Recommendations

The following recommendations address the issues presented in the previous section. Recommended improvements include: curb realignments, traffic calming devices, re-striping, improved signage, and signal timing adjustments. The recommendations presented here may or may not address all of the issues either corridor-wide, or at each intersection, and those involving either structural or operational changes may be subject to a traffic analysis to determine feasibility. Implementation funds of $910,000 are allocated for this project.

Corridor-Wide Improvements

The following recommended improvements should be applied throught the East Houston Street corridor to improve pedestrian and bicycle safety and circulation.

East Houston Street Bicycle Lane

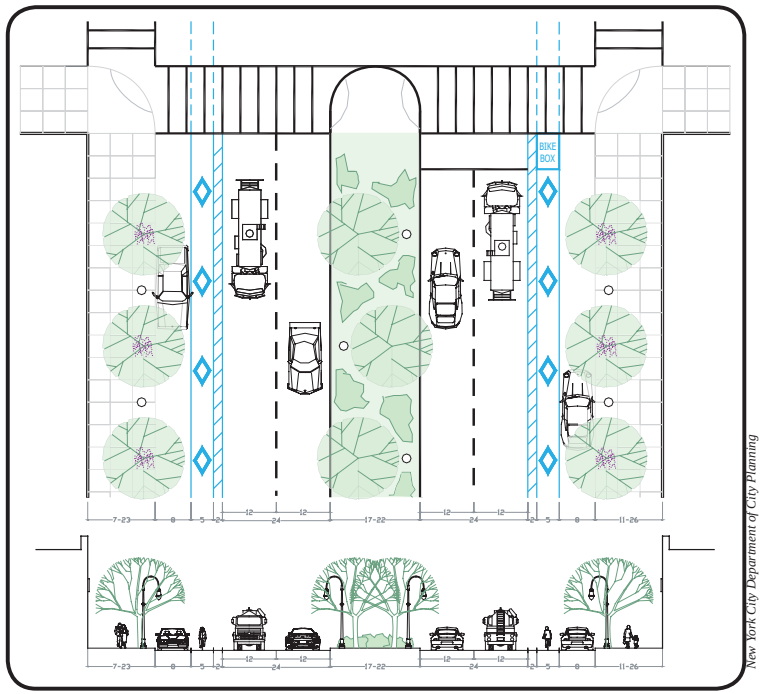
The *New York City Bicycle Master Plan* designates Houston Street from Sixth Avenue to East River Park as a recommended on-street route for cyclists. This route provides connections to north-south on-street bicycle routes at its intersections with Second Avenue, First Avenue and Allen Street, Ridge Street, Avenue C and Pitt Street, and just east of FDR Drive. it connects to the Manhattan Waterfront Greenway at East River Park.

This study recommends installing Class 2 striped on-street bicycle lanes from Forsyth Street to the FDR Drive in the both directions. The bicycle lane would nearly connect with the existing southbound bicycle lane on Second Avenue and its northbound pair (First Avenue) with the Manhattan Waterfront Greenway at the East River Park. A traffic analysis (see next section) was conducted to assess the impacts of removing a travel lane in each direction along East Houston Street from the Second Avenue to the FDR Drive. The study showed that traffic conditions could be improved to feasibly permit the installation of a five-foot bicycle lane with a two-foot buffer along this section of East Houston Street. However, congested traffic conditions from Second Avenue to the Bowery could not be improved, and therefore, this portion of the route would be a signed Class 3 Route only. The reconfiguration of East Houston Street would leave two 12-foot travel lanes, an eight-foot parking lane, and a bicycle lane in each direction.

New York City Department of City Planning

Views of East Houston Street looking east from Norfolk Street and west from Mangin Street (top and middle). Renderings of the proposed on-street bike lane (above and top right). A sectional and plan view of the proposed East Houston Street bicycle lane.

New York City Department of City Planning



New York City Department of City Planning

Figure 10: Bicycle Lane Section

Widened Medians

Raised medians on East Houston Street act as both a pedestrian refuge within the roadway and a pedestrian amenity, when planted. The reconfiguration of East Houston Street to provide two travel lanes, a parking lane, and a bicycle lane in each direction would still leave some excess roadbed throughout most of the corridor. This study recommends widening the medians along East Houston Street to recapture needed space for the pedestrian. Widening the medians would maximize pedestrian safety and enhance pedestrian amenities by creating additional space for landscaping. Currently, the width of the median ranges from 14-and-a-half feet at the east end of the corridor to nearly 16 feet at the west end (see below). Medians could be widened to anywhere from 17 feet, as at Mangin Street, to nearly 22 feet, as at Ludlow and Orchard streets. The widened medians could be implemented as part of a long-term capital project that would reconstruct East Houston Street to match West Houston Street.

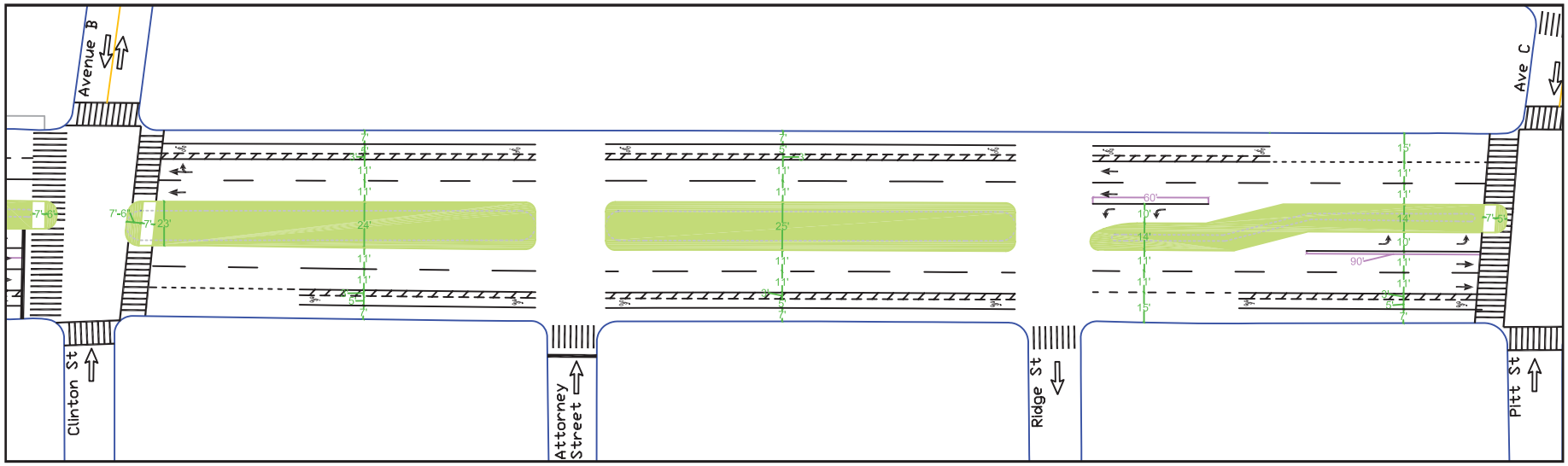
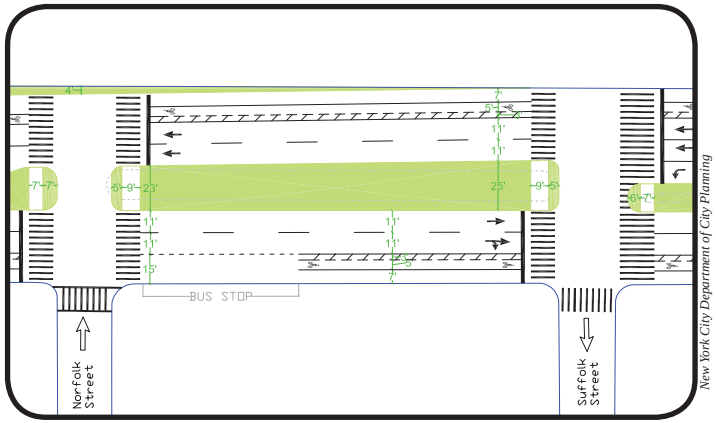


Figure 11: Widened Medians

Curb and Median Tip Extensions

In addition to widening the medians, extending the curbs to shorten crossing distances and extending median tips through crosswalks is another means by which to improve pedestrian safety on East Houston Street. Where feasible, neckdowns are recommended at corners of signalized intersections and at T-intersections. This recommended improvement will shorten the crossing distance for pedestrians by five to ten feet. In some instances, the installation of neckdowns may require the removal of on-street parking spaces. Extending medians, which currently stop short of the crosswalks, to extend through the crosswalks will provide needed pedestrian refuge space for pedestrians who cannot make this long crossing and are stranded on the medians.

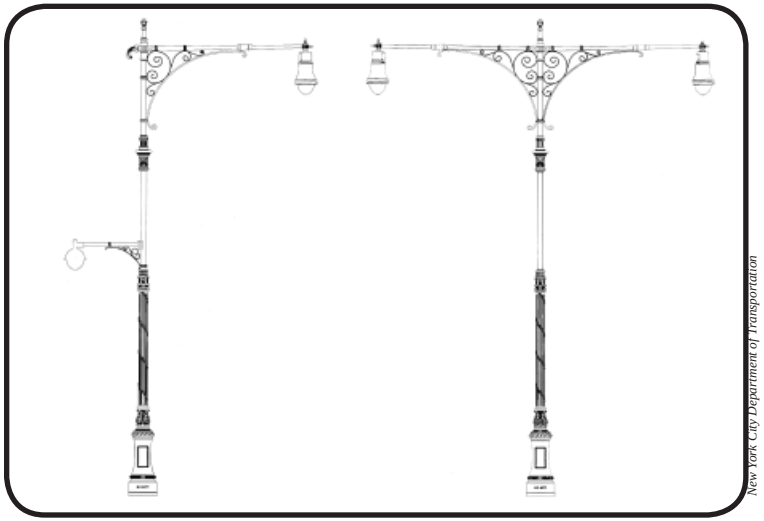
Plan view with recommended street improvements.



