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ATTRIBUTION

The QueensLink Corridor Analysis was paid for with Discretionary Funding through the NYC Council. The study was commissioned by QueensRail Corporation, a 501(c)3 Not-for-Profit that advocates for improved public transportation and in a community sensitive and environmentally responsible way.







1. INTRODUCTION

The New York rail and transit systems have been subject to change over the years due to the evolving transportation needs of the city. The continuing evolution and integration of the rail system has been facilitated by the joint ownership of both the New York City Transit Authority (NYCTA) and Long Island Rail Road (LIRR) by the Metropolitan Transportation Authority (MTA.)

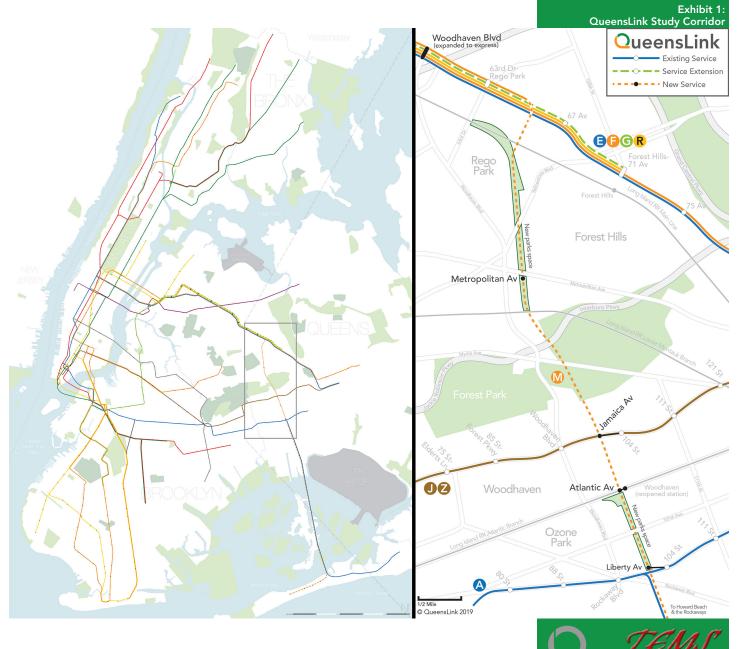
The QueensLink Corridor, formerly known as the Rockaway Beach Branch (RBB) in Exhibit 1 is a currently disused segment of former LIRR rail line that has been lying idle since service ended in 1962, but the right of way is still in public ownership. QueensRail has worked to create **QueensLink**, a dual rail and park project and advocates for utilizing this alignment for both rail and trail use. QueensLink is the name for an ambitious, forward thinking, rail and trail project that will be built along the old RBB right-of-way.

If service were restored as part of the NYCTA subway system rather than in its historic role as an LIRR branch line, the corridor could serve a very new purpose in New York's transit system. It would provide a north-south rail link in an otherwise east-west transit system that has primarily focused on getting daily commuters to and from Manhattan. While the proposed QueensLink would help speed some Manhattan trips as well, its ridership will be much more focused on the local Queens internal travel market than these other rail lines.



Previous studies have suggested that the QueensLink project could be feasible from an engineering point of view but have reported very high costs and potential negative impacts on existing rail and subway operations. Considering the critical role played by the RBB/QueensLink corridor for increasing mobility and efficiency of travel in Queens, it is essential to review the existing studies in terms of their costs and economic impact.

QueensRail Corporation, a 501 (c) a Not-for-Profit that advocates for improved public transportation and in a community sensitive and environmentally responsible way, has asked TEMS to undertake a preliminary review of previous studies, to identify ways to make the project more affordable, and to quantitatively assess the likely economic impacts of the corridor.



1.1 PURPOSE OF THE STUDY

The purpose of this study, which is Phase 1 of a full comprehensive Feasibility Study, is to provide a "prima facie" assessment of the opportunity, to review previous studies, and provide a guide to the economic impact that the development of the QueensLink is likely to provide.

- The current phase of work will undertake a review of previous research and reports, but most particularly focus on the most recent engineering study by SYSTRA ¹, to provide an understanding of the potential offered by adding the RBB-QueensLink interconnection to the New York subway system, and the weaknesses and strengths of various proposals for developing the system. This will provide a clearer picture of what next steps should be taken, and where extra data and information will be needed to allow QueensRail to move forward with its advocacy of the rail line opportunity.
- It will also assess the likely Economic Impact of developing the QueensLink corridor. This analysis will be completed by a benchmarking process that uses the findings of previous studies, appropriately scaled, to identify the likely range of Economic Impacts that will be generated by the system.
- In the next phase of work, a Business Plan can be developed that will consider all critical factors in moving the project forward. These include its capital costs, operating performance, development of a detailed ridership forecast, operational impacts assessment, financial performance and a cost benefit study that meets USDOT requirements, the contribution to the regional economy in terms of both transportation mobility and economic impact at stations along the route, and potential fundability including innovative options such as Private Public Partnerships, such as are being used to develop the REM Light Metro system in Montreal, Canada. This Business Plan would provide a detailed financial and implementation roadmap for supporting the actual implementation of the QueensLink project.

This Preliminary Assessment will consider the strengths and weakness of previous planning work and identify opportunities and approaches not considered in the earlier assessments. It will identify some new approaches and factors to be considered and propose new development scenarios for evaluation. These new scenarios will consider the full range of factors including how the markets for the service can be developed to maximize the benefit to the region, ways by which the project can be made affordable in terms of capital and operating costs, and for optimizing the likely impact of the scenarios on the regional economy.



1.2 REPORT OUTLINE

Chapter 1 – Introduction: This chapter details the work that will be undertaken as a part of this Phase I – Preliminary Assessment as well as describing the path forward for development of a Phase II – Business Plan.

Chapter 2 – Review and Assessment of Previous Studies: This chapter reviews the history of the RBB for putting both the historical and current studies in context. Over the years certain unifying principles have emerged as common factors leading to a lack of progress. The path forward must directly address these issues if we wish to develop a different outcome for the corridor.

Chapter 3 – QueensLink Development: This chapter focuses on a detailed description and definition of the QueensLink corridor itself in terms of the option that has been defined for assessment here. A key component of this chapter will be the integration of a rail and parkway alignment along the corridor.

Chapter 4 – Capital Cost Benchmarking Results: This chapter summarizes the key results of the benchmarking of the SYSTRA report, and specifically the Capital Cost estimates. A detailed explanation of the benchmarking procedure and assumptions used in this review is provided in Appendix A.

Chapter 5 – Economic Impact Benchmarks: This chapter summarizes the key results of the benchmarking of the Economic Rents impact analysis estimate. It provides a quick introduction to the concepts underlying the economic rests analysis but then focuses on the detailed explanation of a benchmarking procedure.

Chapter 6 – Conclusions and Next Steps: This chapter describes the key study findings to-date and proposes next steps for further consideration in future studies.



2 REVIEW AND ASSESSMENT OF PREVIOUS STUDIES

Historically, LIRR service to the Rockaways has been provided over two different routes: the Far Rockaway Branch through Nassau County which remains as an LIRR route today, and the Rockaway Beach Branch (RBB) line which provided a more direct route using a trestle across Jamaica Bay. Exhibit 2 shows the RBB line in its historical configuration as a LIRR branch line. The abandoned portion is shown as a dashed red line, along with the historic stations in their original locations.

Rockaway Beach Branch Study Area

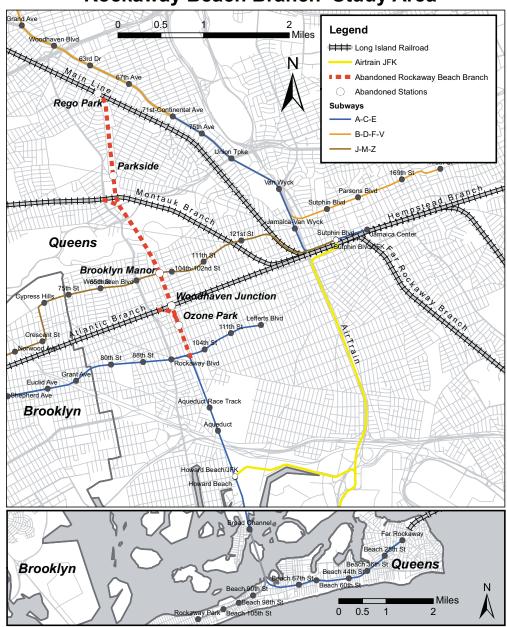
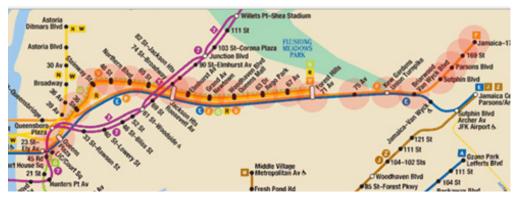


Exhibit 2: Rockaway Beach Branch (RBB) Study Corridor



However, a fire on the trestle on May 8, 1950 cut service to the south end of the RBB line. The LIRR, then bankrupt, saw the Rockaway Beach Branch as a liability, but the City of New York saw great potential in extending subway service over Jamaica Bay and purchased the whole line on June 11, 1952 for \$8,500,000². When New York bought the RBB line in 1952, it had a choice to connect it to any of three possible subway routes:

The first possibility would have been to connect it to the Queens Boulevard line (QBL, which operates "F", "E", "M" and "R" trains) as had been planned from the beginning. However, this was more expensive than any of the other options because it would have required the development of a tunnel from the Rego Park/63 Drive station over to White Pot Junction for connecting to the newly purchased right-of-way. Making this connection is, of course the object of the current study. The Queens Boulevard Line (QBL) and its stations are shown in Exhibit 3. As shown in Exhibit 3, the QBL also has a branch to Jamaica center, where the route connects with the LIRR Jamaica station and AirTrain to JFK Airport.

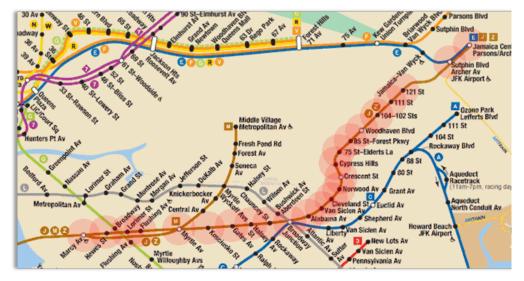


The second possibility would have been to connect the RBB-QueensLink to the BMT Jamaica Line (which operates "J" and "Z" trains). However, the line interlines with the Myrtle Line ("M" train) over the Williamsburg Bridge, constraining the capacity of this line. It does not appear that connecting the RBB-QueensLink line to the BMT Jamaica Line at Brooklyn Manor ever received really serious consideration, but it was one of the options on the table at the time. This line is shown in Exhibit 4 on the next page.

Exhibit 3: IND Queens Boulevard Line or QBL¹



Finally, the third possibility, which is the option that was selected, was to connect the RBB-QueensLink to the IND Fulton Street Line. As shown in Exhibit 5 on the next page, the Fulton Street Line (which operates "A" and "C" trains) extends to Lefferts Boulevard, but it was originally planned to have extended much farther east into Queens. Much of the route was built with quadruple track and yet because the line had never been fully extended it has a lot of available capacity. Connecting the RBB-QueensLink to the Fulton Street line would have been by far the cheapest of the three options available to the city, so this was the most expeditious choice available to the City of New York back in 1952 when it chose to connect the Rockaway Branch line extension to the Fulton Street Line, rather than to either of the other two possible routes.



