

New York City Department of Transportation Willoughby Pedestrian Priority Street

Appendices





A Existing Conditions



New York City Department of
Transportation

**Willoughby Street Pedestrian
Priority**

Existing Conditions Report

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1 Introduction

1.1 Project Background

Over the past 20 years Downtown Brooklyn in New York City has become an increasingly successful and vibrant area that supports a broad mix of uses and attracts world-class businesses and institutions. Stimulated in part by the Downtown Brooklyn Rezoning of 2004 and leveraging unparalleled transit access, the area has undergone a transformation, with \$9 billion of private investment and \$300 million in public improvements underway. Several parcels have been redeveloped with education, office, and residential uses, while retail uses, always a popular attraction in Downtown Brooklyn, are beginning to command premium rents.

As redevelopment has intensified the uses on parcels throughout the area, and ridership at local subway stations has increased, pedestrian activity continues to grow. Future redevelopment will likely continue this trend. In support of this enhanced vibrancy at the street level, the City continues its efforts to make Downtown Brooklyn a comfortable place for pedestrians, as both an economic driver and means to efficient transportation.

The Willoughby Street Pedestrian Priority Streetscape project, Task Order #12 under the Engineering Services Agreement (ESA) contract between Arup and the New York City Department of Transportation (NYCDOT), focuses on creating new conceptual street designs for three key blocks in the heart of Downtown Brooklyn. These blocks include Willoughby Street between Pearl and Jay Streets, and Pearl Street between Fulton Street and the Brooklyn Renaissance Plaza pedestrian walkway. A primary aim of the project is to create a design that better reflects the site's existing pedestrian activity and anticipates future demand through a more pedestrian-friendly environment. Given these characteristics, a particular focus of the project will be exploring designs that prioritize pedestrians while allowing multiple modes to share roadway space—a concept often referred to as “Pedestrian Priority” streets or spaces.

This project will build on recent improvements to the adjacent Willoughby Plaza, which was transformed from a standard city block and service road to a vibrant pedestrian plaza in 2006.¹ In 2008, NYDOT's Brooklyn Borough Commissioner's Office and Capital Program Management division developed high-level planning concepts for the remainder of Willoughby Street, from the Willoughby Plaza to Fort Greene Park. The block of Willoughby Street west of Jay Street, which includes the project site, was identified to be a high priority for pedestrian-focused improvements due to the state of existing infrastructure, lack of walkability, and relatively poor economic performance.

This Existing Conditions Report, the first deliverable of the Willoughby Street Pedestrian Priority Streetscape project, documents existing conditions related to

¹ Initially using temporary materials, the plaza was reconstructed as a permanent plaza in 2012.

mobility within the site, including transit, pedestrians, vehicles, and cycling, as well as conditions associated with general character and the environment. These conditions include the quality of pedestrian gathering areas, landscape, hardscape, availability of sunlight, noise, views, and safety. Key issues and opportunities related each of these conditions are identified. Finally, a review of five pedestrian priority and shared streets precedents from other cities in the United States are included. These precedents help provide a basis for understanding how different types of design treatments can support pedestrian activity within public areas.

1.2 Goals and Objectives

Following initial meetings with project stakeholders, including adjacent property owners, business owners, Community Board 2, and other City agencies, six key project goals and objectives were identified to help inform and guide the street design process. These goals and objectives include:

1. **Create a safe, comfortable, and convenient walking environment for all users.** Improvements to the pedestrian environment should accommodate users of all ages and abilities.
2. **Support and enhance economic and retail vitality.** Investment in streetscape improvements helps to attract businesses to an area, increases property values, and supports local revitalization efforts. Pedestrian-priority treatments can be particularly beneficial to retail businesses, as making streets comfortable places to linger can increase retail sales.
3. **Improve street aesthetics and visual quality.** The character and design of the streetscape are determining factors of the success of the corridor. In order to foster an environment for people to visit and gather, aesthetics and visual quality of the street should be enhanced.
4. **Accommodate all legitimate mobility and access needs, including goods deliveries and passenger drop offs, but place a priority on pedestrian needs.** Goods deliveries and passenger drop-offs are essential for adjacent restaurant, retail, office and educational uses to function; however loading demands need not be a defining characteristic of the street design. Instead, pedestrian movement will be prioritized while allowing for necessary drop offs and loading.
5. **Design for sustainability, maintainability, and resiliency.** Design strategies should be created to help the corridor grow stronger and more vibrant while facing economic, environmental and social challenges. Infrastructure that manages storm water will help to create an area that is resilient from flooding and other severe weather events. The consideration of the design's maintenance features should be considered early in the design process to reduce maintenance cost and improve safety.
6. **Integrate project area into existing streetscape and facilitate connections with surrounding activity centers, such as Willoughby Plaza, Fulton Street Mall, MetroTech, and Columbus Park.** The project site is within one of Downtown Brooklyn's key crossroads and has the opportunity to better link neighboring activity centers in a manner that is more efficient, comfortable, and enjoyable.

1.3 Project Site and Adjacent Uses

Located in the heart of Downtown Brooklyn, the project site, shown in Figure 2, includes Pearl Street between Fulton Street and the Brooklyn Renaissance Plaza pedestrian walkway, and Willoughby Street between Pearl and Jay Streets.

Directly to the north of the project site is a parcel occupied by the Brooklyn Renaissance Plaza, a hotel and office complex which is managed by Muss Development. The New York Marriott at the Brooklyn Bridge is a major tenant. At the southern boundary of the project site a pedestrian walkway provides an important east-west connection between Adams and Jay Streets adjacent to the study area. Spanning the plaza, a pedestrian bridge connects the Marriott to the Hotel Addition Tower located at the Pearl Street terminus.

The west side of Pearl Street north of Willoughby Street is defined by the 13-story, 345 Adams Street building. The building has a lobby with dual access from Adams Street and Pearl Street. The building is occupied by New York City municipal tenants, including the Department of Finance, Administration for Children's Services, and the Board of Elections. There are a number of restaurants on the first two floors of the 345 Adams Street building with frontage on Adams Street and/or Willoughby Plaza and limited back of house services along Pearl Street. These include Hill Country Barbeque Market, Panera Bread, Pot Belly's sandwiches, Orange Leaf frozen yogurt, and Rocco's Tacos.

The east side of Pearl Street north of Willoughby Street is defined by Brooklyn Friends School, ASA Institute, and the rear of an 14-story building that fronts at 370 Jay Street. Brooklyn Friends School occupies a historic building that was originally constructed for the Brooklyn Law School, which currently serves roughly 600 elementary and middle school students. The ASA Institute is a college that offers associate degrees and professional certificates. Both buildings front onto Pearl Street, which acts as the primary access for students, parents and staff.

370 Jay Street was formerly occupied by MTA-New York City Transit and is under refurbishment to be re-occupied by NYU's new Center for Urban Studies and Progress (CUSP). NYU's building sits atop the Jay Street - MetroTech subway station, and much of the building's first floor is comprised of an atrium that provides access to the subway below. To the building's rear, Pearl Street provides access for the building's loading dock and basement parking. Construction is planned to begin in late 2014 or early 2015, and when completed will be occupied with retail, classroom, and business incubators by 2017.

Along Willoughby Street are various small business, restaurants and food chains including, Blimpie, Buffalo Boss, Conway Stores, and the Community Financial Service Center. The section of Willoughby Street between Pearl Street and Jay Street also functions as the de-facto back-of-house for Fulton Mall. Toward the west, Willoughby Street transitions into the pedestrianized Willoughby Plaza, which is lined by Shake Shack and Hill Country Barbeque Market. Pearl Street between Fulton Street and Willoughby Street has no active retail entrances.



Figure 1: Willoughby Plaza, directly adjacent to the project site



Figure 2: Map of project area within Downtown Brooklyn

Site History

In the first half of the twentieth century, this section of Downtown Brooklyn was a neighborhood of mixed-use, low-rise buildings surrounded by elevated rail, shown in Figure 3. Willoughby Street ran uninterrupted from the East River waterfront in the west to Fort Greene Park in the east; while Pearl Street ran from Fulton Street to the East River waterfront to the north. The Fulton Street Elevated ran adjacent to the site above today's Fulton Mall, and the Myrtle Avenue Elevated existed at the northern edge of our study area where the Renaissance Plaza pedestrian walkway is today. Both provided direct transit access to Manhattan via the Brooklyn Bridge.

To accommodate a shift towards vehicular mobility in the 1950s, the Brooklyn-Queens Expressway, Cadman Plaza and Adams Streets were constructed. With the construction of Adams Street south from the Brooklyn Bridge, Willoughby Street was severed from the west. Meanwhile, the construction of superblocks of court and city buildings to the north after 1950 turned Pearl Street into the two block dead-end it is today.

When Downtown Brooklyn was rezoned by the City in 2004, the rezoning action enabled the de-mapping of Pearl Street between Fulton and Willoughby Streets within the project site, as well as Red Hook Lane to the south of the project site. The de-mapping, however, is incomplete, and further action would have to be taken to develop the streets as private sites. At this time, Red Hook Lane may have a higher likelihood of being disposed of the City for development, while Pearl Street is more likely to remain as a public street.



Figure 3: 1924 Brooklyn aerial². Yellow star denotes intersection of Willoughby & Pearl Streets

² <http://maps.nyc.gov/doitt/nycitymap/>

Surrounding Area

Beyond the project site and adjacent uses, shown in Figure 4, the surrounding area includes numerous civic and educational uses, such as courthouses, Brooklyn Law School, and the rest of the NYU School of Engineering campus. Downtown Brooklyn is one of the most robust retail and commercial activity centers in New York City that now attracts significant upscale retailers along Fulton Street. Renowned educational institutions, great public transit connections, and a quickly growing downtown residential community all contribute to a mixed-use urban environment that is becoming among the most vibrant in New York City.

Nearby residential districts are predominantly defined by row housing, while high-rise residential is increasingly being added to the nearby housing market, especially to the south and east of the site. The economics of the development and construction market appear to favor high-rise residential within the areas recently re-zoned for increased height. While the Marriot Hotel, just north of Pearl Street, was for many years the only new hotel in Downtown Brooklyn, today, interspersed within the new residential high-rises, five new hotels have been constructed recently in the Downtown core.

To the northeast of our project area, the MetroTech office and educational center provides 3.7 million square feet of work space and houses an estimated 22,000 jobs³. Occupants include FDNY, National Grid, Empire Blue Cross, and New York University (NYU) School of Engineering. Other areas containing office space include the downtown Court Street corridor, which has historically housed offices related to the courts and other Borough services, as well as some dedicated buildings in the surrounding district such as the NYCT offices at Livingston Plaza to the south of our project area.

In addition to the NYU campus housed within MetroTech, several other educational facilities are located nearby, including the new Brooklyn Law School building, the NYC College of Technology, St. Francis College, Long Island University, and independent K-12 schools Packer Collegiate and St. Ann's in Brooklyn Heights.

Nearby institutional uses include the government uses housed in the court buildings, Borough Hall, the Municipal building, and the large US Post Office at Cadman Plaza.

Public realm amenities are managed by three BIDS—the MetroTech BID, Fulton Mall Improvement Association, and Court-Livingston-Schermerhorn BID—all of which are operated by the Downtown Brooklyn Partnership (DBP). Each BID is a defined area that is funded by an additional business tax to fund projects within the BID's boundaries, shown in Figure 5. The BID provides services such as cleaning streets and sidewalks, providing security, making capital improvements, construction of pedestrian and streetscape enhancements, and marketing of the area.

³ http://www.forestcity.net/properties/mixed_use/property_listing/Pages/metrotech_center.aspx

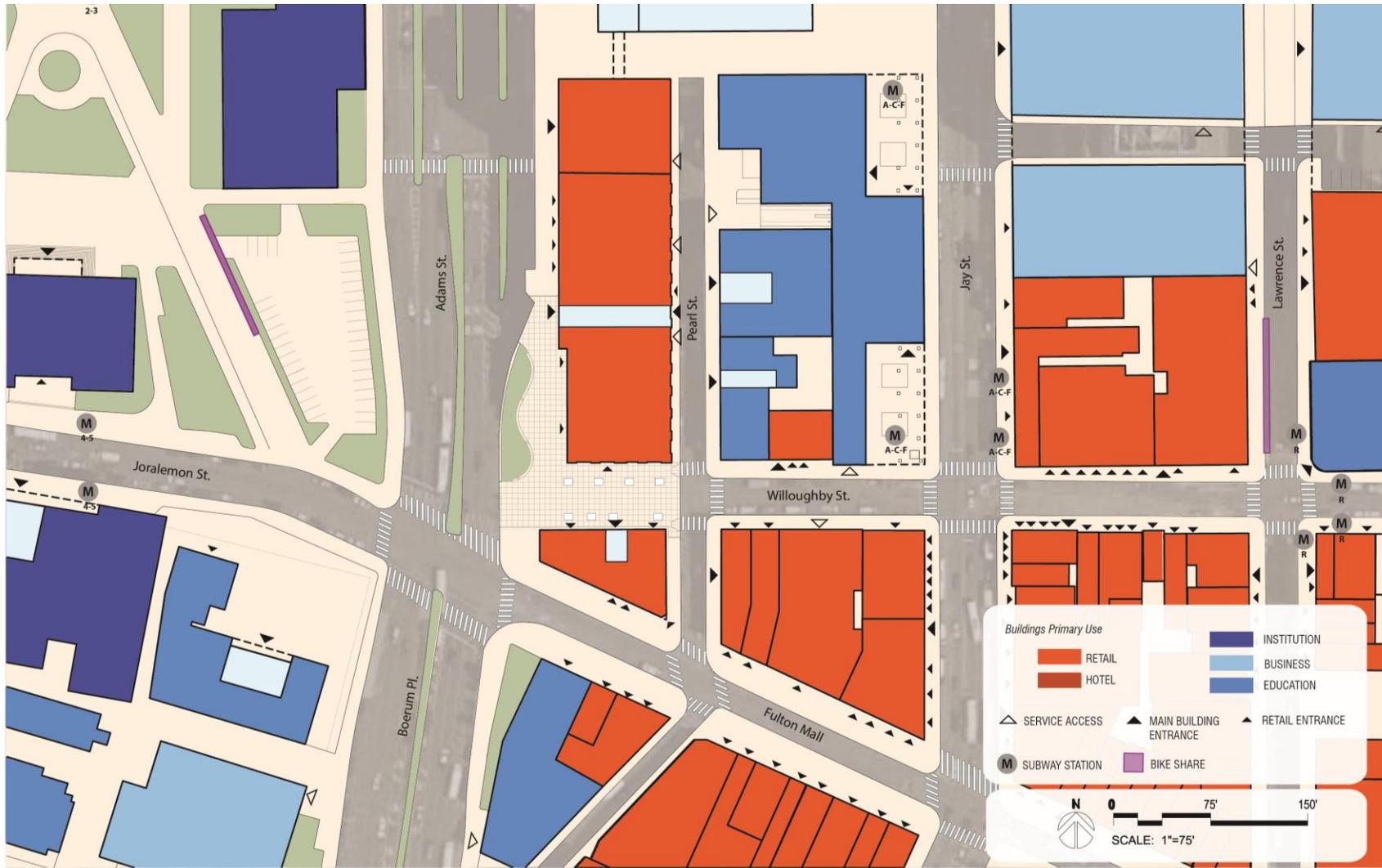


Figure 4: Map of Adjacent Land Use

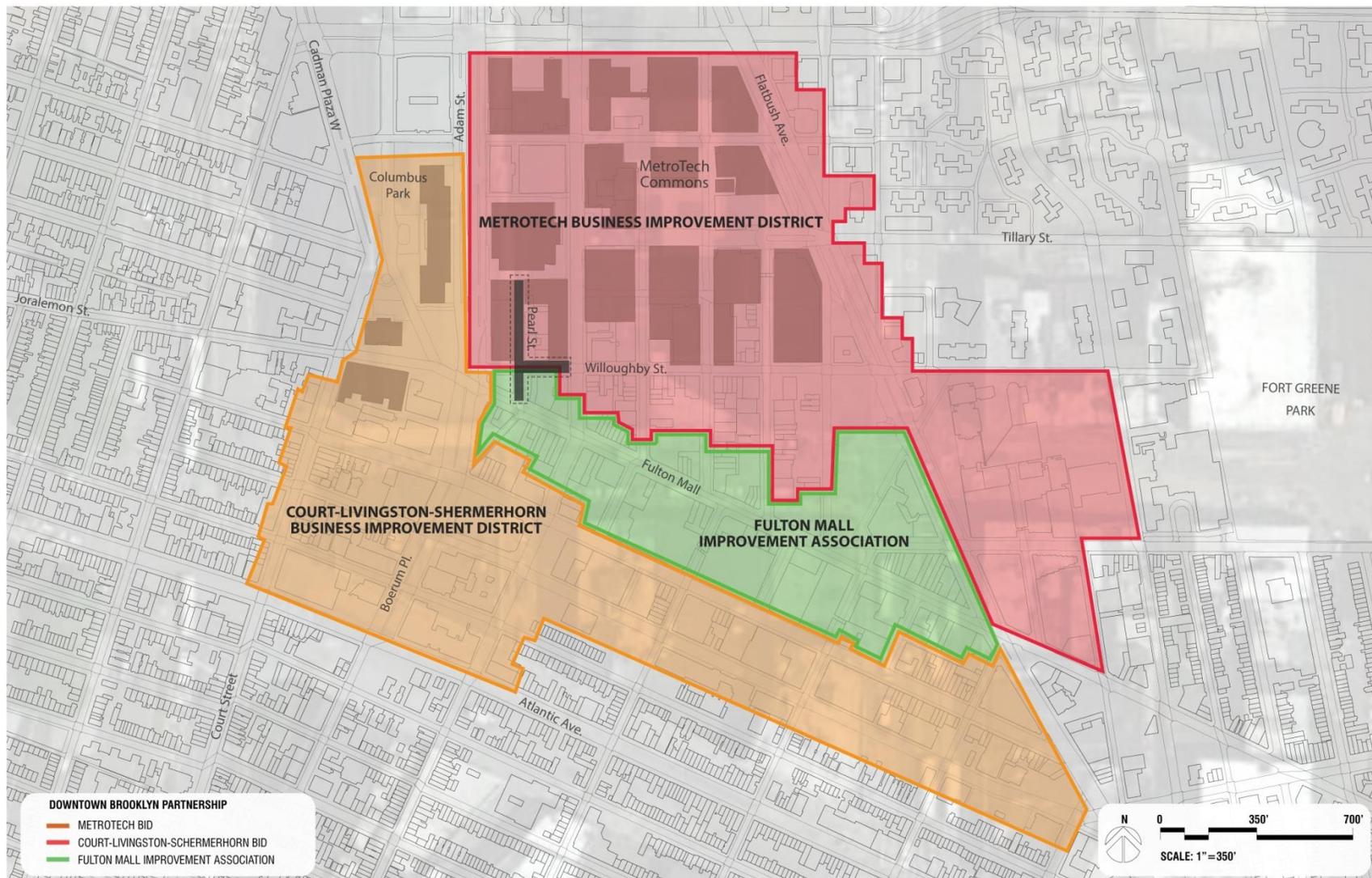


Figure 5: Map of Downtown Brooklyn Partnership and associated Business Improvement District

2 Existing Conditions: Mobility

The following section describes qualitative observations made during six site visits, as well as a quantitative analysis of pedestrian and vehicular activity. Observations on transit access; pedestrian, bicycle, and vehicular mobility; parking and loading are included. Interviews were conducted with local stakeholders, which further informed these observations. The quantitative analysis of pedestrian and vehicular activity is based on traffic counts, and further analysed to better understand key pedestrian and vehicle movements within the site.

2.1 Transit

The Court Street-Borough Hall and the Jay Street-MetroTech stations are located near the study area and therefore heavily influence pedestrian traffic. The subway system is the primary mode of transportation within New York City, averaging 5.5 million weekday rides in 2013.

