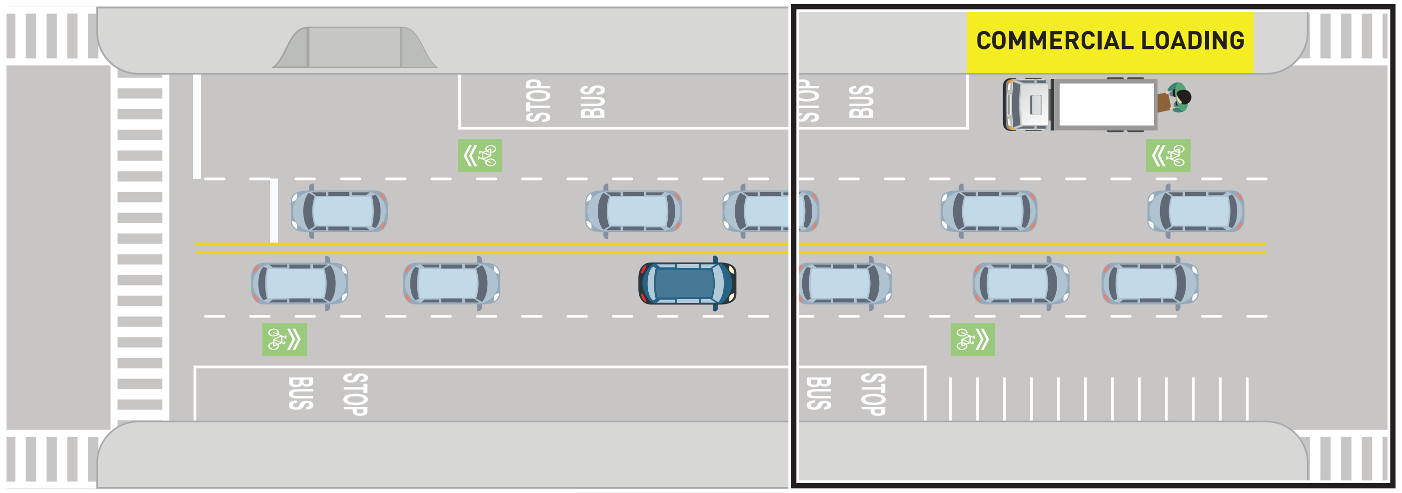
Case Study: **High-Density Office Neighborhood** | High-rise office and commercial area

Based on observations and data collected on Second Street in San Francisco, CA

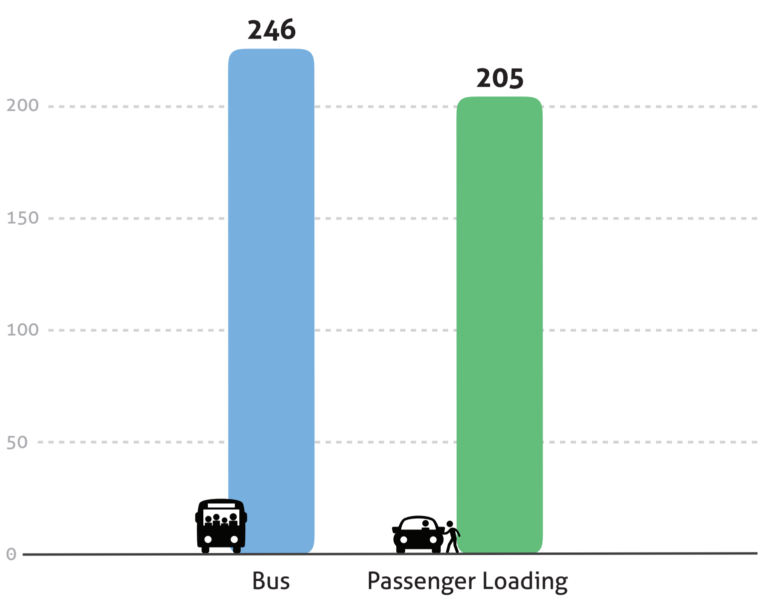
Increasing Curb Productivity

Uber
FEHR & PEERS

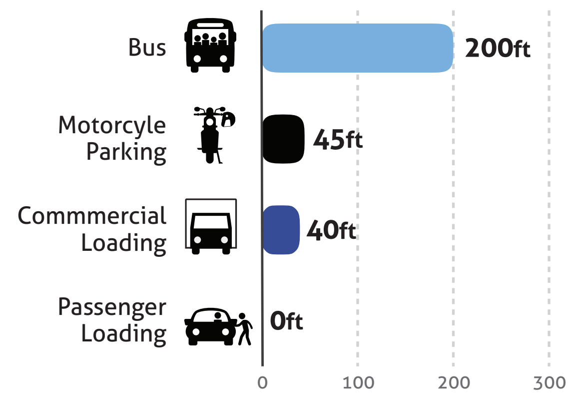
Existing Conditions



Curb Space Productivity (Passengers per space-hour)

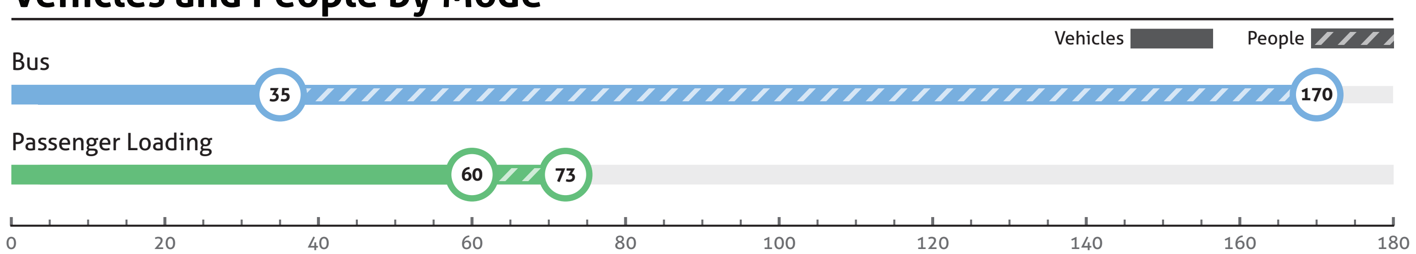


Curb Allocation



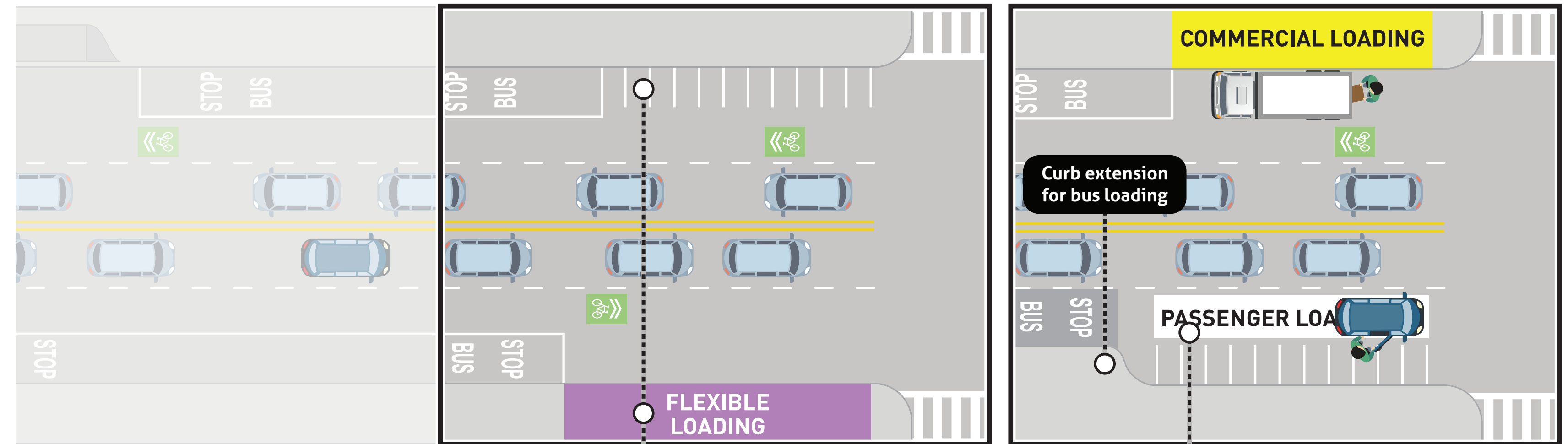
Average Dwell Time

Vehicles and People by Mode



Peak* Passenger Loading Curb Space Demand
110-180 feet

Potential Opportunities



1 Relocation + Flexibility

Curb Allocation

	Existing	Change	Total
Passenger loading	0ft	+45ft	45ft
Motorcycle parking	45ft	-5ft	40ft
Commercial loading	40ft	-40ft	45ft

Swap motorcycle parking and commercial loading zone to opposite sides of street and convert time of day commercial loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

2 Conversion

Curb Allocation

	Change	Total
Passenger loading	+45ft	45ft

Explore a lane reduction in the southbound direction by extending the curb for bus loading. Allow for a PASSENGER LOADING zone in front of motorcycle parking during peak rideshare demand.

