QueensLink Environmental Impact & Accessibility Analysis: the Case for Reactivation of the Rockaway Beach Branch as Part of the NYC Subway System

Deven Barth and **Matt Kohn**

Center for Urban Science and Progress, New York University

May 13, 2026

Abstract

QueensLink is an advocacy group proposing the reactivation of the abandoned Rockaway Beach Branch (RBB) rail alignment as part of the NYC Subway System, with the goal of improving environmental, public health, and mobility outcomes to residents living in Outer Queens, namely through added subway transit, bike infrastructure, and greenspace. With the use of publicly available data, we produced a comprehensive environmental/transportation impact analysis in order to quantify and benchmark public-oriented benefits of the proposed route, with respect to present-day environmental/transportation burdens. We also performed a rigorous accessibility impact study to further quantify the benefits of added rail service, in the form of measuring travel-time savings. We found that QueensLink has the potential to significantly improve environmental and public health outcomes across the immediate service region, with reduced transportation-induced Vehicle Miles Traveled (VMTs) and proximity to greenspace among the core contributors. We also noticed significantly reduced travel-times under QueensLink, specifically for local trips within the borough.

Contents

I: Introduction

QueensLink, a community-led initiative born from the advocacy of QueensRail, proposes a transformative multimodal rail and trail project along the abandoned Rockaway Beach Branch (RBB) right-of-way. While this former Long Island Rail Road (LIRR) line has remained idle since 1962, the QueensLink vision seeks to reactivate the corridor as a New York City Transit extension, connecting the Queens Boulevard line to the Rockaways.

This reactivation would not only introduce four new stations and provide vital transfers to the A, J/Z, E, F, M, R, and 7 lines, but also integrate 33 acres of new parkland and protected cycling infrastructure. By addressing the critical lack of north-south connectivity in Queens, the project aims to alleviate the borough's reliance on inefficient east-west transit and congested municipal highways, a goal long championed by local stakeholders and recently bolstered by a $400,000 USDOT Reconnecting Communities Pilot Program grant.

Despite the compelling vision of the RBB reactivation, the project faces significant hurdles in the form of high projected capital costs and the need for a definitive justification for such a substantial investment. Moving beyond the preliminary ridership forecasts of previous studies, there remains a critical need for a rigorous, data-driven analysis that can quantify the broader environmental and public health benefits of the proposal. Such an analysis is an essential component for strengthening public trust and support.

This report seeks to provide that missing empirical foundation through a comprehensive, multi-layered environmental impact analysis. Central to our research is the development of a Multi-Criteria Spatial Synthesis Environmental Justice Composite Index, which identifies and balances the unique burdens and benefits faced by communities along the corridor. We generate the composite index for the current day circumstances for the community to establish an environmental baseline, and then examine the changes to this baseline in Build vs. No-Build scenarios to visualize the estimated impact of the proposed rail addition.

We further evaluate the project's impact across various transportation modes to understand its role in reducing local congestion and emissions. Additionally, we utilize isochrone accessibility mapping to quantitatively demonstrate how the QueensLink expands the reach of residents to key destinations within specific travel timeframes. By integrating these computational methods, this capstone aims to present an objective, data-driven case for the QueensLink as a vital instrument for environmental equity and transit justice in Queens.

II: Literature Review

Per a report in 2015, Woodhaven Blvd has been deemed one of the most congested roadways in Queens, with intersections such as Liberty Av / Rockaway Blvd and Metropolitan Av seeing some of the largest bottlenecks[28]. With approximately 30,000 daily bus riders utilizing the corridor, Woodhaven Blvd saw the expansion of bus service in the form of the Q52 and Q53 routes being converted into SBS's (select bus services), yielding modest increases in ridership across both routes[15]. However, overall travel metrics across the corridor have yielded little improvement, in terms of overall travel time, with bottlenecks re-distributed along different portions of Woodhaven Blvd[15]. Despite an overall positive reception to the increase in bus service across riders, traffic capacity has largely remained unchanged[15]. Coinciding with the introduction of the Q52/Q53 SBS's, the MTA sketched out a feasibility study of revitalizing the abandoned LIRR Rockaway Beach Branch into an operational rail service, listing out the LIRR (branching via the LIRR Main Line) and the NYC Subway (branching via the Queens Blvd. subway) as potential operators. The study, while listing out "tree/vegetation loss" as a potential "environmental sensitivity", didn't focus on environmental justice, but rather, listed out various considerations to be looked at in the future, such as hazardous waste, noise pollution, and tree conservation along the corridor[16]. To-date, no comprehensive environmental justice report has been done on the QueensLink site and the surrounding communities to our knowledge.

The EPA defines environmental justice (EJ) as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies"[34]. The EPA developed a tool called EJSCREEN to help aid in efforts to ensure programs, policies, and resources are appropriately inclusive and consider the needs of communities most burdened by pollution[34]. EJSCREEN is an environmental justice screening and mapping tool that utilizes standard and nationally consistent data to highlight places that may have higher environmental burdens and vulnerable populations, and provides both summary and detailed information at a high geographic resolution for both demographic and environmental indicators[34]. These indicators include measures like Particulate Matter (PM 2.5), Ozone, NATA Air Toxics Cancer Risk, Traffic Proximity and Proximity to Hazardous Waste Facilities[34]. While the tool is useful for screening which communities may have higher environmental burdens and more vulnerable populations, it is too broad and often fails to capture state-specific environmental conditions, and is vulnerable to changes in federal administrations[29]. We are seeing this currently, as the current federal administration has removed the tool completely, although mirrors and backups of it exist across various trusted sources. Thus, more in-depth analyses into the ground truth of environmental burdens of local communities are necessary.

The core challenge of quantifying the environmental benefits of the QueensLink project is the reduction of emissions achieved by removing vehicles from the roadway. This challenge is effectively addressed by studies focusing on the emissions balance introduced by new transit infrastructure. For example, a case study analyzing the Brenner Base Tunnel, a large-scale rail tunnel, demonstrates a rigorous methodology for defining a “breakeven point,” where the operational emissions savings from shifting traffic to rail compensate for the substantial CO2 emissions generated during the construction phase[36]. To calculate emissions, the study incorporated elements such as road gradient (which affects fuel consumption), annual energy consumption for each type of vehicle (e.g. diesel, battery electric vehicle) and other pertinent emission factors derived from the HBEFA (Handbook Emissions Factors for Road Transport) database[36]. By first quantifying the current vehicle pollution baseline and then comparing it against the future state, which incorporates both the projected traffic reduction and the indirect carbon footprint from operating the electrified rail service, the research was able to illustrate the net annual reduction in emissions[36].

On another thread of environmental burden, New York City is famously plagued with floods, and as climate change continues to cause more severe weather events that result in heavy rainfall and flooding, it is critical to consider how the proposed QueensLink will intersect with existing floodplains, and how the necessary infrastructure for the reactivated line could help shore up neighborhoods against future flooding. One study developed a method for predicting flood-prone road and rail intersections based on catchment characteristics, and it can be used to aid planning and transportation authorities in estimating and mitigating flood hazards[11]. Generally, integrating this type of predictive flood assessment is crucial for defining baseline environmental hazards, and for ensuring the QueensLink project can transition from being merely a transit solution to a critical piece of resilient infrastructure capable of minimizing climate-related environmental burdens on adjacent communities.

III: Necessary Assumptions

Definitions

For the purposes of this study, we define the "QueensLink Service Region" to be all U.S. census tracts with non-zero population (i.e. excluding parks, trainyards, cemeteries, etc.) within 0.75 miles of the QueensLink corridor right-of-way (ROW), stretching from Queens Boulevard to Liberty Avenue.

We also define the "Combined Service Region" to be all U.S. census tracts with non-zero population within 0.75 miles of the entire proposed route of the M train within Queens from Hunters Point to the Rockaways. The full extent of this region encompasses:

(1) All present-day services feeding into the proposed QueensLink corridor. This includes neighborhoods serving the present-day Queens Blvd. subway (E/M/R/F), including Long Island City, Astoria, Woodside, Jackson Heights, Elmhurst, and Forest Hills.

(2) The proposed QueensLink alignment itself, including the abandoned LIRR Rockaway Beach Branch and the associated above-grade portions in Richmond Hill and Ozone Park. This section also includes the traversal through Forest Park, and is defined as the aforementioned "QueensLink Service Region."

(3) All present-day services to Rockaway Beach (A/Rockaway Shuttle). The re-developed alignment in (2) will allow M trains to be routed from the Queens Blvd. portion of the system (1) into the Rockaways.

Interborough Express (IBX)

The Interborough Express (IBX) is an ongoing MTA capital expansion project with political support from New York State Governor Kathy Hochul. The proposed route for this light rail runs from Brooklyn Army Terminal in Sunset Park to Roosevelt Avenue in Jackson Heights, and runs parallel to the QueensLink ROW. As this project is only in the design and environmental review phase, and is projected to complement the QueensLink's ridership[33], we will not be taking the potential impact of the IBX into consideration when assessing the projected impact on the future build/no-build scenarios.

Fixed Land-use Policy / Zoning Patterns (No-Build/Build Forecasts)

Land-usage plays a critical role in shaping the way transportation policy is implemented and vice versa, specifically in the form of transit-oriented developments (TODs) and mixed-use zoning. TODs serve as an optimal solution to maximize accessibility to transit while also minimizing social/environmental externalities associated with urban/suburban development, in the form of sprawl and automobile-dependency. While much of the QueensLink ROW occupies neighborhoods that are significantly denser than the average North American suburb, the additional transit capacity provided by QueensLink could result in existing industrial and empty lots to be re-developed as multi-unit residential facilities and other land-uses geared towards enriching the local community (lifestyle/shopping facilities, restaurants, entertainment, etc.), especially around core transit hubs. However, while it is possible to simulate hypothetical changes to land-usage to model various environmental/social benefits, this was outside the scope of our study. The City of Yes initiative is a significant step towards land-use reform across NYC, specifically in the form of upzoning existing lots. However, it does not explicitly re-designate lots into new zoning districts[25] and forecasting long-term changes to land-use at the level of each individual parcel is conditional on a multitude of social variables (localized community response/resistance, political decisions) that are outside the scope of what a mathematical model can project. Hence, in keeping our study space consistent and targeted towards assessing primary environmental/transportation effects only, we omit any forecasted changes to land-use under our build/no-build forecasts and assume present-day zoning patterns to hold into the future.

Queens Bus Network System

When performing the Accessibility Impact / Isochrone Analysis, only subway transit and pedestrian travel were taken into account in our final marketing deliverable(s). It is difficult to predict long-term changes to bus networks, as they are subject to periodic re-designs based on a complex set of political, economic, and social factors (evolving employment/travel patterns, ridership demand, farebox revenue collection, etc.) that are well outside the scope of this study. In addition, modelling service patterns with infrequent headways (as is the case with off-peak local bus routes) were difficult to fully capture in our workflow, as our cost definitions reflect a global average of operational ride times/speeds only, without wait/idle times taken into account.

LIRR Atlantic Avenue

This study does not consider network and specific ridership impacts of the LIRR resuming service at the Woodhaven station on the LIRR Atlantic Branch and thereby connecting the QueensLink corridor with a direct LIRR Atlantic Branch transfer as they pertain to accessibility or reduction in private automobile trips. The larger ramifications of this LIRR/NYCT subway transfer point would have resulted in a significant scope creep, as many more variables and data sources would be required. As such, all proposed scenarios explored in this study do not consider the LIRR or the reopening of the LIRR Woodhaven station on the Atlantic Branch.

Isochrone Cost Definitions

Because it is impossible to discern between geometries at the route/link-level in ArcGIS Pro when performing the network analysis, a uniform cost definition was applied to each "sub-network" in the workflow (Subway and Streets). We assumed an average subway speed of 17.4 mph and an average walking speed of 3 mph. All time-based costs were derived based on these fixed speed parameters as well as the calculated distances off of each link in the sub-networks.

Temporal Changes

We also do not consider changes to any other variables involved in our composite index calculation from current day baseline measurements to future scenarios other than population growth patterns as they relate to changes in private vehicle automobile trips and changes in greenspace due to the introduction of parks as part of the QueensLink project.

Fixed Trip Parameters: Transportation Impact Analysis

To model trip counts and distances, we leveraged fixed parameters based on the 2022 NYCDOT Mobility Survey. In other words, for every HH with an "active" vehicle, the same (daily) trip-counts were applied (2.5 trips per day, based on an average) for every household within the QueensLink Service Region. The same logic was applied when calculating Vehicle Miles Traveled (VMTs), where every forecasted trip was assumed to be around 2.75 miles, again based on an average of responses from the same 2022 survey. A more comprehensive approach would be to use a gravity-model (trip distribution) to delegate tract-wise trips to regions in the QueensLink Service area based on a combination of attraction (employment, commercial activity) and friction factors (time-based travel costs). However, implementing this was out of scope for the sake of our analysis, as we were interested in the reduction of trip counts as a whole, rather than focusing on forecasting the socioeconomic nuances around specific travel patterns.

Additional Greenspace

This study assumes that the park space added by the QueensLink project results in net new greenspace for the relevant census tracts. Thus, the additional 33 acres translates to strict increases in greenspace percentage for the census tracts in which the park space is planned to be built.

IV: Scenarios Examined

To quantify impacts in environmental justice and accessibility under QueensLink, we needed to examine three scenarios. This included our baseline, measuring present-day disparities across neighborhoods contained in the QueensLink Service Region, as well as two forecasts, namely a build and a no-build scenario, contingent on the execution of the QueensLink project over a 20-year horizon.

(A) Current Day Baseline

Figure: *Map of Q52/Q53 SBS along Woodhaven Blvd*

Under the current-day scenario, no revenue service exists along the abandoned LIRR Rockaway Beach line, resulting in many residents dependent on the Q52 and Q53 SBS for north-south travel across Queens. Existing subway and rail service in Queens is heavily east-west dependent (the E/M/F/R, 7, J/Z, LIRR), providing critical links to-and-from Central Business Districts (CBDs) such as Midtown Manhattan and Long Island City. However, much of the borough lacks high-capacity transit service connecting locations within the borough itself, particularly for communities located directly north and south of Forest Park. As a result, many residents resort to using Woodhaven Blvd (or even the Van Wyck Expressway / Grand Central Parkway) to perform intra-borough trips, largely via automobile. Despite efforts to address vehicular congestion across the region by modifying Woodhaven Blvd to include bus-only lanes for the Q52-Q53, bus-bunching and overcrowding are still a reality for riders dependent on the service for quick trips across the borough and NYC as a whole[13]. In addition, many residents directly north of Forest Park (around Metropolitan Av / Woodhaven Blvd) do not have access to any subway service within a 15-minute walking radius, as the QueensLink service region is dotted with transit deserts in its present-day state.

In addition, accessibility to core employment centers in Manhattan is heavily dependent on Queens' urban topology: residents in Richmond Hill and Ozone Park (neighborhoods adjacent to the J/Z and A/C services) have easier access to Downtown but not Midtown, and vice versa for neighborhoods north of Forest Park (served by the E/M/F/R), such as Rego Park and Glendale. Residents living in neighborhoods further south such as the Rockaways and Howard Beach, while served by the A train, are often subjected to commutes exceeding an hour (approximately 1.5 hours for trips to Midtown), largely in-part due to its geography within Queens. Trips to/from locations from Rockaway Beach and regions north of Forest Park (Jackson Heights, Flushing/Mets Stadium) are especially impacted by the absence of service.

Land-use and greenspace across the service region are heavily intertwined with the legacy infrastructure that exists today. While Forest Park serves as a critical asset for communities around the service region, neighborhoods directly adjacent to the ROW are vulnerable to risks associated with the corridor's historical development and growth. The elevated portion of the ROW in Ozone Park is currently occupied by light industry (metal fabrication, autobody repair shops), often prone to incidents involving ground toxins, spills, and other site-related pollutants that can tamper with future redevelopment and reactivation in the form of public infrastructure. In addition, regions directly north of Forest Park as well as Howard Beach and Ozone Park, despite being located in NYC, are subject to many of the environmental and public health externalities of many modern American suburbs, exacerbated by urban heat induced by pavement and asphalt[32].

Through our composite EJ index, we intended to encapsulate all of these factors into a single, quantifiable measure, based on historical and present-day records across a variety of open data sources, which is elaborated upon in section *V: Methodology*. Furthermore, for the accessibility impact portion of the project, our baseline consists of the NYC Subway system in its current state, specifically taking into account the recent F/M service swap along the Queens Blvd subway. In addition, when including bus networks into the isochrone analysis, the 2025 Queens bus network re-design was taken into account as well.

(B) QueensLink Built (Build)

Figure: *The proposed M-train service under a build scenario*

The build scenario assumes revenue service along the ROW, in the form of the M train running along the elevated LIRR Rockaway Beach Branch alignment south of Forest Park, as well as a bored tunnel segment connecting the alignment with the Queens Blvd Subway in Rego Park. It also assumes M train service in tandem with the A train south of Rockaway Blvd / Liberty Av towards Howard Beach and the Rockaways. Assuming a

20-year completion horizon, if executed upon, the combination of added transit capacity with greenspace will address many of the factors defined in our baseline measurement, especially in terms of reduced transportation-induced emissions across the region (lesser dependence on private vehicles for short trips). In addition, the modified subway network incorporating the QueensLink is expected to enhance connectivity across the borough and NYC as a whole, with the addition of a much-needed north-south rail service (shown to complement the future service provided by IBX)[33].

Because we examined nearly a dozen features for our composite index, only a few were selected for calibration regarding our two forecasted scenario definitions (build/no-build). These features included projections related to transportation behavior and mode choice (as a proxy for vehicle consumption/usage/emissions) as well as greenspace. Specific methodologies in constructing the build scenario are further elaborated upon in *V: Methodology*, as well as any limitations encountered in the analysis.

(C) QueensLink Not Built (No-Build)

The no-build scenario assumes the NYC Subway network will retain the same shape as it does in its present state (no development), even after a twenty-year period. In essence, no parameters/features are adjusted off of the baseline with the exception of projected population and household growth patterns, and in turn, a forecast on expected (private) auto usage. While a number of socioeconomic and land-use characteristics are bound to change over such a long time horizon, we assume that the region largely stays the same with the exception of household growth/decay alone.

V: Methodology

(A) Data Sources

The following data sources were used as part of our analyses:

- [EJ] NYS Air Quality by Particulate Matter, 2025
- [EJ] NYC Environment & Health Data Heat Vulnerability Index, 2023
- [EJ] NYC Asthma Emergency Department Visits by NTA, 2017-2019
- [EJ] NYC 311 Noise Complaint Data, 2024-2026
- [EJ] NYC Primary Land Use Tax Lot Output (PLUTO) Data, 2026

- [EJ] NYDEC Environmental Site Brownfields Data
- [EJ] NYDEC Environmental Site Spills Incident Data
- [EJ, Transportation] US Census / American Community Survey API, 2022-2024
- [Transportation] NYCDOT Mobility Survey, 2022
- [Accessibility] MTA Subway static GTFS, Versions 2025/02
- [Accessibility] MTA Bus static GTFS (MTA Bus Co., NYCT Queens), Versions 2025/02
- [Accessibility] Modified No-Build and Build Subway MTA static GTFS
- [Accessibility] NYC DCP LION road network geodatabase
- [General] NYC Stormwater Flood Maps, 2024

The individual availability of each dataset is detailed in the appendix, and direct access to these datasets are provided on the chart, if possible.

(B) Overview of EJ Benchmarking Methodology

This study follows a Multi-Criteria Spatial Synthesis approach, where we construct a composite environment justice index on the basis of several factors, by leveraging several open datasets related to emissions, traffic volumes and transportation behavior, land-use, greenspace coverage, urban heat vulnerability factors, and more. The data sources comprising all iterations of the composite environmental justice index can be found in (A) above. This environmental justice index can illustrate disproportionate environmental disparities across different areas within the area of interest. The goal is to construct census tract-level distributions across each of the specified variables per dataset, within the scope of the QueensLink Service Region and the Combined Service Region, as defined above in *III: Assumptions*.

Alongside the composite environmental justice index, this study highlights several constituent aspects of the data. Primary Land Use Tax Lot Output (PLUTO) data is utilized to pinpoint noise-sensitive locations along the QueensLink route, including schools, hospitals, nursing homes, and daycare centers, while identifying industrial land-uses and unremedied brownfield sites. The spatial correlation between PM2.5 concentrations, traffic volumes, and asthma hospitalization rates offer a perspective on the health-baseline for the region, alongside projections of current transportation-induced emissions along the Woodhaven and Cross Bay Boulevard corridors. To assess climate resilience, this study overlays constituent elements of the

NYC Heat Vulnerability Index with existing transit deserts and identifies flood-prone regions within the service area.

Composite Index Construction and Normalization

The core of this environmental impact analysis is a multi-factor composite index designed to quantify the spatial distribution of environmental burdens across the study area. To ensure a uniform scale for disparate datasets ranging from social indicators to atmospheric concentrations, all variables were first normalized using a Min-Max scaling technique. This transformed all raw values into a dimensionless range between 0 and 1.

To ensure the index accurately reflects cumulative burden, the directionality of specific variables was adjusted through inversion (1 - value). For variables where higher values traditionally indicate better outcomes, such as Median Income, Greenspace Coverage, and Access to Air Conditioning, inversion was applied so that 0 represents the most favorable environmental/socioeconomic condition and 1 represents the highest level of vulnerability or lack of resources. This established a consistent scale across the entire indicator suite that signifies a higher value is a worse environmental burden.

Indicator Suite and Comparative Weighting

The index integrates eleven distinct variables to capture the intersection of public health, environmental justice, and physical surroundings. These include:

- **Climate and Ecology:** Average Surface Temperature and Greenspace Coverage.
- **Socioeconomic Vulnerability:** Median Income, Percent Households with Air Conditioning, Percent Black Population, and Percent of Community Identified as Disabled.
- **Public Health and Pollution:** Age-adjusted Asthma Emergency Room Visits, PM2.5 Concentrations, Brownfield Sites Count, and Recorded Chemical Spills.
- **Transportation Flux:** Vehicle Miles Traveled (VMT), utilized as the primary variable for scenario modeling.