Court Street-Borough Hall station is located 500 feet to the west of the project site and is the third busiest station in Brooklyn servicing the 2/3, 4/5 and R lines⁴. Station access entrances are clustered at the Brooklyn Borough Hall Park along Joralemon and Court Street. Pedestrian traffic between the station and project site primarily travels through Willoughby Plaza and the Adams Street signalized pedestrian crossing. This was observed as particularly popular thoroughfare for pedestrians on route to nearby government agencies, educational institutes, local businesses and Fulton Mall.

Jay Street-MetroTech station is located in the project site and is the second busiest subway station in Brooklyn, servicing the A/C, F and R lines. The station has multiple points of entries dispersed along Jay Street at the intersections of Myrtle Promenade, Willoughby Street, and Fulton Mall; and along Willoughby Street at the intersections of Lawrence and Bridge Street. Two entrances are located underneath the 370 Jay Street building at the northern and southern corners on Jay Street. The southern entrance, shown in Figure 6, generates traffic directly onto Willoughby Street within the project site. The northern entrance generates pedestrian traffic along the Renaissance Plaza pedestrian walkway, some of which has been observed to use Pearl Street as thoroughfare.

There are some 14 bus lines serving downtown Brooklyn, shown in Figure 7, all but one of which are within three blocks of the project site. Fulton Street Mall, located towards the south of the project site, is a bus mall with bus stops located along its length. This substantial level of bus service in close proximity to the project site is assumed to contribute significantly to pedestrian activity.

⁴ Source for all MTA ridership statistics:
http://web.mta.info/nyct/facts/ridership/ridership_sub.htm



Figure 6: Jay St-MetroTech Station entrance with 370 Jay Street on Willoughby Street



Figure 7: Transportation within Downtown Brooklyn

2.2 Pedestrians

Substantial pedestrian volumes were identified in the project site and surrounding area, which is indicative of nearby subway stations, high-rise office and hotel development, civic and educational uses, and Fulton Street Mall. Despite high pedestrian volumes, significant sidewalk congestion was not observed, except at the northwest corner of Willoughby and Jay Streets near the subway entrance; however, pedestrians often walk in the street and mid-block crossings were also common. This type of behaviour can be indicative of low vehicular traffic volumes, high sidewalk congestion, or sidewalk clutter.

Pedestrian movement and volumes reflect the current environment, which is unwelcoming and confusing for many pedestrians. The appearance of a dead end at the northern terminus of Pearl Street likely discourages many pedestrians from using this as an access route, despite its connection for pedestrians to the Renaissance Plaza pedestrian path. The area lacks wayfinding signage directing pedestrians to nearby subway entries and other notable destinations.

Pedestrian movement is also impeded due to sidewalk clutter which decreases pedestrian comfort and make the sidewalk seem more crowded. Figure 8 shows Willoughby Street with an A-frame advertisement, a sidewalk shed, commercial garbage receptacles and other items that occupy the sidewalk space; Figure 9 shows retail garbage on the sidewalk.

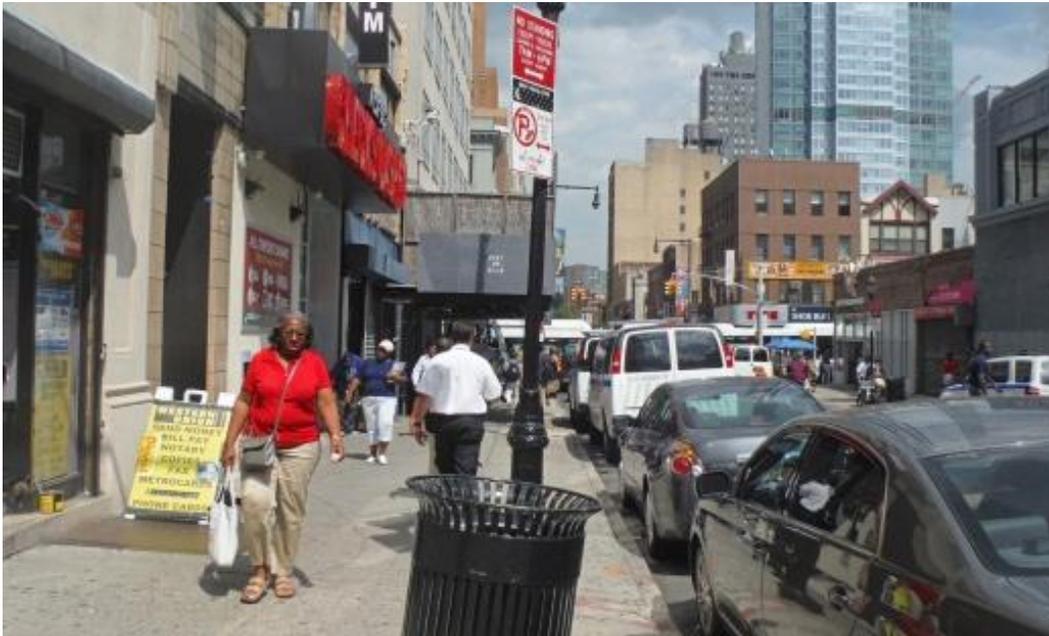


Figure 8: Pedestrians walking along Willoughby Street

Though the existing pedestrian infrastructure is adequate for the existing demand, as the population of Downtown Brooklyn continue to grow, pedestrian mobility will become increasingly inhibited. Further, as nearby retail uses, shown in Figures 8 and 9, continue to transition and draw larger customer bases significant additional pedestrian volumes should be anticipated. Reconstruction of the project

site into a more pedestrian-friendly environment would help to accommodate anticipated growth and better drive customers to adjacent businesses.



Figure 9: Transitioning retail uses along Willoughby Street

Pedestrian Volumes and Desire Lines

American Traffic Information (ATI) undertook an existing conditions pedestrian survey on June 10, 2014. The survey involved counting the number of pedestrians crossing at the following locations:

- Intersection of Pearl Street and Willoughby Street;
- Intersection of Jay Street and Willoughby Street;
- Midblock along Willoughby Street, between Pearl Street and Jay Street;
- Midblock along Pearl Street, between Willoughby Street and Fulton Street;
- and
- Midblock along Pearl Street, between Willoughby Street and the dead end.

Figure 10 shows the location of the pedestrian count surveys. The pink circles represent counts taken at intersection crossings and orange circles represent counts taken midblock at informal street crossings.

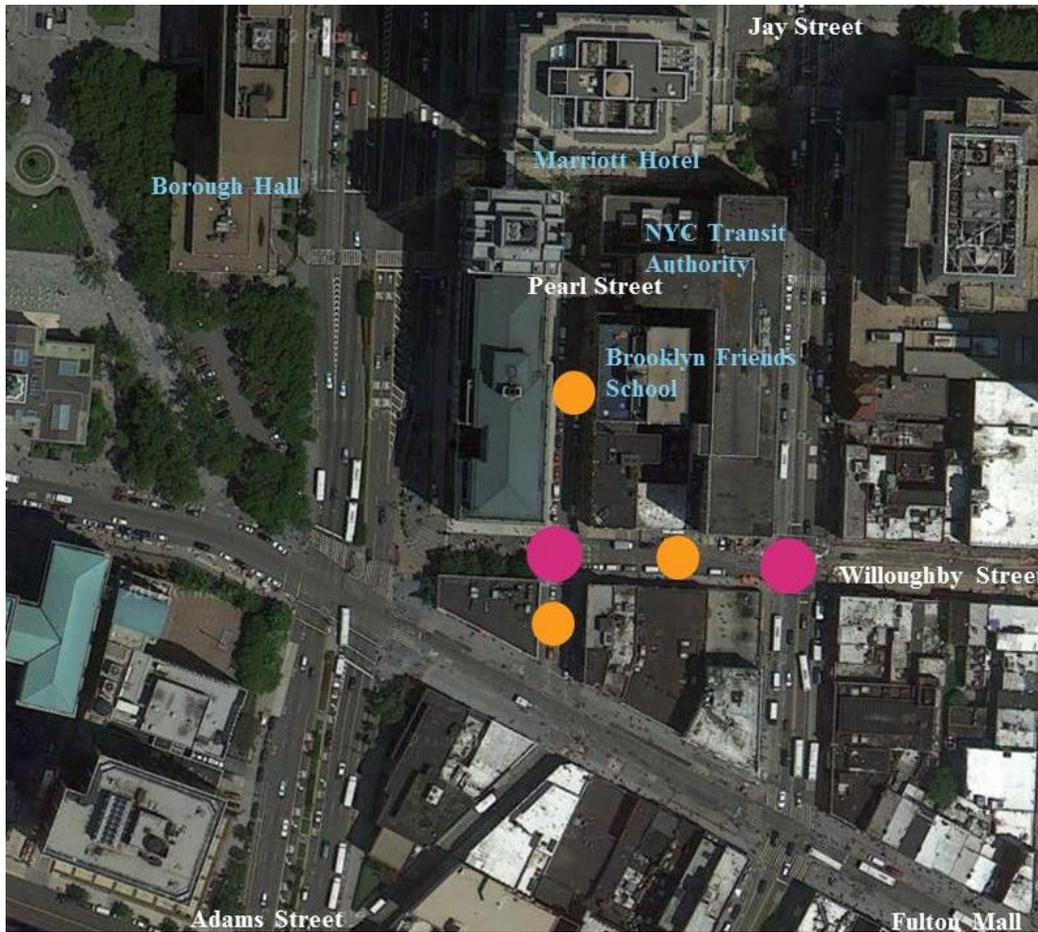


Figure 10: Location of pedestrian survey

The survey was undertaken over three different time periods:

- AM: 7:00–9:00;
- Midday: 12:00–2:00; and
- PM: 5:00–7:00.

These times were chosen to capture the peak periods during the day and also to understand how pedestrian volumes varied during the day at the various crossing locations. The pedestrian counts were undertaken in 15-minute intervals for each two-hour peak period.

The next six figures show pedestrian peak hour volumes during the different peak periods through the day, along with the corresponding main desire lines for that peak period. “Desire lines” represent the heaviest pedestrian flows for each survey period.

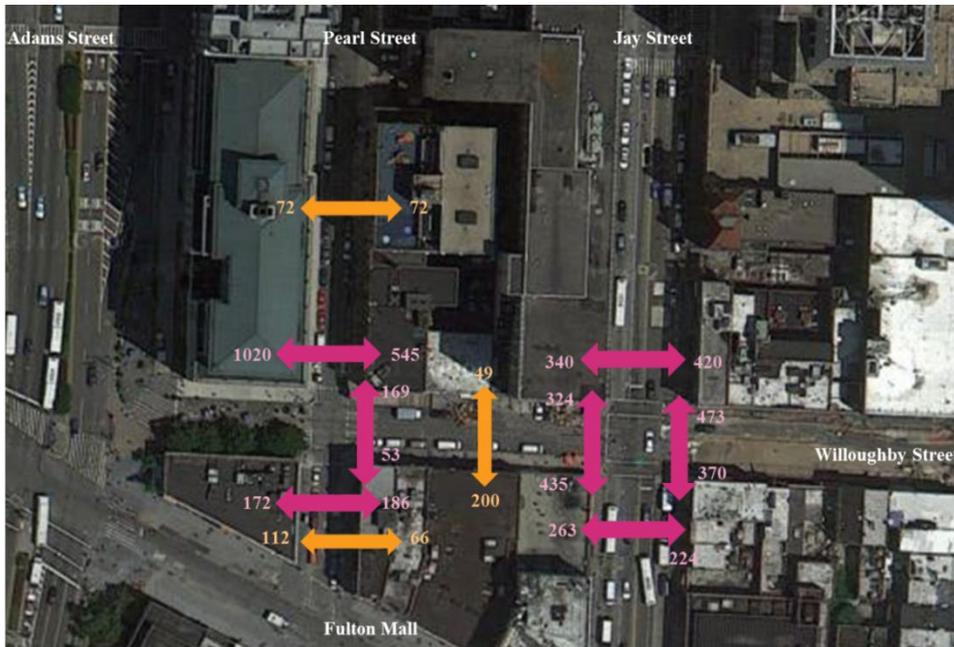


Figure 11: AM peak hour pedestrian volumes

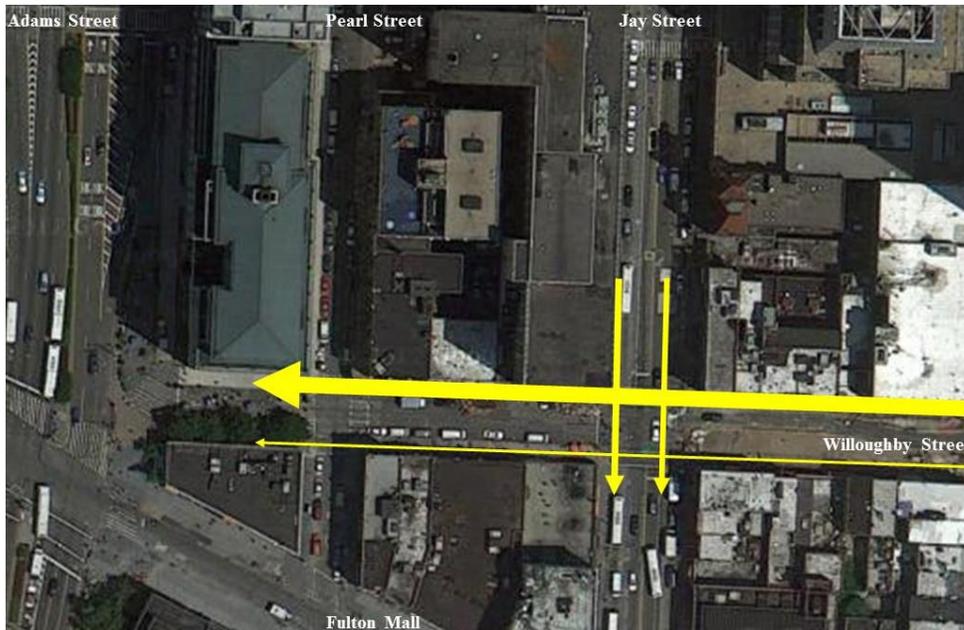


Figure 12: AM peak period main desire lines

In the morning, the most significant pedestrian volumes are seen crossing west from the north-east corner of Willoughby and Pearl Street, towards Willoughby Plaza. A much larger proportion of pedestrians were observed traveling west on the northern side of Willoughby Street, towards Willoughby Plaza, compared to the southern side of Willoughby Street.

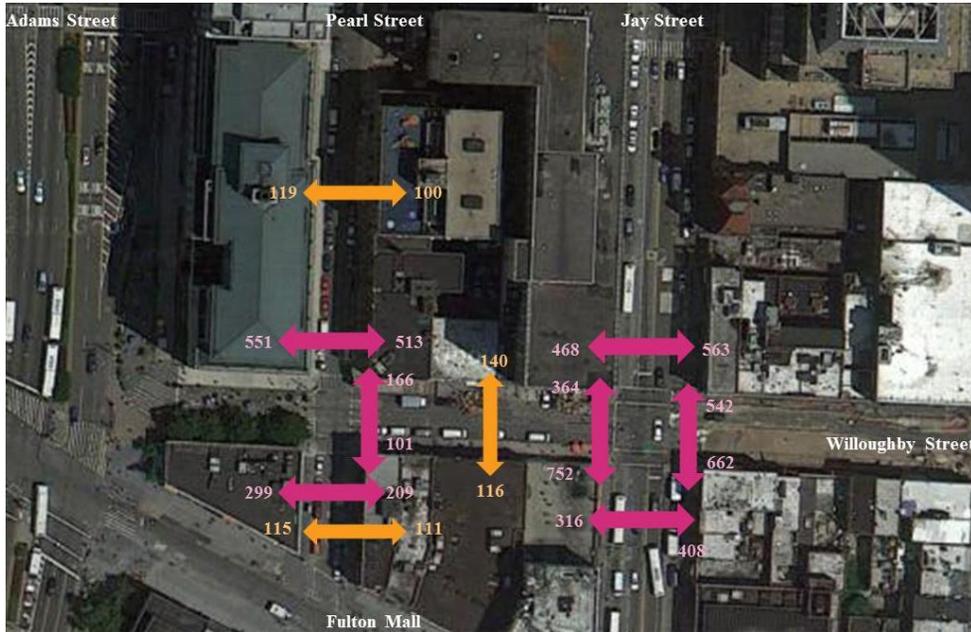


Figure 13: Midday peak hour pedestrian volumes

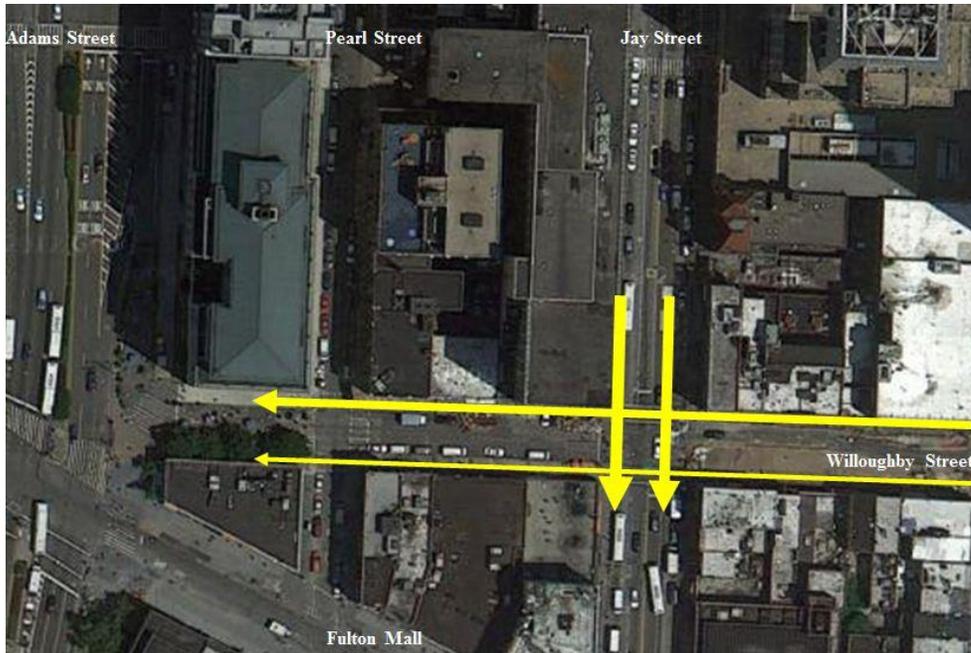


Figure 14 Midday peak period main desire lines

During midday peak hour, the most significant pedestrian volumes are seen crossing south from the corner north-east and north-west intersections of Willoughby and Jay Streets. The Midday peak period is similar to the pedestrian desire lines from the AM peak period, with the main pedestrian flow towards Willoughby Plaza.

