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Urban Environmental Gentrification: Evaluating the Impact Large Green Infrastructure Projects Have On Urban Residents

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Evaluating the Impact Large Green Infrastructure Projects Have on Urban Residents

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Introduction:

With the rise of the environmental movement nationally and internationally, American cities are becoming increasingly focused on environmental initiatives to improve environmental quality, boost economic revenue, and better the quality of life for urban residents. Cities across the country have adopted the trend of implementing Large Green Infrastructure Projects, converting formerly developed but now unused areas into environment-oriented parks, based on the model project of the New York City High Line. While these projects benefit urban communities economically, socially, and environmentally, they often do so at the expense of minority and low-income residents. The Large Green Infrastructure Projects generally increase cost-of-living in their surrounding areas, displacing the at-risk communities unable to afford the higher cost in a process known as gentrification. In this research, I develop a methodology for quantitatively measuring the occurrence of gentrification, largely based on prior research with a similar goal. I apply the created methodology to several Large Green Infrastructure Projects in an attempt to validate the methodology and analyze gentrification occurring in surrounding neighborhoods. The analysis aims to show that gentrification in neighborhoods adjacent to the Large Green Infrastructure Projects has occurred at a greater rate than on a city-wide scale. The goal of this research is to identify project implementation as a primary cause for the displacement of low-income and minority urban residents; the application of my methodology will provide quantitative evidence for Large Green Infrastructure Projects being a cause of urban environmental gentrification. This research emphasizes the necessity for development companies and local housing authorities to implement better policies to protect low-income and minority housing during Large Green Infrastructure Project planning.

Background Case:

The New York City High Line, completed in 2014, consists of a one-and-a-half-mile long park and greenway built within the original framework of the former New York Central Railroad. The elevated railway, originally referred to as the West Side Elevated Line, became fully operational in the early 1900s for the transportation of meat, dairy, and produce to Manhattan based factories.

By 1980, transportation of goods had primarily shifted from train to truck, and almost all of the industrial factories had relocated outside of Manhattan; as a result, sections of the line had been demolished, and the elevated High Line section stood sturdy but unused. After decades of proposed demolition and modernization projects, the non-profit organization *Friends of the High Line* formed to advocate for the railway's preservation and use as a public open greenspace.

Twenty years later, the High Line project has transformed an aesthetically unpleasing and functionally useless infrastructural ruin of Manhattan's Upper West Side into a social, economic, and cultural asset. The linear greenspace offers a multitude of gardens, a dedicated bicycle and running path, a set of public artwork displays, and a system of community programs. At its core, the High Line rededicates an urban development to an area of environmental focus. Not only has the High Line become one of New York City's most popular Instagram-able destinations, but the park has become a global inspiration for transforming unused urban industrial zones into dynamic environmental spaces.

New York City's High Line project is one of several major urban greenspace projects within the United States, converting formerly developed but now unused areas into environment-

oriented parks. The modern construction of urban greenspace projects including the High Line and other rail lines, canals, roads, and bridges are categorized together as Large Green Infrastructure Projects or LGIPs (Rigolon & Nemeth, 72). The twenty-first century has witnessed a significant rise in the popularity and prominence of these projects in cities across the country.

The rise in the urban greenspace concept has become a dominant component of the modern environmental movement adopted by American cities; the legislature of many city governments has begun to reflect a global concern for addressing environmental issues such as sea level rise, atmospheric warming, and carbon dioxide emissions. LGIPs are a prime method for both improving urban environmental quality as well as for solidifying an urban government's dedication toward an environment-focused agenda. New York City's High Line, as one of the most visible projects, has been a leading example of its city's dedication to increasing their urban environmental quality and proceeds as a model for the adoption of similar projects in other cities.

The environmental quality of the West Side massively improved following the implementation and construction of the High Line. The reduction of air pollution, the mitigation of drainage runoff, and the lessening of pollutant emissions like carbon dioxide represent some of many environmental improvements that have been measured. Public health has witnessed a similar improvement, as those living in proximity to the High Line gain access to cleaner air and water as well as land enabling them to exercise, relax, and take advantage of open space abnormal within the dense development of New York City (Kennicott).

The art installations and social programs of the High Line represent successful social benefits that its construction has brought to the surrounding communities. The foot traffic brought in by the destination, when combined with the new residential and commercial construction alongside the High Line, has produced a significant economic contribution for New York City. Overall, the

High Line exemplifies the diverse positive roles that a Large Green Infrastructure Project can have within a city.

