The Role that Off-Street Parking and Curb Cuts play in the Urban Environment

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Abstract

Despite the population density, level of mixed-use, and transit connectivity of many neighborhoods in New York City, off-street parking facilities are prevalent throughout the City. These off-street parking facilities, often required by the Zoning Resolution of the City of New York, greatly impact the pedestrian streetscape. Each off-street parking facility requires a curb cut in the sidewalk for access between the parking facility and the street. These curb cuts hinder the pedestrian experience and put pedestrians at risk of getting hit by a vehicle. Each additional curb cut increases the risk of a pedestrian-vehicular collision. This study analyzes three areas in the inner ring neighborhoods of New York City. These three study areas each have high population densities, high levels of mixed-uses, and high levels of connectivity to the New York City transit system, yet the percentage of sidewalk taken up by curb cuts in each of the three study areas greatly impedes upon the pedestrian environment. Rather than encourage automobile use as off-street parking facilities do, New York City should instead refocus its efforts on improving the pedestrian streetscape by reducing the number of off-street parking facilities, thereby eliminating the curb cuts needed to access them. The three study areas are compelling cases as to why parking as well as driving on a regular basis is unnecessary given the plethora of amenities available in these areas and the transit access and connectivity of these study areas.

Acknowledgements

I would like to thank my advisor, David King, for his advice and guidance throughout my research and analysis process. I would also like to thank my reader, Margaret Forgione, for taking the time to read and critique my thesis and for providing me with the tool to measure the distances of the curb cuts in my study areas.

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Introduction

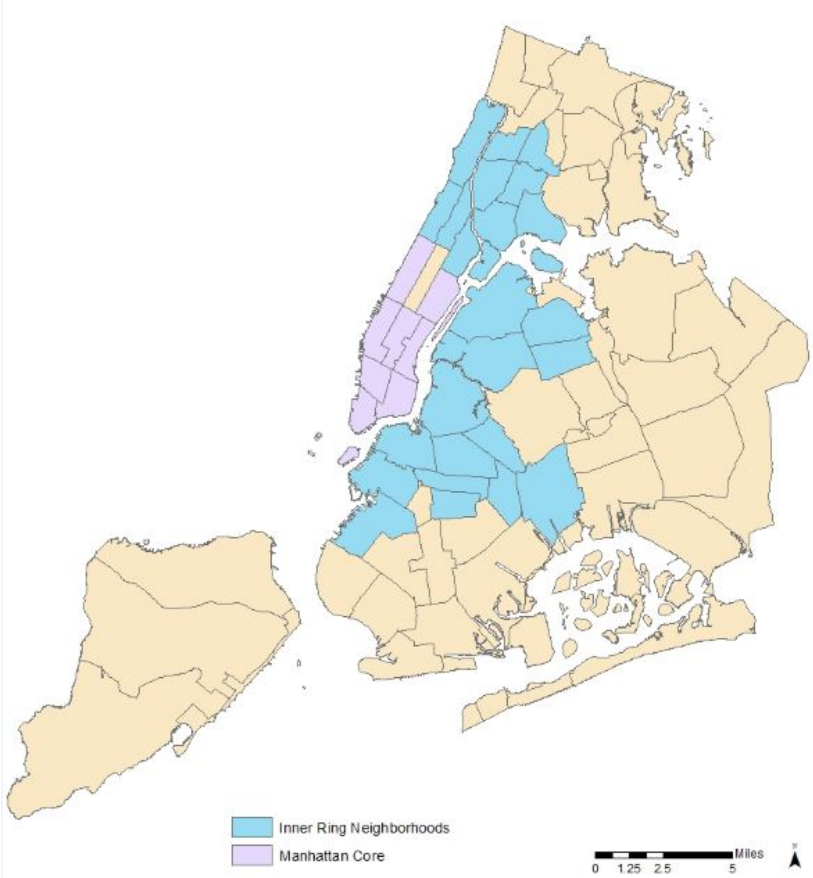
Minimum parking requirements are pervasive throughout municipal zoning codes in the United States. Although the daily driver is thankful for the ease these parking spaces provide, few people beyond planners, real estate developers, and policy makers think about the implications of off-street parking requirements. Off-street parking requirements create a number of externalities. For one, 99% of all private vehicle trips end with free parking, meaning the individual using that space is not directly paying for it; rather the costs are spread across the entire population, even those who do not own and drive cars (Shoup, 2004). Off-street parking requirements in zoning codes impact the physical, social, and economic environment of a city.

The negative externalities generated by off-street parking requirements are vast. Aside from the large amount of land that off-street parking consumes, the availability of parking created by off-street parking requirements promotes driving and automobile ownership. This in turn leads to traffic congestion and air pollution, as well as lower density of buildings. Another externality of off-street parking, which is often over looked and greatly affects urban form and pedestrian safety and experience, is curb cuts. Curb cuts are a break in the sidewalk that allows automobiles and other vehicles to enter or exit an off-street parking facility. They "…interrupt the streetscape, expand the distances between destinations, and undermine walkability" (Mukhija and Shoup 2006). Curb Cuts take away the limited space dedicated to pedestrian use and give more space to automobiles and other motor vehicles. Curb cuts force pedestrian-automobile interactions not just at crosswalks, but also on the sidewalk. These interactions have a high rate of pedestrian-automobile collisions.

Pedestrians may feel a false sense of security while walking on a sidewalk; although they have the right of way on sidewalks curb cuts greatly diminish their actual safety on sidewalks. Curb cuts for access to driveways and parking facilities pose a large risk to pedestrians. A study on automobile-pedestrian collisions found that nearly 20 percent of collisions occurred on sidewalks, parking lots, and driveways (Loukaitou-Sideris, Liggett, Sung 2007). This study found that long blocks with multiple curb cuts for driveways further increased the number of occurrences of automobile-pedestrian collisions (Loukaitou-Sideris, Liggett, Sung 2007). Little data is available on the number of automobile-pedestrian collisions. One statistic that is available is that seventy-four percent of child pedestrian fatalities occur at non-intersections (Safe Kids USA). Curb cuts create a constant threat to pedestrian safety by creating a place for automobiles to drive over sidewalks and invade pedestrian space.

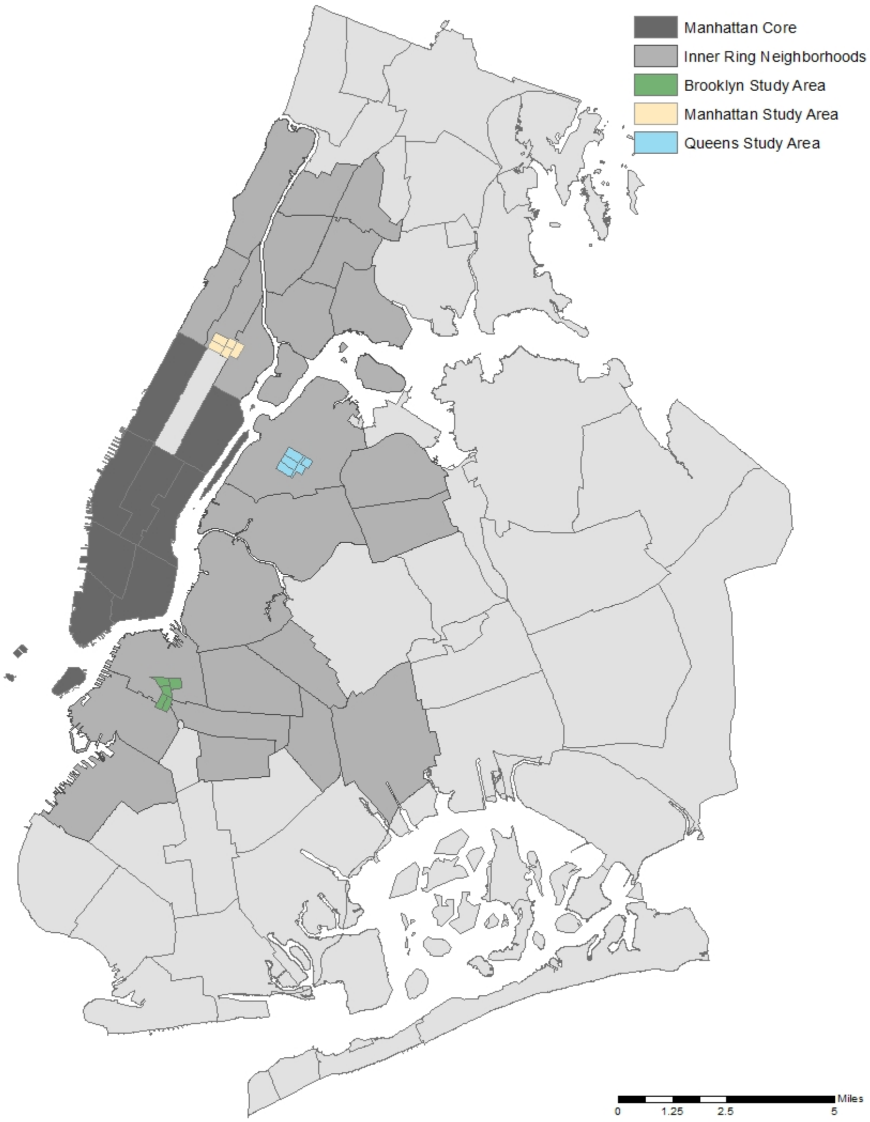
This study will look at the presence of curb cuts and factors that influence their existence in certain neighborhoods located in the inner ring of New York City. The inner ring is defined as neighborhoods in upper Manhattan within Community Districts 9, 10, 11, and 12, in the South Bronx, which includes Community Districts 1 through 6, Astoria, Long Island City, and Corona in Queens, consisting of Community Districts 1 through 4 and in Brooklyn, the neighborhoods of Greenpoint south to the neighborhood of Sunset Park as well as the neighborhood of East New York which include Community Districts 1 through 9.

Figure 1. Map of New York City, highlighting the Manhattan Core and the Inner Ring Neighborhoods.



This study focuses on three areas within the inner ring neighborhoods. Each main study area is comprised of five contiguous census tracts. These study areas are located in south central Harlem, Astoria, Queens, and an area of Brooklyn that overlaps the neighborhoods of Fort Greene and Park Slope.

Figure 2. Map of New York City's Inner Ring Neighborhoods with the study areas highlighted.



In each of these study areas data was collected for the total length of each sidewalk block as well as the length and number of curb cuts on each block. Below is a table of the independent variables that I expect will influence the distance of sidewalk space taken away for the creation of curb cuts. The expected directional effect refers to whether the variable will have a positive correlation or a negative correlation to the length of curb cuts. The size of the effect is how large of an impact the variable has on the phenomena, the total length of curb cuts compared to the total length of sidewalk space.

Table 1. Table of the independent variables and there expected effects.

Variable	**Expected Directional Effect**	**Size of Effect**
Owner occupied housing units	Positive	Small
Population density	Negative	Small
Connectivity to transit network	Negative	Small
Degree of mixed land uses	Negative	Small

The expected directional effect that owner occupied housing units will have on the number of meters of curb cuts is positive. The size of this effect is expected to be small. The expected directional effect that population density will have on the number of meters curb cuts is negative. However, the size of this effect is small. The directional effect is expected to be negative because, as McCahill and Garrick found in their study, as the area dedicated to parking increases the population density decreases (McCahill and Garrick 2012). Therefore, I expect that as population density increases, the area dedicated to parking will decrease. Curb cuts as a proxy for off-street parking will also decrease as population density increases. Although an area may have a high population density the policies currently in place, such as minimum parking requirements will most likely interfere with the size of the effect that a high population density could have on the presence and length of curb cuts. The proximity and connectivity of an area to the New York City transit network has an expected negative directional effect. The size of this effect is small. Based on the research conducted by McDonnell, Madar and Been, on the number of parking spaces per lot throughout New York City, they found that lots within a half of a mile of a subway station have a significantly reduced amount of parking compared with lots overall throughout the City (McDonnell, Madar and Been 2011). However, because this study only indicates that the overall amount of parking is lower in lots within half a mile of a subway, it may not have a large effect on the total number or length of curb cuts. Regardless of the number of spaces a lot requires, it is still necessary for curb cut to exist for access purposes. For this reason the size of the effect is small. The expected directional effect of the level of mixed land use is negative and the expected size is small.

