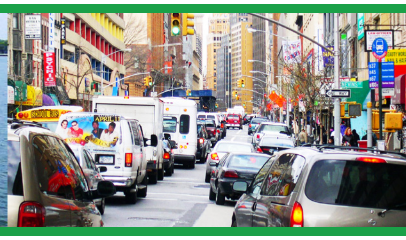
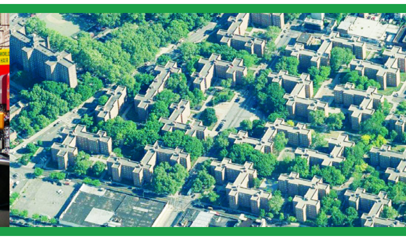
# BROOKLYN STREETCAR *FEASIBILITY STUDY*



# BROOKLYN STREETCAR FEASIBILITY REPORT


# TABLE OF CONTENTS

# FIGURES

# TABLES

# 1.0 INTRODUCTION

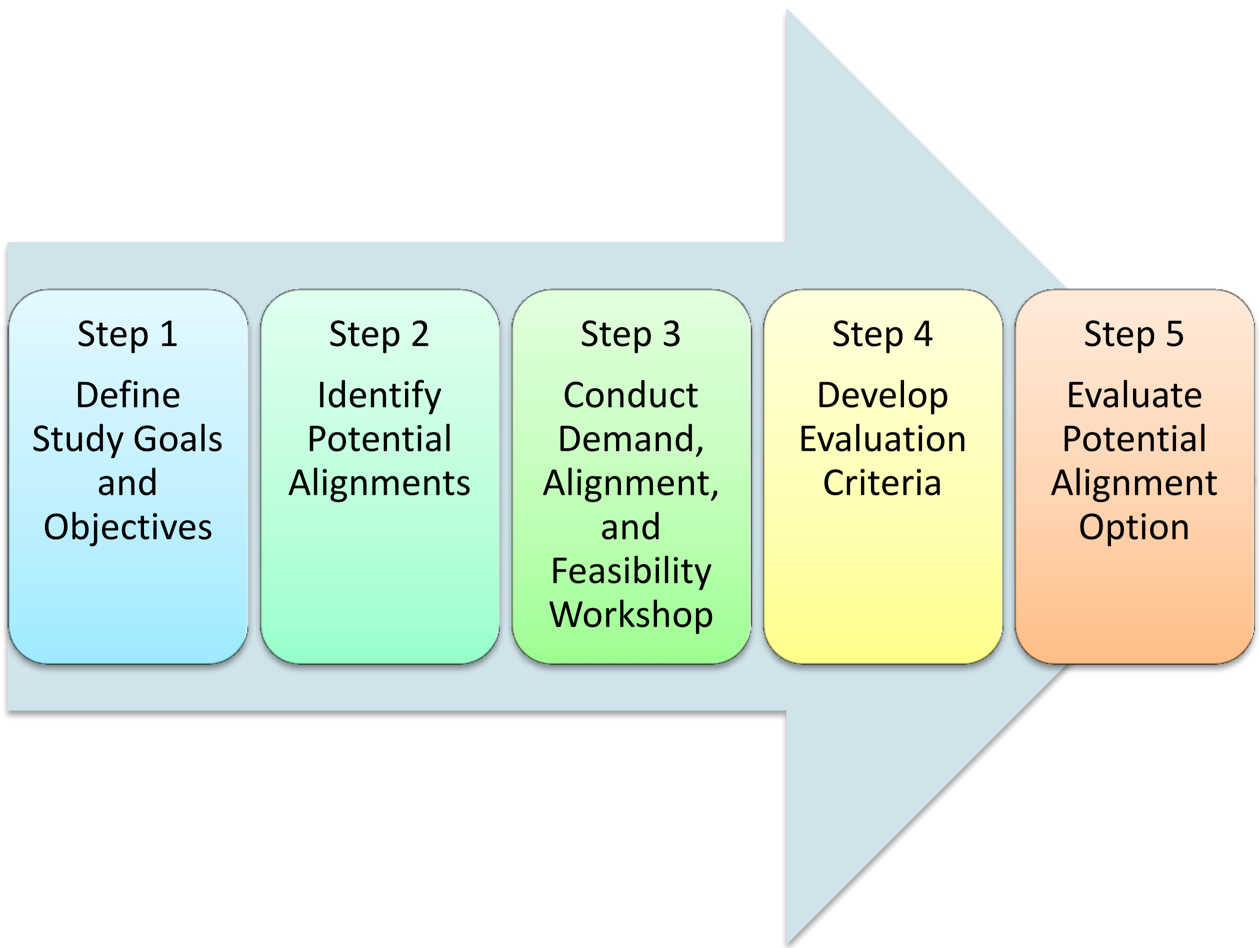
This report presents the results of a detailed evaluation on the feasibility of implementing a streetcar system in Brooklyn. This analysis draws upon the experience and lessons learned from several existing streetcar systems presented in the Case Study Report. As part of that effort, the Study Team and representatives of NYCDOT conducted a field visit of the Philadelphia Route 15 Trolley system. In addition, a number of site investigations were performed in Red Hook and Downtown Brooklyn to identify alignment options and feasibility considerations related to clearances and turning radii, track geometry, sidewalks, bikeways, and utilities.

This detailed analysis considers constructability issues, vehicle options, and overall costs to implement and operate a streetcar system in Brooklyn. The evaluation was conducted based on the approach outlined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum. In addition to feasibility from an engineering standpoint, this report also includes discussion related to the NYCDOT policy decision for a future streetcar in Red Hook. NYCDOT's policy specifically relates to the selection and evaluation of the alignment options, feasibility considerations, expected benefits, and cost considerations.

# 2.0 METHODOLOGY

This section outlines the process used for selecting and evaluating potential alignments for a streetcar service in Brooklyn, as defined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, as well as the process for developing a policy decision in regard to a future streetcar in Brooklyn. The process for selecting and evaluating potential alignments for a streetcar service in Brooklyn includes defining the study's goals and objectives, identifying potential streetcar alignments, developing evaluation criteria to measure how well the alignment options satisfy the study's goals and objectives, and evaluating various alignment options in comparison to each other. This multi-step process is graphically shown in Figure 2-1.

**Figure 2-1: Alignment Selection and Evaluation Process**




In Step 1, study goals and objectives were discussed and developed during the initial study meetings. In Step 2, conceptual alignments were identified based on a combination of factors, including land uses that generate significant person trips, employment densities that concentrate these trip generating uses, connecting existing transit that allows for citywide access, and input from the Community Advisory Committee.

In Step 3, additional streetcar alignments were identified and reviewed during a Demand, Alignment, and Feasibility Workshop attended by NYCDOT and members of the consultant team. Based on the input received at this workshop and considering planning factors such as existing land use, employment density, existing transit, and the roadway network, the alignments were refined to include one basic potential alignment with various alternative options. This potential alignment with options was presented at the second Community Advisory Committee meeting on December 13, 2010 for public feedback.

## EVALUATION CRITERIA

Using the goals and objectives defined in Step 1, evaluation criteria were developed in Step 4 to assess how well the alignment options address the defined goals and objectives. Step 5 considers the degree to which each alignment option satisfies the defined goals and objectives using a rating scale for the developed evaluation criteria. While these measures are generally qualitative, they allow for a comparison of the order of magnitude benefits and drawbacks of each alignment option. Each of the study goals and objectives are listed below, along with a description of the evaluation criteria, which were used to evaluate the potential alignment options. Table 2-1 includes the streetcar goals and objectives and the corresponding evaluation criteria for the forthcoming evaluation of the potential alignment options.

### *Improve Transportation Mobility*

Five objectives are related to the goal of improving transportation mobility:

- Provide transit accessibility;
- Minimize travel time;
- Provide intermodal connectivity;
- Enhance pedestrian movements; and
- Accommodate bikeways.

To evaluate whether an alignment option provides transit accessibility, population, employment, and activity centers were measured within 1/3-mile of the potential alignment options (for both directions) using Geographic Information Systems (GIS) and the New York Metropolitan Transportation Council (NYMTC) 2005 traffic analysis zone (TAZ) level population and employment data. Traffic analysis zones were considered to be within 1/3 of a mile if more than half of the zone was within 1/3-mile of the proposed alignment. For this analysis, the following activity centers were identified: Atlantic Terminal, Borough Hall, Red Hook Houses, Long Island College Hospital, Fairway, and IKEA. Alignment options with a higher concentration of population, employment, and activity centers within 1/3-mile received a higher rating than alignment options with a lower concentration.

Similarly, GIS was also used to measure route distance and potential trip time savings between the following trip generators: Atlantic Terminal, Borough Hall, Red Hook Houses, Long Island College Hospital, Fairway, IKEA, and the Smith / 9$^{th}$ Street subway station. Using the scheduled speed of the existing Metropolitan Transportation Authority New York City Transit Authority (MTA NYCT) B61 bus as a benchmark, alignment options that would provide shorter travel times to these trip generators, due to more streamlined routing, received a higher rating than alignment options that would result in longer travel times.[1]

To assess an alignment option's ability to provide intermodal connectivity, the existing subway and bus connections were mapped. The alignment options with a bus or subway connection within one block received a higher rating than alignment options with more distant connections or with a lack of intermodal connections. Moreover, alignment options with multiple intermodal connections were rated accordingly higher.

In terms of pedestrian movements, alignment options were examined based on potential conflicts with pedestrian movements and interference with pedestrian space. Alignment options that would require the narrowing of sidewalks or the removal of pedestrian space received a lower score for these evaluation criteria.

Similarly, alignment options were examined based on their integration with bike routes. Those that would conflict with the right-of-way of existing or planned bikeways received a lower score. In addition, alignment options that would result in unsafe bicycle/streetcar crossings (60-degree or less crossing angles) received a lower score for bicyclist-related evaluation criteria.

*Provide economic opportunity and investment and enhance the community character*

Three objectives are related to the goal of providing economic opportunity and investment and enhancing the community character:

- Serve proposed/projected development;
- Maintain parking supply; and
- Support neighborhood resident and local business community sentiments.

To evaluate whether an alignment option would serve proposed/projected development, locations of future developments were identified within 1/3-mile of the alignment options using GIS. Alignment options with a larger number of future developments received a higher rating than alignment options adjacent to a lesser number.

Since none of the potential alignment options would be anticipated to create an increase in parking supply, this criterion was evaluated with respect to requirements to remove on-street parking supply. Alignment options received a lower score if on-street parking removal was necessary to accommodate for the streetcar track right-of-way. The removal of on-street parking would be required at most of the potential streetcar stops. However, this would occur regardless of the alignment option selected; and therefore, was not a factor in determining the evaluation criterion score.

The support of neighborhood residents and local businesses is an important factor in developing a future streetcar route. As discussed in the Case Study Report, streetcar support in Portland, Seattle, and Philadelphia influenced the planning (and success) of each city's streetcar system. Based on initial

[1] For a conservative evaluation, this analysis assumed streetcars have no inherent travel time advantage over buses. While streetcars have a higher capacity for passenger loading and quicker acceleration, average speeds of streetcars operating in mixed traffic when traveling in dense urban settings are similar to conventional buses in a similar environment.

discussion with members of the community, the concept of a streetcar in Red Hook generally received favorable reaction. However, a public meeting is planned for the Brooklyn Streetcar Feasibility Study in May, when the alignment options will be presented to the public for their comment and input. A ranking for this criterion will be added following the public meeting, based on public input regarding the potential alignment options. To date there is no sense of consensus from the community indicating that it would welcome a future streetcar. Parts of the community have come forward and stated they would like to keep Red Hook as it is, while others have stated they would like to see additional development within the neighborhood.

*Maintain traffic and delivery access*

Two objectives are related to the goal of maintaining traffic and delivery access:

- Maintain curb access for unloading and loading; and
- Maintain access to Red Hook's arterial roadways and Brooklyn highways.

All proposed alignment alternatives use the existing street network as their primary route locations (with some minor exceptions). Generally, these routes are located in the rightmost travel lane of the roadway. For most of the alignment options, curbside parking is maintained except in station/stop areas, where the sidewalk 'bumps out' to align with the streetcar track for boarding, and in areas where turns preclude the possibility of parking due to the turning radius of the streetcar. For most alignment options, this curb access impact is relatively consistent.

However, there are some locations along the alignment options where the existing street width is not sufficient to maintain parking adjacent to the streetcar alignment. As a result, parking/loading areas would be restricted in these areas. The rating of the various alignment options under this criterion are based on the amount of curbside parking/loading lost due to the location of the streetcar route.

In determining the initial alignment options, impacts to major intersections, arterial streets, and highway ramps were generally avoided. Streetcar design allows the mixing of the streetcar operation with the urban automobile traffic; and therefore, street and highway access was not generally impacted by the potential routes. (For additional discussion, please see the section on traffic planning on page 3-13.)

A comparative assessment of the alternative routing on access to Red Hook's arterial roadways and Brooklyn highways was made by focusing on the potential impact on truck access to local and through truck routes. The truck routes in the Study Area were reviewed to identify any streetcar/truck route interference, including restrictions on turns, roadway geometrics, parking, loading, driveway access, and double-parking. The alignment options that would create greater interference with existing truck routes received a lower score than the alignment options that would minimize impacts on existing truck traffic patterns.

*Minimize adverse impacts on the built and natural environment*

Four objectives are related to the goal of minimizing adverse impacts on the built and natural environment:

- Minimize property acquisition;
- Minimize adverse impacts to historical resources;

- Minimize impacts to natural features/resources and coastal waters; and
- Minimize traffic impacts.

As a streetcar would operate in the existing street right-of-way, property acquisition would not be necessary for a majority of the streetcar track. However, at some corners, the turning radius would likely infringe on existing sidewalks, even if the minimal radius of 50 feet is utilized. Impacts on the intersection corners could include some right-of-way takings to maintain sidewalk widths. In addition, although the alignment options presented in this study avoid the actual removal of any structures, some reconfiguration of access to buildings could be required to support the revised corner geometry in a few isolated cases. It is noted that at this level of mapping precision, there is some uncertainty in the exact nature and amount of property required. However, most potential impacts have been identified. For rating purposes, the alignment options that could require property acquisition received a lower score.

Two historic districts – Cobble Hill and Brooklyn Heights – were identified in the Study Area. Alignment options within these historic districts present potential impacts, particularly visually, due to the overhead wires used for power distribution. All Northern Section alignment options travel through these districts; and thus, received a lower score for this criterion.

In addition, historic landmarks were mapped in the Study Area. The locations of historic landmarks were compared to the potential alignment options, and it was determined that none of the potential alignment options would require the acquisition of historic property. However, potential visual impacts could occur, due to the overhead wires used for power distribution. These alignment options received a lower score for this criterion.

To evaluate the adverse impacts to natural features/resources and coastal waters, the locations of parkland and coastal waters within the Focus and Study Areas were mapped. Alignment options that traverse parkland received a lower score. Similarly, alignment options adjacent to coastal waters received a lower score.

Traffic data and existing analyses from the *Downtown Brooklyn Surface Transit Circulation Study* were used to identify intersections operating at unacceptable levels of congestion. As provided in the *Highway Capacity Manual*, intersection and street operations are defined in terms of average delay experienced during peak traffic operations. The delay is expressed in terms of level of service (LOS) and is given a rating from LOS A, where delays are minimal, to LOS F, relating to an over capacity, or a jammed condition.

Generally, track alignments were identified that would minimize traffic flow disruption, and allow the streetcar to operate within established traffic lanes, controlled by existing traffic signal phases. However, in some instances, especially where streetcars were required to turn left from the right lane, the signal phasing would have to be modified to accommodate the safe movement of the streetcar, using exclusive, or 'queue jump' phasing. This would necessarily result in a reduction in capacity for the through vehicular movements. These alignment options received a lower score in these instances.

There are also some locations where the existing street operations are so poor that they would create delays to the streetcars. At locations such as these, the severity of the anticipated poor traffic flow produced a lower score than alignment options that would operate in an unobstructed manner.

*Minimize streetcar capital and operating costs and impact*

Three objectives comprise the goal of minimizing streetcar capital and operating costs and impact:

- Implement within a reasonable construction timeframe and cost;
- Avoid conflicts with existing and proposed infrastructure; and
- Avoid or minimize utility relocation.

To determine whether an alignment option could be implemented within a reasonable construction timeframe and cost, a preliminary assessment was made regarding the difficulty of construction, likely capital cost, rights-of-way and property issues, complexity of the route, and physical constraints. At this point in the study, many of these issues were addressed on a qualitative basis only. For example, it has been noted that an alignment option along a cobblestone pavement would be more costly and take more time than a typical asphalt pavement. (Capital costs are discussed in more detail later in section 6.1.) Alignment options that would have a longer construction timeframe or higher cost received a lower score for these criteria.

To evaluate whether the alignment options avoid conflicts with existing and proposed infrastructure, utility infrastructure was located and potential conflicts identified. The alignment options that avoid these potential infrastructure conflicts received a higher score than those alignment options that conflicted with existing infrastructure.

Utility locations are only known on a preliminary basis at this point. Although track alignment can be influenced by the location of certain utilities, it is generally necessary to set the alignment based on other factors, such as traffic movements and parking and loading requirements. As a result, certain alignment options could result in a large number of utility relocations, and would be more costly to implement. Furthermore, utility maintenance can impact streetcar operations after construction is complete. For this assessment, alignments that were in conflict with known underground utilities facilities received a lower score to reflect the likely difficulties of construction and maintenance. (Utilities are discussed in greater detail in section 3.3.)