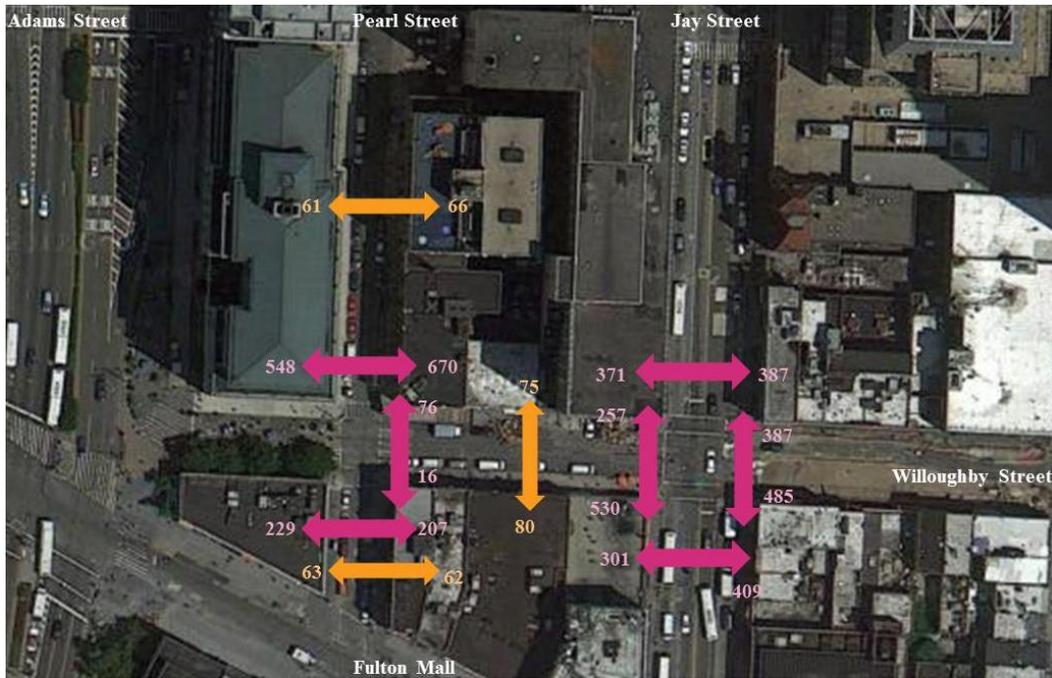


Figure 15: PM peak hour pedestrian volumes



Figure 16: PM peak period main desire lines

During the PM peak the primary desire line is the reverse of the AM peak period, showing more pedestrians walking from Willoughby Plaza and heading eastbound along Willoughby Street. A larger proportion of pedestrians were observed traveling east on the northern side of Willoughby Street, towards Willoughby Plaza, compared to the southern side of Willoughby Street.

During all three peak periods, there is a strong pedestrian flow southbound along Jay Street. This movement is believed to belong to pedestrians accessing Fulton

Mall. The relatively high number of midblock crossings indicated by the data suggests that pedestrians feel comfortable and desire to cross mid-block, due to the low vehicle volumes and the configuration of Willoughby Plaza.

2.3 Vehicles

Just outside the project site major streets, such as Flatbush Avenue, Adams Street, Jay Street, and Atlantic Avenue, channel vehicular traffic on and off the bridges to Manhattan and provide access to the BQE. Therefore, much of the traffic within the project site is slow-moving and local in nature, destined for pedestrian pick-up/drop-off, service or deliveries.

Because Fulton Street is a bus-only corridor, vehicles can only access the project site via Red Hook Lane onto Pearl Street. Drivers wishing to reach the project site have to turn right on Red Hook Lane via Adams Street northbound, which is an indirect route not readily apparent to drivers unfamiliar with the area. From Red Hook Lane, vehicles typically cross Fulton Street to one-way Pearl Street, turning east onto one-way Willoughby Street and exiting onto two-way Jay Street. The northern portion of Pearl Street dead-ends before the Renaissance Plaza requiring vehicles perform a three-point turn to exit via Willoughby Street. As a result of this unusual geometry and the lack of destinations within the study area for vehicles, traffic volumes are low.

2.3.1 Comparing Pedestrian and Vehicular Volumes

Currently, pedestrians far outnumber vehicles at all times of the day. The highest vehicle volumes are at the intersection of Willoughby Street and Jay Street, while the intersection of Willoughby Street and Pearl Street experiences a minimal share of vehicular traffic at all times of the day. The following figures show the pedestrian and vehicle volume comparison at these locations (blue=pedestrians and red=vehicles).

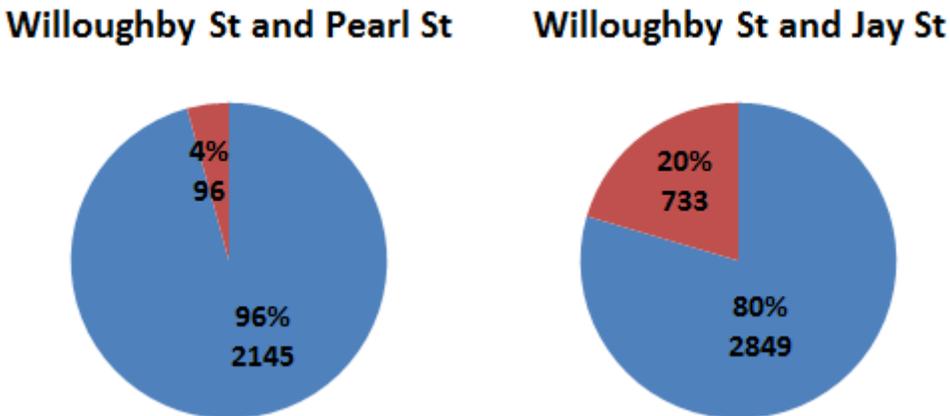
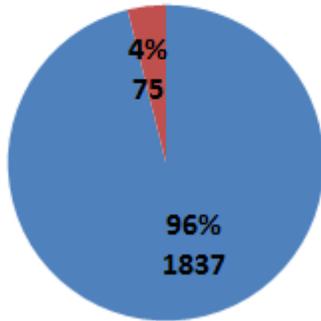


Figure 17 AM pedestrian and vehicle volume comparison

Willoughby St and Pearl St



Willoughby St and Jay St

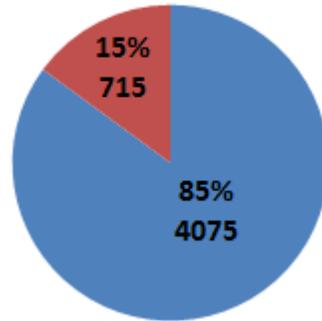
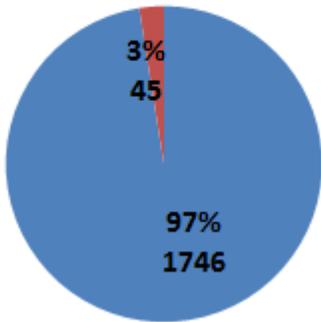


Figure 18 Midday pedestrian and vehicle volume comparison

Willoughby St and Pearl St



Willoughby St and Jay St

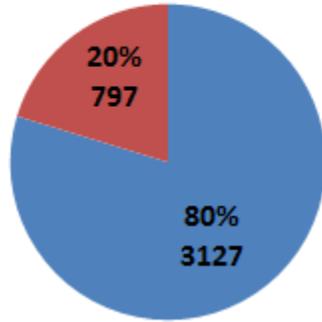


Figure 19: PM pedestrian and vehicle volume comparison

Vehicular Volumes and Intersection Level of Service

The vehicular observations, similar to the pedestrian study, include Willoughby Street from Pearl Street to Jay Street and the segments of Pearl Street from the Fulton Mall to its terminus. Willoughby Street is a one-way local street that connects Pearl Street to Flatbush Avenue and Fort Greene Park. Willoughby is one-way eastbound from Pearl to Jay Street and one-way westbound to the east of Jay. Within the study area, Willoughby has a single travel lane, with commercial loading/overnight parking on both sides, and is lined by many local service retail businesses.

Pearl Street is a low-volume local street. From the Fulton Mall to Willoughby Street, Pearl Street is one-way northbound with a single travel lane and authorized agency on-street parking on both sides. Pearl Street is two-way from Willoughby until it ends one block to the north. The roadway here primarily serves as access to buildings on the block. Jay Street is a major north-south street with one travel lane in each direction, bike lanes, on-street parking, and serves several MTA bus routes.

American Traffic Information (ATI) undertook an existing conditions vehicular survey on June 10, 2014. The analysis focuses on traffic conditions at two intersections:

- Willoughby and Jay Streets (signalized)
- Willoughby and Pearl Streets (unsignalized)

For each intersection, traffic volumes were collected for the morning (AM), mid-day (MD), and afternoon (PM) peak periods.

Additional volumes of drop-offs and pick-ups from the Brooklyn Friends School were observed using a time lapse video of Pearl Street from September 30, 2014, provided by NYCDOT. Only vehicles that entered onto Pearl Street and made a pick-up or drop-off at the Brooklyn Friends School were counted as a part of the additional volumes. The traffic volumes used in the analysis are the combined volumes from the June 10, 2014 and additional September 30, 2014 counts.

Traffic volumes were observed by class (auto, truck, bus, and taxi/limo); however the following figures show the overall total peak hour traffic volumes.

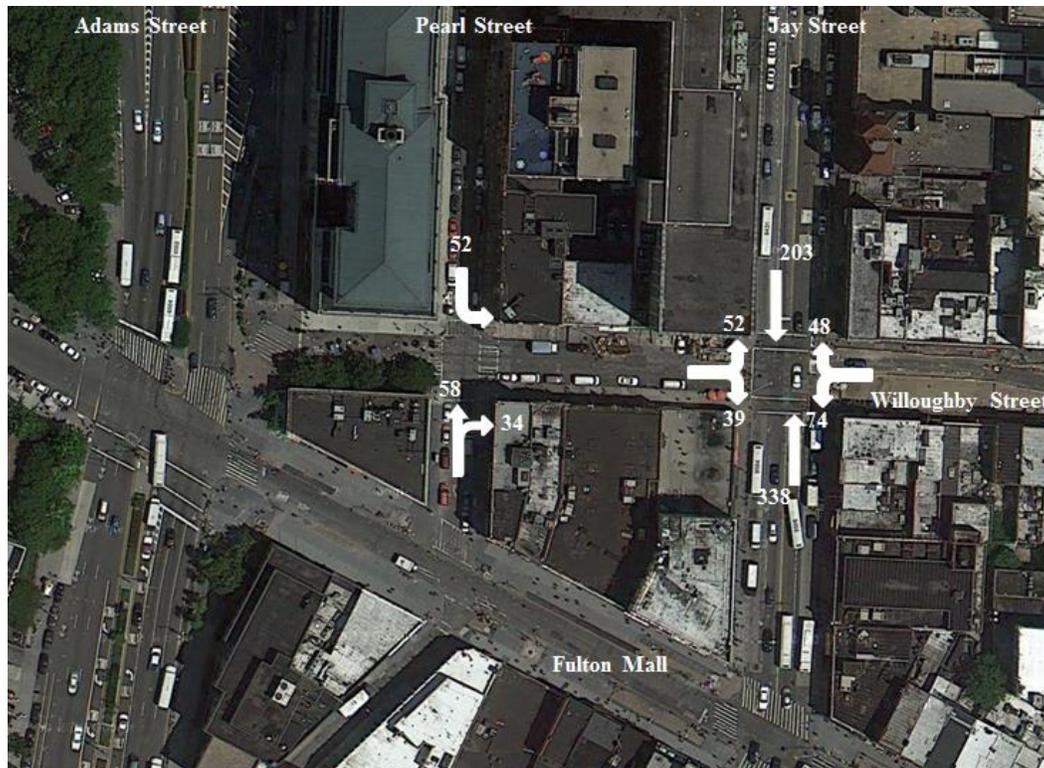


Figure 20: AM peak hour traffic volumes

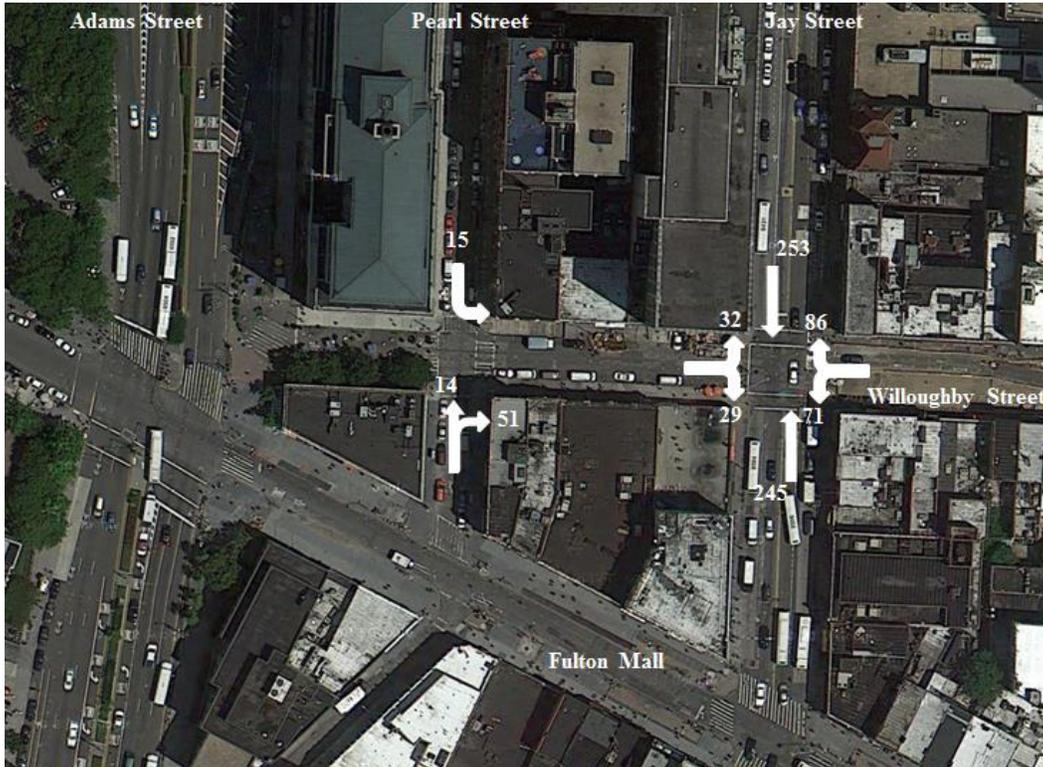


Figure 21: Midday peak hour traffic volumes



Figure 22: PM peak hour traffic volumes

Analysis Methodology

Traffic operations at the study intersections were analyzed using methodologies contained in the *2000 Highway Capacity Manual (HCM)*⁵. The HCM provides analysis methods and equations that estimate the peak hour delay and level-of-service (LOS) experienced by vehicles at signalized and unsignalized (i.e., stop-controlled) intersections. Inputs to the HCM intersection calculations include peak hour traffic and pedestrian volumes, intersection geometrics (number of lanes), traffic signal timing parameters, and other data such as pedestrian volumes and the percentage of trucks.

LOS is a qualitative measure of the effect of a number of factors, including speed and travel time, traffic interruptions, freedom to maneuver, driving comfort, and convenience. LOS is designated A through F from best to worst, which covers the entire range of traffic operations that might occur. LOS A through E generally represent traffic volumes at less-than-roadway capacity, while LOS F represents over-capacity and/or forced flow conditions. These conditions are described for intersections in Table 1.

⁵ Transportation Research Board, 2000

Table 1: Intersection LOS criteria

LOS	Signalized Intersections	Two-Way and All-Way Stop-Controlled Intersections
A	Delay of 0 to 10 seconds. Most vehicles arrive during the green phase and do not stop at all.	Delay of 0 to 10 seconds. Gaps in traffic are readily available for drivers exiting the minor street.
B	Delay of 10 to 20 seconds. More vehicles stop than with LOS A, but many drivers still do not have to stop.	Delay of 10 to 15 seconds. Gaps in traffic are somewhat less readily available than with LOS A, but no queuing occurs on the minor street.
C	Delay of 20 to 35 seconds. The number of vehicles stopping is significant, although many still pass through without stopping.	Delay of 15 to 25 seconds. Acceptable gaps in traffic are less frequent, and drivers may approach while another vehicle is already waiting to exit the side street.
D	Delay of 35 to 55 seconds. The influence of congestion is noticeable, and most vehicles have to stop.	Delay of 25 to 35 seconds. There are fewer acceptable gaps in traffic, and drivers may enter a queue of one or two vehicles on the side street.
E	Delay of 55 to 80 seconds. Most, if not all, vehicles must stop and drivers consider the delay excessive.	Delay of 35 to 50 seconds. Few acceptable gaps in traffic are available, and longer queues may form on the side street.
F	Delay of more than 80 seconds. Vehicles may wait through more than one cycle to clear the intersection.	Delay of more than 50 seconds. Drivers may wait for long periods before there is an acceptable gap in traffic for exiting the side streets, creating long queues.

Source: *Highway Capacity Manual (Transportation Research Board, 2000)*

Analysis Findings

As shown in Table 2, the LOS results are all LOS C or better, which indicate that traffic conditions in the study area are within acceptable operating standards. The Willoughby/Jay intersection has a slightly worse LOS than the Willoughby/Pearl intersection given the higher traffic and pedestrian volumes and heavy vehicle percentages of ten percent or higher. These findings are consistent with field observations.

Table 2: LOS analysis

Intersections	Existing LOS / Delay		
	AM	MD	PM
Willoughby / Jay	C / 24.7	C / 32.8	C / 28.2
Willoughby / Pearl	A / 7.4	A / 6.9	A / 7.1

2000 HCM for Signals and Unsignalized Intersections
Unsignalized LOS is reported for the worst side-street approach



Figure 23: Pearl Street approach to Willoughby Street, looking south towards Fulton Street Mall

Crash History

Crash history from 2008 – 2012 was examined at the following intersections:

- Pearl Street, Red Hook Lane and Fulton Street;
- Willoughby Street and Jay Street;
- Pearl Street and Willoughby Street; and
- Pearl Street and Renaissance Plaza.

During 2008 – 2012, none of the above four intersections experienced any fatalities. The intersections of Pearl Street, Red Hook Lane and Fulton Street, and Pearl Street and Renaissance Plaza showed zero incidents during the five year period.

The intersection of Willoughby Street and Jay Street shows a total of 32 injuries occurring during 2008 – 2012, with 2 severe injuries. The following tables show in detail the severity of injuries and the number of injuries occurring during 2008 – 2012.

Table 3: Willoughby Street and Jay Street injury severity 2008 – 2012

Severity	Pedestrian	Bike	Motor Vehicle
Severe	0	1	1
Moderate	4	0	1
Minor	11	2	11
Unknown	1	0	0
Total	16	3	13

The majority of the pedestrian injuries, a total of 3 out of 16, occurred between 6:00pm and 9:00pm.

Table 4: Willoughby Street and Jay Street injury by year

Year	Pedestrian	Bicyclist	Motor Vehicle
2008	2	0	5
2009	5	1	4
2010	4	0	1
2011	4	2	2
2012	1	0	1
Total	16	3	13

The intersection of Pearl Street and Willoughby Street shows 1 minor incident occurring in 2011 for a motor vehicle.

The average number of people killed or severely injured (KSI) in a five year period at Brooklyn intersections where KSIs were reported is 2.13⁶. With two severe injuries (one cyclist and one driver), the safety at Willoughby and Jay Streets is roughly on par with the Borough-wide average, however, improved safety at the intersection of Willoughby and Jay Streets should be a focus in the street redesign. While most pedestrian accidents were categorized as “minor,” pedestrian safety should also be improved and may indicate that pedestrians exiting the adjacent subway station are at risk. With no accidents reported in the remainder of the project site, however, indicates the safety has not been an issue, despite frequent mid-block crossings.

Parking and Drop-Off Activity

On-Street Parking

According to the signed regulations, Pearl Street is a no standing zone with exceptions for Board of Elections and Department of Finance vehicles at designated locations. Department of Finance vehicles are permitted toward the southeastern end and Board of Elections vehicles are permitted toward the west

⁶ New York State Department of Transportation/New York State Department of Motor Vehicles Accident Database

end of Pearl Street. The signed regulations identify Willoughby Street as a “No Permit Zone.”

Despite signs to the contrary, many vehicles park along Pearl Street, as shown in Figure 24. During several site visits, Pearl Street was found to be unlawfully occupied by private vehicles and governmental bodies not sanctioned for the location (District Attorney and Police Department Vehicles were observed). Vehicles were also observed parked in the no standing area in front of the Brooklyn Friends School and ASA Institute, and in the middle of the intersection alongside the Willoughby Plaza. It has been identified by user groups that illegally parked vehicles become obstacles to the daily functioning of the street.



Figure 24: Placard parking on Pearl Street

Off-Street Parking

The adjacent New York Marriott at the Brooklyn Bridge Hotel has a 1,100 space parking garage. Garage access is located at Adams Street and Jay Street towards the north of the study area. Nearby off-street parking is available in numerous other facilities in Downtown Brooklyn.