A lane reduction would require further analysis and discussion with city officials to determine feasibility. SFMTA is currently planning a lane reduction on this block to accommodate dedicated bike facilities along the Second Street corridor, making this strategy #2 infeasible at this particular location in San Francisco.

Recommended for Implementation**

1 Relocation + Flexibility

Swap motorcycle parking and commercial loading zone to opposite sides of street and convert time of day commercial loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

- ☑ Establishes passenger loading zone
- ☑ Accommodates commercial loading
- ☑ Located where passenger loading was observed

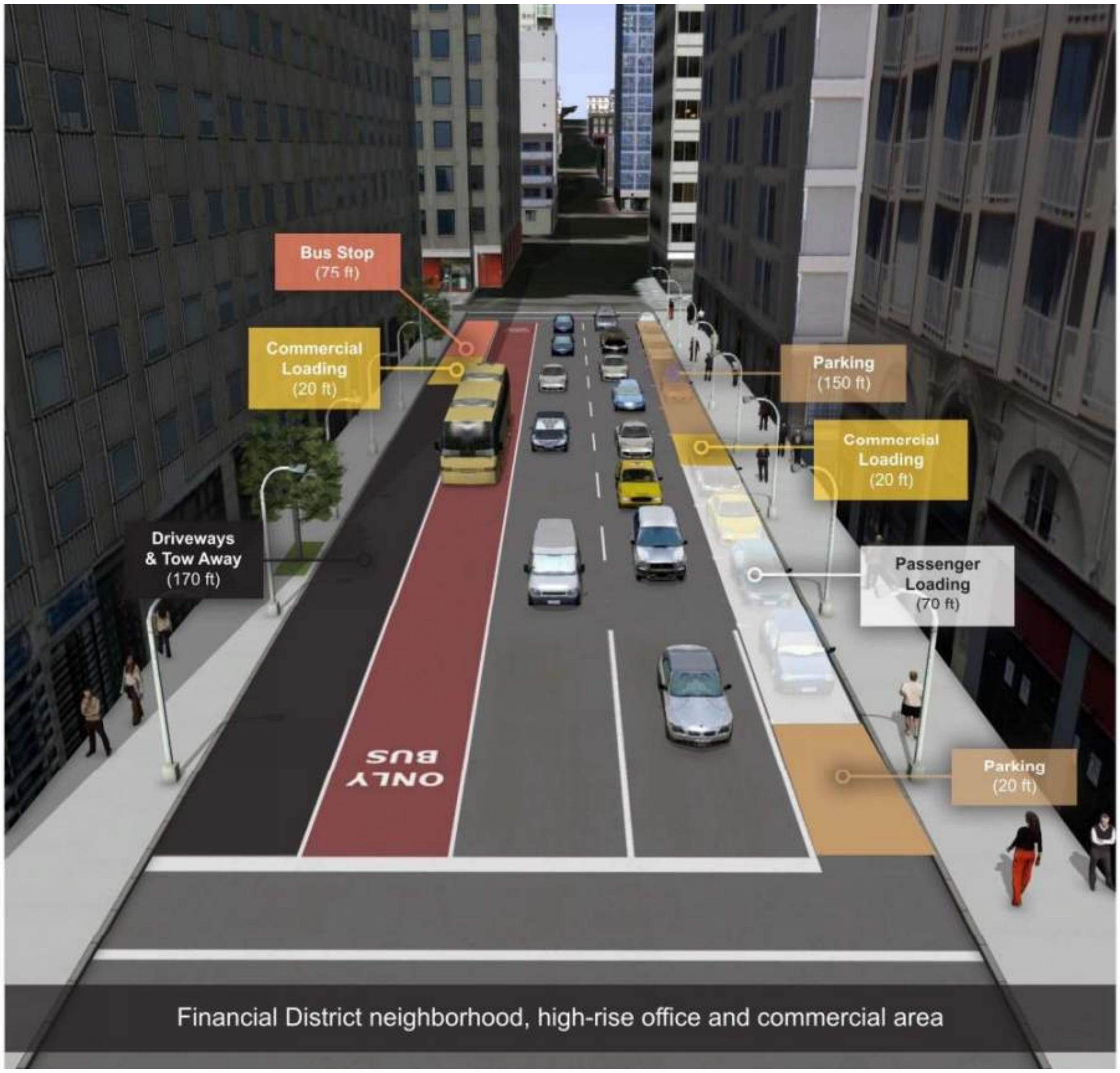
* The peak passenger loading demand observed was three vehicles loading at any one time. This level of demand was seen for 6% of the total observed period and would require 110 to 180 feet of curb space to accommodate loading activity.

** Reconfiguring curb space in the public right of way requires stakeholder agency review & approval, which could include community input, additional analysis/design, and/or other considerations to be determined by the owner agency. The above concepts are intended to illustrate some potential reconfigurations and serve as a framework for discussions.

Financial District: Clay Street

Transportation Context

Clay Street was chosen to represent a busy downtown street with access to office and hotel uses. This corridor is a multi-lane, one-way street carrying high frequency bus service on a bus-only lane. There is a passenger loading zone on one side of the street for the nearby office building. However, passenger loading demand (by taxis, TNCs, private vehicles, and shuttles) is high and frequently requires more than the available curb space, resulting in a large proportion of pick-ups and drop-offs occurring in the travel lane. *An illustration of the physical street layout, including curb space allocation by use type is shown below.*



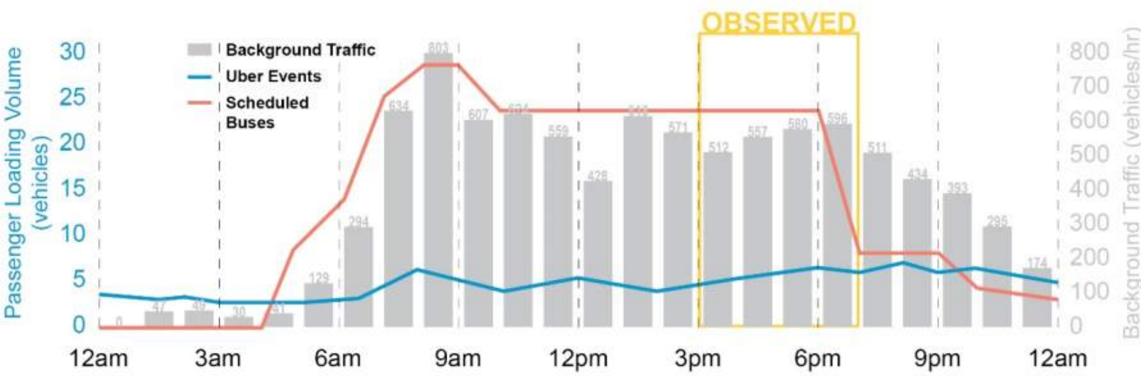
Observations & Findings

Summary

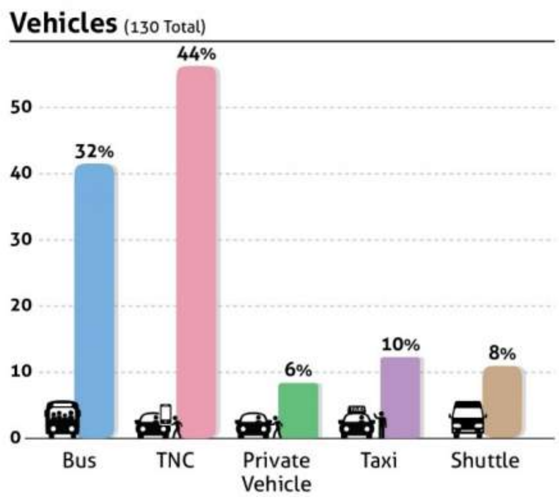
- Bus passenger loading activity is lower than at other study locations, but the location and size of the designated bus curb space is consistent with transit service needs and city priorities.
- Passenger loading by other modes (i.e., taxis, TNCs, private vehicles, and shuttles) serves the greatest number of people compared to any other mode and is higher than the existing curb space designation can accommodate during peak passenger loading demand times.
- The largest amount of curb space is dedicated to parking, which limits passenger throughput by other modes by way of the curb.