**Table 2-1:**
**Brooklyn Streetcar Evaluation Criteria**

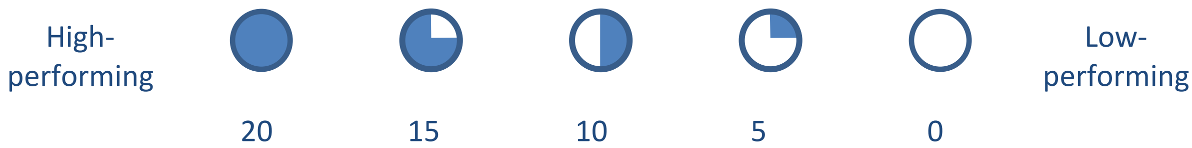
| GOAL/OBJECTIVE | EVALUATION CRITERIA |
|---|---|
| **IMPROVE TRANSPORTATION MOBILITY** | |
| *Provide transit accessibility* | – POPULATION WITHIN 1/3–MILE OF ALIGNMENT<br>– EMPLOYMENT WITHIN 1/3–MILE OF ALIGNMENT<br>– ACTIVITY CENTERS WITHIN 1/3-MILE OF ALIGNMENT |
| *Improve travel time* | – TRIP TIME SAVINGS TO AND FROM VARIOUS TRIP-GENERATORS |
| *Provide intermodal connectivity* | – PROVIDES BUS CONNECTIONS<br>– PROVIDES SUBWAY CONNECTIONS |

**Table 2-1:**
**Brooklyn Streetcar Evaluation Criteria**

| GOAL/OBJECTIVE | EVALUATION CRITERIA |
|---|---|
| *Enhance pedestrian movements* | – MINIMIZES INTERFERENCE WITH PEDESTRIAN MOVEMENTS<br>– IMPROVE PEDESTRIAN SPACE |
| *Accommodate bikeways* | – MINIMIZES INTERFERENCE WITH EXISTING/PLANNED BIKEWAYS AND GREENWAYS<br>– MINIMIZES IMPACTS TO BICYCLIST SAFETY |
| **PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER** | |
| *Serve proposed/projected development* | – FUTURE DEVELOPMENT WITHIN 1/3–MILE OF ALIGNMENT |
| *Maintain parking supply* | – MINIMIZES CHANGES TO PARKING SUPPLY |
| *Support neighborhood resident and local business community sentiments* | – AMOUNT OF STREETCAR SUPPORT/OPPOSITION |
| **MAINTAIN TRAFFIC AND DELIVERY ACCESS** | |
| *Maintain curb access* | – MINIMIZES CHANGE IN CURB ACCESS (LINEAR FEET) |
| *Maintain access to Red Hook's arterial roadways and Brooklyn highways* | – MINIMIZES VEHICLE RESTRICTIONS TO ACCESS RED HOOK'S ARTERIAL ROADWAYS AND BROOKLYN HIGHWAYS<br>– MAINTAIN TRUCK ACCESS TO LOCAL AND THROUGH TRUCK ROUTES |
| **MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT** | |
| *Minimize property acquisition* | – MINIMIZES PROPERTY ACQUISITION |
| *Minimize adverse impacts to historical resources* | – MINIMIZES VISUAL IMPACTS TO HISTORIC RESOURCES<br>– MINIMIZES HISTORIC PROPERTY ACQUISITION |
| *Minimize impacts to natural features/resources and coastal waters* | – MINIMIZES INTERFERENCE WITH PARKLAND OR COASTAL WATERS |
| *Minimize traffic impacts* | – MINIMIZES NEGATIVE IMPACT ON TRAFFIC FLOW |
| **MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT** | |
| *Implement within a reasonable construction timeframe and cost* | – SHORTER CONSTRUCTION DURATION<br>– LOWER CONSTRUCTION COST |
| *Avoid conflicts with existing and proposed infrastructure* | – MINIMIZES INFRASTRUCTURE CONFLICTS |
| *Avoid or minimize utility relocation* | – MINIMIZES UTILITY CONFLICTS<br>– MAINTAIN ACCESS TO UTILITIES |

## RATING SCALE

The relative rating for each evaluation criterion was developed to differentiate between the performances of each alignment option. The rating scale ranges from high-performing to low-performing scores. Point values were assigned for the respective ratings of each evaluation criterion shown in Table 2-1. Below is the rating scale and point system that was designated for the respective evaluation criteria.

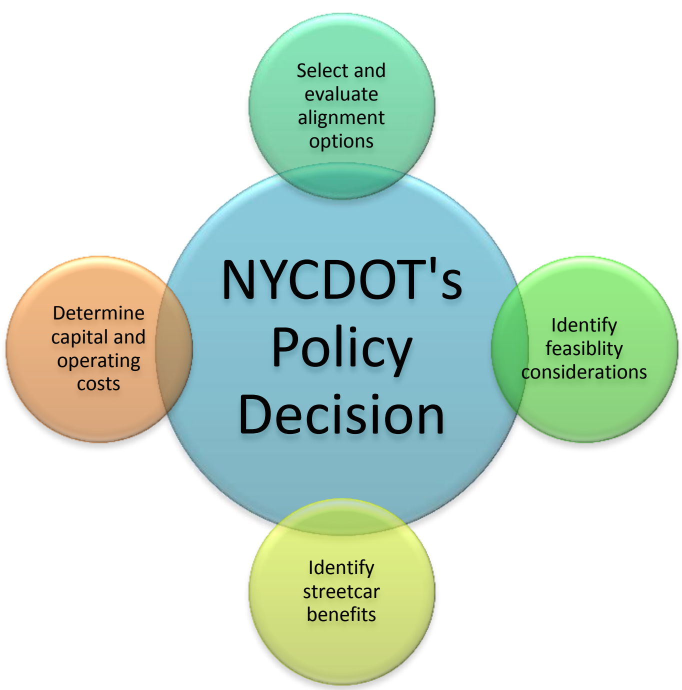



The points for all the evaluation criteria were summed to come up with a final point total for each alignment option. The alignment options were then ranked to determine the alignment(s) that best meet(s) the defined goals and objectives.

## POLICY DECISION

The process for developing a policy decision for a go/no go decision for a future streetcar in Brooklyn includes the selecting and evaluating the alignment options (as described above), identifying feasibility considerations (as described in section 3.0), and determining capital and operating costs (as described in section 6.0). This multi-step process is graphically shown in Figure 2-2. The NYCDOT's policy decision also incorporates streetcar benefits, which are discussed in the Case Study Report.

**Figure 2-2: Policy Decision Process**



# 3.0 FEASIBILITY CONSIDERATIONS

This section describes general streetcar feasibility considerations typical of a streetcar operating in an urban environment, which were considered for the proposed Brooklyn Streetcar. These general considerations include alignment considerations (right-of-way, horizontal curvature, major infrastructure obstacles, station platforms, and vertical clearance), traffic planning (traffic operations and signals, parking and loading, and bicycle integration), and constructability (construction methodology, construction impacts, pavement type, and utilities). In addition to a description of each of these considerations, the related evaluation criteria are identified in relation to the applicability to streetcar feasibility. Specific areas of concern within the Study Area and an assessment of the potential future streetcar alignment options are included in section 4.0.

## *3.1 Alignment Considerations*

### RIGHT-OF-WAY

The minimum desired lane width for a streetcar track is 11 feet, which accommodates a typical nine-foot wide streetcar and a reasonable separation from adjacent travel lanes, parking, or other streetcar lanes. Adjacent parking lanes should be a minimum of eight feet in width. However, experience in areas where snow can be present, indicates that wider parking lanes (up to 11 feet wide) are preferable to accommodate snow piles. Adjacent travel lanes should not be less than 11 feet in width to avoid 'crowding' of ambient traffic next to the moving streetcar.

Based on these guidelines, the minimum typical cross section to accommodate two-way vehicular, streetcar traffic, and parking on each side is 38 feet. (To accommodate 11-foot parking lanes, 44 feet would be desirable.) Many of the streets along the potential alignment options are less than forty feet in width, curb to curb, and serve multiple users. Streets less than 38 feet in width would require the removal of parking from one side, unless the sidewalk areas could be reconfigured to allow the road to be widened to 38 feet.

This feasibility consideration impacts various evaluation criteria, including 'Minimizes interference with pedestrian movements', 'Minimizes changes to parking supply', 'Maintains truck access to local and through truck routes', and 'Minimizes property acquisition'. As such, alignment options with roadway widths of 44 feet or more received a high performing score (20) for these evaluation criteria. Similarly, alignment options with a cross section less than 44 feet, but greater than 38 feet received a mid-performing score (15 or 10), and alignment options with 38-foot roadway widths received a lower performing score (5). Finally, alignment options with a cross section less than 38 feet received a low performing score (0).

### HORIZONTAL CURVATURE

The industry standard[2] for the minimum desired horizontal radius for streetcar tracks is 82 feet. However, depending on the vehicle type being utilized, the radius can be reduced to as little as 50 feet

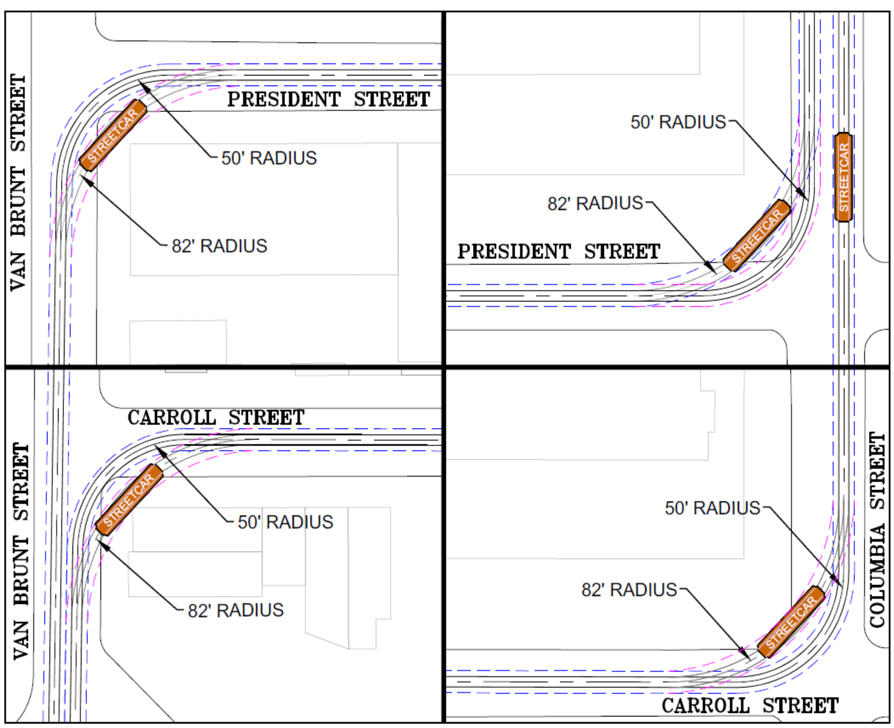
[2] TCRP Report 57 – Track Design Handbook for Light Rail Transit

to accommodate specific field conditions. In addition, horizontal curvature is related to the required operating speeds. At the low operating speeds typically found in mixed traffic service, the radius of the curve is a function of the ability of the vehicle's truck to pivot without encountering physical obstruction in the drive mechanism or car body. On tangent sections (straight track), a curve radius of 600 feet is required to achieve operation speeds of 25 miles per hour.

Based on preliminary investigation in the Study Area, and as reported in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, the minimum desired horizontal radius of 82 feet would be difficult to achieve in many locations, as the track would infringe on existing sidewalks. For these locations, a turning radius of 50 feet may be necessary to avoid comprehensive intersection reconstruction.

This feasibility consideration impacts various evaluation criteria, including 'Minimizes interference with pedestrian movements', 'Minimizes changes to parking supply', and 'Minimizes property acquisition'. For example, as reported in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum the potential alignment options traveling between Columbia Street and Van Brunt Street (President Street and Carroll Street) would require the streetcar make difficult turns, due to the narrowness of the streets and the small existing corner radii, as shown in Figure 3-1. In order to make this turn, one or two corner on-street parking spaces would need to be removed, and minor curb adjustments would likely be required. As such, this alignment option received a low performing score (0) for the associated evaluation criteria.

**Figure 3-1: Horizontal Curvature Considerations on President and Carroll Streets**




URS Corporation

## MAJOR INFRASTRUCTURE OBSTACLES

As reported in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, the location of Interstate 278 (I-278) and the Brooklyn Battery Tunnel are important in terms of the constructability of a streetcar line crossing these facilities. Specifically, the Hicks Street conceptual alignment was eliminated due to its proximity to I-278. Based on this preliminary investigation, Columbia Street, which crosses I-278 east of the Brooklyn Battery Tunnel portal, would provide the most feasible option. This feasibility consideration is in accordance with the 'Minimizes infrastructure conflicts' evaluation criteria. Alignment options that would result in minimal infrastructure conflicts received a high performing score (20), and alignment options that would result in greater infrastructure conflicts received a low performing score (0) or (5), depending on the magnitude of the conflict.

## STATION PLATFORMS

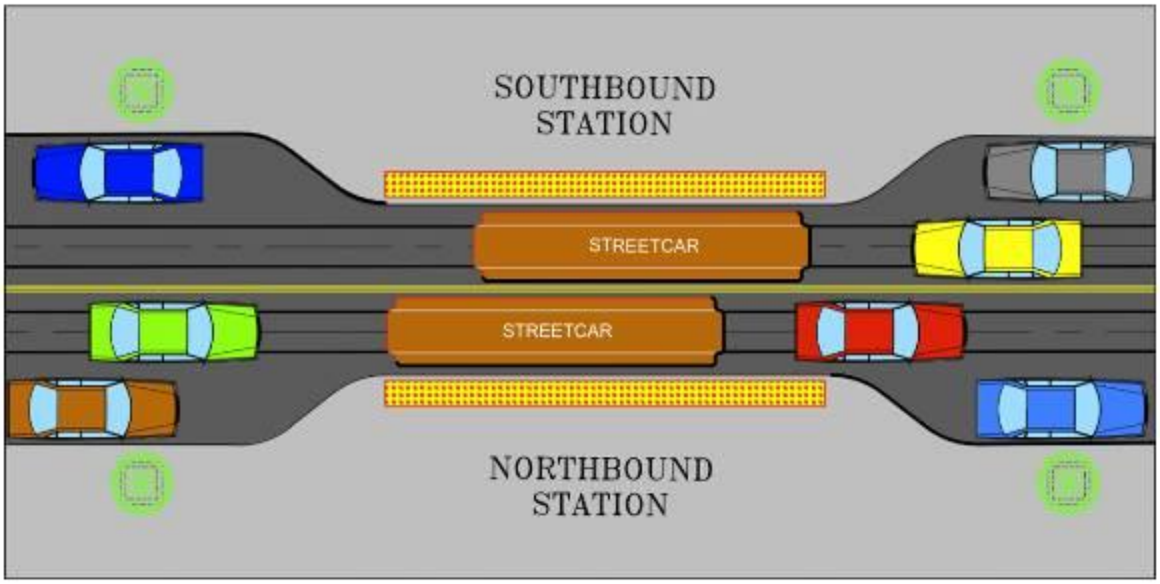
Assuming a typical modern streetcar vehicle, the length of the station platform should be between forty and sixty feet in order to provide platform access to all vehicle doors. The platform is treated as an extension of the curb and sidewalk at intersections with stops, and at a minimum, the width should be eight to 12 feet to allow for good pedestrian circulation and handicap circulation. In addition, the track alignment at the station platform should be tangent with less than a two percent grade.

The typical curb height at stations is between ten and 14 inches, and is dependent to some extent on the vehicle. If the vehicle is not capable of self-leveling, a bridge plate is necessary. The horizontal clearance, between the centerline of the track and the platform edge, should be approximately four feet, and is also dependent on vehicle type. Americans with Disabilities Act (ADA) access and grade requirements must be complied with for all new construction.

Because of the grade differential between the existing standard sidewalk and the desired level platform boarding, sidewalk reconstruction and grading work would be required at each stop. The design concept being examined includes the utilization of a bulb out from the existing sidewalk and curb line into the existing on-street parking lane to allow for platform boarding, as shown in Figure 3-2. This would typically eliminate three or four on-street parking spaces at each stop, in each direction.

Due to the elimination of on-street parking at each stop, this feasibility consideration will impact the following evaluation criteria: 'Minimizes changes to parking supply' and 'Change in curb access'. The removal of on-street parking would be required at most of the potential streetcar stops. However, this would occur regardless of the alignment option selected; and therefore, was not a factor in determining the evaluation criterion score.

**Figure 3-2: Typical Streetcar Stop**




URS Corporation

### VERTICAL CLEARANCE

The minimum vertical clearance from the top of the rail to power supply wire is 13 feet, and the maximum height is 21 feet. Vertical clearance less than 18 feet requires the streetcar to be in an exclusive (no other vehicles) lane, unless a variance from the National Electrical Safety Code (NESC) is obtained. Alignment options with potential vertical clearance conflicts received a low performing score (0 to 5) for the 'Minimizes infrastructure conflicts' evaluation criteria.

## *3.2 Traffic Planning*

### TRAFFIC OPERATIONS / SIGNALS

Streetcar operation is flexible and is typically similar to other vehicles in shared lanes using line of sight. As such, no additional traffic signal control is necessary. However, in a typical urban environment, lane arrangements and geometric constraints can require special traffic signal phasing to accommodate some streetcar movements. For example, this occurs when a streetcar in the rightmost lane on a multi-lane street must turn left, crossing through and/or left turning traffic. This is generally handled with an exclusive signal phase and an exclusive streetcar lane, also known as 'queue jump' phasing.

Many cities introduce transit priority movements through detection of the streetcar and the priority service of the streetcar phase, either through a pre-emption system or through a multi-phase actuated signal system; these could be coordinated with transit signal priority systems being implemented for buses elsewhere in the city. This type of priority phasing could be utilized at any of the signalized intersections throughout the route to facilitate streetcar operations.

This feasibility consideration impacts evaluation criteria related to traffic flow 'Minimizes negative impact on traffic flow' and pedestrian movements 'Minimizes interference with pedestrian movements'. Alignment options that would not require any signal modifications received a high performing score (20) for these evaluation criteria. By contrast, alignment options that would require signal modifications received lower performing scores (5 or 0), depending on the degree of the modification.