School Drop-Offs

The Brooklyn Friends School is located within the study area and fronts the northern portion of Pearl Street as shown in Figure 25. Though many students arrive by foot or transit some parents use their vehicles for pick-up and drop off their children. Many of the parents who drive their children to school drop them off on Willoughby Street, with students walking the short distance to the school entrance on Pearl Street. The parents of younger children often drive all the way to the entrance on Pearl Street and make a difficult U-Turn or three-point turn when leaving. This situation, combined with illegal parking, can make for a car dominated and chaotic environment on Pearl Street. Peak drop-off times are 7:30-8:30 in the morning, and 2:45-3:30 in the afternoon. For field trips, Brooklyn Friends School utilizes buses that load passengers on Adams Street.



Figure 25: Parents and children on Pearl Street outside Brooklyn Friends School

Loading & Unloading

The northern portion of Pearl Street terminates into the Marriott's Renaissance Plaza. At present, vehicles utilize the 370 Jay Street building's driveway for U-turn maneuvers before exiting out to Jay Street via Willoughby Street.

The northern portion of Pearl Street is the location of many service elevators of the surrounding buildings. The elevator to the New York Marriott at the Brooklyn Bridge tower is located toward the north of Pearl Street. 370 Jay Street building's elevator stack, shown in Figure 26, is located opposite toward the north, this access will be particularly critical in the near future during the construction stages as NYU-CUSP reoccupy the building.



Figure 26: 370 Jay Street loading dock at the end of Pearl Street

345 Adams Street building has a number of restaurants including Hill Country Barbeque Market, Panera, Orange Leaf, and the soon to be opened Rocco's Tacos. Most of these businesses front onto Adams Street with back of house functions on Pearl Street. Typical behavior is that vehicles park on Adams Street and load directly into the establishment as per the regulations, however there are some exceptions. The Rocco's Tacos location, under construction at the time of observation, had been observed loading from Pearl Street due to low volumes and ease of access. Hill Country Barbeque Market has been observed loading from Willoughby Street and then hand-carting goods into the establishment. Hungry Jacks located south of the 345 Adams Street building, has been observed loading from vehicles parked along Willoughby Plaza.



Figure 27: 370 Jay Street building loading access along Willoughby Street

With the conversion of Fulton Street Mall into a pedestrian-oriented street with a dedicated busway in 1973, retail loading for businesses on the north side of Fulton Street was shifted to Willoughby Street. Business fronting on Willoughby Street, such as Blimpie and Buffalo Boss, also use Willoughby Street for loading. 370 Jay Street has a service entrance on Willoughby Street, shown in Figure 27, which will be converted into active frontage when NYU-CUSP occupies the building.

2.4 Cycling

Significant levels of cycling traffic were not observed during morning, afternoon, and evening observations during the month of July; however, stakeholders identified a demand for bike parking, which suggests that many local building users use bicycles to access the area. Heavy bicycle traffic is instead more common just outside the study area on Adams and Jay Streets, which both have dedicated bike paths and connect cyclists with the Brooklyn and Manhattan Bridges. Willoughby Street is not an optimal cycling route because Willoughby Plaza inhibits cycling movement and therefore disrupts the potential for east-west connections through the project site. Similarly, Pearl Street dead-ends into the Renaissance Plaza pedestrian path that, although doesn't expressly prohibit cyclists, has high pedestrian activity that makes cycling difficult.

CitiBike has two docking stations nearby the study area. The first is located west of the study area adjacent to Borough Hall, on the corner of Adams Street and Joralemon Street. The second CitiBike docking station is located two blocks east of the site, at the northeast corner of Willoughby Street and Lawrence Street.

Bike Parking

Brooklyn Friends School provides private bike parking to staff and students on-site. Anecdotally, biking has been identified as popular means of transport for parents, students and staff. Bike parking is available to the commercial tenants

occupied in the upper floors of the 345 Adams Building and the New York Marriott at the Brooklyn Bridge Hotel⁷. Bikes parked ad hoc to the construction scaffolding indicate a need for additional parking shown in Figure 28.



Figure 28: Existing bike parking in the study area

⁷ Applies to commercial office buildings with at least one freight elevator
<http://www.nyc.gov/html/dot/html/bicyclists/bikesinbuildings.shtml>

3 Existing Conditions: Character and Environment

This section describes observations of the character and environment of the project site and surrounding area, including general character, pedestrian gathering areas and public open space, landscape/hardscape, views and view corridors, availability of sunlight, noise, and safety. The observations were further informed by interviews conducted with local stakeholders.

3.1 General Character

Despite many positive characteristics of the adjacent area, the street character of project site itself is degraded. Crowded with parking at the curbs, trash storage on the sidewalks, a cacophony of traffic signals and signs (see Figure 29), and without trees, the space does not perform well for passenger vehicles, service operations, pedestrians, or bicyclists. This is reflected in the relatively under-optimized utilization of the commercial space, although that is beginning to change with the introduction of Willoughby Plaza to the immediate west of the site.



Figure 29: Sign clutter at Willoughby and Pearl Streets

In the immediate vicinity of the project site, there are significant built assets, as well as some structures not currently utilized at the highest and best uses of the existing zoning. The large 345 Adams Street building on the west side of Pearl

Street has the potential to be renovated, restored, and upgraded. 370 Jay Street on the west side of Jay Street is going through with renovations that will restore, and upgrade the building with new educational and retail programming. However, on the south side of Willoughby Street are a collection of lower scale buildings that are occupying sites that may be considered for development at a much greater scale. Pearl Street between Willoughby and Fulton Streets is currently de-mapped, so a development on this site may (or may not) include the small triangle building currently housing Shake Shack. This building may have some historic significance and could play a role as a pavilion-like structure within a larger development plan for the area.

3.2 Architecture

The three blocks that constitute the project site present a range of architectural conditions.

The buildings facing the northern section of Pearl Street are significant assets. 345 Adams Street, a 13-story building constructed in the mid-1920s was recently rehabilitated on its lower two floors. The renovation has restored the original Renaissance style building by opening the arched windows along the façade to their original height, and restored mouldings and lighting details. Given that the building is located on a uniquely narrow block, 345 Adams Street reveals itself in all three sides. Currently the ground floor houses various active restaurants along Adams and Willoughby Streets. However, active uses of this building do not yet extend along Pearl Street. The retail spaces, now inactive, could play a role in potential future developments.

The seven-story building at 375 Pearl Street, now occupied by Brooklyn Friends School but originally designed as the Brooklyn Law School, is a beautiful, well maintained Art Deco building constructed in 1928. Its limestone ground floor is composed of various ornamental features including tile sunburst patterns and detailed reliefs along the main entrance.

While now in a dilapidated condition, the former 370 Jay Street at 370 Jay Street was once seen as an example of post-war modernism. Recently acquired by NYU, the building is being renovated to become a contemporary, energy efficient, high-tech structure. This new construction is expected to revitalize the surrounding spaces that have been unused for years, and will improve the public environment for the daily commuters of the A-C-F lines, also located at this address.

While the rest of the architecture along Willoughby and the south section of Pearl Street include currently underutilized 1 - 2 story retail buildings, recent new developments in the area are expected to affect changes to these structures. In particular, the block bounded by Pearl, Willoughby, Jay, and Fulton Streets may experience new development. Together with the pedestrian-oriented public realm designs for Willoughby and Pearl Streets, the project area is expected to become an active and vibrant place for public use in the near future.

3.3 Pedestrian Gathering Areas and Public Open Space

Pedestrians gather at nearby Willoughby Plaza, which has become a popular public space since its construction using temporary materials in 2006, with a capital build-out in 2013. The Plaza's adjacent restaurant uses, such as Shake Shack and Hill Country Barbeque Market, spill into the plaza, which contains fixed and movable seating for the general public. Pedestrians also gather along Willoughby near restaurant uses, such as the Blimpie sandwich shop and the newly opened Buffalo Boss. Along Pearl Street, pedestrians dwell in front of the recessed lobbies, particularly of the Brooklyn Friends School, shown in Figure 30, the ASA Institute building and 345 Adams Street.



Figure 30: Pedestrians mingling outside of Brooklyn Friends School on Pearl Street

In addition to Willoughby Plaza, the surrounding area includes a notable number of publicly accessible green spaces. Fort Greene Park at the eastern terminus of the Willoughby view corridor provides for a range of passive and active outdoor recreation options. Midway along the same corridor, the proposed new Willoughby Square Park promises to provide new, high-quality outdoor public space. Columbus Park and Cadman Plaza Park to the west of the site, provide significant green space; however, they are currently underutilized as such. The southern end of Columbus Park, closest to the project site, is currently used as a parking lot.

And farther to the west of our project site, the city has recently proposed the creation of the “Brooklyn Strand” a linear outdoor public space that will connect Joralemon Street to the northern edge of Brooklyn Bridge Park shown in Figure 31. At the western terminus of Joralemon Street, an underpass beneath the BQE

provides one of the few direct access points to the Brooklyn Bridge Park. Since Joralemon Street is the western extension of Willoughby, this east/west axis, bookmarked by major outdoor recreational spaces and punctuated by other parks suggests the potential for a new “Green Connection.”



Figure 31 Green connections in Downtown Brooklyn

3.4 Landscape/Hardscape

As noted previously, there is an absence of trees on the six blocks of sidewalks within the project area. Brooklyn Friends School has small, well-maintained planters along the front of their building; the only green relief for that section of Pearl Street. At the terminus of Pearl Street, along the Marriott’s Renaissance Plaza there are elevated landscaped features with trees maintained by the Marriott Hotel. The new Willoughby Plaza maintained mature trees and planted additional ones creating an appealing pedestrian environment shown in Figure 32.

The paving material throughout the study area is primarily asphalt roadways with concrete sidewalks and granite or steel-faced concrete curbs.



Pearl Street shaded by buildings



To the east, busy Adams Street



To the west, noisy Jay Street



Mature Trees along Willoughby Plaza providing shade

Figure 32: Collage of views depicting the local character

3.5 Views and View Corridors

Figure 33 shows a view corridor east along Willoughby Street. The Prison Ship Martyrs' Monument provides the street with a view of an important landmark, drawing the eye east toward Fort Greene Park. Consistent lighting and banner standards contribute some sense of order to an otherwise “messy” streetscape. Looking west, Willoughby Plaza establishes a pedestrian-oriented environment, with the street trees on the south side creating a more intimate scale. Views terminate across Adams Street at the Brooklyn Law School.



Figure 33: Looking east on Willoughby Street towards Fort Greene Park

Views north up Pearl Street from Willoughby Street do not present an attractive or inviting image. Trash bags, dumpsters and service doors dominate the view, as shown in Figure 34. The south façade of the Marriott presents a monolithic wall at the terminus of Pearl Street, providing no indication of any reason to walk to the end of the street. On the north end of Pearl Street, the loading dock at the NYU building occupies an extended section and dominates the views looking south from the end of Pearl Street. The gate at the end of Pearl Street similarly serves to send a visual cue that the midblock pedestrian crossing is disconnected from Pearl Street. Views south at the intersection of Willoughby and Fulton Streets look through to the Fulton Street retail corridor, which terminates at the corner of Fulton and Pearl Streets.



Figure 34: Unattractive views looking north on Pearl Street

3.6 Availability of Sunlight

Pearl Street is flanked on either side by tall buildings such as the historic 345 Adams Street, New York Marriott at the Brooklyn Bridge Hotel, 370 Jay Street and the Brooklyn Friends School. The north-south orientation of the street results in Pearl Street being in constant shadow. In contrast, Willoughby Street is flanked by low 1-2 story buildings toward the south side which ensures generous daylight exposure to the street. Mature street trees along Willoughby Plaza thrive in these conditions.

3.7 Source of Noise Pollution

The study area is located between two busy streets, Jay Street and Adams Street which are the primary sources of noise. Jay Street, to the east is classified as a minor arterial street and to the west Adams Street is classified as a primary arterial street. The built form along Jay Street and Adams Street buffers noise creating a quiet refuge along Pearl Street. However, the presence of loud exhaust fans at the northern end of Pearl Street was noted during one site visit and may detract from the otherwise peaceful nature of the street. There is also minimal periodic noise from delivery vehicles and during school pick-up/drop-off times.

Willoughby Street is more exposed to noise from traffic and connects to the activity on Fulton Street. A lack of trees and soft surfaces results in the noise not being diffused.

3.8 Perception of Safety

Willoughby Street is in a state of transition. Along Willoughby Street many buildings do not activate street life and do not offer passive surveillance and a sense of safety. On street level there is a lack of engaging land uses and a lack of active store frontages.

The present condition of the entrance to the Jay Street-MetroTech subway station is a particular example; it has poorly lit atriums, lacks active street frontages and lacks an overall perception of safety. There are plans to rectify this condition in the plans for the NYU-CUSP refurbishment of the building.

Despite these degraded conditions, actual crime level is not high within the project site as shown in Figure 35. Over the last three months crime activity has occasionally occurred on the surrounding study area, specifically along Fulton Street Mall between Adam and Jay Street and at the intersection of Jay St. and Willoughby St. These crimes include ten grand larcenies and one felony assaults.⁸

⁸ New York City Police Department, New York City Crime Map, August 2104, available at <http://maps.nyc.gov/crime/>

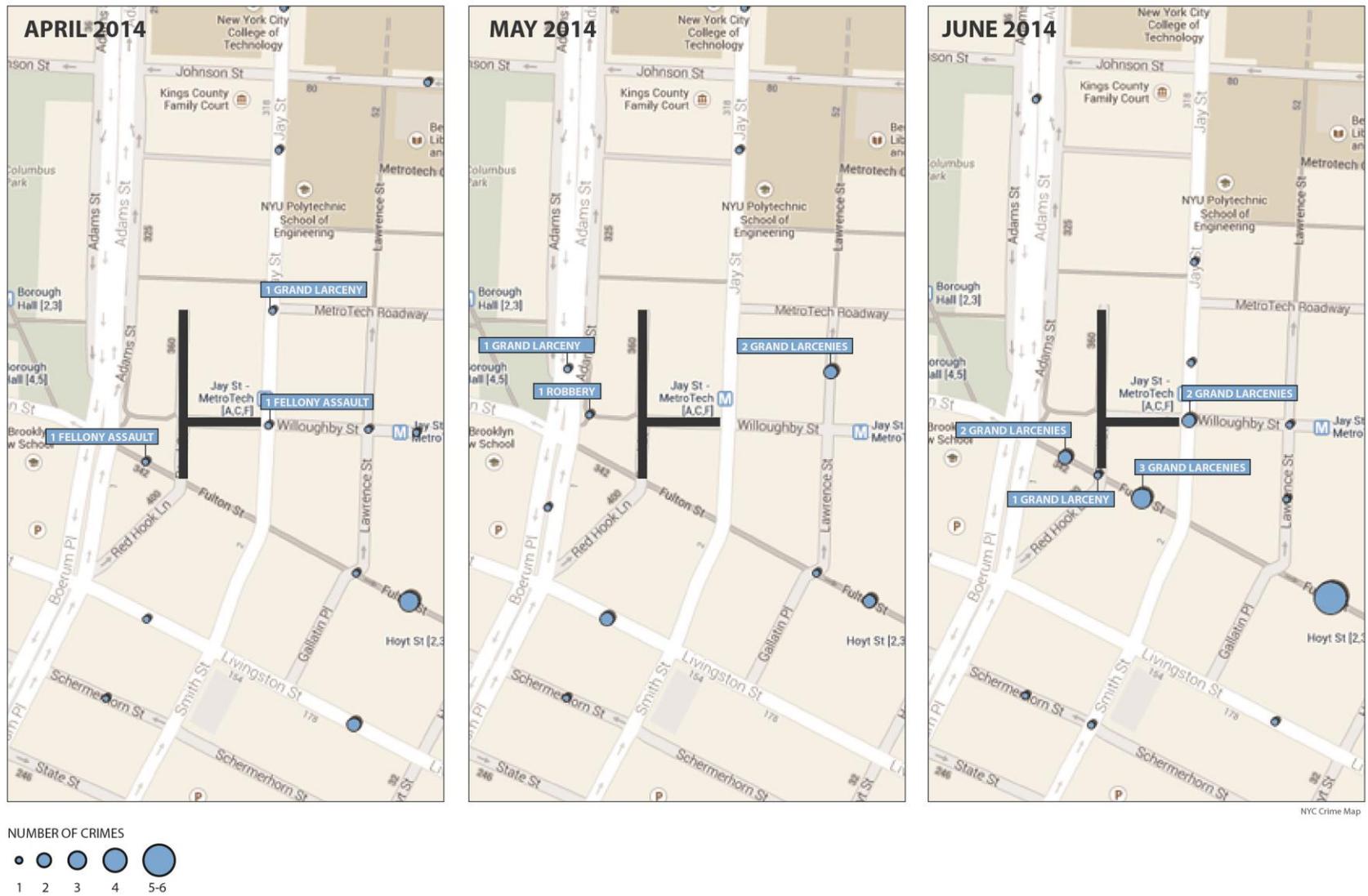


Figure 35 Crime levels over the past 3 months (source: New York City Police Department, New York City Crime Map, August 2014)

4 Key Issues and Opportunities

Through pedestrian and vehicular analyses, site observations and stakeholder interviews, several key issues and opportunities emerged. An understanding of these issues will allow for a more informed development of conceptual design alternatives. Key issues and opportunities are as follows:

Mobility

- Pedestrians already dominate mobility patterns within the site; providing a safe and more attractive environment will likely further enhance mobility and access.
- There is an opportunity to incorporate public art features and wayfinding elements as a means place making and provide an ease of navigation.
- Cycling activity is primarily local, and consists of cyclists accessing uses within the project site. There appears to be an unmet demand for bike parking, and the expansion of bike parking within the street may further encourage bicycle usage.
- Crash data indicate a safe environment for all modes and the ability for all modes to share space. The need for loading and waste pick-up at adjacent uses will need to be carefully considered in the project design.
- The dead-end nature of Pearl Street poses both an issue and opportunity for the project design, as it can emphasize the street as a public open space that prioritizes pedestrians, but can make necessary loading and unloading difficult.
- Illegal vehicular parking is a significant issue and project design should reinforce parking restrictions or consider eliminating the provision of parking altogether.
- Although full pedestrianization of the project area is infeasible due to loading and drop-off requirements, “pedestrian only” periods where the space is closed to vehicles should be explored.

Character & Environment

- Because the surrounding area is in transition and development has been happening at a brisk pace in recent years, the project will need to consider both the existing and potential future environment surrounding the site.
- The success of Willoughby Plaza as a public open space can be leveraged to reimagine the project site as a space more equitably shared by all modes.
- Chairs and tables in the Willoughby Plaza are often used to capacity and pedestrians were noted gathering within the project site without a place to sit, which both indicate a potential unmet demand for seating.

- Visual appearance of the existing site is somewhat degraded and surrounding uses have great potential of benefitting from a reconstructed street with more thoughtful streetscape design and amenities.
- The project site has tremendous potential for leveraging views and connection to Fort Greene Park, as well as supporting the “Brooklyn Strand” concept that will use a series of green spaces to connect Borough Hall with the northern end of Brooklyn Bridge Park.
- With the presence of Brooklyn Friends School and their expressed need for more play space, treatments that safely accommodate children at play should be considered.
- Tall buildings that produce significant shade along Pearl Street, and which may produce significant shade along Willoughby Street following future potential development, will affect landscaping opportunities.
- Opportunities for enhanced lighting for aesthetics and to ensure appropriate lighting levels should be explored.

5 Pedestrian Priority Streets

In tandem with research, analysis, and observations associated with existing project site conditions, a review of relevant precedents was undertaken to help inform conceptual design for the project area. Precedent research focused on “pedestrian priority streets” implementation, as the project site was previously identified as a pilot project for this type of street design. This approach is cited in NYCDOT’s Street Design Manual as a pilot application.