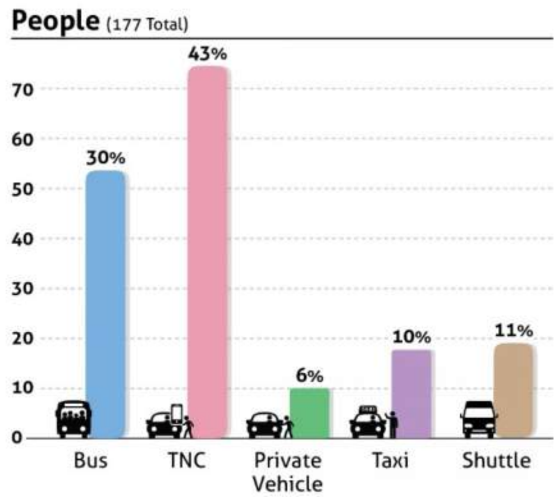
Passenger Loading Activity

Observations at this location were recorded from 3PM to 7PM. Background traffic volumes on this block peaked at around 800 vehicles per hour in the AM peak, and then hovered between 500 and 600 vehicles for the remainder of the workday before tapering off around 8PM. PM volumes were significantly lower than AM volumes because the one-way directionality of this street aligns with reverse commute traffic in the PM. Uber activity was around five events per hour throughout the day. Scheduled bus service peaks during morning commute hours, and then provides slightly reduced frequencies until 6PM. Two Muni lines serve this block of Clay Street and during the observed time periods, buses are scheduled to run every 4-8 minutes between the two lines. The following chart illustrates the various traffic patterns over the course of the weekday our data was collected.



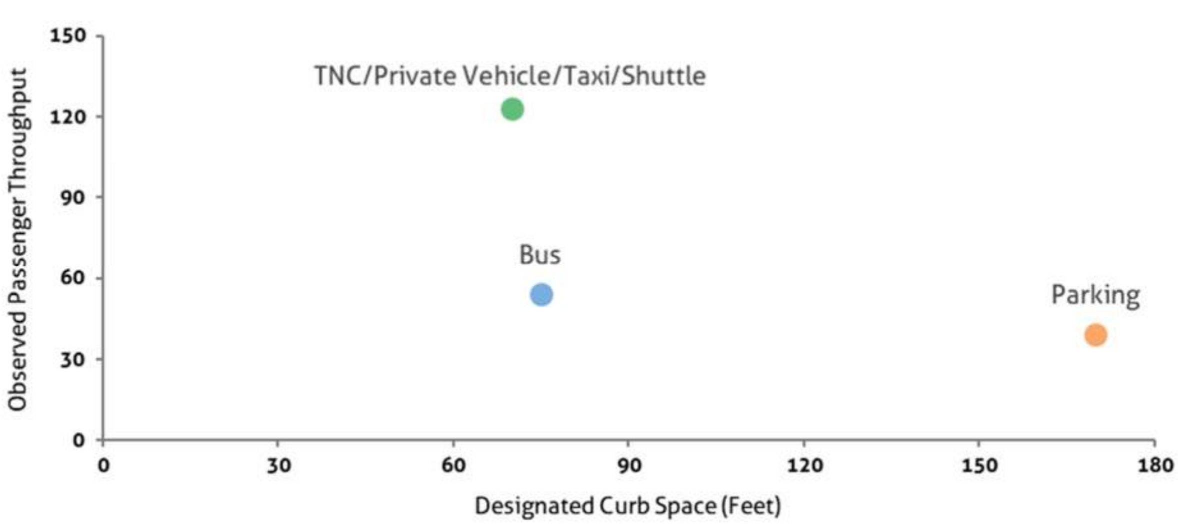
On the observed weekday, TNCs and private vehicles accounted for 50 percent of passenger loading events and 49 percent of people loading or unloading along this stretch of Clay Street. Buses, 32 percent of loading vehicles, were the next most common loading vehicle, and served 30 percent of the people loading or unloading. Taxis and shuttles also provided approximately ten percent each of vehicle and people loading totals.





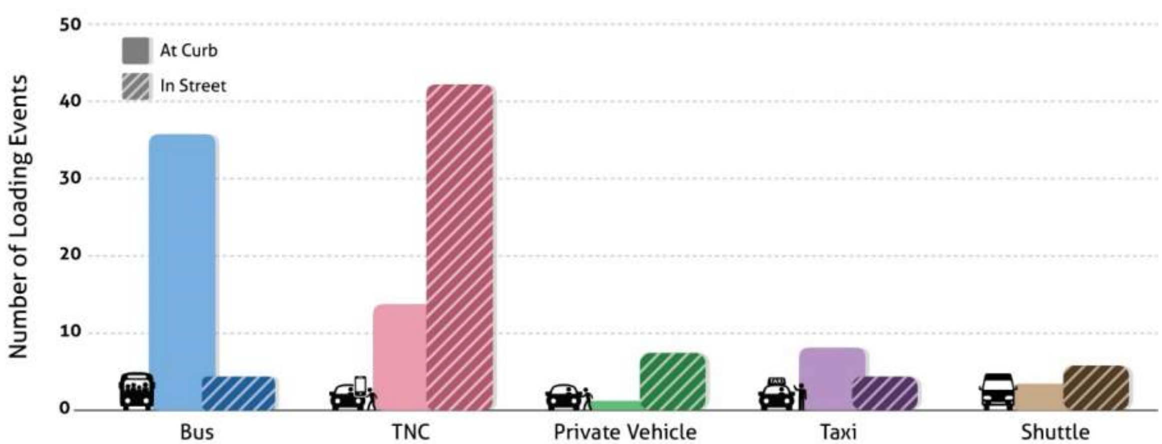
All modes served approximately the same number of people per vehicle, 1.3 to 1.7.

The number of people served by each mode (i.e., observed passenger throughput) with respect to the amount of curb space allocated to that mode is presented in the graph below. Unlike at other study locations, buses at these stops have relatively few boardings and alightings. While the curb space allocated to buses (75 feet) was less productive when compared to the other study locations, its location and size is consistent with the needs of the bus to provide transit service based on the city's transit first policy. There is, however, a slight curb space allocation/demand mismatch between passenger loading (taxis, TNCs, private vehicles, and shuttles) and parking. Taxis, TNCs, private vehicles, and shuttles, served the most people (123) on Clay Street and has 70 feet of curb space allocated to it. Parked vehicles served 39 people and have 170 feet of curb space.