For the baseline (Current Day) analysis, a Simple Additive Weighting (SAW) approach was initially employed, assigning equal weight to all variables. To validate the robustness of this index and account for multi-collinearity between factors like heat and income, Principal Component Analysis (PCA) was subsequently performed. By extracting the first principal component, we were able to observe how the index visualization shifted when weights were dictated by the data's internal variance rather than previous assumptions of equality.

Scenario Modeling and Change Detection

The impact of the QueensLink was evaluated through a comparative analysis of Build and No-Build scenarios. The No-Build scenario adjusted the baseline VMT to account for projected population growth, serving as a proxy for increased future emissions. In the Build scenario, the VMT variable was modified to reflect the projected reduction in private automobile trips resulting from the modal shift to the QueensLink subway extension, while the Greenspace variable was increased to reflect the 33 acres of parkland provided by the project to the relevant census tracts. A detailed explanation of the VMT calculation is provided in section (D) below.

Final visualization was conducted in ArcGIS Pro using Graduated Colors categorized by Natural Breaks (Jenks). This method was chosen to minimize variance within classes while maximizing the difference between them, highlighting the distinct spatial clusters of environmental burden. To isolate the specific impact of the project, a Change Detection map was generated by subtracting the No-Build index scores from the Build index scores. This subtraction resulted in a delta value for each census tract, allowing for the direct visualization of environmental improvements specifically attributable to the QueensLink intervention.

(C) Accessibility Impact Analysis

Overview

To calculate the accessibility impact of service along the QueensLink right-of-way, we performed a network analysis in ArcGIS Pro to generate two isochrone (walk-shed) plots, one for the existing travel network (post F/M service swap) and the other with M-train service running along the right-of-way, fully connecting the Queens Blvd Subway (E/M/F/R) in Rego Park/Forest Hills with the Rockaway Beach branch (A) in Ozone Park. Because the road/transit networks for the baseline and no-build scenarios are fundamentally the same, we are treating them as such in our analysis. Modes examined in our analysis included the combination of walking/subway transit as well as walking/subway/buses, with the two isochrones (build/no-build) created for each. Because bus networks undergo periodic re-designs conditional on changes to growth patterns, political willpower, and financial imperatives by transit agencies[30], it is hard to predict the magnitude of change over a twenty-year forecast horizon. Hence, we assumed the bus network to be the same over both no-build and build scenarios.

Accessibility Impact: No-Build Data

Two core datasets were required to build our network for the no-build scenario:

(1) **The NYC DCP LION road network data**, a geodatabase consisting of all roadway links within the bounds of NYC proper. This dataset served as our foundation to model localized, street-oriented pedestrian travel, to-and-from service facilities (subway stations).

(2) **Static GTFS files from the MTA**, used to define the NYC Subway network in its present state. For the analysis consisting of bus transit, we additionally looked at GTFS files pertaining to both NYCT (Queens only) and the MTA Bus Company, resulting in a total of three sets of GTFS files as input into our workflow.

Accessibility Impact: Build Data

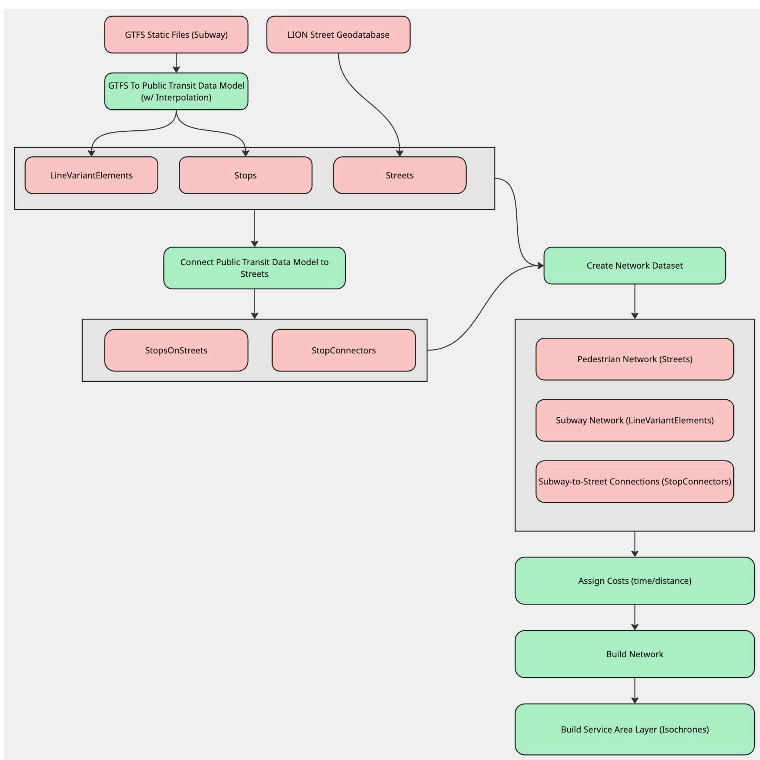


Figure: *Isochrone/Service Area Analysis Workflow in ArcGIS Pro*

Both the street-network (LION) and bus-transit (MTA GTFS) input datasets were recycled for the build scenario analysis. However, we needed to source/produce raw files (GTFS) containing metadata on the inclusion of QueensLink into the existing subway network. Luckily, we were able to leverage GTFS files from QueensLink's 2025

CUSP Capstone Group, specifically with the inclusion of the added M train service along the ROW and into the Rockaways. Hence, no extra work was needed to be done in defining our updated subway network.

Core Methodology

We primarily used ArcGIS Pro to construct our isochrone maps, specifically via the construction of a Service Area Layer in ArcGIS's suite of Network Analysis tools. In order to enable Network Analysis functionality, we needed to ingest all of our raw datasets (LION geodatabase, GTFS files) into ArcGIS and integrate them into a single data structure, rendering our mobility network as a foundation for any further calculations on top of it (optimal routing, coverage analyses, OD-pair behavior, etc.). Doing so required the use of several built-in geoprocessing tools in a chained fashion, which is described upon in the figure above.

A core component of this workflow included the use of the `Connect Public Transit Data Model To Streets` tool, which specifically defines a street network (LION) as input and appends "connectors" from the street to the designated transit facilities (as defined by the input GTFS files), effectively creating network joints connecting the street to the subway system (equivalent to traversing through a subway station from the station entrance to the train platform). This tool enabled the integration between the street and transit network layers, allowing us to define parameters specific to both components while ensuring they are connected when performing the analysis post build.

Defining link-wise costs was another crucial step towards building our base mobility network. Because it was nearly impossible to decipher and designate between specific links within our subway network without having to build an entirely separate sub-network per individual route (express versus local services, effects of CBTC on select routes, for example), a uniform speed of 17.5 mph was assigned across the entire system, defined as the systemwide average speed by the MTA. The same logic was applied to our bus network, assuming an average speed of 9.5 mph as reported by the MTA for buses in Queens. Buses, however, are heavily prone to service delays attributable to roadway congestion (assuming no ROW/bus-only lanes for non-SBS routes) and bus-bunching, a phenomenon where delayed buses are susceptible to unequal passenger load-balances due to the delay itself as well as the accumulated time at each stop for embarkment/disembarkment under a capacity/service-strained system. In addition, various local routes in outer Queens in particular have headways exceeding 30 minutes by design during off-peak hours, making this difficult to fully capture in a holistic model such as the one we've built. Hence, we emphasize that the bus transit analysis was merely done as a proof-of-concept, as many parallel studies for similar capital projects (namely, for the IBX) have only looked at the combination of subway and pedestrian travel. A uniform walking speed of 3 mph was defined for our street network. Ultimately, these fixed speed parameters in conjunction with the network lengths (distances) were used to calculate our link-wise costs, in terms of time.

After building a network dataset off of the link-wise costs we defined, ArcGIS recognizes this dataset as a data structure suitable for the construction of a Service Area layer, which in other words is our final isochrone map output. Defining our coverage-radius in terms of 15-minute increments (up to an hour max.) as well as a point-based layer representing our reference location, we were able to retrieve our finalized output. Because running this workflow required individual runs per reference location, only a few facilities were considered for the analysis, including Metropolitan Ave/Woodhaven Blvd (an existing rail-transit desert north of Forest Park), Howard Beach, the Rockaways, and various locations outside of the immediate scope of the QueensLink ROW, including Mets-Willets Point (7) and Queens Plaza (E/M/F/R) in LIC. To look at results outside the scope of the selected locations, an OD-pair analysis was produced using the same suite of network analysis tools, and a Python script was created to parse the results further into a usable dataset for analysis. Results are further detailed in the *VI: Results and Discussion* section.

(D) Transportation Impact Analysis

Overview

A major component of our analysis consisted of benchmarking travel mode shifts as a result of the reactivation of the QueensLink right-of-way, as a proxy for predicting reductions in transportation-induced emissions across the service region, and more broadly, the entirety of Queens. Under the anticipation that added transit capacity will empower local residents to adopt the new service as a viable alternative away from automobiles, especially for intra-Queens trips, we looked at performance in terms of both totalled trip reductions and VMT, with the latter used to further forecast emission output. A trimmed down interpretation of the standard four-step travel demand model framework was used to estimate these figures, with an emphasis on trip generation and mode choice.

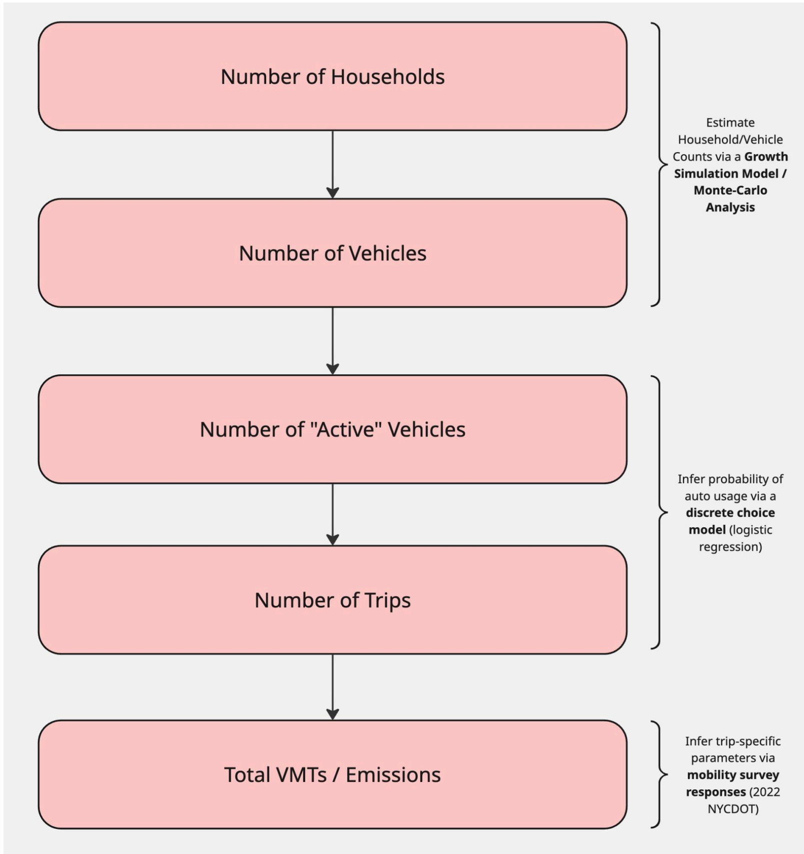


Figure: *Transportation Impact Analysis Workflow*

MPOs (Metropolitan Planning Organizations) and transit agencies / DOTs often rely on the four-step travel demand framework[7] to benchmark regional transportation emissions against Federal EPA (and sometimes state-level) standards (per the Clean Air Act)[12], with NYMTC and NJTPA as the core MPOs responsible for such forecasts in the Greater NYC Area. This is a critical step in ensuring large-scale capital projects such as QueensLink are eligible to receive Federal backing in the form of direct funding (specific grants/subsidies) and other channels of fiscal assistance (loans, especially for projects with a longer-term ROI). In addition, MPOs play the role of issuing economic forecasts to transit agencies, local/state governments, and in some cases, the public at large, in order to ensure coordination on regional matters such as the construction of new transportation infrastructure[6]. Although NYMTC periodically publishes statistics related to socioeconomic/population growth and regional transportation behavior (travel mode choice, select travel patterns), public visibility into such forecasts is relatively lacking, especially at the granularity we are interested in at the Census Tract level. In addition, access to the models themselves are often limited to government agencies and private-sector partnerships (planning/engineering consulting firms). Hence, for this portion of the study, we attempted to emulate some of the most important steps of a regional transportation model, while acknowledging that there will be some limitations to our approach, which are outlined further in the *VII: Limitations* section below.

Methodology: Trip Generation

For the trip generation phase, we were interested in estimating tract-level automobile trip counts, by leveraging assumptions from existing survey data, including the US Census / API for modeling tract-level growth patterns and household-level automobile ownership/usage as well as NYCDOT's 2022 mobility survey, for acquiring trip-specific attributes (purpose, locations/scope). With only three years (2022-2024) of reliable historical data to infer over a time horizon of twenty years (for our build scenario), instead of modeling a discrete outcome, a simulated distribution was generated to account for all possible growth scenarios, using a Monte-Carlo analysis.

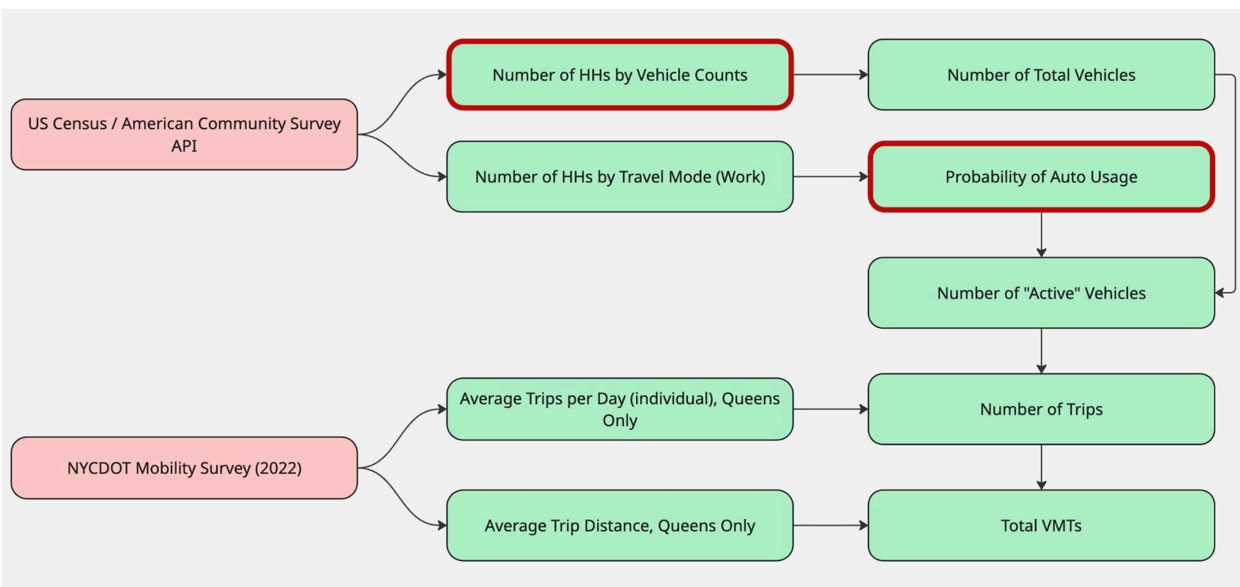


Figure: *Trips/VMT Calculation Workflow. Items outlined in red represent the subjects of our build/no-build forecasts and are adjusted as such.*

The following pieces of data were required in order to generate trips:

(1) [US Census / ACS] The total number of households in a given census tract.
(2) [US Census / ACS] (number_vehicles) The total number of vehicles in a given census tract.

(3) [US Census / ACS] (probability_auto) The probability of any given trip being performed via automobile. For our build/no-build forecast, this quantity is estimated via a mode-choice model, which is further elaborated in this section.
(4) [NYC DOT] (daily_trip_count_average) The estimated number of trips per day.

The most critical component of this analysis was to forecast household (HH) growth for our build/no-build scenarios. Estimating the number of trips for our baseline measurement (present-day) was relatively straightforward, especially since the American Community Survey provides estimates on the number of HHs stratified by the number of vehicles (0,1,2,3,4+) they own (ID `B08201`), and in turn, obtain the total number of vehicles per census tract. Translating vehicles into trips, the ACS also provides attributes related to commute/transportation mode choice (ID `B08006`) as well (albeit emphasizing work-based trips), providing the number of HHs that commute via automobile versus transit (bus, rail, etc.), among others. We can use the mode-choice feature to infer the probability that a vehicle is "active" at any given point (auto HHs divided by all recorded HHs), which is especially important to consider since it is incredibly unlikely that every recorded vehicle will be on the road all at once over a 24 hour period. Lastly, now that we have a count of "active" vehicles, we would like to estimate the number of trips per vehicle. This quantity is inferred via a global estimate from the 2022 NYC Mobility Survey, based on recorded trips from that dataset. While this value can be further calibrated, an average of 2.75 trips per day was observed based on the ground truth survey data, to which we assume every active vehicle will undergo a similar number of trips per day. Hence, the baseline calculation for trip counts is just a simple multiplication: number_vehicles * probability_auto * daily_trip_count_average.

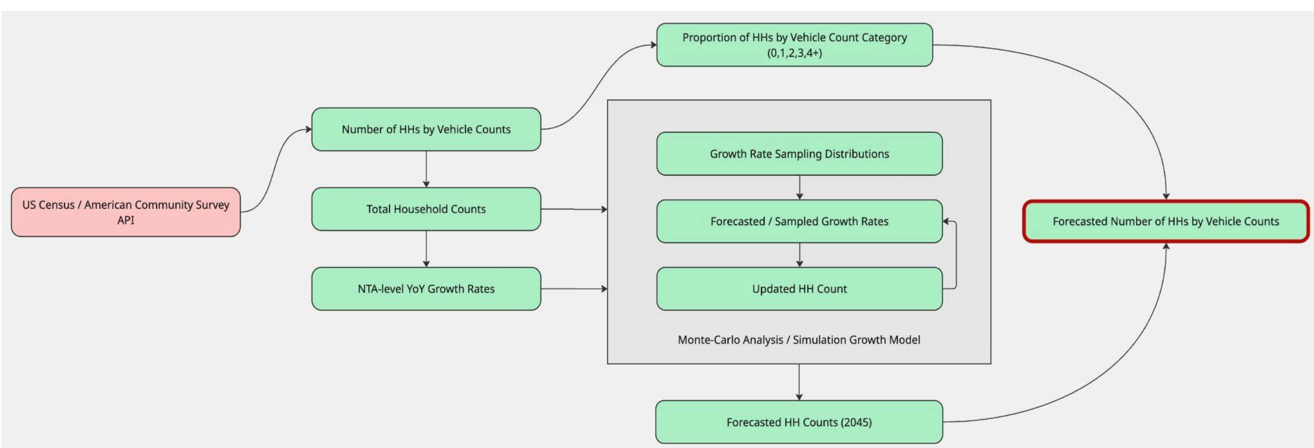


Figure: *HH Growth Model Workflow (20-Year Forecast)*

To calculate trip counts for the build/no-build scenarios, both the number_vehicles and probability_auto features needed to be adjusted and forecasted. The probability_auto feature forecast is elaborated upon below under `Methodology: Mode Choice`. The number_vehicles forecast can be thought of as a forecast on population/HH growth over the twenty-year horizon we defined. Long-term population forecasts often require a great deal of complexity as they are highly dependent on other dynamic factors (socioeconomics, political events) that can't be explicitly defined in a standard supervised learning (regression-based) framework. Hence, a simulation-based approach was adapted for our use case, to enumerate a range of possible outcomes and account for the uncertainty in our forecasts. To do this, we used existing NTA-level (neighborhood-tabulation area) growth rates from the Census/ACS to parameterize a series of random (normal) distributions. The distributions are then sampled from for over 20 iterations (per forecasted year) per census tract, and the resulting HH populations are iteratively updated, based on the sampled rates. Note that each census tract is assigned a distribution based on the NTA the census tract is fully contained in. The final result is the forecasted number of HHs for each given census tract, and hence, the number of vehicles can be inferred upon.

Methodology: Mode Choice

The mode-choice stage of the transportation analysis is what ultimately differentiates the no-build with the build forecast, by calculating the `probability_auto` feature under a build scenario. In other words, this is the quantity that predicts the magnitude to which residents will switch over to transit under a build scenario. A probabilistic model was created in order to predict the likelihood of automobile usage for any given trip within the bounds of the QueensLink service area. Using a standard discrete choice model in the form of a logistic regression and calculating the change in forecasted odds across the no-build and build scenarios, we were able to pinpoint which locations (census tracts) will see the greatest demonstrable change in trip-mode selection as a result of QueensLink.