New York City Department of City Planning

The north side of Houston Street at Norfolk Street, and a rendering of the proposed curb extension.
Left: Type "M" lamppost with pedestrian arm and Type "M" twin lamppost.

New York City Department of City Planning



New York City Department of Transportation

Pedestrian Amenities

This study recommends installing pedestrian-scale lighting to illuminate the sidewalks for pedestrians navigating the study area's lively late night street scene. However, DOT requires the signing of a maintenance agreement by a local organization for the installation of additional lighting along the corridor. Alternatively, or additionally, decorative street lighting fixtures could be installed to improve the appearance of the streetscape (see illustration, left).

Uniform Crosswalks

Crosswalks should be marked appropriately and consistent with the land use of the area in which they are located. This study recommends three different crosswalk styles for the corridor:

High-visibility crosswalks are parallel lines, spaced 12" to 24" apart, perpendicular to the direction of pedestrian movements. High-visibility crosswalks increase visibility and awareness of a shared intersection, and are recommended at intersections along the western portion of the corridor from the Bowery to Avenue C, where there is a higher concentration of commercial activity, and truck and commercial vehicular traffic.

School crosswalks are two parallel lines running from curb to curb connected by perpendicular lines spaced 12" to 24" apart. School (sometimes called ladder) crosswalks increase visibility and awareness of a shared intersection even further. These enhanced, high-visibility crosswalks are recommended at intersections at the east end of the corridor where there are schools and high pedestrian volumes.

Barnes Dance crosswalks are used to mark a signal-controlled intersection with an all-pedestrian phase that permits pedestrians to cross the intersection in all directions at once. Barnes Dance crosswalks, as illustrated in the *Manual of Uniform Traffic Control Devices* (MUTCD), use striping to mark two diagonal pathways at the corners intersecting the typically-marked crosswalks. This study recommends the installation of a Barnes Dance crosswalk at Baruch Drive and East Houston Street, where there is an existing all-pedestrian signal phase.

Also, pedestrian ramps should be installed for the west crosswalk at Baruch Drive, the west crosswalk at Baruch Place, the crossing at the southbound entrance ramp to the FDR Drive, the crossing at the northbound exit ramp to the FDR Drive, as well as any additional crossings where pedestrian ramps are not present.

Dan Burden

Trailblazer Signage

There are twelve parks and recreational facilities in and around the study area. However, some of these spaces are obscured from view, such as Hamilton Fish Park, or access is constricted, such as East River Park. This study recommends improving orientation and access to open spaces by installing signage to direct pedestrians to entry points of open spaces that are otherwise obscured. Parks Department logo banners, affixed to light fixtures at every open space, could be installed as a possible, short-term signage solution. New signage could be developed and placed at every open space. One option is to use neighborhood maps, to indicate the area's open spaces.

Recommended crosswalk styles: High-visibility crosswalk (top left), School crosswalk (top right), and Barnes Dance crosswalk (left).

Trailblazer signage for the Brooklyn Children's Museum (right).

Focus Intersection Improvements

Corridor-wide recommendations are augmented by opportunities for pedestrian improvement at eight intersections along East Houston Street. Recommended actions at these intersections were developed based on identified opportunities to relieve pedestrian congestion, improve pedestrian safety and orientation, and improve conditions for cyclists.

Forsyth Street @ East Houston Street

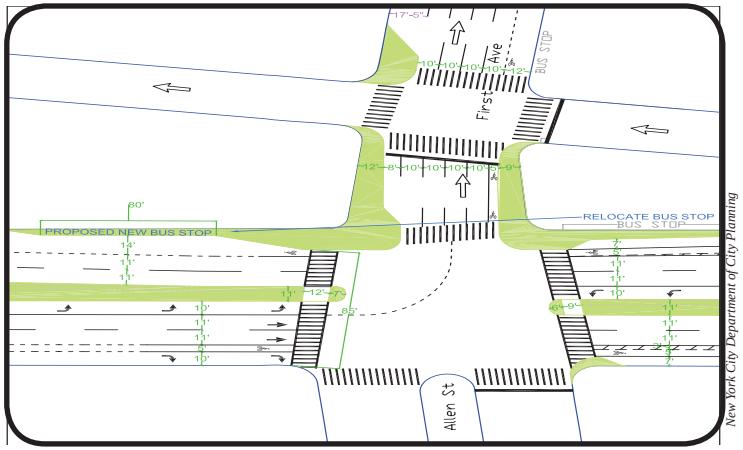
This study recommends installing a five-foot bicycle lane with a two-foot buffer connecting the existing bicycle lane from Forsyth Street to the East River Park greenway on East Houston Street. The existing four-second Leading Pedestrian Interval (LPI) at this intersection is also an opportunity to improve conditions for cyclists. The LPI should function as a pre-green cyclist signal to allow cyclists a head start.

First Avenue/Allen Street @ East Houston Street

The intersection of Allen Street at East Houston Street is extraordinarily wide, making it difficult for pedestrians to cross either East Houston Street or Allen Street during the allotted pedestrian walk phase. This study recommends installing a neckdown at the southeast corner of the intersection to decrease pedestrian crossing distance and improving pedestrian safety. The neckdown would slow down right-turning vehicles onto East Houston Street to alleviate conflicts between vehicles making the turn onto East Houston Street and bicyclists using the bicycle lane.

The east curb of First Avenue is striped between East Houston Street and First Street to channelize vehicles. Neckdowns and curb extensions

Conditions to be improved at First Avenue.



Planned improvements for First Avenue/Allen Street and East Houston Street

should be installed at the northwest and northeast corners and on First Avenue to decrease pedestrian crossing time and improve pedestrian safety. To avoid conflict with the neckdowns, the bus stop on East Houston Street should be relocated from east of First Avenue to west of First Avenue. Parking regulations on East Houston Street and along the west curb of First Avenue at East Houston Street permit the installation of neckdowns at these locations.

This study also recommends that the existing four-second LPI at this intersection function as a pre-green cyclist signal.

Avenue A/Essex Street @ East Houston Street (including First Street @ East Houston)

The intersection of East Houston Street at First Street poses challenges for pedestrians and cyclists. Vehicles traveling at high speeds on East Houston Street bear right onto First Street, pedestrians are forced to cross mid-block without the benefit of a crosswalk because the traffic triangle created at First Street, East Houston, and First Avenue stop short of the intersection.

This study recommends extending the curb to the traffic triangle, replacing First Street from the intersection of East Houston Street and First Street to the intersetion of East Houston Street and Avenue A. The traffic triangle would be truncated to allow vehicles to turn onto First Street arcoss from Ludlow Street. A crosswalk would be installed to link the traffic triangle to the curb extension. A turning lane should be installed on East Houston Street between the bicycle lane and the extended curb to allow vehicles to turn onto First Street. Neckdowns should be installed at both ends of the curb extension to reduce pedestrian crossing time and improve pedestrian safety.

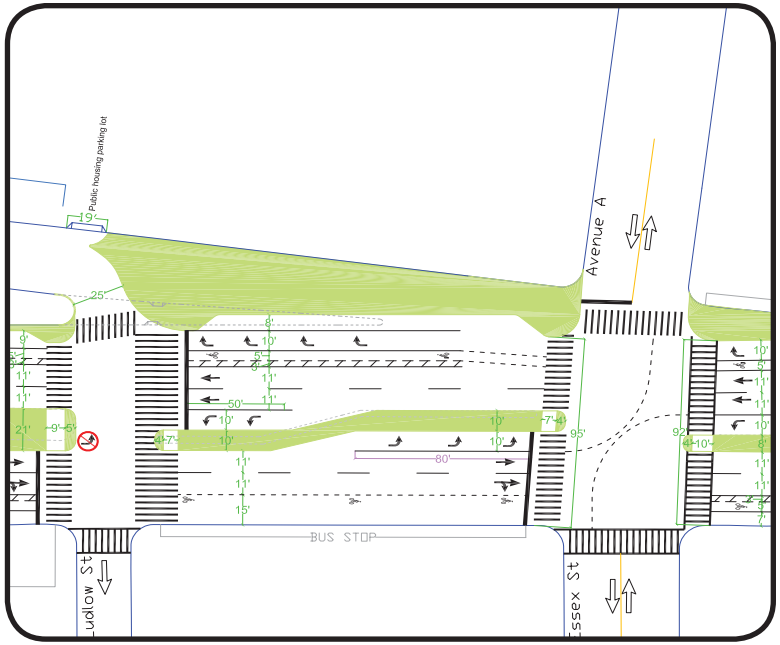
The curb at the northeast corner of Avenue A and East Houston is not parallel to the street; as a result, the northern moving/turning lane on East Houston Street is wider then other lanes. This might create confusion for drivers, pedestrians, and bicyclists. This study recomands extending the curb to create a uniform curb line that is parallel to the street. The moving/turning lane would become a turning-only lane that is in between the curb extension and bicycle lane.

This study recommends appealing to the community and the local Business Improvement District (BID) to press upon the building owners to maintain their property. Additionally, more attractive fencing, such as at Liz Chrystie Gardens, would be a vast improvement over what is there and is recommended at this location. Another option might be to host an open competition for local artists and community members for the design of an effective treatment.

Avenue B/Clinton Street @ East Houston Street

Vehicles turning left from East Houston Street to northbound Avenue B conflict with pedestrians in the crosswalk. This study recommends allotting dedicated signal time for left turns to reduce the conflict between pedestrians and motorists at the intersection.

A plan view of recommended improvements at Avenue A (left); a view of East Houston and East First streets looking west from Avenue A (below left); and a rendering of proposed improvements (below right). Installing bollards would prevent cars from encroaching on pedestrian space (below right).