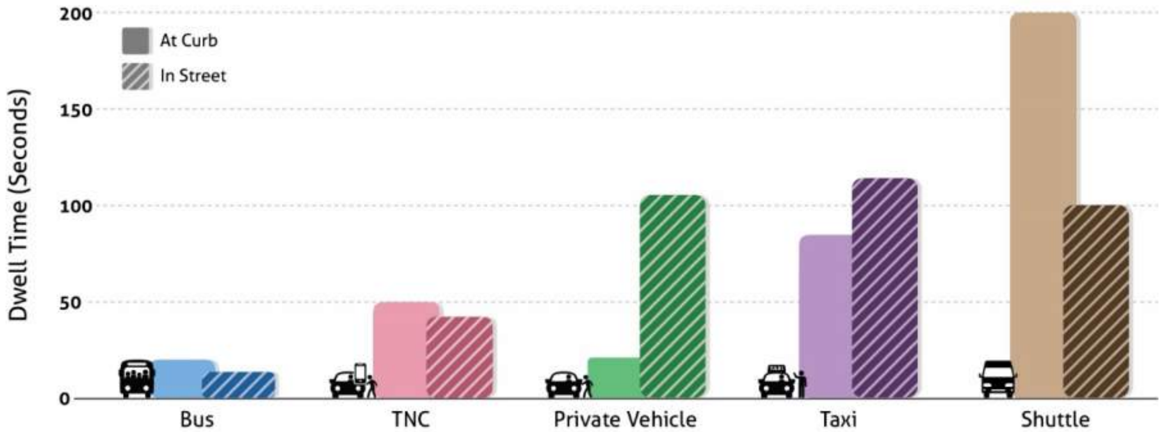


Passenger Loading Impact

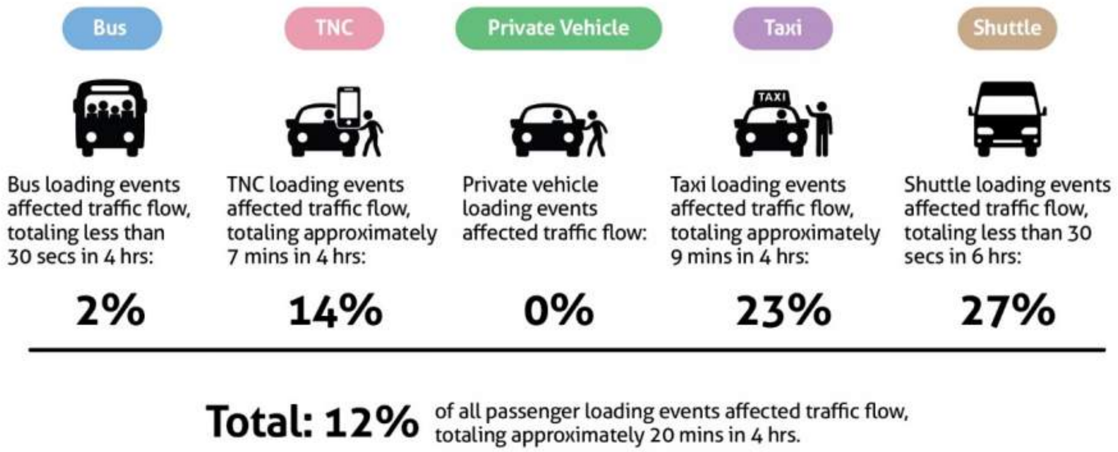
Of the observed events, buses and TNCs saw the highest level of passenger loading. A greater proportion of buses loaded/unloaded at the curb and a greater proportion of passenger vehicles loaded/unloaded in the street. The high volume of cars loading and unloading in the street takes into account vehicles that let passengers off in the right turn lane that, while technically curbside, is a travel lane and not designated for this purpose. The right turn lane effectively means less overall curb space available on that block. The right turn lane is adjacent to a busy hotel that generates passenger loading demand on that side of the block.



Except for buses, the average dwell time across all modes is relatively high compared to the other case study locations, ranging from 50-200 seconds for events both in the street and at the curb. Average dwell times are longer curbside than they are in the street for shuttle buses and TNCs, but longer in the street for taxis and private vehicles. The average dwell time for TNCs and private vehicles was 25-50 seconds at the curb and 50-100 seconds in the street. Street dwell time is, again, likely higher due to the right turn lane and lack of available curb space for loading.

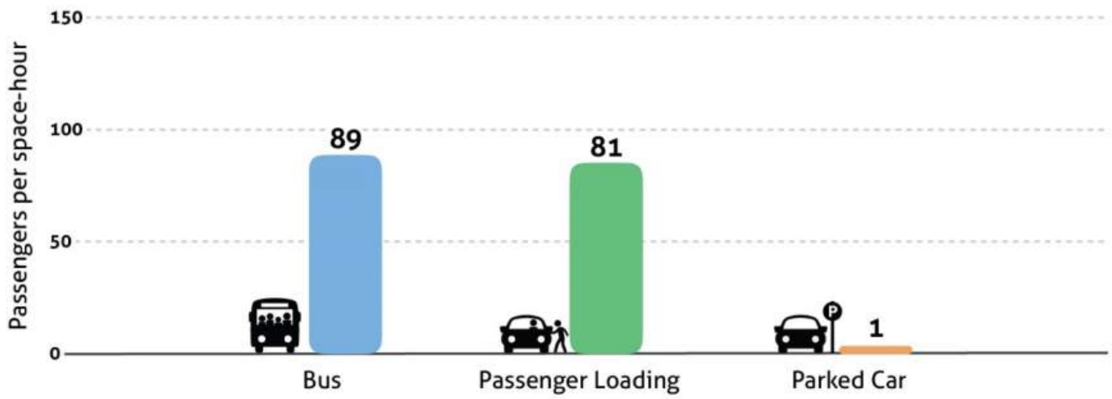


Twelve percent of all loading events affected traffic flow. This percentage is higher than at other study locations in part due to the relatively higher proportion of trips that loaded in the travel lanes. Effects were defined by instances in which vehicles fully blocked travelers (cars, bikes, buses, etc.) behind them or in which trailing modes had to maneuver around the loading event. Loading events for taxis and shuttles affected traffic flow the most. Almost all taxi-related delay was the result of taxis waiting in the right turn lane for guests of Le Meridian Hotel. Lengthy dwell times and frequent in-street passenger loading events resulted in 20 minutes of affected traffic flow in four hours.



Curb Productivity

The following are the calculated curb productivity indices for the zones dedicated to serving passengers along Clay Street; "passenger loading" includes all vehicles using the passenger loading zone, which in this case were taxis, TNCs, private vehicles, and shuttles.



Passenger Loading Curb Demand

The following table shows the percentage of time during the analysis period when specific numbers of simultaneous passenger loading events by TNC, private vehicle, or taxi were observed in this case study location.

Simultaneous Passenger Loading Events (by TNC/Private Vehicle/Taxi)	Amount of Time During Analysis Period
0	47% (1 hour, 53 minutes)
1	37% (1 hour, 29 minutes)
2	7% (17 minutes)
3	6% (14 minutes)
4	**3% (7 minutes)**
5 or more	0%

Notes:
Analysis period duration was four hours for Clay Street
Bold denotes the percentage of time the maximum number of passenger loading activities were observed

To accommodate the peak passenger loading demand from taxis, TNCs, and private vehicles, space for four simultaneous passenger loading events would be required. Approximately 160 to 240 feet of passenger loading space would be necessary to accommodate four simultaneous passenger loading events, depending on how the passenger loading zone is configured.

Recommendations

Passenger loading activity levels are constant for the majority of a typical weekday. Video observations found that providing passenger loading space for four vehicles (160-240 feet) would accommodate peak passenger loading demand for this study area on a typical weekday.

Each opportunity identified would provide adequate space for a passenger vehicle to pull out of the travel lane completely to pick up or drop off a passenger, in some instances by utilizing the driveway area and/or red zone to pull into and out of the zone (e.g. opportunity #4). However, none of the individual opportunities would provide sufficient space to accommodate three vehicles and, thus, a combination of several of the identified opportunities would need to be implemented to accommodate the peak passenger loading demand at the curb.

Our observations found that passenger loading demand was pretty even between both sides of the street, thus recommended strategies should provide space on both sides as well. Therefore, opportunities #2 and #3, both establishing flexible loading zones, would be the recommended locations and treatments to provide dedicated passenger loading zones on both sides of the street while still maintaining existing commercial loading space. For the south side of the street, opportunity #3 would be recommended to utilize the existing commercial loading zone while minimizing the impact to current street conditions. Opportunity #2 would minimize parking impact by being located adjacent to the existing loading zone and thus increasing its effective length.

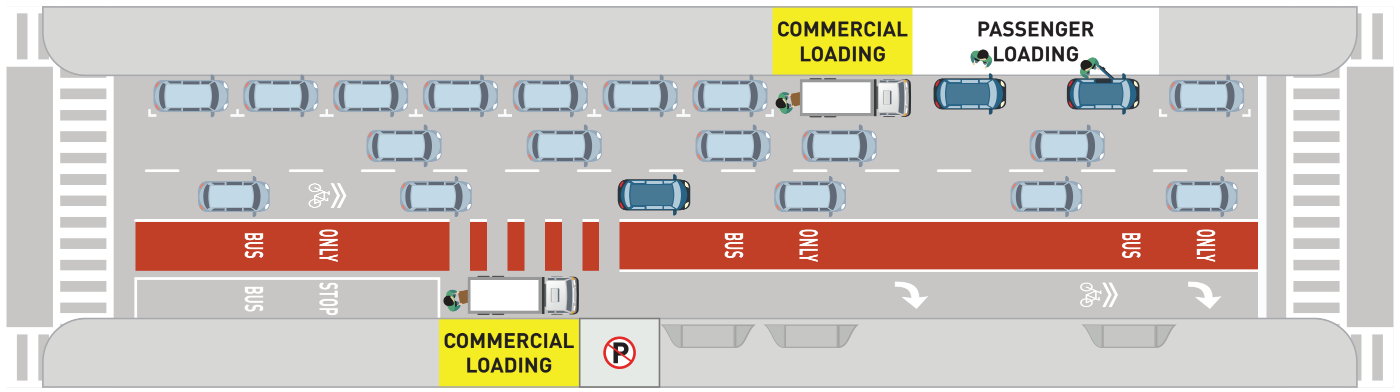
Case Study: Financial District | High-rise office and commercial area