Independent variables consisted of features derived from our Accessibility Impact portion of the project, in the form of system-induced travel costs across different locations within Queens from our network analysis (using an OD-pair matrix, matching census tract centroids to subway stations), which is elaborated upon in Section B above, titled `Accessibility Impact Analysis`. The accessibility predictors included select locations inside of the QueensLink Service Region (Queens Plaza/LIC, Jackson Heights, Flushing, Forest Hills/Rego Park) as well as Midtown (Times Square/42, Grand

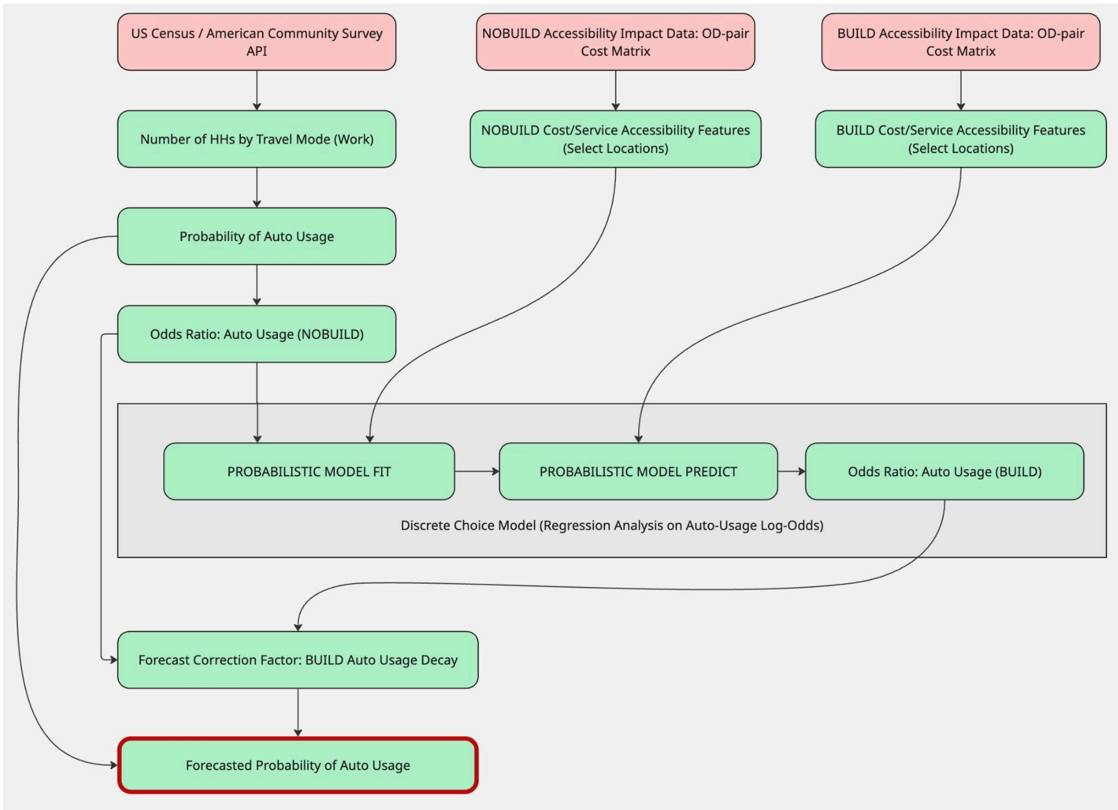


Figure: *Mode-choice model workflow / auto-usage forecast for the build scenario*

Central), with each item representing a time-based cost of traveling from a given census tract (in the QueensLink Service Region) to the selected locations. Our dependent variable was the log-odds transformation of `probability_auto`, which allows us to better interpret the change in behavior under the two scenarios.

To fit the model, we used the existing `probability_auto` calculations based on the Census/ACS, and the model was trained using the baseline/no-build accessibility costs. To calculate a forecast for the build scenario, accessibility costs from the build scenario/isochrone analysis were used as inputs. A corrective/magnitude-based factor was then calculated based on the ratio in log-odds between the build and no-build outputs, and directly applied to `probability_auto` for our forecasted (build) scenario.

Ideally, a more robust model specification would include socioeconomic and land-use predictors as well, especially as multi-vehicle ownership/usage is correlated with upward social mobility (income) and HH vehicle-dependency is often connected to the spatial land-use distribution of a neighborhood (heavy presence of single-family homes, parking facilities). However, because we treated these variables as fixed across both the no-build/build forecasts, only features related to station/hub accessibility and travel-induced costs were included in the final model.

The Final Result

Combining our trip-generation estimates with the mode-shift predictions, we were able to calculate the delta in potential automobile trips under our two (build/no-build) scenarios. Multiplying our trip counts by the probability of automobile ownership using the formula outlined in the `Methodology: Trip Generation` section above (in addition to several fixed parameters related to trip mileage, coverage, and trips per day, derived from the NYCDOT mobility survey in lieu of performing the trip distribution phase), we obtained distributions related to potential outcomes in HH growth, trip-reductions, and overall VMT by repeatedly simulating this process 1000 times. In addition, the tract-level forecasts for each attribute were utilized and calibrated in our composite spatial EJ index, based on the distribution means.

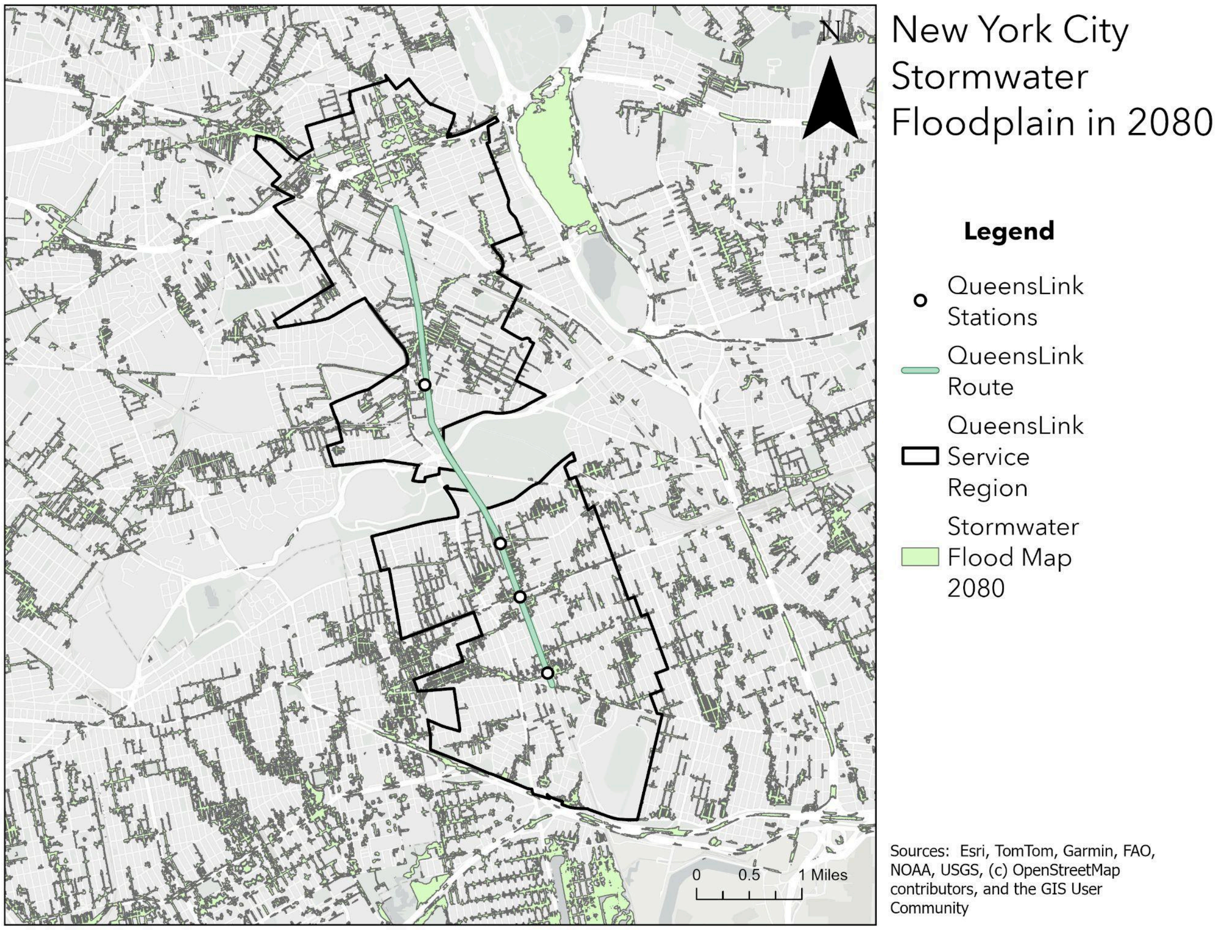
VI: Results & Discussion

(A) Non-Critical Environmental Indicators

Context

In addition to the primary drivers of the environmental justice index, several supplemental variables were analyzed to determine their potential as project constraints or receptors of negative impact. Specifically, evaluations of localized flood hazards and historical noise complaint data revealed that these factors remained statistically stable or negligible across the study area, suggesting that the QueensLink reactivation does not present significant new risks in these categories.

Flood Maps

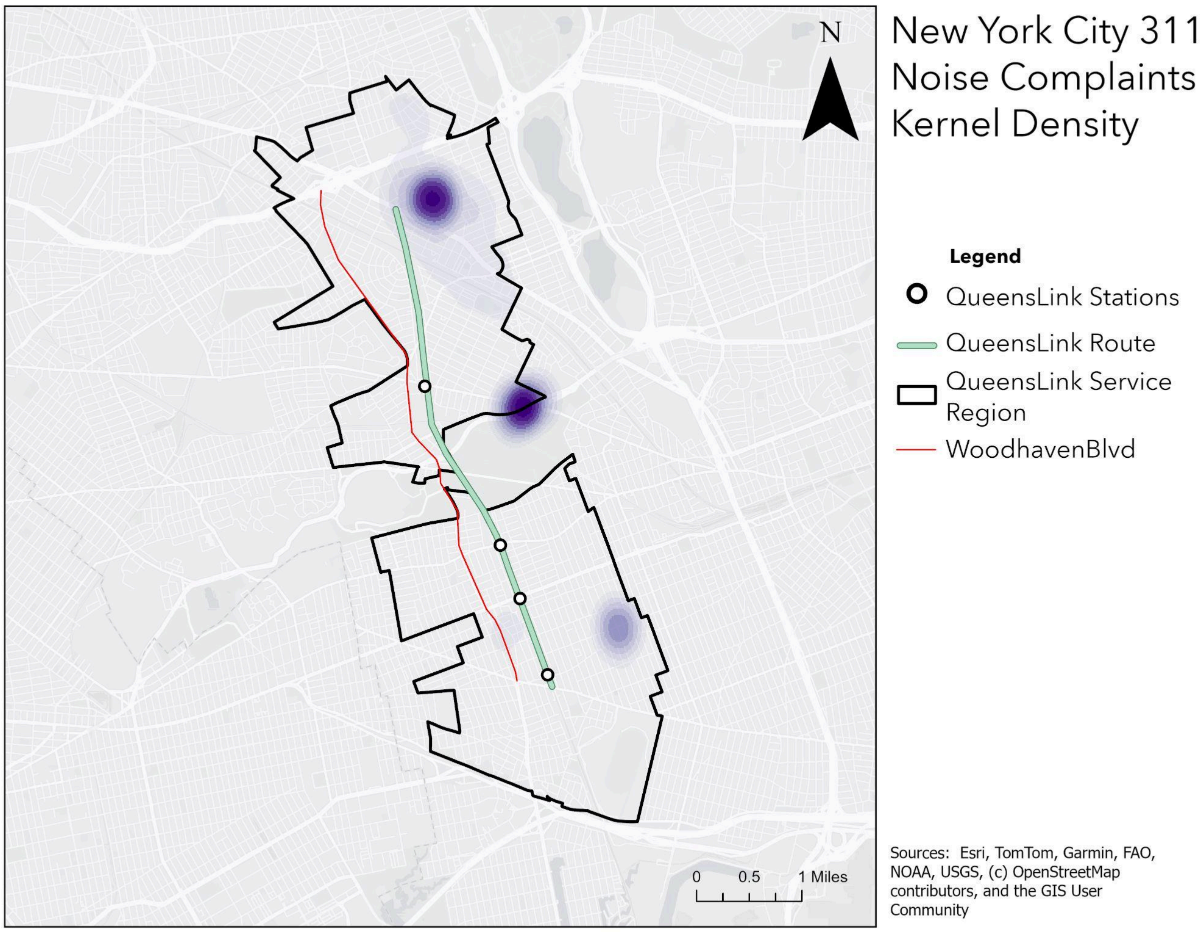


To assess the long-term viability and climate resilience of the proposed alignment, we examined several iterations of the NYC Stormwater Flood Maps to identify potential hydrological risks to the right-of-way. Our analysis reviewed scenarios for Moderate Flooding (2.13 in/hr) under both current sea levels and projected 2050 sea level rise, as well as Limited Flooding (1.77 in/hr) under current conditions. Across these models, the results were largely negligible, showing no significant flooding depth or extent that would impede the QueensLink's operations or structural integrity within the immediate ROW. Furthermore, because the project's primary contribution to stormwater resiliency is the addition of 33 acres of permeable greenspace via the accompanying park, the majority of the surrounding built environment would remain unaffected by the transit reactivation itself.

Consequently, we have opted to display only the NYC Stormwater Flood Map for Extreme Flooding (3.66 in/hr) with 2080 Sea Level Rise as a worst case reference point.

Even under these extreme conditions, the spatial analysis indicates that the QueensLink corridor is not a primary site of inland flooding concentration. Given that the project's footprint does not exacerbate existing vulnerabilities and that significant interventions beyond the planned greenspace are not required for feasibility, we will not be conducting further granular analysis on stormwater impacts.

Noise Complaints



In an effort to quantify the acoustic benefits of reducing vehicular congestion, we analyzed historical 311 noise complaint data specifically categorized under traffic-related disturbances, including vehicle idling, engine honking, and general traffic noise within the QueensLink service region. By applying a Kernel Density Estimation to these complaint points, we aimed to identify spatial "hot spots" of acoustic distress that might be alleviated by a modal shift from private automobiles to the QueensLink subway extension. Our hypothesis anticipated a high concentration of complaints along the

Woodhaven Boulevard corridor, a major arterial notorious for heavy congestion and high decibel levels.

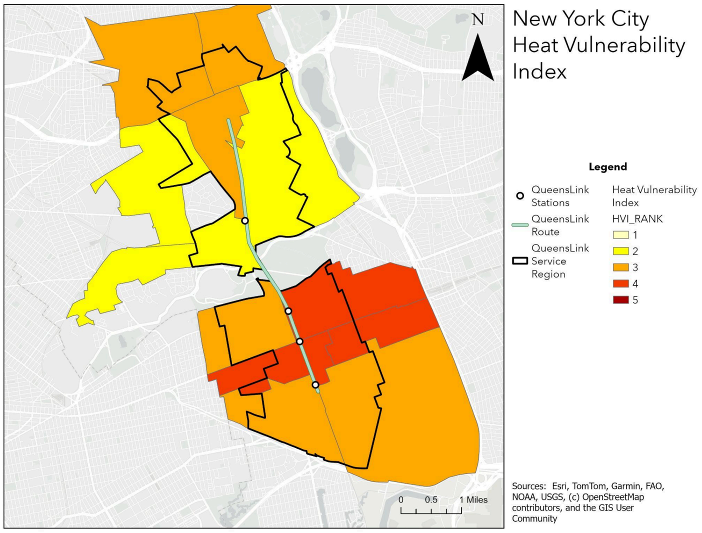
However, the resulting density visualization revealed a spatial distribution that contradicted these expectations. The primary hot spots of noise complaints were concentrated significantly east of the QueensLink right-of-way, effectively on the opposite side of the corridor from Woodhaven Boulevard, with negligible activity recorded along the boulevard itself. This suggests that 311 noise reporting may be influenced more by residential density and reporting behaviors in specific neighborhoods than by the actual decibel levels of the borough's primary transit arterials. Due to this lack of spatial correlation between the proposed transit intervention and the recorded complaint clusters, we concluded that noise complaint reduction along Woodhaven Boulevard would not serve as a reliable or justifiable metric for this study, and we chose not to pursue further modeling of noise abatement in our impact analysis.

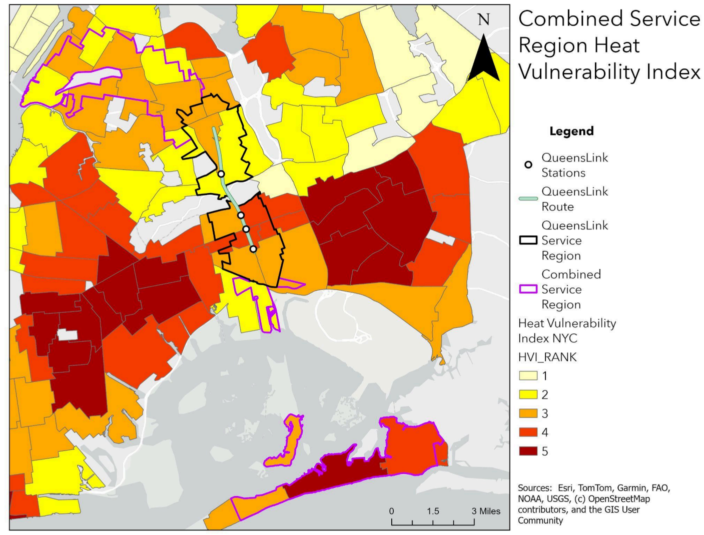
(B) Components of Current Day Environmental Baseline

Context

To provide transparency into the cumulative EJ index, the section outlines a spatial decomposition of the individual indicators that constitute the current-day environmental baseline. By visualizing each variable independently, we establish the foundational geographic patterns that drive the index.

Heat Vulnerability Index

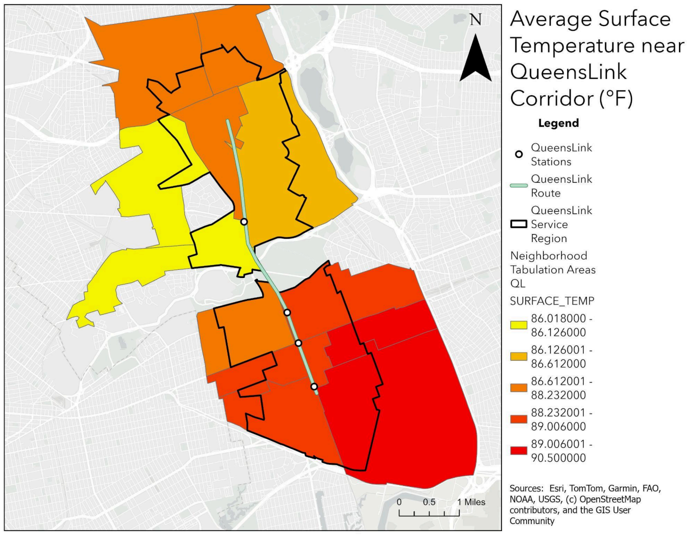


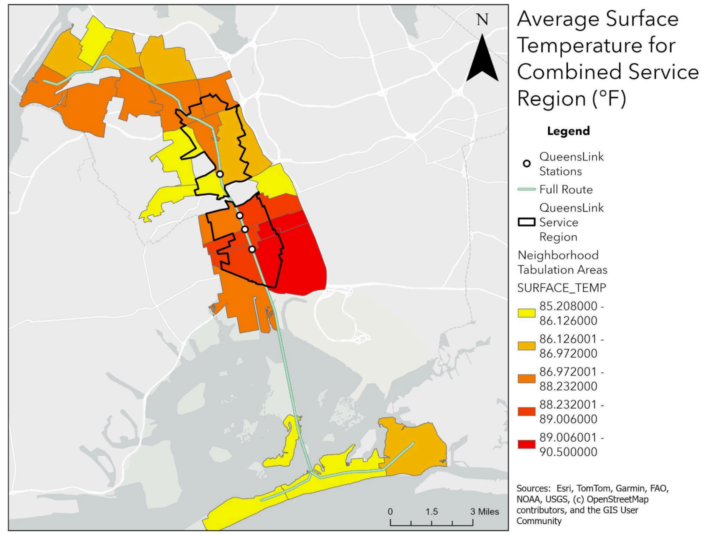


To establish a baseline for climatic risk, our analysis utilizes the official NYC Heat Vulnerability Index (HVI) as a primary data source. The HVI is a comprehensive metric developed by the New York City Department of Health and Mental Hygiene to identify neighborhoods where residents are at the highest risk of heat-related illness or death. This dataset serves as a critical pillar for our composite index, as several of our primary variables, specifically Average Surface Temperature, Median Income, Greenspace Coverage, Percent Households with Air Conditioning, and Percent Black Population. These variables are derived directly from this source. By decomposing the HVI into these constituent parts, we are able to isolate the specific socioeconomic and environmental drivers that contribute to thermal risk along the corridor.

Upon visualizing the HVI distribution, distinct geographic clusters of high vulnerability become apparent. Within the immediate QueensLink service region, **Richmond Hill** and **Ozone Park** emerge as the most vulnerable areas. When expanding the view to the combined service region, the **Rockaways** also stand out as particularly susceptible to heat-related stress.

Average Surface Temperature

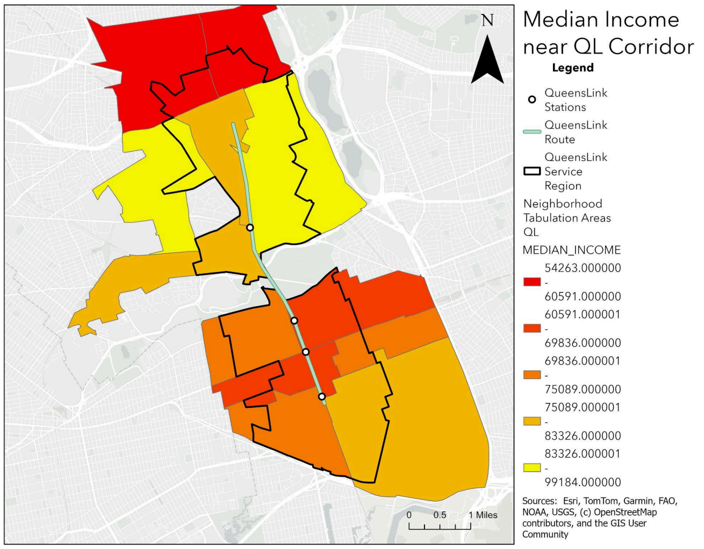


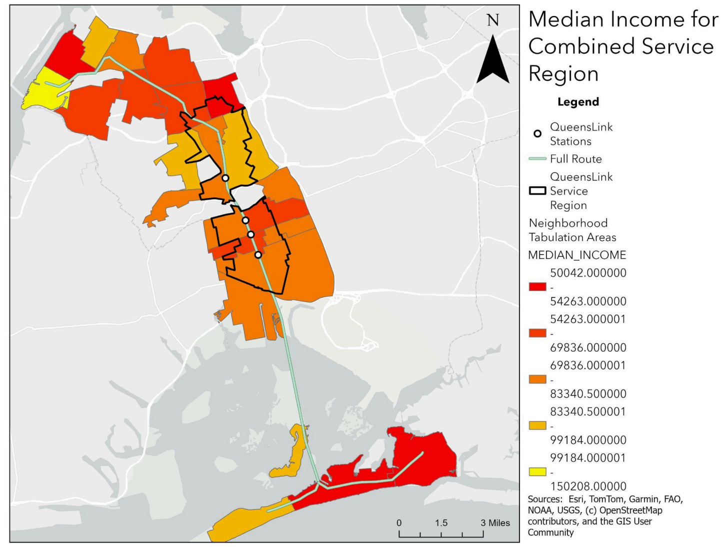


As a core component of the Heat Vulnerability Index, the Average Surface Temperature metric identifies the physical manifestation of the Urban Heat Island (UHI) effect within the project study area. This variable is particularly significant for the QueensLink proposal, as the conversion of the abandoned, heat-absorbing rail embankment into a "green" corridor with parkland serves as a direct mitigation strategy against localized thermal extremes. By mapping this data, we can pinpoint precisely where the physical environment is most hostile to residents during extreme heat events.