Literature Review

History of Off-Street Parking Requirements

Minimum parking requirements in zoning codes are largely the outcome of the post-World War II suburban housing boom. This zoning tool began to be widely implemented during the 1950's because development occurred in the form of low-density suburban development and the population around cities began to disperse. Since this style of development is so reliant on the automobile, policy makers felt that cities needed to cater to the automobile by creating free and easily accessible parking (Mccahill and Garrick, 2012). As a result, Policy makers instituted off-street parking as an accessory land use to the primary land use in the municipal zoning code. According to the New York City Department of City Planning an accessory land use is, "a use that is incidental to and customarily found in connection with the principal use. An accessory use must be conducted on the same zoning lot as the principal use to which it is related, unless the district regulations permit another location for the accessory use" (NYCDCP, 2012).

The use of off-street parking requirements continues to be widespread throughout the United States today and as a result curb cuts are pervasive throughout the country. Given this, it is troubling to note how little research is undertaken to develop the standard for determining the number of parking spaces that are required for different types of land uses. Especially because with each land use that requires off-street parking, it is necessary for a curb cut to be constructed in order to allow automobiles to travel from the street and into the parking facility. The Institute of Traffic Engineers developed a single standard for determining these parking rates, which are published in Pa*rking Generation* (Shoup 1999). Using a single standard for parking requirements ignores the fact that across the United States there are numerous types of development levels, ranging from rural to urban, and transportation infrastructure, ranging from completely automobile-centric to communities that are mainly pedestrian. To understand how parking requirements are set Richard Wilson surveyed planning directors in 144 cities across the U.S. Wilson found that the two most common methods that planning directors employed to set parking requirements were to "consult Institute of Transportation Engineers (ITE) handbooks" and to "survey nearby cities" and instate their parking requirements (Shoup 1999).

While both of these methods may seem to be reasonable approaches to setting parking standards, they are highly flawed. The minimum parking rates set by the ITE in *Parking Generation* are determined from poorly designed studies in places that do not reflect the zoning and development of much of the U.S. The surveys used to determine the parking rates were conducted in suburban areas that rely almost completely on automobile transportation and have little mixed-use development. The ITE has determined parking rates for 101 different land uses such as fast food restaurants with drive in windows, churches, and residential condominiums. The parking generation rates are in units of number of parking spaces per 1,000 square feet of floor area of the building. The average of the peak parking occupancy of each survey at a particular land use determines the parking generation rate for that land use. A major issue with the determination of the parking generation rates is that of the 101 different rates, more than half were based on four or fewer surveys of parking occupancy and 22% of the parking generation rates only relied on a single survey (Shoup 1999). The standards greatly overestimate the number of parking spaces that are necessary. Additionally, in instances where multiple surveys were conducted for a land use the range of peak parking occupancy is quite large. An example of these flaws is the rate of parking spaces ITE determined for Fast Food Restaurants with Drive-in

Window. To determine the parking standard ITE conducted eighteen surveys during weekday peak hour demand at Fast Food Restaurants with Drive-in Windows. The average parking rate was 9.95 vehicles, the range was 3.55-15.92, and the standard deviation was 2.41. Most telling is the coefficient of determination, or R^2, which was 0.038, indicating that the line of regression does not fit well and is not statistically significant (Litman 2006). The standard for parking is set at the 85th percentile of the observed parking at a facility for the surveys for a land use, meaning that 85% of parking facilities will have more parking than is actually needed during peak periods (Litman 2006). This coupled with the fact that the surveys are conducted in single use auto-dependent suburbs creates an abundant oversupply of parking.

Despite the fault in the parking generation rates developed by ITE and published in its *Parking Generation* manual, there are few guideline options for municipalities to turn to when determining their parking standards, aside from municipalities undertaking their own parking studies, which is both monetarily and time expensive (Shoup 1999). The other most popular method Wilson found for municipalities determining parking rates was to use the same minimum parking requirements as a municipality close to them. However, this also does not alleviate any of the issues of using the *Parking Generation* rates because it is likely this nearby municipality used these rates or may have even picked minimum parking rates arbitrarily (Shoup 1999).

History of Parking in New York City

In union with the nationwide trend of instituting parking requirements, New York City instated parking minimum requirements for new residential developments in 1950. The City further increased its parking minimum requirements in its new zoning resolution in 1961(McDonnell, Madar, Been 2011). However in the following decades, due to poor air quality, New York City along with some other large municipalities was forced to re-evaluate its minimum parking requirements. The maximum parking requirements written into New York City's zoning code came about as a result of environmental health concerns. The Clean Air Act of 1970 required that each state achieve National Ambient Air Quality Standards, NAAQS, by 1975 (USEPA 2012). However, many states including New York failed to meet this deadline, leading the Act to be amended in 1977 and again in 1990. Under the Clean Air Act each state was required to devise a plan, known as a State Implement Plan, SIP, outlining how it would meet the NAAQS (USEPA 2012). After failing to meet the NAAQS standards outlined in the Clean Act, law suits were brought against New York and other cities, that also failed to meet the NAAQS, which forced them to limit the amount of parking in their Central Business Districts (Weinberger, et al. 2010).

Although New York City did implement parking maximum requirements as a part of New York State's SIP, the majority of the City continues to have parking minimum requirements. In accordance with the State's SIP, New York City's maximum parking requirements first appeared in the City's zoning code in 1982 with the primary goal of improving air quality in New York City (NYC DCP 2011). This zoning amendment capped off-street parking for all new residential and commercial development within the bounds of the Manhattan Core; defined as the area of Manhattan south of 96th Street on the east side and south of 110th Street on the west side, corresponding with Manhattan Community Districts 1 through 8 (NYCDCP 2011). The intention of the off-street parking maximum requirements was to control the number of parking spaces and thereby limit the amount of traffic and subsequently reduce the emissions and improve the air quality in the Manhattan Core (NYCDCP 2011). Subsequently, in 1995, New York City expanded its parking maximum regulations in the zoning code to include Long Island City, Queens. The area is bounded by, "Queens Plaza North, 21st Street, 41st

Avenue, 29th Street, 40th Road, Northern Boulevard, 43rd Street, Skillman Avenue, 39th Street, 48th Avenue, 30th Street, 49th Avenue, Dutch Kills Canal, Newtown Creek, the East River, the westerly prolongation of 50th Avenue, Center Boulevard, 49th Avenue, Fifth Street, Anable Basin, the East River, and the prolongation of Queens Plaza North", and lays partially in Queens Community Districts 1 and 2 (NYCDCP 2011). However, many of the densely populated and transit rich neighborhoods are located outside of the Manhattan Core and are still required to have off-street parking minimum requirements.

Related Research

A number of studies have shown the effect of off-street parking requirements on automobile ownership rates and automobile usage. Research has shown that providing off-street parking with residential developments increases car ownership rates. This is for numerous reasons. First, requiring accessory off-street parking with residential developments bundles the cost of parking with housing. This encourages car ownership. One major impediment and cost of owning an automobile is the cost of storage to park the vehicle. However, if residents are already paying for the parking space because it is bundled, included, in the cost of the residential unit they are more likely to own a vehicle (Weinberger, Seaman, Johnson 2008). The additional barrier to automobile ownership that off-street parking eliminates is a guaranteed parking space. A guaranteed parking spot removes the time-cost of searching for a parking space (Weinberger, Seaman, Johnson 2008). Further, Rachel Weinberger's study "Death by a thousand curb-cuts: Evidence on the effect of minimum parking requirements on the choice to drive" examines the relationship between accessory residential off-street parking and using automobiles for commuting. This study found that even in areas very well served by transit, guaranteed off-street parking leads to more commuters traveling by automobile rather than by alternative modes compared with areas where accessory off-street parking is not provided (Weinberger 2012). As stated in the history, New York City first altered its zoning code to instate maximum parking requirements in the Manhattan Core in 1982. As a result, between 1982 and 2009, the number of people entering the Manhattan Central Business District by automobile decreased by approximately 118,000. Meanwhile the total number of trips to the Central Business District grew by about 364,000. During this time period the number of public parking spaces in the Central Business District decreased by approximately 25,000. This data indicates that as the number of parking spaces was limited, people were forced to use alternative modes to the automobile to enter the Central Business District (Department of City Planning 2009). Therefore the conclusion can be made that automobile trips can be limited by limiting parking.

Rather than reducing congestion as some suggest, accessory off-street parking requirements increase traffic and congestion on the surrounding streets. Some policy makers and developers claim that off-street parking, by increasing parking availability, greatly reduces "cruising" for parking, the act of drivers driving around looking for a space, and therefore reduces traffic and congestion. However, research by Weinberger, Seaman, and Johnson found that as development continues in New York City, off-street parking requirements will most likely increase cruising for parking because as residential off-street parking has a higher availability and leads to higher automobile ownership there will be more competition for the parking spaces at destinations, especially in high destination neighborhoods. Having guaranteed parking at home does not necessarily lead to guaranteed parking at a destination (Weinberger, Seaman, Johnson 2008). Similarly, Shoup and Manville found that because the supply of off-street parking is occurring continually and street space is not, traffic congestion will continue to rise (Shoup and Manville 2005). Off-street parking encourages automobile ownership and use and therefore increases traffic on streets, “contributing disproportionately to traffic throughout the city” (Weinberger, Seaman, Johnson 2008). Off-street parking requirements create a cycle where more parking leads to higher car ownership rates, which in turn induces the demand for more off-street parking (Mukhija and Shoup 2006).

Minimum parking requirements stand in the way of developing a higher density city. Required parking consumes land that could otherwise be used to develop housing or commercial development (McDonnell, Madar, Been 2010). A study of twelve cities in the United States showed the relationship between commuters traveling by automobile and the land use dedicated to parking and population density. For each 10% increase in commuters traveling by automobile there is an increase of 2,500 square meters of parking per 1,000 people and a population density decrease of 1,700 people per kilometer (McCahill and Garrick 2012). These studies indicate that off-street parking leads more people to drive, consumes a vast amount of land, and decreases the population density of a city. Automobile use reduces the amount of land that can be used for primary human uses, rather than accessory uses such as parking. This in turn forces primary land uses to be more spread out and development to occur at lower density to accommodate automobile infrastructure (Shin, Vuchic, Bruun 2009).

Off-street parking requirements also greatly increase the cost of development projects both in opportunity costs and concrete costs. One example of lost opportunity cost of required off-street parking is that parking can take land away that could otherwise be developed (McDonnell, Madar, Been 2010). The cost of constructing parking structures is also quite costly. It costs at least $21,000 dollars per parking space to construct an above ground parking structure in New York City; this does not include the cost of land acquisition or soft costs of construction. The construction of below grade parking structures is much higher. When evaluating just how costly it is to construct parking structures in New York City, it is also important to take into consideration the high cost of land acquisition in the City (McDonnell, Madar, Been 2011). A New York City based real estate developer, Alan Bell, stated that in his experience as a developer, the cost of constructing a single parking space ranges from $25,000 dollars to $50,000 dollars (Kazis 2011). An example of this cost is a newly constructed building in Fort Greene, The Avalon, where each parking space cost $50,000 dollars to construct (Kazis 2012). A study that researched the cost of developing parking in conjunction with residential development in San Francisco, estimated that the cost of including parking in housing developments adds 20% to the total cost of a project (Millar-Ball 2002). Tom Cody, a project manager at Gerding/Elden Development Company, stated that eliminating parking spaces greatly reduces construction costs and therefore reduces housing prices for consumers (Baker 2006). The price of an apartment without parking can cost between $30,000 dollars and $40,000 dollars less than a comparable apartment that includes parking (Baker 2006). However, the cost of parking is often bundled, or included in the cost of housing; people are not given the option to forgo the cost of parking regardless of whether or not they own an automobile. Therefore, people who do not own a vehicle are subsidizing the cost of car ownership (McDonnell, Vadar, Been 2010).

Data and Methodology

The dependent variable is the total length of curb cuts in a study area compared to the total length of sidewalk in that study area. The independent variables, or factors that influence the phenomena, that were tested are the housing tenure of units, whether rental or owner-occupied, the population density, the proximity and degree of connection to transit, and the degree of mixed land use.

In order to analyze curb cuts and the factors that influence their existence, I collected a combination of primary and secondary data sources. The phenomena studied, the presence of and length of curb cuts, is a primary data source. The degree to which an area has a diverse number of uses is also primary source data. The remaining factors that were tested for possibly influencing the presence and total distance of curb cuts were collected from secondary data sources.