Based on observations and data collected on Clay Street in San Francisco, CA

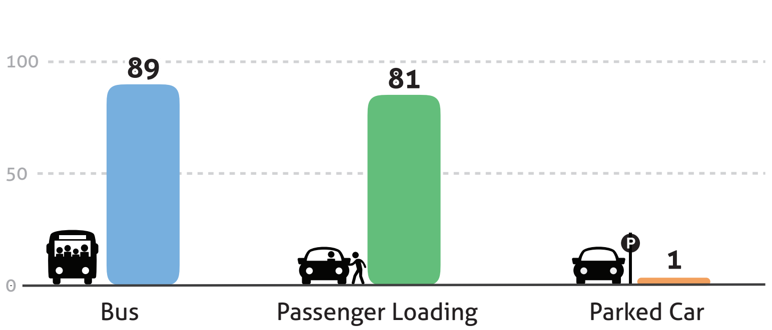
Increasing Curb Productivity

Uber FEHR PEERS

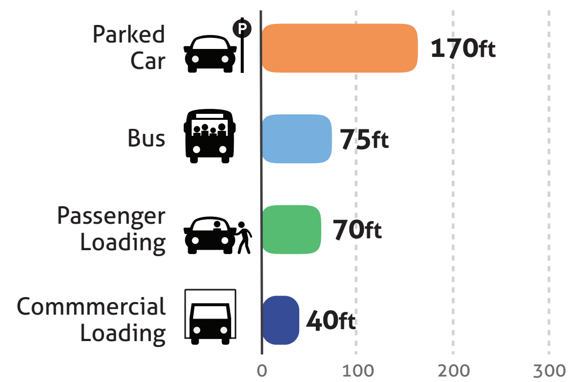
Existing Conditions



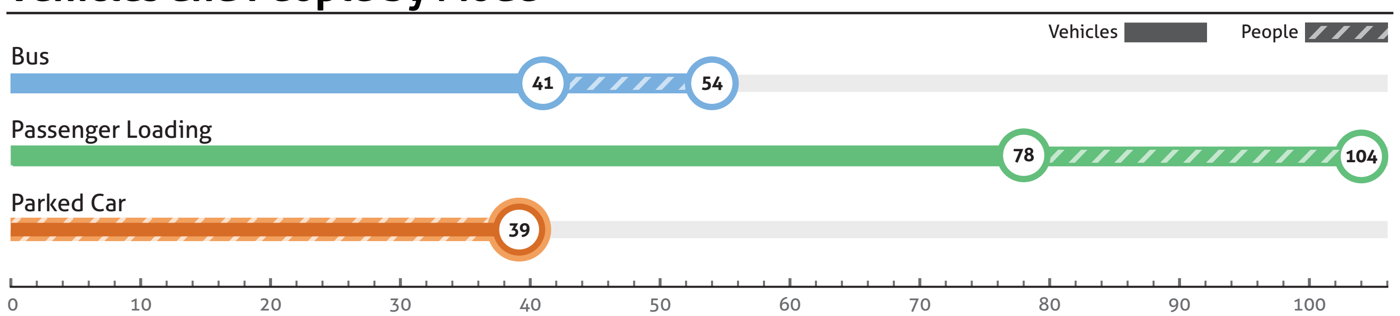
Curb Space Productivity (Passengers per space-hour)



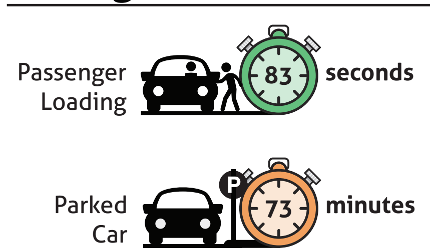
Curb Allocation



Vehicles and People by Mode



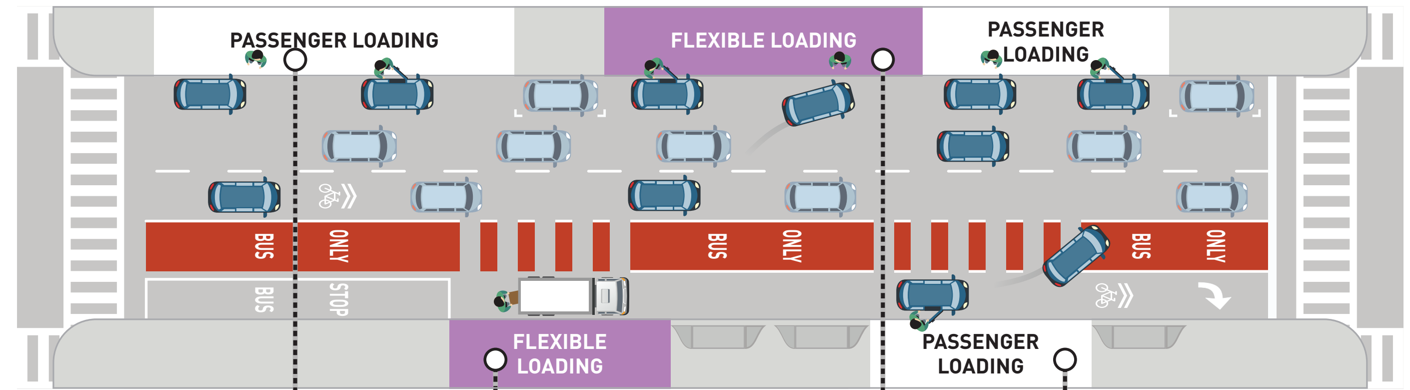
Average Dwell Times



Peak* Passenger Loading Curb Space Demand

160-240 feet

Potential Opportunities



1 Conversion

Curb Allocation

	Existing	Change	Total
Passenger Loading	70ft	+80ft	150ft
Parked Car	170ft	-80ft	90ft
Commercial Loading	40ft		40ft

Convert four parking spaces to a PASSENGER LOADING zone.

2 Flexibility

Curb Allocation

	Change	Total
Passenger Loading	+40ft	70ft + 40ft
Commercial Loading	-20ft	20ft + 40ft

Convert commercial loading zone and no parking zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

3 Flexibility

Curb Allocation

	Change	Total
Passenger Loading	+60ft	70ft + 60ft
Parked Car	-40ft	130ft
Commercial Loading	-20ft	20ft + 60ft

Convert two parking spaces and a commercial loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

4 Conversion

Curb Allocation

	Change	Total
Passenger Loading	+40ft	110ft

Reduce right turn pocket length and convert tow-away zone between driveways to a PASSENGER LOADING zone.

Recommended for Implementation**

2 Flexibility

Convert time of day commercial loading zone and no parking zone in front of driveway to a FLEXIBLE LOADING zone. Motorists exiting the loading zone could use a portion of the driveway to re-enter the travel lane, thus minimizing impact to the bus stop.

+

3 Flexibility

Convert two parking spaces and time of day commercial loading zone to a FLEXIBLE LOADING zone. This strategy consolidates passenger loading zone to increase the effective length.

- ☑ Establishes passenger loading zone
- ☑ Minimizes parking loss
- ☑ Accommodates commercial loading
- ☑ Located on both sides of the street
- ☑ Locates passenger loading on both sides of the street

* The peak passenger loading demand observed was four vehicle loading at any one time. This level of demand was seen for 3% of the total observed period and would require 160 to 240 feet of curb space to accommodate loading activity.

** Reconfiguring curb space in the public right of way requires stakeholder agency review & approval, which could include community input, additional analysis/design, and/or other considerations to be determined by the owner agency. The above concepts are intended to illustrate some potential reconfigurations and serve as a framework for discussions.

Bicycle Corridor: Polk Street

Transportation Context

Polk Street was chosen to represent a medium density residential and commercial corridor with bicycle lanes. This corridor includes commercial and passenger loading zones, vehicle parking, and a high volume of passenger loading activity. This location was selected to observe interactions between passenger loading activities and bicycle lanes near the Civic Center area. *An illustration of the physical street layout, including curb space allocation by use type is shown below.*