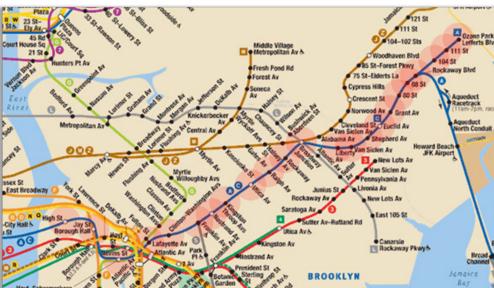


Exhibit 4: BMT Jamaica Line²

Exhibit 5: IND Fulton St Line³



After the fire on the trestle across Jamaica Bay, the LIRR continued to operate the RBB as far as it could, to Hamilton Beach just north of the trestle; and it served the Rockaways using a circuitous route via the Far Rockaway Branch. But on June 27, 1955, the LIRR stations south of Ozone Park were taken out of service so the line south of there could be rebuilt for subway operations. No LIRR trains ever ran south of Ozone Park again. Shortly after the LIRR operation was truncated, the RBB connection to the Atlantic Branch at Woodhaven Junction was closed and removed in October 1955. This connection had primarily been used to allow trains from Brooklyn to reach Aqueduct Racetrack. After the line was truncated at Ozone Park, riders from Brooklyn could no longer use LIRR to reach the Racetrack; they needed to use the IND Fulton Street line instead.

After rebuilding the trestle across Jamaica Bay, the city began operating the southern end of the RBB line as the IND Rockaway Line on June 26, 1956. (Exhibit 5).

LIRR service continued on the remaining 3.5-mile portion of the RBB from Rego Park to Ozone Park, under a lease from the city. No connection with the IND Rockaway Line was ever made in Ozone Park, stunting any potential for ridership growth. As service and ridership on the truncated branch line sharply declined, weekend service ended in 1957, and by 1959 just one train was still operating in each direction between Penn Station and Ozone Park (Penn Station-bound in the morning, and Ozone Park-bound in the evening) on weekdays. The LIRR quietly ended RBB service on June 8, 1962.

No sooner did RBB service end, than studies began on service restoration. The earliest of these proposals was a 1963 proposal (Exhibit 6) that would have connected RBB to the IND Queens Boulevard Line. This had been proposed under the IND Second System and a provision was built at the 63rd Drive subway station for a future connection to the RBB line.

According to Raskin³ in spite of the apparent desirability of the RBB connection to the QBL, the historic failure to reactivate the northern portion of the RBB line has been due to the high costs of the needed tunnel for connecting RBB to the QBL, and due to capacity issues on the QBL line at the time. These are recurring themes which have echoed in all subsequent studies since 1963 up to the current day.

To address congestion issues on the QBL, the 63rd Street-Queens Boulevard Connection project began construction in 1969 but was delayed by the city's fiscal crises in the 1970's. Funding issues prevented this route (called the 63rd Street line) from being completed as planned on the Queens side, and so it was terminated at the 21st Street station. Initially dubbed the "tunnel to nowhere" the partially finished line was not put into service until 1989.

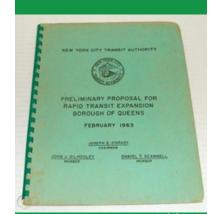


Exhibit 6: 1963 NYTA RBB Study



Given the limited connection, it had only a small ridership in Queens and was underused. Meanwhile, nearly 200,000 people using the QBL to commute between Queens and Manhattan experienced severely overcrowded trains. The E and F routes along the QBL operated at more than 120- percent capacity during peak hours.

The 63rd Street-Queens Boulevard Connection project had a simple mission: to traverse 1,500 feet underground to connect the 63rd Street tunnel to the QBL. The link involved extending the existing tunnel from just east of the 21st Street station to the QBL roughly halfway between the Queens Plaza and 36th Street stations. It was designed to increase the number of rush-hour trains into Manhattan by 50 percent, from 30 to 45, easing overcrowding on the E and F lines. Although only about one-third of a mile was needed to connect the two subway lines, the project was situated in a complex subterranean infrastructure posing significant engineering challenges. Construction was started in September 1994 and completed in 2001.

The 63rd Street-Queens Boulevard Connection provided a desperately needed over-flow for what were the crowded E and F lines running through Queens. The F express was rerouted through the new tunnel, and the V, a brand-new train line, was added along Queens Boulevard as a local along the route the F once took. As a result of the increased number of trains running along the QBL with the connection, New York City Transit estimates that the average Queens rider on the E, F, and R lines saves approximately 31 hours per year because of the 63rd Street Connection project.

Some service changes that were implemented with the opening of the new connection created dissatisfaction among some commuters who had taken the F express through its old route. However, the connection enabled a significant expansion of service capacity for NYCTA, increased commuter options for customers, reduced overcrowding between Manhattan and Queens, and reduced commute time for passengers. The implementation of this 63rd Street connection has sufficiently resolved the capacity issues along the QBL to allow for serious reconsideration of the possibility of adding an RBB interconnection.

An additional recurring theme has been the numerous studies over the years that have attempted to develop a single-seat ride from JFK Airport terminals to Manhattan. This has proven to be an elusive goal for New York, in spite of the fact that many other large cities in the world have been able to achieve it. Nonetheless, the RBB line has been repeatedly recognized as an ideal alignment for reaching JFK Airport and is understood to be a key part of any such plans. The RBB line was assessed by SYSTRA for this purpose as recently as 2018⁴. Many other single seat-ride studies have similarly focused only on LIRR options to the neglect of NYCTA options^{5,6,7}. Some have proposed operating Air Train vehicles on the LIRR tracks, which is not allowable under FRA crashworthiness regulations⁵, or operating special



LIRR vehicles on the Air Train tracks, which would bring the Air Train system under FRA regulatory jurisdiction.

In the numerous airport access studies that have been performed over the years, the clear focus has been on getting air travelers from Manhattan to JFK as quickly and comfortably as possible, but the local communities along the route have seen no benefit to themselves in these proposals and have opposed them on environmental grounds⁸. This stalemate is likely to continue so long as airport access studies continue to be separated from the issue of access and transit needs of the local communities.

A third recurring theme has to do with the structure of NYCTA services themselves. The NYCTA's capacity issues have become a significant inhibitor to further system development. NYCTA does not want to extend routes if this will further exacerbate the overcrowding conditions that it already experiences on its core network. In fact, this issue has specifically inhibited the development of the RBB interconnection over the years.

The NYCTA subway system, being one of the world's oldest systems, has evolved over the years into a highly complex and interconnected rail network. It has two divisions, "A" (IRT) and "B" (BMT/IND) built to different standards regarding curves and platform widths, requiring two different equipment fleets and limiting interoperability between lines. Many stops are very closely spaced, slowing the trains, although in some cases this has been mitigated by the provision of additional "Express" tracks, so that "Express" trains are able to perform up to the standard of modern Metro systems (such as BART and WMATA) in terms of average speed and travel time. However, some lightly used lines that do not have enough volume to support express trains have some very long travel times, because of their numerous stops.

NYCTA's network also features many complex network interconnections. This high degree of network interconnectivity expands the number of single-seat rides and reduces the number of transfers that passengers have to make. However, it can also exacerbate NYCTA's capacity issues. A tradeoff associated with this complexity is the tendency for delays on any one route to propagate across the whole network, especially as lines reach capacity. As a result, a complex interconnected system like New York's can only work well if the lines are operating with some slack capacity. In recent years some lines however have been operating at essentially full capacity. NYCTA's current initiatives for installing Communications-Based Train Control (CBTC) may help reduce the problems, but they cannot fundamentally eliminate the problem of cascading delays as the physical capacity of the subway tubes and stations is reached.

^{5.} FRA based its new Tier 3 rail crash worthiness regulation on the European Standard EN 15227 for main line railway vehicles, which still requires much heavier vehicles than are used for Metro or subway operations. As a result, even with the new regulations it is not allowable to mix NYCTA and LIRR vehicles on the same track without temporal separation. See: https://www.cencenelec.eu/news/articles/Pages/AR-2020-011.aspx



This has led to pressure from some quarters for "de-interlining" NYCTA routes, which means simplifying the operations of heavily used rail lines and reducing the number of subway route interconnections. The ideal situation from an operational point of view would be that each route operates independently, as the Canarsie Line does today. However, an inevitable result of "de-interlining" is a reduction of single seat rides and an increase in the need for transfers, and this may reduce the attractiveness of NYCTA subway service to the riders.

The US economy is only now recovering from the COVID-19 pandemic, and a consensus view in the transit industry seems to suggest that for the next few years at least, an increase in telecommuting may reduce peak hour loads. This will require more emphasis on improving all-day and evening transit services especially for the benefit of "essential" workers. If this results in a more evenly spread pattern of travel demand across the day, it will actually be more efficient for transit agencies to serve, since high peak demands result in poor equipment and crew utilization. Such high peaks are very expensive to accommodate. A reduction of peaks and smoothing of demand across the day may help to alleviate some capacity problems on NYCTA's routes, at least in the short term, and reduce the pressure for "de-interlining." Any shift of demand away from the peak towards off peak hours could buy the NYCTA additional time for addressing its capacity issues.

Furthermore, some of the NYCTA's most crowded subways are, of course, in Manhattan. If by providing connections outside Manhattan it would be possible to deliver commuters closer to their actual destinations, then some of the most critical bottlenecks may be alleviated. Major initiatives like LIRR East Side Access may alleviate overcrowding on some of the busiest Manhattan subway lines. A reactivation of the RBB-QueensLink corridor could well result in some shifts in travel demand across the network, improving capacity in Manhattan:

- For example, riders commuting from the Rockaways to mid-town Manhattan must today endure a very long and circuitous subway ride through Brooklyn, then ride half the length of Manhattan before reaching their destinations.
- Reactivation of RBB-QueensLink would give these riders a faster, more direct
 way to travel since some riders would be expected to shift away from the Fulton
 Street line and travel via the QBL instead.



By building the QueensLink it may also be possible to increase overall service on the QBL by restoring the Crosstown "G" train from Court Sq back to Forest Hills-71 Av. As operated, Forest Hills only has a capacity to turn 20 trains per hour (TPH) on the local tracks; express trains run at a higher frequency and continue through the station. The limiting factor is not the tunnel itself but the terminal. With the existing signal system it should be possible to run up to 30TPH on the local tracks. If the QueensLink siphons off one of the local lines, this would then open up these slots at Forest Hills, keeping the same level of service there while increasing local service between Queens Plaza station and 63rd Dr station 50%.

In general, any shift of riders away from longer slower routes, toward shorter more efficient routes should actually benefit the NYCTA in terms of reduced operating costs. For the long term, it is likely more cost effective to expand subway capacity in the outlying boroughs, since any capacity expansion in Manhattan will almost assuredly require expensive tunneling under difficult circumstances. Therefore, it makes sense to let subway riders sort themselves outside of Manhattan, as QueensLink would do, so that riders can approach the urban core on the optimal routes. The expected RBB-QueensLink ridership shift would relieve demand on some very congested Manhattan subway routes, so even if it does put more load on the QBL, this should still result in overall better performance for the network.

In the next phase of study, the ridership impacts and segment loadings should be quantitatively modeled, so the network impacts of the proposed RBB-QueensLink interconnection on capacity, ridership and operating costs can be effectively determined.