New York City Department of City Planning

The neglected backs of buildings fronting East Houston Street between Avenues B and C have resulted in a number of “pedestrian-unfriendly” activities, such as parking on the sidewalk. This study recommends installing self-enforcing physical barriers, such as bollards, on the north side of East Houston Street east of the intersection, where cars waiting to be serviced at the gas station park on the sidewalk. Bollards would effectively define the

inner sidewalk line, discourage vehicles from parking there, and clear the sidewalk for pedestrians.

Avenue C/Pitt Street @ East Houston Street

As with Avenue B/Clinton Street, left-turning vehicles from southbound Avenue C onto East Houston Street conflict with pedestrians in the crosswalk. This study recommends allotting dedicated signal time for left turns to reduce the conflict between pedestrians and motorists at the intersection.

Although the backs of buildings front nearly all of East Houston Street's north side, some areas along the corridor are better kept than others. The block on the north side of East Houston Street, between Avenues B and C, is particularly challenged with both traffic-related issues, as discussed above, and aesthetic issues, most notably at the intersection of East Houston Street at Avenue C. The buildings are boarded up in the back and are covered in graffiti. Also, the building lots are bordered by unattractive corrugated metal fencing.

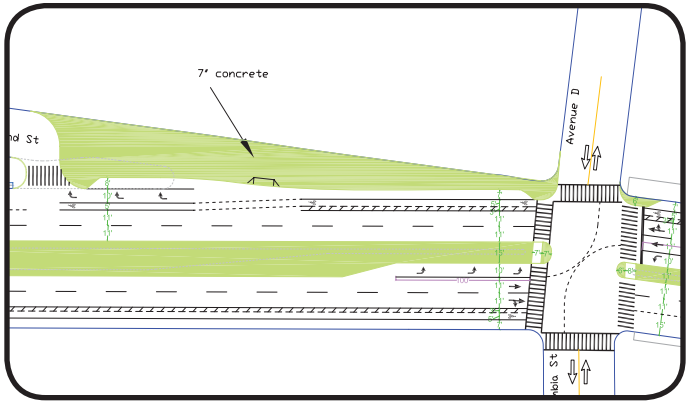
While the upkeep of privately owned buildings is beyond the scope of this study, this study recommends appealing to the community and the local Business Improvement District (BID) to press upon the building owners to maintain their property. Additionally, more attractive fencing, such as at Liz Chrystie Gardens, would be a vast improvement over what is there and is recommended at this location. Another option might be to host an open competition for local artists and community members for the design of an effective treatment.

Avenue D/Columbia Street @ East Houston Street (including Second Street @ East Houston Street)

As at Avenue A, the traffic triangle created by the junction of East Houston Street and Second Street poses challenges for pedestrians and cyclists when vehicles traveling at high speeds on East Houston Street bear right onto Second Street. Pedestrians on the south side of East Houston Street must cross the street without any safe means of crossing to the curb.

This study recommends extending the curb to the traffic triangle, replacing Second Street from the intersection of East Houston Street and Second Street to the intersetion of East Houston Street and Avenue D. The traffic triangle would be truncated to allow vehicles to turn onto Second Street. A crosswalk would be installed to connect the traffic triangle to the curb extension. A turning lane should be installed on East Houston Street between the bicycle lane and the extended curb to allow vehicles to turn onto

Left: Examples of alternatives to unkempt backs of properties abutting the north side of East Houston Street include a fenced rear patio area and a mural in memory of the singer Celia Cruz.



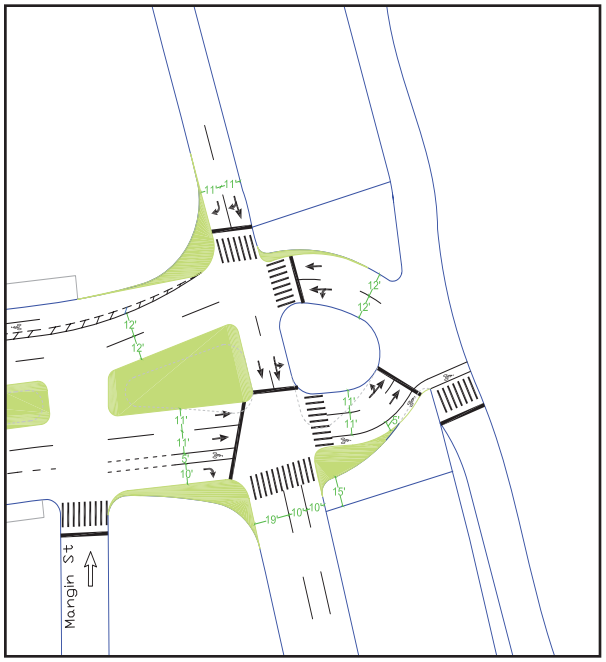
Planned improvements for Avenue D

Second Street. Neckdowns should be installed at both ends of the curb extension to reduce pedestrian crossing time and improve pedestrian safety. The bus stop would be relocated from the tip of the traffic triangle to the end of the recomanded truncated traffic triangle.

FDR Drive @ East Houston Street

High speeds on East Houston Street present problems throughout the corridor for both pedestrians and vehicular circulation. This issue is particularly problematic at the junction of East Houston Street and the FDR Drive. Eastbound vehicles make uncontrolled right turns from East Houston Street onto southbound FDR Drive at high speeds, conflicting with pedestrians using the striped crosswalk. Roadbed striping at the corners of East Houston Street and FDR Drive should be replaced with raised curb extensions to sharpen the turn onto East Houston Street and FDR Drive as a traffic calming measure. The curbs on East Houston Street between south bound and north bound FDR Drive should be extended to create a uniform road bed width on East Houston Street. The curb extensions would reduce pedestrian crossing time and improve pedestrian safety. Crosswalks should be striped on East Houston Street and FDR Drive to further improve pedestrian safety. Also, jersey barriers on the eastern end of the intersection block views of, and constrict access to, East River Park. This study recommends removing the jersey barriers and replacing them with a more pedestrian and cyclist-friendly traffic barrier, such as bollards.

New York State DOT is currently studying the FDR Drive, including this intersection, and seeking a comprehensive solution to traffic flow issues. Another DCP study, the *East River Esplanade Access Study*, proposes the reconfiguration of this intersection as a roundabout.



Improvements at the intersection of East Houston Street and FDR Drive

From left to right: A vehicle driving over striping at East Houston Street and the FDR Drive; Pedestians in the crosswalk; The striped area should be paved to slow turning vehicles.

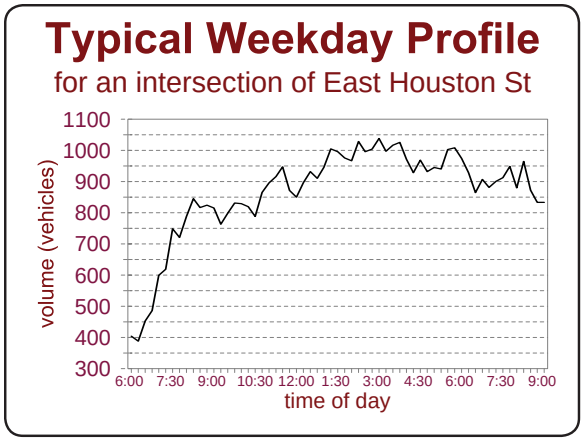
Traffic Analysis

This section presents a traffic study conducted by the NYC Department of City Planning in order to determine the feasibility of installing a bicycle lane along the East Houston Street corridor. The analysis assesses existing traffic conditions and any future impacts that a bicycle lane would pose on vehicular traffic. This analysis was conducted by evaluating traffic data with Highway Capacity Software (HCS), the standard and accepted methodology to assess traffic conditions and impacts. HCS is a computer application that processes data on variables such as street geometry, signal timing and traffic volumes and determines the optimal capacity of the roadway. HCS assigns a Level of Service (LOS) value to transportation facilities, including intersections and roadways, as well as facilities for transit, bicycles and pedestrians.

Data Collection

Traffic data sets were collected to perform analyses of existing traffic operations in the study area. The data collection included Automatic Traffic Recorder (ATR) counts, manual turning movement counts, and manual vehicle classification counts. According to NYCDOT, it was not necessary to collect traffic data on the surrounding streets in order to determine the feasibility of installing a bicycle lane along East Houston Street; as a result this analysis does not balance the network.

Counts were conducted at eight major intersections along the East Houston Street corridor: the Bowery, Second Avenue and Chrystie Street, First Avenue and Allen Street, Avenue A and Essex Street, Avenue B and Clinton Street, Avenue C and Pitt Street, Avenue D and Columbia Street, and the FDR. Additionally, three of these eight intersections, the Bowery and Second and First avenues, are part of the designated truck route network, and therefore, vehicles were classified by type and number of axles.



Automatic Traffic Recorder (ATR) Counts

Over the course of three weeks the NYC Department of Transportation installed ATRs at eight intersections along East Houston Street to collect 24-hour traffic volume data for a one week period. Traffic data was recorded at the following locations from September 9 through September 16, 2002:

- Bowery at East Houston Street
- Second Avenue and Chrystie Street at East Houston Street
- Avenue C and Pitt Street at East Houston Street

Traffic data was recorded at the following locations from September 23 through September 30, 2002:

- First Avenue and Allen Street at East Houston Street
- Avenue A and Essex Street at East Houston Street
- Avenue B and Clinton Street at East Houston Street

Traffic data was recorded at the following locations from September 30 through October 7, 2002:

- Avenue D and Columbia Street at East Houston Street
- FDR Drive at East Houston Street

Additional data was collected at certain locations where ATRs malfunctioned. For the periods essential to the analysis, NYC Department of City Planning staff collected the missing through movement data on June 11 and June 19, 2003. During the midday period of 12:00noon-2:00 pm data was collected at Avenue A and Essex Street at East Houston Street. During the evening period of 4:00pm-6:00pm data was collected at the following locations:

- First Avenue and Allen Street at East Houston Street
- Avenue A and Essex Street at East Houston Street
- Avenue B and Clinton Street at East Houston Street

Turning Movement Counts

Manual turning movement counts were conducted on the Thursday of each week that ATR counts were recorded. This day was chosen because the traffic data was representative of typical weekday traffic. Traffic data from the days which manual counts were collected were compared to the other days of the week in order to determine which day represented typical weekday traffic. Figure 1 represents typical weekday vehicular traffic volumes on East Houston Street between 6:00 am and 9:00 pm.