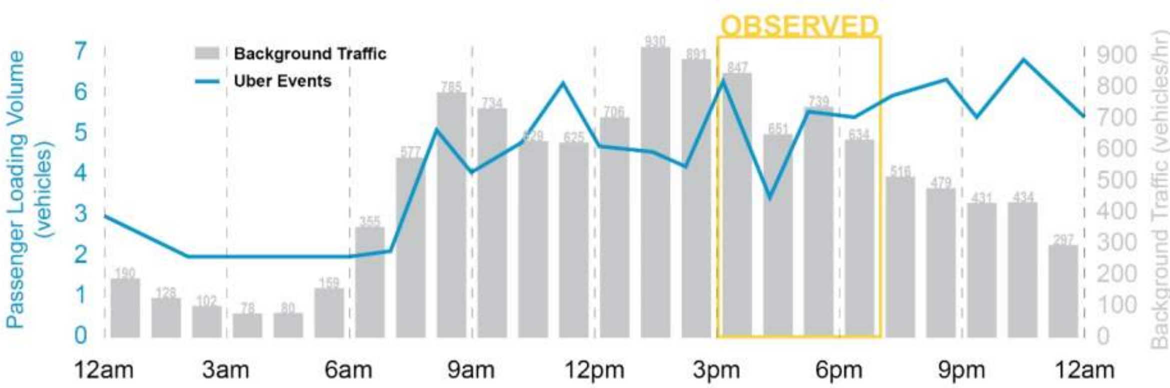
Observations & Findings

Summary

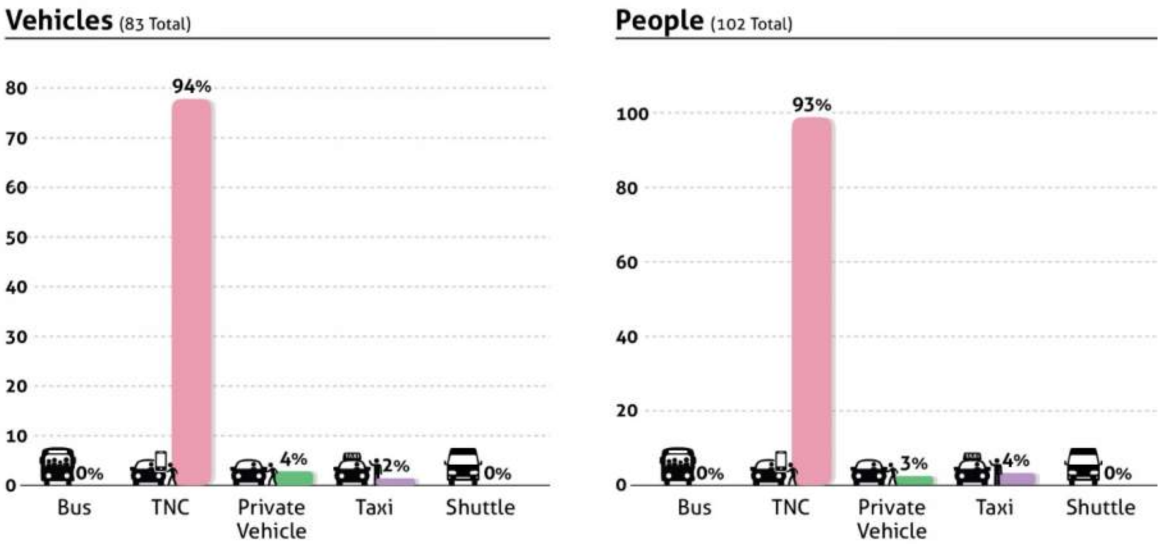
- No bus loading activity or designated curb space.
- Passenger loading by other modes (i.e., taxis, TNCs, and private vehicles) is higher than the existing curb space designation can accommodate during peak passenger loading demand times.
- The largest amount of curb space is dedicated to parking, which limits passenger throughput by other modes by way of the curb.
- The presence of bicycle lanes and high bicycle activity introduces safety concerns and the desire to minimize vehicle-bicycle conflicts.

Passenger Loading Activity

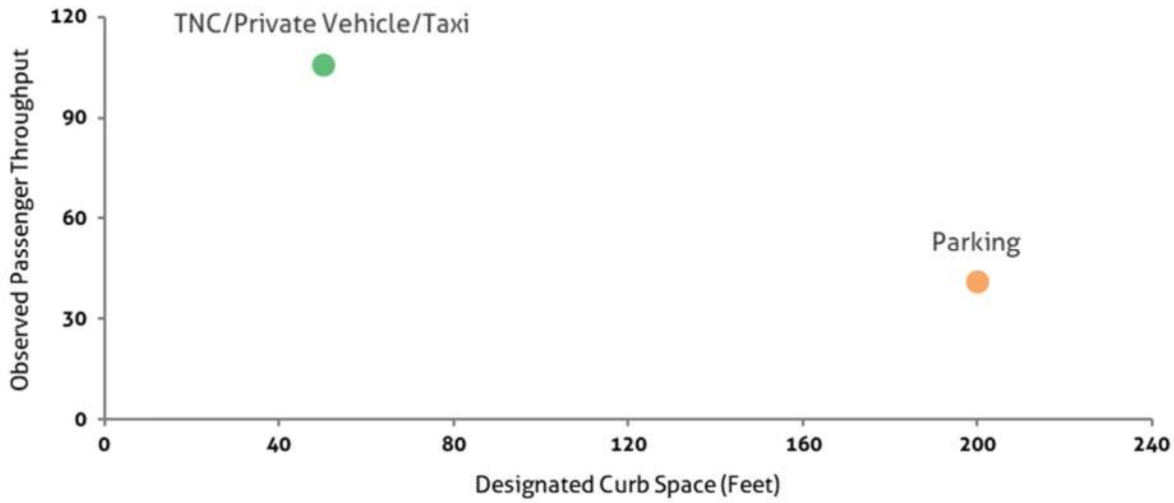
Observations at this location were recorded from 3PM to 7PM. Background traffic volumes on this block peaked at around 900 vehicles per hour midday and around 600-700 vehicles in the AM and PM periods. While not as heavily trafficked as other corridors, Polk Street has moderate levels of traffic throughout normal work hours. Uber activity fluctuates throughout the day, with peaks at 8AM, 11AM, 3PM, and 5PM and general increase from 5PM to 11PM. There are no bus stops along this stretch of Polk Street. The following chart illustrates the various traffic patterns over the course of the weekday our data was collected.



On the observed weekday, TNCs and private vehicles accounted for nearly all of passenger loading events apart from two percent from taxis. Similarly, nearly all *people* loading or unloading along this stretch of Polk Street used a TNC or private vehicle, while only four percent used a taxi. One shuttle was observed dropping one person off for two minutes; this affected traffic flow. TNC and private vehicle averaged one to 1.3 people per event. The observed passenger loading activity by vehicles and people is illustrated below, along with the relative number of vehicles and people by each mode.

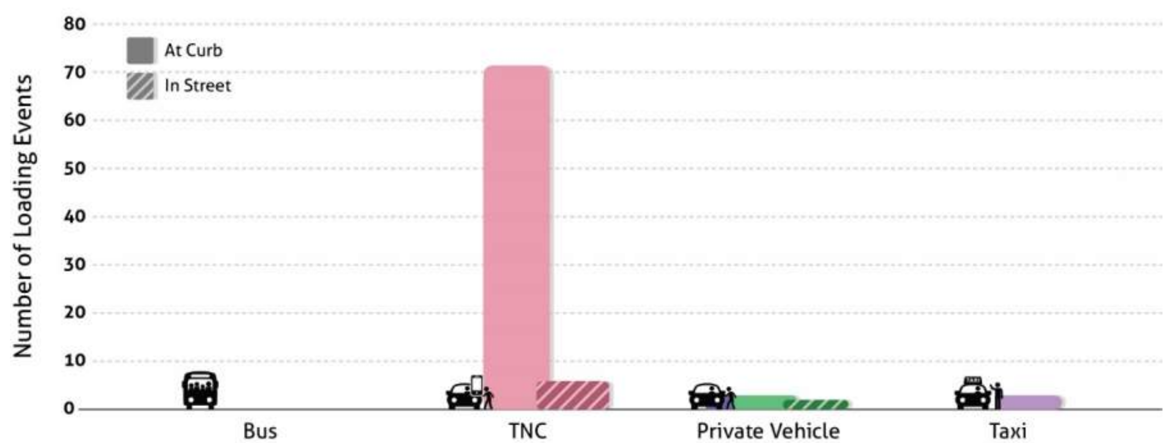


The following graph presents the number of people served by each mode (i.e., observed passenger throughput) with respect to the amount of curb space allocated to that mode. As such, the comparison of how productive each mode (and curb space) is in terms of passenger throughput, and the amount of dedicated curb space to that mode can be made. TNCs, passenger vehicles, and taxis served 106 people during the observed period and has 50 feet of curb space designated for its use. In contrast, parked cars bring about half the number of people to the area (41) during the observed period, but have 200 feet of curb space allocated to this use. While parked cars spend much longer at the curb than vehicles solely picking up and dropping off passengers, and thus, require more curb space than passenger loading for a similar number of vehicles and people served, this corridor presents a curb space demand/allocation mismatch for these two uses.