3 DEVELOPMENT OF THE QUEENSLINK

The QueensLink looks to provide a new north-south transit connection in Queens, by integrating the currently abandoned segment of the RBB into the NYCTA subway system. As shown in Exhibit 7 on the next page, a new 3.7-mile NYCTA link would be developed south from Rego Park station through the neighborhoods of Forest Park, Woodhaven, and Ozone Park to join the existing "A" train route to Rockaway Park at Liberty Avenue. QueensLink proposes to develop the RBB as an NYCTA service to implement the long-planned direct connection between the QBL and the Rockaways, and this would facilitate the diversion of "M" trains to the RBB line via Queenslink

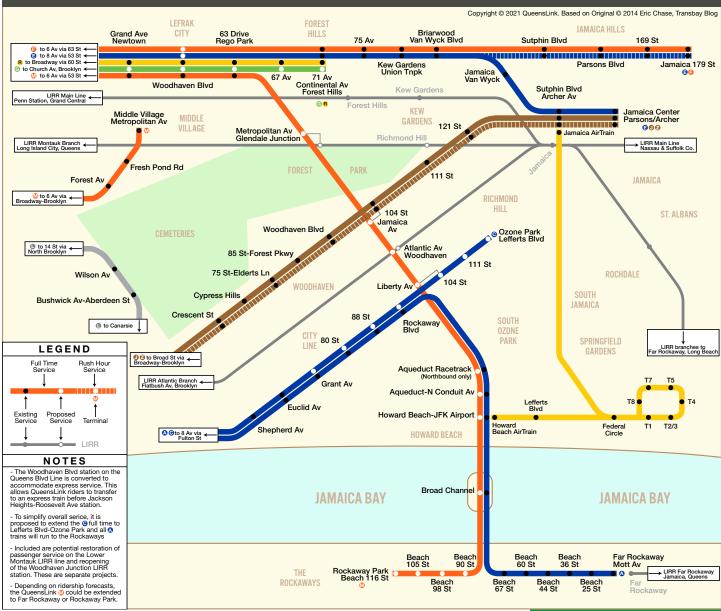
This relatively short segment of rail line would link two otherwise disconnected portions of the New York City subway system, while interconnecting with no fewer than four other rail lines. Today, making a trip between south and north Queens requires either traveling west through Brooklyn and Manhattan, then back out to Queens again; or else east to Jamaica Center, which today provides the only direct connection in Queens between the southern and northern parts of the subway system. The proposed QueensLink corridor would unify Queens by linking the southern portion of the borough with major developments along Queens Boulevard, as well as by providing a more direct route from southern Queens to mid-town Manhattan.



QueensLink

Reactivation of the LIRR Rockaway Beach Branch for Integration into the New York City Subway

Conceptual Schematic



The NYCTA has already integrated a portion of the RBB corridor south of Liberty Avenue by connecting it to the IND Fulton Street line (Exhibit 5). However, from Liberty Avenue north to Rego Park, a 3.5 mile stretch of former LIRR alignment remains unused (Exhibit 2). A 0.2-mile tunnel connection is needed in Rego Park to link the QBL to the RBB line and the Rockaways. This has been planned for a long time, so the Rego Park subway station already has the bell mouths needed to accommodate the planned rail connection.

Exhibit 7: Conceptual Schematic for QueensLink Integration⁶



As shown in Exhibit 7, interchange stations are proposed at four locations for providing easy connections with all the crossing rail lines. By virtue of these interconnections, the QueensLink can serve not only Rockaway riders and those living near its stations, but it can also offer improved mobility throughout all of Queens. Station stops will be recommended at Metropolitan Ave.-Glendale Jct., Jamaica Avenue, Atlantic Ave.-Woodhaven Jct. and Liberty Avenue. Thus, the QueensLink will make new transit trips within Queens possible and will also speed existing trips to midtown Manhattan:

- The first benefit of QueensLink will be to connect southern Queens to local destinations along the QBL, which the current NYCTA network does not do. As a practical matter, southern Queens residents who wish to go to Queens Boulevard today must either take a slow bus service or drive their automobiles. Beyond service to local station, transfers are now available so that riders can continue to other areas of the city and Queens, such as Jamaica and Flushing.
- A second benefit of QueensLink will be to offer a faster ride for southern Queens residents to get to mid-town Manhattan. This would be facilitated by converting the QBL Woodhaven Boulevard station (the next station west of Rego Park) into an Express configuration as originally planned⁷. From Woodhaven Boulevard, express riders would have only three stops to mid-town Manhattan on either the E or F trains. An added benefit to this conversion would be a reduction in transfer-related delays at Roosevelt Ave-Jackson Heights station as riders could transfer earlier at Woodhaven Blvd.
- Likewise, the QueensLink would provide residents of northern Queens with a
 one-seat-ride to Rockaway Beach in the summer time. This would bring many
 more revelers to the beach, increasing customers for small businesses there and
 reducing the levels of car traffic on the peninsula.
- Finally, bicycle and walking trails that could be developed along the right of way could help facilitate access to QueensLink's stations using non-motorized modes of transportation. Many parts of Queens still remain beyond walking distance from any rapid transit station, but can use bicycle, bus or auto for accessing the rail system. Careful consideration of the needs of pedestrians and bicycles is not just about parks, but serves an important transportation need as well.

^{7.} The QBL Woodhaven Boulevard station has had provisions for conversion to an Express configuration since it was built. This conversion would be an optional add-on to the QueensLink interconnection and we do not have a cost for it, since this was not assessed by SYSTRA in their recent study of the RBB. It would shorten trip times to Manhattan for RBB interconnecting riders, so the cost for making this conversion should be estimated in the next phase of work.



Rebuilding the Rockaway Beach Branch right of way has the potential to add up to 33 new acres of parks and protected bike paths along the right-of-way. The section of embankment running from Fleet Street to Union Turnpike spans 100 feet at its base but only has about 35 feet at track level. There is no space to fit both new tracks and recreational facilities atop the embankment. But if the embankment were not there at all, there would be a much wider space available to use for parks. As shown in Exhibit 8, removing the existing embankment, and replacing it with a rail elevated structure would create 25 acres of new park space.



A modern aerial guideway could be built to replace the existing earth embankment. A guideway is a much smaller, concrete structure which would use modern technology which makes significantly less noise. These guideways are the standard for new elevated track built all over the world. In New York it has been tried only on the AirTrain to JFK Airport. But even if this were not done, there is still a potential for improving the appearance of the existing right of way by landscaping accessible areas of the right of way, particularly underneath the bridges and viaducts as shown in Exhibit 9.

Exhibit 8: Rendering looking north from Yellowstone Boulevard showing proposed park below new





Exhibit 9: QueensLink on the Existing Embankment at Yellowstone Boulevard

To further reduce unwanted noise and visual pollution, sound barriers would be installed on the sides of the guideway and smaller embankments, no more than 8 to 10 feet high, would run along the sides of the new open space. Once planted, trees would further shield homes along the route from noise and prevent park users and train riders from seeing inside.

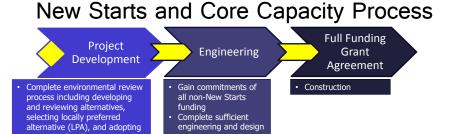
South of Forest Park the right of way becomes narrower and adjacent homes and back yards reach to the edge of the right of way. The section through Woodhaven from Jamaica Ave to Atlantic Ave is the trickiest section as the line runs closer to homes here than elsewhere. But there are options. A new aerial guideway would have a smaller footprint than the current earth embankment.



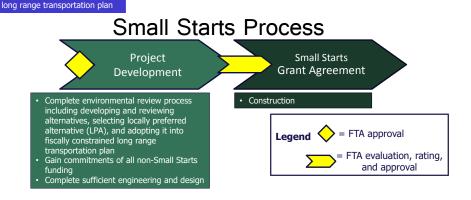
Exhibit 10: Possible Cut-and-Cover Tunnel Option for QueensLink



Exhibit 12: FTA Project Development Process for Capital Investment Grants



it into the fiscally constrained



The path forward for QueensLink, following the completion of the current feasibility study, will follow the Federal Transit Administration's (FTA) Project Development process, as shown in Exhibit 12. The formal FTA process starts with an Environmental review, which must include a significant component of public outreach providing opportunity for participation by the community in the development and selection of a Locally Preferred Alternative (LPA.) This shows how the decisions regarding the development of stations and enhancements, such as bicycle and parkway development will be made in future planning phases.



4 CAPITAL COST BENCHMARKING RESULTS

A key step in this assessment is a review of the project capital costs proposed by the SYSTRA study. The details of the capital cost benchmarking analysis are described in Appendix A. It is important to note that SYSTRA developed a cost only for adding NYCTA subway service to the Rego Park to Liberty Avenue segment, and SYSTRA's cost does not include any expenses for investments outside these specific project limits. For example, SYSTRA's cost does not include any costs for converting the QBL Woodhaven Boulevard station to an express configuration, or for providing a grade-separated rail junction at Liberty Avenue. The only adjustment made here was an allowance for adding direct connectivity to the Fulton Street and Jamaica Avenue NYCTA lines, which are within the project limits, as described below.

A key concern of SYSTRA's Engineering analysis has been that the bridges along the line have been out of service for many years, and this has led to some doubts regarding their structural integrity. However, an inspection of all the bridges by Weidlinger Associates, Inc.⁹ in 2014 seemed to suggest that many of the bridges may actually be able to be returned to service with only minor repairs⁸. Since this is an area of considerable uncertainty, a sensitivity analysis has been performed on the question of bridge replacement.

^{8.} From Weidlinger: "The bridges' current conditions are generally all in fair-to-good condition, and we observed no structures that appear to need major structural rehabilitation work, such as a superstructure, substructure, or major structural component replacement. There are concerns relating to the elevated viaduct structure running from 97th Ave to Rockaway Blvd., and more discussion on this structure is made below. Most of our findings and recommended repairs will be to address potential cosmetic or safety hazard defects due to continued further deterioration, and not structural defects."



Exhibit 13: SYSTRA Capital Cost Benchmarking Results

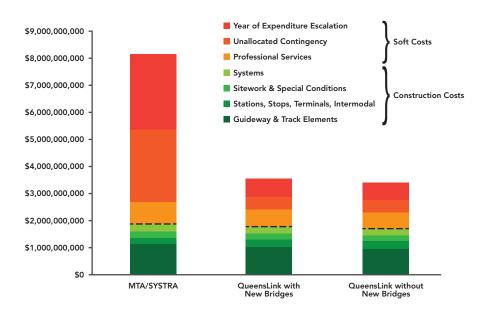


Exhibit 13 compares the original SYSTRA cost estimate to the benchmarked results, both with and without bridge replacement. The comparison shows a striking similarity in the basic Construction Costs for each option. The dashed line crossing the three bars in Exhibit 13 shows this comparison of construction costs. In terms of basic construction costs, some individual unit cost factors were adjusted in the benchmarking, but these unit cost reductions were generally offset by an increase in Allocated Contingencies. This comparison has found that the Construction Costs for RBB-QueensLink restoration will likely fall within a \$1.7 to \$1.8 Billion range and has validated SYSTRA's overall cost estimate.

It is clear in Exhibit 13 that the very high \$8.1 Billion SYSTRA cost estimate does not result from the detailed engineering cost build up, but rather from the application of very high, likely excessive levels of overhead applied in the SYSTRA estimate for Professional Services, Unallocated Contingency, and Inflation YOE Escalation (Soft Costs.) Although the basic engineering costs developed by SYSTRA appear to be reasonably solid on an overall basis, the escalation and contingency factors they applied to develop the \$8.1 Billion estimate are out of line with industry standards, exceed the levels recommended by USDOT FTA guidance and would not likely be accepted by FTA. Reducing these overhead and contingency allocations to industry standard levels, with the addition of soft costs, contingencies and YOE cost escalation, the overall project should cost in the range of \$3.4 to \$3.7 Billion in 2021 dollars. In the benchmark analysis it can be seen that the bridge replacement sensitivity shows that bridge costs have less than a 10% impact on the overall capital cost of the project.