Our spatial analysis reveals that **Ozone Park** experiences the highest average surface temperatures within the service region, likely due to its high density of industrial land use and lack of significant canopy cover, as identified in the Greenspace section below. However, the thermal burden is not limited to the southern end of the corridor; **Richmond Hill** and **Rego Park** also exhibit comparatively high temperatures that exceed borough averages. These findings suggest that the heat-mitigating benefits of the proposed 33 acres of new greenspace would provide relief not only to the underserved southern neighborhoods but also to the more residential northern sections of the alignment, where high surface temperatures currently pose a public health risk.

Median Income

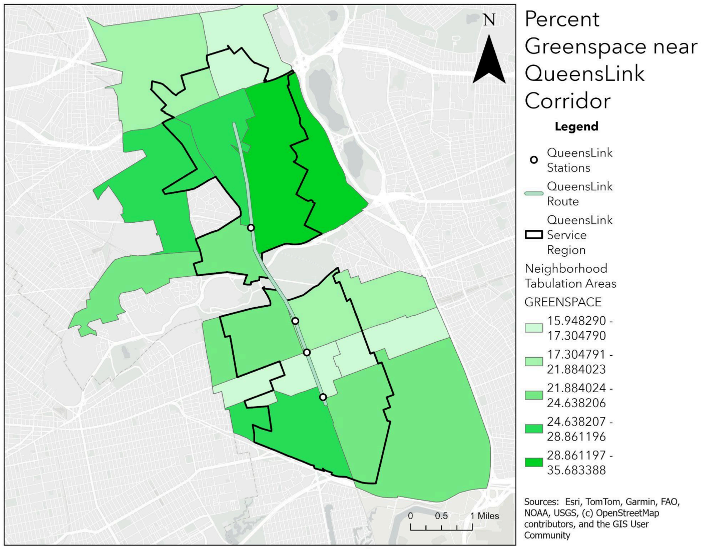


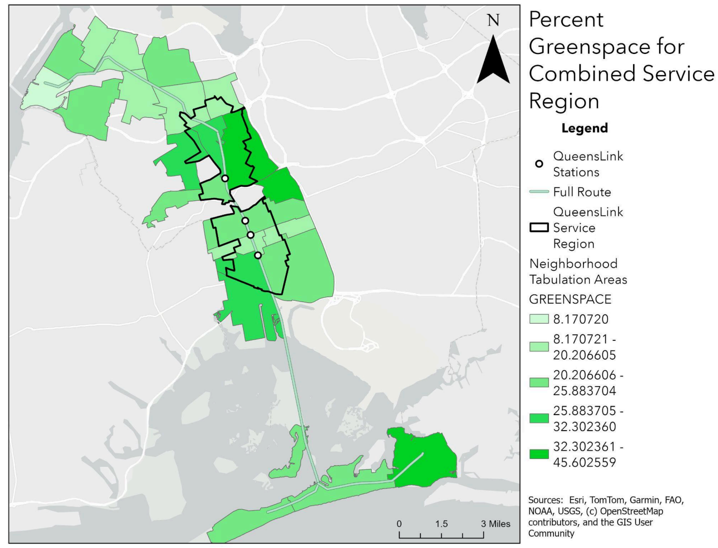


The distribution of Median Household Income provides a critical socioeconomic lens for our environmental justice index, serving as a primary indicator of a community's capacity to adapt to environmental stressors. In the context of the Heat Vulnerability Index, lower-income households often face higher risks due to the increased financial burden of utility costs and the potential lack of high-quality insulation or cooling infrastructure[19]. Consistent with our normalization methodology, this variable was inverted to ensure that neighborhoods with the lowest median incomes received the highest burden scores within our composite index.

Within the primary QueensLink service region, **Ozone Park** and **Richmond Hill** exhibit the lowest median household incomes, marking them as high-priority areas for equitable transit investment. While areas such as Corona and Elmhurst appear on the periphery of our maps with worse economic profiles, they are geographically further from the RBB ROW, and our focus remains on the direct corridor where the QueensLink can most effectively reduce transportation-related costs for cost-burdened residents. Looking at the combined service region, the **Rockaways** present the lowest income levels in the study area, followed closely by a belt of economically diverse but vulnerable neighborhoods including **Sunnyside Gardens**, **Jackson Heights**, **Elmhurst**, **Corona**, **Richmond Hill**, and **Ozone Park**. This spatial trend reinforces the project’s goal of connecting low-income transit deserts to the broader economic opportunities provided by the Manhattan-bound subway network.

Greenspace

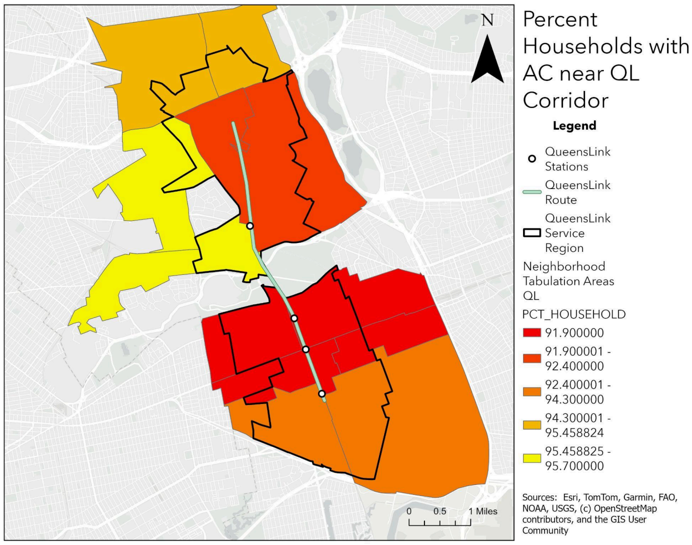


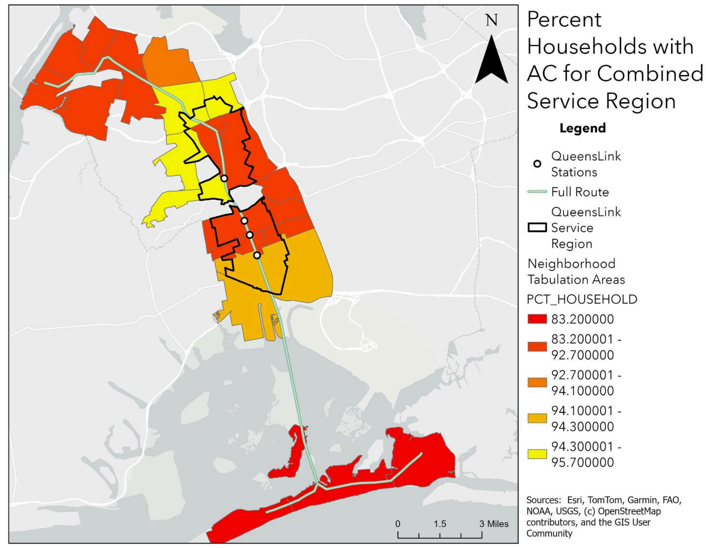


The Greenspace coverage variable, sourced from the HVI dataset, measures the percentage of land area dedicated to vegetation and open space. In the context of the QueensLink project, this metric is double-edged: it identifies areas currently benefiting from the cooling effects of greenery while simultaneously highlighting the gray infrastructure gaps that the proposed 33-acre park could fill. As a key component of our composite index, this variable was inverted to emphasize areas of low vegetative cover as high-priority zones for environmental intervention.

Spatial analysis of the QueensLink service region shows that **Forest Hills**, **Rego Park**, **Middle Village**, and **Ozone Park** currently possess the highest greenspace values. When expanding to the combined service region, these neighborhoods maintain their status as leaders in vegetative cover, though **Far Rockaway** also emerges with one of the highest values in the study area due to its coastal open spaces. Despite these high-performing pockets, the data reveals significant “green deserts” along the immediate RBB right-of-way, reinforcing the necessity of the QueensLink’s park component to bridge these existing ecological gaps and provide a continuous green corridor through the heart of Queens.

Households with Air Conditioning

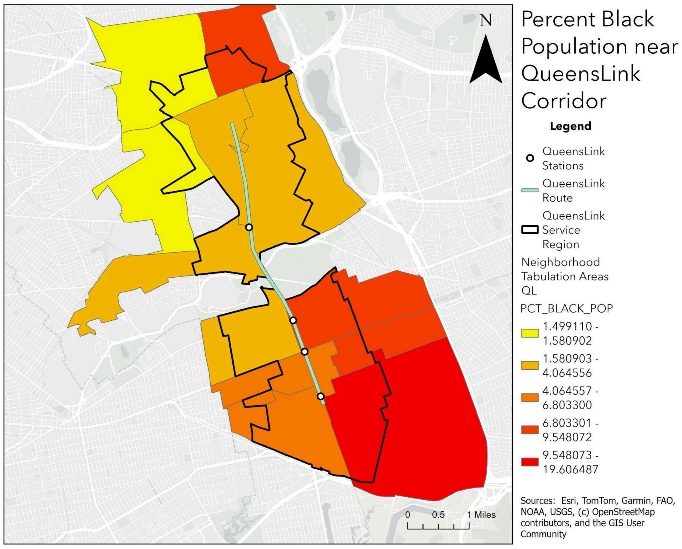


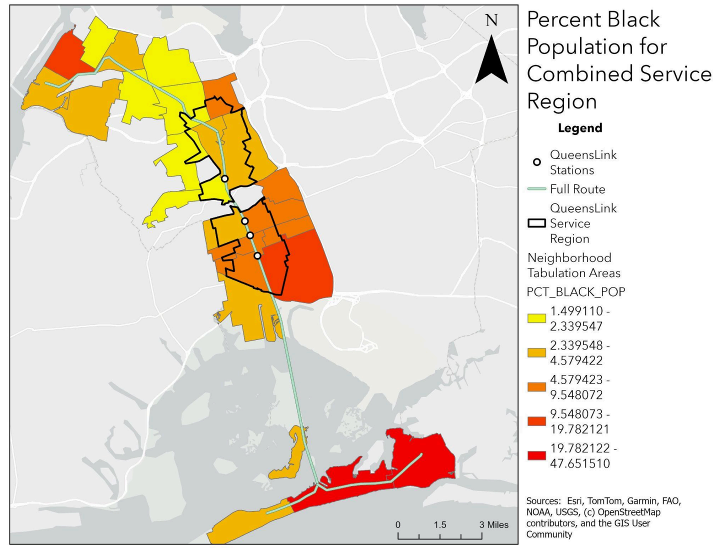


The Percent of Households with Air Conditioning is a critical indicator of a community's adaptive capacity: the ability of residents to physically shield themselves from extreme heat. In the New York City climate, access to air conditioning is not merely a matter of comfort but a vital public health necessity that significantly reduces the risk of heat-stroke and heat-related mortality. For our composite index, this variable was inverted so that neighborhoods with the lowest rates of AC penetration received higher burden scores, identifying where residents are most exposed to the indoor thermal impacts of the urban heat island.

Our mapping of the QueensLink service region reveals a surprising concentration of vulnerability in **Forest Hills**, **Rego Park**, and **Richmond Hill**, which exhibit some of the lowest rates of residential cooling access in the area. This suggests that despite the higher vegetative cover or median incomes in certain parts of these neighborhoods, a significant portion of the housing stock may lack centralized or adequate cooling systems. When viewed through the lens of the combined service region, these northern clusters remain critical, alongside **Long Island City**, **Astoria**, and **Sunnyside Gardens**. However, the **Rockaways** emerge as the most severely burdened area in the entire study, showing the lowest levels of air conditioning access. These findings highlight a stark geographical disparity in climate resilience, marking the Rockaways and the central Queens corridor as high-priority zones for the cooling benefits and improved energy-efficient transit access proposed by the QueensLink.

Black Population

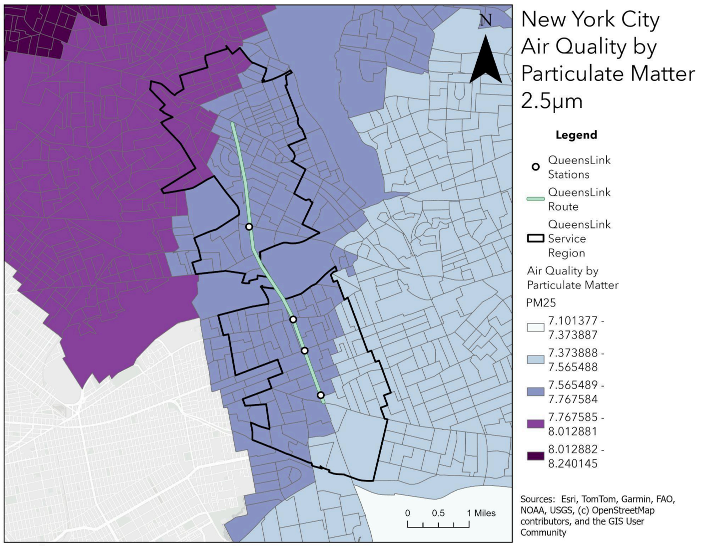


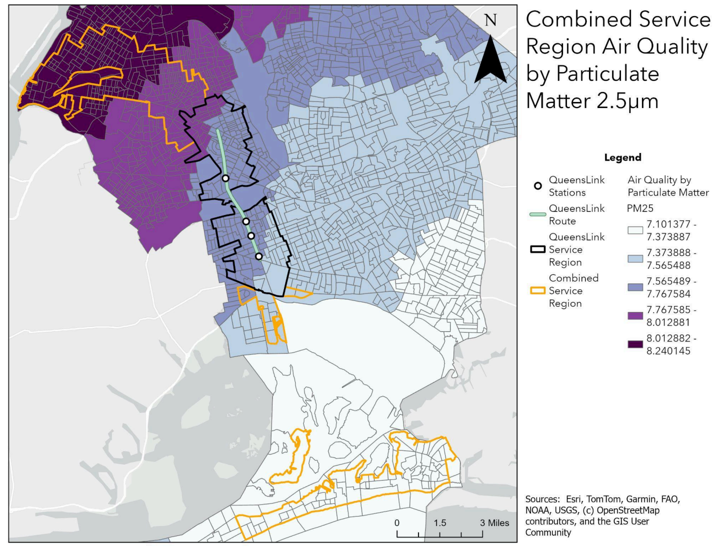


The Percent Black Population was integrated into our composite index as a primary indicator of historical and systemic environmental vulnerability. National and local studies have consistently demonstrated that Black communities suffer disproportionately from environmental burdens, ranging from higher exposure to industrial pollutants to the urban heat island effect[10]. In the context of the QueensLink project, mapping this demographic is essential to ensuring that the proposed transit and park infrastructure serves as a tool for environmental equity, directly addressing the infrastructure gap in historically marginalized neighborhoods.

Spatial analysis of the primary QueensLink service region reveals high concentrations of Black residents in **Richmond Hill** and **South Ozone Park**. These neighborhoods coincide with areas previously identified in our study as having high surface temperatures and significant clusters of industrial land use, reinforcing the overlap between racial demographics and environmental risk. When expanding to the combined service region, the most pronounced concentrations are located in **the Rockaways** and **Far Rockaway**. The alignment of these demographic zones with the proposed RBB reactivation route underscores the project's potential to provide high-quality transit and recreational assets to communities that have historically been excluded from major north-south infrastructure investments in Queens.

Air Quality by Particulate Matter

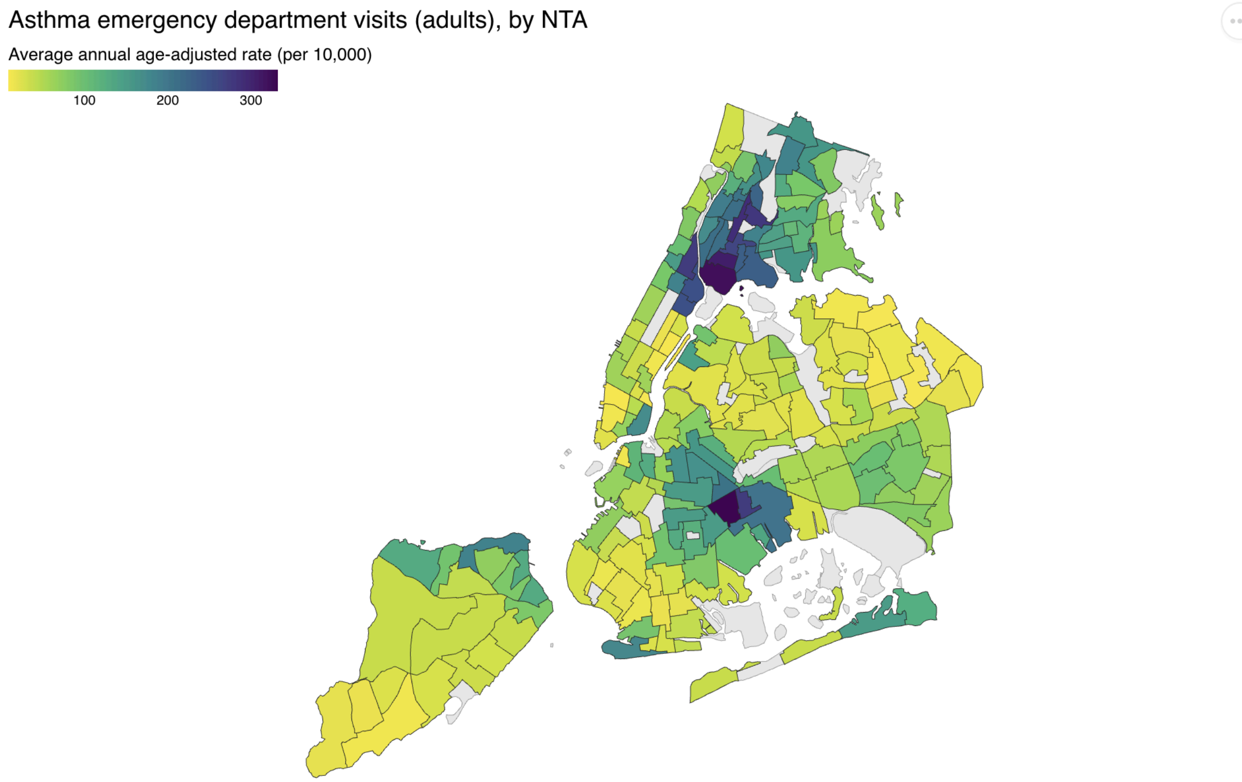




Shifting from heat-related indicators to atmospheric pollutants, we analyzed the spatial distribution of Fine Particulate Matter (PM2.5) across the study area. PM2.5 is a critical public health metric, as these microscopic particles can penetrate deep into the lungs and enter the bloodstream, exacerbating respiratory and cardiovascular conditions. In the context of the QueensLink, PM2.5 levels serve as a baseline for current air quality, providing a benchmark against which we can measure the potential clearing effect of shifting thousands of daily commuters from internal combustion engine vehicles to zero-emission electric rail.

The mapping of PM2.5 reveals a distinct borough-wide gradient: concentrations are highest in the westernmost sections of Queens, intensifying as they approach the industrial and high-traffic corridors of **Long Island City** and the crossings into **Manhattan**. This trend suggests that the baseline air quality is largely influenced by cross-borough vehicular traffic and the proximity to the city's dense urban core. Conversely, the **Rockaways** exhibit the lowest PM2.5 values in our combined service region, likely due to the cleansing effects of oceanic wind patterns and the absence of heavy industrial through-traffic.

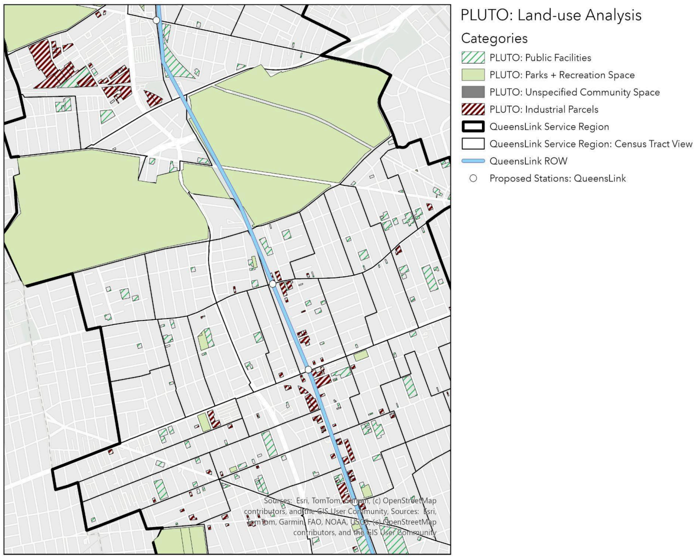
Asthma Emergency Department Visits

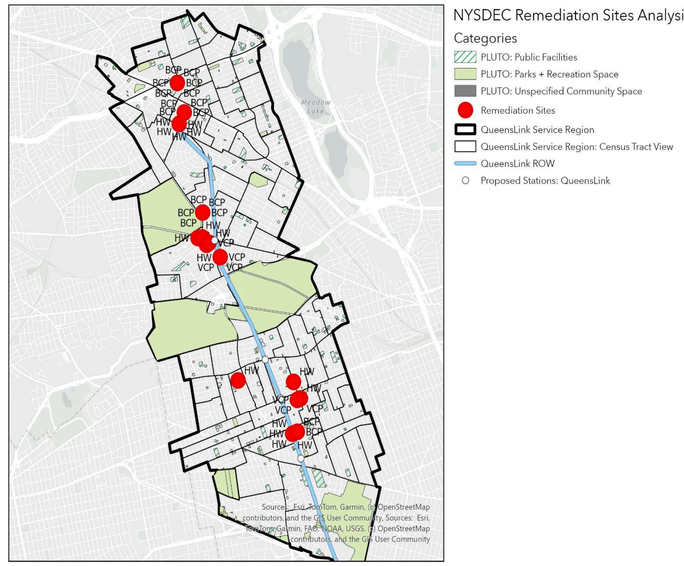


To assess the respiratory health baseline of the corridor, we analyzed the average annual age-adjusted rate of asthma-related emergency department (ED) visits (per 10,000 residents). Asthma rates serve as a high-sensitivity indicator of environmental health, as they are frequently exacerbated by poor air quality, localized emissions, and substandard housing conditions. For this variable, we utilized spatial data directly from the NYC Environment and Health Data Portal to ensure the highest level of accuracy regarding neighborhood tabulation area classifications and reporting periods.