### PARKING AND LOADING

As discussed in the Right-of-Way section, parking lanes should be a minimum of eight feet in width. However, experience in areas where snow can be present indicates that wider parking lanes (up to 11 feet wide) are preferable to accommodate snow piles. This feasibility consideration impacts two evaluation criteria: 'Minimizes changes to parking supply' and 'Minimizes changes to curb access'. Alignment options with parking lanes of 11 feet or more received a high performing score (20) for these evaluation criteria. Similarly, alignment options with parking lanes less than 11 feet, but greater than 8 feet received a mid-performing score (15 or 10), and alignment options with an 8-foot parking lane received a lower performing score (5). Finally, alignment options with less than 8 feet available for parking received a low performing score (0). As detailed in the Right-Of-Way section, alignments that are too narrow to accommodate parking on both sides of the street also receive a low performing score (0) for these criteria.

### BICYCLE INTEGRATION

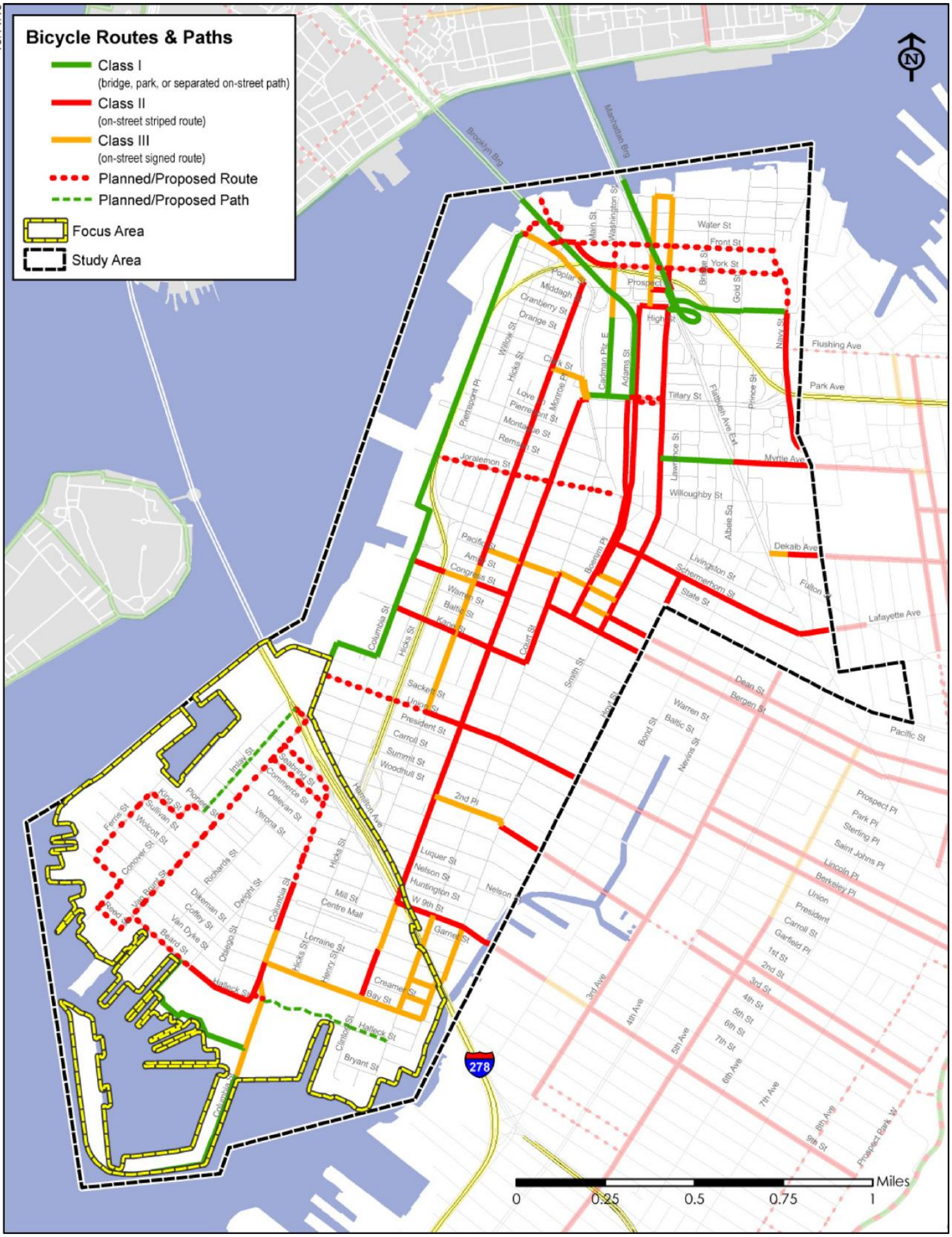
Bicycle integration comprises two components: whether the streetcar interferes with existing or planned bikeways; and whether the streetcar impacts the cyclist's safety. Figure 3-3 shows the designated bike routes and lanes within the Focus Area and Study Area. As reported in the Existing Conditions Report, bicycle routes crisscross the Study Area. In the Focus Area, Class II bike routes or Class III bike paths are provided along Bay Street, Creamer Street, Lorraine Street, and West 9$^{th}$ Street. Alignment options that conflict with the existing or planned bicycle routes and paths received a low performing score (0 or 5) for 'Minimizes interference with existing/planned bikeways/Greenways'.

Streetcar systems can experience safety issues with bicycle integration, as reported in the Case Study Report. Bicycle wheels and tires are susceptible to getting caught within the gap of the streetcar track flange. Specifically, this situation occurs when a bicyclist is required to cross the tracks at less than a 60-degree angle. When a track 'catches' a wheel, a bicyclist may be thrown from their bicycle. To decrease the number of accidents, streetcar infrastructure should be designed to eliminate crossings with less than 60-degree crossing angles and be designed with as close to 90-degree crossings as possible.

In addition, right-side running tracks and streetcar track curves may create instances where a bicyclist riding in the right lane chooses to cross the tracks at an angle less than 60 degrees. This configuration can lead to accidents. Center-running and left-running tracks are typically safer scenarios for bicyclists, as they avoid many of the conflicts between side running streetcars and parallel bike tracks. Signs and pavement markings can be used to assist cyclists in maneuvering around track curves at safe angles. Alignment options with 60-degree or less crossing angles received a low performing score (0 or 5) for 'Minimizes impacts to bicyclist safety'.

## Figure 3-3: Bicycle Routes and Paths

10.14.10



## 3.3 Constructability

The constructability of a future streetcar is related to two evaluation criteria 'Shorter construction duration' and 'Lower construction costs'. Alignment options with identified infrastructure or utility conflicts or longer alignment options would incur longer construction durations and consequently, greater costs. As such, these alignment options received a low performing score (0 or 5, depending on the construction impact).

### PROPOSED METHODOLOGY

As described in the Case Study Report, both Portland and Seattle instituted a shallow track, single pour construction system that minimized excavation and expedited construction. Shallow slab construction would be preferable to operate a streetcar in the existing streets in Brooklyn, compared to light rail full-depth construction. As such, the alignment options developed for this phase of the feasibility study considered minimal roadway reconstruction related to utility relocation.

Following preliminary and final design of the streetcar alignment and stations, the typical construction sequence for shallow slab streetcar track construction is as follows:

1. Construction would begin with the relocation or adjustments to any private and public utility lines, manholes or structures. (Utilities are discussed in greater detail on page 3-18.)
2. The roadway pavement would be excavated to a depth of roughly 18 inches and the subgrade would be fine graded for the track slab.
3. Track drains would be installed and tied into the existing storm system.
4. Rails that have been welded at an off-site staging area would be pulled into place and set to grade, and reinforcing steel would be placed and tied.
5. The track slab concrete would be poured, finished, and cured.
6. The adjacent asphalt pavement would be milled and overlaid to the proper cross slope to restore the driving surface.
7. Following the track construction, the foundations, poles, hardware, electrical distribution system, communications equipment, overhead contact wiring, and systems for new traffic signals would be installed.
8. The construction of the streetcar station stops, fare collection devices, installation of signage, and application of pavement markings would complete the system.

In all, the major construction activities for track and roadway modifications would require approximately four weeks to complete 600 to 800 feet of track. In general, construction activities would occur during daytime hours (i.e., 7:00 AM to 7:00 PM), and all work would comply with the City of New York's Noise Ordinance, which would likely require major noise-generating work, such as rail grinding and jack-hammering, to occur outside of late-night hours. Any nighttime construction would require and conform to a noise variance to be obtained by the project from the City of New York. All construction work would be performed in full coordination with other city agencies and would comply with all applicable safety requirements.

## ENVIRONMENTAL CONSIDERATIONS

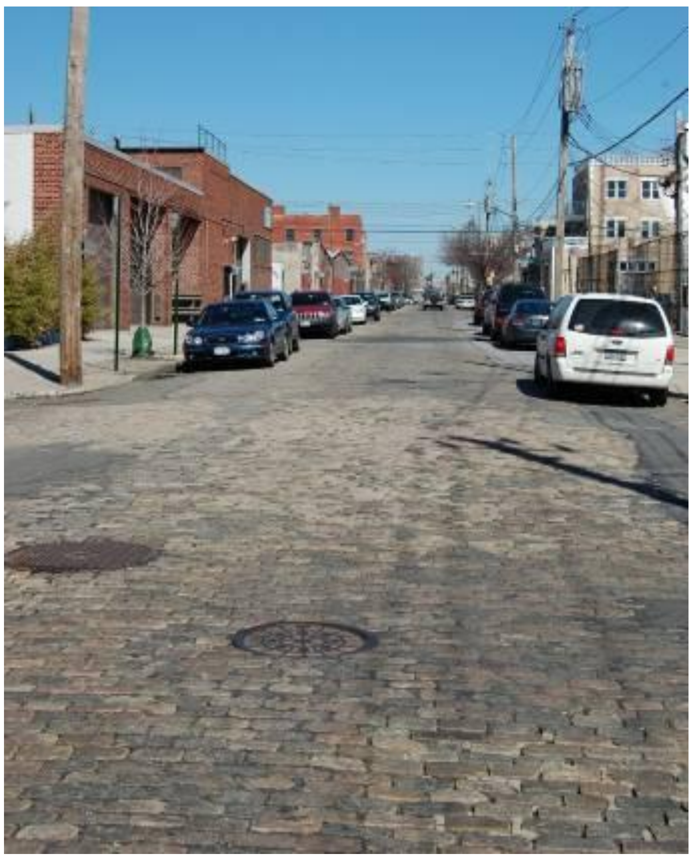
The evaluation criteria focused on construction duration and cost. However, based on the construction methodology described above, there are short-term environmental consequences that could result from construction activities of a future Brooklyn streetcar. Construction impacts would be further analyzed if the project progresses and an Alternatives Analysis and environmental review are prepared. These short-term environmental consequences include the following categories:

- Transit – NYCDOT would coordinate with NYCT to notify riders of detours and closed/temporary bus stops related to construction.
- Traffic – at least one travel lane would be maintained in each direction at all times, and truck routes would not be eliminated during construction, but could be maintained temporarily on alternate routes (truck detour signs would be provided as necessary).
- Land Use and Socio-economic – typical construction best management practices would be employed to avoid or minimize adverse economic consequences to occupants, such as avoiding full access closures, providing temporary alternate access and signage, and timely communications with business owners.
- Neighborhoods and Community – construction would utilize standard industry practices to avoid or minimize increasing noise, the creation of dust, establishing construction zones and signage, altering or reducing access and establishing detours, and temporarily disrupting utilities as they are relocated or reinforced.
- Noise – construction would comply with the New York City Noise Ordinance, which defines hours for construction related noise.
- Air Quality – construction contractors would be required to use reasonable measures to control fugitive dust.
- Visual and Aesthetic Resources – due to their temporary nature and due to the fact that construction is a common visual element in New York City, visual impacts related to a future Brooklyn streetcar would be classified as low to moderate.
- Historic, Archaeological and Cultural Resources – unknown archaeological or cultural resources potentially encountered during construction would be protected from any adverse effect by taking some or all of the following actions, in compliance with Federal and state regulations: notification to and consultations with regulatory agencies and/or tribes; temporary work stoppage at the site; additional surveying and/or documentation; removal and preservation; other actions as appropriate.
- Parklands and Recreation Areas – temporary noise and dust related to streetcar construction is not expected to negatively affect use of nearby parks and recreation areas during the construction period.
- Hazardous Materials – prior to construction of a future Brooklyn streetcar, a Phase I (and potentially Phase II) Environmental Site Assessment (ESA) would be prepared and remedial actions would be identified, if necessary.
- Biological Resources and Endangered Species – no effect to listed aquatic species and their designated critical habitat would be expected because project activities would implement construction containment plans and BMPs.
- Water Resources – construction effects on water quality from a future Brooklyn streetcar would be negligible, as construction would follow New York City's *Erosion and Sediment Control Code*.

## PAVEMENT TYPE

Some Red Hook streets would require more extensive reconstruction due to the existing street material. For example, the alignment option on Beard Street would be considered full roadway reconstruction, since the existing road is cobblestone, as shown in Figure 3-4. This would require extensive reconstruction and grading in order to build the track slab and running rail. This feasibility consideration impacts both evaluation criteria related to construction, as discussed above. Alignment options that would require more extensive reconstruction received lower performing scores (0 or 5) for the ‘Shorter construction duration’ and ‘Lower construction costs’ evaluation criteria.

**Figure 3-4: Typical Cobblestone Street in Red Hook**



URS Corporation

## UTILITIES

Utility clearance requirements should be established with input from the local agencies and utility companies during the early stages of design. For new construction, a utility-free zone within nine to twenty feet from the track centerline to any parallel utility is considered to be ideal. However, in most instances of construction in existing streets, the need to revise infrastructure is related to the functional needs of the individual utility companies and the municipalities involved. As discussed in the Case Study Report, in both Portland and Seattle, utility coordination was critical to successful design and operations. In both cases, utility conflicts significantly increased the cost of the project.

There are several types of utility conflicts that should be resolved during the design stage of a future Brooklyn streetcar. These include:

- Parallel utility conflicts, where utilities may be too shallow to permit them to stay in place, or where the utility may be restricted due to the need to operate under the streetcar line;
- Crossings (such as water), which are typically sleeved, or the pipe is replaced with another, non-conductive material;
- Surface conflicts where access structures, manholes, valves, etc. are in physical conflict with the streetcar tracks; and
- Deep parallel utilities, which would not typically need to be relocated.

Alignment options that would not result in utility conflicts received a high performing score (20), and alignment options that would result in utility conflicts received a low performing score (0 or 5), depending on the degree of conflict.

### CONCLUSION

The feasibility considerations discussed will be factored into the Alignment Options Evaluation. However, in addition to helping identify the best alternative, these considerations will also inform the policy decision of whether any alignment in Red Hook is advisable for the city to pursue at this time, based on financial constraints and competing needs. Facts identified, such as right-of-way constraints, parking impacts, and bicycle impacts, would create challenges regardless of which optimal alignment is chosen. Other considerations, such as utility relocations, would impact expected costs (see section 6.0).

# 4.0 ALIGNMENT OPTIONS EVALUATION

This section presents the results of the evaluation of alignment options. Using the developed evaluation criteria described in section 2.0, and taking into account the streetcar feasibility considerations outlined in section 3.0, the alignment options were assigned scores for each evaluation criteria. Based on these scores, the alignment options were then compared to determine the optimal alignment option.

## *4.1 Focus Area East*

Focus Area East includes two alignment options: Centre Street and Lorraine Street. Both alignment options extend from Columbia Street to Clinton Street. The results of the evaluation criteria ranking for these alignment options are shown in Table 4-1.