Benchmark Results

The Economic Impact benchmarking in the next section will compare the QueensLink corridor with the Purple Line project in Maryland¹⁰. These two projects are similar since they are both essentially circumferential segments of new rail alignment that cross multiple existing radial commuter rail lines that serve the downtown business center.

For supporting a comparison of the results, the Capital cost of the Purple Line in SCC 10-80 (Appendix A) was estimated as \$1.6 Billion in 2007 dollars; but as according to the USDOT FTA cost database, there has been a 77% escalation in the construction unit costs since then, even though the general inflation rate has only been 24%.

- Applying this escalation factor to the Purple Line cost estimate, it would be a \$2.8 Billion project in current dollars, or \$175 million per mile.
- By comparison, the Capital cost of the QueensLink in SCC 10-80 is \$2.5 Billion (from Appendix A, Exhibit A.2) for a 3.9-mile project, or \$641 million per mile which is consistent with the cost of a heavy rail project with tunneling. SCC 10-80 includes allocated contingencies and professional services, but it does not include Unallocated Contingencies or future YOE escalation. The most appropriate basis for comparing the projects is on SCC 10-80 costs, since the Purple Line only used a 5% unallocated contingency, and its capital cost estimate did not include any YOE escalation factor at all.
- As a result, it can be seen that the QueensLink project will cost far more than the Purple Line; the high cost per mile of QueensLink is driven mostly by the cost of the tunnel connection to Rego Park at the north end. However, since the QueensLink is a much shorter project than the Purple Line, the QueensLink project as a whole is still slightly (11%) less expensive than the Purple Line, but the RBB-QueensLink has 30% greater ridership.

Summary

This review suggests that the capital costs for the QueensLink project are likely to be in the \$1.8 Billion range, and cost \$641 million per mile. Professional services and an unallocated contingency would raise costs to \$3.4-\$3.7 Billion in 2021 prices. Year of Expenditure (YOE) costs is not used in USDOT or state DOT cost benefit analysis. Cost benefit analysis for a project is always completed in base year (2021) real dollars.



5 ECONOMIC IMPACT BENCHMARKS

To estimate the economic impact of the QueensLink project, it is important to understand the character of the different economic benefits to be quantified. These benefits arise from developing and operating the system and have a substantial impact on the productivity of the local and state economy.

The Character of the Overall Economy – A model of the economy¹¹ shows that an economy is circular in character, with two equal sides (see Exhibit 14). On one side of the economy is the consumer side – the market for goods and services – in which consumers buy goods and services by spending the income earned by working for a commercial enterprise. For example, a transportation investment improves individuals travel times and costs and, therefore, increases consumer (traveler) surplus (travel and money savings). An analysis of the impact of a transportation investment in the market for goods and services quantifies the level of consumer surplus generated by a project, by showing how much money and travels individuals save because a given project (i.e., a transportation improvement) reduces their cost of travel, or makes their travel more efficient.

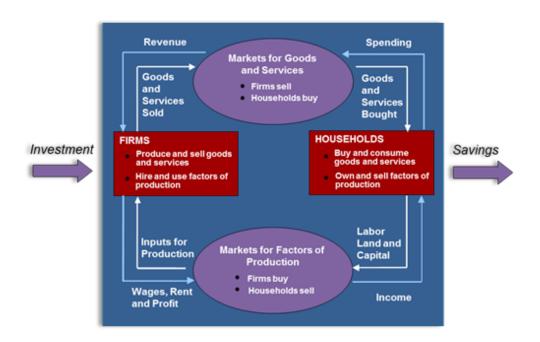


Exhibit 14: A Simple Model of the Economy



The notion that a transportation project can be worthwhile if travel is made more cost effective is based on the idea that not only the cost, but also the time of a trip, has value. This axiom is agreed to by most transportation companies and by business travelers as well as by both academia and important transportation authority's such as USDOT Federal Highway Administration (FHWA)¹² and Federal Transit Administration (FTA). In addition, academic and empirical research has shown that this concept holds true for commuters and social, recreational travelers as well¹³. Considerable research has been carried out to both identify the theoretical justification for value of travel time and to quantify its value.

On the other side of the economy is the market for factors of production. Most importantly, it is the market for land, labor, and capital, which individuals provide to firms in exchange for wages, rent and profit. From the perspective of policy makers and the local community, this side of the economy is very interesting as it shows how investment in a new transportation infrastructure changes the efficiency of the economy and how the investment increases transportation efficiency, creates new jobs, opportunities, and, therefore, increases income and wealth and expands the tax base.

One of the most important aspects of the circular economy model is that it shows that any project has two impacts, one in the consumer market – the benefits to travelers; the second, in the factor markets or supply side of the economy – the benefit to the community in terms of improved welfare such as increases in jobs, income and wealth (see Exhibit 15).

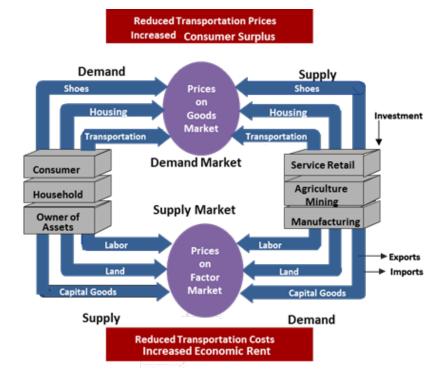


Exhibit 15: Relation between Consumer Surplus and Economic Rent in the Economy



For the economy to reach equilibrium, both sets of benefits must be realized. As such, the benefits of a project are realized twice, once on the demand side and once on the supply side. As a result, there are two ways to measure the productivity benefits of a transportation project and, theoretically, both measurements must equal each other¹⁴. This is a very useful property since in specific analysis one can be used to check the other, at least at the aggregate level. This is very helpful and provides a check on the reasonableness of the estimates of project benefits.

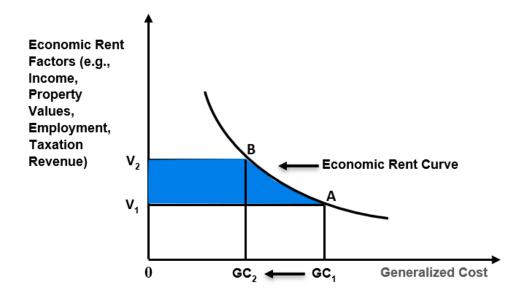
However, in assessing the benefits of a transportation project, it is important not to double-count the benefits by adding supply side and demand side benefits together. It must be recognized that these two sets of benefits are simply different ways of viewing the same benefit. The two markets are both reflections of and measure the same thing. For example, if both sets of benefits equal \$50 million, the total benefit is only \$50 million, but expressed in two different ways: travelers get \$50 million of travel benefits and the community gets \$50 million in jobs, income, increased profits.

As a ripple effect (or transfer payment) the economy also gets an expanded tax base. Therefore, if a given transportation project is implemented, equivalent productivity benefits will be seen in both the consumer market for goods and services (as the economy benefits from lower travel times and costs), as well as in the supply side factor markets. In the supply side market, improved travel efficiency is reflected in more jobs, income, and profit. For a given transportation investment, therefore, the same benefit occurs on both sides of the economy. In the consumer markets, users enjoy lower travel costs and faster travel times. On the supply side of the economy, the factor markets take advantage of the greater efficiency in transportation. As a result, both sides of the economy move to a new level of productivity in which both sides of the economy are balanced in equilibrium.

Improved efficiency will generate supply-side spending and productivity benefits that have a very real impact on the performance of the local economy. The method that develops estimates of productivity jobs and wealth creation is an Economic Rent Methodology. It measures how the performance of a new transportation facility raises the efficiency of the economy. This efficiency improvement creates jobs and income and raises local property values to reflect the improved desirability of living or working in the area. Specific methods for applying Economic Rent economic theory will be identified and appropriate measurement methodologies will be developed. In particular, the issue of measuring the quality of the transportation system will be addressed.



Economic Rent theory builds from the findings in Urban Economics, and Economics of Location that support Central Place Theory^{15,16}. Central Place Theory argues that in normal market economy places that are closer to the "center" have a higher value or economic rent. This can be expressed in economic terms, particularly jobs, income, and property value. There is a relationship between economic rent factors (as represented by employment, income, and property value) and impedance to travel to market centers (as measured by utility or generalized cost). As a result, lower generalized costs associated with a transport system improvement led to greater transportation efficiencies, and increased accessibility. This, in turn, results in lower business costs/higher productivity and, consequently, in an increase in economic rent. This is represented by moving from point A to point B in Exhibit 16.



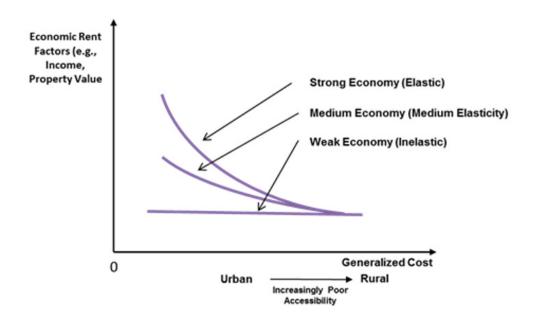
The shape of the economic rent curve reflects the responsiveness of the economy to an improvement in accessibility. Large cities typically have very steep curves, which indicate more significant economic impacts due to a transportation improvement; smaller communities have less steep curves, and rural areas have very flat curves that indicate lower economic responsiveness (Exhibit 17). However, the New York City area is known to have one of the steepest Economic Rent Curves in the nation, as evidenced by the astronomical property values in Manhattan and generally high property values throughout the rest of the region.

Property value increases associated with a strong Economic Rent curve will manifest themselves in several ways. A major portion of the benefit will be spread out among existing property and landowners who will see major appreciation in the value of their properties. This is well documented in various studies of the impact of commuter rail^{17,18}, where value increases in the order of 10% of appraised suburban property value are typical; however, for the development of a rapid transit service in a heavily urbanized area, the value increases can be much greater.

Exhibit 16: Economic Rent Illustration







Although not typical, we are aware of one instance where the property value of a condominium property tripled as a result of the implementation of the Hudson-Bergen Light Rail project.

In some instances, the property value increase is so great that it can spur new Transit Oriented Development (TOD), which represents only a fraction of the total value created by a transit project. It is typical for the value of TOD alone to exceed the cost of the transit project; for example, in Exhibit 18 the Hudson-Bergen line investment of \$2.2 Billion triggered a \$5.3 Billion housing and office development boom along the west shore of the Hudson River; the results of which can now be seen on any Circle Line tour of the New York waterways. TOD alone, which only represented a small share of the total value increase, was 2.4 times the investment in the rail system. These results are typical for a well-planned and executed urban rail transit project.



Exhibit 18: Hudson Bergen Case Study¹⁹



Economic Impact Assessment – The development of a full Economic Rents calculation requires the development of a fully calibrated COMPASSTM forecasting model. Since this is not available for this Preliminary Assessment, a benchmarking approach has been used to develop a very high-level estimate of the likely economic impact that QueensLink will have on the economy of Queens and New York City.