When viewed within the context of the entire city, the neighborhoods along the QueensLink corridor do not represent the absolute highest extremes of asthma morbidity. However, significant localized clusters are evident. Within the combined service region, **Richmond Hill** and **Ozone Park** exhibit comparatively high ED visit rates, indicating an underlying respiratory vulnerability that coincides with the high surface temperatures and industrial land-usage previously identified. The most pronounced health burden in our study area is found in the **Rockaways** and **Far Rockaway**, which consistently post the highest asthma rates for the combined service region. By providing a zero-emission transit alternative and expansive new parkland, the QueensLink seeks to mitigate the environmental triggers that contribute to these elevated health disparities.

Land-use / Remediation Sites





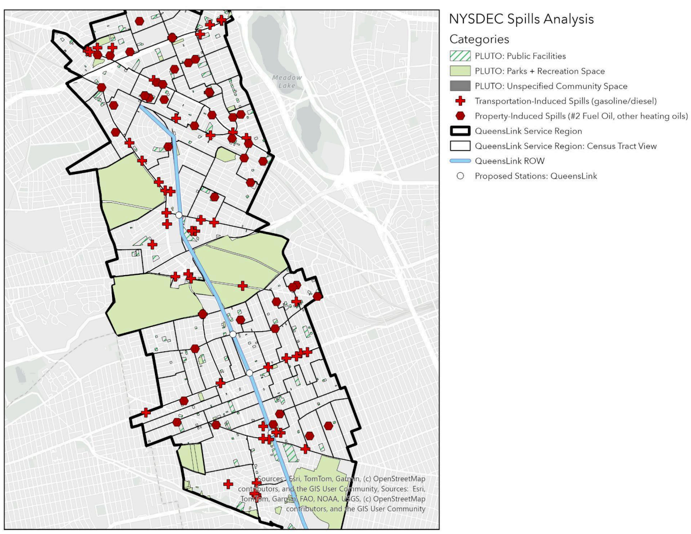
Using a combination of the PLUTO land-use dataset as well as NYSDEC's Remedial Site database, we took a look at which specific parcels/locations along the QueensLink ROW are most problematic in terms of environmental impacts to the community (any block/lot tagged as "industrial" per the PLUTO dataset), as well as overlaying historical/ongoing remediation programs (Brownfields, State Superfunds, and Volunteer Cleanup Programs) to further validate which areas contribute the most risk to the community at large. Additionally, in order to establish a spatial risk reference, all PLUTO-designated community spaces/public facilities (schools, places of worship, public/recreational spaces/parks) inside of the immediate QueensLink Service Region were mapped out as well, to visually inspect particularly vulnerable locations. This was partially done in light of a study by Laefer et. al., which lists the density of community gathering spaces as part of a methodology to rank brownfields inside of NYC.

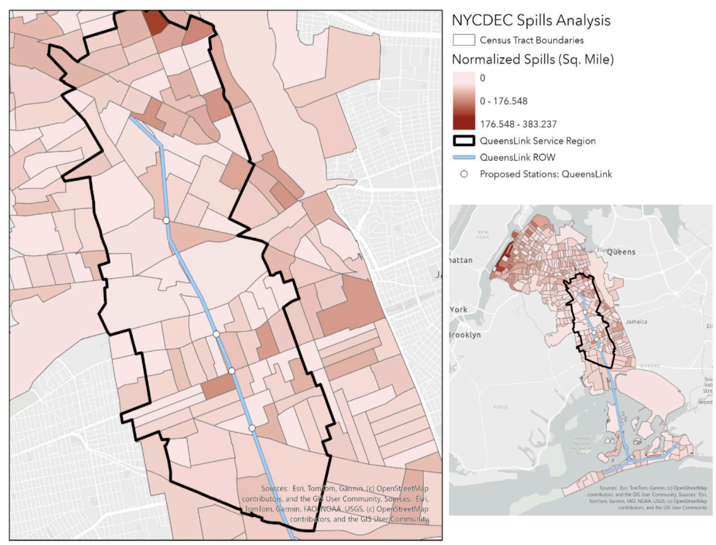
Upon eye-balling the physical locations of these industrial/remediation sites, we've noticed a higher density of such land-usage concentrated around the corridor itself, particularly in **Ozone Park between Jamaica Av and Rockaway Blvd / Liberty Av**. This confirms much of what we observed during our site tour with our sponsors (Andrew Lynch and the QueensLink team), as the locations corresponding to these labelled sites according to the PLUTO dataset are primarily auto-body and repair shops. Although not explicitly defined in the analysis above, we also observed many of these types of businesses occupying the base of the abandoned corridor itself.

When taking into account remediation sites, we can see that there are three core clusters: **around the track split between QueensLink and the Queens Blvd Subway in Rego Park, the area directly north of Forest Park around Metropolitan Av, and south of Forest Park in Ozone Park**. These sites seem to visually coincide with areas that are currently zoned for industrial and/or miscellaneous commercial usage, which is no surprise. In all there are:

- 7 brownfield sites, in which two remain active (C241258,C241282).
- 9 state superfund programs, in which two remain active and are flagged as "significant" (241033,241036). One of these programs is located on 100 st between 101st and 103 Av, which turns out to be on the QueensLink ROW itself, just north of the proposed Rockaway Blvd / Liberty Av station.
- 7 voluntary remediation programs.

Spills

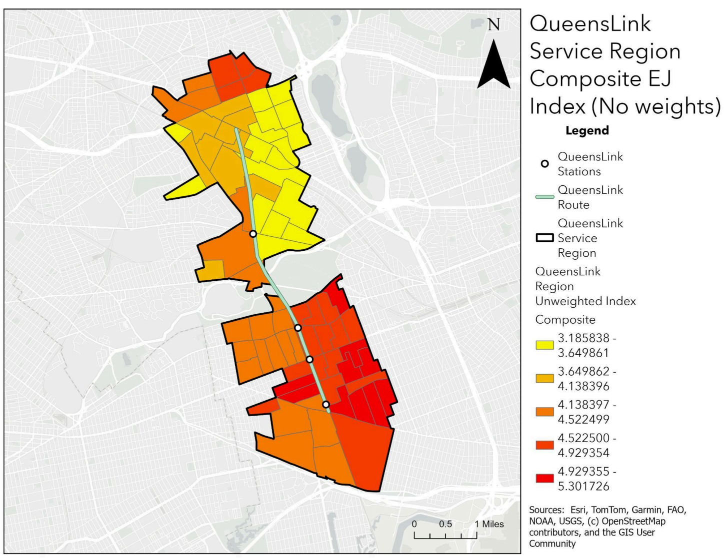


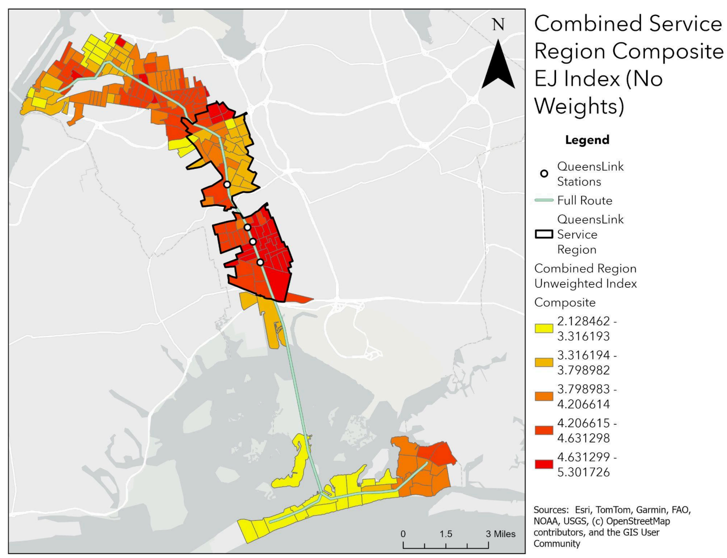


Likewise, spill incidents were obtained via NYSDEC's environmental remedial database. Unlike brownfield sites / superfunds, which indicate prolonged contamination as a direct result of a property's historical/present-day function (as a repair shop, factory, dry cleaner, etc.), spills are defined as one-off incidents, and are remedied over a significantly shorter time frame. The left-hand plot in the figure above maps out "severe" (defined as "Class A/B" incidents) spills within the immediate QueensLink Service Region, with the vast majority of labelled contaminants petroleum-based, specifically either gasoline/diesel (suggesting that the incident is transportation induced) or #2 fuel oil, a product commonly used for heating. There appears to be no discernable spatial pattern in spill frequency across the QueensLink Service Region as evident by the right-hand plot, which accounts for all recorded spills (regardless of contaminant, severity, spill medium) in the NYSDEC dataset. However, upon closer inspection, many of the transportation-induced spills (gasoline/diesel) mapped out on the left-hand figure appear to **roughly correlate to major roadway arteries**, which makes sense. Namely, directly parallel to the QueensLink ROW north of the proposed Metropolitan Av Subway stop is **Woodhaven Blvd**, which appears to have one such "cluster" spread across multiple tracts. Another "cluster" is visible along **Atlantic Av**, directly east of the QueensLink ROW. While there have been a number of "severe" spills in the QueensLink Service Area, none have been deemed as a direct hazard to adjacent communities in terms of the affected mediums (namely sources for tap/drinking water).

(C) Composite Environmental Justice Indices

Unweighted Current Day Composite Index



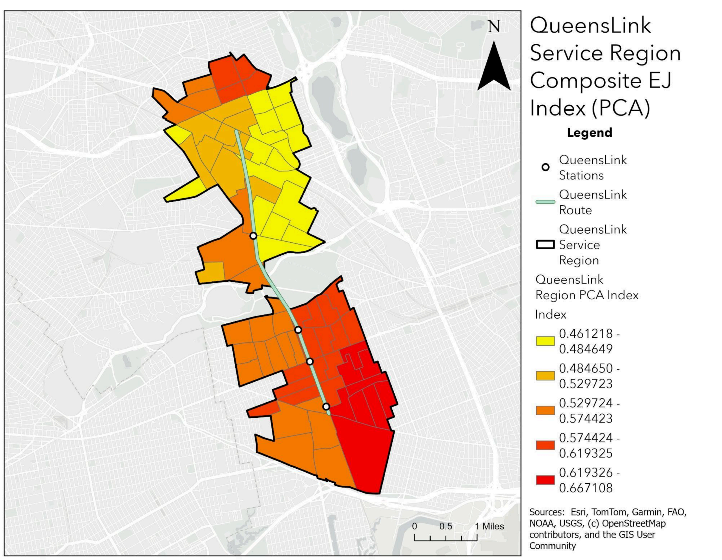


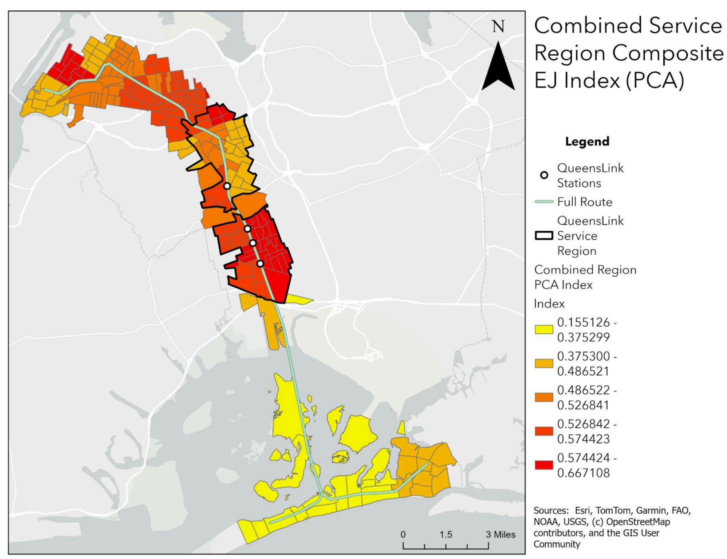
The synthesis of the aforementioned variables into a singular Unweighted Composite Index allows for a comprehensive visualization of cumulative environmental and socioeconomic burdens. By aggregating normalized scores across all eleven indicators, we can identify "hot spots" where multiple vulnerabilities intersect, such as high surface temperatures, low median income, and elevated respiratory risks. This baseline index serves as a definitive spatial justification for targeted intervention along the RBB ROW.

Within the primary QueensLink Service Region, the most severe environmental burdens are heavily concentrated in **South Ozone Park** and **Richmond Hill**, specifically in the census tracts situated to the east of the ROW. The tracts covering **Corona** also exhibit peak index values, representing the highest tier of vulnerability in the study area. Moving outward from these cores, the remainder of **Ozone Park** maintains high burden scores, while the areas south of Forest Park, along with **Glendale** and the tracts covering **Elmhurst**, display medium-high values. These results highlight a continuous corridor of environmental need that spans the southern and central portions of the proposed alignment.

When evaluating the Combined Service Region, the spatial concentration of risk becomes even more distinct. The neighborhoods south of Forest Park within the immediate QueensLink corridor emerge as the most burdened overall, rivaled only by specific clusters in **Far Rockaway**. While other parts of the borough including **Jackson Heights**, **Astoria**, and the northern sections of **Forest Hills** and **Rego Park** show elevated index values, they do not reach the same level of sustained intensity found along the RBB. Ultimately, the visualization confirms that the QueensLink service region is uniquely characterized by a high-density concentration of environmental and social stressors, reinforcing the project's role as a critical environmental justice intervention for Western Queens.

Principal Component Analysis (PCA) Current Day Composite Index



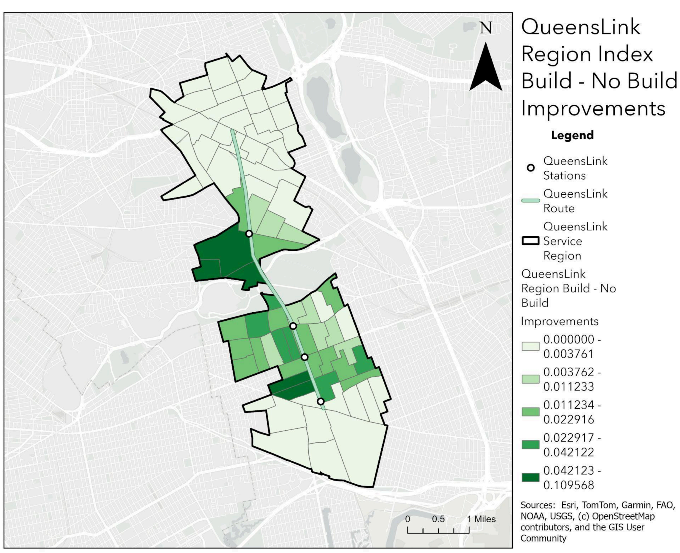


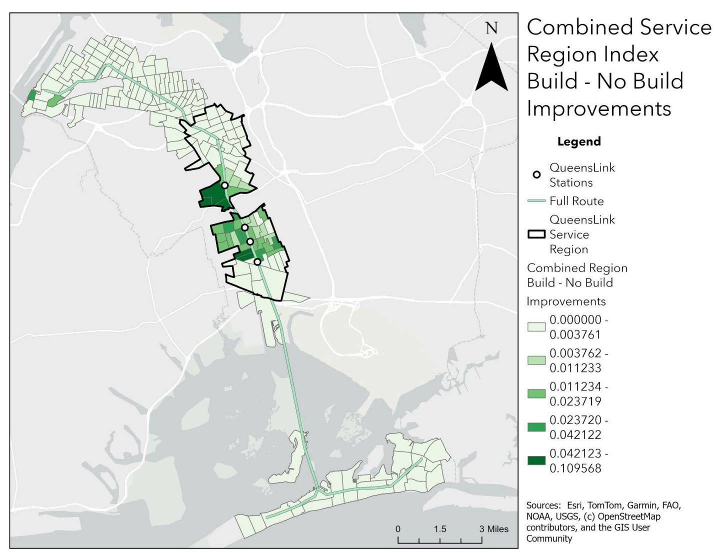
To validate the robustness of our unweighted index, we performed a Principal Component Analysis (PCA) to determine if a data-driven weighting scheme that emphasizes variables with the highest variance would significantly alter the spatial distribution of environmental burden. By extracting the first principal component and re-visualizing the results, we aimed to identify if specific hidden drivers in the data would shift our understanding of which census tracts are most at risk.

The results of the PCA-weighted index largely serve as a statistical validation of our initial findings. Within the QueensLink Service Region, the PCA maps appear nearly identical to the unweighted version, maintaining the same peak burden clusters in **South Ozone Park** and **Richmond Hill**. This consistency suggests that the environmental and socioeconomic stressors in this corridor are so tightly correlated that an unweighted additive approach already effectively captures the most significant features of the data.

In the Combined Service Region, the PCA visualization reinforces the high-priority status of the neighborhoods south of **Forest Park** adjacent to the right-of-way. While the overall pattern remains stable, the PCA model highlights slightly elevated burden scores in **Glendale**, **Rego Park**, and **Dutch Kills**. The emergence of Dutch Kills as a more prominent hot spot under PCA suggests that specific variables, likely related to industrial land use or air quality, carry a higher statistical weight in that sub-region. Ultimately, the high degree of similarity between the two indices confirms that our baseline results are not skewed by arbitrary weighting; rather, they reflect a clear and consistent geographic concentration of environmental vulnerability centered on the QueensLink corridor.

Build - No Build 2045 Improvements





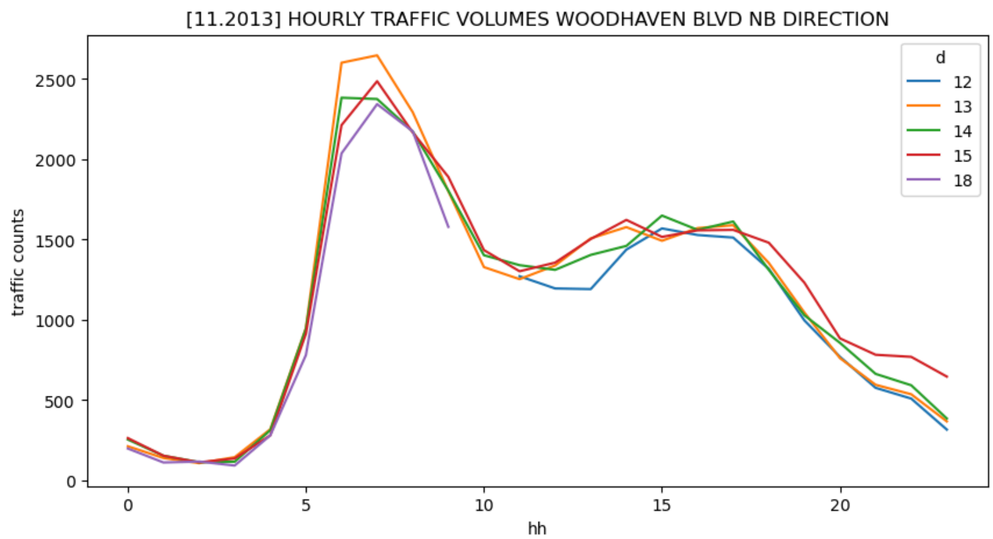
To isolate the specific environmental benefits of the QueensLink project, we performed a spatial subtraction between the Build and No-Build future scenarios. By calculating the delta between these two indices, we can visualize the “net improvement” at the census tract level. In this model, positive values represent a reduction in cumulative environmental burden, specifically accounting for the modal shift from private automobiles to rail and the introduction of 33 acres of restorative parkland.

The resulting change-detection map reveals that the environmental benefits are most concentrated within the heart of the service region. **Richmond Hill**, **Ozone Park**, and **Glendale** emerge as the primary beneficiaries of the project, showing the most significant decreases in index scores. A portion of **Forest Hills** also displays a notable improvement, largely driven by the reduction of local traffic volumes. These findings indicate that the project’s dual-purpose infrastructure directly targets the hot spots of vulnerability identified in our baseline analysis.

When viewed at the scale of the Combined Service Region, these core neighborhoods remain the focal points of improvement. Interestingly, two census tracts in **Long Island City** also exhibit measurable gains. Since these tracts are far from the physical park component of the project, their improvement is primarily attributable to the projected system-wide reduction in VMT. This suggests that the QueensLink’s impact on mode shift extends beyond the immediate RBB corridor, providing subtle but quantifiable air quality and congestion benefits to the dense transit hubs of Western Queens.