Table 4-1:
Focus Area East Evaluation Results

| EVALUATION CRITERIA | CENTRE STREET | LORRAINE STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| IMPROVE TRANSPORTATION MOBILITY | | | |
| *Provide transit accessibility* | | | |
| **Population within 1/3–mile of streetcar alignment** | ◔ | ◔ | |
| **Employment within 1/3–mile of streetcar alignment** | ◑ | ◑ | |
| **Activity centers within 1/3-mile of streetcar alignment** | ◑ | ◑ | |
| *Improve travel time* | | | |
| **Trip time savings to and from various trip-generators** | ◑ | ◑ | |
| *Provide intermodal connections* | | | |
| **Provides bus connections** | ○ | ○ | |
| **Provides subway connections** | ◕ | ◕ | |
| *Enhance pedestrian movements* | | | |
| **Minimizes interference with pedestrian movements** | ◑ | ◑ | |
| **Affect pedestrian space** | ◔ | ◕ | *Centre Street – reduction in pedestrian space (Pedestrian Mall)* |
| *Accommodate bikeways* | | | |
| **Minimizes interference with existing/planned bikeways/Greenways** | ◑ | ◑ | |
| **Minimizes impacts to bicyclist safety** | ◑ | ◑ | |

Table 4-1:
Focus Area East Evaluation Results

| EVALUATION CRITERIA | CENTRE STREET | LORRAINE STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| **PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER** | | | |
| *Serve proposed/projected development* | | | |
| **Proposed developments with 1/3-mile of alignment** | ◕ | ◕ | |
| **Minimizes changes to parking supply** | ◑ | ○ | *Lorraine Street – reduction in parking supply* |
| *Support neighborhood and local business community sentiments* | | | |
| **Amount of streetcar support/opposition** | N/A | N/A | |
| **MAINTAIN TRAFFIC AND DELIVERY ACCESS** | | | |
| **Maintain curb access** | | | |
| **Change in curb access (linear feet)** | ◑ | ◑ | |
| *Maintain access to Red Hook's arterial roadways* | | | |
| **Minimizes vehicle restrictions to access Red Hook's Arterial roadways and Brooklyn highways** | ◑ | ◑ | |
| **Maintain truck access to local and through truck routes** | ◑ | ◑ | |
| **MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT** | | | |
| *Minimize adverse impacts to historical resources* | | | |
| **Minimizes visual impacts to historic resources** | ◑ | ◑ | |
| **Minimizes historic property acquisition** | ◑ | ◑ | |
| *Minimize property acquisition* | | | |
| **Minimizes property acquisition** | ◔ | ◑ | *Centre Street – increased property acquisition due to transitway conversion* |
| *Minimize impacts to natural features/resources and coastal waters* | | | |
| **Minimizes interference with parkland or coastal waters** | ◑ | ◑ | |
| *Minimize negative impact on traffic flow* | | | |
| **Minimizes negative impact on traffic flow** | ◔ | ◔ | |

Table 4-1:
Focus Area East Evaluation Results

| EVALUATION CRITERIA | CENTRE STREET | LORRAINE STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT | | | |
| *Implement within a reasonable construction timeframe and cost* | | | |
| **Shorter construction** duration | ◕ | ◑ | *Centre Street – greater flexibility during construction due to reduced vehicular conflicts* |
| **Lower construction cost** | ◕ | ◑ | *Centre Street – greater flexibility during construction due to reduced vehicular conflicts* |
| *Avoid conflicts with existing or proposed infrastructure* | | | |
| **Minimizes infrastructure conflicts** | ◕ | ◑ | *Centre Street – less infrastructure conflicts and horizontal curvature issues* |
| *Avoid or minimize utility relocation* | | | |
| **Minimizes utility conflicts** | ◕ | ◑ | *Centre Street – greater flexibility to avoid utility conflicts* |
| **Maintain access to utilities** | ◕ | ◑ | *Centre Street – greater flexibility to avoid utility conflicts* |
| TOTAL SCORE | 255 | 235 | |

Scoring Key:

| ● | ◕ | ◑ | ◔ | ○ |
|---|---|---|---|---|
| 20 | 15 | 10 | 5 | 0 |

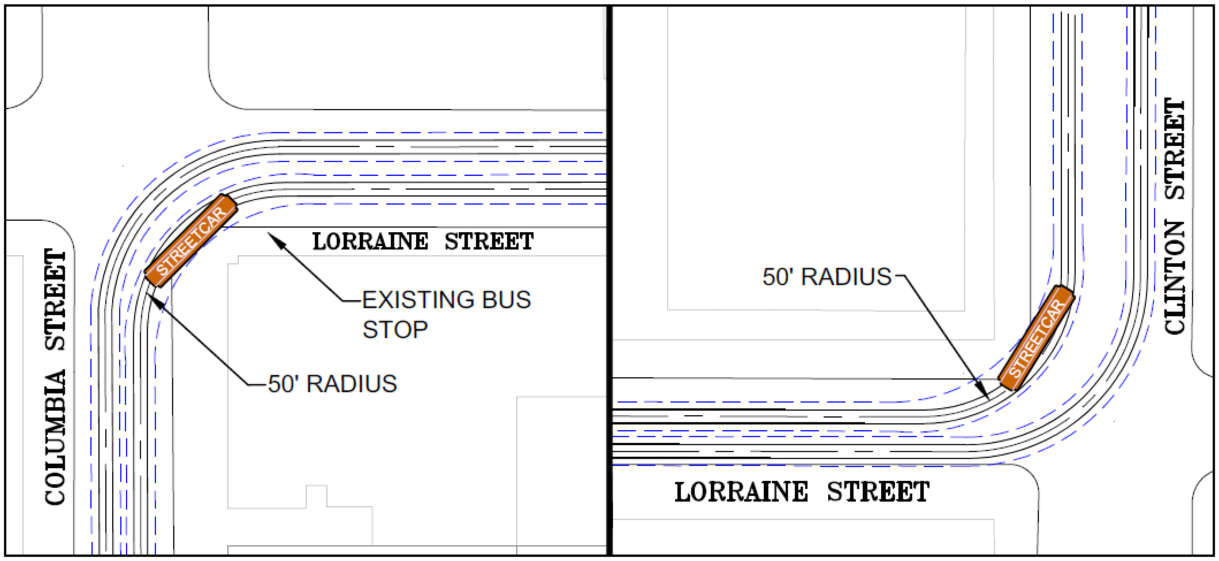
Both Focus Area East alignment options have horizontal curvature considerations. These considerations are listed below and shown in Figure 4-2:

- Court Street at West 9th Street – curb conflict at the northeast corner;
- Garnet Street at Smith Street – curb conflict and potential building conflict at the southwest corner;
- Clinton Street at Mill Street – curb conflict and potential building conflict at the southwest corner; and
- West 9th Street at Gowanus Expressway – potential conflict with viaduct columns.[3]

For example, a 50-foot radius would be necessary for the turns to and from Lorraine Street to avoid property acquisition, as shown in Figure 4-1.

[3] This potential conflict is based on GIS data and approximate location of viaduct columns. This conflict would be resolved during the design phase.

**Figure 4-1: Horizontal Curvature Considerations on Lorraine Streets**



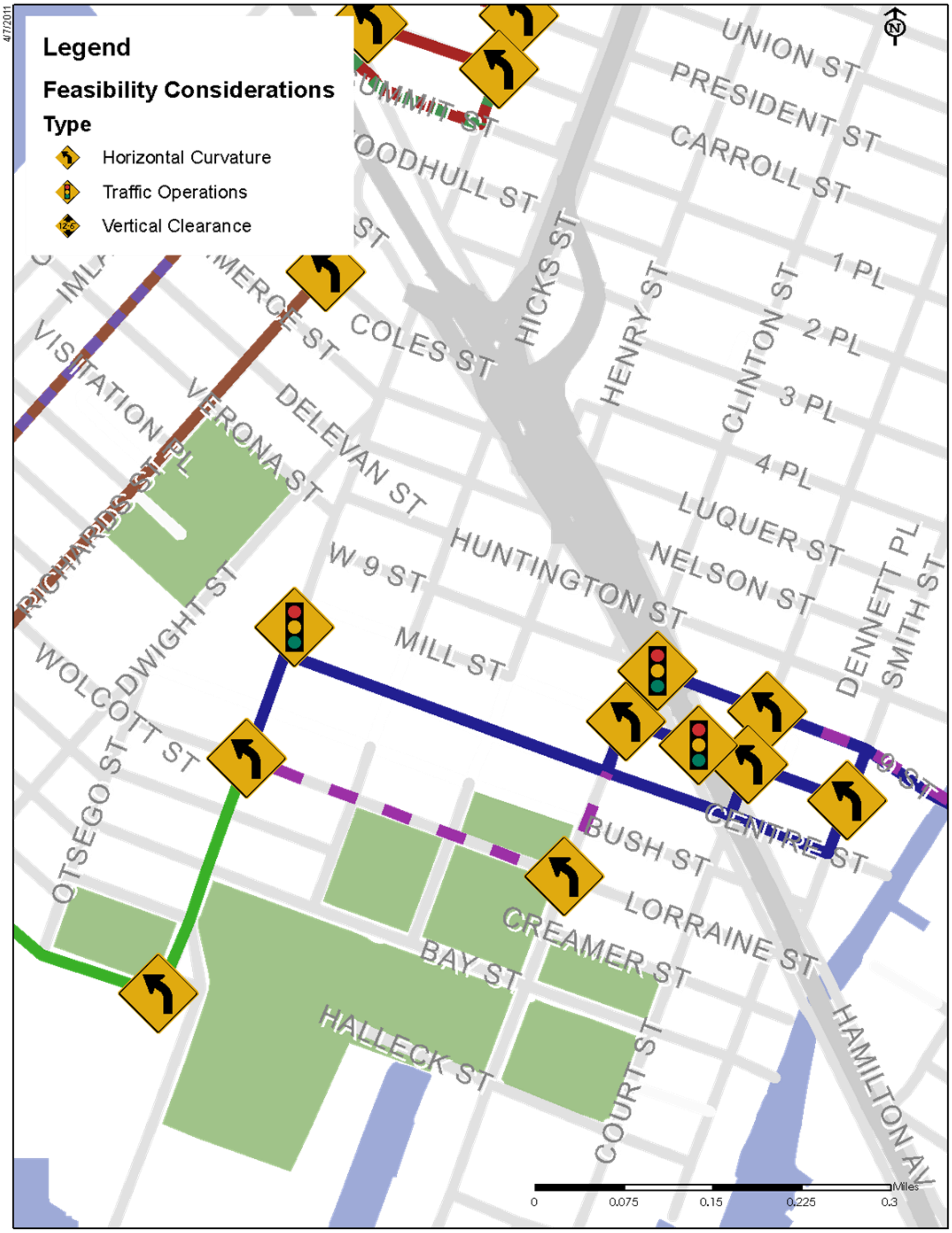

URS Corporation

In addition to horizontal curvature, traffic operation considerations for both alignment options are listed below and shown in Figure 4-2.

- An additional signal phase would likely be necessary at the Smith Street and West 9th Street intersection in order to handle the streetcar traffic exiting the new terminal at this location.
- Crossing under the Gowanus Expressway would require signal modification where the potential alignment crosses Hamilton Avenue. This is due to the alignment of the streetcar through the columns that support the Gowanus Expressway above Hamilton Avenue. Currently no signal exists at Mill Street/Garnet Street and Hamilton Avenue, as there is no vehicular crossing. In addition, signal timing modifications could be necessary at West 9th and Hamilton Avenue.

Both Focus Area East alignment options would potentially conflict with the Class II bike route on West 9th Street, particularly at the streetcar station stop locations. To integrate these two modes, the bike route could be relocated around the stop, taking some of the sidewalk space. This solution has been successfully implemented in Portland and shown in Figure 4-3.

**Figure 4-2: Focus Area East Feasibility Considerations**




NYCDOT - BROOKLYN STREETCAR FEASIBILITY STUDY

Feasibility Considerations

**Figure 4-3: Portland Bike Integration**

URS Corporation

Another potential bicycle conflict would occur when the dedicated lane converts to sharrows (or shared-lane markings, as shown in Figure 4-4 ) along the south section of Columbia Street, between Halleck Street and Creamer Street. In order to integrate a future streetcar with the existing bicycle use along this alignment, the on-street parking lane could be removed from Bay Street to Lorraine Street and a buffered curbside bike lane would run adjacent to the streetcar track, as shown in Figure 4-5.

**Figure 4-4: Typical Shared-lane Marking (Sharrow) along Bay Street**

URS Corporation

**Figure 4-5: Bicycle Integration along Columbia Street**


URS Corporation

In addition to the feasibility considerations described above, the Centre Street and Lorraine Street alignment options have feasibility considerations that are unique to the individual alignment option. These are described below. Similarly, the Centre Street alignment option has certain advantages, which further affect the evaluation criteria rating.

### CENTRE STREET

For this alignment option, a signal warrant analysis would need to be conducted at the intersections with Clinton Street and Columbia Street. In addition, pedestrian space would be affected, as Centre Street is currently a pedestrian-only mall. With the addition of a streetcar, some pedestrian space would be replaced by streetcar track. However, adjacent pedestrian space would remain on both sides of the streetcar alignment. The existing pedestrian mall along Centre Street would have to be reclaimed from the New York City Housing Authority, further reducing the score for this alternative, due to property acquisition issues. However, as an advantage, construction along Centre Street would result in shorter duration and lower costs, as there is no existing vehicular traffic using the area. Initial study outreach to the Red Hook East and West Tenants' Associations has resulted in local concerns about the impacts of a streetcar in the Centre Mall. If this option were to be pursued, further discussions with the residential stakeholders would take place.

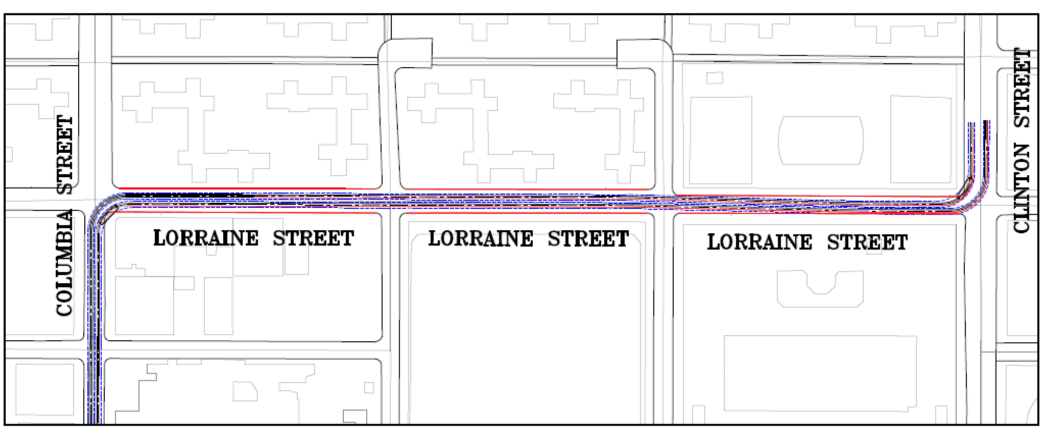
### LORRAINE STREET

In addition to the horizontal curvature considerations described above, the Lorraine Street alignment has potential conflicts at the following locations:

- Columbia Street at Lorraine Street – curb conflict and potential building conflict at the southeast corner; and
- Lorraine Street at Clinton Street – curb conflict and potential building conflict at the northwest corner.

Moreover, the right-of-way along Lorraine Street is narrow (thirty feet), which would require either the removal of on-street parking or the reduction of sidewalk space, as shown in Figure 4-6. This in turn, could potentially reduce access to the curb, impacting delivery loading and unloading.

**Figure 4-6: On-Street Parking Removal on Lorraine Street**




URS Corporation

Based on the evaluation of the Focus Area East alignment options, the Centre Street option resulted in a total score of 255 and the Lorraine Street option resulted in a total score of 235. Although the Centre Street option would affect pedestrian space and result in property acquisition, the Lorraine Street option would result in a reduction in the parking supply, longer construction duration, increased construction-related costs, and reduced flexibility to avoid utility conflicts. This results in a higher ranking for the Centre Street alignment option.

## 4.2 *Focus Area West*

Focus Area West includes two alignment options extending from Beard Street to Columbia Street: a two-way track on Van Brunt Street and a one-way track traveling southbound on Van Brunt Street with a one-way track traveling northbound on Richards Street. The results of the evaluation criteria ranking for these alignment options are shown in Table 4-2.

Table 4-2:
Focus Area West Evaluation Results

| EVALUATION CRITERIA | VAN BRUNT STREET | VAN BRUNT STREET / RICHARDS STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| IMPROVE TRANSPORTATION MOBILITY | | | |
| *Provide transit accessibility* | | | |
| **Population within 1/3–mile of streetcar alignment** | ◔ | ◔ | |
| **Employment within 1/3–mile of streetcar alignment** | ◔ | ◔ | |
| **Activity centers within 1/3-mile of streetcar alignment** | ○ | ○ | |
| *Improve travel time* | | | |
| **Trip time savings to and from various trip-generators** | ◑ | ◑ | |
| *Provide intermodal connections* | | | |
| **Provides bus connections** | ○ | ○ | |
| **Provides subway connections** | ○ | ○ | |
| *Enhance pedestrian movements* | | | |
| **Minimizes interference with pedestrian movements** | ◑ | ◑ | |
| **Affect pedestrian space** | ◔ | ◔ | |
| *Accommodate bikeways* | | | |
| **Minimizes interference with existing/planned bikeways/Greenways** | ◑ | ◑ | |
| **Minimizes impacts to bicyclist safety** | ◑ | ◑ | |

Table 4-2:
Focus Area West Evaluation Results

| EVALUATION CRITERIA | VAN BRUNT STREET | VAN BRUNT STREET / RICHARDS STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER | | | |
| *Serve proposed/projected development* | | | |
| **Proposed developments with 1/3-mile of alignment** | ◑ | ◑ | |
| **Minimizes changes to parking supply** | ◔ | ◑ | *Van Brunt Street – reduction in parking supply* |
| *Support neighborhood and local business community sentiments* | | | |
| **Amount of streetcar support/opposition** | N/A | N/A | |
| MAINTAIN TRAFFIC AND DELIVERY ACCESS | | | |
| **Maintain curb access** | | | |
| **Change in curb access (linear feet)** | ◑ | ◔ | *Richards Street – increased curb conflict* |
| *Maintain access to Red Hook's arterial roadways* | | | |
| **Minimizes vehicle restrictions to access Red Hook's Arterial roadways and Brooklyn highways** | ◑ | ◑ | |
| **Maintain truck access to local and through truck routes** | ◑ | ◑ | |
| MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT | | | |
| *Minimize adverse impacts to historical resources* | | | |
| **Minimizes visual impacts to historic resources** | ◑ | ◑ | |
| **Minimizes historic property acquisition** | ◑ | ◑ | |
| *Minimize property acquisition* | | | |
| **Minimizes property acquisition** | ◑ | ◑ | |
| *Minimize impacts to natural features/resources and coastal waters* | | | |
| **Minimizes interference with parkland or coastal waters** | ◑ | ◑ | |
| *Minimize negative impact on traffic flow* | | | |
| **Minimizes negative impact on traffic flow** | ◑ | ◔ | *Richards Street – traffic direction would be reversed* |

Table 4-2:
Focus Area West Evaluation Results

| EVALUATION CRITERIA | VAN BRUNT STREET | VAN BRUNT STREET / RICHARDS STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| **MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT** | | | |
| *Implement within a reasonable construction timeframe and cost* | | | |
| **Shorter construction** duration | ◕ | ◑ | *Van Brunt Street / Richards Street – construction along two streets* |
| **Lower construction cost** | ◕ | ◑ | *Van Brunt Street / Richards Street – construction along two streets* |
| *Avoid conflicts with existing or proposed infrastructure* | | | |
| **Minimizes infrastructure conflicts** | ◑ | ◑ | |
| *Avoid or minimize utility relocation* | | | |
| **Minimizes utility conflicts** | ◔ | ◑ | *Van Brunt Street / Richards Street – greater flexibility with track placement of one-way tracks* |
| **Maintain access to utilities** | ◔ | ◑ | *Van Brunt Street / Richards Street – greater flexibility with track placement of one-way tracks* |
| TOTAL SCORE | 200 | 195 | |

Scoring Key:

| ● | ◕ | ◑ | ◔ | ○ |
|---|---|---|---|---|
| 20 | 15 | 10 | 5 | 0 |

Both alignment options along this corridor would be impacted by the proposed bike lanes in the New York City Bicycle Master Plan. A Class II bike lane is proposed for Van Brunt Street, although NYCDOT has no immediate plans to implement the lane. As such, for either option, on-street parking would need to be removed from both the east and west sides of the street to introduce a Class II bike lane. Alternatively, the proposed Class II bike route could be implemented on another street. Based on preliminary investigation of Van Brunt's street width, the latter option would be recommended, as a Class II bike lane would be difficult to integrate into the existing traffic pattern.