Impact of the QueensLink on Corridor Ridership – A key feature of the QueensLink route is the fact that it provides transfers between rail lines that will multiply both ridership and economic benefits of the system. For example, the Purple Line (in the Washington D.C. suburbs of Maryland) is a 16-mile circumferential light rail line that will link Bethesda, Silver Spring, College Park, and New Carrollton. In making this connection, it will cross MetroRail in four places, with direct connections to the Red, Green and Orange Lines. It also connects to all three of MARC's commuter rail lines, to Amtrak, and of course with local bus services all along the route. This connectivity has had a multiplier effect on both the forecasted ridership and therefore the economic impacts of the Purple Line¹⁹. See Exhibit 19.

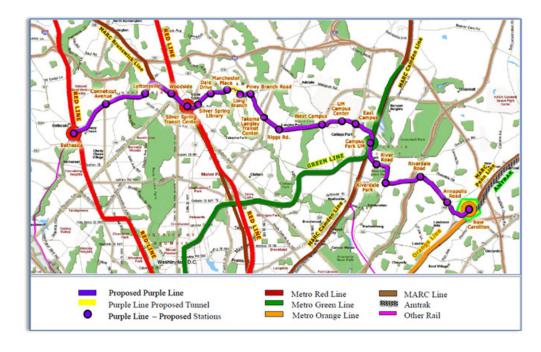


Exhibit 19: Purple Line Route and Station Map



As shown in Exhibit 20, the local traffic is increased by interconnecting riders who make use of the ability to use two or more routes to get to their final destination. Interconnecting ridership with other rail lines raised the Purple Line's base line corridor ridership estimate from 36,100 to 68,100, an 88.6% increase due to connecting traffic.

Transit Ridership (daily boardings)	Low Invest. LRT	Low Invest. LRT	High Invest. LRT
Purple Line	32,500	33,900	<mark>36,100</mark>
Purple Line via Metrorail	25,300	27,200	30,500
Purple Line via MARC	1,500	1,500	1,500
Total	59,300	62,600	<mark>68,100</mark>

Since the QueensLink forecast of 47,000 riders daily by SYSTRA does not include connecting ridership, it is comparable to the base 36,100 daily riders for the Purple Line. Taking account into account of the increasing ridership due to the proposed connectivity due to the new stations of the QueensLink project, the ridership forecast would increase to 88,642 daily riders. This shows that the overall daily ridership for the QueensLink will be 30 percent higher than that of the Purple Line. This is reasonable given the density of the QueensLink population and the fact that QueensLink is being developed as a heavy metro, whereas the Purple Line is being built as a light rail project.

Benchmark Analysis

Using the above data, the following benchmark analysis was completed between the Purple Line corridor and the QueensLink corridor:

- For estimating the economic rent elasticities as required in Exhibit 16, the population density of Montgomery County, MD. (in which the Purple Line is located) is 2,117 people per square mile. By comparison, the population density of Queens, New York is 21,000 people per square mile. This is nearly a 10 to 1 ratio in population density for the counties as a whole. As a result, the population densities of the zones served by QueensLink are between 10 to 20 times those of Purple Line's zones.
- If we adjust the Purple Line economic rent elasticity based on the square root of population density, the economic rent elasticity of QueensLink's zones will to be 3.1 to 4.5 times stronger than that calibrated for Montgomery County, MD.
- Since ridership is 30% greater the multiplier factors on the Purple Line economic benefits would fall in the range of 4.0 to 6.0.

Exhibit 20: Year 2030 Purple Line Forecasted Ridership



The application of the rent elasticity multipliers on the results of the 2015 update of the Purple Line's economic impacts suggests that the productivity impacts of the Purple Line investment will likely fall within the ranges shown in Exhibit 21. As a result, the Purple Line will create over 24,000 jobs, raise income by \$2.2 Billion per year, and increase property values by nearly \$13 Billion in the corridor. For QueensLink, the impact will be 4 to 6 times larger.

The estimates for QueensLink are:

- Employment 100,000 150,000 annual jobs over the life of the project
- Income \$9 Billion to \$13 Billion per year over the life of the project
- Property Value \$50 Billion to \$75 Billion increase over the first 5 to 10 years

	Purple Line in Maryland	QueensLink Adjusted Rang
Employment Increase annual jobs	27,183	100,000 to 150,000
Personal Income Increase per year	\$2.2 Billion	\$9-13 Billion
Property Value Increase over the life of the project	\$12.8 Billion	\$50-75 Billion

For the Purple Line, the property value increase was projected to be 4 to 6 times the capital cost of the project even at an inflated 2020 level. For QueensLink, the property value increase will likely be 15-20 times the capital cost of the project. This is largely because the completion of a relatively short connection will leverage the still unrealized value associated with previous multi-Billion-dollar investments that have already been made in the existing rail network by serving additional destinations with the same infrastructure.

In addition to the community benefits that will be realized by the QueensLink system, a Cost Benefit Analysis of the demandside benefits will show reduced travel times, reduced auto congestion, reduced fuel use (gasoline), reduced emissions, and improved accident and safety benefits. Finally, a detailed input/output analysis is required to show the temporary construction jobs that will be created by the building of the project.

Exhibit 21:
Employment, Income
and Property Value
Comparison of Economic Benefits
with the Purple Line



While this is a very preliminary analysis, order of magnitude estimates of the value of the economic benefit associated with the productivity improvement to the economy suggests a very substantial benefit to the corridor. Because of the strength of the ridership forecast, its connectivity to other rail lines and the steepness of the economic rent curve in New York City (which has the strongest economic rents and highest property values in the USA) the economic benefits associated with the QueensLink project will be very large.

Given the cost of the QueensLink corridor and the size of its benefits, it is essential to follow-up this preliminary analysis with a comprehensive feasibility study. As part of that analysis both a traditional cost benefit analysis that is used to guide USDOT and state DOT project funding and an economic rent analysis is needed to show how the local economy will grow and develop with the development of the QueensLink corridor.

A more specific economic impact study that will assist the benefits to the community will require the development of the COMPASSTM and RENTS™ models, similarly to those that were developed for the Purple Line in Maryland, to provide a more precise estimate in the future.



6 CONCLUSIONS AND NEXT STEPS

The QueensLink corridor is a "low-hanging fruit", which could add immense value to New York City's transportation infrastructure if the link were added into the NYCTA network. In recent years due to the size and scope of its network and weak support from the Federal Government, NYCTA has been hard pressed just to keep up with its state of good repair backlog, including recovery from Superstorm Sandy and the COVID-19 pandemic, while the MTA has struggled to deliver major projects including East Side Access and the 2nd Avenue Subway. These issues have been commanding the attention of MTA management, but even so, there are still many opportunities for improving transportation in the outlying boroughs. New York City already has the largest heavy rail transit system of any city in North America and even with such a large network, there are many untapped opportunities for the development of new services and many needs for capacity expansion across the system.

Building the QueensLink corridor to connect the Queens Boulevard Line south to the Rockaway Beach Branch is clearly one of these opportunities because of the size of benefits it generates. These benefits would be to travelers in Queens, and to its improved connections to markets outside Queens. Furthermore, it offers an opportunity as a potential access to JFK and LaGuardia airports. This relatively short rail link could help MTA extract the maximum value from its heavy rail network by increasing the range of origin-destination pairs that the network can serve.

Economic Impact Results – The economic impact of building the QueensLink is to generate significant benefits for the community of Queens.

- Significant increase in long-term productivity employment. This is estimated at between 100,000-150,000 annual jobs over the life of the project.
- Increased personal income of between \$9 Billion and \$13 Billion per year. This results from the increased long-term employment and the higher value of the wages created within Queens.
- Property Values will increase significantly with major opportunities for commercial and office and housing development at or near the new stations to be created along the corridor. This could be between \$50 Billion and \$75 Billion.

Clearly these benefits are very significant and would greatly add to the integration of the Queens community providing not just significant mobility, but also potential re-development of the urban infrastructure and opportunities for recreational activities. It should be noted that not only do the benefits appear very large, but there is strong evidence that the capital costs for the project have been greatly overstated. It would appear that the capital costs could be as low as \$2 Billion, but with risk factors of an additional \$1 Billion. There is no case for using YOE escalation in financial and economic analysis required for government funding. Projects are quoted in real terms not in inflated terms.



In the development of new stations, care should be taken to consider the needs of both pedestrians, as well as bicyclists for accessing the rail stations. The use of bicycle as an access mode is common in Europe and Asia, but much less common in North America. This is largely due to the hostility of urban streets to bicycle safety due to heavy auto traffic, which actively discourages the use of both bicycles and walking. Even if there is community concern about the potential development of a new park that could provide access to people's backyards, there is still a need to provide for improvements in both bicycle and pedestrian modes as means of access to the rail stations.

In addition, there would also major opportunities to integrate and improve the regional and local transportation system to provide an enhanced mobility to the population of Queens in its accessing regional jobs and opportunities. There have also been the perennial studies as the Port Authority has sought to connect New York's three major airports with the urban core. It has been apparent for a long time that the QueensLink is the key to providing effective access to JFK Airport and yet this critical regional asset has not yet been developed. Developing QueensLink for local rail transit use will open the opportunity for improved mobility and create the case for improving access to JFK Airport on the one-hand and Manhattan on the other hand.

6.1 NEXT STEPS

In order to develop the QueensLink corridor the following steps need to be taken:

- In order to progress the QueenLink Feasibility Study, request the MTA to release the underlying data to their 2018 publicly funded Feasibility Study by SYSTRA Engineering.
- Look into the feasibility of funding the rail line through the NYC budget as in the recent 7 Train extension.
- Complete the feasibility study to provide an accurate (±20% error) and detailed assessment of the costs and benefits of building the QueensLink.
- If the feasibility study provides the level of impact suggested in this preliminary analysis, complete an Environmental Impact Study as required for New York DOT and USDOT funding.
- Complete a public outreach program to provide stakeholders and the public with information the benefits and costs of building the project.
- Get QueensLink project included in next MTA capital budget.



APPENDIX A: CAPITAL COST BENCHMARKING

The purpose of the Capital Cost benchmarking exercise was to review SYSTRA's \$8.1 Billion capital cost estimate for the NYCTA option in the PHASE ONE: ROCKAWAY BEACH BRANCH SKETCH ASSESSMENT report, dated September 21, 2018.

The approach used has been to compare SYSTRA's \$8.1 Billion capital cost estimate against cost estimates developed for other transit projects, most particularly the King of Prussia extension proposal in Philadelphia. However, costs are different in New York, for this purpose cost comparisons for other New York area projects were also sought. Some published cost figures were found; however, it has been the practice of New York MTA and other agencies not to make their detailed cost estimates public. Some New York area costs have been published by others, for example Traylor https://www.traylor.com/projects/queens-bored-tunnels-east-side-access-project/ published a 2008 cost of \$777 million for two miles of bored tunnel under Sunnyside Yard in Queens; an average cost of \$389 million per mile of single track bore as an actual realized project cost.

New York transit agencies have, however, still been required to report their costs to the Federal Transit Administration (FTA) who have included a New York costing basis in their Capital Costs Database https://www.transit.dot.gov/capital-cost-database. The FTA maintains this database, makes it publicly available and encourages its use in developing cost estimates for transit projects. This database has been used to directly develop some New York unit costs as according to FTA recommended levels, but the database also facilitates year-to-year and city-to-city comparisons by enabling unit costs from other cities and years to be converted to a New York equivalent cost.

Thus, the FTA database can be used to compare 2017 Philadelphia costs to 2020 New York costs on an apples-to-apples basis, and to develop appropriate USDOT approved conversion factors. For example, US Federal Transit Administration data suggests that New York costs are generally about 20% higher than Philadelphia costs; and also, that infrastructure costs have risen by 77% since 2008, compared to a general inflation increase of only 24% in the same time period.