(D) Transportation Impact

Initial Context and Shortcomings: Woodhaven Blvd Traffic Flow Analysis



We originally intended to focus our study space on Woodhaven Blvd exclusively. In other words, we wanted to estimate the total number of cars taken off of Woodhaven Blvd under a build scenario, by looking at traffic volume counts under NYC DOT's ATR (automated traffic recorder) dataset. Note that we did not end up incorporating this dataset into our formal deliverables, so it isn't listed in our `Data Sources` section denoted earlier. This is largely because of the lack of data available across our study space, with only one "active" recorder situated between Atlantic Av and 95 Av, in the northbound direction only. In addition, the latest available traffic counts for this particular ATR dated back to 2013, which does not accurately reflect the state of Woodhaven Blvd. today (with the incorporation of the Q52/Q53 SBS). Nevertheless, an analysis was preliminarily performed to assess trip flows within the area. Echoing relatively predictable traffic-flows under a standard weekday, we were interested in seeing how many daily travel counts along this segment of Woodhaven Blvd could be translated into QueensLink trips. The problem is that the ATR counts do not differentiate between private vehicles and commercial/freight traffic, making any further inference unreliable on top of the dataset's spatio-temporal limitations. As a result, we looked into using a combination of US Census/ACS and travel survey data (from NYCDOT) to ground our analysis further, and even more importantly, expand our scope across the entire QueensLink Service Region (not just Woodhaven Blvd).

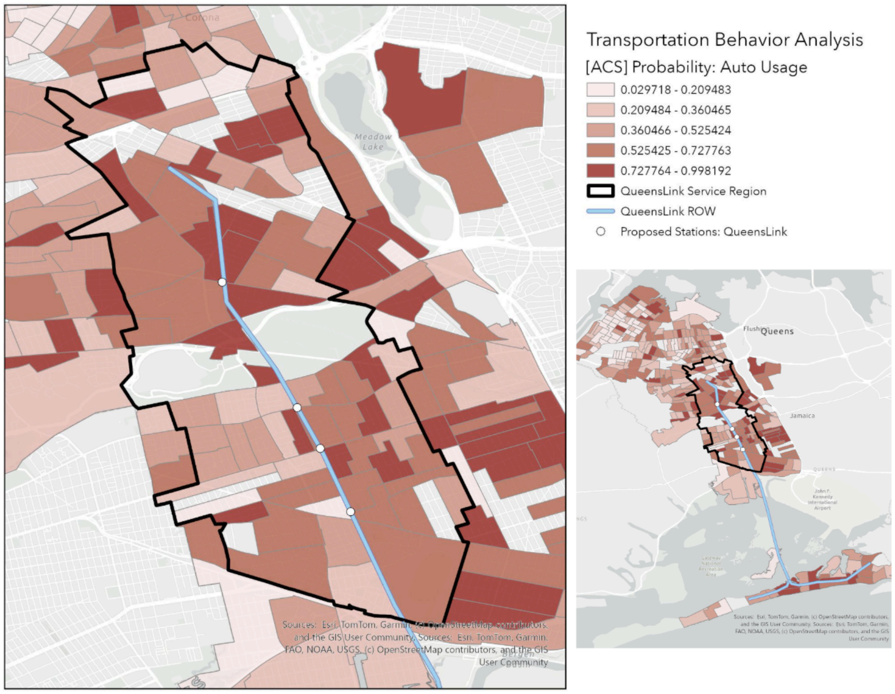
2022 NYCDOT Mobility Survey

As stated in the `Transportation Impact: Overview` section under the `Methodology` portion above, we employed a trimmed-down variant of the four-step travel demand model to calculate trip/emission reductions under a build scenario, focused on trip generation (number of trips) and mode-choice (how each trip is performed) only. For the trip distribution/assignment phases (modelling where trips are going and how they're allocated across the region), we leveraged survey data to fill in the missing gaps. Specifically, we were interested in:

- (1) The proportion of automobile trips undertaken within Queens exclusively. This turned out to be **0.79**.
- (2) Conditional on (1), assuming a trip is contained within Queens, the average distance per trip. This ended up to be a value around **2.75 miles**.
- (3) The number of trips per day, which was averaged out at **2.5**.

After geo-filtering to only account for Queens-only trips per (1), we obtained a total of **4119 logged trips** from this survey, which we assumed to be a sufficient sample size. A more rigorous approach would be to allocate trips across different TAZs (traffic analysis zones) across the service region. However, no allocation was performed other than measuring trip generation counts per census tract (origins), with no destination specifications other than assumption (1) listed above, which was suitable for our use case.

Findings: Trip Generation + Mode Selection Analysis

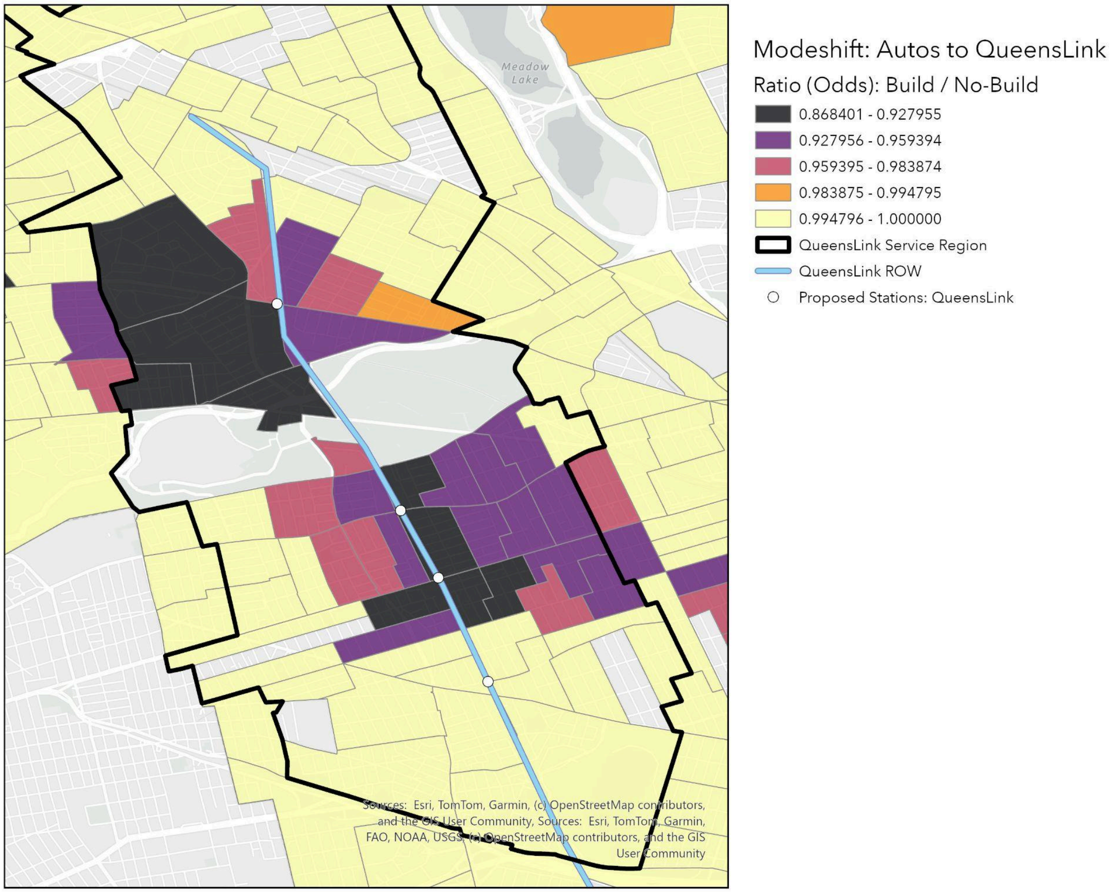


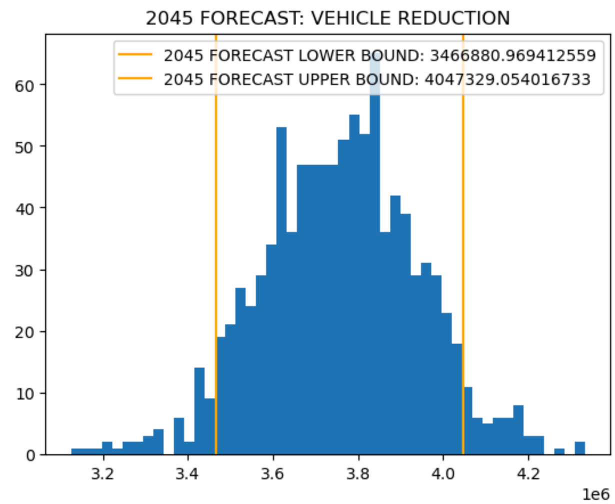
As discussed in the `Methodology` section above, our Transportation Impact Analysis is an attempt to quantify environmental benefits in the form of reduced vehicle trips (and hence, emissions) under a build forecast. Prior to forecasting, we looked at the present-day distribution of automobile ownership and usage across the service region and Queens at large by leveraging attributes from the American Community Survey. Measured as the proportion of auto-preferred households ('B08006_002E', “Means of Transportation to Work”) over all recorded households in a given census tract, we were able to obtain an approximate ground truth in terms of auto-usage under a no-build scenario, using present-day figures as a heuristic (assuming no changes to the subway network). We can see that **current auto-usage is relatively heavy** around the service region (>0.5), particularly in census tracts **north of Forest Park (Glendale, Rego Park)** where high-capacity transit access is severely lacking. On the other hand, census tracts **directly southwest of Forest Park (Woodhaven, Richmond Hill) appear to show less dependence** (<0.5), possibly as a result of transit proximity via the J/Z train.

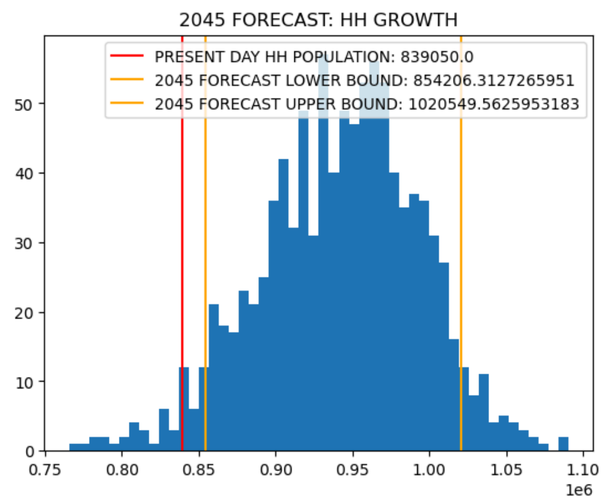
As a whole, **Outer Queens (including the service region, stretching from Forest Hills into the Rockaways) appear to be more dependent on personal vehicles than their Manhattan-adjacent counterparts**, namely Astoria, Sunnyside, and parts of LIC.

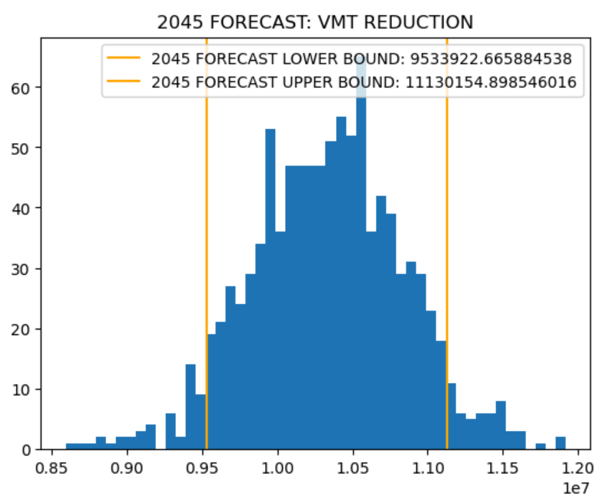
Unsurprisingly, this is likely a consequence of factors related to employment/amenity proximity (LIC/Astoria with respect to Midtown), enhanced rail accessibility resulting in higher levels of service (particularly along the 7-train corridor from LIC to Jackson Heights, with 2 minute headways during peak hours post CBTC implementation), and most importantly, land-usage/infrastructure that's more conducive to allowing alternative forms of transportation (particularly in Astoria, with access to the N/W trains as well as a set of bi-directional, grade-separated bike lanes along Crescent St.). While the QueensLink Service Area will still be disadvantaged from a purely geographical standpoint (particularly in Howard Beach and the Rockaways), enhancing transit connectivity to the region with the addition of newly installed bike infrastructure could serve as a catalyst for existing residents to opt for alternative, carbon-neutral forms of transportation, especially for local trips within the bounds of the QueensLink Service Region.

After running our mode-selection model for the build scenario, which is described in the `Methodology: Mode Choice` section above, we were able to determine which locations within the Service Area stand to gain the most riders onto transit (QueensLink) off of present-day (or no-build) automobile dependency. In other words, we wanted to find which tracts will see the greatest projected reduction in automobile usage as a direct result of QueensLink, via the ratio in odds (p_auto / 1 - p_auto) between the build and no-build forecasts. Because we anticipate a reduction in auto dependency under a build scenario (that is, p_auto_build < p_auto_nobuild), any areas that see the greatest reduction in auto dependency will see values converging to 0. Based on the model output, we can see that areas **directly adjacent to the ROW on both sides of Forest Park** (and more broadly within a 0.5-1 mile radius on both sides of the ROW) have the greatest magnitude of projected behavioral shift onto transit/alternative modes, in large part due to enhanced service accessibility offered by QueensLink (one of the core predictors of the model) within the affected tracts. While the tract-wise reduction ratios are still relatively "modest" even at their highest magnitudes (at 0.868), translating these forecasted mode-shift probabilities into aggregated trip-count and VMT reductions across the entire Service Region paints a more compelling picture.


Meadow Lake
Sources: Esri, TomTom, Garmin, (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
Modeshift: Autos to QueensLink
Ratio (Odds): Build / No-Build
0.868401 - 0.927955
0.927956 - 0.959394
0.959395 - 0.983874
0.983875 - 0.994795
0.994796 - 1.000000
QueensLink Service Region
QueensLink ROW
Proposed Stations: QueensLink







Summing up over all projected trips / VMTs across all census tracts, we were able to obtain aggregated forecasts under our no-build and build forecasts, adopting the workflows described in the `Methodology: Trip Generation` and `Methodology: Mode Choice` sections above. Because the trip generation (growth model) portion of the workflow assumes a stochastic process, we can enumerate an unlimited number of growth scenarios based on the input parameters into the model (historical growth rates from the ACS/Census). With the expectation that our core performance variables (forecasted/aggregated trips, VMTs) converge to some approximate mean under a normal distribution, we ran this workflow 1000 times (1000 simulations), in order to acquire a 90% confidence interval (plausible range) of outcomes. We were able to retrieve the following scales for our performance variables:

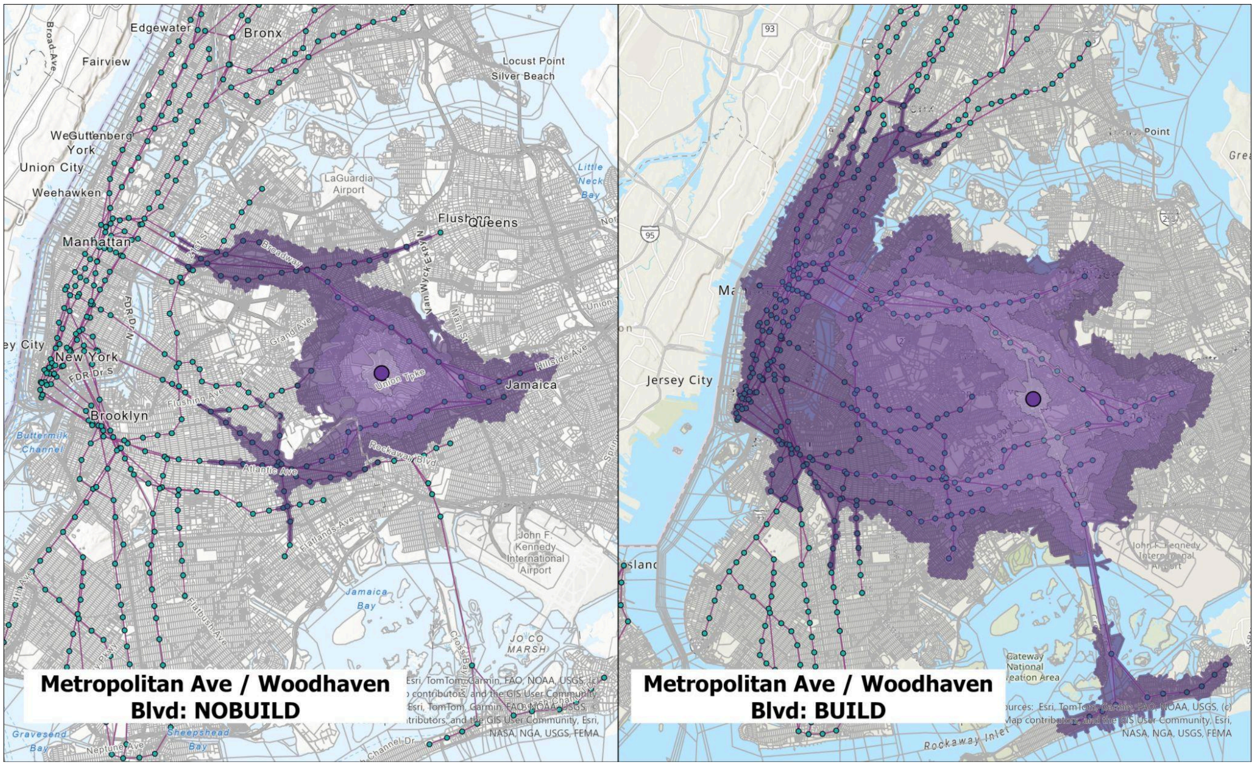
- [HH Growth 20-Yr Forecast] **+1.8% - +21.6%**
- [Trip Reductions 20-Yr Forecast: No-Build - Build] **3.46 - 4.04 million trips**

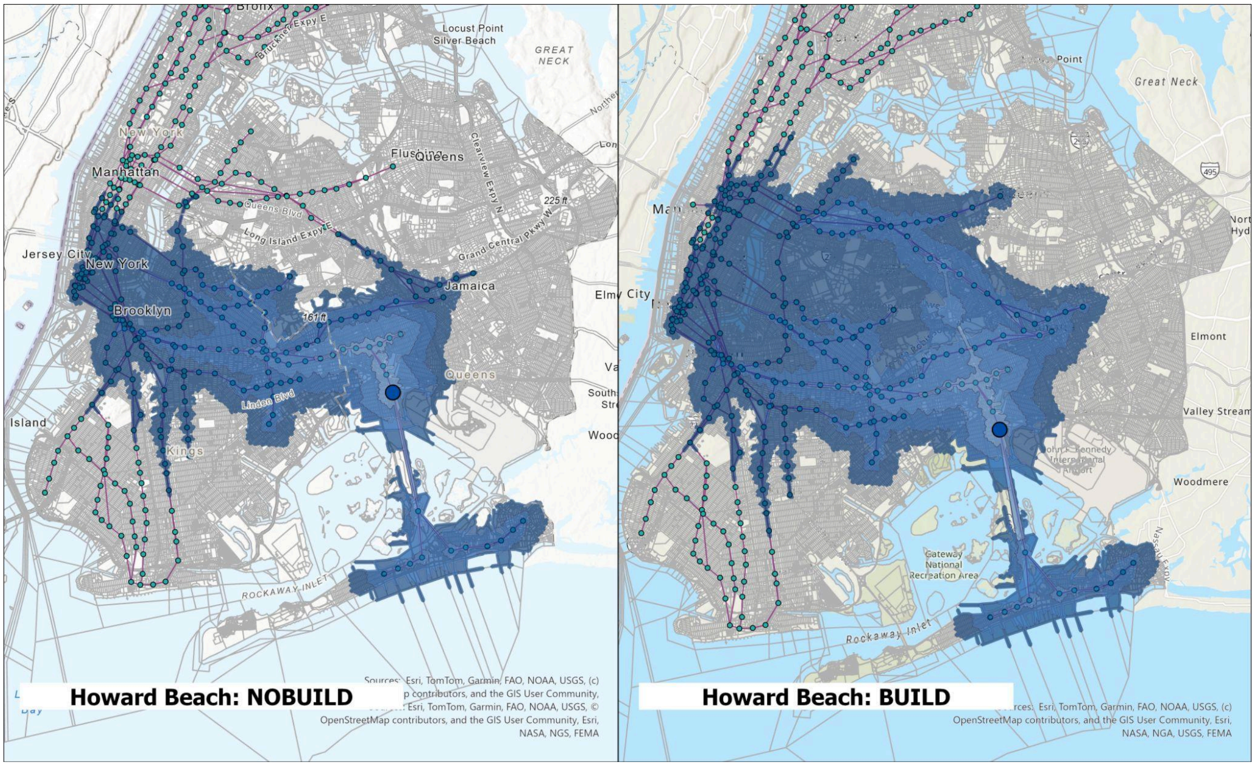
- [VMT Reductions 20-Yr Forecast: No-Build - Build] **9.5 - 11.1 million VMTs**