5.1 What is a pedestrian priority street?

A pedestrian priority street is a street that allows all users – pedestrians, bicyclists, and vehicles – to move within the same space, but where pedestrian movement is prioritized, as shown in Figure 36. Pedestrian priority streets, sometimes called shared streets, often provide a pedestrian priority zone where vehicles are allowed but must yield to pedestrians, challenging the common concept that streets should be designed primarily for automobiles. These street environments encourage visual and personal communication between pedestrians and motorists to avoid conflicts, promoting slow vehicular speeds and relatively unconstrained pedestrian movement.

Pedestrian priority and shared streets have been adopted across an incredibly wide spectrum of street types and densities throughout the world. In places like Copenhagen, Denmark, these streets have been part of the urban fabric for generations. In the Netherlands, many northern cities have moved to strip away devices such as curbs, signs, road markings, traffic signals and other vehicle oriented design elements to an approach that presents the vehicle as a guest in the roadway. In more dense cities such as Seoul, Korea and Tokyo, Japan, pedestrian priority streets have become the primary design basis for a number of areas characterized by heavy pedestrian traffic, significant ground floor retail and low vehicle movements. In the United Kingdom, Australia and the United States, shared spaces have been created around residential streets, short retail corridors and in very active areas. Because non-traditional street design methods are employed, special attention must be paid to accessibility by people with disabilities, particularly the visually impaired, so that safety is provided for all users.

Streets are often described as the largest and most prevalent public spaces in cities but their value to the pedestrian is often restricted given limited space allocation within the overall right of way. Pedestrian priority streets propose to redefine the streetscape and apportion the majority of space to the major user group – pedestrians. Through great urban design, these streets can become an extension and expansion of the city’s open space, putting people first and creating a vibrant public realm.



Figure 36: Shared street in Copenhagen, Denmark

5.2 Pedestrian Priority /Shared Street Precedents

5.2.1 Winthrop Street in Cambridge, MA



Figure 37: Winthrop Street Photo & Aerial

Winthrop Street was a neglected street located in the Harvard Square neighborhood of Cambridge, Massachusetts. With narrow sidewalks and low traffic volumes, pedestrians would often overflow into the street. Additionally, the street was not ADA compliant. In 2007 as part of the Harvard Square Improvement Project, the City of Cambridge turned Winthrop Street into a shared street by removing curbs, designing flush surfaces with unique pavers, and installing bollards to define the space and planters to enhance the pedestrian environment, seen in Figure 37. The City's Traffic Regulations designate a shared street as "a public right-of-way without a designated sidewalk, where users are permitted to use the entire public right-of-way" shown in Figure 38. The space is

regulated with a speed limit of 10 mph with vehicles and bicycles yielding to pedestrians. Its success as a pedestrian-oriented street led restaurant owners along the street to ask the city to close the street to traffic for a portion of each day to accommodate outdoor seating

Table 5: Winthrop Street Characteristics

Element	Description
Dimensions	The shared section of Winthrop Street, a one-way street between John F. Kennedy Street and Eliot Street, is 320 feet and 30 feet wide.
Context	Winthrop Street's proximity to the world renowned Harvard University, as well as the regional shopping area Harvard Square, makes it an attractive destination for residents and visitors alike.
Land uses	The streets adjacent to the site have a diverse mix of land uses including institutional, as it is located in the heart of the Harvard University. Winthrop Street itself has mostly commercial uses with the exception of Winthrop Square, a passive park with benches and mature, large shade trees, at the northeast corner.
Ground floor	Ground floor uses include small businesses and restaurants with outdoor seating, including Shake Shack. A large commercial property currently occupied by large format retailer Staples is located on the southern side of the eastern end of the street. Activity from Winthrop Square spills over into the street.
Landscape	The street is lined with planters containing small trees and flowers.
Pavement Treatments	When entering from John F. Kennedy Street, the roadway ramps up to side walk grade to sit flush with the sidewalk. The curbs and markings were eliminated and the street is laid with a continuous brick surface. A gray brick denotes the roadway while sidewalks are red brick. The sidewalk has bollards and long planters to provide a protected zone for pedestrians who do not want to share space with vehicles.
Street Furniture	Street furniture is limited to the chairs and tables (with umbrellas) for patrons of the restaurants on the street. Pedestrian scale street lamps line the street.
Access	Signage at the entrance of the street reads "Shared Street 10 MPH – Street closed 11AM-2AM", meaning Winthrop Street is open to vehicle traffic from 2am-11am.
Intersection	The intersection with John F. Kennedy Street is not signalized but there are "laddered" crosswalks and signs reminding drivers that vehicles must stop for pedestrians in the crosswalk. Additionally curb extensions enhance pedestrian safety by shortening the crossing distances. At the opposite end of Winthrop Street, there are no safe crossings over Eliot Street. Pedestrians must walk north to Mt. Auburn Street or south towards Bennett Street.
Parking	There is no parking along Winthrop Street. Limited metered parking is available on the adjacent streets.
Loading	Loading is permitted along Winthrop Street between 2 am – 11 am. Loading activities are separate to that of the shared street use.
Maintenance	Winthrop St is maintained by Cambridge Department of Public Works. Street-cleaning is the major maintenance requirement.



Figure 38 Winthrop Street, Cambridge, MA

5.2.2 165th Street, Jamaica, Queens, NY



Figure 39: 165th Street Photo & Aerial

In order to strengthen Jamaica as a viable commercial center, 165th Street was redesigned in the 1970s to function as a pedestrian priority street. Specifically, the idea was to transform this street from a local retail area serving customers from Queens into “shopping hub” that would attract visitors from all of New York City. To better support this economic development objective, 165th Street was closed to regular vehicular traffic for one long block and narrowed to one lane, though still accommodating deliveries to businesses. Prior to its redevelopment, 165th Street functioned as a normal two-way street with one lane of traffic in each direction. The street now has many small to medium size retail uses, as well an indoor shopping mall, Jamaica Colosseum, at one end. The project used different paving and lighting standards, and included new street trees and furniture to enhance the

public realm. This pedestrian mall is managed by the 165th Street Mall Improvement Association.

Table 6: 165th Street Characteristics

Element	Description
Dimensions	The shared section of 165 th Street, a one-way street between Jamaica Avenue and 89 th Street, is 840 feet and 60 feet wide.
Context	165 th Street is located in the borough of Queens in New York City, in Jamaica's Central Business District. This area is a main shopping corridor for local residents. The shared street is located ½ mile north-east of Jamaica Center Station, which serves the E, J & Z subway lines, and 1 mile north-east of Jamaica Station, serving the Long Island Rail Road, a commuter railroad.
Land uses	Adjacent land uses are mainly commercial and office, though there are a number of institutional uses as well such as a library and a post office.
Ground floor	The street functions as a pedestrian mall comprised of small to medium size apparel stores (160 in total) including Jimmy Jazz, Sports World, and Foot Locker. The indoor mall, Colosseum Mall, anchors the northern end of the shared street, and has additional vendors, as well as rooftop parking. Jamaica Bus Terminal, a major bus terminal, is located nearby.
Landscape	Mature street trees line the shared street at regular intervals.
Pavement Treatments	Markings were eliminated and the street is laid with a continuous brick surface. Curbs are indicated by long paving blocks which separate the vehicular roadway (maroon brick) from the pedestrian space (gray brick). While helpful at delineating space, the specific type of pavers being used present maintenance challenges as they often come loose and create tripping hazards, thereby requiring replacement.
Street Furniture	The space features distinctive pedestrian-scaled lampposts, which were recently upgraded by NYCDOT. The shared street lacks places to sit. Large art sculptures are placed on the edge of the sidewalk.
Access	Signage at the entrance of the street reads "No thru traffic – Except deliveries this block". Closed to traffic, except for emergency vehicles, from 12pm-6pm, 7 days a week. Deliveries occur before noon, as NYPD often barricades the entrance to prohibit access.
Intersection	At the entrance at Jamaica Avenue, a signalized intersection with box line markings reinforces to the driver that they are approaching a shared area. Signage along Jamaica Avenue indicates that turns onto the shared portion of the street are prohibited. The terminus of the shared portion at 89 th Avenue features a signalized intersection including crosswalks with pedestrian signals.
Parking	There is no parking along 165 th Street. This street is completely closed off to vehicular traffic. Metered parking along adjacent streets is provided between 8:30am – 7pm, with the exception of Sundays. There is parking available on the roof of the Colosseum Mall.
Loading	Commercial delivery loading and unloading is permitted along 165th Street outside the streets closure times of 12PM-6PM.

Element	Description
Maintenance	165 th Street is maintained by the City of New York City in partnership with the 165th Street Mall Improvement Association; the local Business Improvement Districts (BID). Although the paving blocks create a unique streetscape distinct from adjacent streets, the maintenance of the pavers has been deemed an issue. Under traffic loading, some of the paving blocks have become loose, creating an uneven surface and a trip hazard.



Figure 40 165th Street, Jamaica, Queens, NY

5.2.3 Exhibition Road, Kensington, London



Figure 41: Exhibition Road Photo & Aerial

Exhibition Road has served as a key destination in London since the Great Exhibition of 1851. Institutions such as the Natural History Museum, Victoria and Albert Museum, Science Museum, National Art Library and Royal Albert Hall attract more than 11 million visitors each year, creating large amounts of pedestrian traffic. In 2003 the City decided to create a shared street to better accommodate all users and to de-clutter the street. In 2011, the Exhibition Road project was completed, transforming the street into shared public space designed to entice visitors, students, and local workers. The previous design was dominated by fast-moving traffic and limited pedestrians to narrow sidewalks with few places to cross the street. Removed boundaries and clear rights of way have encouraged drivers to be more cautious, increasing pedestrian safety along Exhibition Street. Slowed vehicular traffic has resulted in a much improved

pedestrian environment and an overall revitalization; attractive storefronts, cafes with outdoor seating and other new additions have created a pleasing public space which is widely regarded as a major success.

Table 7: Exhibition Road Characteristics

Element	Description
Dimensions	The shared section of Exhibition Road, a two-way street between Kensington Road and Thurloe Street, is .49 miles long and 88 feet wide.
Context	Exhibition Road lies to the south of London’s Hyde Park and other popular destinations including major cultural institutions. Close to the heart of London, Exhibition Road can be accessed by transit users via any of the four Tube stations that are in its vicinity, as well as bus stops located along the road.
Land uses	The area surrounding Kensington Road has a rich diversity of land uses including commercial, institutional, recreational and residential.
Ground floor	Ground floor uses include restaurants, housing, retail, museums, and educational and religious institutions.
Landscape	The lack of curbs, the irregular placement of trees, car and bike parking, street furniture and other fixed objects necessitates cautious driving while ensuring a vibrant streetscape for pedestrians.
Pavement Treatments	Exhibition Road is marked by a distinct diamond pattern made from contrastingly colored granite pavers . There are no markings or grade differences to separate pedestrians from vehicles, though the drainage channels do provide some demarcation for the visually impaired
Street Furniture	Many cafés have their own outdoor seating areas for patrons along the sidewalk, but there are also public benches staggered along the street, especially near the entrances to major destinations Street lights are located on the sides of the road in the southern segment and located in the middle in the northern segment. Bike racks, bike sharing stations, and car parking “bays” are dispersed in a random fashion along the corridor. At various points along the street are large sculptures and other public art installations.
Access	Exhibition Road is a two-way road with a 20 mile per hour speed limit on vehicles and few if any of the normal vehicular traffic cues. This forces drivers to pay more attention and helps foster a more pedestrian friendly environment.
Intersection	Along the corridor, Exhibition Road is intersected by five other roadways, all of which allow vehicular traffic. Exhibition road features short, wide dividers before intersections; these dividers serve to separate areas where driving is not permitted (such as sides of the road with outdoor seating or street lights) from areas where vehicles may travel. Pedestrian crossings are lightly marked and signalized at intersections.
Parking	Parking is only allowed at marked parking bays along Exhibition Road. Only special permit holders have access to use these bays. No visitor parking is offered along Exhibition Road.
Loading	Loading and unloading, including picking up and dropping off passengers is permitted, but only between the two lines of delineator tactile paving located four meters from the building line on both sides of the road.

Element	Description
Maintenance	Exhibition Rd is maintained by the local borough council, the Royal Borough of Kensington and Chelsea. The large granite pavers set with regularly spaced expansion and contraction joints have proved to be a very durable surface with only street cleaning required.

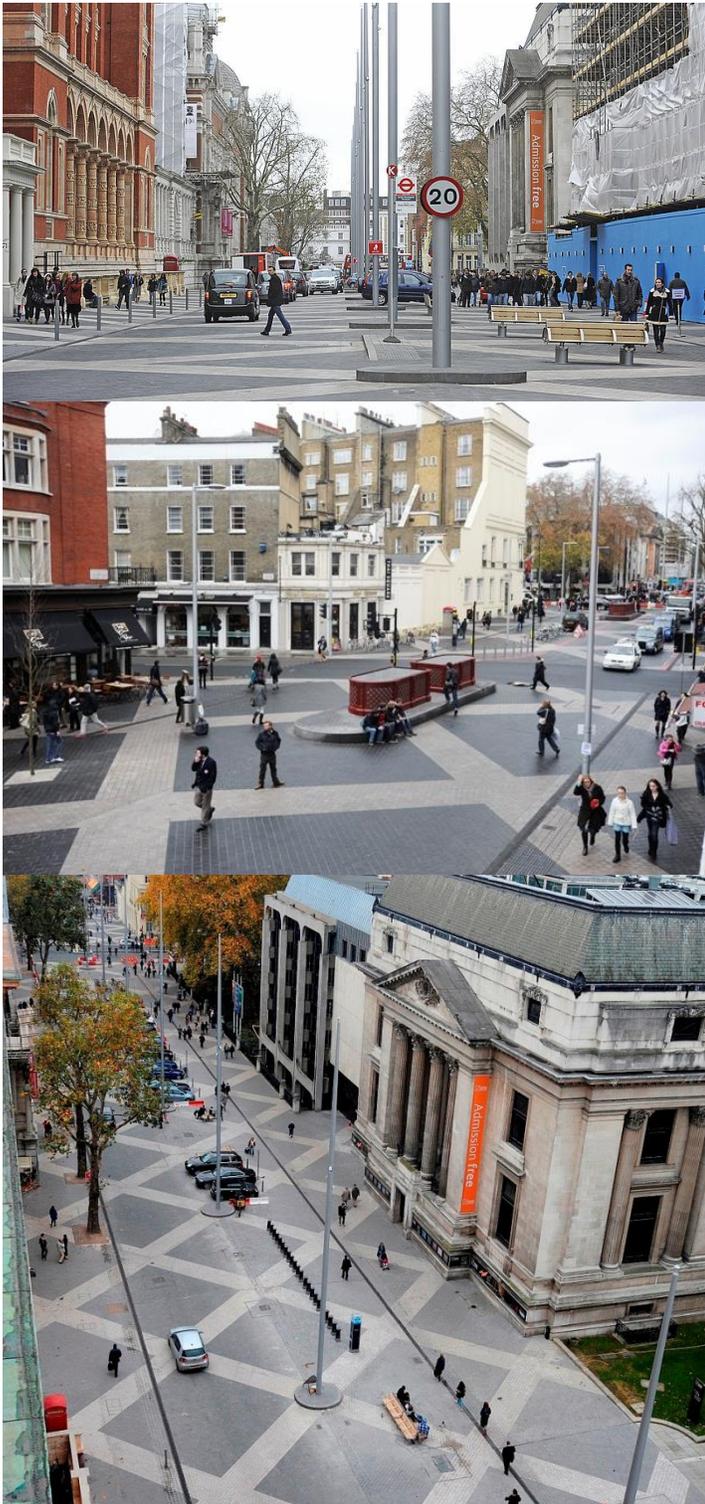


Figure 42 Exhibition Road, Kensington, London

5.2.4 Festival Streets – Davis & Flanders Street, Portland, OR



Figure 43: Festival Streets Photo⁹ & Aerial

In 2006 the City of Portland completed construction on the Chinatown Streetscape Improvements Project which included a redesigned and renovated block-long section of Davis Street between 3rd and 4th Avenues. This renovation was prompted by the community's concerns over a lack of public space in the neighborhood. Through this streetscape planning process Davis Street was one location of two locations¹⁰ identified by the city to receive improvements to material type and quality, as well as upgrades to the features on the street and sidewalk. The new design featured curbsless streets closed to vehicular traffic for

⁹ Photo source: Flickr-Fai Chong

¹⁰ Flanders Street between 3rd and 4th Avenues also received the "Festival Street" improvements.

special occasions and intended to function as a public space. Davis Street has regular two-way traffic operations with on-street parking but this “festival street” can easily be blocked off for events. Although pedestrians cross freely, vehicles do have the right of way. The project was a partnership between the Portland Development Commission and the Portland Office of Transportation.

Table 8: Festival Street Characteristics

Element	Description
Dimensions	The shared section of Davis Street, a two-way street between 3 rd Avenue and 4 th Avenue is 230 feet long and 50 feet wide.
Context	Located in Portland’s Chinatown neighborhood, the street is designed to convert into ‘festival streets’ to accommodate seasonal events.
Land uses	Adjacent land uses are predominantly low-rise commercial development (1-2 levels) including entertainment and retail. There are also residential and community services uses, as well as a number of surface parking lots.
Ground floor	Ground floor uses along Davis Street feature a travel agent, a language school, and restaurants with decorative facades and outdoor seating.
Landscape	Distinctive landscaped planters with sculptural elements are used to narrow access and calm traffic. There are Gateway elements to help announce entrance into a new space.
Pavement Treatments	The roadway ramps up and sits flush with the side walk. There are no curbs or markings. The majority of the street is paved with large concrete pavers. The roadway is distinguished with a border of darker granite pavers with concrete bollards. The space is ADA compliant using tactile paving indicating the change from the sidewalk to the roadway.
Street Furniture	Street furniture includes distinctive pedestrian-scaled lampposts consistent with the neighborhood and decorative bike racks.
Access	Davis Street provides two-way access with no restrictions for vehicular access. However, sculptural landscape and planters funnel traffic to a one-way access. Vehicles are restricted during seasonal events making the street a pedestrian-only zone.
Intersection	Intersections feature curb extensions to reduce crossing distances, consistent with the rest of the neighborhood. There are no dedicated pedestrian crossings over 3 rd or 4 th Avenues
Parking	Metered parking is located on both sides of the street between the sculptural landscape planters. There is no parking is permitted between 10pm-3am on Friday and Saturday. Additional metered parking spaces are provided adjacent to Davis Street, with these parking spaces also adhering to the same no parking restrictions from 10pm-3am on Friday and Saturday.
Loading	Loading is permitted on adjacent 3 rd Avenue and 4 th Avenue.
Maintenance	Davis Street is maintained by the City of Portland. On the first phase of the project, Flanders Festival Street, the City had problems with pavers in the wheel path of the traffic showing spalling. For the second phase, the new installed pavers ¹¹ were durable and they have had no incidents of spalling or cracking.

¹¹ New pavers sat on a new bedding of a lean concrete base and ASTM C33 coarse multi-grained sand with a 1/8” joint between pavers sealed with heavy-duty joint sand stabilizer.



Figure 44 Festival Streets, Portland, OR

5.2.5 Wall Street - Asheville, North Carolina



Figure 45: Wall Street Photo¹² & Aerial

Wall Street in Asheville, North Carolina was originally a delivery alley for the buildings on Patton Avenue. Over time, the narrow, one-way street with slow speeds and low volumes gained a pedestrian friendly reputation. Then, in the late 1980s, the City of Asheville included Wall Street as part of a larger program to preserve its historic buildings. The streetscape improvements included new cobblestone paving and moving the utilities underground. A few years later metered on-street parking was added help further lower driving speeds. Wall Street now includes 69,000 square feet of retail shops and restaurants, appealing to both locals and tourists. The improvements have transformed Wall Street into a

¹² Photo source: Pinterest-FunkyVilleUSA

quaint destination with heavy pedestrian traffic and a healthy mix of retail destinations.