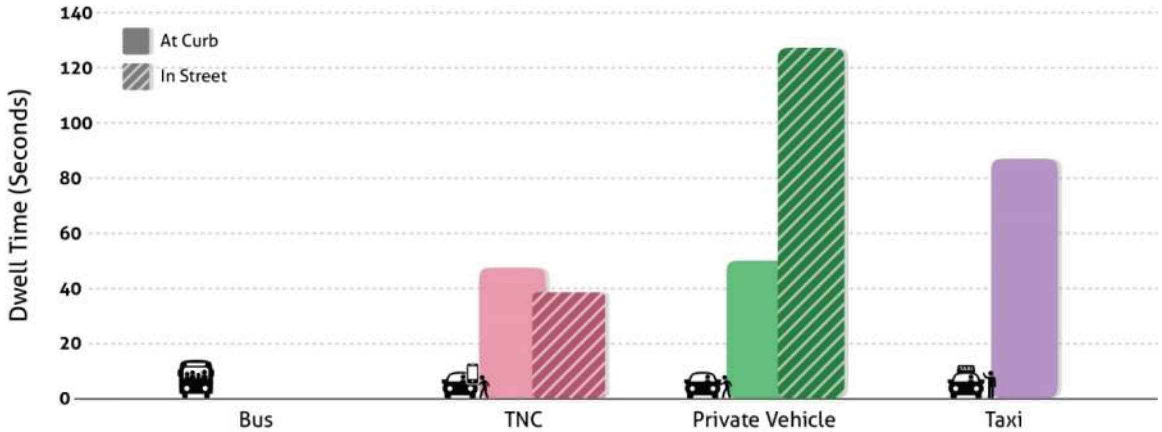


Passenger Loading Impact

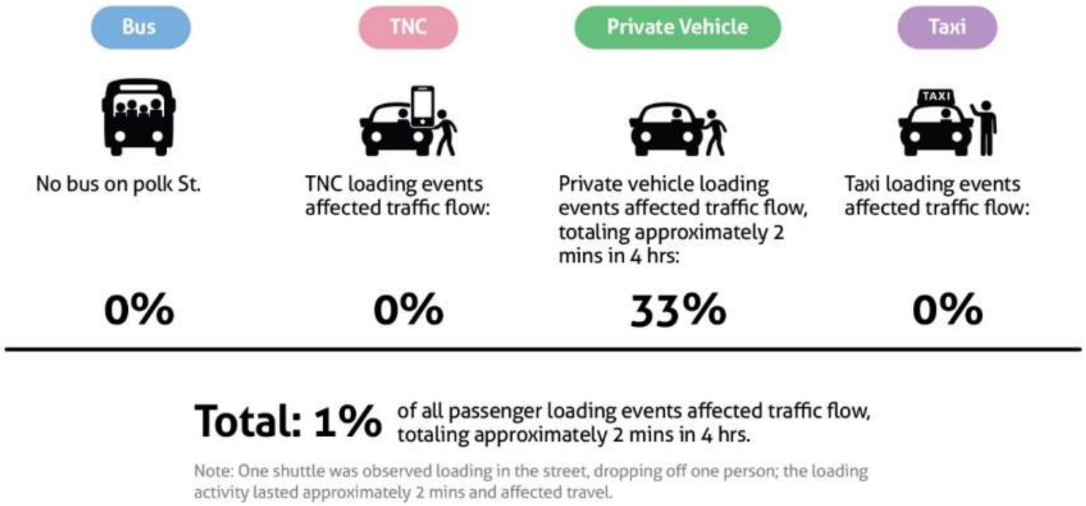
Nearly all passenger loading occurred at the curb with a few exceptions in the street. Nearly a third of all loading events occurred in the bike lane, approximately 40 percent of which affected cyclists. This includes events that occurred primarily at the curb, but not fully out of the bike lane.



Dwell times for TNCs and private vehicles averaged around 50 seconds curbside with similar in-street dwell time for TNCs. The sample size for private vehicles and taxis loading in the street was quite small, leading to exaggerated dwell times based on only a few events.

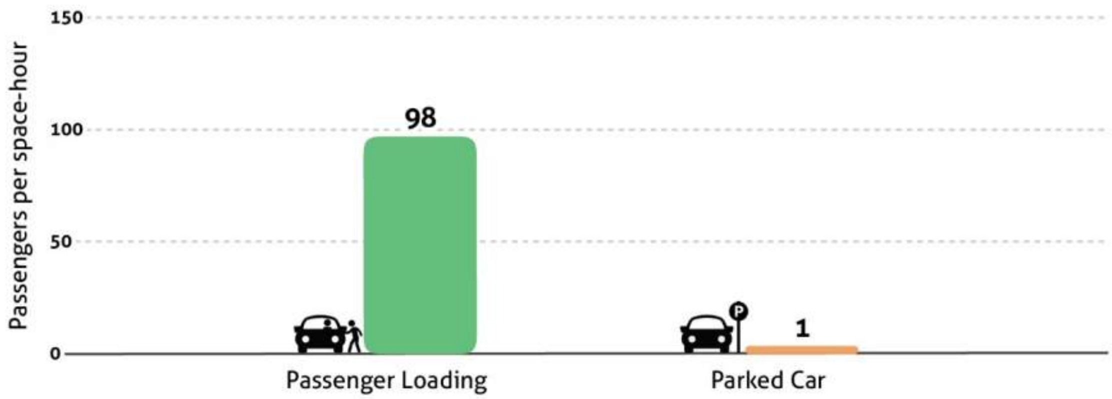


Only one percent of all loading events affected traffic flow. Effects were defined by instances in which vehicles fully blocked travelers (cars, bikes, etc.) behind them or in which trailing modes had to switch lanes to go around the loading event. The full temporal impact of these effects is about two minutes in four hours. While this is a small percentage of time, all events not occurring curbside blocked the bicycle lane and, thus, have the potential to impact cyclists traveling along this corridor (in this case it was a about 15 percent of all passenger loading events). Safety concerns arise with the presence of conflicts between vehicles and cyclists and, thus, improvements in operations or design should be considered that would limit these conflicts to the extent possible.



Curb Productivity

The following are the calculated curb productivity indices for the zones dedicated to serving passengers along Polk Street; "passenger loading" includes all vehicles using the passenger loading zone, which in this case were taxis, TNCs, and private vehicles.



Passenger Loading Curb Demand

The following table shows the percentage of time during the analysis period when specific numbers of simultaneous passenger loading events by TNC, private vehicle, or taxi were observed in this case study location.

Simultaneous Passenger Loading Events (by TNC/Private Vehicle/Taxi)	Amount of Time During Analysis Period
0	50% (2 hours)
1	37% (90 minutes)
2	7% (17 minutes)
3	**6% (14 minutes)**
4 or more	0%

Notes:
Analysis period duration was four hours for Polk Street
Bold denotes the percentage of time the maximum number of passenger loading activities were observed

To accommodate the peak passenger loading demand, space for three simultaneous passenger loading events would be required. Approximately 110 to 180 feet of passenger loading space would be necessary to accommodate three simultaneous passenger loading events, depending on how the passenger loading zone is configured.

Recommendations

Though passenger loading activity levels peak slightly in the PM commute period and evening hours, they are constant for the majority of a typical weekday. Video observations found that providing passenger loading space for three vehicles (110-180 feet) would accommodate peak passenger loading demand for this study area on a typical weekday.

Each opportunity identified would provide adequate space for a passenger vehicle to pull out of the travel lane completely to pick up or drop off a passenger, in some instances by utilizing the driveway and/or red zone to pull into and out of the zone (e.g. opportunity #2). However, none of the individual opportunities would provide sufficient space to accommodate three vehicles and, thus, a combination of several of the identified opportunities would need to be implemented to accommodate the peak passenger loading demand at the curb. Additionally, while only one percent of all loading activity affected traffic flow, the presence of a bicycle corridor means that special care is required to minimize conflicts with nearby bicycle activity.

Our observations found that the directionality of passenger loading was pretty even, with a slightly higher activity in the northbound direction (west side of the street). Given that the existing passenger loading space is in the northbound direction, additional space can be evenly distributed between the two sides of the street. In the northbound direction, opportunity #2 would provide space for one passenger loading vehicle and minimize parking loss by taking advantage of the adjacent driveway and red zone to pull into and out of the zone. In the southbound direction, opportunity #1 would be recommended because opportunity #4 would increase the potential for conflicts between bicyclists and motorists.