Manual turning movements were collected on Thursday, September 12, 2002 at the following locations:

- Bowery at East Houston Street
- Second Avenue and Chrystie Street at East Houston Street
- Avenue C and Pitt Street at East Houston Street

On Thursday, September 26, 2002 at the following locations:

- First Avenue and Allen Street at East Houston Street
- Avenue A and Essex Street at East Houston Street
- Avenue B and Clinton Street at East Houston Street

On Thursday, October 3, 2002 at the following locations:

- Avenue D and Columbia at East Houston Street
- FDR Drive at East Houston Street

Turning movement counts were conducted by NYC Department of City Planning employees for the 8:00am-10:00am, 12:00noon-2:00pm (MD or midday) and 4:00pm-6:00pm peak periods. Continuous counts were recorded in 15-minute intervals for all eight intersections.

At some locations data collected was incomplete due to rain. In order to complete the analysis NYC Department of City Planning staff collected the missing data on June 11 and June 19, 2003. During the midday period of 12:00noon-2:00pm data was collected at Avenue A and Essex Street at East Houston Street. During the evening period of 4:00pm-6:00pm data was collected at the following locations:

- First Avenue and Allen Street at East Houston Street
- Avenue A and Essex Street at East Houston Street
- Avenue B and Clinton Street at East Houston Street

Vehicle Classification Counts

Vehicle classification counts were conducted by the NYC Department of City Planning at three intersections along East Houston Street. These counts were conducted simultaneously with the vehicular turning movement counts.

The recorded vehicle classifications were used to determine the percentage of heavy vehicles for each approach at the three intersections. The calculated percentage of heavy vehicles for each approach was entered into the Highway Capacity Software (HCS), in order to acurately measure delay and the resulting level of service (LOS) and to count the number of buses traveling along the corridor.

Counts were recorded in 15-minute intervals for each peak period. Vehicles were classified as autos, buses, small two-axle trucks, large three-axle trucks, oversize trucks with more than three axles. Vehicle classification counts were conducted as follows:

Thursday, September 12, 2002

- Bowery at East Houston Street
- Second Avenue and Chrystie Street at East Houston Street

Thursday, September 26, 2002

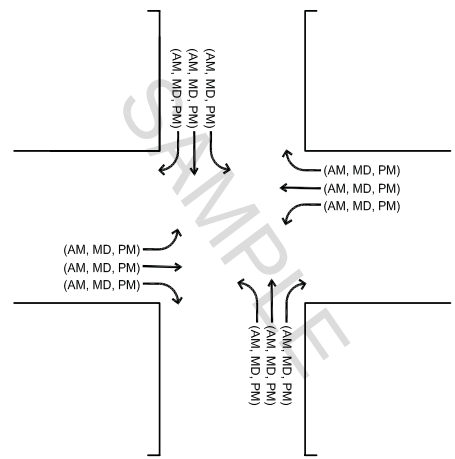
- First Avenue and Allen Street at East Houston Street

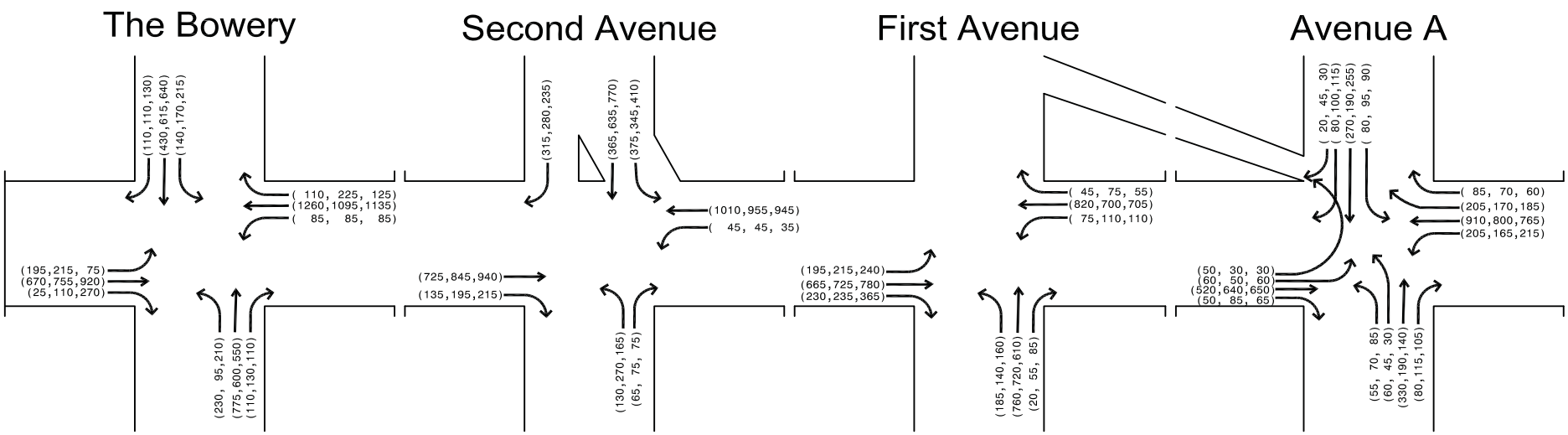
The north-south corridors which traverse East Houston Street experience higher truck volumes than East Houston Street. The Bowery experienced the highest volume of truck traffic along the corridor, particularly during the midday peak period (38.81% of northbound traffic). Truck traffic along the Bowery consisted primarily of small, two-axle trucks (36.65%). The highest percentage of large trucks with three axles (2.15%) was found along First Avenue during the midday peak period. The vehicle classification percentages are detailed in Appendix 1.

Existing Traffic Network

Figure 12, below, shows the existing traffic network using traffic volumes obtained from ATR counts and manual turning movement counts as described.

Figure 12: Traffic Volumes Map





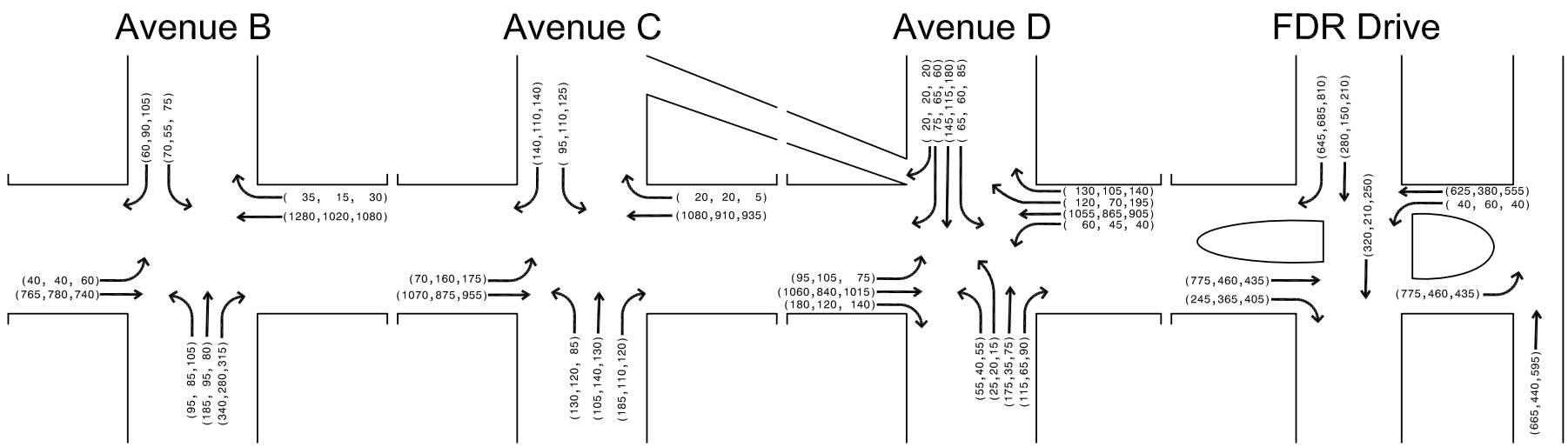
SAMPLE

Traffic was generally heavier for the eastbound direction in the PM period, while westbound traffic was heaviest in the AM period. Southbound traffic approaching East Houston Street was highest in the PM period, while northbound traffic was generally higher in the AM period.

Supplementary Counts

Department of Transportation conducted supplementary manual traffic counts on 30 March and 31 March, 2005 at the following locations:
First Avenue and Allen Street at East Houston Street
East First Street at East Houston Street
East First Street at First Avenue
Ludlow Street and East First Street at East Houston Street
Avenue A and East First Street at East Houston Street
Suffolk Street at East Houston Street
Avenue B and Clinton Street East Houston Street
Ridge Street at East Houston Street
East Second Street at East Houston Street
Avenue D and Columbia Street at East Houston Street
Baruch Place and East Houston Street

The counts were recorded in 15-minute intervals for the 8:00am-10:00am, 12:00noon-2:00pm, and 4:00pm-6:00pm peak period. Vehicles were classified as cars, taxis, large trucks, buses, and bicycles. The average volume of the two days was incoperated in the traffic analysis.



Methodology

Existing conditions at the eight intersections were analyzed for the peak morning, midday and evening hours of traffic volume, as determined through analysis of the data collected for the ATR counts. The peak hour for each period is defined as the four consecutive 15 minute intervals whose sum of traffic volumes measures the highest. Upon determination of the peak hours for the focus areas each identified period was analyzed by applying the accepted methodology of the 2000 Highway Capacity Manual (HCM) and its accompanying Highway Capacity Software (HCS). The HCM has established separate approaches to the analysis of signalized and unsignalized intersections. Five intersections analyzed, including the First Avenue, Avenue A, Avenue B, Avenue C and Avenue D, are signalized intersections.