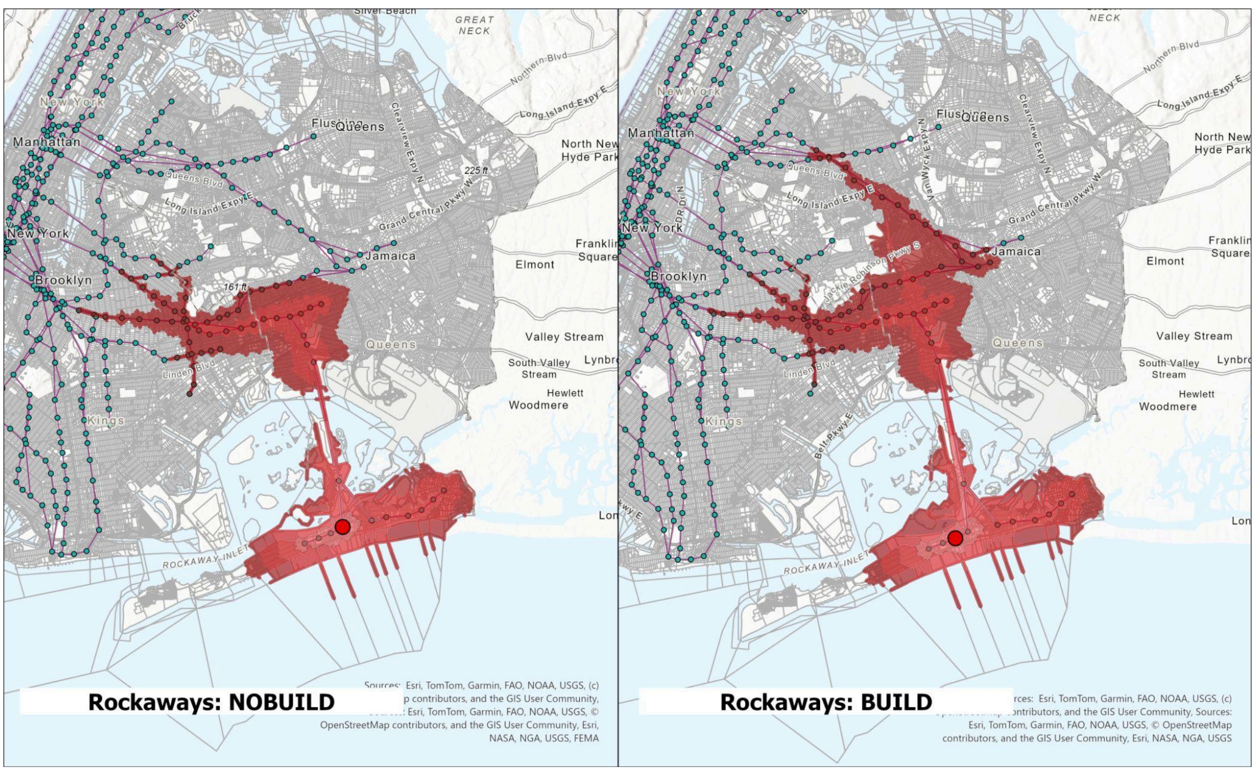
Note that NYMTC's decade-based projections place a borough-wide (Queens) growth rate of 6-8% over a 20-year horizon (in terms of population, not HHs), which sits nicely inside of our confidence interval. In terms of our consensus findings on transportation impact, we can see that there is a rather **significant difference in expected trip behavior (and hence emissions reduction) under the presence of QueensLink**, solely based on our HH growth projections and accessibility/travel-cost attributes acquired from the accessibility impact analysis (as input into the mode-choice model). However, despite the observed reduction in trip counts, our findings are a bit more **conservative** compared to parallel studies commissioned by QueensLink, namely their Initial Business Case (IBC) conducted by Steer. Their estimates are a bit more optimistic, placed at around 4.7 million trips saved. Part of the reason for this is a difference in methodology; while we attempted a more "grounds-up" approach, modeling individual trips based on HH/vehicle growth counts and a probabilistic model to dissect which are likely to be auto trips, Steer appeared to look at transit forecasts (from the FTA's STOPS model) across the no-build/build scenarios exclusively, and interpreted the delta in transit-trip counts (trip gains on transit per the Build scenario) as potential trips taken via automobile if QueensLink weren't to be reactivated. In addition, while it is a bit unclear to us, it is possible that Steer looked at individual/rider-level subway-transit demand counts rather than HH/vehicle counts, which would result in a higher figure by design (as there are often multiple individuals per vehicle trip). Because of the inherent differences in interpreting trips for private vehicles versus public transit (oftentimes a "many-to-one" mapping of individuals-to-trips, as a result of carpooling, multiple occupants per vehicle per trip etc.), we believe that our methodology might provide a more robust estimation in terms of modeling changes to transportation-induced environmental outcomes under QueensLink as a result of performing our calculations at the vehicle level to measure auto trips.

(E) Accessibility Impact

Select Isochrones: Glendale (Metropolitan Av/Woodhaven Blvd), Howard Beach, and The Rockaways




Howard Beach: NOBUILD
Howard Beach: BUILD
Manhattan
New York
Jersey City
Brooklyn
Kings
Queens
Flushing
Jamaica
Elmont
Valley Stream
Woodmere
Great Neck
Locust Point
Silver Beach
Queens Blvd
Long Island Expy E
Grand Central Pkwy W
Clearview Expy N
Linden Blvd
Rockaway Inlet
Gateway National Recreation Area
John F. Kennedy International Airport
225 ft
161 ft
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGS, FEMA
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS, FEMA

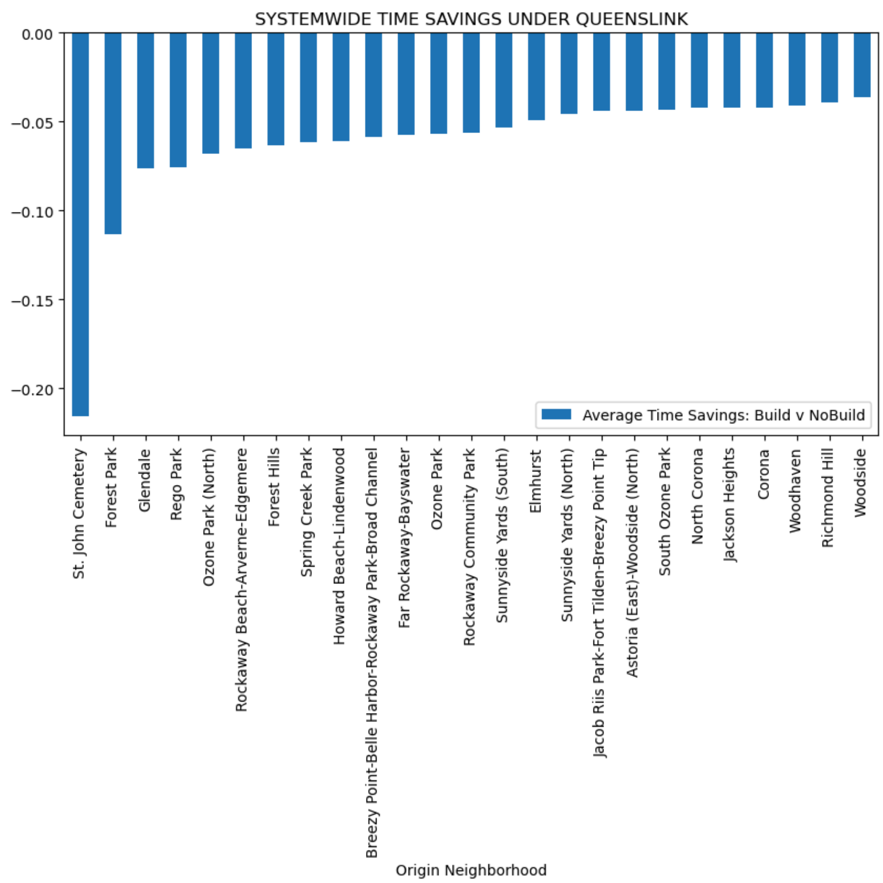

Rockaways: NOBUILD
Rockaways: BUILD
Manhattan
New York
Brooklyn
Kings
Queens
Flushing
Jamaica
Elmont
Valley Stream
South Valley Stream
Hewlett
Woodmere
Franklin Square
North New Hyde Park
Great Neck
Silver Beach
Queens Blvd
Long Island Expy E
Grand Central Pkwy W
Clearview Expy N
Northern Blvd
Linden Blvd
Belt Pkwy E
Rockaway Inlet
225 ft
161 ft
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS, FEMA
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS

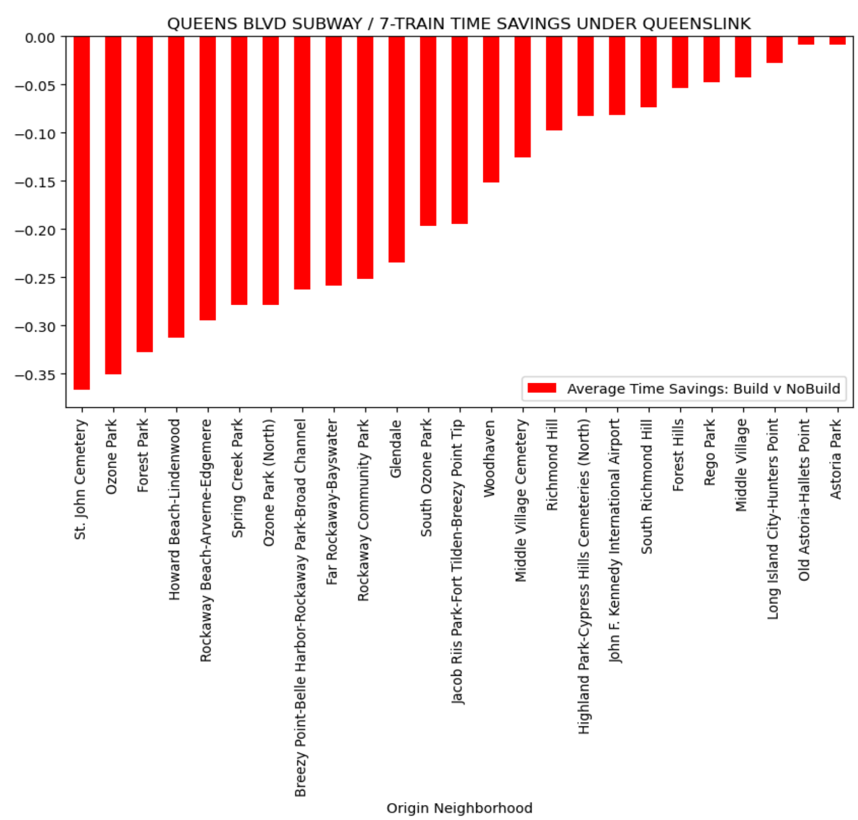
Using our workflow in ArcGIS Pro to generate isochrones for select locations, we were able to get a visual sense of the service coverage gain under a QueensLink build scenario, within an hour radius of select stations/neighborhoods along the QueensLink ROW. Unsurprisingly, locations along the QueensLink ROW that are notable (subway/rail) transit-deserts demonstrate the greatest level of accessibility-gain, which is evident by the isochrone plot above for **Glendale / Metropolitan Av/Woodhaven Blvd**, where the nearest subway station (Forest Hills / 71st, along the Queens Blvd Subway) is approximately a 25 minute walk (20 minute transit/bus trip, per Google Maps) under the no-build/current scenario. Adding QueensLink will significantly reduce travel times to/from neighborhoods directly **north of Forest Park**, with a build-scenario travel-time savings reduction of nearly **20-40%** off of the no-build scenario for stops along the **Queens Blvd corridor as well as the 7 train east of Jackson Heights** (into Corona and Flushing). This is further detailed in the following section titled `Origin-Destination Time Savings Analysis`.

North of the Rockaways, it appears that QueensLink will improve travel access **to/from Manhattan**, which demonstrates that QueensLink will not only expand on travel outcomes pertinent to local trips within Queens but also better link Outer Queens to Manhattan, yielding positive feedback between enhanced access to employment opportunities and collective social mobility across the QueensLink Service Region, while lowering travel-induced costs for the individual (time-spent commuting, improved levels of service quality with respect to individual fares) and the transportation system (congestion, transport-induced emissions reductions) as a whole. While the isochrone plot for the Rockaways may seem less impressive from a pure coverage standpoint, a number of significant locations inside of Queens are within an hour's reach of Beach-90th St (our reference location) under the build scenario, such as **Forest Hills Stadium, Jamaica (LIRR/Airtrain to JFK), and Jackson Heights**, with the latter serving as a crucial gateway to LGA Airport, via access to the Q70 SBS.

Origin-Destination Time Savings Analysis

Due to the cumbersome nature of generating individual plots for every reference point of interest, we created a Python script used to construct a global dataset of origin (neighborhoods) - destination (NYC Subway stops) pairs across all of NYC, for both the no-build and build scenarios. We primarily looked at the (time-based) savings incurred under a build scenario versus no-build as our performance variable. From this table, we were able to pinpoint which locations will see the greatest overall gain in accessibility under QueensLink at a finer level of granularity.

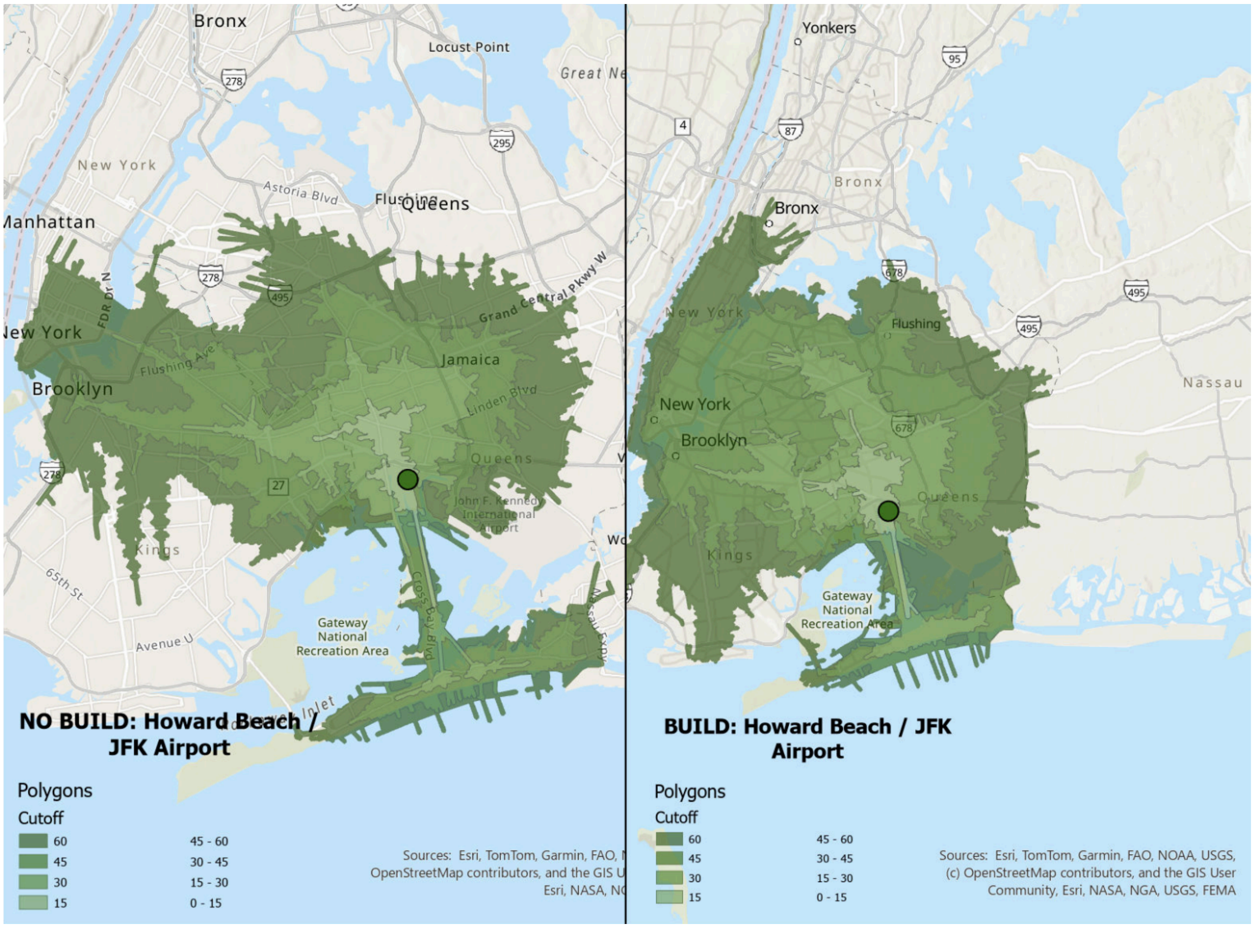

SYSTEMWIDE TIME SAVINGS UNDER QUEENSLINK
0.00
−0.05
−0.10
−0.15
−0.20
Average Time Savings: Build v NoBuild
St. John Cemetery
Forest Park
Glendale
Rego Park
Ozone Park (North)
Rockaway Beach-Arverne-Edgemere
Forest Hills
Spring Creek Park
Howard Beach-Lindenwood
Breezy Point-Belle Harbor-Rockaway Park-Broad Channel
Far Rockaway-Bayswater
Ozone Park
Rockaway Community Park
Sunnyside Yards (South)
Elmhurst
Sunnyside Yards (North)
Jacob Riis Park-Fort Tilden-Breezy Point Tip
Astoria (East)-Woodside (North)
South Ozone Park
North Corona
Jackson Heights
Corona
Woodhaven
Richmond Hill
Woodside
Origin Neighborhood


QUEENS BLVD SUBWAY / 7-TRAIN TIME SAVINGS UNDER QUEENSLINK
0.00
−0.05
−0.10
−0.15
−0.20
−0.25
−0.30
−0.35
Average Time Savings: Build v NoBuild
St. John Cemetery
Ozone Park
Forest Park
Howard Beach-Lindenwood
Rockaway Beach-Arverne-Edgemere
Spring Creek Park
Ozone Park (North)
Breezy Point-Belle Harbor-Rockaway Park-Broad Channel
Far Rockaway-Bayswater
Rockaway Community Park
Glendale
South Ozone Park
Jacob Riis Park-Fort Tilden-Breezy Point Tip
Woodhaven
Middle Village Cemetery
Richmond Hill
Highland Park-Cypress Hills Cemeteries (North)
John F. Kennedy International Airport
South Richmond Hill
Forest Hills
Rego Park
Middle Village
Long Island City-Hunters Point
Old Astoria-Hallets Point
Astoria Park
Origin Neighborhood

destination_fullname origin_fullname	Sutphin Blvd-Archer Av-JFK Airport	Woodhaven Blvd	Jackson Hts-Roosevelt Av	Mets-Willets Point	Queens Plaza	Times Sq-42 St
Glendale	0.031902	0.340054	0.296054	0.249979	0.222313	0.105244
Howard Beach-Lindenwood	0.253506	0.421685	0.387161	0.341393	0.221757	0.049986
Ozone Park	0.281491	0.495733	0.443819	0.378329	0.235324	0.023996
Richmond Hill	-0.000000	0.153092	0.122512	0.093878	0.095363	0.055401
Rockaway Beach-Arverne-Edgemere	0.235828	0.379766	0.353255	0.317240	0.224124	0.063754
Woodhaven	-0.000000	0.235557	0.196165	0.155573	0.157487	0.017866

Overall, it appears that trips with destinations along the Queens Blvd corridor will see the most significant time savings reduction (hence, gain in accessibility), with Ozone Park to Queens Center Mall (Woodhaven Blvd Subway) trips being nearly **cut-in-half** under a build scenario. It also appears that **Forest Park** itself and adjacent neighborhoods (especially on the northside of the park, such as **Glendale, Rego Park**) will stand to gain the most in terms of added connectivity to the NYC Subway system as a whole, as demonstrated in the bar chart above labelled `SYSTEMWIDE TIME SAVINGS UNDER QUEENSLINK`. However, when narrowing in on a subset of trips within the NYC Subway system, specifically to only include transit corridors connected to the QueensLink ROW (namely the Queens Blvd Subway, the 7 Train via a transfer at Jackson Heights - Roosevelt Av), we can see that **Howard Beach and the Rockaways** will massively benefit from QueensLink for any conducted trips to locations along the aforementioned connected corridors.

Isochrones with Bus Transit



We explored looking at integrating bus networks into our isochrone/walk-shed analyses, knowing that buses serve as a critical lifeline for captive riders (riders unable to afford a car) as well as last-mile transit to link neighborhoods underserved by the NYC subway with local transit hubs (namely, the Woodhaven Blvd stop adjacent to Queens Center Mall as well as Jackson Heights - Roosevelt Ave, both serving as termini for the Q52/Q53 SBS). Realistically, riders more often than not utilize a combination of transit modes to reach a final destination, and this isn't captured in our primary analyses (taking into account subway and walking only). Hence, to address this, we looked at the integration of (Queens-only) bus networks to validate whether our subway-only findings truly reflect a constrained sense of mobility in subway-deserts. We used the Howard Beach / JFK Airport station as our reference point for this analysis.

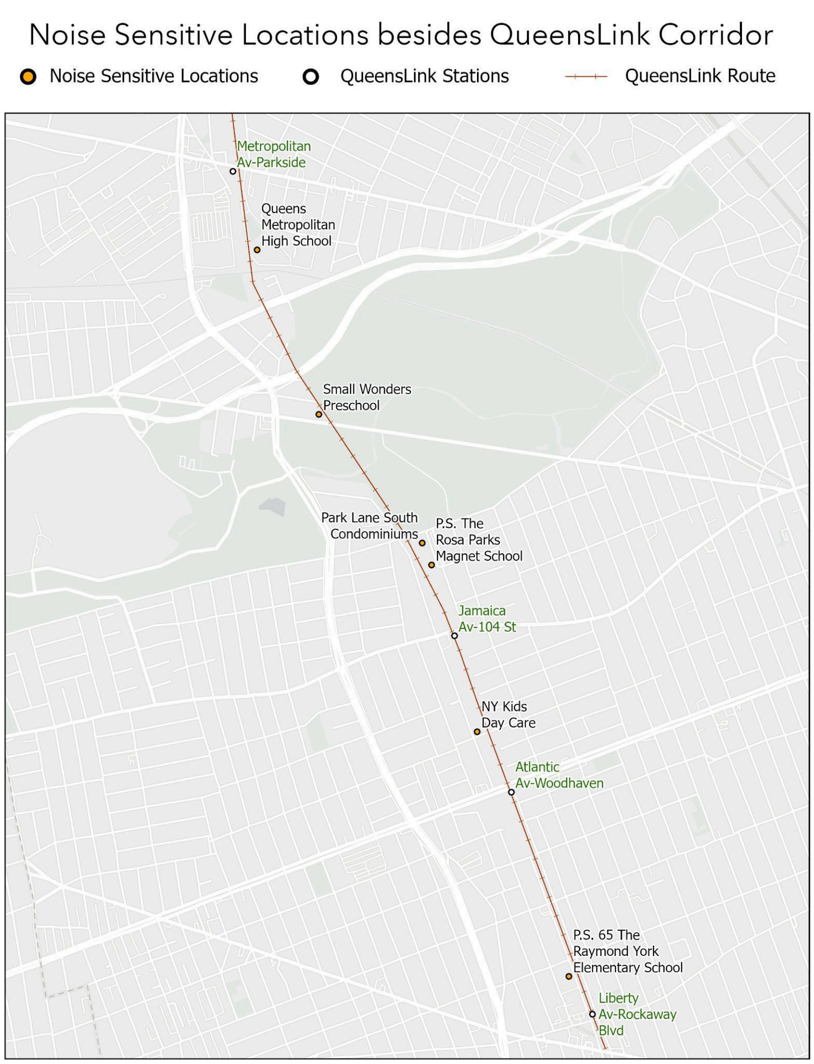
Because we are including all bus routes (local routes and SBS's), our spatial coverage estimates are likely to expand off of our base analyses, which only took into account walking as a form of last-mile transportation. In addition, the magnitude of coverage difference between a build/no-build scenario was likely to be subdued as a result of the incorporation of other modes of transportation (such as the Q52/Q53 SBS, which serves as our present-day stand-in for subway service along the QueensLink ROW). However, even when taking these considerations into account, there's still a relatively noticeable coverage gain under a QueensLink build scenario. This is especially the case for **longer trips exceeding 15 minutes; almost all of Queens (except for Bayside, Douglaston/Little Neck), Brooklyn, and Manhattan** are within an hour's reach of Howard Beach if we were to take into account bus travel. This stands in stark contrast to our no-build scenario, in which many critical locations such as Astoria/LIC, LGA Airport, Mets Stadium/Flushing, and Midtown Manhattan aren't shaded in.