The data collected for the number of curb cuts as well as the distance of curb cuts was collected manually. I walked each block and measured the distance of curb cuts and counted the number of curb cuts present on each block. Measurement of curb cuts was collected using a Rolatape Professional Series Model 112 measuring wheel that was calibrated and inspected by the New York City Department of Transportation for accuracy. For the purpose of consistency, I measured each curb cut from the point where the edge of the curb began to slope.

Figure 3. The red lines indicate where measurement for the curb cut began and ended for each curb cut.

In some instances curb cuts exist where they do not lead to a driveway or parking facility. Rather, a building has been erected in place of what at one time was a location dedicated to automobiles. In these circumstances where curb cuts are simply vestiges of a past land use, they were not included into calculation of the total curb cut length because they no longer serve the purpose of bringing automobiles onto and across the sidewalk. The distance of the length of each sidewalk was collected from a secondary source. This data was collected by using the PAVEMENT_EDGE shapefile, available from NYC OpenData and originally created by the New York City Department of Transportation (NYC DOT 2009). However, to ensure that the data in this PAVEMENT_EDGE shapefile was accurate, I measured the length of the sidewalk of twenty blocks and compared the distance of sidewalk length I collected and the distance of sidewalk length in the shapefile. In each of these instances the measurements of the sidewalk block length were no more than 9 feet different from each other. Considering the block lengths compared were approximately 220 feet for short blocks and approximately 820 feet for avenue blocks the discrepancy between these two forms of measurement is minimal and could most likely be accounted for by my human error, such as I may have not walked in a perfectly straight line while measuring or may not have started my measurement at the exact edge of the block.

The independent variable data on the types of uses in each area was also collected manually. I walked each block and made note of the type of use on each block. This was done by making a tally mark in the category when a particular use was present on a block. The twenty-seven different categories of uses included:

- full grocery store
- deli
- drug store,
- discount/dollar store
- bar, restaurant
- take-out/fast food
- school,
- day-care/preschool
- bakery/coffee shop
- place of worship
- services such as dry-cleaners, Laundromat, and salon

- doctor
- eye doctor
- clothing store
- electronics store
  home goods
- community center/non-profit

community oriented

- public institution/agency
- bank
- specialty food store
- real estate firm

- law firm
- tax/accountant
- gym
- insurance
- liquor store
- other category

The uses were recorded based on their existence at the time of data collection, which took place between February 11, 2013 and March 8, 2013. Therefore if a business had recently closed down or if a business was in the process of opening but not yet open, it was not counted. The determination behind combining services such as salons, dry cleaners, Laundromats, and barber shops was that each of these uses are services that people expect to have close to home and people are not necessarily willing to travel far distances to obtain these services. Eye Doctor's Offices/Stores were separated from the category of Doctor which includes dentists, primary care physicians, and specialists because many Eye Doctor Establishments are set-up and run in a fashion much more similar to a retail store than a typical doctor's office. These Eye Doctor Establishments almost always sell different types of eyewear and related products, making them more closely related to a retail use than a medical use. The category of "Bank" only includes credit unions and commercial banking establishments, not locations that are solely A.T.M.'s; check cashing establishments were included in the "Other" category. A deli is characterized as an establishment that not only carries convenience items, but also a limited amount of grocery items, and a delicatessen counter where food can be ordered.

The data for the variable of housing tenure and data on population is from the 2010 U.S. Census Summary File 1, Profile of General Population and Housing Characteristics (U.S. Census Bureau, 2010 Census). This data provided the population of each census tract, the total number of occupied housing units of each census tract, the number of owner occupied housing units in each census tract, and the number of renter occupied housing in each census tract. In order to calculate the population density of each census tract, I also needed to obtain data on the geometric area of each census tract. Using data originally contained in a shapefile of the 2010 New York City Census Tracts, I calculated the geometric area of each of the fifteen census tracts in units of square mile. Using the 2010 population data from the 2010 U.S. Census Summary File 1, I was able to calculate the population density of each census tract by square mile.

The independent variable, connectivity to transit network required secondary data collection as well. I obtained a shapefile for bus routes from the MTA New York City Transit Authority, and a shapefile created by Steven Romalewski at Spatiality (MTA 2012; Romalewski 2012). From these shapefiles I counted the number of local subway lines, express subway lines, and bus routes that had at least one stop within the census tract. To determine each census tract's connectivity to the transit network I created two different systems. The first is a weighted analysis of the transit connectivity. In this analysis each bus route was weighted 0.5, each local subway line was weighted 0.75, and each express subway line was weighted 1. These weights were based off of peoples' general preference for subway travel over bus travel and the speed of each of these options. The second method of transit connectivity analysis only factored in subway data, local lines and express lines were treated equally in the calculation of connectivity. Using these two methods, I arrived at two sets of independent variable for transit connectivity.

Analysis

The data is analyzed in two different categories of geographic areas. Each of the three larger main geographic study areas is comprised of five smaller geographic study areas. Therefore the data for each of the independent variables and the dependent variable will be analyzed in the fifteen individual census tract study areas and the three main study areas. The majority of the analysis will focus on the larger geographic areas, but it is also useful to look at the data analysis at a smaller level.

Each of the main three study areas has a high population density. To put the population density of these three study areas in perspective, it is useful to compare the population densities of the study areas to New York City as a whole, which has a population density of 26,951 people per square mile, the Borough of Manhattan which has a population density of 70,102 people per square mile, and New York City excluding Staten Island, which has a much lower population density than the other four boroughs, has a population density of 31,444 people per square mile (U.S. Census Bureau 2010). Comparatively, the study areas have a much higher density than New York City, which has the highest population density of any major U.S. City (NYC DCP Population).

Table 2. Table of the population density for each of the main study areas.

Geographic Area	Population Density (people/square mile)
Manhattan Study Area	105,326
Queens Study Area	62,886
Brooklyn Study Area	42,334

To see tables that include the population density of the smaller study areas and the total population of each study area as well as the total area of each study area please refer to Appendix A.

Housing Tenure

Housing tenure refers to whether a housing unit is owner or renter occupied. The hypothesis of this study was that a high level of owner occupied housing would lead to more off-street parking and as a result more sidewalk space taken for curb cuts. Below is a chart listing the percentage of occupied housing units that are owner occupied and the percentage of occupied housing units that are occupied by renters for each of the three major study areas.

Table 3. Table of housing tenure in the three main study areas.

Geographic Area	Percentage of renter occupied housing units	Percentage of owner occupied housing units
Manhattan Study Area	83.2%	16.8%
Queens Study Area	87.4%	12.6%
Brooklyn Study Area	73.5%	26.5%

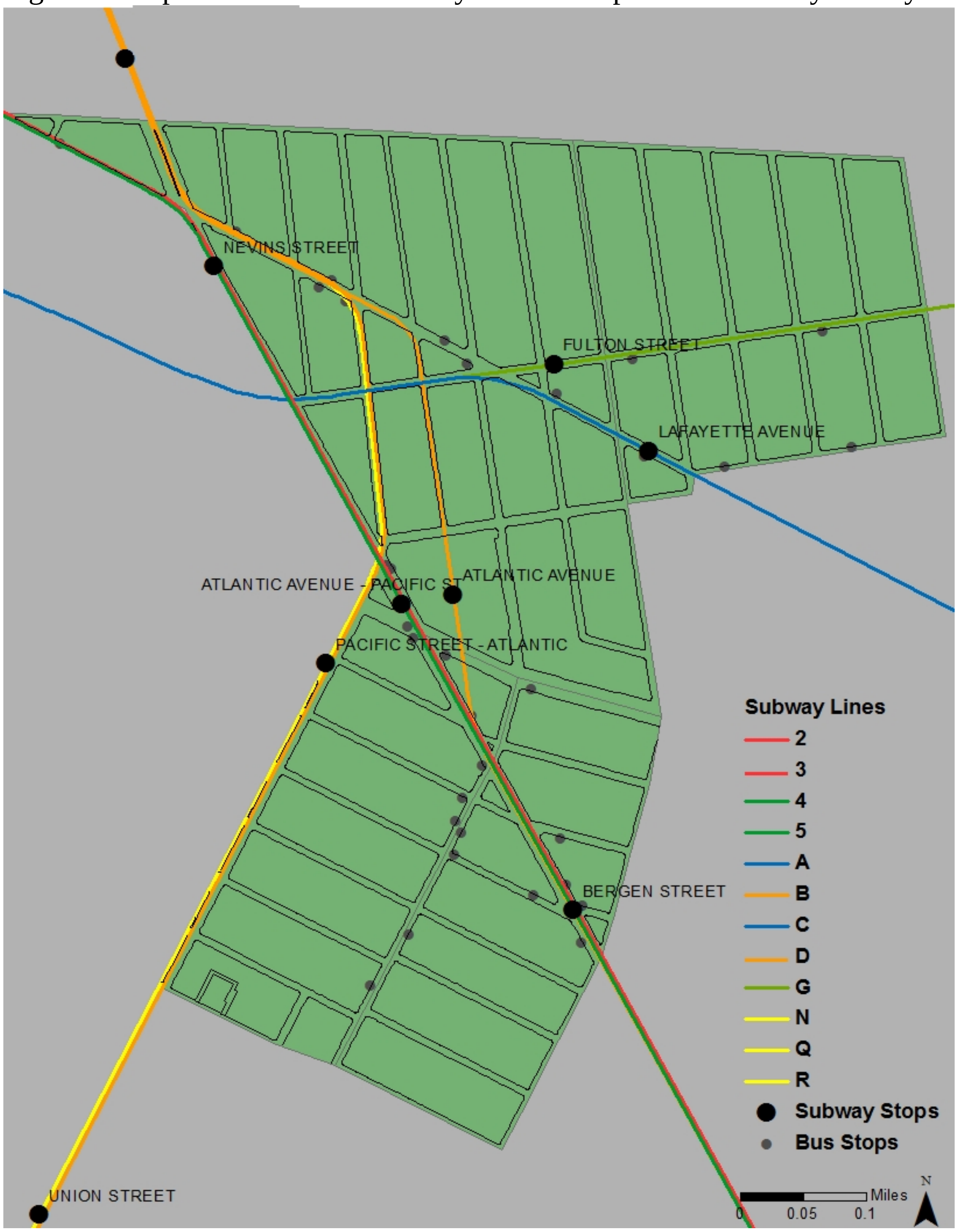
Refer to Appendix B for the housing tenure statistics for the smaller study areas. Overall, 16.8% of the occupied housing units in the main Manhattan study area are owner occupied. In the main Queens study area, 12.6% of the occupied housing units are owner occupied, and in the Brooklyn study area 26.5% of the occupied housing units are owner occupied. Of all of the geographic study areas, Manhattan census tract 190 has the highest percentage of owner occupied housing units, at 43.3%.

Transit Connectivity

It is important to keep in mind just how small these areas are when understanding the transit connectivity and that one of the criterion for choosing these study areas was good transit connectivity. It is best to look at the three main study areas that encompass the smaller study areas in order to get an understanding of an areas' transit connectivity. This is because the main study areas are quite small, the main Manhattan study area is just 0.29 square miles, the main study area of Queens is just 0.33 square miles and the main study area of Brooklyn is 0.28 square miles. This means that from any location within any of the three main study areas it is a very short distance to a transit stop located within the study area.