Table 9: Wall Street Characteristics

Element	Description
Dimensions	The shared section of Wall Street, a one-way street between Otis Street and Battery Park Avenue, is 730 feet long and 38 feet wide.
Context	Wall Street is located in the Downtown Asheville Historic District. Asheville's civic center lies a block to the south.
Land uses	Adjacent land uses are a mix of commercial and retail on ground floor with residential and offices above. Wall Street is part of the Downtown Asheville Historic District, featuring historic architecture. Government buildings with landscaped plazas are located to the west across Otis Street.
Ground floor	Ground floor uses include pub restaurants and boutique retail. A parking garage anchors the western end of Wall Street, which features a rock climbing wall on the façade of the structure.
Landscape	Mature trees line the northern side of the road, at regular intervals. Planter boxes buffer café seating areas.
Pavement Treatments	The roadway ramps up and sits flush with the side walk. Red brick pavers, granite cobble sets and permanent bollards along the street distinguish the sidewalk and roadway spaces. The roadway is pigmented concrete and the sidewalk is constructed of concrete pavers.
Street Furniture	Bollards separate sidewalk and roadway areas. Public benches and trash receptacles line the street; café furniture spills out onto the street. There are distinctive pedestrian-scaled lampposts consistent with the neighborhood and decorative bike racks. Bronze sculptures and graphic street murals are found throughout the neighborhood.
Access	Wall Street is one-way with metered parking. The average speed is 20 mph. Signage marks distinct areas for parking, loading and emergency services.
Intersection	There are no dedicated pedestrian crossings at either intersection. Connection to Wall Street is difficult; pedestrians must walk a block in either direction to a dedicated crossing. At Battery Park Avenue to the north the streetscape is furnished with curb extensions.
Parking	The majority of the street serves as a through traffic street for private vehicles and is dedicated as a Fire Lane. Two dedicated disabled parking spaces are provided before it intersects with Battery Park Avenue - one near the middle of the street and one at the end of the street. Parking dedicated for residential and retail users is available just outside of the area. These parking spaces are indented away from the main roadway to comply with the street's Fire Lane regulation.
Loading	Spaces are dedicated as Loading Zones toward the northern end of the street. Loading is limited to 30 minutes.
Maintenance	Wall Street is maintained by the City of Asheville. The pigmented concrete roadway has cracked in some areas and been patched with asphalt and some of the cobble sets have become loose.



Figure 46 Wall Street, Asheville, NC

5.2.6 Cady's Alley, Washington DC



Figure 47: Cady's Alley Photo¹³ & Aerial

For many years, Cady's Alley functioned primarily as a service alley for businesses along M Street in Washington D.C.'s Georgetown neighborhood. By the 1980's the street had become largely neglected until a local developer had ideas for improvements. The developer repurposed the alley by building out the adjacent parcels to the alley's edge and converting them to include front entrances for retail and restaurants at a pedestrian scale. Even with the new design, the alley continues to allow deliveries and other service needs. In 2005, the project received a prestigious AIA Honor Award for Urban Design.

¹³ Photo source: Flickr – Eric Fidler

Table 10: Cady's Alley Characteristics

Element	Description
Dimensions	Cady's Alley, a one-way shared street between 33 rd Street NW and 34 th Street NW, parallel to M Street. It is 500 feet long and 22 feet wide.
Context	Washington, D.C.'s historic Georgetown neighborhood, immediately north of the Potomac River, is home to the distinguished university of the same name and some of the most desirable residential properties in the city. This neighborhood is a main commercial and entertainment district in the region that attracts both local visitors and tourists.
Land uses	Adjacent land uses include high-end retail, bars and restaurants, as well as residential uses to the north of the site. The alley is the internal circulation of a 120,000-square-foot retail and residential redevelopment comprising of low-rise, 2-3 story buildings. Access to the Francis Scott Key Memorial park and the Chesapeake and Ohio Canal Towpath trail is located to the west.
Ground floor	Ground floor uses include boutique design shops, furniture stores, and high-end retail. Cafés and restaurants spill out into the alleyway.
Landscape	Planters are used along the alley to define the spaces.
Pavement Treatments	The roadway ramps up and sits flush with the sidewalk. The alley is paved with decorative red brick along the building edge and historic granite Belgian blocks along the roadway. The curb lines are distinguished with long granite pavers.
Street Furniture	Bollards, retaining walls, and concrete planters protect alcove spaces between the buildings which become spill out spaces for adjacent cafés.
Access	Cady's Alley is a one-way street. There are no restrictions for vehicular access.
Intersection	There are no designated pedestrian crossings or treatments at the adjoining, low volume, streets. To the west, continuous street treatment extends the public realm to the park.
Parking	Public Parking is not allowed along the laneway.
Loading	Loading provisions are provided away from the main roadway via indented spaces between buildings. Signage indicating when loading is allowed is limited.
Maintenance	Caddy's Alley is maintained by developer, EastBanc and real estate investors, Jamestown Properties. Some of the long granite pavers distinguishing the roadway have become loose under the wheel tracks of heavy goods vehicles.

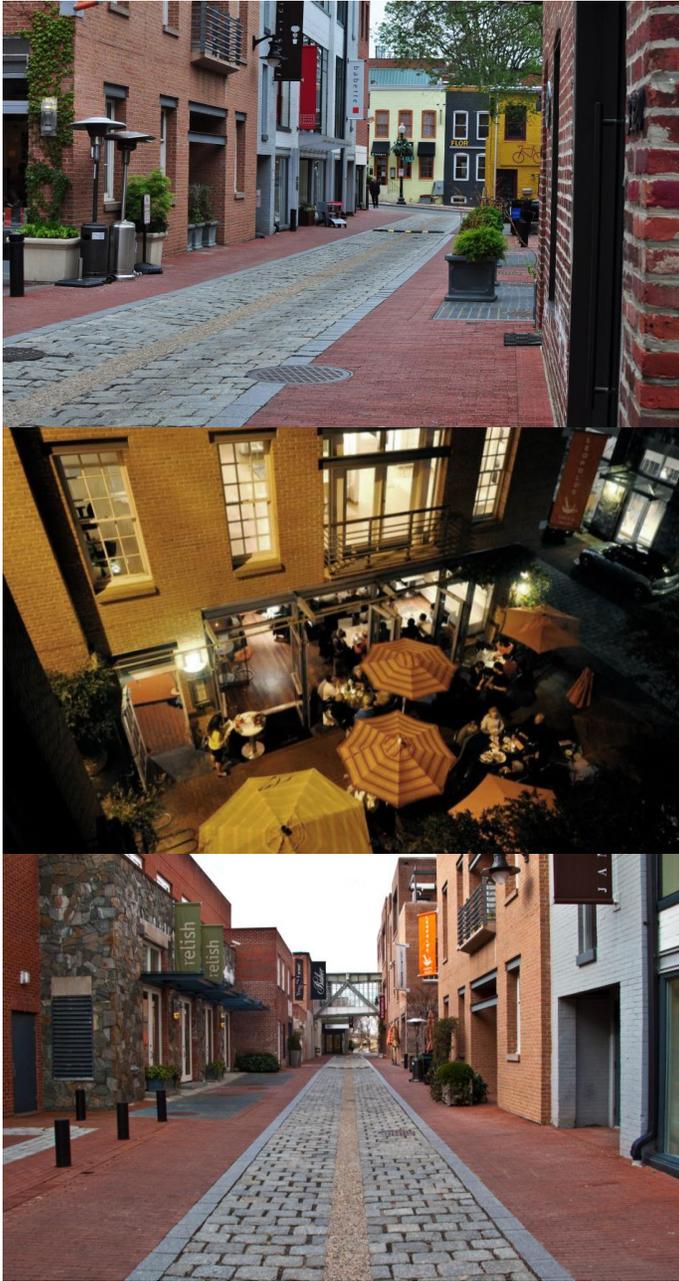


Figure 48 Cady's Alley, Washington, D.C.

5.2.7 Other Precedents Considered:

- 16th Street Pedestrian and Transit Mall, Denver, Colorado
- Nicolette Mall, Minneapolis, Minnesota
- State Street, Madison, Wisconsin
- Rockefeller Center, New York, New York
- Jefferson Street, Fisherman's Wharf, San Francisco, California

- Third Street Promenade, Santa Monica, California
- Lynn and Pearl Street, Columbus, Ohio
- Basque Block, Boise, Idaho
- Urban Lounge, St Gallen, Switzerland
- St. Catherine Street, Montreal, Canada



B Design Alternatives



Alternative Design Concepts

In the initial data collection phase, three alternatives were developed. Documented site observations, interviews with key stakeholders, the existing conditions analysis, and NYCDOT comments all provided a thorough understanding of the key issues and concerns underlying the project, potential opportunities and desired outcomes. A broad cross section of potential design solutions were explored to understand the full range of options that could work for the project site.

This section provides a detailed discussion of Alternatives 1, 2, and 3, summarized below in Table 1. Each alternative is a collection of different circulation and design elements, which are described according to the following seven categories:

- Circulation Pattern
- Surface and Paving
- Vertical Separation
- Commercial Loading
- Passenger Pick-up/Drop-off
- Landscape Design
- Lighting Design

Alternatives Summary			
	Alternative 1	Alternative 2	Alternative 3
Circulation pattern	<ul style="list-style-type: none"> • Same as existing condition 	<ul style="list-style-type: none"> • Same as existing condition 	<ul style="list-style-type: none"> • Two-way Pearl Street and Willoughby Street • Pearl Street (south) closed to vehicles
Surface and Paving	<ul style="list-style-type: none"> • Flush Surface at Pearl Street (north) • Curbed at Willoughby Street and Pearl Street (south) 	<ul style="list-style-type: none"> • Flush Surface • Distinct Paving 	<ul style="list-style-type: none"> • Flushed Surface • Two pavers, Paving distinguishes sidewalks and roadway
Vertical Separation	<ul style="list-style-type: none"> • Both sides on Pearl Street • Both sides on Willoughby Street 	<ul style="list-style-type: none"> • Eastern side on Pearl Street • Both sides on Willoughby Street 	<ul style="list-style-type: none"> • Minimal
Commercial Loading	<ul style="list-style-type: none"> • Loading Lane on Willoughby Street 	<ul style="list-style-type: none"> • Loading Zone on Willoughby and Pearl Street 	<ul style="list-style-type: none"> • Loading Zone on Willoughby and Pearl Street
Passenger Pick-up/Drop-off	<ul style="list-style-type: none"> • Pick-up/Drop-off on Willoughby Street 	<ul style="list-style-type: none"> • Pick-up/Drop-off on Willoughby and Pearl Street 	<ul style="list-style-type: none"> • Pick-up/Drop-off on Willoughby Street
Landscape Design	<ul style="list-style-type: none"> • Trees along Willoughby Street • Planters regular along Pearl Street 	<ul style="list-style-type: none"> • Trees along Willoughby Street • Planters sporadic along Pearl Street 	<ul style="list-style-type: none"> • Trees along Willoughby Street • Planting on Pearl Street (south)
Lighting Design	<ul style="list-style-type: none"> • Street lighting along Pearl Street • Catenary Lighting 	<ul style="list-style-type: none"> • Street lighting along Willoughby and Pearl Street • Facade, Bollard and Ground Lighting 	<ul style="list-style-type: none"> • Street lighting along Willoughby Street • Catenary Lighting

Alternative 1

The concept for Alternative 1 is driven by the existing circulation pattern, which divides the site into two distinct spaces. Pearl (south) and Willoughby Streets have a traditional streetscape feel, using symmetrical tree planting and a curb to separate the sidewalk from the roadbed. Pearl Street, north of Willoughby Street, has a public plaza feel with a flush surface treatment throughout, with vertical elements included only on the east side of the street.

Circulation Patterns

The circulation pattern is unchanged from the existing condition. Vehicles can access the site from Red Hook Lane, crossing Fulton Street, to Pearl Street. Pearl Street, north of Willoughby, remains two-way, while Willoughby Street remains one-way. Pedestrians are encouraged to use all areas of site. Permit parking is not permitted within the project site.

Surface and Paving

Pearl Street has an elevated roadway to be flush with the sidewalks and Willoughby Street maintains a differentiated surface with rounded curbs and streetscape features similar to the current conditions. Willoughby Street currently has five to seven inch curb reveals; Alternative 1 elevates the roadway to create a four-inch rounded curb separating the sidewalk from the roadway. Though pedestrians would be encouraged to walk within the roadway, the curb reinforces a more typical street environment feel.

Vertical Separation

Alternative 1 maintains the most amount of vertical separation compared to the other Alternatives. Along Willoughby Street, bollards and street trees line the shallow curbed sidewalk. Seating is located on the north side of the street. This alternative uses perpendicular style seating, similar to the example of the East River Esplanade on page 25. Pearl Street north of Willoughby Street becomes flush with the sidewalk and is lined with vertical elements including seating, planters, street lights and bollards at the curb line to maintain a public plaza feel. Pearl Street south of Willoughby Street maintains a shallow curb and is reinforced with street trees, bollards, street lights and a planter. Pedestrian-only spaces within the site are significantly extended from the existing condition to have 20-foot widths along Willoughby Street



Alternative 1

- bollards
- ✦ street lighting
- linear drains/ ground lighting
- facade lighting
- planters
- seating
- strung lighting
- loading area
- trees
- ramp
- pavement 1

Adams St.

Jay St.

Wiloughb

Red Hook Ln.

Fulton St.

15.5 20 14.5

15.00

7.35

8.00

40.70

31.14

25.00

12.00

6.00

20.00

20.00

20.00

67.38

15.00

20.00

16.00

25.00

and 11- to 13-foot widths along Pearl Street. An example of vertical separation using bollards can be seen in the photo of Exhibition Road, and an example of shallow curbs can be seen in the photo of the Third Street Promenade, both on the right.

Commercial Loading

This alternative designates commercial loading along the south side of Willoughby Street, the east side of Adams Street, and at the rear loading dock for 370 Jay Street. The designated loading space on Willoughby Street is approximately five truck lengths, while the designated loading space on Adams Street can accommodate approximately two trucks. Trucks are able to enter from Pearl Street and can make a right onto Willoughby Street to access the loading space along Willoughby Street.

Passenger Pick-up/Drop-off

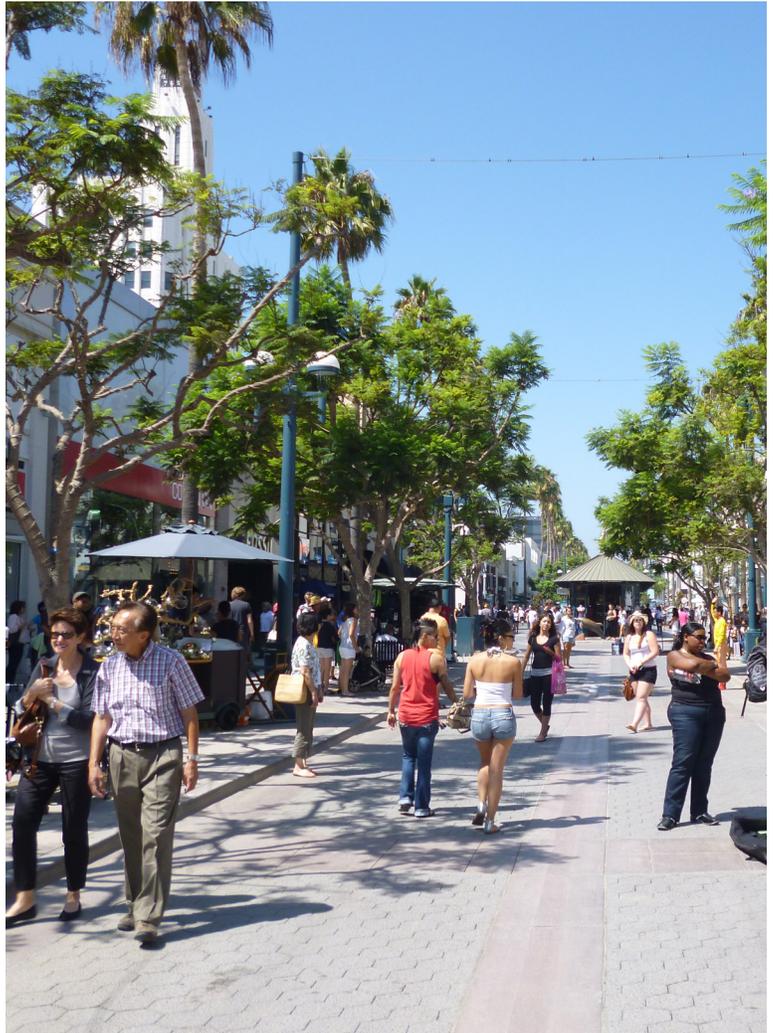
Alternative 1 designates school drop-off/pick-up areas along the south side of Willoughby Street. The designated space on Willoughby Street is approximately eight car lengths. Vehicles are able to enter from Pearl Street and can make a right onto Willoughby Street to access the loading space along Willoughby Street, and continue along Willoughby Street to the intersection of Jay Street to exit the site.

Landscape Design

Street trees line both sides of Willoughby Street as well as the east side of Pearl Street south of Willoughby Street. Planters line the west side of Pearl Street north of Willoughby Street. A planter is also positioned between both street trees on Pearl Street south of Willoughby Street.

Lighting Design

Alternative 1 suggests catenary lighting along Willoughby Street between Jay Street and Pearl Street, continuing the existing strung lighting from Willoughby Plaza. The use of catenary lighting allows for a reduced number of street lights, while increasing the level of light on the street, and help to enhance the site's sense of place. An example of catenary lighting can be seen in the Willoughby Plaza photo on the right. Along Pearl Street, street lights line the entirety of the street.



Clockwise from top left: Exhibition Road, London, UK (source: Arup), Third Street Promenade, Santa Monica, CA (source: Creative Commons), Catenary Lighting at Willoughby Plaza, New York (source: Arup), East River Esplanade, New York (source: Arup)

Alternative 2

Alternative 2 employs a flush surface throughout the entire project site to emphasize a unique sense of place and create a pedestrian plaza feel. Paired, symmetrical vertical elements along Willoughby Street reinforce the view corridor, however asymmetrical vertical elements along Pearl Street are arranged more free form to influence different gathering spaces.

Circulation Pattern

The circulation pattern is unchanged from the existing condition. Vehicles can access the site from Red Hook Lane, crossing Fulton Street, to Pearl Street. Pearl Street, north of Willoughby, remains two-way, while Willoughby Street remains one-way. Pedestrians are encouraged to use all areas of site, similar to the examples of St. Catherines Street and New Road. Permit parking is not permitted within the project site.

Surface and Paving

Alternative 2 features a flush surface throughout the project site along the lengths of Willoughby Street and Pearl Street. This concept design is typical of pedestrian-priority street benchmarks, both nationally and internationally. The flush surface also provides a more seamless connection with Willoughby Plaza to the west. The paving pattern would be largely uniform throughout to underscore its design emphasis as a public plaza. Examples of uniform paving patterns can be seen in the photos of Exhibition Road and St. Catherines Street.