## VAN BRUNT STREET

The two-way Van Brunt Street alignment option has one horizontal curvature consideration, as listed below and shown in Figure 4-7:

## Figure 4-7: Focus Area West Feasibility Considerations


NYCDOT - BROOKLYN STREETCAR FEASIBILITY STUDY

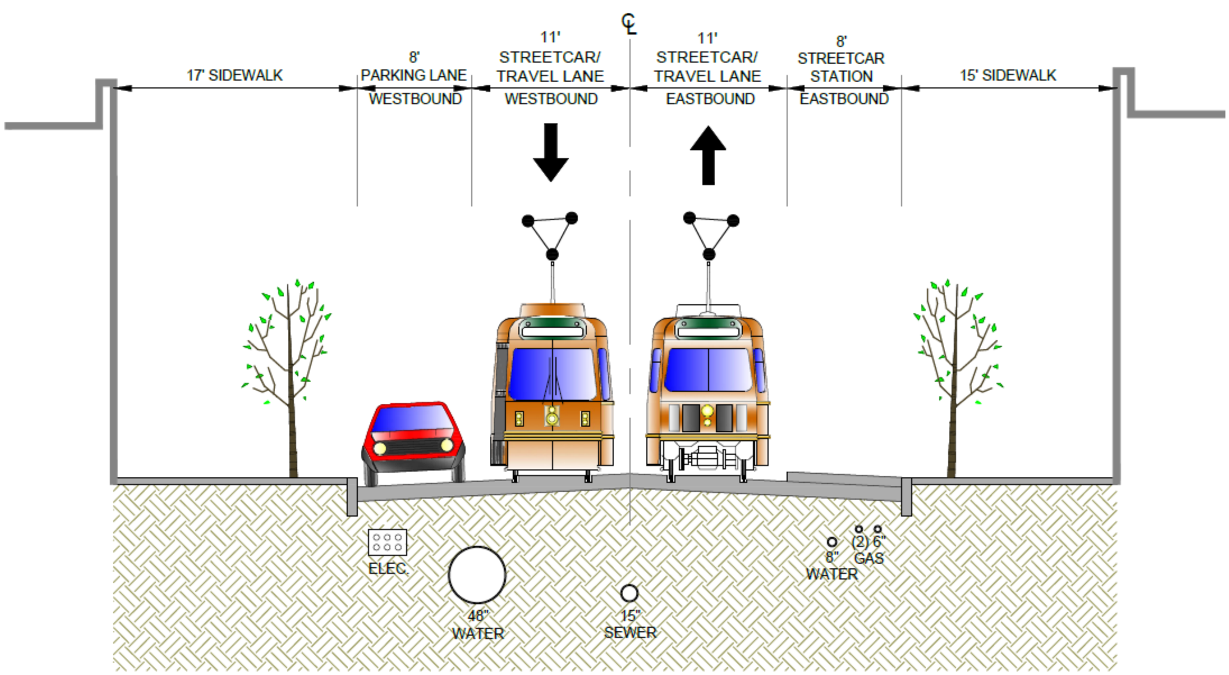
Feasibility Considerations

- Van Brunt Street at Beard Street – curb conflict and potential building conflict at the northeast corner.

In addition, because this alignment option is a two-way streetcar track, the existing right-of-way along Van Brunt Street would require eight foot parking lanes or a reduction in sidewalk space to accommodate the space for the streetcar track. Leaving only eight feet for parking could potentially reduce access to the curb, which could further impact delivery loading and unloading. Moreover, narrow right-of-ways could impact streetcar operations when delivery trucks (or other vehicles) double park and block the streetcar track right-of-way.

Utility concerns along Van Brunt Street include a 48-inch water main running parallel to the southbound track alignment. According to the information provided, there are no shallow private utilities along the Van Brunt Street that would need to be relocated. Figure 4-8 shows the approximate location of the utilities.

**Figure 4-8: Typical Cross Section along Van Brunt Street (at Hamilton Avenue)**




Not to scale
URS Corporation

## VAN BRUNT STREET / RICHARDS STREET

The increased number of turns required for the Van Brunt Street / Richards Street couplet increases the number of curb conflicts for this alignment option. Horizontal curvature considerations for the Van Brunt Street / Richards Street alignment option are listed below and shown in Figure 4-7:

- Richards Street at Beard Street – curb conflict and potential building conflict at the northeast corner;

- Richards Street at Van Dyke Street – curb conflict and potential building conflict at the northeast and southwest corners;
- Richards Street at Seabring Street – curb conflict and potential building conflict at the southwest corner; and
- Richards Street at Van Brunt Street – curb conflict and potential building conflict at the northeast corner.

This alignment option would also have to address some of the utility conflicts along Van Brunt Street. However, greater flexibility would be available for streetcar track placement as only a one-way southbound track would be placed on Van Brunt Street. Similarly, there would be limited impact to the curb access as the existing roadway cross-section would not require the modification necessary for the Van Brunt Street alignment option. One-way couplet tracks do have some drawbacks, however. The construction duration would be longer for this alignment option and costs would be higher, as this alignment option would require two street shutdowns.

Based on the evaluation of the Focus Area West alignment options, the Van Brunt Street option resulted in a total score of 200 and the Van Brunt / Richards Street option resulted in a total score of 195. Although the Van Brunt Street option would result in a reduction to the parking supply, the Van Brunt / Richards Street option would result in curb conflicts along Richards Street and impacts to the traffic flow. Similarly, although the Van Brunt Street option could result in more utility conflicts, the Van Brunt Street / Richards Street option would result in a longer construction duration and increased construction-related costs, as this option would require one way track construction on two streets, as opposed to two way track construction on only Van Brunt Street. This results in a higher ranking for the Van Brunt Street alignment option.

## 4.3 Middle Section

The Middle Section includes two alignment options to connect Columbia Street and Van Brunt Street: President and Carroll Streets and Summit Street. The results of the evaluation criteria ranking for these alignment options are shown in Table 4-3.

Table 4-3:
Middle Section Evaluation Results

| EVALUATION CRITERIA | COLUMBIA STREET / PRESIDENT STREET AND CARROLL STREET | COLUMBIA STREET / SUMMIT STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| IMPROVE TRANSPORTATION MOBILITY | | | |
| *Provide transit accessibility* | | | |
| **Population within 1/3–mile of streetcar alignment** | ◑ | ◑ | |
| **Employment within 1/3–mile of streetcar alignment** | ◔ | ◔ | |
| **Activity centers within 1/3-mile of streetcar alignment** | ○ | ○ | |
| *Improve travel time* | | | |

Table 4-3:
Middle Section Evaluation Results

| EVALUATION CRITERIA | COLUMBIA STREET / PRESIDENT STREET AND CARROLL STREET | COLUMBIA STREET / SUMMIT STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| **Trip time savings to and from various trip-generators** | ◐ | ◐ | |
| *Provide intermodal connections* | | | |
| **Provides bus connections** | ○ | ○ | |
| **Provides subway connections** | ○ | ○ | |
| *Enhance pedestrian movements* | | | |
| **Minimizes interference with pedestrian movements** | ◔ | ◔ | |
| **Affect pedestrian space** | ◔ | ◔ | |
| *Accommodate bikeways* | | | |
| **Minimizes interference with existing/planned bikeways/Greenways** | ◐ | ◐ | |
| **Minimizes impacts to bicyclist safety** | ◐ | ◐ | |
| PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER | | | |
| *Serve proposed/projected development* | | | |
| **Proposed developments with 1/3-mile of alignment** | ◔ | ◔ | |
| **Minimizes changes to parking supply** | ◐ | ◔ | *Summit Street – reduction in parking supply* |
| *Support neighborhood and local business community sentiments* | | | |
| **Amount of streetcar support/opposition** | N/A | N/A | |
| MAINTAIN TRAFFIC AND DELIVERY ACCESS | | | |
| **Maintain curb access** | | | |
| **Change in curb access (linear feet)** | ◐ | ◔ | *Summit Street – Reduction in curb access* |
| *Maintain access to Red Hook's arterial roadways* | | | |
| **Minimizes vehicle restrictions to access Red Hook's Arterial roadways and Brooklyn highways** | ◐ | ◐ | |
| **Maintain truck access to local and through truck routes** | ◐ | ◐ | |

Table 4-3:
Middle Section Evaluation Results

| EVALUATION CRITERIA | COLUMBIA STREET / PRESIDENT STREET AND CARROLL STREET | COLUMBIA STREET / SUMMIT STREET | REASON FOR DIFFERENCE |
|---|---|---|---|
| **MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT** | | | |
| *Minimize adverse impacts to historical resources* | | | |
| **Minimizes visual impacts to historic resources** | 10 | 10 | |
| **Minimizes historic property acquisition** | 10 | 10 | |
| *Minimize property acquisition* | | | |
| **Minimizes property acquisition** | 10 | 10 | |
| *Minimize impacts to natural features/resources and coastal waters* | | | |
| **Minimizes interference with parkland or coastal waters** | 10 | 10 | |
| *Minimize negative impact on traffic flow* | | | |
| **Minimizes negative impact on traffic flow** | 10 | 5 | *Summit Street – introduction of vehicle restrictions* |
| **MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT** | | | |
| *Implement within a reasonable construction timeframe and cost* | | | |
| **Shorter construction** duration | 10 | 15 | *President Street / Carroll Street – construction along two streets* |
| **Lower construction cost** | 5 | 10 | *President Street / Carroll Street – construction along two streets* |
| *Avoid conflicts with existing or proposed infrastructure* | | | |
| **Minimizes infrastructure conflicts** | 10 | 10 | |
| *Avoid or minimize utility relocation* | | | |
| **Minimizes utility conflicts** | 10 | 10 | |
| **Maintain access to utilities** | 10 | 10 | |
| TOTAL SCORE | 195 | 190 | |

Scoring Key:

| Full circle | Three-quarter circle | Half circle | Quarter circle | Empty circle |
|---|---|---|---|---|
| 20 | 15 | 10 | 5 | 0 |

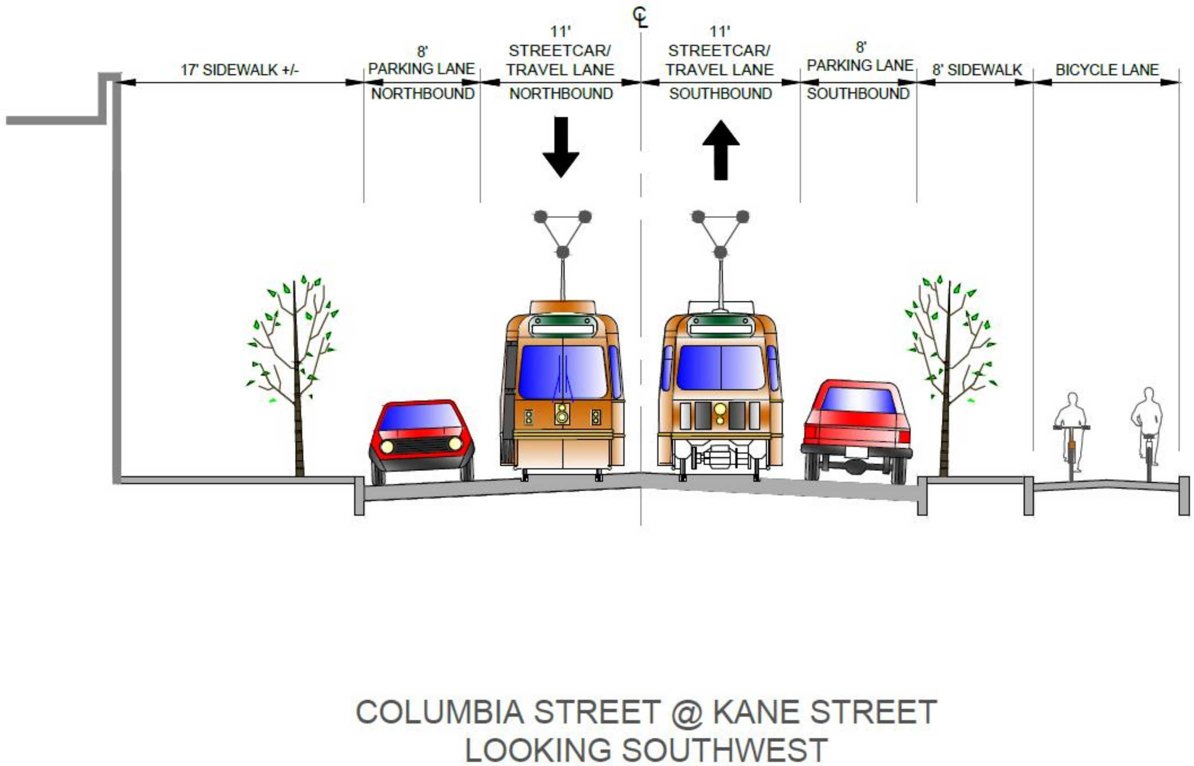
Both alignment options have horizontal curvature considerations. These considerations are shown in Figure 4-9 and listed on the following page:

- Columbia Street at President Street – curb conflict at the northeast corner;
- Columbia Street at Carroll Street – curb conflict at the northeast corner;
- President Street at Van Brunt Street – curb conflict and potential building conflict at the southwest corner; and
- Carroll Street at Van Brunt Street – curb conflict and potential building conflict at the southwest corner.

**Figure 4-9: Middle Section Feasibility Considerations**

A future streetcar would integrate with the separated bicycle path along Columbia Street, as shown in Figure 4-10.

**Figure 4-10: Bicycle Integration**




URS Corporation

### COLUMBIA STREET / PRESIDENT STREET AND CARROLL STREET

This alignment option would have limited impact to the curb access as the existing roadway cross-section would not require the modification necessary for the two-way Columbia Street / Summit Street alignment option. As previously discussed, one-way couplet tracks do have some operational drawbacks. The construction duration would be longer for this alignment option and costs would be higher, as this alignment option would require two street shutdowns. However, President Street and Carroll Street are both short blocks (approximately 630 feet), and construction impacts would be of a short duration with limited traffic flow impacts.

### COLUMBIA STREET / SUMMIT STREET

The Columbia Street / Summit Street two-way track would require more right-of-way for streetcar track placement. This would impact on-street parking, as well as curb access. In addition, the Van Brunt Street, Hamilton Street, and Summit Street intersection would require geometric changes and signal modification, and would also require Summit Street to be converted to two-way operation.

Based on the evaluation of the Middle Section alignment options, the Columbia Street / President Street and Carroll Street option resulted in a total score of 195 and the Columbia Street / Summit Street option resulted in a total score of 190. Although the Columbia Street / President Street and Carroll Street option would result in a longer construction duration and increased construction-related costs, the Columbia Street / Summit Street option would result in a reduction in the parking supply and curbside access and impact traffic flow. This results in a higher ranking for the Columbia Street / President Street and Carroll Street option.

## 4.4 Northern Section

The Northern Section includes three alignment options: Atlantic Avenue, Borough Hall (two-way on Boerum Place), and Borough Hall Boerum Place/Court Street Loop. The Atlantic Avenue alignment option extends along Atlantic Avenue from Columbia Street to Flatbush Avenue. The Borough Hall alignment options extend along Atlantic Avenue from Columbia Street to Boerum Place into Downtown Brooklyn. The Borough Hall / Boerum Place alignment option is a two-way streetcar track, while the Borough Hall / Boerum Place and Court Street alignment option is a one-way loop streetcar track. The evaluation criteria ranking for these alignment options are shown in Table 4-4.