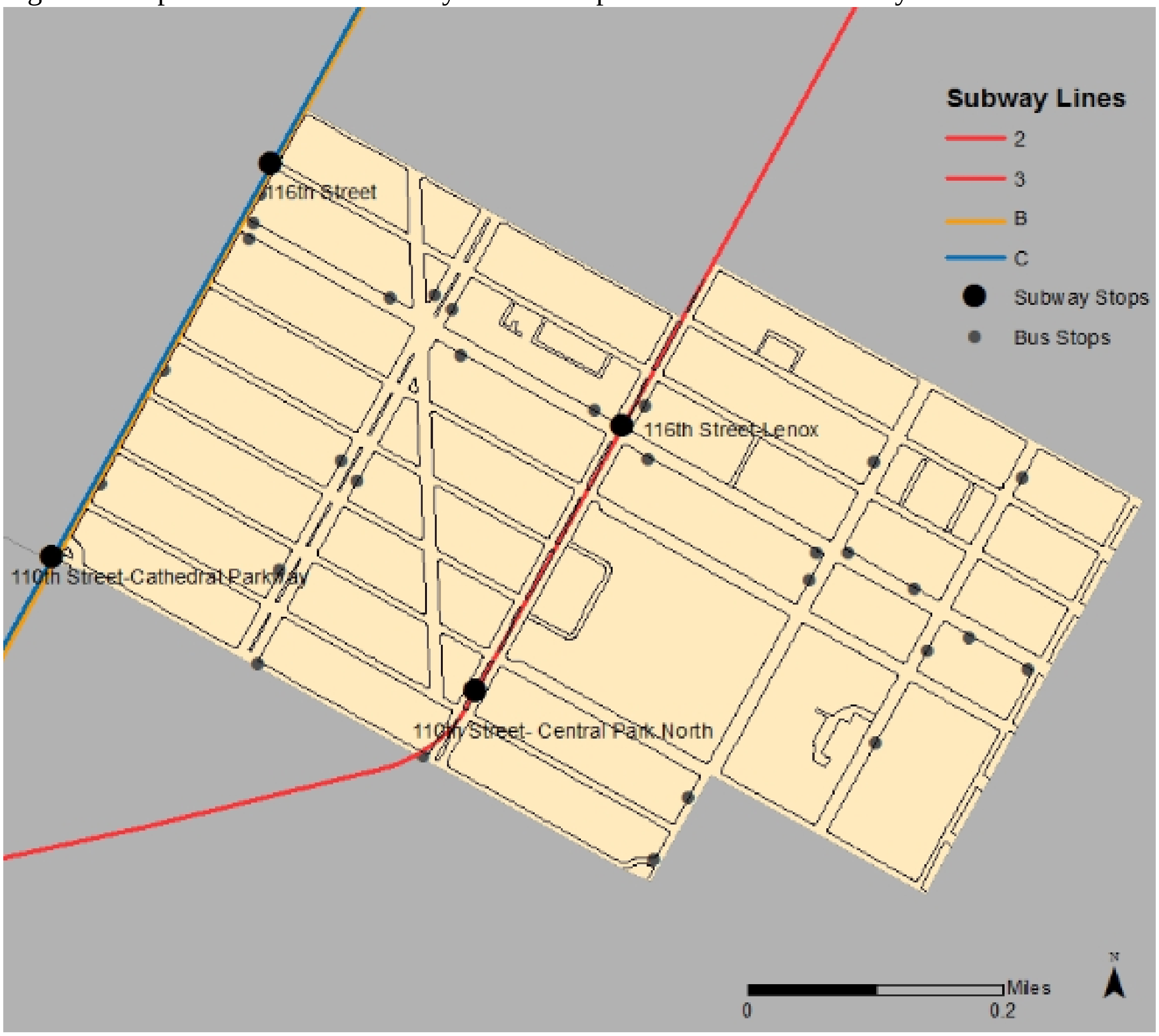
In the study area of Brooklyn, there is the option of twelve different subway lines, four of which are express, and ten different bus routes.

Figure 4. Map of the Bus and Subway Transit Stops in the Brooklyn Study Area.



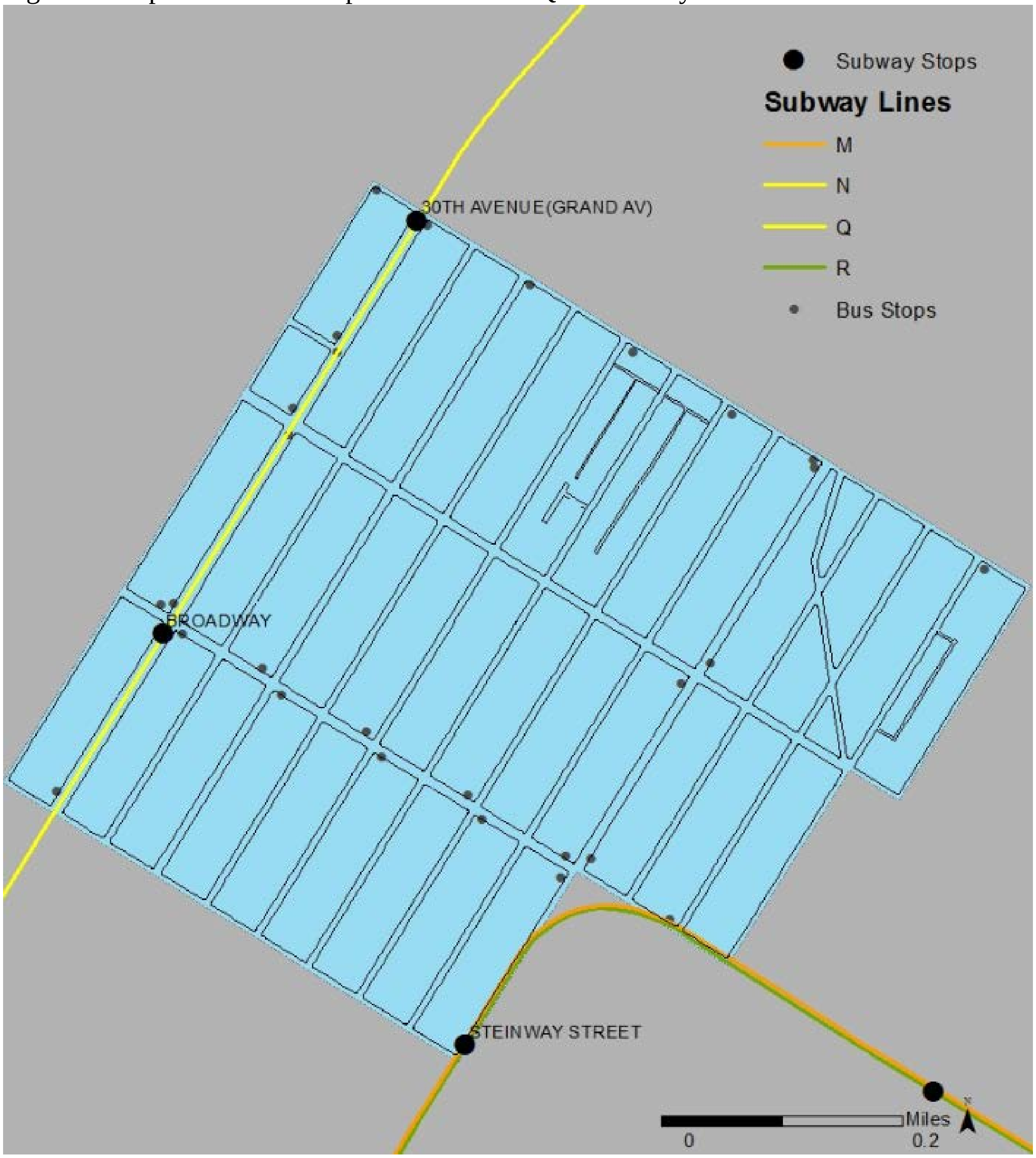
The Manhattan study area is served by four different subway lines, two of which are express and is served by eight different bus routes.

Figure 5. Map of the Bus and Subway Transit Stops in the Manhattan Study Area.



The Queens study area is served by three different subway lines, one of which is an express line and four bus routes. The Map below shows all of the bus and subway transit stops that are located within the Queens study area.

Figure 6. Map if the transit stops located in the Queens Study Area.



The tables below show the results of the methods I used to determine the transit connectivity of each study area using the weighted method and unweighted method.

Table 4. Table of the level of Transit Connectivity of the three main study areas using the weighted model.

AREA	Number of Local Subway Lines	Score	Number of Express Subway Lines	Score	Number of Bus Routes	Score	Total Score
Total Manhattan Study Area	2	1.5	2	2	8	4	7.5
Total Queens Study Area	3	2.25	1	1	4	2	5.25
Total Brooklyn Study Area	8	6	4	4	10	5	15

Table 5. Table of the level of Subway Transit Connectivity of the three main study areas using the unweighted model.

Area	Local Lines	Express Lines	Score
Total Manhattan Study Area	2	2	4
Total Queens Study Area	3	1	4
Total Brooklyn Study Area	8	4	12

Both the weighted and unweighted models show that these geographic areas which are all 1/3 of a square mile and under are extremely well served by transit. As the tables show, when factoring in subway lines, whether express lines or local lines, and bus routes the Brooklyn study area is considered to be the most well connected of the three larger study areas. Also when just using the total number of subway lines as a determinant, the Brooklyn study area is also the best served by transit. Again, be mindful that all three main study areas are very well connected to the transit network, as transit connectivity was factored into the selection process of the study areas. To give another perspective on the transit connectivity of these study areas is the time it takes to get from each to midtown Manhattan. These times are based on a 9 am weekday arrival time and are determined by Google Maps. In the Queens study area, depending on which station departing station and which arrival station in midtown the trip is between 13 minutes and 19 minutes. From the Manhattan study area to midtown, depending on the departure and arrival stations, the trip is between 11 minutes and 14 minutes. The trip between the Brooklyn study area and midtown Manhattan is between 21 minutes and 26 minutes, depending on the departure and arrival stations. For the specific travel times between stations please refer to Appendix C for the table with the full travel times and for the transit connectivity matrices for each of the smaller study areas.

Uses/Amenities

Each of the three main study areas has numerous land uses. Not only did each of the three main study areas have at least one use within the twenty-seven uses categories, but in each of the three study areas there are multiple options for each of these uses. A chart with the full list of all of the different uses of each area can be seen in Appendix D. To highlight some of the uses located in each of the study areas refer to the table below.

Table 6. Example of some of the uses located in each study area.

Study Area	Full Grocery Store	Sit-down Restaurant	Day-care/ Pre-school	Bakery/Coffee Shop	Personal Services
Brooklyn	3	36	2	30	39
Manhattan	4	16	8	5	58
Queens	3	76	8	23	96

Considering that each of the major study areas are 1/3 of a square mile or less, it is evident from the survey of uses that these areas have an extremely high level of mixed use and are able to provide residents living in these areas with the amenities that are needed on a regular basis, but also the high level of mixed use allows residents different options within each category as well.

Curb Cuts

It is important to discuss the dependent variable, the distance of sidewalk that is curb cuts compared with the entire distance of sidewalk. The percentage of sidewalk length that was taken up by curb cuts in Queens far exceeded the percentage of sidewalk length that was taken up by curb cuts in both Manhattan and Brooklyn. Below is a chart that shows the percentage of curb cuts in the Manhattan area, the Brooklyn area, and the Queens area.

Table 7. Table of percentage of sidewalk taken up by curb cuts.

Geographic Area	Sum of sidewalk length (meters)	Sum of curb cut length (meters)	Percentage of curb cuts
Brooklyn	871	24,458	3.6%
Manhattan	481	23,876	2.0%
Queens	3052	27,465	11.1%

When reviewing the percentage of curb cuts compared with the sidewalk length as a whole, it is important to realize that values as small as 1% are quite significant values. From this table it is clear that the study area in Queens has overwhelmingly more of its sidewalks taken up by curb cuts than the study area in Brooklyn and the study area in Manhattan. To put this in perspective, in the 17.07 miles of sidewalk studied in Queens, 1.90 miles of sidewalk are essentially taken from the pedestrian realm and given to the automobile realm. This means that in this small area of Queens alone, there is 1.90 miles pedestrian-vehicle interaction space, with each additional curb cut increasing the potential for a pedestrian-vehicle collision. Although less than the study area in Queens, both the study area in Brooklyn and the study area in Manhattan have a significant area of their sidewalks that are dedicated to curb cuts at 3.6% and 2.0% respectively. While such small percentages may not seem like an important issue, it is imperative to be mindful that these percentages equate to huge distances of space where pedestrians are forced to give up their sidewalks for the use by automobiles. There are 0.54 miles of curb cuts in the study area in Brooklyn compared to the 15.20 total miles of sidewalk in the study area. This means that there is over ½ of a mile of sidewalk space where pedestrians have a raised risk of getting hit by an automobile. In the Manhattan study area curb cuts account for 0.30 miles of the total sidewalk space, of 14.84 miles. Sidewalks, as designated pedestrian areas, having this amount of space taken for automobile use is quite astounding.