(F) Proximity Analysis of Noise-Sensitive Locations

Context

While the aggregate noise complaint data did not show a correlation with Woodhaven Boulevard, a project of this scale requires a granular assessment of noise-sensitive locations directly adjacent to the ROW. This analysis identifies specific institutional locations, such as schools and childcare centers, where the introduction of subway operations could potentially impact daily activities through increased ambient decibels or ground-borne vibrations.

Results



Our spatial proximity analysis identified several high-priority receptors, most notably the Small Wonders Preschool, which is situated approximately 75 feet from the center line of the elevated rail portion of the corridor. Other identified sensitive locations, including educational facilities and a condominium, fall within a 100 to 150-foot buffer of the ROW.

Given the close proximity of the Small Wonders Preschool to the elevated structure, this location would likely experience the most significant acoustic and vibrational shifts during train pass-bys. Depending on the final engineering profile, sections of the track, particularly those utilizing bridge structures or elevated embankment, can act as secondary radiators of noise. However, modern mitigation strategies, such as continuous welded rails, rubber vibration-isolation pads, and acoustic barriers, can substantially attenuate these impacts regardless of the track's final elevation. While the current-day baseline for these locations is relatively quiet compared to major truck routes, the Build scenario assumes that site-specific engineering controls would be necessary to maintain an indoor environment conducive to learning and to meet FTA (Federal Transit Administration) noise and vibration criteria for sensitive land uses[1].

For structures located within the 100 to 150-foot buffer, the anticipated noise and vibration impacts are significantly lower, as decibel levels typically dissipate following the inverse-square law over distance[1]. While these buildings may still experience some audible pass-by noise, the intensity is expected to be well within acceptable federal thresholds.

VII: Limitations

Data Granularity & Temporal Constraints

The environmental and demographic variables utilized in this analysis are subject to the inherent limitations of their source data's spatial and temporal resolution. A primary challenge involves the lack of standardized geographic units across datasets. For instance, while PM2.5 concentrations are available at the granular Census Block Group level, other critical metrics, such as the Heat Vulnerability Index (HVI) and asthma-related health outcomes, are reported by Neighborhood Tabulation Areas (NTAs). This discrepancy necessitates spatial interpolation, which can introduce averaging errors when aggregating fine-scale data into larger zones. Furthermore, the asthma data utilizes NTA definitions from prior to the 2020 Census, requiring complex cross-walking to align with modern administrative boundaries.

Temporally, the study is constrained by the fact that the available data does not represent a singular, synchronized snapshot of Queens. Instead, the analysis synthesizes data sources from different moments across the last decade, ranging from pre-2020 health statistics to more recent 2024 environmental sensors. While this mosaic approach is necessary to create a comprehensive multi-factor index, it assumes that the underlying relationships between these variables have remained relatively stable over time. For the purposes of this analysis, it is assumed that these datasets provide a sufficiently representative proxy for existing conditions, though actual impacts may fluctuate based on seasonal shifts or more localized micro-climatic variations not captured at the Census Tract or Block Group level.

Human Factors

While this report utilizes quantitative methods to identify environmental justice burdens, the model cannot fully account for the subjective “human factors” and community perceptions that influence project viability. Quantitative indices for noise, emissions, and greenspace serve as essential proxies for physical impact, yet they do not encapsulate the lived experience or the qualitative “neighborhood character” valued by local residents. For interpretation purposes, it is assumed that the standardized sensitivity thresholds discussed for receptors, such as schools and daycares, correlate with the community’s broader public health and safety priorities. However, it should be noted that the perceived impact of an elevated rail structure may vary significantly across different socio-economic and cultural contexts within the corridor.

Operational Nuances

The accessibility analyses presented here are based on idealized service parameters and do not account for the granular operational nuances of the New York City Transit system. Factors such as real-time signal delays, equipment failures, or variations in off-peak versus peak-hour headways are simplified into generalized service frequency assumptions within the isochrone mapping. For the sake of this study’s impact estimation, it is assumed that the QueensLink would operate at optimal efficiency with consistent service patterns. In a real-world operational environment, the actual environmental burden or accessibility benefit would be contingent upon the MTA’s final dispatching protocols and the long-term maintenance of the physical infrastructure.

Exclusion of Secondary Impacts

This analysis is intentionally constrained to the primary environmental and social impacts directly associated with the reactivation of the Rockaway Beach Branch corridor. Consequently, the scope excludes secondary or downstream impacts such as induced land-use changes, potential property value appreciation, or the risk of secondary displacement (gentrification) following improved transit access. While these factors are critical to the long-term lifecycle of the project, they involve complex market variables that fall outside the immediate data-driven environmental impact framework established here. For the purposes of this report, the findings should be interpreted as an assessment of the immediate physical and social relationship between the proposed alignment and its current surrounding environment.

Sampling Biases and Errors: American Community Survey

While the ACS provides an incredibly comprehensive foresight into niche socioeconomic trends across a variety of different spatial granularities, it is by no means a perfect representation of the situation on the ground. With a nearly 1:40 respondent-to-population ratio[37], it is likely that the ACS will fail to capture various segments of the population that are harder to reach, particularly in the most socioeconomically vulnerable areas of our study space, and more broadly, the United States as a whole. As it relates to our work specifically, we noticed some peculiarities from the ACS dataset that did not reflect our domain understanding of the region we studied. Specifically, we noticed that several census tracts fully contained inside of parks (namely Forest Park), cemeteries, and airports were registering non-zero population and HH counts across much of our studied attributes (HHs by vehicle counts, commute mode of transportation). This is potentially due to the ACS imputing year-over-year estimates off of their survey responses (over a five-year cycle), and hence upweighting from an extremely small sample size to begin with (population), failing to address edge cases in terms of land-usage specifically. Nevertheless, the ACS remains the dominant currency for transportation modellers (and other quantitative social scientists) based on sheer data available, and it served as a backbone for much of our work in this study.

Mode-shift Model Complexity: Transportation Impact Analysis

Typically, a more comprehensive travel demand model would take into account a wide range of socioeconomic and demographic factors when extrapolating trip counts (trip generation) and assigning travel modes (mode selection). In addition, land-use is another factor to consider when building an aggregate (tract-level) model, particularly as denser, mixed-use developments are more likely to be transit-trip generators and single-family homes otherwise. However, we did not include these features into our model by design (only using HH/vehicle growth and greenspace as our differentiating features cross-scenario), provided the complexity involved for the scope of the project. For instance, modelling changes to land-use over a 20-year horizon isn't as simple as arbitrarily assigning existing block/lots and converting them into upzoned/mixed-use TODs, which is further elaborated upon under our *III: Necessary Assumptions* section above. This is also complicated by the fact that it is incredibly difficult to model trip-rates associated with TODs and mixed-use developments, as much of existing literature/surveys rely on models assuming suburban travel (primarily SFH/auto dominant), where the delineation between residential land-use types and mode preferences is more well-defined.

VIII: Conclusion & Future Outlook

This environmental justice and accessibility impact analysis demonstrates that the QueensLink project, integrating both a subway extension and 33 acres of new parkland, is a vital intervention for the climate resilience and public health of Central Queens. Our composite index reveals that the corridor currently suffers from high concentrations of heat vulnerability, respiratory distress, and economic burden, particularly in **Richmond Hill**, **Ozone Park**, and the **Rockaways**. The data shows that the No-Build scenario leaves these communities exposed to intensifying urban heat island effects and stagnant air quality, whereas the QueensLink Build scenario directly mitigates these risks by replacing a heat-absorbing derelict embankment with permeable greenspace and reducing vehicle miles traveled along congested arterials like Woodhaven Boulevard. By addressing the overlap between racial demographics and environmental risk, the project fulfills a critical environmental justice mandate, providing high-quality transit and cooling assets to the neighborhoods that need them most. In addition, our transportation impact analysis further validated the fact that QueensLink has the potential to alter the way residents think about travelling around the borough, by ditching their cars for carbon-neutral alternatives in the form of rail transit and bike travel.

The transformation of the abandoned Rockaway Beach Branch into a multimodal green corridor aligns with 21st-century urban planning goals that prioritize climate adaptation alongside traditional transit expansion. While our analysis identified specific noise-sensitive locations, such as the Small Wonders Preschool, these localized impacts can be effectively managed through modern engineering and acoustic barriers, ensuring that the benefits of regional connectivity do not come at the cost of neighborhood peace. Ultimately, the QueensLink offers a rare opportunity to bridge green deserts and transit deserts simultaneously. As New York City prepares for the extreme climate realities of 2050 and 2080, the reactivation of this right-of-way represents a proactive, layered investment in the physical and environmental health of the borough, transforming an underutilized right-of-way into a cornerstone of a more resilient and equitable Queens.

IX: Acknowledgements

The QueensLink Environmental Impact & Accessibility Analysis Study is a graduate capstone project towards the fulfillment of the Master of Science in Urban Data Science degree at the Center of Urban Science and Progress, New York University Tandon

School of Engineering. We want to extend our gratitude to the QueensLink non-profit organization for their continued assistance in the formulation of this report, especially our sponsor Andrew Lynch. We also want to extend gratitude to Franklin Tang and Malik Salman and their help and data from their QueensLink Ridership Study capstone, as well as the Metropolitan Transit Authority for the invaluable MTA Open Data resources.

X: References

[1] American Public Transportation Association. (2024, October). Design of Transit Facilities for Noise and Vibration Control. APTA RT-SET-RP-001-02. https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-RT-SET-RP-001-02.pdf

[2] Centers for Disease Control and Prevention. (2025). Daily Census Tract-Level PM2.5 Concentrations, 2016 to Present [Data set]. HealthData.gov. Retrieved December 10, 2025, from https://healthdata.gov/CDC/Daily-Census-Tract-Level-PM2-5-Concentrations-2016/k9st-jhz8/about_data

[3] City of New York. (2025). 311 Noise Complaints [Data set]. NYC OpenData. Retrieved December 10, 2025, from https://data.cityofnewyork.us/Social-Services/311-Noise-Complaints/p5f6-bkga/about_data

[4] City of New York. (2025). Air Quality [Data set]. NYC OpenData. Retrieved December 10, 2025, from https://data.cityofnewyork.us/Environment/Air-Quality/c3uy-2p5r/about_data

[5] Environmental Protection Agency. (2024). Environmental Justice Mapping and Screening Tool (EJScreen). Harvard Dataverse, V4. Retrieved October 20, 2025, from https://doi.org/10.7910/DVN/RLR5AX

[6] Federal Transit Administration. (2018). Transit Noise and Vibration Impact Assessment Manual (FTA Report No. 0123.0). U.S. Department of Transportation. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-no-0123_0.pdf

[7] *Gen2 Travel Model*. Metropolitan Washington Council of Governments. (2026, April 20). https://www.mwcog.org/transportation/data-and-tools/modeling/gen2-current-model/

[8] Hanley, A. (2024, January 17). Rethinking zoning to increase affordable housing. The National Association of Housing and Redevelopment Officials (NAHRO). https://www.nahro.org/journal_article/rethinking-zoning-to-increase-affordable-housing/

[9] Hertz, K., Laefer, D. F., Edid, M., & Ren, M. (2025). Community-based Brownfield engagement tool in Sunset Park, Brooklyn. *Sustainable Communities*, *2*(1). https://doi.org/10.1080/29931282.2025.2468241

[10] Hoffman, J. S., Shandas, V., & Pendleton, N. (2020). The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas. Climate, 8(1), 12. https://doi.org/10.3390/cli8010012

[11] Kalantari, Z., Ferreira, C. S. S., Koutsouris, A. J., Ahlmer, A.-K., Cerdà, A., & Destouni, G. (2019). Assessing flood probability for transportation infrastructure based on catchment characteristics, sediment connectivity and remotely sensed soil moisture. Science of The Total Environment, 661, 393–406. https://doi.org/10.1016/j.scitotenv.2019.01.009

[12] Kim, M., & Collins, B. (2026, February 12). *Regional Transportation Planning Through Intergovernmental Collective Action: Does Planning Conformity With Federal Regulations Improve Regional Air Quality?*. Public Works Management & Policy. https://journals.sagepub.com/doi/10.1177/1087724X261421903

[13] *Life in the slow lane: A report card for New York City's bus system*. Office of the New York City Comptroller Brad Lander . (2025, September). https://comptroller.nyc.gov/wp-content/uploads/documents/Life-in-the-Slow-Lane-A-Report-Card-for-New-York-Citys-Bus-System.pdf

[14] *Metropolitan Planning Organization (MPO)*. Metropolitan Planning Organization (MPO) | FTA. (2022). https://www.transit.dot.gov/regulations-and-guidance/transportation-planning/metropolitan-planning-organization-mpo

[15] Metropolitan Transportation Authority. (2018). Q52/Q53 Woodhaven/Cross Bay Blvd SBS. https://www.nyc.gov/html/brt/downloads/pdf/brt-woodhaven-after-fall2018.pdf

[16] MTA Long Island Rail Road. (2018, September 18). PHASE ONE: ROCKAWAY BEACH BRANCH SKETCH ASSESSMENT FINAL WHITE PAPER. https://www.mta.info/document/10941

[17] Mudigonda, S., Ozbay, K., Ozturk, O., Iyer, S., & Noland, R. B. (2014). Quantifying Transportation Benefits of Transit-Oriented Development in New Jersey. Transportation Research Record, 2417(1), 111-120. https://doi.org/10.3141/2417-12

[18] Nassiri, P., Abbaspour, M., Mahmoodi, M., & Givargis, Sh. (2007). A rail noise prediction model for the Tehran–Karaj commuter train. Applied Acoustics, 68(3), 326–333. https://doi.org/10.1016/j.apacoust.2006.02.003

[19] New York City Department of Health and Mental Hygiene. (2025). 2025 Heat Mortality Report. Environment and Health Data Portal. https://a816-dohbesp.nyc.gov/IndicatorPublic/data-features/heat-report/

[20] New York City Department of Parks and Recreation. (2015). 2015 Street Tree Census - Tree Data [Data set]. NYC OpenData. Retrieved November 14, 2025, from https://data.cityofnewyork.us/Environment/2015-Street-Tree-Census-Tree-Data/uvpi-gqnh/about_data

[21] New York State Department of Environmental Conservation. (2025). Air Quality by Particulate Matter [Data set]. New York State Geospatial Information Gateway. Retrieved November 10, 2025, from https://opdgig.dos.ny.gov/datasets/air-quality-by-particulate-matter/about

[22] New York State Department of Environmental Conservation. (2025). Environmental Remediation Sites Map [Data set]. NYS Open Data. Retrieved December 8, 2025, from https://data.ny.gov/Energy-Environment/Environmental-Remediation-Sites-Map/jvqh-m7fz

[23] New York State Department of Environmental Conservation. (2023). MOVES5-2023 Input Data Tables [Data set]. NYS Open Data. Retrieved December 9, 2025, from https://data.ny.gov/Energy-Environment/MOVES5-2023-Input-Data-Tables/ucsk-j8pb/about_data

[24] New York State Energy Research and Development Authority. (2025). Disadvantaged Communities - NYSERDA. https://www.nyserda.ny.gov/ny/Disadvantaged-Communities

[25] NYC Department of City Planning. (2024). *City of Yes for Housing Opportunity*. nyc.gov.

https://www.nyc.gov/content/planning/pages/our-work/plans/citywide/city-of-yes-housing-opportunity#proposal-explainers

[26] NYC Department of Transportation. (2015, May). Citywide Congested Corridors Project: Woodhaven Boulevard From Queens Boulevard to Liberty Avenue. https://www.nyc.gov/html/dot/downloads/pdf/woodhaven-blvd.pdf

[27] NYC Planning. (n.d.). Jamaica Neighborhood Plan. https://www.jamaicaplan.nyc/

[28] NYC Planning. (2025, April 28). Draft environmental impact statement (DEIS): One LIC Long Island City Neighborhood Plan. https://www.licplan.nyc/draft-environmental-impact-statement-deis

[29] Onat, Y., Buchanan, M., Duskin, L., Massidda, C., & O'Donnell, J. (2025). A State-Specific Approach for Visualizing Overburdened Communities: Lessons from the Connecticut Environmental Justice Screening Tool 2.0. Sustainability, 17(10), 4535. https://doi.org/10.3390/su17104535

[30] Parks, S. (2025, May 29). *Bus network redesigns in the modern age: How U.S. transit agencies adapt to evolving travel*. The Eno Center for Transportation. https://enotrans.org/article/bus-network-redesigns-in-the-modern-age-how-u-s-transit-agencies-adapt-to-evolving-travel/

[31] QueensLink. (2024). QueensLink: Connect Queens. https://thequeenslink.org/

[32] Stone, B., Jr., & Rodgers, M. O. (2001). Urban Form and Thermal Efficiency: How the Design of Cities Influences the Urban Heat Island Effect. Journal of the American Planning Association, 67(2), 186–198. https://doi.org/10.1080/01944360108976228

[33] Tang, Z., & Salman, M. (2025, May 20). QueensLink Ridership Study: the Case for Reactivation of the Rockaway Beach Branch as Part of the NYC Subway System [Capstone report]. Center for Urban Science and Progress, New York University.

[34] U.S. Environmental Protection Agency. (2016). EJSCREEN Technical Documentation: Environmental Justice Screening and Mapping Tool. https://www.epa.gov/sites/default/files/2016-07/documents/ejscreen_fact_sheet.pdf

[35] U.S. National Library of Medicine. (n.d.). Trichloroethylene. National Center for Biotechnology Information. https://pubchem.ncbi.nlm.nih.gov/compound/Trichloroethylene

[36] Vaccaro, R., Maino, F., Zubaryeva, A., & Sparber, W. (2024). The environmental impact in terms of CO_2 of a large-scale train infrastructure considering the

electrification of heavy-duty road transport. iScience, 27(10), 110987. https://doi.org/10.1016/j.isci.2024.110987

[37] Wei, R., Knaap, E. & Rey, S. American Community Survey (ACS) Data Uncertainty and the Analysis of Segregation Dynamics. *Popul Res Policy Rev* 42, 5 (2023). https://doi.org/10.1007/s11113-023-09754-6

XI: Appendices

Appendix I: List of Data Sources

Dataset Name	Source	Availability	URL
NYS Air Quality by Particulate Matter, 2025	New York State Department of State Geographic Information Gateway	Public, Open	https://opdgig.dos.ny.gov/datasets/air-quality-by-particulate-matter/about
NYC Environment & Health Data Heat Vulnerability Index, 2023	NYC Environment & Health Data Portal	Public, Open	https://a816-dohbesp.nyc.gov/IndicatorPublic/data-features/hvi/
NYC Asthma Emergency Department Visits by NTA, 2017-2019	NYC Environment & Health Data Portal	Public, Open	https://a816-dohbesp.nyc.gov/IndicatorPublic/data-explorer/asthma/?id=2414#display=summary
NYC 311 Noise Complaint Data, 2024-2026	NYC 311	Public, Open	https://portal.311.nyc.gov/article/?kanumber=KA-02125
NYC Primary Land Use Tax Lot Output (PLUTO) Data, 2026	NYC Department of City Planning	Public, Open	https://www.nyc.gov/content/planning/pages/resources/datasets/mappluto-pluto-change

Dataset Name	Source	Availability	URL
NYDEC Environmental Site Brownfields Data	New York State Department of Environment and Conservation	Public, Open	https://dec.ny.gov/environmental-protection/site-cleanup/database-search
NYDEC Environmental Site Spills Incident Data	New York State Department of Environment and Conservation	Public, Open	https://dec.ny.gov/environmental-protection/site-cleanup/database-search
US Census / American Community Survey API, 2022-2024	US Census (acquired by API `GET` request)	Public, Open	https://api.census.gov/data/{YYYY}/acs/acs5
NYCDOT Mobility Survey, 2022	NYC Department of Transportation	Public, Open	https://www.nyc.gov/html/dot/html/about/citywide-mobility-survey.shtml
MTA Subway static GTFS, Versions 2025/02	MTA	Public, Open	https://www.mta.info/developers
MTA Bus static GTFS (MTA Bus Co., NYCT Queens), Versions 2025/02	MTA	Public, Open	https://www.mta.info/developers
Modified No-Build and Build Subway MTA static GTFS	QueensLink	Private	
NYC DCP LION road network geodatabase	NYC Department of City Planning	Public, Open	https://data.ny.gov/City-Government/LION/2v4z-66xt/about_data
NYC Stormwater Flood Maps, 2024	NYC OpenData	Public, Open	https://data.cityofnewyork.us/Environment/NYC-Stormwater-Flood-Maps/9i7c-xyvv/about_data