Vertical Separation

Alternative 2 includes vertical elements on both sides of Willoughby Street; however, along Pearl Street vertical elements are employed in an asymmetrical fashion, only along the western side of the street. Along Willoughby Street, bollards and seating line the street along with street trees and free form planters. The bollards along Willoughby Street are located to accommodate space for a loading area on the south side of the street. Pearl Street north of Willoughby Street contains street lights, bollards, seating and planters that taper into the roadway to create additional pedestrian space at the northern end of the street. Pearl Street south of Willoughby Street contains street trees, benches and bollards on the eastern side of the street. Pedestrian-only spaces within the site are significantly extended from the existing condition to have 12



Alternative 2

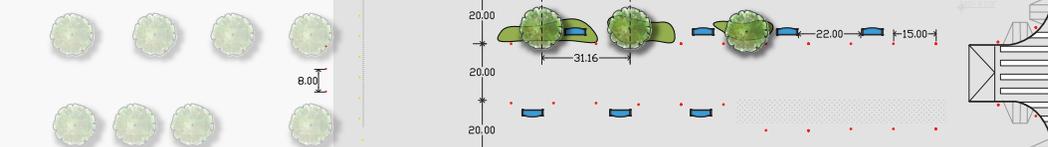
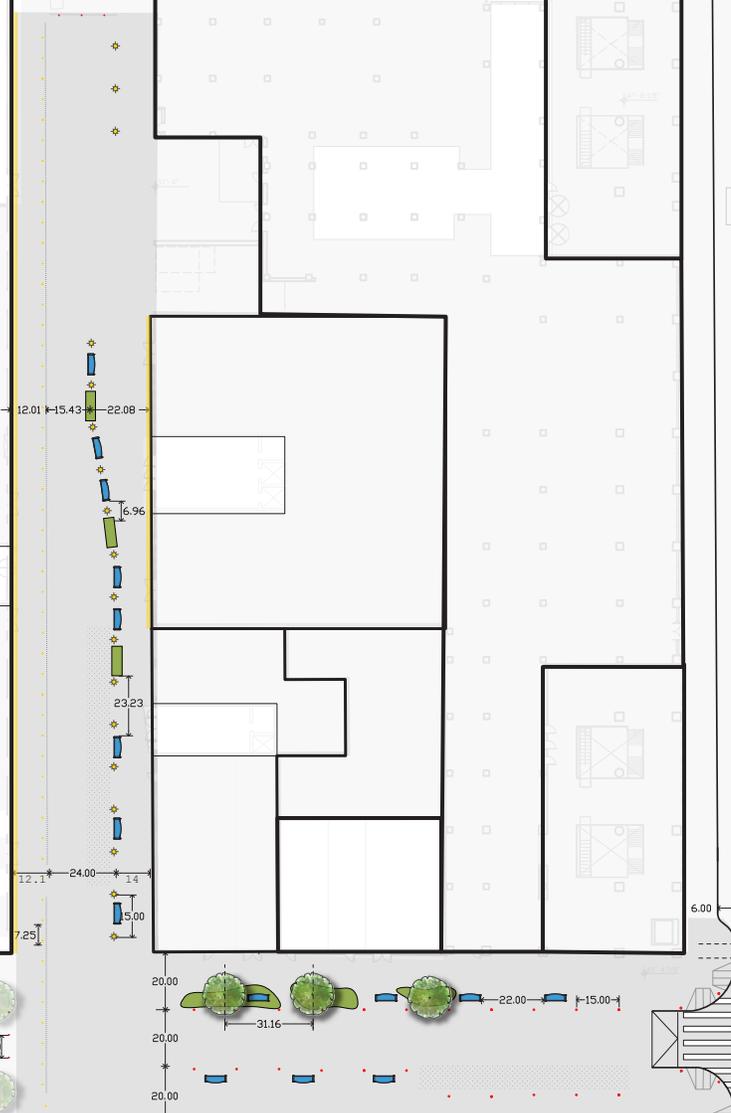
- bollards
- ✦ street lighting
- planters
- seating
- strung lighting
- loading area
- trees
- ramp
- pavement 1
- pavement 2
- concession

Adams St.

Jay St.

Fulton St.

Red Hook Ln.



to 22-foot widths along Willoughby Street and 11 to 21-foot widths along Pearl Street.

Commercial Loading

This alternative designates commercial loading along the south side of Willoughby Street, the east side of Pearl Street, and at the rear loading dock for 370 Jay Street. The designated loading space on Willoughby Street is approximately two truck lengths, while the designated loading space on Pearl Street can accommodate approximately three trucks. Trucks are able to enter from Pearl Street and can make a right onto Willoughby Street to access the loading space along Willoughby Street. Trucks can also continue straight onto Pearl Street to access the loading space along Pearl Street, and are able to make a three-point turn at the northern terminus of Pearl Street.

Passenger Pick-up/Drop-off

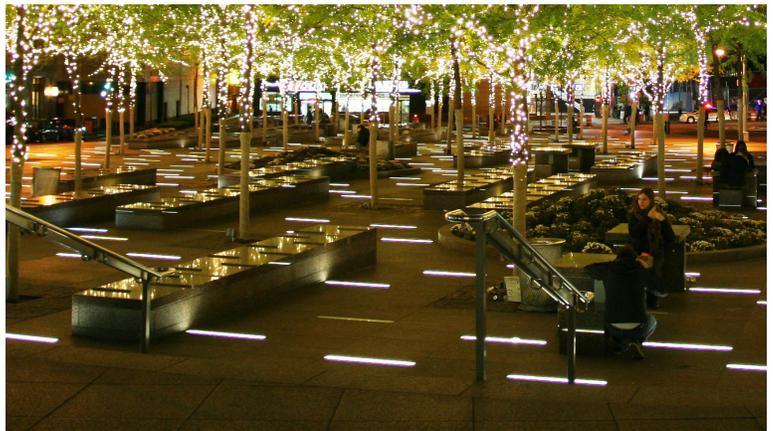
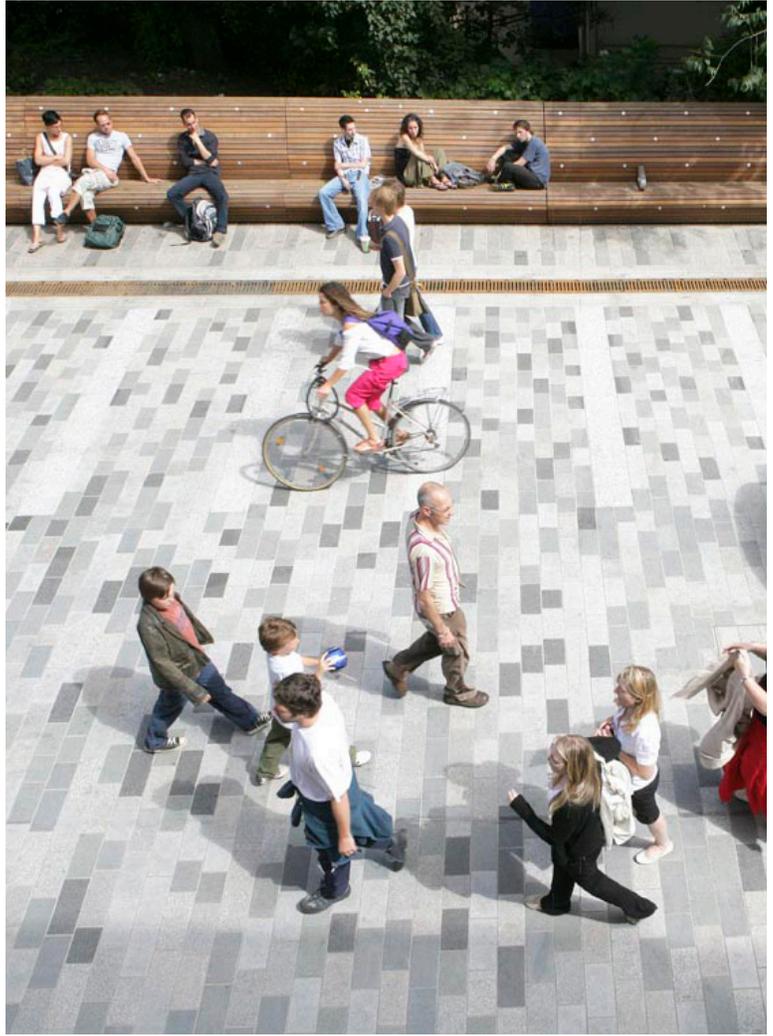
Designates school drop-off/pick-up areas along the south side of Willoughby Street and the east side of Pearl Street. The designated space on Willoughby Street is approximately 4 car lengths, while the designated space on Pearl Street can accommodate approximately 5 cars. Vehicles are able to enter from Pearl Street and can make a right onto Willoughby Street to access the space along Willoughby Street. Vehicles can also continue straight onto Pearl Street to access the space along Pearl Street, and are able to make a three-point turn or a U-turn at the northern terminus of Pearl Street.

Landscape Design

Street trees are present on the north side of Willoughby Street and east side of Pearl Street south of Willoughby Street. Asymmetrical planters taper into the roadway along Pearl Street north of Willoughby Street. Free form planters are also present on the north side of Willoughby Street.

Lighting Design

This alternative contains the most amount of lighting which is constrained exclusively to Pearl Street. Street lights form an asymmetrical chain of vertical elements that taper into the roadway along east side of Pearl Street. On the west side of Pearl Street, ground lighting lines the space to designate the roadway from sidewalk space due to the flush surface, as seen in the example of Zuccotti Park on the right. Façade lighting affixed to all buildings on the west side of Pearl Street, as well as the Brooklyn Friends School provide additional lighting as well as highlight the architectural assets of the site.



Clockwise from top left: St. Catherines Street, Montreal (source: Arup), New Road, Brighton, UK (source: NYCDOT), Zuccotti Park, New York (source: Creative Commons), Exhibition Road, London, UK (source: Arup)

Alternative 3

Alternative 3 provides the greatest design contrast when compared to the existing condition. It includes the transformation of Pearl Street between Willoughby and Fulton Streets into a pedestrian-only plaza to accommodate the potential for either Red Hook Lane or this section of Pearl Street to be transferred to private ownership and redeveloped.¹¹ This alternative is the most sparing in its use of vertical elements, which strongly emphasizes a public plaza feel and allows a maximum amount of flexibility for programming and special events. Alternative 3 features a flush surface throughout, in the same manner as Alternative 2, although the paving pattern is not uniform and instead reinforces the division between pedestrian-only and shared spaces. The new plaza at the southern end of Pearl Street features a concession to activate the space, as well as space for seating and landscaping.

Circulation Patterns

Vehicles access the site only from the Willoughby and Jay Street intersection, with two-way circulation along both Willoughby Street and Pearl Street. Pearl Street between Fulton and Willoughby Streets would be restricted for use by vehicles. Pedestrians are encouraged to use all areas of site. Permit parking is not permitted within the project site.

Surface and Paving

Alternative 3 features a flush surface through the site, with contrasting paving types to distinguish between pedestrian-only and shared street spaces. The use of contrasting pavement allows more minimal use of vertical segregating elements, while still providing a visual cue to the visually impaired. The photo of Poynton Street on page 33 shows a pavement treatment that guides drivers while maintaining a finish surface.

Vertical Separation

Alternative 3 contains the least amount of segregation using vertical elements, allowing for the maximum amount of flexibility for special events, as shown in the Artisan Street Market on page 33. Along Willoughby Street, street trees and street lights line the northern half of the street. There are no vertical elements on the south side of Willoughby Street. Pearl Street north of Willoughby Street has planters and bollards that line the entrance to the Brooklyn Friends School, but the street segment is otherwise free from vertical elements. Pearl Street south of Willoughby Street contains a concession and street furniture, as well as a cluster of street trees and planters to create a public plaza.



Alternative 3

- bollards
- ☀ street lighting
- planters
- seating
- strung lighting
- 4" rounded curb
- loading area
- trees
- ramp
- pavement 1
- pavement 2

Bollards line the intersection of Willoughby Street and Pearl Street to restrict traffic from the plaza, as well as guide cars onto Pearl Street safely. Pedestrian-only spaces within the site are significantly extended from the existing condition to have 15- to 22-foot sidewalk widths along Willoughby Street and 12-foot width along northern Pearl Street.

Commercial Loading

Commercial loading can take place along the south side of Willoughby Street, the west side of Pearl Street, and at the rear loading dock for 370 Jay Street. The designated loading space on both Willoughby Street and Pearl Street can accommodate approximately four truck lengths. Since Pearl Street, south of Willoughby Street, is converted into a public plaza in this concept, vehicles must enter from two-way Willoughby Street, turn right onto Pearl Street, and make a three-point turn at the northern terminus of Pearl Street to access the loading spaces on Pearl Street. Trucks can also make a three-point turn at the intersection of Willoughby Street and Pearl Street to access the space along Willoughby Street.

Passenger Pick-up/Drop-off

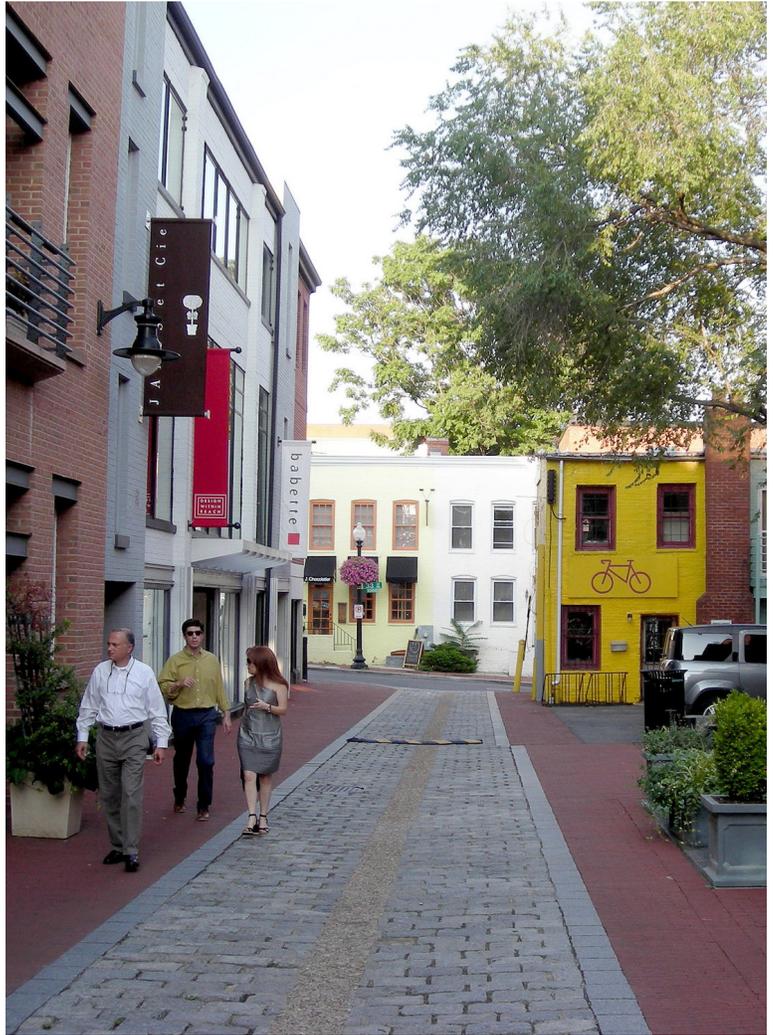
Alternative 3 designates school drop-off/pick-up areas along the south side of Willoughby Street and the west side of Pearl Street. The designated loading space on both Willoughby Street and Pearl Street can accommodate approximately six vehicle lengths. Since Pearl Street south of Willoughby Street is converted into a public plaza in this concept, vehicles must enter from two-way Willoughby Street and turn right onto Pearl Street and make a U-turn at the northern terminus of Pearl Street to access the loading spaces on Pearl Street. Vehicles can also make a U-turn at the intersection of Willoughby Street and Pearl Street to access the space along Willoughby Street. An example of paving design that facilitates U-turns can be seen in the Poynton Shared Space example on the right.

Landscape Design

Street trees are present on the north side of Willoughby Street as well as a cluster of trees in the public plaza on Pearl Street south of Willoughby Street. There are planters underneath the street trees on Willoughby Street as well as planters that mark the entrance to the Brooklyn Friends School on Pearl Street.

Lighting Design

This design employs street lighting only along the north side of Willoughby Street. Pearl Street is lined with catenary lighting with the exception of the intersection of Willoughby Street and Pearl Street. The use of catenary lighting allows for a reduced number of street lights, while increasing the level of light on the street, and help to enhance the site's sense of place.



Clockwise from top left: Weekend Artisan Street Market, Sydney (source: Arup), Cady's Alley, Washington, D.C. (source: Creative Commons), Bell Street, Seattle (source: Arup), Poynton Shared Space, Poynton, UK (source: Project for Public Spaces)



C Alternatives Cost Estimates



Willoughby Street Pedestrian Priority Alternative 1

Item	Number	Unit	Unit Cost	Total Cost	Product
Demolition					
Striping Surface	4400	SY	50	220000	Removing Concrete and Asphalt
Remove Sign Supporting Structure	10	No	300	3000	
Remove Phone Booths	2	No	479	958	Costed as Removal of Street Light with Base
			Sub-Total	223000	
Site Set-Up					
Fill	300	CY	115	34500	Subbase
Grading	2200	SY	4.5	9900	Grading of Existing Roadway
			Sub-Total	44400	
Utilities					
Adjust Castings	46	No	450	20700	Assume all greater than 39"
			Sub-Total	20700	
Pavement Treatment					
Pavement 1 (Ped)	3500	SY	295	1032500	Concrete Hexagonal Pavers on Concrete Base
Pavement 2 (Vehicular)	1000	SY	295	295000	Concrete Hexagonal Pavers on Concrete Base
Straight Curb	650	LF	130	84500	Straight Granite Curb
Corner Curb	200	LF	180	36000	Corner Granite Curb
Striping	500	LF	1	500	4" Wide Striping
			Sub-Total	1448500	
Street Furniture					
Bollards	34	No	2000	68000	ADNY Bollard
Benches	22	No	2300	50600	Steel Perforated Benches, Straight, Double Back
Tree Pits	9	No	700	6300	Tree Planted, 2-1/2" to 3" Caliper, in 5' x 5' Tree Pit
Planters	7	No	1200	8400	In Ground Concrete Planters
Shrubs	35	No	82	2870	5 No. Shrubs (18" to 24" High) in Each Planter
Sign Posts	11	No	600	6600	Ground Mounted Sign Structure
Tree Guards	9	No	60	540	
Trash Receptacles	6	No	1300	7800	Decorative Metal Trash Receptacle
			Sub-Total	151110	
Lighting					
Street Lights	22	No	3000	66000	
Strung Lights	1100	LF	50	55000	
			Sub-Total	121000	
Concessions (Assuming an electrical connection, no construction of unit, no water supply or sanitary disposal)					
Electrical Connection	1	No	3200	3200	Con Edison Meter, Outlet Box and 50 LF of 1" Conduit
Flexible Tables	10	No	350	3500	Bistro Duraflon Folding Tables
Flexible Chairs	20	No	150	3000	Bistro Duraflon Folding Chairs
			Sub-Total	9700	
			Total	\$ 2,018,410	
			25% Contingency	\$ 504,603	
			Total Inc Contingency	\$ 2,523,013	

The following items are not included in the estimate:

- Bicycle Racks
- Removal of Traffic Signals

Willoughby Street Pedestrian Priority Alternative 2

Item	Number	Unit	Unit Cost	Total Cost	Product
Demolition					
Striping Surface	4400	SY	50	220000	Removing Concrete and Asphalt
Remove Sign Supporting Structure	10	No	300	3000	
Remove Phone Booths	2	No	479	958	Costed as Removal of Street Light with Base
			Sub-Total	223958	
Site Set-Up					
Fill	450	CY	115	51750	Subbase
Grading	4500	SY	4.5	20250	Grading of Existing Roadway
			Sub-Total	72000	
Utilities					
Adjust Castings	43	No	450	19350	Assume all greater than 39"
Modify Catch Basins	3	No	2400	7200	
			Sub-Total	26550	
Pavement Treatment					
Pavement 1 (Main)	4500	SY	295	1327500	Concrete Hexagonal Pavers on Concrete Base
Straight Curb	0	LF	130	0	Straight Granite Curb
Corner Curb	200	LF	180	36000	Corner Granite Curb
Striping	500	LF	1	500	4" Wide Striping
			Sub-Total	1364000	
Street Furniture					
Bollards	32	No	2000	64000	ADNY Bollard
Benches	17	No	2300	39100	Steel Perforated Benches, Straight, Double Back
Tree Pits	2	No	700	1400	Tree Planted, 2-1/2" to 3" Caliper, in 5' x 5' Tree Pit
Planters	3	No	1200	3600	In Ground Concrete Planters
Seeding	52	No	8	416	
Sign Posts	10	No	600	6000	Ground Mounted Sign Structure
Tree Guards	2	No	60	120	
Trash Receptacles	6	No	1300	7800	Decorative Metal Trash Receptacles
			Sub-Total	122436	
Lighting					
Street Lights	21	No	3000	63000	
Ground Lighting	65	No	1000	65000	
Façade Lighting	375	LF	500	187500	Assuming 1 Level of Light Source
			Sub-Total	315500	
Drainage					
Linear Drainage	500	LF	430	215000	
			Sub-Total	215000	
			Total	\$ 2,339,444	
			25% Contingency	\$ 584,861	
			Total Inc Contingency	\$ 2,924,305	