There does not seem to be any sort of correlation between the housing tenure of occupied housing units and the percentage of sidewalk taken up by curb cuts, as the Brooklyn study area has a far higher percentage of owner occupied housing units, yet it has a much lower percentage of curb cuts than the Queens study area which has a much lower percentage of owner occupied housing units. Similarly, in Manhattan census tract 190, 43.3% of the occupied housing units are owner occupied, which is the highest percentage of owner-occupied housing units of all of the study areas, but the percentage of curb cut is 1.8%, which is one of the lowest percentages of curb cuts in all of the study areas.

The total length and percentage of curb cuts varies between 2.1% and 5.0% between the five census tracts in Brooklyn, with a total percentage of 3.6% of the sidewalk taken as curb cuts in the total study area of Brooklyn. Below is a table with the corresponding sidewalk length and curb cut length for each geographic area, as well as the percentage of sidewalk that is curb cuts.

Table 8. Percentage sidewalk that is taken by curb cuts in the five Brooklyn study areas.

Geographic Area- Brooklyn census tracts	Sum of sidewalk length (meters)	Sum of curb cut length (meters)	Percentage of sidewalk that is curb cuts
33	5,980.8	269.3	4.5%
35	4,364.5	218.6	5.0%
129.01	4,566.1	159.4	3.5%
129.02	4,174.8	110.5	2.7%
181	5,371.5	113.6	2.1%
Total of all census tracts	24,457.8	871.4	3.6%

While walking along each block of the Brooklyn study area, I was amazed to see the extent to which automobiles encroach on and take over pedestrian space and endanger pedestrians. With such high levels of mixed use and high population density in the Brooklyn study area, these curb cuts greatly impact the pedestrian environment and force people to share their space with automobiles. Particularly distressful are the curb cuts located on sidewalks where children frequent. This photograph depicts curb cuts for parking located at M.S. 113 located at 300

Adelphi Street. As evident in the photograph the car is pulling into the parking lot and driving across the sidewalk.

Figure 7. Photograph of car entering the parking lot located at M.S. 113 at 300 Adelphi Street in Brooklyn.

There are also basketball courts and other outdoor play areas for children located on the school grounds so this area attracts children at all times and children are constantly walking along the sidewalk and are forced to share it with automobiles.

Rather than provide more mixed use space, such as retail on the bottom floor this recently constructed apartment building located at 383 Carlton Avenue, has parking on its bottom floor.

Figure 8. This photograph is of an apartment building at 383 Carlton Avenue in Brooklyn. Rather than a more residential units or retail on the first floor, parking is on the first floor.

This not only creates the need for a curb cut and more pedestrian/automobile interaction but it also negatively impacts the pedestrian environment by creating a dull streetscape and further reduces the density and mixed-uses of an area.

Perhaps the most egregious example of motor vehicles encroaching on the pedestrian environment is on Fort Greene Place between Atlantic Avenue and Hanson Place. This block functions almost like an alley way with many loading docks for the Atlantic Terminal shopping center. However, this block is not an alley. It is the full width of the surrounding blocks and it also has some store entrances on it. Additionally, it is in an area with a high pedestrian volume and receives a large amount of pedestrian traffic. However, on a large portion both the east side and the west side of the block, the sidewalk just ends mid-block to allow for loading areas for the shopping center. However, no warning is given to pedestrians; people walking down this block are just forced to walk the rest of the block with no sidewalk. There is a feeling of danger, as there is no longer the barrier of a curb between vehicles and pedestrians. Since the vast majority of vehicles on this block are large delivery trucks the feeling of safety is reduced even further for pedestrians. The layout of this block makes it clear vehicles not pedestrians were in mind when it was designed. This was street design with complete disregard to pedestrians in the urban environment. All streets in the urban environment should have adequate and safe areas dedicated to pedestrians. Especially, on this street, where there are multiple storefront entrances.

Figure 9. This is a photograph of the western side of the block of Fort Green Place between Atlantic Avenue and Hanson Place, where the sidewalk ends.

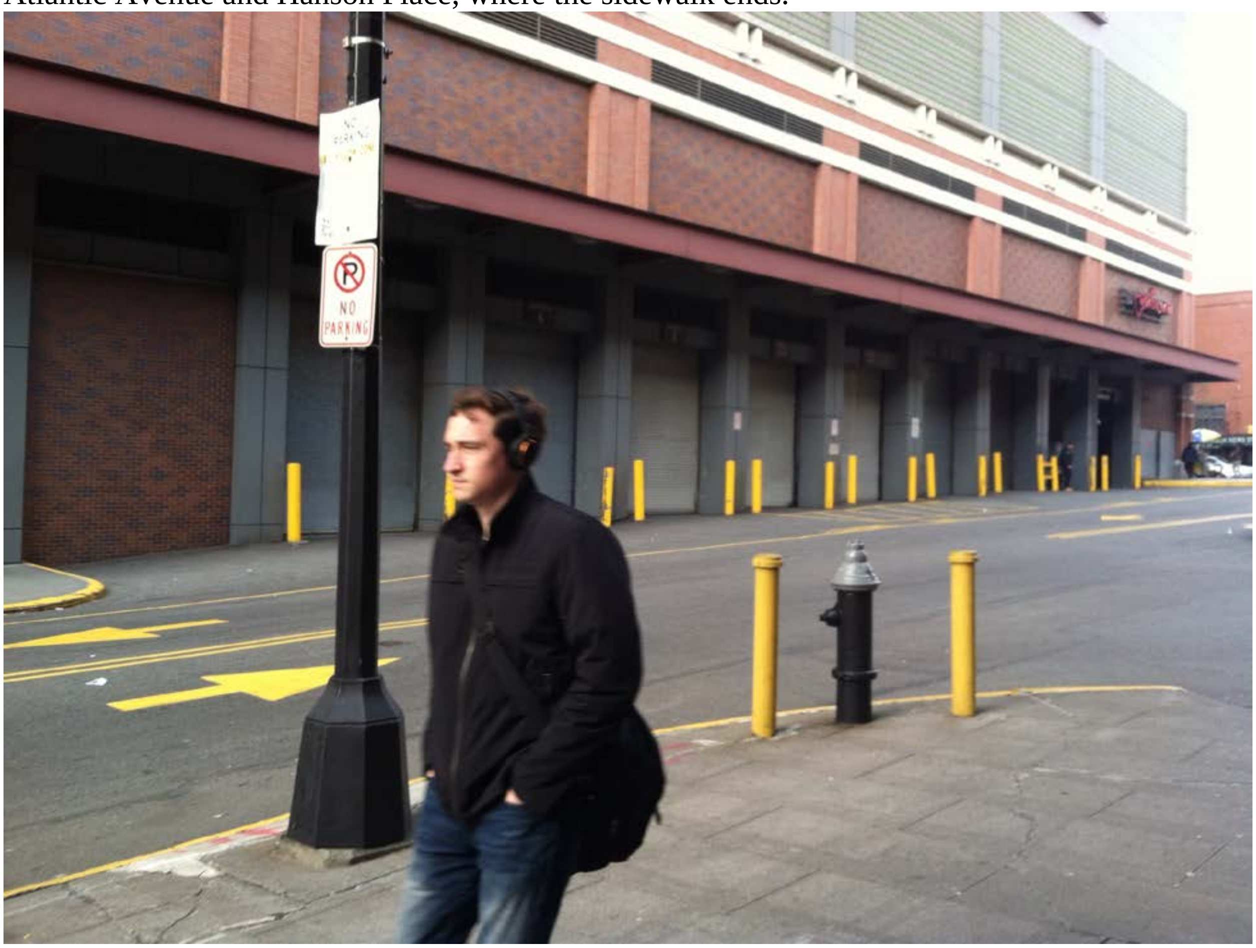


Figure 10. A photograph of the eastern side of the block of Fort Greene Place between Atlantic Avenue and Hanson Place, and an entrance to a parking facility where rather than a curb cut the just does not exist.

The sidewalk space on the small block of 6th Avenue between Bergen Street and Flatbush Avenue has essentially been made into a parking lot for the personal vehicles of the 78th Precinct Police Force, even though the 78th Precinct is located on the preceding block of 6th Avenue between Dean Street and Bergen Street. The sidewalk on this entire block is partially obstructed by police vehicles which are parked perpendicular to and partially on the sidewalk. However, on the sidewalk space on the block of 6th Avenue between Bergen Street and Flatbush Avenue automobiles are parked completely on the sidewalk. It is as if these vehicles are parallel parked against the curb; however they are actually entirely on the sidewalk. These vehicles are encroaching on the pedestrian realm so that not only are vehicles transiently taking over the sidewalk while using curb cuts, but in instances such as this they are completely taking over the sidewalk by parking on it. The photograph below shows what the sidewalk looks like on a typical day.

Figure 11. Photograph of the block of 6th Avenue between Bergen Street and Flatbush Avenue. Cars are parked on the sidewalk, leaving little space for pedestrians.

The Manhattan study area has fewer curb cuts and a lower percentage of curb cuts compared with total sidewalk length than both the Brooklyn study area and the Queens study area, yet these curb cuts are still destructive to the pedestrian streetscape. The table below shows the total length of curb cuts in each Manhattan study area.

Table 9. Table of the length of curb cuts, total sidewalk length, and percentage of sidewalk space taken up by curb cuts in the Manhattan study areas.

Geographic Area- Manhattan census tracts	Sum of sidewalk length (meters)	Sum of curb cut length (meters)	Percentage of curb cut per curb length
216	5,922.8	84.5	1.4%
218	6,364.8	103.9	1.6%
186	2,863.7	79.6	2.8%
190	3,228.6	57.1	1.8%
184	5,496.4	155.9	2.8%
Total of all census tracts	23,876.2	481.0	2.0%

This large parking lot located on West 115th Street between 5th Avenue and 6th Avenue has very few cars parked in it. Rather than creating more or residential units on this lot, it stands mostly vacant for use by the occasional vehicle. This parking lot makes the streetscape along this block very dull and uninviting for pedestrians.

Figure 12. Photograph of a nearly vacant parking lot on West 115th Street between 5th Avenue and Sixth Avenue in Manhattan.

Just a bit further down the block from this nearly vacant parking lot is another parking facility located on the ground floor of a recently built apartment building. Rather than put more retail on the ground floor a parking garage entrance stands. Further taking away from the pedestrian environment and creating another curb cut just meters away from the curb cut for the parking lot in the photograph above.

Figure 13. Photograph of the entrance to a parking garage on West 115th Street between 5th Avenue and 6th Avenue.

To make matters worse, just across the street from these two parking facilities, which are located on the north side of the block, is a parking lot for the NYCHA Dr. Martin Luther King Complex. The sidewalks on both sides of the block of West 115th Street between 5th Avenue and 6th Avenue have multiple large curb cuts, which are unnecessary; especially considering this block is only 1 block away from an express subway stop. These curb cuts impede the pedestrian streetscape and create unnecessary potential for a pedestrian-automobile collision.

The Queens study areas have by far the highest percentage of curb cut length compared to total sidewalk length than the Brooklyn study areas and the Manhattan study areas. The table below depicts the curb cut lengths in the Queens study areas.

Table 10. Table of the length of curb cuts, total sidewalk length, and percentage of sidewalk space taken up by curb cuts in the Manhattan study areas.

Geographic Area-Queens tracts	Sum of sidewalk length (meters)	Sum of curb cut length (meters)	Percentage of sidewalk that is curb cuts
59	5,654.7	914.9	16.2%
61	5,764.1	711.8	12.3%
63	7,546.8	464.5	6.2%
149	4,137.7	420.5	10.2%
155	4,362.2	540.6	12.4%
Total of all census tracts	27,465.4	3,052.3	11.1%

As evident in this table, curb cuts cover between 6.16% and as high as 16.18% of the sidewalk space in the census tracts studied in Queens. Census tract 59, which has the highest percentage of curb cut space, 16.18% has a total of 3.51 miles of sidewalk and 0.57 miles of curb cuts. This high percentage of sidewalk space that is taken away from pedestrians for automobile use is unjustifiable. Unlike in the main Manhattan study area and the Brooklyn study area, the main Queens study area has many more curb cuts for private single driveways at residences. There are a few instances of this in the Brooklyn study area, but it is not nearly as prevalent as in the Queens study area. The magnitude of private driveways in the Queens study area most likely accounts for the high percentage of curb cuts in Queens compared with the percentage of curb cut space in the Brooklyn study area and the Manhattan Study area. The private driveways are located on the smaller mostly residential streets, 31st Street, 32nd Street, 33rd Street, 34th Street, 35th Street, 36th Street, 37th Street, 38th Street, 41st Street, 42nd Street, and 43rd Street. The presence of private driveways on these streets seems somewhat redundant considering that each of these streets has on-street parking on both sides of the street. The photograph below is an example of the private driveways.