Table 4-4:
Northern Section Evaluation Results

| Evaluation Criteria | Atlantic Avenue | Borough Hall / Boerum Place | Borough Hall / Boerum Place and Court Street | Reason for Difference |
|---|---|---|---|---|
| **Improve Transportation Mobility** | | | | |
| *Provide transit accessibility* | | | | |
| **Population within 1/3–mile of streetcar alignment** | ◕ | ◕ | ◕ | |
| **Employment within 1/3–mile of streetcar alignment** | ● | ● | ● | |
| **Activity centers within 1/3-mile of streetcar alignment** | ◑ | ◑ | ◑ | |
| *Improve travel time* | | | | |
| **Trip time savings to and from various trip-generators** | ◔ | ◑ | ◑ | *Atlantic Avenue – existing congestion would result in delays* |
| *Provide intermodal connections* | | | | |
| **Provides bus connections** | ● | ● | ● | |
| **Provides subway connections** | ● | ● | ● | |
| *Enhance pedestrian movements* | | | | |
| **Minimizes interference with pedestrian movements** | ◑ | ◑ | ◑ | |

Table 4-4:
Northern Section Evaluation Results

| Evaluation Criteria | Atlantic Avenue | Borough Hall / Boerum Place | Borough Hall / Boerum Place and Court Street | Reason for Difference |
|---|---|---|---|---|
| **Affect pedestrian space** | ◑ | ◔ | ◑ | *Borough Hall / Boerum Place – reduction in pedestrian space* |
| *Accommodate bikeways* | | | | |
| **Minimizes interference with existing/planned bikeways/Greenways** | ◑ | ◑ | ◑ | |
| **Minimizes impacts to bicyclist safety** | ◑ | ◑ | ◑ | |
| PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER | | | | |
| *Serve proposed/projected development* | | | | |
| **Proposed developments with 1/3-mile of alignment** | ◔ | ○ | ○ | *Atlantic Avenue – Atlantic Yards development* |
| **Minimizes changes to parking supply** | ◑ | ◑ | ◑ | |
| *Support neighborhood and local business community sentiments* | | | | |
| **Amount of streetcar support/opposition** | N/A | N/A | | |
| MAINTAIN TRAFFIC AND DELIVERY ACCESS | | | | |
| **Maintain curb access** | | | | |
| **Change in curb access (linear feet)** | ◑ | ◑ | ◑ | |
| *Maintain access to Red Hook's arterial roadways* | | | | |
| **Minimizes vehicle restrictions to access Red Hook's Arterial roadways and Brooklyn highways** | ◑ | ◑ | ◑ | |
| **Maintain truck access to local and through truck routes** | ◑ | ◑ | ◑ | |
| MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT | | | | |
| *Minimize adverse impacts to historical resources* | | | | |
| **Minimizes visual impacts to historic resources** | ◔ | ◔ | ◔ | |
| **Minimizes historic property acquisition** | ◑ | ◑ | ◑ | |
| *Minimize property acquisition* | | | | |

Table 4-4:
Northern Section Evaluation Results

| EVALUATION CRITERIA | ATLANTIC AVENUE | BOROUGH HALL / BOERUM PLACE | BOROUGH HALL / BOERUM PLACE AND COURT STREET | REASON FOR DIFFERENCE |
|---|---|---|---|---|
| **Minimizes property acquisition** | ◑ | ◑ | ◑ | |
| *Minimize impacts to natural features/resources and coastal waters* | | | | |
| **Minimizes interference with parkland or coastal waters** | ◑ | ◑ | ◑ | |
| *Minimize negative impact on traffic flow* | | | | |
| **Minimizes negative impact on traffic flow** | ○ | ◔ | ◔ | *Atlantic Avenue – congested corridor* |
| MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT | | | | |
| *Implement within a reasonable construction timeframe and cost* | | | | |
| **Shorter construction** duration | ◔ | ◑ | ◔ | *Boerum Place / Court Street – construction along two streets* <br> *Atlantic Avenue – complex construction* |
| **Lower construction cost** | ◔ | ◑ | ◔ | *Boerum Place / Court Street – construction along two streets* <br> *Atlantic Avenue – complex construction* |
| *Avoid conflicts with existing or proposed infrastructure* | | | | |
| **Minimizes infrastructure conflicts** | ◑ | ◑ | ◑ | |
| *Avoid or minimize utility relocation* | | | | |
| **Minimizes utility conflicts** | ◔ | ◑ | ◔ | *Atlantic Avenue and Court Street – known utility conflicts* |
| **Maintain access to utilities** | ◔ | ◑ | ◔ | *Atlantic Avenue and Court Street – known utility conflicts* |
| TOTAL SCORE | 240 | 260 | 245 | |

Scoring Key:

| ● | ◕ | ◑ | ◔ | ○ |
|---|---|---|---|---|
| 20 | 15 | 10 | 5 | 0 |

All three of the Northern Section alignment options have one common horizontal curvature consideration. This consideration is listed below and shown in Figure 4-11:

## Figure 4-11: Northern Section Feasibility Considerations

– Atlantic Avenue at Columbia Street – curb and potential abutment conflict at the southwest corner.

In addition all three Northern Section alignment options have a feasibility consideration in regards to vertical clearance. The vertical clearance is a concern where Atlantic Avenue crosses under the Brooklyn-Queens Expressway, as shown in Figure 4-12. The clearance is estimated to be, at its lowest, between 14 feet 2 inches and 15 feet and 6 inches, on the south side of the structure. This is less than the 18-foot minimum clearance; and therefore, a variance would be required. Alternatively the streetcar could be routed under the highest point of the structure, in the middle of Atlantic Avenue. While this would eliminate the vertical clearance issue, it would require additional intersection signal modification to accommodate the left turn onto Columbia Street (for southbound streetcars) and the thru movement along Atlantic Avenue (for northbound streetcars).

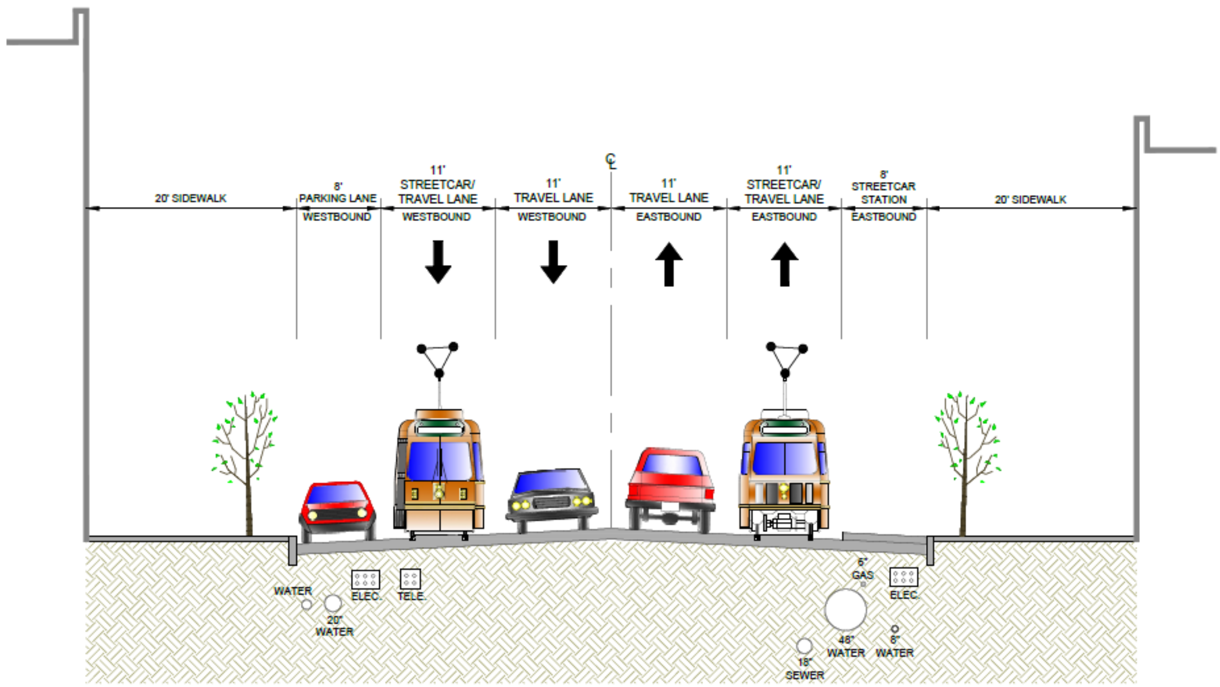
**Figure 4-12: Vertical Clearance on Atlantic Avenue under the Brooklyn-Queens Expressway**


URS Corporation

In terms of utilities, according to the records obtained for the Brooklyn Streetcar Feasibility Study, most of the major underground infrastructure along the Atlantic Avenue corridor is below the rightmost travel lane and parking lane, which is in conflict with the proposed streetcar location. Therefore, it may be necessary to relocate some of the utilities, as indicated in Figure 4-13. (Utilities shown here are not to scale, and the depths shown are estimates based on prior experience.)

Key concerns include an existing 48-inch water main, which runs just below the streetcar track alignment for a major portion of the route, as well as electrical and telephone duct banks, which are shallow and just below the road. While the entire duct bank system may not have to be relocated, most manholes and access vaults would need to be reconstructed out of the streetcar track alignment.

**Figure 4-13: Typical Cross Section along Atlantic Avenue (at Clinton Street)**




Not to scale
URS Corporation

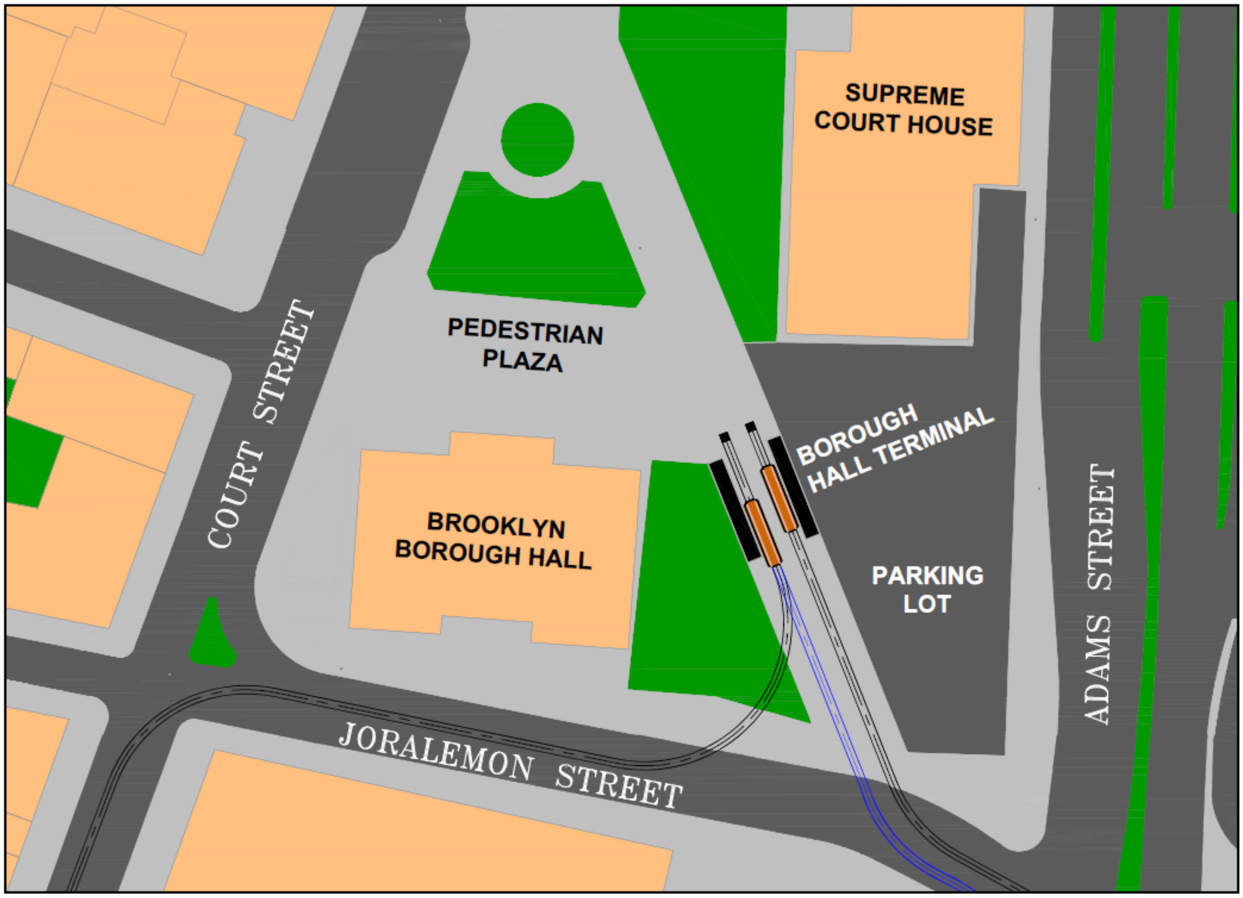
## ATLANTIC AVENUE

The advantage of the Atlantic Avenue alignment option is that it would serve a greater existing population, as well as the future Atlantic Yards project. This alignment option extends along Atlantic Avenue from Boerum Place to Flatbush Avenue, which is a congested corridor with existing traffic delays. Due to this existing congestion, a streetcar track running along this corridor would likely experience travel time delays. In addition, as this alignment option is longer in length, the construction duration would be longer for this alignment option and costs would be higher. Moreover, as this alignment option would operate for a longer distance along Atlantic Avenue, the known utility conflicts would further contribute to construction duration and cost.

## BOROUGH HALL / BOERUM PLACE

This alignment option would require a reduction of pedestrian space at the terminal station, as shown in Figure 4-14.

**Figure 4-14: Borough Hall Terminal Station**




URS Corporation

This alignment option would require traffic signal modification at two intersections, as shown in Figure 4-11 on 4-42. At Atlantic Avenue and Boerum Place vehicles would have to turn left from the right hand lane. A queue jump would be necessary at this intersection, and the left turn phasing would have to be protected. Also, at Boerum Place and Joralemon Street, vehicles would have to turn left from the right hand lane. A queue jump would be necessary at this intersection, and the left turn phasing would have to be protected.[4] This signal modification would also allow southbound contraflow streetcar movements for the Borough Hall / Boerum Place alignment option. Both intersections already have complicated, multi-phase signals. Therefore, introducing a streetcar-only phase would create greater complexity and could impact congestion levels.

[4] A median alignment along Boerum Place could be considered for a more simplified signal modification. However, the median alignment would require median reconstruction for the potential streetcar stop placement along Boerum Place. Therefore, a right-side running track was used for the alignment options evaluation.

### BOROUGH HALL / BOERUM PLACE AND COURT STREET LOOP

In addition to the common horizontal curvature consideration described above, this alignment option would have an additional horizontal curvature consideration as shown in Figure 4-11 and listed below:

- Atlantic Avenue at Court Street – curb and potential building conflict at the northeast corner.

This alignment option would also require the traffic signal modification described above and shown in Figure 4-11. The construction duration would be longer for this alignment option and costs would be higher, as this alignment option would require two street shutdowns.

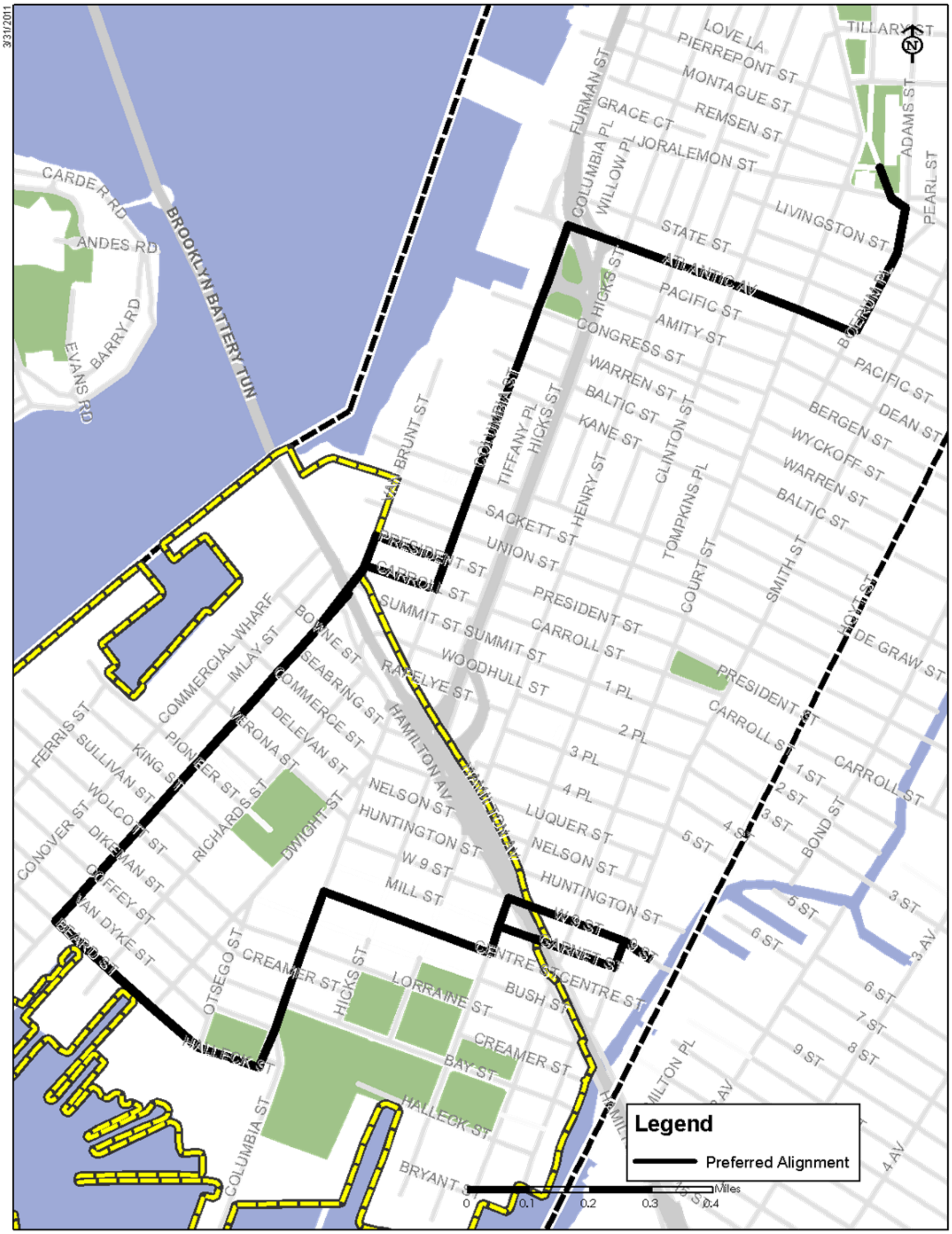
Based on the evaluation of the Northern Section alignment options, the Atlantic Avenue option resulted in a total score of 240, the Borough Hall / Boerum Place resulted in a total score of 260, and the Borough Hall / Boerum Place and Court Street option resulted in a total score of 245. Although both the Borough Hall / Boerum Place and the Borough Hall / Boerum Place and Court Street option would affect pedestrian space, these options would result in greater travel time savings and reduced impacts to traffic flow. The Atlantic Avenue option would serve proposed developments; however, the Borough Hall / Boerum Place option would result in a shorter construction duration, reduced construction-related costs, and limited utility conflicts. This results in a higher ranking for the Borough Hall / Boerum Place option.