Signalized Intersections

The capacity analysis methodology divides an intersection approach into lane groups on the basis of the movements occurring during each signal phase. The lane groups are then analyzed to determine the specific vehicular capacity and level of service (LOS). The analysis requires the following information: number and width of travel lanes, on-street parking conditions, locations of bus stops, number of buses stopping per hour, vehicle movements, vehicle classification, conflicting pedestrian movements, traffic signal length, and allocation of green time.

The operating characteristics of signalized intersections may be estimated and evaluated by analyzing capacity and performance. The capacity of the intersection represents the through put of the facility, or the maximum number of vehicles that may be processed in one hour. An important outcome of capacity analysis is the volume-to-capacity ratio (v/c ratio). This ratio indicates the proportion of the capacity (supply) utilized by the existing traffic volume (demand). High v/c ratios (>0.85) indicate some traffic congestion and low v/c ratios (<0.60) indicate smooth traffic flow.

The delay time, or the average stopped time per vehicle, is determined based on the capacity of a lane group, the amount of green time allotted to a lane group, and the signal cycle length. The performance of an intersection is based on the estimated average delay for each vehicle utilizing a roadway segment. The delay time is the determining factor in assigning a LOS to a lane group. Short delays result in an acceptable LOS, and long delays result in a poor LOS (e.g., an average delay of up to five seconds per vehicle corresponds to LOS A and 30 seconds per vehicle corresponds to LOS D). LOS definitions for signalized intersections are defined in Table 1 above.

Table 1: Level of Service Definitions for Signalized Intersections

Flow Quality	Description
Level A	Describes operation with very low delay, i.e., less than 10.0 seconds per vehicle. This occurs when progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.
Level B	Describes operation with delay in the range of 10.1 to 20.0 seconds per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than LOS A, causing higher levels of average delay.
Level C	Describes operation with delay in the range of 20.1 to 35.0 seconds per vehicle. These higher dealys may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear in this level. The number of vehicles stopping is significant at this level, although some may still pass through the intersection without stopping.
Level D	Describes operation with delay in the range of 35.1 to 55.0 seconds per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, longer cycle lengths, or high v/c ratios. Many vehicles stop and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.
Level E	Describes operation with delay in the range of 55.1 to 80.0 seconds per vehicle. This is considered to be the limit of acceptable delay. These high dealy values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.
Level F	Describes operation with delay in excess of 80.0 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with saturation, i.e., when arrival flow rates exceed capacity of the intersection. It may also occur at high v/c ratios below 1.00 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Source: *Highway Capacity Manual*, Transportation Research Board, National Research Council, Washington, D.C., 2000.

Table 2: Level of Service Definitions for Unsignalized Intersections

Flow Quality	Description
Level A	Describes operation with very low delay, i.e., 10.0 seconds or less per vehicle. This occurs when there is no conflicting traffic for a minor street.
Level B	Describes operation with delay in the range of 10.1 to 15.0 seconds per vehicle. This generally occurs with with light levels of conflicting traffic for a minor street. More vehicles stop than LOS A, causing higher levels of average
Level C	Describes operation with delay in the range of 15.1 to 25.0 seconds per vehicle. These higher dealys may result from fair levels of conflicting traffic. The number of vehicles stopping is significant at this level.
Level D	Describes operation with delay in the range of 25.1 to 35.0 seconds per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays result from increased conflicting traffic.
Level E	Describes operation with delay in the range of 35.1 to 50.0 seconds per vehicle. This is considered to be the limit of acceptable delay.
Level F	Describes operation with delay in excess of 50.0 seconds per vehicle. This is considered to be unacceptable to most drivers. There are insufficient gaps of suitable size to allow a side street demand to cross safely through a major traffic stream. This level of service is generally evident from extremely long total delays and queues on the minor approaches.

Source: *Highway Capacity Manual*, Transportation Research Board, National Research Council, Washington, D.C., 2000.

Unsignalized Intersections

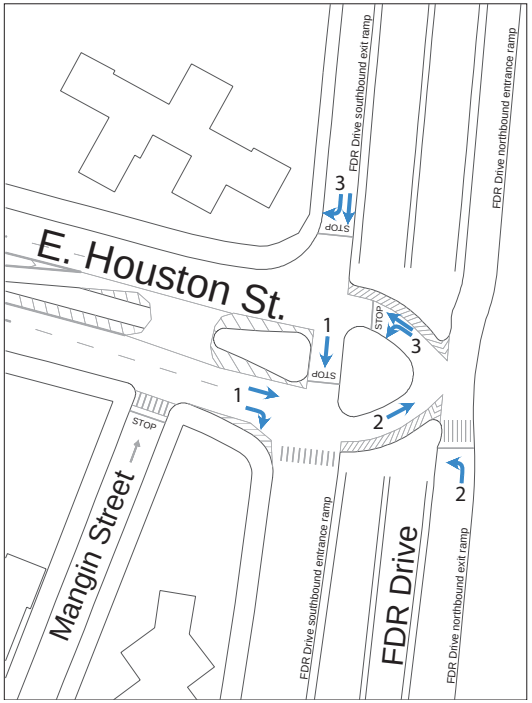
The intersection of East Houston Street and the FDR is the only unsignalized intersection analyzed in this study. The LOS criteria for stop-controlled intersections are different from the criteria used for signalized intersections, primarily because of the expectation that a signalized intersection is designed to carry higher traffic volumes and experience greater delay than an unsignalized intersection. The intersection of the FDR Drive and East Houston Street has many approaches so it has been analyzed as three separate intersections, FDR 1, FDR 2, and FDR 3 (see inset, right).

The capacity analysis is based on the use of “gaps” in a major traffic stream by vehicles crossing through or turning into that stream. At unsignalized intersections, “Stop” or “Yield” signs are used to assign the right-of-way to one street while controlling the movements from the other street. The methodology assumes that major street traffic is not affected by minor street flows. Left turns from the major street are assumed to be affected by the opposing major street flow. Minor street traffic is obviously affected by all conflicting movements, vehicular and pedestrian. LOS definitions for unsignalized intersections are detailed in Table 2.

An explanation of the FDR Drive intersection

The first intersection included eastbound traffic on Houston Street that was accessing the northbound and southbound entrance ramps to the FDR Drive, and southbound traffic continuing south on the FDR entrance ramp. The second intersection included traffic entering the northbound entrance ramp, and traffic exiting the FDR from the northbound exit ramp. The third intersection included southbound traffic exiting the FDR to westbound Houston Street, southbound exit ramp traffic continuing south to the southbound entrance ramp, and northbound exit ramp traffic entering westbound Houston Street. Due to the complicated nature of the intersection of the FDR Drive and East Houston Street, the intersection is not analyzed.

Figure 13: FDR Drive Approaches



Existing Conditions

Existing levels of service and signal timing for traffic operations at all eight intersections analyzed in this study are explored in this section. The capacity analysis of the existing traffic conditions indicates that most intersection approaches operate acceptably at mid-LOS D or better for all peak hours.

Table 3.1: Existing Intersection LOS and Signal Timing

First Avenue and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.55	30.0	C
T	0.78	33.3	C
R	0.68	35.8	D
Westbound			
L	0.25	19.1	B
TR	0.69	20.0	C
Northbound			
LTR	0.81	33.2	C
Southbound			

Inters.Delay 29.0 LOS = C

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.57	28.1	C
T	0.79	33.2	C
R	0.72	38.2	D
Westbound			
L	0.33	21.9	C
TR	0.60	18.6	B
Northbound			
LTR	0.73	30.4	C
Southbound			

Inters.Delay 28.2 LOS = C

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.65	29.0	C
T	0.83	26.4	C
R	0.94	59.2	E
Westbound			
L	0.34	25.3	C
TR	0.58	26.5	C
Northbound			
LTR	0.69	29.4	C
Southbound			

Inters.Delay 17.5 LOS = C

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	30.0	5.0
EB L /WB L	2	12.0	5.0
NB Ped /SB Ped	3	4.0	
NB LTR+Ped /SB Ped	4	29.0	5.0
Cycle Length		90.0	

* Signal timing is constant throughout the day

In the AM period, the intersection operates at LOS C with 29.0 seconds of delay.

In the MD period, the intersection operates at LOS C with 28.2 seconds of delay.

In the PM period, the intersection operates at LOS C with 17.5 seconds of delay.

Table 3.2: Existing Intersection LOS and Signal Timing

Avenue A and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.41	31.7	C
TR	0.41	22.8	C
Westbound			
L	0.53	22.1	C
TR	0.87	24.1	C
Northbound			
LTR	1.02	74.5	E
Southbound			
LTR	0.93	54.9	D

Inters.Delay 37.2 LOS = D

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.26	22.3	C
T	0.53	24.4	C
Westbound			
L	0.48	23.0	C
TR	0.75	19.6	B
Northbound			
LTR	0.83	42.3	D
Southbound			
LTR	0.82	41.6	D

Inters.Delay 27.7 LOS = C

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.30	22.8	C
T	0.51	15.7	B
Westbound			
L	0.60	28.4	C
TR	0.72	28.1	C
Northbound			
LTR	0.64	32.2	C
Southbound			
LTR	0.58	31.1	C

Inters.Delay 25.5 LOS = C

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	32.0	5.0
EB L /WB L	2	9.0	5.0
NB Ped /SB Ped	3	6.0	
NB LTR+Ped /SB Ped	4	27.0	6.0
Cycle Length		90.0	

* Signal timing is constant throughout the day

In the AM period, the intersection operates at LOS C with 37.2 seconds of delay.

In the MD period, the intersection operates at LOS C with 27.7 seconds of delay.

In the PM period, the intersection operates at LOS C with 25.5 seconds of delay.