The following items are not included in the estimate:

- Bicycle Racks
- Removal of Traffic Signals

Willoughby Street Pedestrian Priority Alternative 3

Item	Number	Unit	Unit Cost	Total Cost	Product
Demolition					
Striping Surface	4400	SY	50	220000	Removing Concrete and Asphalt
Remove Sign Supporting Structure	10	No	300	3000	
Remove Phone Booths	2	No	479	958	Costed as Removal of Street Light with Base
			Sub-Total	223958	
Site Set-Up					
Fill	450	CY	115	51750	Subbase
Grading	2200	SY	4.5	9900	Grading of Existing Roadway
			Sub-Total	61650	
Utilities					
Adjust Castings	46	No	450	20700	Assume all greater than 39"
			Sub-Total	20700	
Pavement Treatment					
Pavement 1 (Ped)	2700	SY	295	796500	Concrete Hexagonal Pavers on Concrete Base
Pavement 2 (Vehicular)	1800	SY	295	531000	Concrete Hexagonal Pavers on Concrete Base
Straight Curb	80	LF	130	10400	Straight Granite Curb
Corner Curb	50	LF	180	9000	Corner Granite Curb
Striping	500	LF	500	250000	4" Wide Striping
			Sub-Total	1596900	
Street Furniture					
Bollards	26	No	2000	52000	ADNY Bollard
Benches	0	No	2300	0	Steel Perforated Benches, Straight, Double Back
Tree Pits	5	No	1500	7500	Tree Planted, 2-1/2" to 3" Caliper, in 7' x 15' Tree Pit
Planters	2	No	1200	2400	In Ground Concrete Planters
Shrubs	35	No	82	2870	5 No. Shrubs (18" to 24" High) in Each Planter
Sign Posts	10	No	600	6000	Ground Mounted Sign Structure
Tree Guards	0	No	60	0	
Trash Receptacles	6	No	1300	7800	Decorative Metal Trash Receptacles
			Sub-Total	78570	
Lighting					
Street Lights	7	No	3000	21000	
Strung Lights	2000	LF	50	100000	
			Sub-Total	121000	
Concessions (Assuming an electrical connection, no construction of unit, no water supply or sanitary disposal)					
Electrical Connection	2	No	3200	6400	Con Edison Meter, Outlet Box and 50 LF of 1" Conduit
Flexible Tables	16	No	288	4608	Bistro Duraflon Folding Tables
Flexible Chairs	32	No	108	3456	Bistro Duraflon Folding Chairs
			Sub-Total	14464	
			Total	\$ 2,117,242	
			25% Contingency	\$ 529,311	
			Total Inc Contingency	\$ 2,646,553	

The following items are not included in the estimate:

- Bicycle Racks
- Removal of Traffic Signals



D Alternatives Evaluation



Evaluation of Alternatives

The following section describes the Alternatives evaluation process that led to the selection of the Concept Design. The evaluation included the following three steps:

- A traffic study was performed to evaluate the impact of each Alternative on intersections within the site;
- A qualitative evaluation of the Alternatives was conducted, based on a list of desired outcomes derived from the project goals and objectives; and
- High-level costs were estimated to foresee cost impacts of various design solutions.

Traffic Impacts

Traffic operations at the project site intersections were analyzed using methodologies contained in the 2000 Highway Capacity Manual (HCM). The HCM provides analysis methods and equations that estimate the peak hour delay and level-of service (LOS) experienced by vehicles at signalized and unsignalized (i.e., stop controlled) intersections. Inputs to the HCM intersection calculations include peak hour traffic and pedestrian volumes, intersection geometrics (number of lanes), traffic signal timing parameters, and other data such as pedestrian volumes and the percentage of trucks.

LOS measures the effect of a number of factors, including speed and travel time, traffic interruptions, freedom to maneuver, driving comfort, and convenience. LOS is designated A through F from best to worst, which covers the entire range of traffic operations that might occur. LOS A through E generally represent traffic volumes at less-than-roadway capacity, while LOS F represents over-capacity and/or forced flow conditions.

The vehicular LOS at the intersection of Willoughby and Pearl Street and intersection of Willoughby and Jay Street were calculated during the AM, midday (MD), and PM peaks using a Synchro model. As shown in Tables 2 and 3 below, almost no impact to intersection delay is expected for any of the Alternatives. The intersection of Willoughby and Pearl Street remains at a LOS A for all the alternatives, and the intersection of Willoughby and Jay Street remains at a LOS C. For this reason, traffic impacts were not a significant driver in the selection for a Preferred Alternative.

Vehicular LOS at the Intersection of Willoughby and Pearl Streets

	LOS			Delay in Seconds		
	AM	MD	PM	AM	MD	PM
Existing Condition	A	A	A	7.4	6.9	7.1
Alternative 1	A	A	A	6.8	6.6	6.8
Alternative 2	A	A	A	7.4	6.9	7.1
Alternative 3	A	A	A	7.4	7.1	7.2

Vehicular LOS at the Intersection of Willoughby and Jay Streets

	LOS			Delay in Seconds		
	AM	MD	PM	AM	MD	PM
Existing Condition	C	C	C	24.7	32.8	28.2
Alternative 1	C	C	C	25.0	32.9	28.3
Alternative 2	C	C	C	24.5	32.7	28.2
Alternative 3	C	C	C	25.3	32.1	28.6



Vehicle turning east onto Willoughby Street (source: Arup)

Qualitative Evaluation

To evaluate whether the alternatives advance the goals and objectives outlined for the project, a qualitative evaluation process was developed to compare the Existing Condition and three Alternatives across a variety of desired outcomes. This section reviews the desired outcomes, criteria, and key findings of the evaluation. For the complete evaluation table, see Appendix C, Alternative Concept Evaluation.

It is important to note that the evaluation did not aim to provide a quantitative scoring mechanism with which to select one of the Alternatives. Instead, the evaluation methodology was designed to provide a transparent way to discuss the potential advantages and disadvantages of each design concept and to ensure thoroughness when selecting the Preferred Alternative by linking design decisions to the project's goals and objectives.

Desired Outcomes

Starting with the project goals and objectives, 34 desired outcomes were identified and then organized into seven categories, listed below. Most of the seven categories link directly to a specific project goal and objective.

Street aesthetics and visual quality

- Existing architectural assets are complemented and highlighted;
- View corridor is emphasized toward Fort Greene Park along Willoughby Street;
- Placement and use of street amenities such as lights, planters, and seating complement surroundings and create a comfortable setting for people to gather;
- Street design conveys a unique sense of place;
- Placement of landscaping enhances streetscape character;

Economic and retail vitality

- Street design conveys sense of place and desire to linger;
- Storefront visibility is emphasized;
- Sufficient space and flexibility for deliveries, in support of business operations;
- Potential to activate new development, retail & restaurant activity;
- Accommodates potential closure of Red Hook Lane;
- Accommodates potential closure of Pearl Street south of Willoughby Street;

Pedestrian movement, safety and comfort

- Pedestrians are able to move freely through and with-in the site without significant congestion;
- Pedestrians are encouraged to use entire right-of-way;
- Pedestrians achieve priority over other modes;
- Pedestrian connections with adjacent areas are emphasized and enhance the overall navigability of the project site;
- Pedestrian safety needs are addressed throughout the site, including the intersection at Willoughby/Pearl Street and Willoughby/Jay Street;
- Pedestrian seating supports adjacent uses and attracts passersby to the site;
- Achieves appropriate level of shading to encourage pedestrian comfort;
- Improved nighttime environment and perception of safety;

Inclusive design, accessibility, & flexibility

- Site is convenient and safe for members of the senior community;
- Site is convenient and safe for members of the visually impaired community;
- Site is convenient and safe for members of the physically impaired community;
- Design of alternative supports opportunity for play street;
- Design of alternative supports opportunity for special events and programming;
- Adaptable over time as development and social patterns shift around the site;
- Clear circulation patterns conveyed through design;

Vehicle Circulation

- Minimal traffic impact on surrounding area;
- Minimal vehicular congestions at Willoughby/Pearl Street (LOS analysis);
- Minimal vehicular congestion at Willoughby/Jay Street (LOS analysis);

Commercial loading

- Sufficient space for goods loading within designated loading area;
- Adequate ability for large trucks up to 40 feet to move to and from NYU loading dock;
- Adequate ability for large trucks up to 40 feet to move to and from designated loading area(s);

Passenger pick-up/drop-off

- Sufficient space for school pick up/drop off within designated loading area; and
- School pick up/drop off is convenient and allows for ease of maneuverability.

Criteria

Each desired outcome was rated according to the criteria below.

●	Strongly achieves desired outcome.
⦿	Moderately achieves desired outcome.
⦿	Minimally achieves desired outcome.
○	Does not adequately meet desired outcome.



Key Findings

Following the completion of the ranking process, the Existing Condition was determined to not adequately achieve many of the desired outcomes outlined in the project's goals and objectives. It received the numerous low rankings indicating little or no conformity with the desired outcomes. The Existing Conditions set up a base line for vehicular circulation with acceptable LOS at both intersections on site, as well as adequate spaces for goods delivery. All Alternatives built upon this base condition and resulted in an improved outcome when compared to the Existing Condition.

Alternative 1, which features the most traditional streetscape, contains the highest number of vertical elements, which allows for a generous amount of pedestrian amenities such as seating and lighting. It includes the most amount of street trees and shading, which is also a benefit for pedestrians. However, this alternative has the least amount of capability to host special events and programming as well as adapt to new development and social pattern shifts in the area over time. Alternative 1 has increased space for goods loading, but school pick-up/drop-off is also restricted in this alternative.

Alternative 2, which features a flush surface with uniform pavement, creates a unique place that conveys a public plaza type feel. The site-wide flush surface increases pedestrian comfort and ability to cross the roadway safely, and additional seating will foster a comfortable place for pedestrians to enjoy and gather. This alternative provides the best scenario for school pick-up and drop-off with designated space on both streets. However, this alternative has the least amount of space for goods delivery. It also had the smallest area for a play space compared to the other alternatives.

Alternative 3, which features a new pedestrian plaza and a flush surface throughout, allows space for a second concession and provides the strongest pedestrian linkage between Willoughby Plaza and Fulton Street. This alternative also has the least amount of segregation and permanent street furniture which allows freer pedestrian movement and increased programming flexibility compared to the other alternatives. However, this alternative had the least amount of pedestrian amenities such as lights, planters, and seating. There is sufficient space for loading, but was the most restricted alternative to vehicles, as it allowed access only at certain times.

From the results of the evaluation process, it was clear that not one individual alternative was a direct candidate for the Preferred Alternative, since every Design Alternative had its strengths and shortcomings. Therefore, the Preferred Alternative would be a hybrid of the successful elements from each of the design alternatives.

Cost Estimate

This section describes some high-level estimates for potential costs calculated for each of the Alternatives. These estimates were based on a conceptual list of materials and quantities, and priced by the NYC Department of Design and Construction (DDC) price per unit guide.¹² The following cost categories were taken into account for estimation: demolition, site set-up, utilities, pavement treatment, street furniture, lighting, concession utilities, and drainage. Each category contains specific items, for which costs were estimated based on total number of units required.

The cost estimation process indicated that all three alternatives were within a similar costs range between \$2.0 million - \$2.3 million.¹³ The primary driver of the differences in cost were attributed to the amount of fill and grading required for creating flush surfaces, as well as drainage work.

Alternative 1

The least expensive alternative, since it maintains a traditional streetscape and requires less to fill and grade the site. This alternative spends the most in street furniture, as well as the addition of a concession. Alternative 1 is estimated at a total of \$2,018,000.

Alternative 2

Maintains a flush surface, is the most expensive alternative due to the work required to grade, fill, and modify drainage on site to include linear drains. Another unique cost to Alternative 2 is the addition of façade lighting. Alternative 2 is estimated at a total of \$2,339,000.

Alternative 3

Maintains a flush surface, which requires additional costs to grade and fill the site. However, this alternative does not require the same modification to drainage systems. Alternative 3 also includes a concession, but the least amount of street furniture out of all three alternatives. This alternative is estimated to cost the most for pavement treatment compared to the other alternatives since it includes two unique pavements, a straight curb and additional striping. Alternative 2 is estimated at a total of \$2,117,000.



Pearl Street looking north (source: Arup)

Cost Estimate

	Total	Total with 25% Contingency
Alternative 1	\$2,018,000	\$2,523,000
Alternative 2	\$2,339,000	\$2,924,000
Alternative 3	\$2,117,000	\$2,647,000

Since the cost estimation for all three alternatives were within a similar range, the evaluation process determined that cost was not a significant driver in the selection for a Preferred Alternative.



E Green Infrastructure



To	NYCDOT	Date	October 3, 2014
Copies		Reference number	227520-12
From	Arup	File reference	4-05
Subject	Feasibility Study for Green Infrastructure on Willoughby Street and Pearl Street, Brooklyn		

1 Introduction

Green infrastructure is a network of decentralized stormwater management practices, such as green roofs, trees, rain gardens, bioswales and permeable pavement, that can capture and infiltrate rainfall where it falls, thus reducing stormwater runoff and improving the health of surrounding waterways.

The ability of these practices to deliver multiple ecological, economic and social benefits has made green infrastructure an increasingly popular strategy in recent years. In addition to reducing polluted stormwater run-off, GI practices can also positively impact energy consumption, air quality, carbon reduction and sequestration, property prices and recreation.

This memorandum explores the feasibility of green infrastructure for the Willoughby Shared Street project area.

2 Criteria for Siting of Green Infrastructure

NYC Department of Environmental Protection (DEP), MTA New York City Transit (NYCT) and New York City Department of Transportation (DOT) have guidelines relating to the siting of green infrastructure. These criteria and their relation to the Willoughby Shared Street project site are described below.

2.1 Geotechnical Investigation

2.1.1 NYC DEP Requirements

Geotechnical investigation is required prior to the construction of these GI practices to determine subsoil characteristics, subsoil permeability rates, and depths to groundwater table and bedrock.

The geotechnical investigation consists primarily of:

1. Soil borings to determine the subsoil characteristics as well as the depths to groundwater table and bedrock, and
2. Falling-Head In-Situ permeability tests to determine subsoil permeability rates.

Memorandum

For GI practices which are confined to the right-of-way or street, a single soil boring may be used to represent the soil data for multiple green infrastructure practices within 100 feet of the boring location or a single PT may be used to represent the permeability of multiple GIs within 75ft of the PT location.

In order for green infrastructure to be sited in a location, the permeability of the subsoil is required to be 0.2-5in/hr with a fines content of less than or equal to 20%.

2.1.2 Analysis

Two boreholes (B-1 and B-2) were drilled on the south-west corner of the intersection of Willoughby St and Pearl St as part of the Willoughby Street Plaza Reconstruction Project (NYC Department of Design and Construction Project ID: HWK1170). The boreholes logs are included on drawing B-101.00 in Appendix A.

Arup carried out an analysis of the two borehole logs and made the following conclusions. B-1 indicates the presence of fill material overlying silty sand (SM), which in turn overlies poorly graded sand (SP). Similarly, B-2 shows the fill layer overlying silty sand (SM), which in turn overlies the poorly graded gravel (GP). The sieve analyses results indicate that percent fines are less than 20% for all the samples collected from both B-1 and B-2. The sample depths range from 10 ft to 25 ft. No information is available regarding the groundwater table from the drilled borings. DEP's geotechnical procedure for assessing feasibility of the site for green infrastructure typically involves permeability testing in conjunction with soil boring and sieve analysis. However, no permeability information is available for the site. Based on the limited available information, the site seems suitable for green infrastructure, especially green infrastructure with stone columns which can penetrate through SM to generally more pervious SP and GP. However, additional soil investigation including permeability tests need be conducted before final recommendations are made for the site and the type of green infrastructure is selected.

2.2 MTA New York City Transit

2.2.1 Requirements

Green infrastructure must not be sited above or within a 25' radius of subway structures or within a 25' radius of subway entrances and exits. Notification of green infrastructure within a 200' radius of a subway structure should be made to MTA New York City Transit. These requirements apply to unlined green infrastructure that encourage infiltration and therefore may cause water damage to a subway structure.

2.2.2 Analysis

Cross-sections of Willoughby Street were prepared for the Willoughby Street Plaza Reconstruction Project (NYC Department of Design and Construction Project ID: HWK1170). These cross-sections are included on drawing D2, sheet number 8 in Appendix A. The drawings indicated that the subway structure roof is approximately 39' below the compacted granular fill layer of Willoughby Street. As a result, unlined green infrastructure cannot be sited on Willoughby Street. Unfortunately the drawings do not show the extent of the tunnel and therefore no analysis can be made of the feasibility of green infrastructure on Pearl Street.

Memorandum

2.3 Utilities

2.3.1 Requirements

Green infrastructure should be sited 3.5' away from sewers, water mains and gas mains and any major electrical and data cables. Minor electrical conduits and data cables can be accommodated in protective conduits through the green infrastructure. Any major electrical conduits, gas mains and data cables can be relocated as part of construction by undertaking the Section U process. This will require extensive consultation with the utility suppliers.

2.4 NYC DOT Siting Guidelines

2.4.1 Requirements

New York City DOT provides siting guidelines for green infrastructure to ensure that street safes continue to be safe and accessible for all road users, including pedestrians, cyclists, private motorists, bus operators, delivery trucks and emergency services. The criteria are listed below.

Horizontal Clearances to Existing Conditions	
Existing Condition	Minimum Clearances
Commercial sidewalks	Maintain a width >8'
Doors and gates	Maintain a width of 5' wide (or the width of the door/gate, whichever is greater) for the access path from the front of the door to the curb line at the street
Building vaults	A clearance of 8' around building vaults (where the sidewalk width is greater than 12')
Bus stops	A clearance of 100' from the sign towards the back of the bus and from 20' from the sign towards the front of the bus.
Driveways or legal curb cuts	A clearance of 5' either side of driveways and legal curb cuts.
Fire hydrants	A clearance of 3' around fire hydrants
Pedestrian ramps, marked or unmarked crosswalks	In commercial areas, a clearance of 10' into the block from the building line is required at corner quadrants.
Manholes	A clearance of 5' around manholes.
Munimeters	A clearance of 4' around munimeters.
School entrances	A clearance of 25' from the center of the main entrance.
Street furnishings	A clearance of 5' around street furnishings.
Subway entrances and exits	A clearance of 25' around subway entrances and exits.
Trees	The tree trunk should be 15' from the edge of crosswalks with approaching traffic or the stop sign, whichever is greater and 35' from the apex of a corner.
Utility poles and streetlights	A clearance of 5' around utility poles and streetlights.

2.4.2 Analysis

All of the above criteria were overlaid on a plan to give permitted locations for green infrastructure. This plan is included in Appendix B.

Memorandum

3 Summary

In summary:

- Based on the limited geotechnical information available, the site seems suitable for green infrastructure with stone columns which can penetrate through SM to generally more pervious SP and GP. However, additional soil investigation including permeability tests must be conducted before final recommendations are made for the site.
- Unlined green infrastructure is not permitted above the MTA structure on Willoughby Street. Further investigation is required to determine the extent of the MTA tunnel on Pearl Street.
- The NYC DOT siting guidelines have been applied to the site to indicate potential locations for green infrastructure.