Figure 14. Photograph of private driveways on a residential block in the Queens study area.

As evident in this photograph, the curb cuts for private single car driveways essentially take an on-street parking space away to create the curb cut to access a private single off-street parking space. An alternative view of this is public pedestrian space is impinged upon to create access to a private parking space. Public space should not be taken away for private use as it is with these curb cuts.

Figure 15. A photograph of a private driveway in the Queens study area.

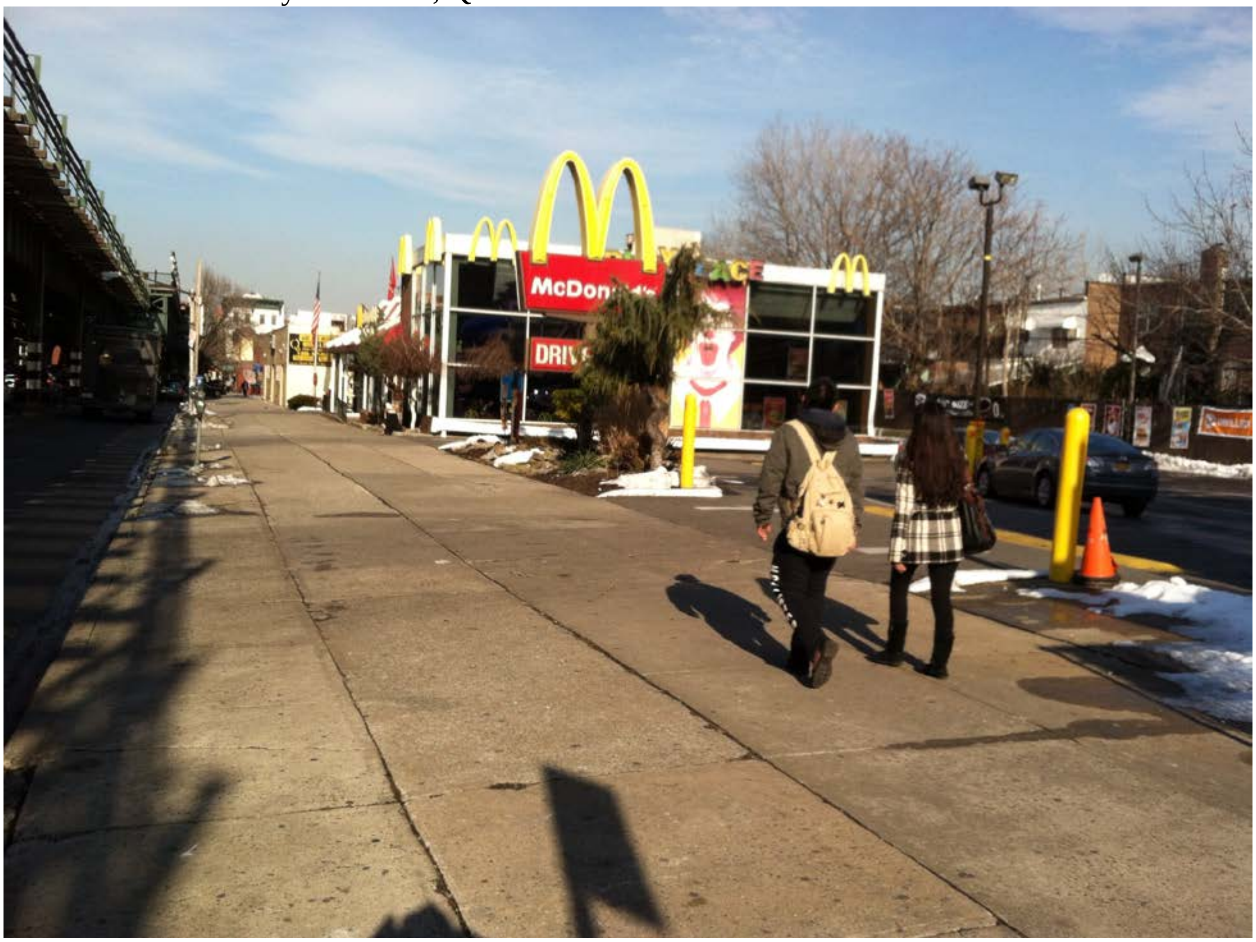
In this photograph it is evident that another on-street parking space could fit on the street where the curb cut is located. From a safety perspective these private driveways raise safety concerns because many of these private driveways have a wall on at least one side of them, which greatly obstructs the driver's view of anyone who may be approaching the curb cut. This places even more of an unfair burden on the pedestrian because they are walking on a presumably safe sidewalk and should not have to be constantly vigilant about vehicles entering their space; however these curb cuts force them to always be on the alert for a vehicle on the sidewalk.

Figure 16. Photograph of a parking Facility located next to a children's day care center.

This photograph portrays an off-street parking lot directly adjacent to a child day care center. This poses even more dangers than an ordinary curb cut. Because of children's heights they are often hard to see from the driver's perspective, especially in Sports Utility Vehicles and Trucks. Four out of five driveway related pedestrian-vehicle incidents occur to children four years of age and younger (Safe Kids USA). This fact makes the presence of a curb cut next to a day care center unconscionable. A curb cut and off-street parking facility next to a child care center greatly raises the risk of pedestrian injury or fatality of children who are attending this day care.

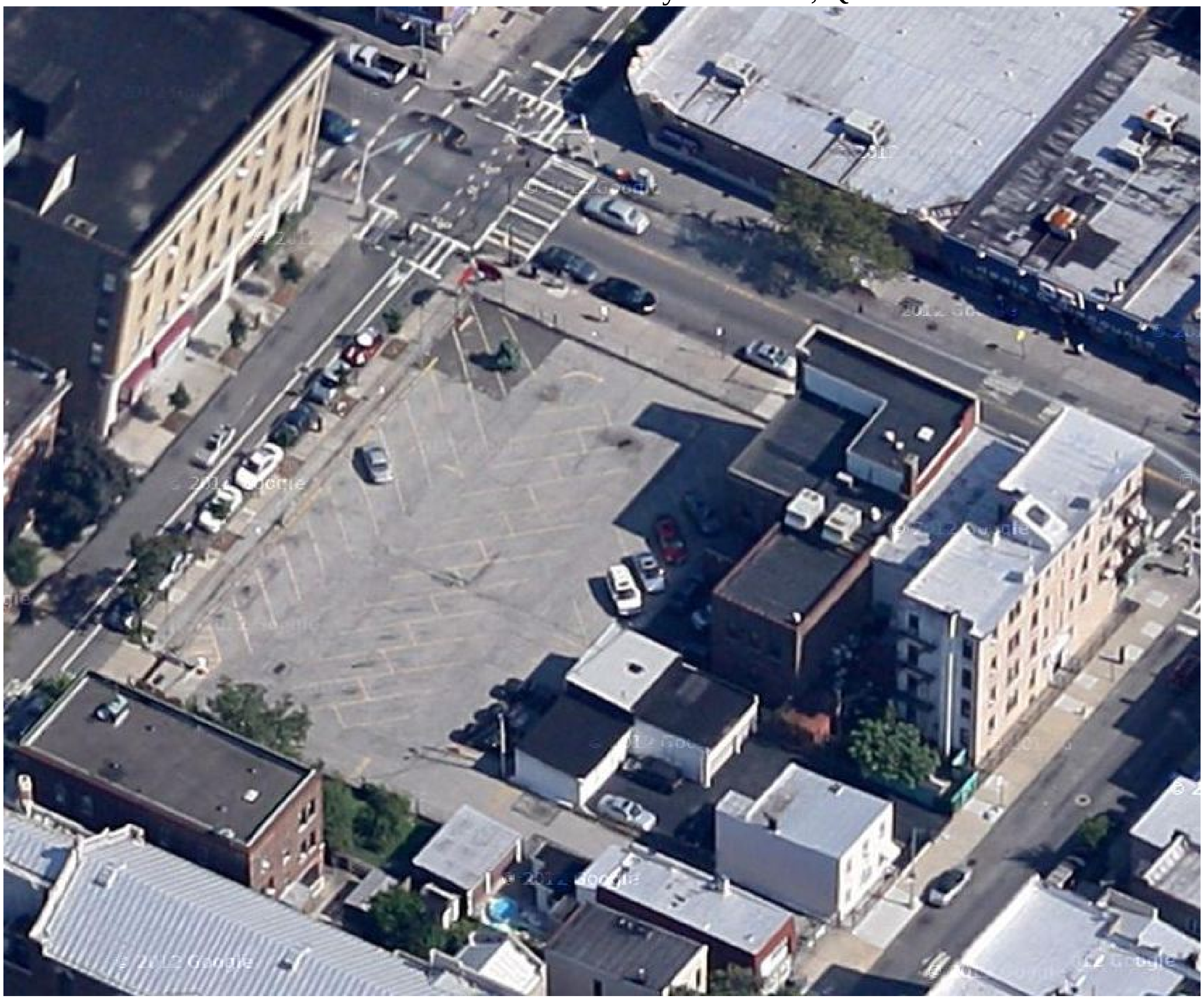
The Queens study area also has more parking facilities than the other two major study areas. These parking facilities include municipal lots, accessory parking for stores, and church parking lots. Of the four days of data collection in the Queens study area; I did not observe a single parking facility to be anywhere near capacity. Below is an example of the conditions I observed. This is a McDonald's Parking lot located on 31^{st} Street between 34^{th} Avenue and Broadway.

Figure 17. Photograph of the nearly empty McDonald's Parking lot on 31^{st} Street between 34^{th} Avenue and Broadway in Astoria, Queens.



The McDonald's parking lot is nearly empty. It also takes up a huge amount of space, preventing higher density and the option for more mixed-use. Another example of a nearly empty parking lot is the Most Precious Blood Church parking lot. While collecting my data, I walked past this parking lot on at least five occasions, and each time very few cars were parked in this enormous lot.

Figure 18. Google image of Most Precious Blood Church Parking lot, located on the southeast corner of the intersection of 36th Street and Broadway in Astoria, Queens.



Parking lots such as these create an uninviting streetscape atmosphere for pedestrians.

The City of New York also operates three off-street parking municipal lots located within the Queens study area. These parking facilities are located in prime locations, close by to main retail corridors, close to subway stations, and very close to many residential units. However, rather than this land having a use that would further enhance the amenities of the area, these parking lots lower land use density, create unattractive streetscapes, and increase the number of pedestrian-vehicle interactions that occur on sidewalks.

Figure 19. Photograph of Municipal lot located on the southeast corner of the intersection of 38th Street and 30th Avenue.

As this photograph shows, this municipal lot is not close to capacity. Only seventeen of the eighty-eight parking spaces were filled at the time this photograph was taken. The large number of off-street parking facilities located in the Queens study area is unnecessary and only leads to a uninviting pedestrian streetscape and an increase in the probability of a pedestrian-vehicular collision.

Impact of Zoning and Building Age on Off-Street Parking

The New York City Zoning Code specifies the number of off-street parking spaces required for buildings of different use and zoning designation. Outside of the Manhattan Core and Queens Community Board 1 and Community Board 2 where off-street parking requirements have been removed, these requirements are standard unless a developer obtains a waiver on the off-street parking requirement. The two tables below show the off-street parking requirements that are written into the New York City zoning code. Each zoning designation that is present in the three study areas is listed in the tables below.

Table 9. Table of Parking Spaces required for residential zoned properties (NYC DCP 2013).

Zoning District	Required Parking Ratio
R4B	100
R5	85
R6	70
R5B	66
R6A,R6B, R7-2, R7A , R8	50

Table 10. Table of Parking spaces Required Based on Commercial Use and Zoning District (NYC DCP 2013).