Table 3.3: Existing Intersection LOS and Signal Timing

Avenue B and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.35	20.9	C
T	0.38	14.4	B
Westbound			
TR	0.67	7.3	A
Northbound			
LTR	0.85	38.9	D
Southbound			
L	0.60	43.9	D
R	0.17	22.8	C

Inters.Delay 17.4 LOS = B

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.23	15.6	B
T	0.39	14.5	B
Westbound			
L	0.53	6.0	A
Northbound			
LTR	0.63	29.8	C
Southbound			
L	0.32	27.3	C
R	0.25	24.0	C

Inters.Delay 14.4 LOS = B

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.48	16.4	B
T	0.37	5.1	A
Westbound			
L	0.56	16.6	B
Northbound			
LTR	0.68	31.1	C
Southbound			
L	0.47	33.2	C
R	0.29	24.7	C

Inters.Delay 16.9 LOS = B

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	45.0	5.0
EB L /WB L	2		
NB Ped /SB Ped	3	6.0	
NB LTR+Ped /SB Ped	4	29.0	5.0
Cycle Length		90.0	

* Signal timing is constant throughout the day

In the AM period, the intersection operates at LOS B with 17.4 seconds of delay.

In the MD period, the intersection operates at LOS B with 14.4 seconds of delay.

In the PM period, the intersection operates at LOS B with 16.0 seconds of delay.

Table 3.4: Existing Intersection LOS and Signal Timing

Avenue C and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.62	37.6	D
T	0.54	16.3	B
Westbound			
TR	0.92	17.9	B
Northbound			
LTR	0.58	28.5	C
Southbound			
L	0.46	31.4	C
R	0.39	26.6	C

Inters.Delay 20.1 LOS = C

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.81	44.8	D
T	0.44	15.1	B
Westbound			
L	0.75	9.5	A
Northbound			
LTR	0.47	26.1	C
Southbound			
L	0.45	30.2	C
R	0.31	25.0	C

Inters.Delay 17.4 LOS = B

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.89	43.8	D
T	0.47	5.6	A
Westbound			
L	0.78	22.9	C
Northbound			
LTR	0.48	26.5	C
Southbound			
L	0.60	36.6	D
R	0.39	26.5	C

Inters.Delay 19.5 LOS = B

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	45.0	5.0
EB L /WB L	2		
NB Ped /SB Ped	3	6.0	
NB LTR+Ped /SB Ped	4	29.0	5.0
Cycle Length		90.0	

* Signal timing is constant throughout the day

In the AM period, the intersection operates at LOS B with 20.1 seconds of delay.

In the MD period, the intersection operates at LOS B with 17.4 seconds of delay.

In the PM period, the intersection operates at LOS B with 19.5 seconds of delay.

Table 3.5: Existing Intersection LOS and Signal Timing

Avenue D and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.75	48.4	D
TR	0.91	29.8	C
Westbound			
L	0.72	44.1	D
TR	0.92	17.5	B
Northbound			
LTR	0.59	29.3	C
Southbound			
L	0.48	26.7	C

Inters.Delay 25.5 LOS = C

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.69	37.6	D
T	0.69	19.8	B
Westbound			
L	0.36	11.7	B
LTR	0.75	9.4	A
Northbound			
LTR	0.27	23.7	C
Southbound			
L	0.38	25.0	C

Inters.Delay 17.0 LOS = B

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.75	42.4	D
T	0.82	11.3	B
Westbound			
L	0.33	20.2	C
LTR	0.88	27.9	C
Northbound			
LTR	0.39	25.4	C
Southbound			
L	0.52	27.4	D

Inters.Delay 21.7 LOS = C

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	45.0	5.0
NB Ped /SB Ped	2	6.0	
NB LTR+Ped /SB Ped	3	29.0	5.0
Cycle Length		90.0	

* Signal timing is constant throughout the day

In the AM period, eastbound and westbound left turning vehicles experience delay (48.4 and 44.1 seconds) due to the high volume of eastbound and westbound through traffic. The intersection operates at a LOS C with a 25.5 second delay.

In the MD period, the intersection operates at a LOS B with a 17.0 second delay.

In the PM period, eastbound left turning vehicles experience delay (42.4 seconds) due to the high volume of eastbound through traffic. The intersection operates at a LOS C with a 21.7 second delay.

Remove a travel lane in each direction and change signal timing

An analysis of the future build conditions indicates that several intersection approaches would experience deteriorated levels-of-service which would not permit the removal of travel lanes and installation of a bicycle lane unless improved. Therefore, signal timing changes are recommended to improve conditions resulting from the removal of travel lanes. The negative impacts of removal of travel lanes at the Bowery cannot be improved through signal timing changes and all three travel lanes are necessary to maintain acceptable levels-of-service. Also, the removal of a westbound travel lane at Second Avenue results in conditions which cannot be sufficiently improved through signal timing changes. Therefore, the recommended street improvements include the removal of a travel lane from Forsyth Street to FDR Drive in both directions. This would allow for the striping of a Class 2 on-street bicycle lane from Forsyth Street to the FDR Drive in the both directions. The recommended signal timing changes and their impacts are outlined in this section.

Table 4.1: Improvements Intersection LOS

First Avenue and Houston Street

AM				MD				PM			
Approach	**v/c**	**Delay**	**LOS**	**Approach**	**v/c**	**Delay**	**LOS**	**Approach**	**v/c**	**Delay**	**LOS**
Eastbound				**Eastbound**				**Eastbound**			
L	0.68	39.7	D	L	0.66	34.3	C	L	0.65	29.0	C
T	0.73	29.1	C	T	0.74	29.0	C	T	0.83	26.4	C
R	0.66	32.5	C	R	0.71	34.9	C	R	0.94	59.2	E
Westbound				**Westbound**				**Westbound**			
L	0.29	20.4	C	L	0.36	23.3	C	L	0.34	25.3	C
T	0.85	24.5	C	T	0.72	19.0	B	T	0.58	26.5	C
R	0.68	32.8	C	R	0.69	33.1	C	R			
Northbound				**Northbound**				**Northbound**			
LTR	0.83	34.3	C	LTR	0.75	31.0	C	LTR	0.69	29.4	C
Southbound				**Southbound**				**Southbound**			
Inters.Delay 30.4 LOS = C				Inters.Delay 28.3 LOS = C				Inters.Delay 26.5 LOS = C			

Recommended Signal Timing

AM / MD

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	33.0	5.0
EB L /WB L	2	9.0	5.0
NB Ped /SB Ped	3	4.0	
NB LTR+Ped /SB Ped	4	29.0	5.0
Cycle Length		90.0	

PM

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	37.0	5.0
EB L /WB L	2	6.0	5.0
NB Ped /SB Ped	3	3.0	
NB LTR+Ped /SB Ped	4	29.0	5.0
Cycle Length		90.0	

First Avenue

The existing cycle length is 90 seconds with four phases as follows:

- Phase one is 30 seconds of green time for eastbound and westbound traffic.
- Phase two is 12 seconds of green time for the eastbound and westbound exclusive left turn.
- Phase three is a four second LPI for northbound and southbound pedestrian traffic.
- Phase four is 29 seconds of green time for northbound traffic.

The recommended allocation of green time would be as follows for AM and MD periods:

- Phase one would have 33 seconds of green time for eastbound and westbound traffic.
- Phase two would continue to have 9 seconds of green time for the eastbound and westbound exclusive left turn.
- Phase three would remain a four second LPI for northbound and southbound pedestrian traffic.
- Phase four would have 29 seconds of green time for northbound traffic.

The recommended allocation of green time would be as follows for PM period:

- Phase one would have 37 seconds of green time for eastbound and westbound traffic.
- Phase two would continue to have 6 seconds of green time for the eastbound and westbound exclusive left turn.
- Phase three would remain a Three second LPI for northbound and southbound pedestrian traffic.
- Phase four would have 29 seconds of green time for northbound traffic.

In the AM period, the signal timing changes would slightly decline the overall operation of the intersection from LOS C with 29 second delay to LOS C with 30.4 second delay.

In the MD period, the overall intersection operation would decline slightly from LOS C with 28.2 seconds of delay to LOS C with 28.3 seconds of delay.

In the PM period, the overall intersection operation would improve from LOS C with 31.2 seconds of delay to LOS C with 26.5 seconds of delay.

Table 4.2: Improvements Intersection LOS

Avenue A and Houston Street

AM

Approach	v/c	Delay	LOS
Eastbound			
L	0.53	40.2	D
TR	0.53	21.6	C
Westbound			
L	0.64	28.5	C
T	1.02	44.3	D
R	0.20	10.0	A
Northbound			
LTR	0.90	45.5	D
Southbound			
LTR	0.81	37.5	D

Inters.Delay 37.1 LOS = D

MD

Approach	v/c	Delay	LOS
Eastbound			
L	0.34	29.1	C
T	0.72	27.1	C
Westbound			
L	0.57	29.8	C
T	0.94	30.0	C
R	0.17	18.8	B
Northbound			
LTR	0.73	32.9	C
Southbound			
LTR	0.73	32.5	C

Inters.Delay 29.8 LOS = C

PM

Approach	v/c	Delay	LOS
Eastbound			
L	0.37	28.7	C
T	0.69	16.6	B
Westbound			
L	0.69	35.2	D
T	0.90	37.1	D
R	0.15	18.5	B
Northbound			
LTR	0.66	30.6	C
Southbound			
LTR	0.74	32.5	C

Inters.Delay 29.6 LOS = C

Recommended Signal Timing

AM

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	37.0	5.0
EB L /WB L	2	6.0	5.0
NB LTR+Ped /SB Ped	3	31.0	6.0
Cycle Length		90.0	

MD / PM

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	35.0	5.0
EB L /WB L	2	8.0	5.0
NB LTR+Ped /SB Ped	3	31.0	6.0
Cycle Length		90.0	

Avenue A

The existing cycle length is 90 seconds with four phases as follows:

- Phase one is 32 seconds of green time for eastbound and westbound traffic.
- Phase two is 9 seconds of green time for the eastbound and westbound exclusive left turn.
- Phase three is a six second LPI for northbound and southbound pedestrian traffic.
- Phase four is 27 seconds of green time for northbound and southbound traffic.