## 4.5 Preferred Alignment

Based on the evaluation of alignment options, the preferred alignment for a future Brooklyn streetcar would be the Centre Street, Van Brunt Street, Columbia Street / President Street and Carroll Street, and Borough Hall / Boerum Place options. This alignment travels from Brooklyn Borough Hall to Smith Street / 9th Street Station, as shown in Figure 4-15 and travels primarily in a dual track route via:

- Boerum Place;
- Atlantic Avenue;
- Columbia Avenue;
- Van Brunt Street;
- Beard Street;
- Columbia Avenue;
- Center Mall; and
- West 9th Street.

**Figure 4-15: Preferred Streetcar Alignment**




NYCDOT - BROOKLYN STREETCAR FEASIBILITY STUDY

Vehicle Operating and Maintenance Facilities

# 5.0 OPERATING PARAMETERS

As reported in the Operations Planning Technical Memorandum, this section presents the operating parameters appropriate for a future Brooklyn streetcar by outlining the key variables that typically affect streetcar service. A summary of the assumptions of these variables is as follows:

*Service Operations*

- Operating hours:
    - Alternative 1 – 24-hour streetcar service; or
    - Alternative 2 – 6 AM to midnight streetcar service and midnight to 6 AM bus service
- Service frequency: 8 to 40 minute headways, depending on time of day (similar to existing bus service)
- System integration: integration with the MTA NYCT existing transit system, including fare collection and intermodal transfer points

*Vehicle Characteristics*

- Average speed: 10.5 miles per hour
- Layover requirements: 15 to 20 percent of trip time, approximately 6 minutes
- Number of vehicles: 8 vehicles plus additional spare vehicles, as required

*Maintenance Facility*

The requirements for the vehicle maintenance facility are:

- 150 feet x 150 feet facility with six tracks
- 1 to 2 acre site
- Manufacturing zoned district

Based on these maintenance facility requirements, several parcels have been identified near the preferred alignment, as shown in Figure 5-1. Utilizing New York City Department of City Planning's land use data, existing land use for each potential site was extracted and analyzed. Table 5-1 summarizes these data.

**Figure 5-1: Potential Locations for Vehicle O&M Facility**

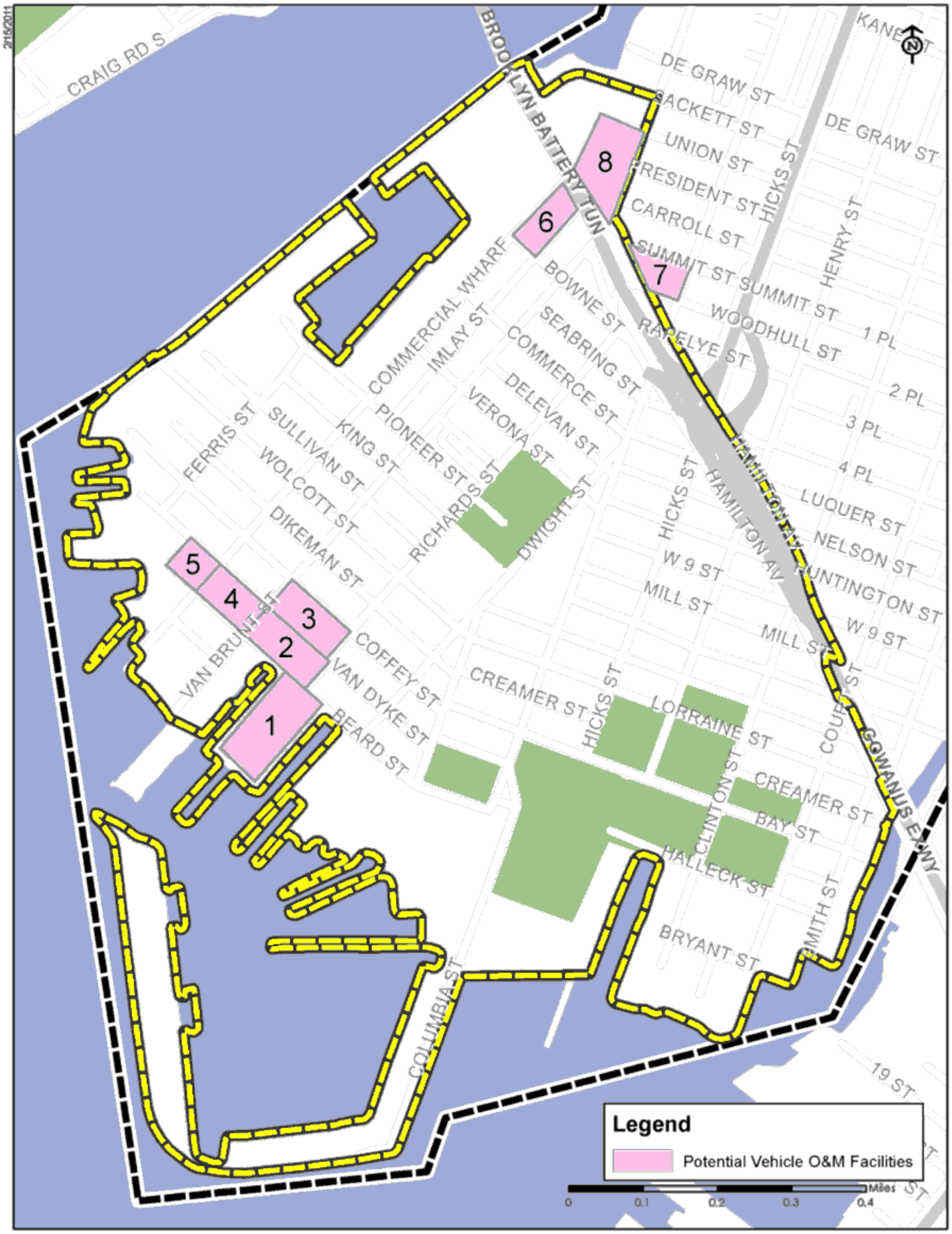


**Table 5-1:**
**Existing Land Use Around Potential Locations for Vehicle O&M Facilities**

| LOCATION | ACRE | COMMERCIAL AREA | RESIDENTIAL AREA | OFFICE AREA | RETAIL AREA | FACTORY AREA | RESIDENTIAL UNITS |
|---|---|---|---|---|---|---|---|
| 1* | 5.71 | - | - | - | - | - | - |
| 2 | 3.47 | 105,980 | 7,500 | 7,200 | - | 88,000 | 11 |
| 3 | 3.31 | 64,550 | 22,897 | 5,500 | 2,350 | 45,600 | 26 |
| 4 | 2.71 | 26,925 | 35,599 | 5,203 | 901 | 4,000 | 38 |
| 5 | 1.68 | 17,900 | 3,300 | 5,100 | - | 12,800 | 5 |
| 6** | 2.33 | - | - | - | - | - | - |
| 7 | 1.99 | 25,950 | 20,287 | - | 6,727 | 6,407 | 23 |
| 8** | 4.68 | - | - | - | - | - | - |

*Vacant Lot
**No Data

Based on the land use data and orthophotography, several identified sites have little or no existing activity; however, several are currently active residential, commercial, or industrial sites. Depending on the location selected, additional property takings could be required. Location 1, 6, and 8 are currently vacant. However, potential developments have been discussed for location 1 and locations 6 and 8 are controlled by the PANYNJ, which would require discussion and coordination.

## VEHICLE TYPE SELECTION

There are several viable options for potential streetcar vehicle types that would be appropriate to operate within the Study Area. This section describes the three most common types of streetcar vehicles: heritage (PCC), replica, and modern. A brief description of how these would be applicable to Brooklyn, along with a comparison of the advantages and disadvantages of each, is included. Recent technological advancements in streetcar vehicle types are also presented.

### *Heritage (PCC) cars*

A wide array of streetcars fit into the heritage category (also known as vintage), from the original streetcars of the late 1800s to the single-ended, single-sided cars of the 1940s. The original streetcar first appeared on American streets near the turn of the 20$^{th}$ Century with the introduction of electric traction. These cars were typically built as step-entry cars with high floors, steel frames, and wooden/steel bodies. In the late 1930s, streetcar design advanced with the introduction of President's Conference Committee Cars (PCC cars), as shown in Figure 5-2. Brooklyn was the first system to receive the PCC cars, with an order of 100 cars delivered in 1936. PCC cars were typically 50 feet long and featured a rounded, streamlined steel construction. The improved ride quality and higher performance of these cars made them the model for streetcar construction.

More than 20 cities in North America used PCC cars, and many are still in use in Eastern European countries. Prior to the end of World War II, when streetcars disappeared from many cities, streetcars in North America were built with a single-ended, single-sided configuration that provided for an operator's position at one end of the car and doors on only one side. This configuration required streetcar routes to include turning loops and 'wyes' (tracks that branch off in two directions) to allow streetcars to reverse direction.

**Figure 5-2: PCC Car in San Francisco, California**


www.sanfrancisco.about.com

The modern use of heritage cars generally consists of rebuilt PCC cars. Philadelphia currently uses rebuilt PCC cars on its recently restored Route 15 line, as shown in Figure 5-3. The extent of rebuilding varies and may include air conditioning, ADA compliance and lately, alternating current traction motors. Most cars available for rebuild were originally constructed between 1945 and 1953. They have maximum speeds of 40 to 45 mph and seated capacities for approximately 50 passengers. These PCC cars are single ended with turning radii as low as 50 feet. The cost of a complete rebuild is approximately $1.5 to $1.8 million per car.

**Figure 5-3: PCC Car in Philadelphia, Philadelphia**


www.railwaypreservation.com

*Replica*

Replica streetcars are modern streetcars that copy heritage designs, as shown in Figure 5-4. The replica streetcars are typically based on cars constructed in the 1920-1935 (pre-PCC) period. Replicas can have new frames and bodies patterned after the original streetcars, or they can incorporate heritage components, including wheels, axles, motors, gears, brakes, and propulsion controls. The predominant supplier of replica cars, the Gomaco Trolley Company, has manufactured streetcars for service in Charlotte, Little Rock, Lowell, Memphis, Portland, and Tampa, as shown in Figure 5-5. Most of these cars use running gears from heritage streetcars imported from Milan, Italy, where many heritage cars were operating until recently. Some replica cars, including those built for New Orleans, are equipped with such modern components as wheelchair lifts and air conditioners, as well as new propulsion systems. However, the majority of replica streetcars have high floors with a step entry from the platform level to the car floor level.

**Figure 5-4: Replica Streetcar in San Pedro, California**


www.lightrailnow.org

**Figure 5-5: Replica Streetcar in Tampa, Florida**


www.lightrailnow.org

*Modern*

Modern streetcars feature a number of improvements to original streetcar design and function. Made in Europe (and more recently in the United States), modern streetcars have wide doors, large windows, and low floors. They also feature advanced propulsion and breaking systems. Constructed of steel or aluminum, modern streetcars incorporate materials that meet current smoke/toxicity requirements and are easy to clean and maintain. An important feature of these streetcars is the modular design, which allows individual units to be assembled into a single car using articulated or pivoting joints. Thus, the length of a modern streetcar varies (from 60 feet to almost 180 feet) increasing their ability to travel in confined urban spaces. In addition, the appearance of modern streetcars can be customized, offering standard modules in various lengths, widths, and door configurations, with custom styling.

The cities of Portland and Seattle, discussed in the Case Study Report, provide examples of modern streetcars, as shown in Figure 5-6 and Figure 5-7.

**Figure 5-6: Modern Streetcar in Portland, Oregon**


www.southwaterfront.com

Portland and Seattle modern streetcars are 66 feet long and comprise three modules. The modules are five inches narrower than heritage or replica cars, helping to minimize interference from parked cars. This is an important factor when considering the narrow streets of the Brooklyn Streetcar alignment. The center section has low floors with two double-width doors for boarding, where passengers step onto the car from a station platform. Wheelchair passengers enter using a bridge plate, which extends from the car to the platform and can be activated by passengers or by the operator. The low center section has few seats, allowing for wheelchairs, carriages, and bikes, alongside standing passengers.

**Figure 5-7: Modern Streetcar in Seattle, Washington**


www.inekon-trams.com

**Table 5-2:**
**Vehicle Comparison**

| | | BUS | HERITAGE STREETCAR (PCC) | REPLICA STREETCAR | MODERN STREETCAR |
|---|---|---|---|---|---|
| Car Capacity (persons) | Seated | 30 to 65 | 40 to 66 | 40 | 60 |
| | Standing | 20 to 55 | 88 | 88 | 200 |
| Vehicle Length (ft.) | | 35 to 60 | 35 to 48 | 35 to 40 | 60 to 180 |
| Vehicle Width (ft) | | 8’6” | 8’6” | 8’6” | 8’1” |
| ADA Accessible | | Low-Floor | Onboard Lift | Onboard Lift | Low-Floor |

Street Smart, Streetcars and Cities in the Twenty-First Century

### *Conclusion*

All of the vehicle types described above are feasible for operation in a Brooklyn Streetcar system. The modern streetcar vehicle, however, offers the highest degree of flexibility, though it is more than double the cost of either a refurbished PCC car or a replica car.[5]

Modern vehicles have several key advantages. They are slightly narrower, affording a better fit on the tangent sections of the route. Additionally, the modern vehicle is best suited for disabled passengers, as it offers virtually seamless access for wheelchair-bound passengers. Finally, the modern vehicle offers the potential for much higher passenger capacity than either of the other two, due to the ability to add sections or modules and multiple door boardings. When implementing a future streetcar system in Brooklyn, consideration could be given to operating the modern streetcar in regular revenue service, but also make several PCC cars available to the system for weekends and special events, as they potentially attract great interest from both tourists and residents, as has been demonstrated in other cities.

### *Advancements in Modern Streetcar Technology*

New streetcar type vehicles now in service in Bordeaux and Nice, France have the capacity to operate without the use of trolley overhead wire for short distances or for the complete system, depending on the type. The Bordeaux tram utilizes a technology developed by Alstom known as Alimentation par Sol (APS), a third rail system under pavement. An alternative to this system was developed by Alstom for Nice. This alternative incorporates a dual power mode for its streetcar vehicle, using electric current from overhead wires in areas where they are permitted and battery power (nickel metal hydride batteries) where overhead wires are prohibited. These systems minimize the visual disturbances caused by overhead wires used for trams in scenic or historic places. Alstom's technology has not yet been put into service in the United States.

**Figure 5-8: Alstom-built 'Tram' in Nice, France**

Alstom

[5] Modern vehicles typically cost approximately $4 million each, whereas both refurbished heritage and new replica vehicles cost approximately $1.5 million each. The primary reason replica streetcars are less expensive than modern vehicles is their smaller size, and their use of parts from retired heritage equipment purchased in bulk from cities around the world.

## POWER SUPPLY

Streetcars are traditionally operated by electricity conveyed to the vehicle via overhead wires. The electricity is collected by a pantograph on the streetcar. Heritage, Replica, and Modern streetcars all use this method of traction power.

Battery and battery/electric methods of traction power are emerging propulsion technologies for streetcars. It is anticipated that the Brooklyn streetcar would operate using a conventional trolley wire/overhead contact system. While battery-powered and/or wireless trolley systems using underground traction power supply are emerging technologies in Europe, these newer systems remain untested in winter conditions similar to Brooklyn and most are not yet operational in North America.

A streetcar system power supply is how electricity from the local electric utility's voltage distribution network is transferred to the streetcar vehicles. The system is called the Traction Power Supply System (TPSS). This power supply includes the traction electrification system (TES) and overhead-contact system (OCS) for power distribution. The utility distributes power as alternating current (AC), while the power to the vehicle is direct current (DC). Therefore, the TES substation must contain transformers to convert the power to a usable voltage. Substations should be located along a streetcar route at approximately ½-mile intervals. Although it is possible to place substations subterranean, it is most desirable for access and cost to place them above ground in a location easily accessible to maintenance personnel.

Streetcar vehicles draw power from the OCS by either trolley pole (a spring-loaded pole with a grooved 'shoe' that straddles the wire and slides along its axis) or pantograph (a hinged frame or tube with a wide contact surface that slides along the wire and can move laterally). Two configurations are also common for the overhead wires. A trolley wire is a single wire hung from pole to pole that conducts current and provides a contact surface for the trolley pole or pantograph. A catenary is a combination of wires, including an upper 'messenger' wire and a suspended contact wire. The trolley wire creates less of a visual disturbance. However, the advantage of a catenary system includes greater overhead current distribution, greater spacing between support structures, and higher speeds.

When transferring power from the wire to the streetcar vehicles, the electricity must be grounded. Typically this is done by directing the current through the vehicle's steel axles and wheels. An insulation material is then used to ground any return current, avoiding any deterioration to nearby conductors.

The primary system elements that would be required for a Brooklyn Streetcar system are:

- Traction power supply system requirements;
- Overhead contact system infrastructure, as shown for Portland's system in Figure 5-9; and
- Streetcar operational control.

**Figure 5-9: Overhead Electric Power System in Portland, OR**


URS Corporation

The key concerns that need to be addressed when considering the TPSS for Brooklyn include: minimizing visual aesthetic impacts of the overhead contact system; minimizing the need for underground conduits and property acquisitions for substations as well as the overhead wire infrastructure; avoiding attachment of wire supports to buildings; and minimizing/controlling stray currents.