Therefore, the approach has been either to use FTA 2020 New York costs directly, or in some case to use the FTA database to develop appropriate factors for normalizing the unit costs from other cities or years to a current 2020 New York basis.

In addition to following US FTA guidance in regard to unit costs we have also endeavored to follow the FTA structure and guidelines in regard to the application of allocated contingency, unallocated contingency, professional services and inflation escalation factors. Thus, the focus of the whole effort has been to utilize as much information as possible from the SYSTRA report -- but at the same time, conform the SYSTRA cost estimate to US FTA requirements by following the US FTA structure, and by using standard unit costs, contingency, professional services and escalation rate that we believe are in compliance with US FTA requirements and would be acceptable to US FTA.



Development of a Base Line FTA Cost Estimate - The SYSTRA cost estimate was developed in a non-standard format and in many cases using non-standard Unit Cost drivers. This makes benchmarking or cost comparisons to the SYSTRA costs difficult to perform. For understanding these estimates, the first step was to reformat the SYSTRA costs into the standard format required by the Federal Transit Administration using FTA's Standard Cost Category (SCC) Codes, as well as to convert SYSTRA's unit costs to equivalent drivers that are consistent with the standard US FTA approach. In this reformatting SYSTRA's costs or results were not changed, only presented in an FTA standard format using SCC codes. For development of a Base Line FTA Cost Estimate, this was done for the purpose of understanding what unit costs and escalation factors SYSTRA actually used in developing their \$8.1 Billion cost estimate.

The steps in this reformatting were as follows:

1. First, the SYSTRA costs were grouped into broad FTA SCC categories as follows:

10 GUIDEWAY & TRACK ELEMENTS
20 STATIONS, STOPS, TERMINALS, INTERMODAL
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS
40 SITEWORK & SPECIAL CONDITIONS
50 SYSTEMS
60 ROW, LAND, EXISTING IMPROVEMENTS
70 VEHICLES (number)
80 PROFESSIONAL SERVICES (applies to Cats. 10-50)
90 UNALLOCATED CONTINGENCY
100 FINANCE CHARGES

Following the FTA approach, these major categories were summed to produce:

Total Project Cost (10 - 100) "CURRENT DOLLAR COST"

In current year dollars this SYSTRA cost would be \$5.3 Billion.

After this, an inflation escalation factor is added for projecting the current dollar cost into future year dollars. SYSTRA used a 10-year future projection so that the \$8.1 Billion is in fact in 2030 dollars. Unfortunately, Year-of-Expenditure (YOE) costs are commonly reported in the press without including the fact that they are denominated in projected future-year (2030) dollars. Costs presented this way do not correspond to most people's common understanding of the cost of a project. For example, if someone asks, "what is the cost of a house," they normally expect you to respond with the cost of a house today, not 10 years into the future. Although YOE projections may be needed for financial planning, the current year cost is really the most relevant to a Cost Benefit analysis, since Cost Benefit analysis is always performed in constant (inflation adjusted) dollars.

For preparing the cost estimate in standard FTA format, all tunnel, bridge, and track costs were grouped together under SCC 10. Three separate subtotals were maintained under SCC 10 for showing these costs separately. Station costs were grouped under SCC 20; right of way preparation costs were put under SCC 40; and signaling, power system costs were put under SCC 50. SYSTRA had no costs for SCC 30 Support Facilities, 60 Land or 70 Vehicles. Some land costs appear to have been included as part of the tunneling cost estimate; these were allowed to remain where they were under SCC 10. However, since the MTA already owns the right of way, no land costs should generally be required. If trains are diverted from other routes, then it is possible that no additional equipment or NYCTA support facilities may be needed either; this needs more detailed assessment in future operations planning studies.



2. Each SCC category has an "Allocated Contingency" which can vary for each item.

The SYSTRA estimate does not have any Allocated Contingencies, but it does have some lines identified as "Force Account" and these are computed on the same percentage basis as Allocated Contingencies. So, in reformatting the cost estimate, the Force Account lines were removed and were converted to Allocated Contingencies for following the FTA required structure. These Allocated Contingencies were generally in the range of 15-20%. This reformatting or relabeling did not change the structure of the actual cost calculations at all.

3. Once the costs were grouped together, then appropriate unit cost drivers were identified.

Cost drivers were selected to enable a meaningful comparison of the costs for each segment. Under SCC 10 for Guideway and Track Elements:

- The first segment of line is the new tunnel section connecting the QBL subway line to Fleet Street. In this stretch two tunnels would be constructed using a combination of bored tunnel, SEM and cut-and-cover methods. The total length of tunnel is 7,715 feet resulting in an average unit cost (before Allocated Contingency) of \$94,339/LF of tunnel.
- The second segment of line includes bridges which SYSTRA proposed to be removed and replaced. These total 3,698 linear feet of bridge structure; of which the four-track viaduct at the south end of the line segment along constitutes 2,812 feet; the balance of 886 feet of bridges constitutes mostly double-tracked highway crossings. This results in an average unit cost (before Allocated Contingency) of \$26,241/LF for bridge replacement.
- Assuming double track is restored for the entire length of the alignment, the length of track would be 41,094 track feet costing \$1,744/TF.

Under SCC 20, the SYSTRA estimate included four stations at \$48.6 million each.

Under SCC 40, there are 20,547 LF of right of way, this was prepared to receive track at a cost of \$7,369 per linear foot, or \$3,685 per track foot.

Under SCC 50 there are 41,094 track feet that need to be equipped with signals (CBTC), communications and electrification. The cost for this is \$5,199 per track foot.

4. Multipliers were Determined for Professional Services, Unallocated Contingency, and Inflation Escalation SYSTRA used a 43% factor for Professional Service, which they multiplied times the Construction Cost estimate that included allocated contingency.

For Unallocated Contingency, SYSTRA multiplied four factors together, coming to an overall multiplier of 98.61%:

- 3rd Party Construction General Conditions Costs (Compounded) 1.00 Lump Sum 18.00%
- 3rd Party Construction Overhead & Profit Costs (Compounded) 1.00 Lump Sum 21.00%
- 3rd Party Construction Insurance & Bond Costs (Compounded) 1.00 Lump Sum 7.00%
- Project Level Contingency Costs (Compounded) 1.00 Lump Sum 30.00%

For inflation escalation, SYSTRA used 10 years at 4.25% per annum, coming to a multiplier of 51.62%

The application of these unit costs and escalation factors results in the overall cost of \$8.1 Billion in 2030 dollars, matching SYSTRA's results. These results are shown in Exhibit A.1 on the next page.



Exhibit A.1 – SYSTRA Cost Estimate in USDOT FTA Format

		,						
) O		
			Unit		Alloc	w/Alloc		TC w/Alloc
	CBS Code Description	δ	Measure	Measure Unit Cost	Cont %	Conting	Total Cost	Conting
10 GU	10 GUIDEWAY & TRACK ELEMENTS						\$992,201,978	\$1,144,615,165
	QBL to Reet St Tunnels (3,800 linear ft total)	7,715	7,715 LF Tunnels	\$94,339	15.00%	\$108,490	\$727,825,300	\$836,999,095
	Fleet St to Conn 'A' Line Bridges + Viaducts (16,747 linear feet total, 3,698 feet of bridges and viaducts)	3,698	3,698 LF Bridges	\$52,114	15.00%	\$59,932	\$192,718,878	\$221,626,710
	1.5 Track Requirements	41,094	41,094 Track Feet	\$1,744	20.00%	\$2,093	\$71,657,800	\$85,989,360
20 STA	20 STATIONS, STOPS, TERMINALS, INTERMODAL	4	4 Stations	\$48,568,435	20.00%	\$58,282,122	\$194,273,739	\$233,128,486
30 SUP	30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS						50	\$0
40 SITE	40 SITEWORK & SPECIAL CONDITIONS	20,547	20,547 LF ROW	\$10,441	15.00%	\$12,007	\$214,524,812	\$246,703,534
50 SYSTEMS	STEMS	41,094	41,094 Track Feet	\$5,199	20.35%	\$6,257	\$213,649,002	\$257,120,053
Constr	Construction Subtotal (10 - 50)						\$1,614,649,531	\$1,881,567,238
60 RO	60 ROW, LAND, EXISTING IMPROVEMENTS						80	50
70 VEH	70 VEHICLES (nu mber)						80	\$0
80 PRC	80 PROFESSIONAL SERVICES (applies to Cats. 10-50)			43.00%			\$694,299,298	\$809,073,912
Subtot	Subtotal (10-80)						\$2,308,948,829	\$2,690,641,150
90 UN	90 UNALLOCATED CONTINGENCY			98.61%			\$2,276,784,710	\$2,276,784,710 \$2,653,159,981
Subtot	Subtotal (10-90)						\$4,585,733,540	\$5,343,801,131
100 FI	100 FINANCE CHARGES						80	\$0
Total F	Total Project Cost (10 - 100)						\$4,585,733,540	\$5,343,801,131
Escalat	Escalation ASSUMED 10 YRS TO MIDPOINT @4.25% PER ANNUM			51.62%			\$2,367,222,000	\$2,758,547,458
Total P	Total Project Cost with Escalation						\$6,952,955,540	\$8,102,348,589



The next step was to benchmark these costs and escalation factors against other studies and FTA guidance. In this step we have not made any changes to the project as proposed by SYSTRA, except for adjusting the locations of the stations and running a sensitivity analysis on the cost of bridge replacements. It should be noted that the station interconnection plans are only conceptual and will need to be refined in the future, based on NYCTA and community input.

Stations – Historically, the RBB-QueensLink was developed as a Long Island Rail Road branch line. When it was built the LIRR was competing, not cooperating with the subway and elevated train operators. Therefore, it had no interest in cooperating with them on development of joint stations. As a result, the only station where the original LIRR layout provides a direct interchange with other rail services is at Woodhaven Jct./Atlantic Avenue, because the LIRR owned both the Rockaways and Atlantic Branches. Unfortunately, the other three historic RBB-QueensLink stations need to be adjusted in any RBB-QueensLink reactivation to facilitate direct transfers between lines at each crossing point. From north to south the proposed stations are:

• Union Turnpike/Glendale Junction – the historic location of Parkway station (on the northern side of Metropolitan Ave) is too far north of the LIRR Montauk Branch (currently freight only) to provide an effective connection if passenger service were ever restored. The Montauk Branch also forms a barrier preventing easy pedestrian or bicycle access from Union Turnpike on the south side. The station here should effectively link or bridge between the two areas so it can provide easy access from both the north and south sides.

At Glendale Junction, there is existing high-density development south of Union Turnpike, as well as a High School north of the track, and both need to be effectively connected with the Parkway station. The most desirable solution would be to have the station span the LIRR Montauk branch, but this is complicated by a curve in the alignment. Therefore, it is proposed to shift the Parkway station south from its historic location as shown in Exhibit A.2, so that the new station would be equidistant from Metropolitan Avenue and the LIRR Montauk Branch. To avoid having a platform on the curve, this section of alignment can be straightened up to the end of the platform at the LIRR Montauk Bridge.

The curve north of the bridge can be sharpened from its current 3-degrees to become a 4.5-to-5.0-degree curve. Such a curve would impose no serious operating restrictions since trains will be stopping there anyway, but by shifting the station slightly further south it would have effective access both from Union Turnpike and Metropolitan Avenue. A pedestrian bridge and parking area, as well as bicycle access should be provided across the Montauk Branch to allow access from both the north and south. Should passenger service ever be reinstated along the Montauk Branch, the station would be ideally located to serve as a transfer and connection point between the two rail lines.