The recommended allocation of green time would be as follows for AM period:

- Phase one would have 37 seconds of green time for eastbound and westbound traffic.
- Phase two would have six seconds of green time for the eastbound and westbound exclusive left turn.
- Phase three would continue to have 31 seconds of green time for northbound traffic.

The recommended allocation of green time would be as follows for MD / PM period:

- Phase one would have 35 seconds of green time for eastbound and westbound traffic.
- Phase two would have eight seconds of green time for the eastbound and westbound exclusive left turn.
- Phase three would continue to have 31 seconds of green time for northbound traffic.

In the AM period, the recommended signal timing changes would slightly improve the overall operation of the intersection from a LOS D with a 37.2 second delay, to a LOS D with a 37.1 second delay.

In the MD period, the overall operation of the intersection would decline slightly from a LOS C with a 27.7 second delay, to a LOS C with a 29.8 second delay.

In the PM period, the recommended signal timing changes would decline the overall operation of the intersection from a LOS B with a 25.5 second delay, to a LOS C with a 29.6 second delay.

Table 4.3: Improvements Intersection LOS

Avenue B and Houston Street

AM Approach	v/c	Delay	LOS	MD Approach	v/c	Delay	LOS	PM Approach	v/c	Delay	LOS
Eastbound				**Eastbound**				**Eastbound**			
LT	0.77	22.8	C	LT	0.73	20.7	C	LT	0.87	15.7	B
Westbound				**Westbound**				**Westbound**			
TR	0.97	23.8	C	TR	0.76	9.0	A	TR	0.81	22.9	C
Northbound				**Northbound**				**Northbound**			
LTR	0.73	28.9	C	LTR	0.55	24.2	C	LTR	0.59	25.0	C
Southbound				**Southbound**				**Southbound**			
L	0.47	30.3	C	L	0.27	22.1	C	L	0.39	25.7	C
R	0.14	19.1	B	R	0.22	20.0	C	R	0.25	20.5	C
Inters.Delay 24.6 LOS = C				Inters.Delay 16.4 LOS = B				Inters.Delay 21.1 LOS = C			

Recommended Signal Timing

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	46.0	5.0
NB LTR+Ped /SB Ped	3	34.0	5.0
Cycle Length		90.0	

* Signal timing is constant throughout the day

Avenue B

The existing cycle length is 90 seconds with three phases as follows:

- Phase one is 45 seconds of green time for eastbound and westbound traffic
- Phase two is a sixe second LPI for northbound and southbound pedestrian traffic
- Phase three is 29 seconds of green time for northbound and southbound traffic

The recommended allocation of green time would be as follows:

- Phase one would have 46 seconds of green time for eastbound and westbound traffic
- Phase two would have 34 seconds of green time for northbound and southbound traffic

In the AM period, the recommended signal timing changes would decline the overall operation of the intersection from a LOS B with a 17.4 second delay, to a LOS C with a 24.6 second delay.

In the MD period, the overall operation of the intersection would decline slightly from a LOS B with a 14.4 second delay, to a LOS B with a 16.4 second delay.

In the PM period, the overall operation of the intersection would decline from a LOS B with a 16.9 second delay, to a LOS C with a 21.1second delay.

Table 4.4: Improvements Intersection LOS

Avenue C and Houston Street

AM

Approach	v/c	Delay	LOS
Eastbound			
L	0.68	44.4	D
T	0.78	21.8	C
Westbound			
TR	0.91	15.8	B
Northbound			
LTR	0.50	23.3	C
Southbound			
L	0.39	24.8	C
R	0.33	21.8	C

Inters.Delay 20.2 LOS = C

MD

Approach	v/c	Delay	LOS
Eastbound			
L	0.80	41.7	D
T	0.61	16.2	B
Westbound			
L	0.75	7.1	A
Northbound			
LTR	0.45	23.8	C
Southbound			
L	0.49	29.2	C
R	0.28	22.4	C

Inters.Delay 16.1 LOS = B

PM

Approach	v/c	Delay	LOS
Eastbound			
L	0.88	39.8	D
T	0.66	5.6	A
Westbound			
L	0.84	23.2	C
Northbound			
LTR	0.43	23.4	C
Southbound			
L	0.60	33.3	C
R	0.36	23.6	C

Inters.Delay 19.0 LOS = B

Recommended Signal Timing

AM

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	46.0	5.0
NB LTR+Ped /SB Ped	2	34.0	5.0
Cycle Length		90.0	

MD / PM

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	48.0	5.0
NB LTR+Ped /SB Ped	2	32.0	5.0
Cycle Length		90.0	

Avenue C

The existing cycle length is 90 seconds with three phases as follows:

- Phase one is 45 seconds of green time for eastbound and westbound traffic
- Phase two is a six second LPI for northbound and southbound pedestrian traffic
- Phase three is 29 seconds of green time for northbound and southbound traffic

The recommended allocation of green time would be as follows for AM period:

- Phase one would have 46 seconds of green time for eastbound and westbound traffic
- Phase two would have 34 seconds of green time for northbound and southbound traffic

The recommended allocation of green time would be as follows for MD and PM period:

- Phase one would have 48 seconds of green time for eastbound and westbound traffic
- Phase two would have 32 seconds of green time for northbound and southbound traffic

In the AM period, the recommended signal timing changes would slightly decline the overall operation of the intersection from a LOS C with a 20.1 second delay, to a LOS C with a 20.2 second delay.

In the MD period, the overall operation of the intersection would improve from a LOS B with a 17.4 second delay, to a LOS B with a 16.1 second delay.

In the PM period, the overall operation of the intersection would improve slightly from a LOS B with a 19.5 second delay, to a LOS B with a 19.0 second delay.

Table 4.5: Improvements Intersection LOS
Avenue D and Houston Street

AM

Approach	v/c	Delay	LOS
Eastbound			
L	0.74	43.2	D
TR	0.89	25.6	C
Westbound			
L	0.70	37.7	D
TR	0.90	12.2	B
Northbound			
LTR	0.57	27.1	C
Southbound			
L	0.46	24.9	C

Inters.Delay 21.2 LOS = C

MD

Approach	v/c	Delay	LOS
Eastbound			
L	0.69	35.7	D
T	0.71	19.0	B
Westbound			
L	0.37	11.0	B
LTR	0.77	8.3	A
Northbound			
LTR	0.24	20.6	C
Southbound			
L	0.34	21.7	C

Inters.Delay 15.6 LOS = B

PM

Approach	v/c	Delay	LOS
Eastbound			
L	0.73	36.2	D
T	0.79	8.0	A
Westbound			
L	0.30	16.7	B
LTR	0.85	23.8	C
Northbound			
LTR	0.36	22.8	C
Southbound			
L	0.48	24.6	C

Inters.Delay 18.1 LOS = B

Recommended Signal Timing

AM

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	49.0	5.0
NB LTR+Ped /SB Ped	2	31.0	5.0
Cycle Length		90.0	

MD

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	47.0	5.0
NB LTR+Ped /SB Ped	2	33.0	5.0
Cycle Length		90.0	

PM

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	48.0	5.0
NB LTR+Ped /SB Ped	2	32.0	5.0
Cycle Length		90.0	

Avenue D

The existing cycle length is 90 seconds with three phases as follows:

- Phase one is 45 seconds of green time for eastbound and westbound traffic
- Phase two is a six second LPI for northbound and southbound pedestrian traffic
- Phase three is 29 seconds of green time for northbound and southbound traffic

The recommended allocation of green time would be follows for AM period:

- Phase one would have 49 seconds of green time for eastbound and westbound traffic
- Phase two would have 31 seconds of green time for northbound and southbound traffic

The recommended allocation of green time would be follows for MD period:

- Phase one would have 47 seconds of green time for eastbound and westbound traffic
- Phase two would have 33 seconds of green time for northbound and southbound traffic

The recommended allocation of green time would be follows for PM period:

- Phase one would have 48 seconds of green time for eastbound and westbound traffic
- Phase two would have 32 seconds of green time for northbound and southbound traffic

In the AM period, the recommended signal timing changes would improvet he overall operation of the intersection from a LOS C with a 25.5 second delay, to a LOS C with a 21.2 second delay.

In the MD period, the overall operation of the intersection would improve from a LOS B with a 17.0 second delay, to a LOS B with a 15.6 second delay.

In the PM period, the recommended signal timing changes would improve the overall operation of the intersection from a LOS C with a 21.7 second delay, to a LOS B with a 18.1 second delay.

Conclusion

The traffic analysis assessed existing traffic conditions along East Houston Street and the impacts that a bicycle lane would pose on vehicular traffic. This recommended action would stripe a five-foot Class 2 bicycle lane with buffer on East Houston Street in each direction. If implemented, this action would complete a portion of the route recommended in the *NYC Bicycle Master Plan* and provide an important crosstown bicycle connection between the Second Avenue bicycle lane and the Manhattan Waterfront Greenway at East River Park. Project data indicates that any impacts from the installation of a bicycle lane on East Houston Street, from Second Avenue to the FDR Drive eastbound and from First Avenue to the FDR Drive westbound, could be mitigated through signal timing changes. The installation of bicycle route signs is recommended to guide riders on-street between the Bowery and First and Second avenues where bicycle lanes are not feasible.

Appendix 1

Figure 1: Total Accidents from 1998 through 2000
The total sum of accidents includes all reportable and non-reportable accidents involving any motor vehicles, pedestrians and cyclists.

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Figure 2: Total Reportable Accidents from 1998 through 2000

The sum of reportable accidents refers to those accidents which are reportable to an insurance company. Such accidents must involve either an injury or at least $1000.00 worth of damages.

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Figure 3: Total Vehicular Accidents from 1998 through 2000
The sum of vehicular accidents represents accidents that occurred between two or more vehicles.

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Figure 4: Total Pedestrian Accidents from 1998 through 2000
The sum of pedestrian accidents represents all accidents that occurred between pedestrians and motor vehicles.