The alignment options reviewed for the Brooklyn Streetcar Feasibility Study include tracks that are located in vehicular traffic lanes, on either one-way or two-way streets, usually with parking lanes on either or both sides. The route has many traffic signal crossings for cross streets with turn lanes for vehicular access. The system would include station stops at side platforms (sidewalk platform bulb outs) for level boarding and alighting. Stops are anticipated to be located roughly every 1/3-mile along the route. The neighborhoods along the various alignment options are typically high-density urban residential and commercial areas where aesthetics are important. For this reason, the design and appearance of the OCS should consider a system that is context sensitive and blends in with the surrounding environment as much as possible to minimize any visual/aesthetic impacts associated with overhead wires.

*Substation Requirements*

The assumptions for a Brooklyn streetcar TPSS are based on similar types of projects, as reported in the Case Study Report, as well as the specific characteristics of the Red Hook and Downtown Brooklyn neighborhoods. The final size and spacing of the substations for Brooklyn would be determined through a detailed analysis based on the vehicle selected, the final operating plan (including frequency of service and headways), track alignment profile, and passenger station spacing, as well as the anticipated speed and power requirements measured over specific time intervals. A typical substation for the Portland Streetcar is shown in Figure 5-10.

**Figure 5-10: Prefabricated Streetcar Substation in Portland, Oregon**

URS Corporation

# 6.0 COST ESTIMATE

## 6.1 Capital Cost

A capital cost estimate was developed for the Brooklyn Streetcar Feasibility Study based on the findings from the Case Study Report, Operations Planning Technical Memorandum, and Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum. Costs for similar projects in other cities were also reviewed, and relevant adjustments were made to unit costs based on construction in the New York City market. Costs included in this memo are also based on two similar streetcar systems in construction or project development in Charlotte, North Carolina and Baltimore, Maryland.

Based on FTA Standard Cost Categories, nine major cost categories were identified as follows:

- Cost Category 10 – Guideway and Track Elements
- Cost Category 20 – Station Stops, Terminals, and Intermodals
- Cost Category 30 – Support Facilities: Yards, Shops, and Administrative Buildings
- Cost Category 40 – Sitework and Special Conditions
- Cost Category 50 – Systems
- Cost Category 60 – Right-of-Way, Land, and Existing Improvements
- Cost Category 70 – Vehicles
- Cost Category 80 – Professional Services
- Cost Category 90 – Unallocated Contingency

Costs from Baltimore were escalated by 10 percent for a labor market adjustment for work that would be conducted in New York City. In addition, there is a 20 percent allocated contingency on each cost item and a 15 percent unallocated contingency applied to the subtotal of all costs.

The preferred alignment, as described on page 4-46, was used to model this cost estimate. This alignment is approximately 6.8 route miles, primarily in dual track routes (approximately 3.4 miles in each direction from Red Hook to Downtown Brooklyn). The design assumptions used to create the concept level capital cost estimate for the Brooklyn Streetcar Feasibility Study are described below, listed for each cost category.

### COST CATEGORY 10 – GUIDEWAY AND TRACK ELEMENTS

Cost associated factors (i.e. track length, intersection impacts, sitework, and signal impacts) were identified for the preferred alignment. The alignment travels from Brooklyn Borough Hall to Smith Street/9th Street Station primarily in a dual track route via:

- Boerum Place;
- Atlantic Avenue;
- Columbia Avenue;
- Van Brunt Street;
- Beard Street;
- Columbia Avenue;
- Center Mall; and
- West 9th Street.

Along this route there is approximately 18,000 linear feet of track in each direction for a total of 36,000 feet of new track bed and girder rail construction. Two embedded turnouts were assumed for connection into a future maintenance and storage facility. Three embedded crossing diamonds were also assumed, one at each terminal station for tail track turnaround and another midway along the alignment for track crossing.

### COST CATEGORY 20 – STATION STOPS, TERMINALS, AND INTERMODALS

Typical streetcar stop platforms were assumed to be located along the route at intervals of approximately 1,500 feet. There are 12 standard platforms located in each travel direction for a total of 24, with two additional terminal stations. Each terminal station was assumed to be an enhanced-stop platform, containing additional amenities, and features to facilitate connections with other modes.

### COST CATEGORY 30 – SUPPORT FACILITIES: YARDS, SHOPS, AND ADMINISTRATIVE BUILDINGS

Based on the Operations Planning Memo, the Maintenance and Storage Facility would be a 22,500 square-foot building on a 1.5-acre site. The structure would house typical streetcar maintenance requirements, including a wash facility and six track bays to perform repairs and maintenance. The site would also require track for access to and from the revenue tracks as well as a yard for storage and employee/operator access.

### COST CATEGORY 40 – SITEWORK AND SPECIAL CONDITIONS

Based on the utility records provided for the major dual track routes of Columbia Avenue, Van Brunt Street, and Atlantic Avenue, it was assumed that some areas would require significant utility relocation or protection to allow for streetcar traffic to operate. An assumption of $600 per linear foot of dual track alignment was used to approximate utility relocation and protection costs. This accommodates the costs associated with relocating any utilities outside of the proposed alignment, as well as costs associated with protecting crossing utilities (i.e. sleeves, cathodic protection, etc.). Allowances were also included for street lighting improvements and drainage improvements due to track construction and cross slope modification.

A $30 per linear foot cost was also included as an allotment for civil reconstruction including sidewalk interface and driveway and/or parking modifications, with an additional $20,000 per turning intersection where more extensive sidewalk and curb reconstruction would be required.

An allowance of $130 per linear foot was also included for roadway reconstruction and repaving due to trackbed modification and interface. Maintenance of Traffic was allotted at 4 percent of direct construction costs. An 8 percent allocation was also added for contractor's indirect costs (i.e. mobilization).

### COST CATEGORY 50 – SYSTEMS

Systems costs include all Traction Power Electrical work, OCS, and electronics associated with operation of the streetcar. A systemwide signal system for the streetcar was included at a cost of $2.5 million. There would be a need for new traffic signals at three locations (Mill Street at Hamilton Avenue, Centre Street at Clinton Street, and Centre Street at Columbia Street) within the streetcar alignment and modification of 14 existing traffic signals to allow for streetcar use. Additional equipment required to give streetcar signal priority, including both the wayside system and the in-vehicle transponders, was also included as a linear foot assumption for the length of track.

A typical fenced-in traction power substation can operate approximately one mile of dual track. A total of three substations were assumed to be installed for the 3.4 mile route. Each traction power substation is approximately a 30 feet by 10 feet prefabricated aboveground structure that is surrounded by fencing. The trolley wire OCS was priced at a linear foot cost based on dual track support (a single support system for both direction of trolley wire).

A systemwide communication system including radio communication for operators and facility was included with a lump sum of $500,000. Also, off-board fare collection machines at each station were priced at $70,000 per terminal, with 28 terminals in the system (one at each station and two at each terminal).

Cost Categories 10 through 50 are a compilation of all direct construction costs.

### COST CATEGORY 60 – RIGHT-OF-WAY, LAND, AND EXISTING IMPROVEMENTS

Land purchase requirements would include the Maintenance and Support Facility site, as well as smaller purchases along the route for any geometric needs, traction power substation requirements, or possible easement for OCS to be attached to buildings on narrow streets in lieu of OCS poles.

### COST CATEGORY 70 – VEHICLES

Modern streetcar vehicles as used in comparison cities cost approximately $4 million per car. Refurbished or heritage cars would be less expensive. (Philadelphia's refurbished PCC cars cost $1.5 million each.) For the purpose of this estimate modern streetcars were used to calculate a conservative estimate.

### COST CATEGORY 80 – PROFESSIONAL SERVICES

Continuing project development engineering and professional services are assumed along the following schedule as a percentage of construction costs (10-50):

- Preliminary engineering (2 percent);
- Final design (6 percent);
- Project management for design and construction (4 percent);
- Construction administration and management (5 percent);
- Professional liability and other non-construction insurance (2 percent);
- Legal, permits, and review fees by other agencies, cities, etc. (2 percent);
- Surveys, testing, investigation, and inspection (2 percent); and
- Start up (2 percent).

### COST CATEGORY 90 – UNALLOCATED CONTINGENCY

An unallocated contingency of 15 percent was also added to the overall cost in consideration of the current level of project development.

### SUMMARY

Based on these assumptions, the total cost for the streetcar system is approximately $176 million, or approximately $26 million per mile of track. Table 6-1 compares these costs with similar systems.[6]

**Table 6-1:
Capital Costs for Similar Cities**

| CITY | CAPITAL COSTS PER TRACK MILE (MILLIONS IN CONSTRUCTION YEAR) | YEAR |
|---|---|---|
| Portland Initial Implementation | $13 | 2001 |
| Tampa | $20 | 2002 |
| Seattle | $20 | 2007 |
| Portland Streetcar Loop Project | $22 | 2010 |
| Source: Case Studies Report | | |

## 6.2 Operating and Maintenance Cost

In order to determine the operations and maintenance (O&M) cost for the proposed Brooklyn streetcar, the O&M cost per vehicle revenue mile and hour from similar systems in Tampa, Florida, New Orleans, Louisiana, and Seattle, Washington were used. These systems were selected based on available O&M costs data as well as average bus operator hourly wage rate. These costs were obtained from the 2009 National Transit Database, which is the latest data available and are summarized below in Table 6-2.

**Table 6-2:
Operating Costs for Similar Cities**

| CITY | O&M COSTS PER VEHICLE REVENUE HOUR | O&M COSTS PER VEHICLE REVENUE MILE |
|---|---|---|
| Tampa | $164 | $32 |
| New Orleans | $185 | $24 |
| Seattle | $211 | $39 |
| Source: 2009 National Transit Database, Federal Transit Administration | | |

The average bus operator hourly rate was used to escalate the cost of these similar systems to estimate the cost for operating and maintaining a streetcar system in New York City. The hourly rates were obtained online from the Occupational Employment Statistics Query System from the Bureau of Labor Statistics for the three comparison cities and New York City. The data are summarized below in Table 6-3.

To calculate the O&M cost for the proposed Brooklyn streetcar, a ratio of labor rates of NYC bus drivers to labor rates bus drivers in each comparison city was developed. This ratio was then applied against the respective operating and maintenance costs for each city and averaged to obtain the value for New York City. Using this method, the cost was determined to be approximately $248 per vehicle revenue hour and $42 per vehicle revenue mile, or approximately $6.2 to $7.2 million dollars annually, as shown in Table 6-4.

[6] However, these costs were based on the year of expenditure and not adjusted for inflation.

**Table 6-3:**
**Average Hourly Bus Operator Labor Rate**

| CITY | AVERAGE HOURLY BUS OPERATOR LABOR RATE |
|---|---|
| Tampa | $15.56 |
| New Orleans | $15.41 |
| Seattle | $22.69 |
| New York City | $23.38 |
| Source: Occupational Employment Statistics Query System, Bureau of Labor Statistics, May 2009 | |

**Table 6-4:**
**Operating Costs for Similar Cities and Projected Costs for New York**

| CITY | O & M COSTS PER VEHICLE REVENUE MILE | ANNUAL O & M COSTS |
|---|---|---|
| Tampa | $32 | $2.4 million |
| New Orleans | $24 | $10 million |
| Seattle | $39 | $2.4 million |
| New York (Projected) | $42 | $6.2 million to $7.2 million |
| Source: 2009 National Transit Database, Federal Transit Administration | | |

A comparison of streetcar O&M costs with NYCT bus and subway O&M costs can be misleading as the breakdown of costs per mode may differ. According to NYCT, the annual O&M costs for the B61 route are approximately $2.5 million.

# 7.0 ALIGNMENT FEASIBILITY CONCLUSION

This report presents the results of a detailed evaluation of the feasibility of implementing a streetcar system in Brooklyn. The analysis draws upon the experience and lessons learned from several existing streetcar systems presented in the Case Study Report, including a field visit to the Philadelphia Route 15 Trolley system. Information gathered from site investigations performed in Red Hook and Downtown Brooklyn to identify alignment options and feasibility considerations related to clearances and turning radii, track geometry, sidewalks, bikeways, and utilities were also incorporated into the evaluation. This detailed analysis considered constructability issues, vehicle options, and overall costs to implement and operate a starter system in Brooklyn. The evaluation was conducted based on the approach outlined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum.

In addition to feasibility from an engineering standpoint, this report also includes discussion related to the NYCDOT's policy decisions related to a future streetcar in Red Hook. The process for developing a policy decision for a future streetcar in Brooklyn includes selecting and evaluating the alignment options (as described in section 2.0 and section 4.0), identifying feasibility considerations (as described in section 3.0), and determining capital and operating costs (as described in section 6.0). The NYCDOT's policy decision also incorporates streetcar benefits, which are discussed in the Case Study Report.

### ALIGNMENT OPTIONS

Using the methodology defined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, potential alignments for a streetcar service in Brooklyn were selected and evaluated. This process included identifying potential streetcar alignments, developing evaluation criteria to measure how well the alignment options satisfy the study's goals and objectives, and evaluating various alignment options in comparison to each other. Based on this evaluation methodology, the alignment options were ranked, with the highest ranking given to those that best satisfied the goals and objectives of the project. This resulted in an individual preferred alignment. The highest ranking alignment options are shown in Figure 4-15 on page 4-47 and as follows:

- Focus Area East – Centre Street;
- Focus Area West – Van Brunt Street;
- Middle Section – Columbia Street / President Street and Carroll Street; and
- Northern Section – Borough Hall / Boerum Place.

### FEASIBILITY CONSIDERATIONS

The Study Team identified general streetcar feasibility considerations typical of a streetcar operating in an urban environment. These general considerations include alignment considerations (right-of-way, horizontal curvature, major infrastructure obstacles, station platforms, and vertical clearance), traffic planning (traffic operations and signals, parking and loading, and bicycle integration), and constructability (construction methodology, construction impacts, pavement type, and utilities). These feasibility considerations contributed to various evaluation criteria, as described in section 3.0.

As demonstrated during the evaluation process, all of the alignments are feasible in a technical sense, as all of the feasibility considerations of implementing a streetcar system can be addressed during the planning, design, and construction phases of a future streetcar. However, when considering factors such as the cost effectiveness of each alignment option, there are distinct differences in the options. The evaluation process produces a ranking of the alignment options representing the most feasible alignment.

Although the Centre Street, Van Brunt Street, Columbia Street / President Street and Carroll Street, and Borough Hall / Boerum Place alignment is most feasible from an engineering standpoint, feasibility considerations, including right-of-way and intersection geometric modifications, property acquisitions, parking reductions, and signal modifications would remain. These considerations, for example the narrow right-of-ways along Van Brunt Street, could impact the operation of a future streetcar, as well as associated vehicular, bicyclist, and pedestrian movements.

## COST

The Study Team has concluded that operation of a modern streetcar is technically feasible in Red Hook. However, this new transit service would require a substantial capital investment. The estimated cost based on the conceptual design of the preferred alignment amounts to approximately $176 million in 2011 dollars. Given the current economic environment, it is questionable whether the City could raise the funds for this substantial capital investment. Moreover, in light of the unfavorable feasibility considerations related to the actual operation of such a system, it is uncertain that a streetcar, while technically feasible, is the most efficient option for meeting Red Hook’s transit goals today.

## ADDITIONAL FACTORS

Additionally, the support of neighborhood residents and local businesses is an important factor in developing a future streetcar route. Streetcar support in Portland, Seattle, and Philadelphia influenced the planning (and success) of each city’s streetcar system, as reported in the Case Study Report. A public meeting is planned for the Brooklyn Streetcar Feasibility Study in May. During this meeting, the alignment options will be presented for comment and input, and a ranking for this criterion will be added based on public input regarding the potential alignment options.

As reported in the Case Study Report, there are a multitude of planning and land use components that work together to create a successful streetcar system. Streetcars provide a historic, romantic appeal and have transformed blighted districts into vibrant areas in a number of U.S. cities. This occurred in Portland and Seattle, as both cities experienced increased development as a result of a streetcar system. However, other factors were at play that likely contributed to this growth, including local land use policies, the construction of a light rail system, urban renewal, and the ability to use tax district funds to subsidize infrastructure costs. In contrast, Philadelphia’s streetcar corridor has not experienced this type of growth. Although the return of the Route 15 trolley was justified for economic redevelopment reasons, the planning process lacked a master planning approach, and redevelopment has not progressed as hoped. In summary, it is essential that a comprehensive approach be applied to the planning and design of a streetcar system.

At this time, the City of New York has no plans to change land use zoning, or use other planning tools to spur economic development in Red Hook. In fact, the New York City Department of City Planning has identified the Red Hook waterfront as a working waterfront, to be maintained in its current industrial state.[7] This conflicts with the mixed used development that typically complements a streetcar system.

It is difficult to determine the viability of the most desirable alignment options from a capital investment perspective. Are the benefits (i.e. increased transit trips, reduced congestion, reduced greenhouse gas emissions) that are expected to be realized from a modern streetcar system commensurate with the costs associated with the system from a ridership, land use, economic development, and quality of life perspective? This is particularly challenging as some benefits would be qualitative in nature, and may not necessarily be quantified from a pure cost/benefit analysis.

## SUMMARY

The selection and evaluation of the alignment options, streetcar feasibility considerations, capital and operating costs, public support, zoning and land use policies in Red Hook, and expected benefits have led the NYCDOT to develop a policy decision for a future streetcar service in Red Hook, Brooklyn. The NYCDOT has determined a streetcar system would be better suited in a neighborhood with fewer physical constraints and potential conflicts (i.e. wider streets). In addition, in implementing a comprehensive planning approach, the neighborhood should be a higher density mixed-use zone, or have the potential for being made into a supportive land use. At the present time, these conditions do not exist in Red Hook.

If in the future, consensus for development becomes apparent, the neighborhood planning goals change, or as economic recovery continues, a streetcar system could become feasible. This document would then provide a resource for future planning and design of a streetcar system. In the interim, the NYCDOT and MTA NYCT are investigating other opportunities to improve transit mobility and accessibility in Red Hook that would be feasible in the short-term, and would be less costly to implement.

[7] NYC Department of City Planning identified the Red Hook waterfront as a Significant Maritime Industrial Area (SMIA) in its 1999 *Waterfront Revitalization Program.*