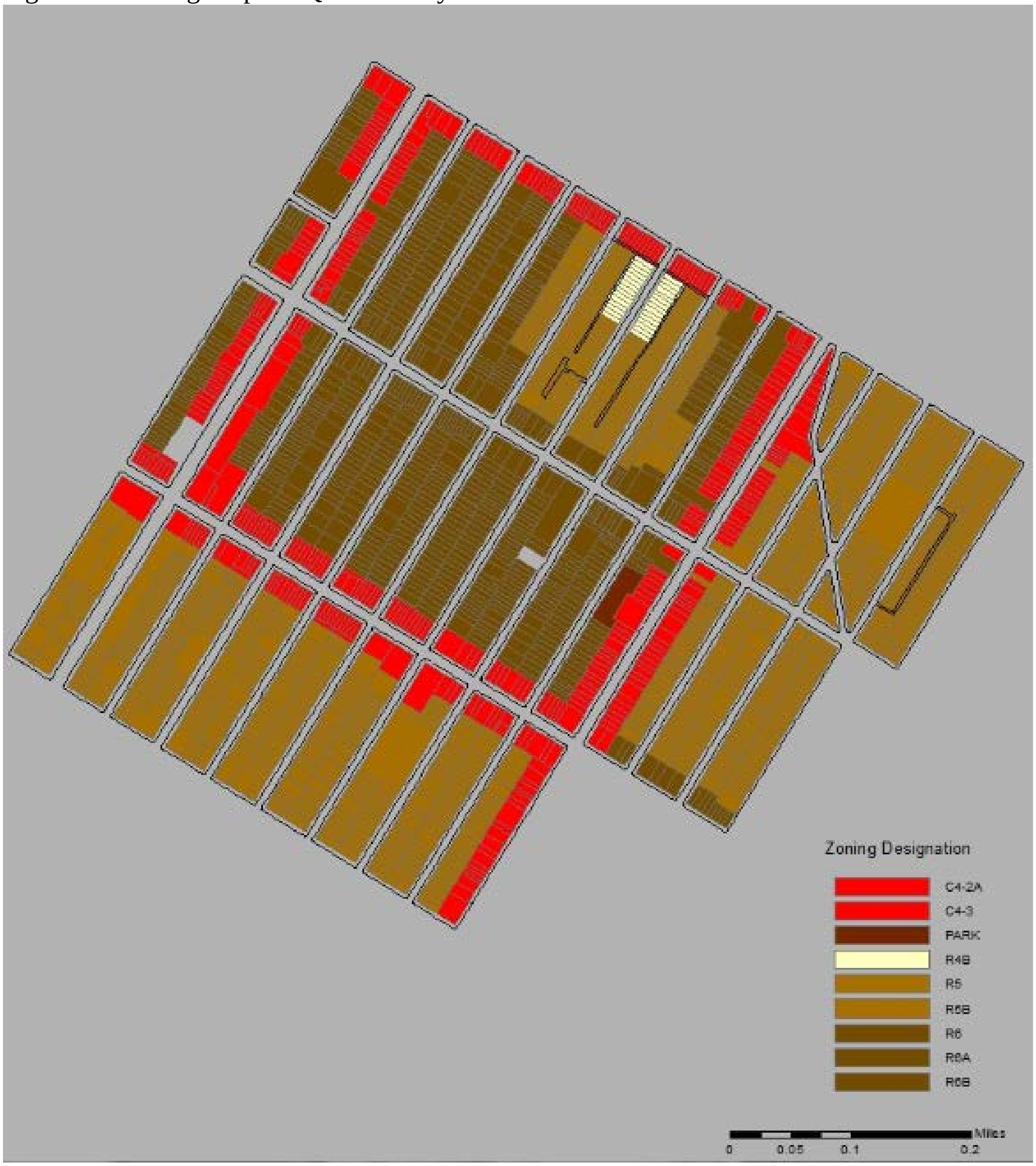
Commercial Zoning	Food Stores-over 2,000 square feet of floor area	General retail or service uses. Food stores with under 2,000 square feet of floor area	Low traffic generating such as offices and stores that sell large items	Houses of worship	Light manufacturing or semi-industrial #uses# , above 7,500 sq. feet or 15 employees	Floor rea used for meeting halls, eating or drinking places
C4-2A	1 space per 300 sq. ft.	1 space per 400 sq. ft.	1 space per 800 sq. ft.	0	1 per 2,000 sq. feet of floor area, or 1 per 3 employees whichever requires a lesser number of spaces	1 per 12 persons-rated capacity
C4-3	1 space per 300 sq. ft.	1 space per 400 sq. ft.	1 space per 800 sq. ft.	0	1 per 2,000 sq. feet of floor area, or 1 per 3 employees whichever requires a larger number of spaces	1 per 12 persons-rated capacity
C4-5X	0	0	0	0	0	0
C4-4A	0	0	0	0	0	0
C6-1	0	0	0	0	0	0
C6-2	0	0	0	0	0	0
C6-4	0	0	0	0	0	0
C6-4.5	0	0	0	0	0	0

The maps below show the zoning designation in each of the study areas.

Figure 20. Zoning Map for Brooklyn study area.

Figure 21. Zoning Map for Manhattan study area.

Figure 22. Zoning Map for Queens study area.



Prior to 1938, off-street accessory parking was prohibited to be built in conjunction with the construction of a residential building. In each of the three study areas a high percentage of the buildings were constructed before off-street accessory parking was allowed (NYC DCP 2009).

Table 11. Buildings Built Before and After Off-Street Parking was permitted.

Study Area	Total Number of Buildings	Constructed Prior to 1938	Percentage of Buildings constructed prior to 1938	Constructed After 1938	Percentage of Buildings Constructed After 1938
Manhattan	764	557	73%	207	27%
Queens	2192	1691	77%	501	23%
Brooklyn	1607	1521	95%	86	5%

It is important to note that the data in this table is from 2010. Therefore it does not count many construction projects that have occurred since 2010, such as the Barclays Center and many of the accompanying developments that do provide off-street parking. As evident in this chart the Queens study area by far has the highest number of buildings constructed after off-street accessory parking was permitted. Queens had 501 buildings erected after 1938, while the Manhattan study area had 207 buildings erected, and the Brooklyn study area had 86 buildings erected between 1938 and 2010. Since the Queens study area had such a large number of buildings constructed built after 1938, it may help to explain why there are so many more curb cuts in the Queens study area than in the Manhattan study area and the Brooklyn study area.

Implications

These photographs illustrate that sidewalks, as pedestrian spaces, are treated as a suggestion rather than as a distinctive space from motor vehicles. Even though motor vehicles already have the right to the majority of the streetscape, they take over and use the pedestrian realm through both legal forms, such as curb cuts to parking facilities and illegal forms such as parking on the sidewalk. Through enforcement and policy change pedestrians can once again regain the sidewalk. Considering these three study areas as case studies it is imperative to understand just how much and how often vehicles encroach on pedestrian space, putting pedestrian safety at risk and creating a negative pedestrian environment.

The incredibly high mixed-use of these three main study areas support the argument that the pedestrian realm in these areas should be improved by better urban design which would help to promote a safer and more inviting pedestrian environment. Not only does each of the three study areas have an enormous amount of mixed-use, but each area has multiple establishments in each of the twenty-seven categories of uses and amenities. The high volume of mixed uses in these areas also supports the assertion that with this amount of diversity in uses, the level of off-street parking currently in existence is not necessary. Each of the main study areas is no more than 1/3 of a square mile in area. The extremely high level of mixed-use in such a small area means residents only need to travel a short distance from their home to any amenity they may need on a regular basis. For any trip a resident needs to take with beyond the study area, there is very good transit connectivity. The mixed-use coupled with the transit connectivity of these areas and the high population density only further helps to bolster the argument that this amount of off-street parking is unnecessary and impinges on the streetscape environment of these areas.

This is especially true in the Queens study area. The Queens study area has by far the highest percentage of sidewalk space taken by curb cuts. The sidewalks in the Queens study area are suffering under the weight of the huge number of curb cuts present on the sidewalks. So much space is devoted to cars, yet this area provides such a high level of amenities and transit connectivity that benefits pedestrians. However, the space given to automobiles in the form of off-street parking and curb cuts greatly hurts the walkability of the area because of the increased danger curb cuts pose to the pedestrians and the drab and uninviting streetscapes that come from off-street parking facilities and curb cuts.

Reducing or eliminating the amount of off-street parking in these areas would greatly benefit the pedestrians. The reduction or elimination of off-street parking requirements would return large quantities of the sidewalk that are now used by motor vehicles back to the pedestrians. Without the risk of vehicles entering the sidewalk through curb cuts to reach off-street parking, pedestrians would be much safer and the risk of a pedestrian-vehicle crash would be minimized. There are a limited number instances where off-street accessory parking is necessary for the type of use that is associated with it. For instance, at hospitals, elderly care centers, care centers for people with disabilities and handicaps, where people may have limited mobility there is often the need for automobiles. Even if there is a high level of amenities and mixed uses as well as good access to transit, people who are severely mobility impaired may be unable to access these options on their own. Also certain businesses such as a furniture store or a glass manufacturer may need parking in order to load and unload merchandise. However, in all of these instances large numbers of automobiles or private vehicles are unnecessary. As many of the photographs illustrate, there are a great deal of vastly underutilized parking lots that are in close proximity to one another. One potential solution to this problem of large parking lots continually having very low occupancy is the idea of combined use parking lots. For instance, the photograph below shows two automobiles exiting parking lots that are located across the street from one another in the Queens study area.

Figure 23. Two parking lots across the street from each other, on 38th Street near 30th Avenue in the Queens Study Area.

Each time I walked past these two parking lots both had very low occupancy rates. Rather than having two parking lots in such close vicinity to one another, it makes much more sense to eliminate one of the parking lots and have one parking lot that has much higher occupancy levels. This way so much land is not wasted as empty parking spaces and by eliminating one or more parking lots, it greatly reduces sidewalk space taken for use as curb cuts. This solution would work especially well in instances where there are multiple parking lots in close vicinity where each are accessory off-street parking for different types of uses. For example the image of the Most Precious Blood Parking lot, which presumably has high levels of occupancy on Sundays, lays almost vacant most other times throughout the week. If zoning permitted, it would be much better if businesses that conduct their business during normal business hours could share parking lots with businesses such as restaurants that conduct most of their business in the evening, and with institutions such as churches that are primarily visited when these other businesses are closed. This type of multi-use shared parking lot would greatly benefit all involved. Businesses could then share the responsibility of maintenance of the parking lot. The land that had previously been used for other parking lots could be used for a much better land use such as a small park or another building that could provide more housing units or more retail. Eliminating unneeded parking lots would also greatly improve the streetscape making it more visually and physically inviting. Lastly, fewer parking lots would mean that less amount of sidewalk would be taken up by curb cuts. This would limit the space of potential vehicle-pedestrian collisions and give more space to pedestrians.

Without such high availability of parking, people may be less likely to drive, especially in instances where there are easy alternatives. Reduced driving in these areas would help to improve air quality; it would also lead to more people walking around the neighborhood, creating a livelier streetscape. Additionally, people may be more likely to patronize local retail, helping to boost the local economy.

In research, three of the most commonly used indicators for measuring walkability are residential density, land use mix, and connectivity to the transit network (Lovasi 2012). As the population density of each study area reveals, each of the study areas has a very high population density, significantly more dense than New York City, which is the densest major city in the U.S. The Brooklyn Study area is more than 1.5 times more densely populated, the Queens study area is almost 2.5 times more densely populated, and the Manhattan study area is almost four times more densely populated than New York City as a whole. This magnitude of density helps to foster walking and greatly reduces any need for driving. It also further highlights that the percentage of sidewalks taken up by curb cuts in these three study areas, and especially in the Queens study area is not only unnecessary but hurtful to the urban environment in these areas.