- Jamaica Avenue Crossing The original Brooklyn Manor station was located between the Woodhaven Blvd and 104th St stations but is closer to the 104th St station; about 440' away as shown in Exhibit A.3. While this is would not pose an impossible transfer location, it is far from ideal. The track curve between the end of the platform and the proposed new Jamaica Ave station makes extending the existing platforms west less than ideal. It may be possible to build an extension of the elevated mezzanine west beneath the tracks in order to provide an in-system transfer.
- Atlantic Avenue/Woodhaven Junction This station can be reconstructed in close to its original configuration, as shown in Exhibit A.4. The abandoned Woodhaven Junction station (below ground) should be evaluated for restoration to provide a transfer to the LIRR Atlantic Branch.
- Liberty Avenue Crossing The historical location of the Ozone Park station (between 101st and 103rd Aves) cannot provide an effective connection with the Liberty Avenue NYCTA stations at Rockaway Boulevard or 104th Street. A new station should be built a block south at Liberty Avenue. It may be possible to extend the 104th St station platforms to meet with the new station, as shown in Exhibit A.5.



Exhibit A.2 – Proposed Platform Configuration at Union Turnpike/Glendale Junction (Integrates Parkway Station with Union Turnpike, Metropolitan Ave and the LIRR Montauk Branch)



Exhibit A.3 – Proposed Platform Configuration at Jamaica Avenue (Proposes an enclosed elevated passage between the new station and existing 104th St station)

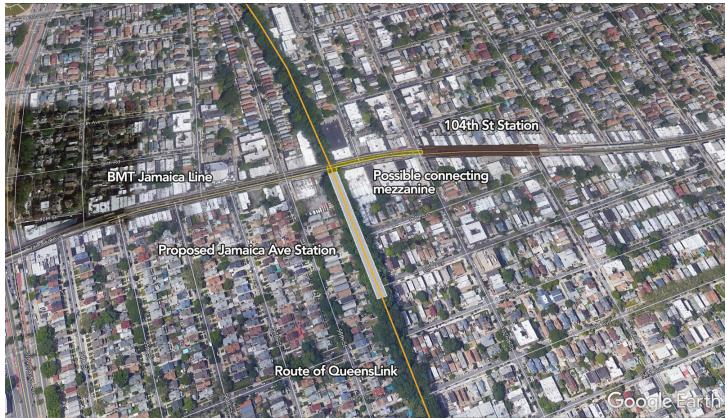
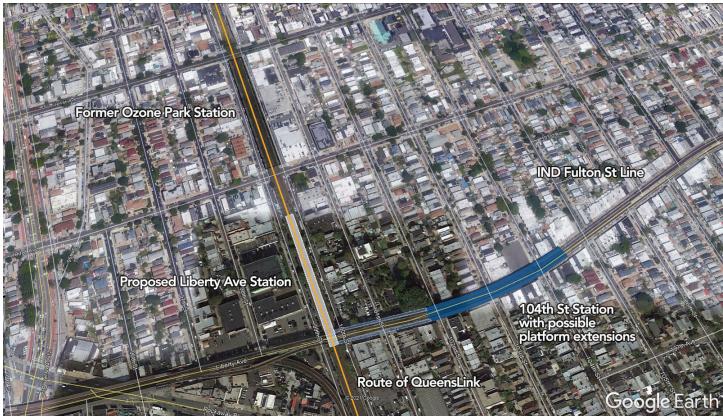






Exhibit A.5 – Proposed Platform Configuration at Liberty Avenue (Integrates Liberty Ave and 104th Street Elevated Stations with extended platforms)





The result of these station adjustments is that station capital costs have been increased from \$48.6 million in SYSTRA's estimate up to \$65 million per each station. The extra money would allow for the construction of full interchange stations at Liberty Avenue and Jamaica Avenue rather than separate, disconnected stations at their historic locations. This does reflect an increase in the capital cost, but if the RBB-QueensLink line is going to be reactivated as a NYCTA line, it is important to provide for effective connections to other rail services at the crossing points.

The new NYCTA route as assessed here would have four stations (from north to south):

- Metropolitan Ave./Glendale Jct.
- Jamaica Avenue
- Atlantic Avenue/Woodhaven Jct.
- Liberty Avenue

Aside from these station changes, the proposed route for the "Basic NYCTA Option" is Identical to the NYCTA option that was assessed by the SYSTRA study. It would connect the QBL at Rego Park with the existing RBB-QueensLink corridor south of Liberty Avenue. All the other engineering assumptions have been adopted for benchmarking SYSTRA's cost estimate. SYSTRA proposed to fully replace all the bridges along the line, including the 2,812' viaduct at Liberty Avenue. Given that it comprises more than ¾ of the total length of bridge structures along the line, the majority of any bridge related costs along the line are going to be related to this single viaduct. The steps in this benchmarking were as follows:

1. First, the unit costs were compared for each category:

Starting with guideway and track related costs for SCC 10:

- SYSTRA's tunnel cost estimate was adopted without change. SYSTRA's cost came to \$94,339 per linear foot of tunnel. By comparison, Traylor's 2008 cost of \$777 million for two miles of bored tunnel under Sunnyside Yard in Queens works out to an average cost of \$389 million per mile of single-track bore works out to \$73,674 per linear foot in 2008 dollars. By applying inflation to this 2008 cost, it is apparent that SYSTRA's tunnel cost estimate of \$727,825,300 (before contingencies) is reasonable for the length of this bore.
- SYSTRA's bridge replacement costs were \$52,114 per linear foot of double track bridge, with demolition costs comprising approximately 27% of this total. By comparison, the FTA database suggested that the cost for new double track bridges should only be \$18,266 per foot. Demolition was assumed to cost 25% of the construction of a new bridge, so a cost of \$4,567 per foot was used for demolition; however, since the viaduct is four tracks, the demolition costs for the viaduct were doubled. The result of this adjustment is an overall bridge replacement cost of \$26,241 per linear foot of double track bridge, with demolition costs comprising 30% of this total. The overall result is to cut bridge replacement costs in half as compared to the SYSTRA estimate.
- SYSTRA's track costs were \$1,744 per Track Foot (TF.) By comparison, the costs for ballasted track in the KOP estimate were just \$511.49 per TF; adjusting for inflation and New York costs, this was raised to \$613 per TF. The overall result is to cut track costs to 35% of SYSTRA's level.
- For SCC 20, Stations, as described on the previous page, costs were raised from \$48.6 million up to \$65 million per station to allow for the development of interchange stations at all four of the key crossings with other rail lines.



- For SCC 40 Site Work, SYSTRA's costs for site preparation were \$10,441 per linear foot of right of way. By comparison, the KOP estimate for all of SCC 40 were \$152.8 million for 4.7 miles of greenfield right of way preparation, and this included a substantial cost for utility relocation. KOP's cost for all of SCC 40 was \$32.5 million per mile or \$6,155 per LF for the development of a greenfield right of way. Adjusting for inflation and for New York costs, this was increased to \$7,369 per LF, which reduces Site Work costs to approximately 71% of SYSTRA's level.
- For SCC 50 Systems, SYSTRA's costs were \$5,199 per TF, or \$54.9 million per route mile. By comparison KOP Rail is 4.7 route miles and the total is \$96.8 million, which is \$20.6 million per route mile. However, since this is New York City, heavy rail and CBTC, no change has been made to SYSTRA's estimate.

In summary, tunnel and CBTC costs remained the same; station costs were increased, and bridge, track and site work unit costs were reduced as a result of this benchmarking analysis.

2. Next, the contingency and cost escalation rates were adjusted to conform to USDOT FTA guidelines.

Four sets of adjustments have been made to the contingency and cost escalation rates:

- SYSTRA's force account allocations, which had been treated as allocated contingencies were generally in the 15-20% range and were averaging 17%. These were increased to the 20-30% level as assumed by KOP rail resulting in an increase to the allocated contingency markup now averaging 26%.
- SYSTRA's professional service costs were 43%. However, the USDOT FTA has analyzed the range for soft costs on FTA major capital projects to be 31% to 34%. One source is TCRP report #138, Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects (2010), Table 3 giving recommended values for rail transit projects. SYSTRA's proposed 43% exceeds the FTA allowance for professional services cost and has been reduced to 33.5%, which is near the upper end of FTA's guideline, and is the same as the KOP rail study used. The Maryland Purple line study used a 32% professional services rate, which also falls with the FTA guidance.
- SYSTRA's unallocated contingencies were 98.61%. This included a number of unusual items, including General Conditions Costs, Overhead & Profit Costs, and Insurance & Bond Costs which to all appearances should have been built into the construction bid unit costs. If the unit cost basis had been very low then perhaps this could have been explained, but in fact mostly the unit cost basis either validated the FTA database or already exceeded it. As a result, the level of unit cost assumed should be sufficient to recover these costs, so they have been removed as a double count. The level of unallocated contingency has been reduced to 20%, which is the same as the KOP rail study used. However, the Maryland Purple Line study only used a 5% rate for unallocated contingency.
- SYSTRA's cost escalation was 10 years at 4.5% resulting in a 51.62% cost escalation factor. However, the KOP rail study only used 6 years at 3.5% resulting in a 22.93% cost escalation factor. The Maryland Purple Line study did not develop any YOE cost escalation at all as a part of their capital cost estimation. The cost escalation factor here has been reduced to 22.93% %, which is the same as the KOP rail study used.
- The result of these adjustments is shown in Exhibit A.6. With these adjustments, the construction cost (Lines 10-50) is reduced to \$1.86 Billion about half of which is due to the tunnel at the north end. Adding Professional Services and Unallocated Contingency, the cost is \$2.97 Billion which would be the capital cost of the project in current dollars. With six years of inflation the cost of the full bridge replacement option would be \$3.7 Billion. This is just 45% of SYSTRA's \$8.1 Billion cost estimate.

Exhibit A.7 shows the results of a sensitivity that was performed with the bridge replacements costs removed. This would be the cost of the project if an inspection of the bridges shows that they are all still serviceable for NYCTA use. Of course, under this circumstance the bridge over the Montauk branch just south of the Parkside station still needs to be replaced, so that is the only bridge cost remaining in the sensitivity.



Without bridge replacement costs included, the construction cost (Lines 10-50) is \$1.73 Billion, slightly more than half of which is due to the tunnel at the north end. Adding Professional Services and Unallocated Contingency the cost is \$2.77 Billion which would be the capital cost of the project in current dollars. With six years of inflation the cost of the full bridge replacement option would be \$3.4 Billion. This is just 42% of SYSTRA's \$8.1 Billion cost estimate.

Overall project costs are projected to fall in the \$3.4 to \$3.7 Billion range depending on whether the bridges need to be replaced. The cost for replacing the bridges is about \$300 million which if needed would add less than 10% of the overall project. The main driver of cost for the NYCTA option is the cost of the tunnel connecting the QBL line. This tunnel costs \$728 million in direct construction costs and by the time all the contingencies, professional services and inflation costs are added, the costs for the tunnel would rise to \$1.9 Billion, about half of the total project cost.