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Figure 5: Total Bicycle Accidents from 1998 through 2000
The sum of bicycle accidents represent all accidents that occurred between cyclists and motor vehicles.

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Figure 6: Total Fatalities from 1998 through 2000
The sum of fatalities represents accidents that resulted in a fatality.

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Appendix 2

Table 1.1: No Build Intersection LOS and Signal Timing at the First Avenue, Avenue A and Avenue B

First Avenue and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.58	31.5	C
T	0.81	34.4	C
R	0.70	36.8	D
Westbound			
L	0.26	19.8	B
TR	0.71	20.5	C
Northbound			
LTR	0.83	34.3	C
Southbound			

Inters.Delay 29.9 LOS = C

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.59	29.6	C
T	0.81	34.4	C
R	0.75	39.7	D
Westbound			
L	0.35	22.9	C
TR	0.62	18.9	B
Northbound			
LTR	0.75	31.0	C
Southbound			

Inters.Delay 29.0 LOS = C

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.67	30.5	C
T	0.86	27.9	C
R	0.97	64.9	E
Westbound			
L	0.35	26.6	C
TR	0.60	26.8	C
Northbound			
LTR	0.71	29.9	C
Southbound			

Inters.Delay 32.7 LOS = C

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	30.0	5.0
EB L /WB L	2	12.0	5.0
NB Ped /SB Ped	3	4.0	
NB LTR+Ped /SB Ped	4	29.0	5.0
Cycle Length		90.0	

** Signal timing is constant throughout the day*

Avenue A and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.42	32.4	C
TR	0.43	22.9	C
Westbound			
L	0.55	23.2	C
TR	0.90	26.0	C
Northbound			
LTR	1.06	86.2	F
Southbound			
LTR	0.97	61.9	E

Inters.Delay 41.1 LOS = D

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.27	23.4	C
TR	0.55	24.6	C
Westbound			
L	0.50	24.3	C
TR	0.78	20.2	C
Northbound			
LTR	0.86	45.4	D
Southbound			
LTR	0.86	44.9	D

Inters.Delay 29.1 LOS = C

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.31	23.9	C
TR	0.53	15.8	B
Westbound			
L	0.62	29.9	C
TR	0.74	28.7	C
Northbound			
LTR	0.78	39.8	D
Southbound			
LTR	0.87	44.5	D

Inters.Delay 29.4 LOS = C

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	32.0	5.0
EB L /WB L	2	9.0	5.0
NB Ped /SB Ped	3	6.0	
NB LTR+Ped /SB Ped	4	27.0	6.0
Cycle Length		90.0	

** Signal timing is constant throughout the day*

Avenue B and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.38	22.9	C
T	0.40	14.6	B
Westbound			
TR	0.69	7.5	A
Northbound			
LTR	0.87	40.9	D
Southbound			
L	0.64	48.5	D
R	0.17	22.8	C

Inters.Delay 18.2 LOS = B

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.26	16.3	B
T	0.40	14.6	B
Westbound			
TR	0.54	6.1	A
Northbound			
LTR	0.65	30.3	C
Southbound			
L	0.34	28.0	C
R	0.26	24.1	C

Inters.Delay 14.6 LOS = B

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.53	19.4	B
T	0.38	5.1	A
Westbound			
TR	0.57	16.9	B
Northbound			
LTR	0.70	31.7	C
Southbound			
L	0.50	34.9	C
R	0.30	24.9	C

Inters.Delay 17.3 LOS = B

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	45.0	5.0
NB Ped /SB Ped	2	6.0	
NB LTR+Ped /SB Ped	3	29.0	5.0
Cycle Length		90.0	

** Signal timing is constant throughout the day*

Table 1.2: No Build Intersection LOS and Signal Timing at Avenue C and Avenue D

Avenue C and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.69	45.8	D
T	0.55	16.5	B
Westbound			
TR	0.95	21.1	C
Northbound			
LTR	0.59	28.8	C
Southbound			
L	0.49	32.5	C
R	0.40	26.8	C

Inters.Delay 21.7 LOS = C

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.82	47.2	D
T	0.45	15.2	B
Westbound			
TR	0.77	10.1	B
Northbound			
LTR	0.48	26.4	C
Southbound			
L	0.47	31.1	C
R	0.32	25.2	C

Inters.Delay 17.8 LOS = B

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.91	48.7	D
T	0.49	5.7	A
Westbound			
TR	0.81	23.9	C
Northbound			
LTR	0.47	26.3	C
Southbound			
L	0.68	41.3	D
R	0.40	26.7	C

Inters.Delay 20.5 LOS = C

Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	45.0	5.0
NB Ped /SB Ped	2	6.0	
NB LTR+Ped /SB Ped	3	29.0	5.0
Cycle Length		90.0	

** Signal timing is constant throughout the day*

Avenue D and Houston Street

AM Approach	v/c	Delay	LOS
Eastbound			
L	0.77	51.2	D
TR	0.93	32.8	C
Westbound			
L	0.73	45.6	D
TR	0.95	20.9	C
Northbound			
LTR	0.62	29.9	C
Southbound			
LTR	0.50	27.1	C

Inters.Delay 28.1 LOS = C

MD Approach	v/c	Delay	LOS
Eastbound			
L	0.75	44.5	D
TR	0.71	20.4	C
Westbound			
L	0.40	13.4	B
TR	0.77	10.0	A
Northbound			
LTR	0.28	23.8	C
Southbound			
LTR	0.40	25.3	C

Inters.Delay 17.7 LOS = B

PM Approach	v/c	Delay	LOS
Eastbound			
L	0.77	46.1	D
TR	0.84	12.3	B
Westbound			
L	0.38	22.5	C
TR	0.91	30.2	C
Northbound			
LTR	0.41	25.8	C
Southbound			
LTR	0.54	27.9	C

Inters.Delay 23.2 LOS = C

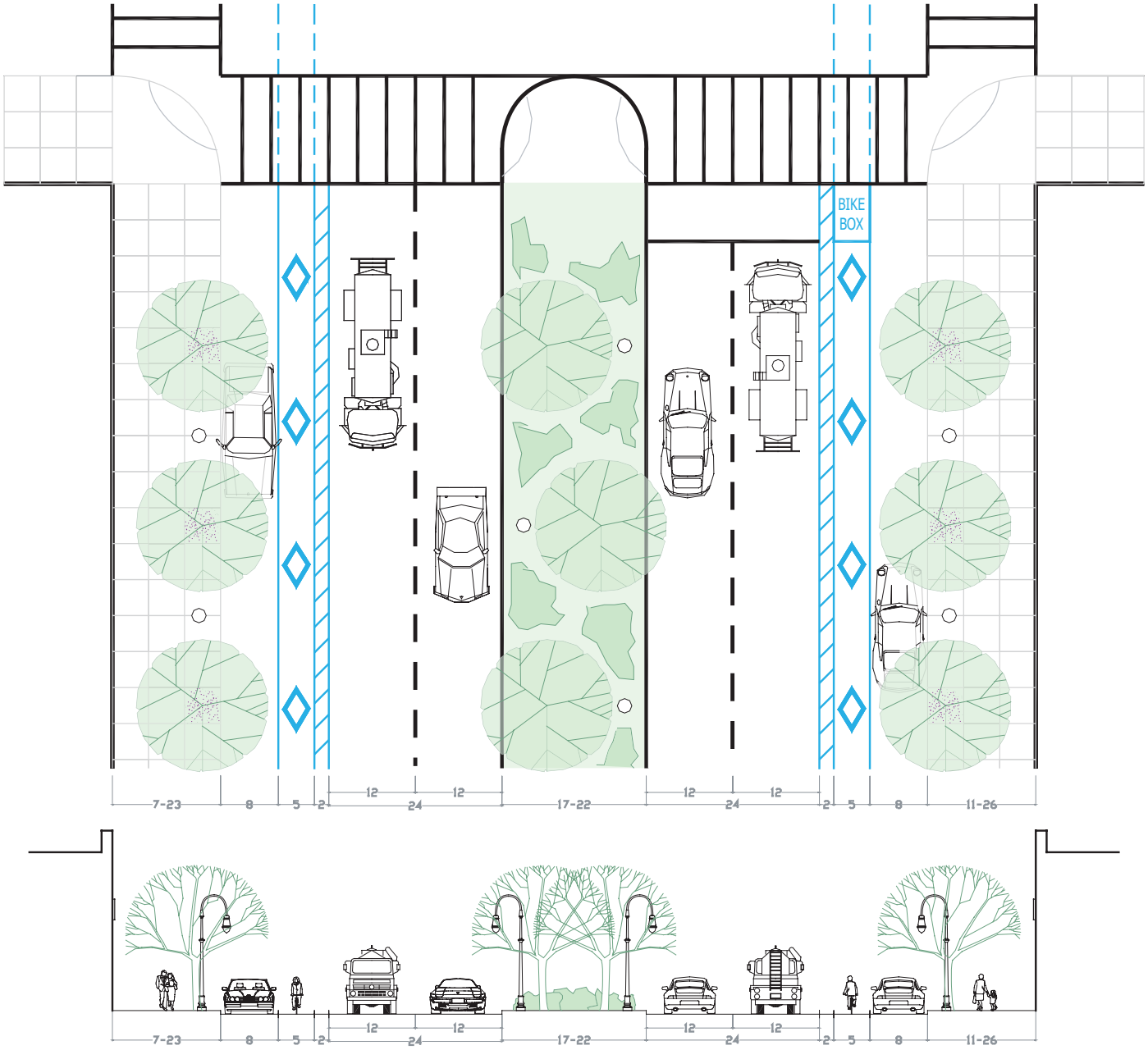
Signal Timing*

Approach	Phase	G	Y/R
EB LTR+PED /WB LTR+Ped	1	45.0	5.0
NB Ped /SB Ped	2	6.0	
NB LTR+Ped /SB Ped	3	29.0	5.0
Cycle Length		90.0	

** Signal timing is constant throughout the day*

Appendix 3

Figure 7: Bicycle Lane Section



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