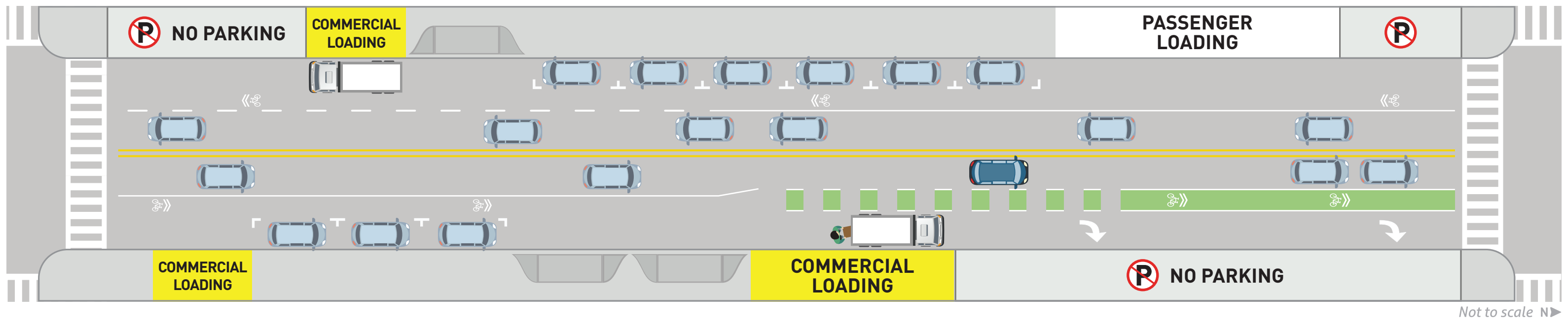
Case Study: **Bicycle Corridor** | Civic center neighborhood, high-density residential and neighborhood commercial area

Based on observations and data collected on Polk Street in San Francisco, CA

Increasing Curb Productivity

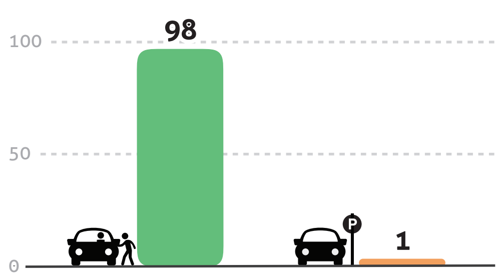
Uber
FEHR PEERS

Existing Conditions

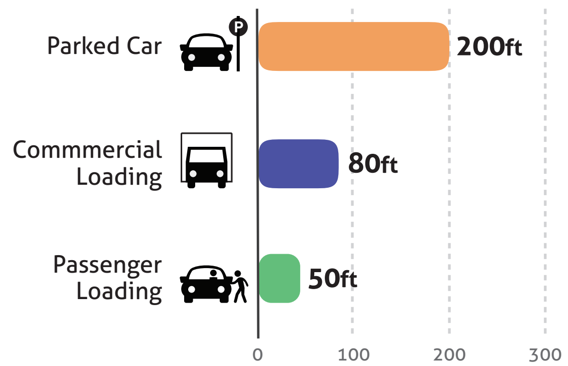


Curb Space Productivity

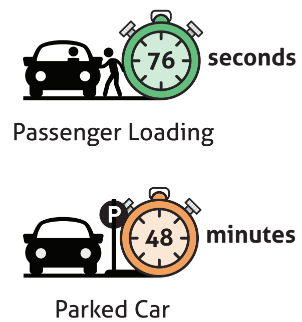
(Passengers per space-hour)



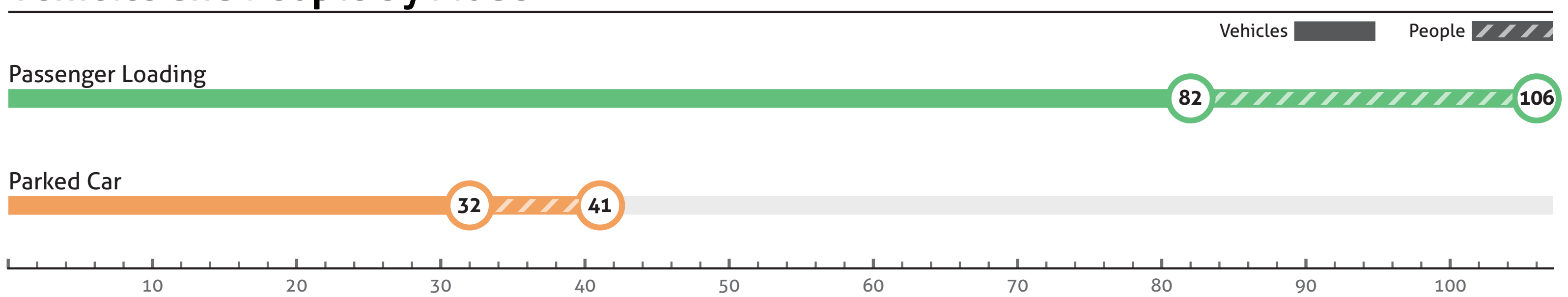
Curb Allocation



Average Dwell Times

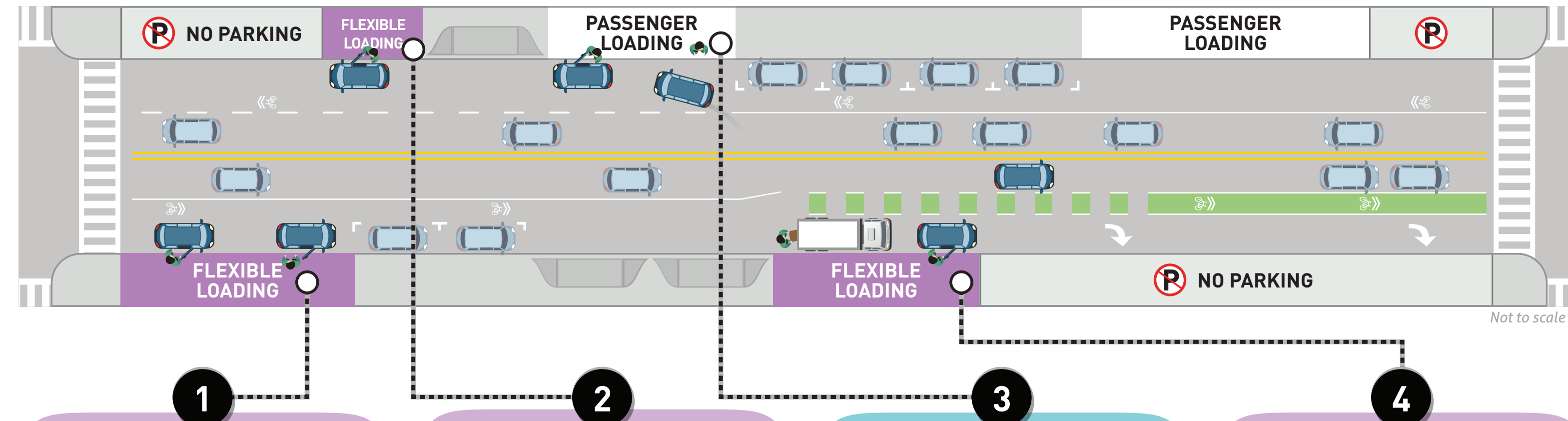


Vehicles and People by Mode



Peak* Passenger Loading Curb Space Demand:
110-180 feet

Potential Opportunities



1 Flexibility

Curb Allocation

	Existing	Change	Total
	50ft	+40ft	50ft + 40ft
	200ft	-20ft	180ft
	80ft	-20ft	60ft + 40ft

Convert commercial loading zone and one parking space to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

2 Flexibility

Curb Allocation

	Change	Total
	+20ft	50ft + 20ft
		220ft
	-20ft	60ft + 20ft

Convert commercial loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

3 Conversion

Curb Allocation

	Change	Total
	+40ft	90ft
	-40ft	160ft

Convert two parking spaces to a PASSENGER LOADING zone.

4 Flexibility

Curb Allocation

	Change	Total
	+40ft	50ft + 40ft
	-40ft	40ft + 40ft

Convert commercial loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

Recommended for Implementation**

1 Flexibility

Convert commercial loading zone and one parking space to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

+

2 Flexibility

Convert commercial loading zone to a FLEXIBLE LOADING zone that includes a PASSENGER LOADING zone during peak rideshare demand.

- ☑ Establishes passenger loading zone
- ☑ Minimizes parking loss
- ☑ Accommodates commercial loading
- ☑ Locates passenger loading on both sides of the street

* The peak passenger loading demand observed was three vehicles loading at any one time. This level of demand was seen for 6% of the total observed period and would require 110 to 180 feet of curb space to accommodate loading activity.

** Reconfiguring curb space in the public right of way requires stakeholder agency review & approval, which could include community input, additional analysis/design, and/or other considerations to be determined by the owner agency. The above concepts are intended to illustrate some potential reconfigurations and serve as a framework for discussions.