Conclusion

The large percentage of sidewalk space that is taken up by curb cuts is astounding considering the high density of mixed uses, population, and the connectivity of these areas to the transit network. It is difficult to argue the need for such large amounts of parking facilities and driveways that these curb cuts lead to considering the number of amenities located within a short walking distance and the ease and access to the transit system that each of these three areas have located within them. The independent factors studied help to illustrate just how exorbitant the curb cut space in these study areas is considering what these factors reveal. The large number of amenities available in each of the three large study areas as well as the smaller study areas illustrates that residents are within easy walking distance of all, if not the vast majority of amenities they would need on a daily or weekly basis. Additionally, the strong connectivity each of the study areas has to the City's transit system further helps to make the point that driving is unnecessary for the vast majority of residents, especially if they are working in New York City or a location that is accessible by transit. Because driving and automobile use is not necessary to obtain typical services and needs there is not the need for so many off-street parking facilities, which all require curb cuts to access. The New York City Department of City Planning should extend its maximum parking requirement in the zoning code beyond just the Manhattan Core and into the areas studied in this project as well as similar areas in the City that can clearly sustain themselves without so many automobiles and even flourish more with an off-street parking restriction which would allow for greater building density, which could create more amenities and uses available to residents of the area. Limiting or eliminating off-street parking in areas with such high levels of mixed uses and connectivity to the transit system would also help to improve the pedestrian streetscape in these areas. Reducing the number and area of curb cuts on sidewalks would create a safer pedestrian environment and in turn encourage even more people to take advantage of walking in the area and experiencing, from a pedestrian perspective all that an area has to offer.

Appendix A-Population Density

Geographic Area-Census Tract	Total Population	Total Area (square mile)	Population Density (people/square mile)
Manhattan Census Tract- 184	7,835	0.07	114,921
Manhattan Census Tract- 186	5,701	0.05	121,288
Manhattan Census Tract- 190	3,083	0.04	76,925
Manhattan Census Tract- 216	7,556	0.07	112,994
Manhattan Census Tract- 218	6,617	0.07	9,4232
Total Manhattan Study Area	**30,792**	**0.29**	**105,326**

Geographic Area-Census Tract	Total Population	Total Area (square mile)	Population Density (people/square mile)
Queens Census Tract-59	4,169	0.07	56,767
Queens Census Tract-61	5,644	0.08	74,944
Queens Census Tract-63	5,949	0.08	72,507
Queens Census Tract-149	2,674	0.04	64,998
Queens Census Tract-155	2,251	0.06	39,475
Total Queens Study Area	**20,687**	**0.33**	**62,886**

Geographic Area-Census Tract	Total Population	Total Area (square mile)	Population Density (people/square mile)
Brooklyn Census Tract -33	2,327	0.06	36,598
Brooklyn Census Tract -35	1,554	0.05	30,256
Brooklyn Census Tract -129.01	2,159	0.05	40,849
Brooklyn Census Tract -129.02	1,964	0.05	40,034
Brooklyn Census Tract -181	3,936	0.07	60,377
Total Brooklyn Study Area	**11,940**	**0.28**	**42,334**

Appendix B-Housing Tenure

Study Area	Percentage of rental occupied housing units	Percentage of owner occupied housing units
Manhattan census tract-184	91.0%	9.0%
Manhattan census tract-186	97.5%	2.5%
Manhattan census tract-190	56.7%	43.3%
Manhattan census tract-216	84.7%	15.3%
Manhattan census tract-218	86.2%	13.8%
Total Manhattan Study Area	**83.2%**	**16.8%**
Queens census tract-59	84.5%	15.5%
Queens census tract-61	92.3%	7.7%
Queens census tract-63	91.1%	8.9%
Queens census tract-149	87.6%	12.4%
Queens census tract-155	81.5%	18.5%
Total Queens Study Area	**87.4%**	**12.6%**
Brooklyn census tract-33	78.1%	21.9%
Brooklyn census tract-35	72.8%	27.2%
Brooklyn census tract-129.01	69.5%	30.5%
Brooklyn census tract-129.02	74.3%	25.7%
Brooklyn census tract-181	72.7%	27.3%
Total Brooklyn Study Area	**73.5%**	**26.5%**

Appendix C- transit connectivity

Weighted Transit Connectivity Matrix

AREA	Number of Local Subway Lines	Score	Number of Express Subway Lines	Score	Number of Bus Routes	Score	Total Score
Total Manhattan Study Area	**2**	**1.5**	**2**	**2**	**8**	**4**	**7.5**
Manhattan Census Tract-184	0	0	0	0	2	1	1
Manhattan Census Tract-186	0	0	2	2	1	0.5	2.5
Manhattan Census Tract-190	0	0	2	2	5	2.5	4.5
Manhattan Census Tract-216	2	1.5	2	2	4	2	5.5
Manhattan Census Tract-218	2	1.5	2	2	5	2.5	6
Total Queens Study Area	**3**	**2.25**	**1**	**1**	**4**	**2**	**5.25**
Queens Census Tract-59	1	.75	1	1	4	2	3.75
Queens Census Tract -61	1	.75	1	1	4	2	3.75
Queens Census Tract -63	1	.75	1	1	4	2	3.75
Queens Census Tract -149	0	0	0	0	3	1.5	1.5
Queens Census Tract -155	2	1.5	0	0	3	1.5	3
Total Brooklyn Study Area	**8**	**6**	**4**	**4**	**10**	**5**	**15**
Brooklyn Census Tract-33	1	0.75	0	0	5	2.5	3.25
Brooklyn Census Tract -35	7	5.25	4	4	7	3.5	12.75
Brooklyn Census Tract -129.01	6	4.5	4	4	5	2.5	11
Brooklyn Census Tract -129.02	0	0	2	2	5	2.5	4.5
Brooklyn Census Tract -181	2	1.5	0	0	5	2.5	4

Appendix C- transit connectivity (continued)

Unweighted Transit connectivity Matrix

AREA	local lines	express lines	SCORE
Total Manhattan Study Area	**2**	**2**	**4**
Manhattan Census Tract-184	0	0	0
Manhattan Census Tract-186	0	2	2
Manhattan Census Tract-190	0	2	2
Manhattan Census Tract-216	2	2	4
Manhattan Census Tract-218	2	2	4
Total Queens Study Area	**3**	**1**	**4**
Queens Census Tract -59	2	0	2
Queens Census Tract-61	2	0	2
Queens Census Tract -63	2	0	2
Queens Census Tract -149	0	0	0
Queens Census Tract -155	2	0	2
Total Brooklyn Study Area	**8**	**4**	**12**
Brooklyn Census Tract -33	1	0	1
Brooklyn Census Tract -35	7	4	11
Brooklyn Census Tract -129.01	6	4	10
Brooklyn Census Tract -129.02	0	2	2
Brooklyn Census Tract -181	2	0	2

Appendix C- transit connectivity (continued)

Travel Times to Midtown Manhattan

Start- Transit Station, Subway Line	**End- Station**	**Time**
Steinway Station- M line	Rockefeller Center	13 minutes
Steinway Station- R line	49th Street	17 minutes
30th Avenue- N, Q line	49th Street	19 minutes
Broadway-N ,Q line	49th Street	18 minutes
116th street- B line	Rockefeller Center	14 minutes
110th street- B line	Rockefeller Center	13 minutes
116th street- C line	50th Street	12 minutes
110th street- Cathedral Parkway- C line	50th Street	11 minutes
110th Street- Central Park North- 2 or 3 line	Times Square-42nd Street	12 minutes
116th Street- 2 or 3 line	Times Square-42nd Street	14 minutes
Atlantic Avenue-Barclay's Center-2, 3 lines	Times Square-42nd Street	23 minutes
Atlantic Avenue-Barclay's Center- 4, 5 lines	Grand Central	24 minutes
Atlantic Avenue-Barclay's Center-B, D lines	Bryant Park	21 minutes
Atlantic Avenue-Barclay's Center- N,Q, R lines	Times Square- 42nd Street	24 minutes
Nevins- 2, 3 lines	Times Square- 42nd Street	22 minutes
Nevins-4, 5 lines	Grand Central	23 minutes
Lafayette Avenue- C line	Port Authority	26 minutes

Appendix D- Amenities

	full grocery	deli	drug store	dollar store/discount store/newspaper	bar	restaurant	take-out /fast food	school
Total Queens area	**3**	**28**	**15**	**23**	**16**	**76**	**21**	**3**
Queens Census Tract- 59	3	2	5	5	4	11	8	0
Queens Census Tract- 61	0	8	1	4	5	24	1	1
Queens Census Tract- 63	3	11	7	4	3	24	1	1
Queens Census Tract- 149	0	5	0	3	0	5	5	1
Queens Census Tract- 155	0	2	2	7	4	12	6	0
Total Manhattan Area	**4**	**30**	**12**	**13**	**3**	**16**	**21**	**7**
Manhattan Census Tract-184	1	11	3	3	0	1	4	0
Manhattan Census Tract-186	0	3	0	0	0	0	2	2
Manhattan Census Tract-190	1	4	2	2	0	0	3	1
Manhattan Census Tract-216	1	6	2	0	1	5	6	2
Manhattan Census Tract-218	1	6	5	8	2	10	6	2
Total Brooklyn Area	**3**	**18**	**8**	**8**	**19**	**36**	**38**	**6**
Brooklyn Census Tract-33	0	7	4	4	2	8	20	1
Brooklyn Census Tract-35	1	3	0	2	3	7	8	0
Brooklyn Census Tract-129.01	1	2	1	1	9	5	2	1
Brooklyn Census Tract-129.02	0	1	2	1	1	13	3	1
Brooklyn Census Tract-181	1	5	1	0	4	3	5	3

	day-care/ preschool	bakery/ coffee shop	dry-cleaners/ salon other services	doctor	clothing store	electronics store	home goods	community center
Total Queens area	**8**	**23**	**96**	**67**	**67**	**24**	**22**	**2**
Queens Census Tract-59	2	6	20	7	6	3	2	0
Queens Census Tract-61	2	8	17	10	8	1	4	1
Queens Census Tract-63	2	4	32	25	7	3	3	1
Queens Census Tract-149	1	1	17	4	14	9	2	0
Queens Census Tract-155	1	4	10	21	32	8	11	0
Total Manhattan Area	**8**	**5**	**58**	**21**	**19**	**8**	**9**	**13**
Manhattan Census Tract-184	1	0	10	11	3	0	3	1
Manhattan Census Tract-186	3	0	4	0	0	0	0	0
Manhattan Census Tract-190	2	1	5	4	2	2	2	3
Manhattan Census Tract-216	1	2	15	4	1	1	0	2
Manhattan Census Tract-218	1	2	24	2	13	5	4	7
Total Brooklyn Area	**2**	**30**	**39**	**21**	**60**	**11**	**18**	**2**
Brooklyn Census Tract- Brooklyn Census Tract-33	1	8	8	5	17	4	5	0
Brooklyn Census Tract-35	0	5	6	5	16	4	2	0
Brooklyn Census Tract-129.01	0	1	10	1	2	2	4	0
Brooklyn Census Tract-129.02	0	13	11	5	21	1	5	1
Brooklyn Census Tract-181	1	3	4	5	4	0	2	1

	church	public institutions	banks	specialty food store	real estate	law	Tax/ accoun tants	gym	liquor store	Eye Doctor	insurance
Total Queens area	**5**	**2**	**17**	**19**	**24**	**12**	**11**	**11**	**4**	**6**	**12**
Queens Census Tract 59	1	1	5	1	3	3	2	1	1	1	0
Queens Census Tract- 61	1	0	5	6	7	1	1	3	1	0	3
Queens Census Tract- 63	3	0	3	8	7	4	6	0	1	0	3
Queens Census Tract- 149	0	0	1	1	1	1	2	2	0	4	3
Queens Census Tract- 155	0	1	3	3	6	3	0	5	1	1	3
Total Manhattan Area	**21**	**3**	**4**	**8**	**2**	**1**	**3**	**5**	**6**	**1**	**0**
Manhattan Census Tract- 184	5	0	0	1	1	0	1	2	2	0	0
Manhattan Census Tract- 186	3	2	0	0	0	1	0	0	0	0	0
Manhattan Census Tract- 190	4	0	2	3	0	0	0	1	1	1	0
Manhattan Census Tract- 216	1	0	0	0	1	0	0	0	1	0	0
Manhattan Census Tract- 218	8	1	2	4	0	0	2	2	2	0	0
Total Brooklyn Area	**9**	**12**	**2**	**4**	**12**	**2**	**3**	**7**	**2**	**5**	**2**
Brooklyn Census Tract- 33	0	0	4	0	1	5	0	1	2	1	1
Brooklyn Census Tract- 35	0	1	5	1	1	2	0	0	0	0	1
Brooklyn Census Tract- 129.01	0	4	3	0	0	2	1	1	4	0	1
Brooklyn Census Tract- 129.02	1	1	0	1	2	3	1	1	1	0	2
Brooklyn Census Tract- 181	1	3	0	0	0	0	0	0	0	1	0

Appendix D- List of Tables and Figures

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