Exhibit A.6 – Adjusted Cost Estimate with Full Bridge Replacement

					on o		
		Unit		Alloc	w/Alloc		TC w/Alloc
CBS Code Description	ΔŢ	Measure	Measure Unit Cost Cont %	Cont %	Conting	Total Cost	Conting
10 GUIDEWAY & TRACK ELEMENTS						\$850,545,421	\$1,105,709,047
QBL to Fleet St Tunnels (3,800linear fttotal)	7,715	7,715 LF Tunnels	\$94,339	30,00%	\$122,641	\$727,825,300	\$946,172,890
Fleet St to Corm "A" Line Bridges + Viaducts (16,747 linear feet total), 3,698 feet of bridges and viaducts)	3,698	3,698 LF Bridges	\$26,241	30.00%	\$34,113	\$97,038,125	\$126,149,563
1.5 Track Requirements	41,094	41,094 Track Feet	\$613	20,00%	\$736	\$25,681,996	\$33,386,595
20 STATIONS, STOPS, TERMINALS, INTERMODAL	4	4 Stations	\$65,000,000	20.00%	\$78,000,000	\$260,000,000	\$312,000,000
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS						50	\$0
40 SITEWORK & SPECIAL CONDITIONS	20,547	20,547 LF ROW	\$7,369	20,00%	\$8,843	\$151,410,843	\$181,693,012
50 SYSTEMS	41,094	41,094 Track Feet	\$5,199	20.00%	\$6,239	\$213,649,002	\$256,378,803
Construction Subtotal (10 - 50)						\$1,475,605,266	\$1,475,605,266 \$1,855,780,862
60 ROW, LAND, EXISTING IMPROVEMENTS						50	50
70 VEHICLES (number)						50	\$0
80 PROFESSIONAL SERVICES (applies to Cats . 10-50)			33.50%			\$494,327,764	\$621,686,589
Subtotal (10 - 80)						\$1,969,933,031	\$2,477,467,450
90 UNALLOCATED CONTINGENCY			20.00%			\$393,986,606	\$495,493,490
Subtotal (10 - 90)						\$2,363,919,637	\$2,363,919,637 \$2,972,960,940
100 FINANCE CHARGES						205	50
Total Project Cost (10 - 100)						52,363,919,637	\$2,972,960,940
Escalation ASSUMED 6 YRS TO MIDPOINT @3.5% PER ANNUM			22.93%			\$541,941,168	\$681,567,131
Total Project Cost with Escalation						\$2,905,860,804	\$2,905,860,804 \$3,654,528,071



Exhibit A.7 – Adjusted Cost Estimate with Serviceable Bridges

					의		
		Unit		Alloc	w/Alloc		TC w/Alloc
CBS Code Description	₽	Measure	Measure Unit Cost Cont %	Cont %	Conting	Total Cost	Conting
10 GUIDEWAY & TRACK ELEMENTS						\$754,457,128	\$980,794,266
QIBL to Fleet St Turnels (3,800 linear ft of twin bore, 7,715 tunnel feet)	17,71	7,715 LF Tunnels	\$94,339	30.00%	\$122,641	\$727,825,300	\$946,172,890
FieetSt to Conn 'A' Line Bridges + Viaducts (16, 747 linear feet total, 3,698 feet of bridges and viaducts)	3,68	3,698 LF Bridges	\$257	30.00%	\$334	\$949,832	\$1,234,782
1.5 Track Requirements	41,09	41,094 Track Feet	\$613	20,00%	\$736	\$25,681,996	\$33,386,595
20 STATIONS, STOPS, TERMINALS, INTERMODAL		4 Stations	\$65,000,000	20.00%	\$78,000,000	\$260,000,000	\$312,000,000
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS						50	50
40 SITEWORK & SPECIAL CONDITIONS	20,54	20,547 LF ROW	\$7,369	20.00%	\$8,843	\$151,410,843	\$181,693,012
50 SYSTEMS	41,09	41,094 Track Feet	\$5,199	20.00%	\$6,239	\$213,649,002	\$256,378,803
Construction Subtotal (10 - 50)						\$1,379,516,973	\$1,730,866,081
60 ROW, LAND, EXISTING IMPROVEMENTS						50	50
70 VEHICLES (number)						50	\$0
80 PROFESSIONAL SERVICES (applies to Cats. 10-50)			33.50%			\$462,138,186	\$579,840,137
Subtotal (10 - 80)						\$1,841,655,159	52,310,706,218
90 UNALLOCATED CONTINGENCY			20.00%			\$368,331,032	\$462,141,244
Subtotal (10 - 90)						\$2,209,986,191	\$2,772,847,461
100 FINA NCE CHARGES						\$0	\$0
Total Project Cost (10 - 100)						\$2,209,986,191	\$2,209,986,191 \$2,772,847,461
Escalation ASSUM ED 6 YRS TO MIDPOINT @ 3.5% PER ANNUM			22.93%			\$506,651,106	\$635,690,050
Total Project Cost with Escalation						\$2,716,637,297	\$2,716,637,297 \$3,408,537,511



APPENDIX B: ECONOMIC RENT METHODOLOGY

The concept of Economic Rent is derived from basic Ricardian economic theory and provides a means of explaining the increased value of economic resources (land, labor and capital) and their change in value in different circumstances or market conditions. For a transportation investment, accessibility is a key spatial variable that affects the likely uses of economic resources and, therefore, their value. Changes in accessibility result in changes in the economic rent (or monetary value) that economic resources can command and, therefore, the value and character of the economic activities that take place at any location. As a result, for important economic welfare criteria (such as employment, house-hold income, and property values) an evaluation can be made of the likely change in economic rent that will be associated with an improvement in accessibility generated by a given transportation investment¹³.

Economic Rent may be defined as the difference between what the factors, or productive services, of a resource-owner earn in their current occupation and the minimum sum he/she is willing to accept to stay there. It is then a measure of the resource-owner's gain from having the opportunity of placing his factors in the chosen occupation at the existing factor price, given the prices his factors would earn in all other occupations. It is the proper counterpart of consumers' surplus when this is regarded as the consumers' gain from having the opportunity of buying a particular good at the existing price, where all other prices are given. And like a change in the consumers' surplus, it is a measure of the change of his welfare when the relevant prices in the market are altered. Whereas the increase of consumers' surplus is a measure of his welfare gain for a fall in one or more product prices, the increase in that person's economic rent is a measure of his welfare gain from an increase in the price or the volume of the sale of his factors, i.e., increased sales should generate increased profit.

Typically, the level of economic rent can be calculated as follows: Economic Rent (ER) = f (Pt, It, Et, Ct, Tt)

Where:

Pt is a measure of Population structure of an area in year t;

It is a measure of Industrial structure of an area in year t;

Et is a measure of Education level of an area in year t;

Ct is a measure of Cultural characteristics of an area in year t;

Tt is a measure of Transportation efficiency of an area in year t.

Any analysis region (area) has its own 'Economic Rent Profile'. Economic rent profile shows the spatial distribution of the economy in terms of key factors such as income, property value and wealth. Each of the characteristics listed above can have a significant impact on economic rent profile.



Population Structure: The population structure can affect the economic potential of an area positively or negatively. For example, an aging population could have a negative effect on the economy as the number of workers in the work force may fall. This can reduce productivity and, as a result, reduce the economic rent profile. The U.S. might experience this problem in the second quarter of this century as baby boomers age if technology improvements and increased output do not raise productivity sufficiently. Typically, the more productive the adult population of an area is, the higher the economic rent profile.

Industrial Structure: The nature of the industrial structure and resource base defines the potential economic rent profile of an area, e.g., manufacturing, commercial, agricultural, residential, and service industry. The higher the value added by industry, the higher the area's economic rent profile. For example, the "new economy" jobs in biotech, computers and finance all have very high incomes and economic rent profiles associated with them.

Education Level: Educational levels can have a dramatic impact on economic rent potential of an area. Typically, a higher education level (especially Ph.D.'s or other high degrees) will increase the wealth generated by the population. The Baltimore-Washington region, for example, boasts one of the highest concentrations of Ph.D.'s in the U.S., which supports the growth of high-tech industry in the region?

Cultural Characteristics: Differences in cultural, ethnic, and other social characteristics of an area can impact its economic potential. For example, cultural belief systems can impact the ability of a population to work at certain jobs or in a certain way and, therefore, the level of economic rent that can be attained. A survey by the United Nations of the economic growth potential of Arab countries found that the low level of freedom, limited Internet use and the absence of women in the workforce have had a marked negative impact on economic productivity¹⁴.

Transportation Efficiency: Transportation efficiency can greatly affect the economic potential of an area. The more effective a transportation system in moving people and goods, the greater its ability to generate wealth if the economy is responsive to the opportunity presented. It is no coincidence that most of the U.S.'s large east coast cities grew as 'break of bulk' ports at locations that had good harbors and good routes to the interior resources and markets of the U.S. Since the quality of a transportation system is a management variable and can be changed in the short term, investment in the transportation system can generate economic development if the investment is made in a growing and vibrant economy. The level of response that the economy will have to a transportation investment is measured by the economic rent profile.

Where it is important to recognize that education, population, industry, structure, and culture can change over time changing the economic rent profile. However, these are not characteristics that typically change rapidly. Only if an area experiences a significant dislocation or migration associated with rapid and dramatic population and industrial base shifts will it experience a radical change in its economic rent profile. For example, the influx of Hong Kong residents to Vancouver, Canada, in the 1980s dramatically changed the economic rent profile of several areas of the city's downtown. The effect was largely due to the wealth and "entrepreneurial" capability of this new population. In the United States one of the issues for the Midwest is the fact that while it has some of the country's leading academic institutes, it is still losing much of this talent because it is not developing the New Economy businesses at a sufficient rate.





^{9.} According to the data assembled by the Metropolitan Washington Council of Governments (source: US Census Bureau), 20.6 percent of individuals over the age of 25 residing in the Baltimore-Washington region have a graduate or professional degree. This is well above the national average of 8.9 percent.

In the absence of a major dislocation, we can assume that the economic rent factors It, Et, Pt, and Ct will remain largely unchanged in the short term (10-20 years). However, transportation efficiency can change significantly in the "short term." Major transportation infrastructure projects can dramatically change the accessibility of markets and the opportunity for economic growth. This can apply to the measurement of goods in a manufacturing-dominated economy or to the movement of people in a service industry-dominated economy. The economic rent generated by transportation improvements (Tt) has driven the desire to move people more quickly and cost-effectively over time. As a result, if population, industrial structure, education levels, and cultural characteristics remain constant, the Economic Rent (ER) model reduces to:

$$ER = f(T_i)$$

By using socioeconomic variables (SEi) as a proxy for economic welfare and generalized cost (GCi) as a specific metric for transportation efficiency measured in terms of time and cost the economic rent equation can be rewritten as:

$$SEi = \beta_{0}GC_{i}^{\beta 1}$$
 (3)

Where:

SEi - Economic rent factors - i.e., socioeconomic measures, such as: employment, income, property value of zone i;

GCi - Weighted generalized cost of auto travel for all purposes from (to) zone i to (from) other zones in the study area;

 β_{1} and β_{1} - Calibration parameters.

The curve generated by this function is the economic rent profile for transportation accessibility. The generalized cost of auto travel includes all aspects of travel time (in-vehicle time), travel cost (tolls, fuel costs and parking charges).

The generalized cost of travel is typically defined in travel time rather than dollars. Costs are converted to time by applying appropriate conversion factors. The generalized cost of auto travel between zones i and j for purpose p is calculated as follows:

$$GC_{ijp} = TT_{ijp} + \frac{TC_{ijp}}{VOT_p}$$
 (4)

Where:

TTijp = Travel time between zones i and j for purpose p¹⁰;

TCijp = Travel cost between zones i and j and purpose p (toll and operating costs for auto);

VOTp = Value of Time for purpose p

Issues of travel time calculation, including the weighting factor for travel time are broadly discussed in the literature. See, for example^{20,21}.





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