The negative effects of Large Green Infrastructure Projects are often overlooked. The High Line, for all its greatness, has introduced a societal negative to the West Side and Manhattan since the first stage of construction completed in 2009: the previously rundown neighborhood of Chelsea has been completely revitalized with real estate development along the length of the High Line's route. Rent and mortgage costs have increased in existent housing units within proximity to the greenspace, and the original lower-cost units are being replaced by the newer and costlier adjacent development (Smallman). The minority communities within Chelsea have been the primary bearers of housing cost changes, and many original minority residents have since been displaced entirely from the area (Navarro).

The High Line's surrounding neighborhood, the intended beneficiary of the project's construction, has become emblematic of urban gentrification: the process of renewal and rebuilding accompanying the influx of middle-class or affluent people into deteriorating areas that often displaces poorer residents. In hoping to improve access to better environmental quality for the Upper West Side, the High Line's planners have altered the affordable housing within the area for minority communities (Navarro).

Modeled after the High Line, other LGIPs in cities across the country have been implemented to improve urban environmental quality for their local communities. The impact on their local real-estate and housing markets are often understudied issues, not taken into account during the planning process and unmeasured in the years after their implementation. The positive benefits of LGIP construction – improved social, public, environmental and economic health – often outweigh the negative process of urban gentrification. American cities like New York have

constructed LGIPs to strengthen the environmental quality for communities that are actually displaced as a result of such improvements. Just as the High Line has become a model for urban environmental projects, it has similarly become a model case for urban environmental gentrification.

Literature Review:

With the rate of urbanization and the concern for environmental degradation both rapidly accelerating in the United States, many city and municipal governments have begun to implement policies aimed at reducing the impact of urban areas on the environment. These policies may fall into several categories; for example, some policies are designed to regulate the energy usage within buildings while others are designed to limit automobile traffic and emissions. Overall, a city's environmental policies are created to transform and redevelop sections of the city to promote environmental health and a higher quality of life for residents.

Residential housing within cities is extremely vulnerable to a city's environmental efforts. Urban environmental projects and policies are notorious for affecting residents of different social and economic statuses in largely unequal ways: "urban sustainability projects focus on the environmental and economic components of sustainability, such as energy consumption or local economic performance, but they seldom include measures of the social or distributional impacts of sustainability" (Pearsall, 872). Policies and projects implemented by city governments to reduce environmental degradation frequently take into account the economic and environmental benefits brought to a region of the city, while not taking into account the social effects that it might have. Urban environmental projects, such as the creation of green space or the redevelopment of a neighborhood, frequently impact residents of different social and economic

statuses in different ways: “sustainability initiatives, particularly when accompanied by economic growth objectives, have the potential to displace lower-income and disadvantaged populations” (Pearsall, 874). A city’s plans to improve the environmental quality of a community, typically boosting its economic productivity as well, largely alter the local housing market and put vulnerable low-income and minority residents at risk of being forced out.

Environmental gentrification refers to the implementation of environmental initiatives that lead to the exclusion, marginalization, and displacement of economically marginalized residents. Also referred to as environmental displacement and green gentrification, the term summarizes the “urban planning process whereby developers purchase or renovate property in deteriorating neighborhoods, increasing property values and often displacing low-income families” (Krisel, 217). The redevelopment of a neighborhood is brought on by investment in the community, such as by the implementation of a new environmental policy or by the construction of a new environmental project. In the absence of housing policy intervention, environmental policies “generate public funding for environmental amenities and restoration from government initiatives and mandates, which in turn increases real estate values” (Gould & Lewis, 14). As real estate values increase surrounding the environmental improvement, some long-term residents become unable to afford the increase rent or home costs now associated with the area.

Environmental gentrification is most evident in city’s efforts to clean up areas where the environment has historically been degraded, such as landfills or Superfund Sites. The environmental rent gap, occurring in areas where the rent is historically low due to degradation, is responsible for gentrification occurring in several urban regions: “environmental contamination depresses property values – up to 45% - through the inherent undesirability of living on or near a polluted site, and property values rise again following environmental

remediation" (Pearsall & Anguelovski, 2). Contaminated areas, where rent costs are usually very low due to their undesirability, experience an increase in rent costs as the contamination is removed and the area is redeveloped. One of the most popular cases of this is the Gowanus Canal in Brooklyn, New York, a toxic industrial canal deemed a Superfund Site in 2010 by the federal government. Development along the canal had been undesirable since banks were unwilling to loan to development companies adjacent to the site and zoning laws along the canal prohibited residential development (Krisel, 221). Since its categorization and clean-up began, residential values along the canal have begun to increase due to redevelopment in the few areas where residential construction is permitted: "when deindustrialized waterfronts are recast as environmental amenities (waterfront views and urban green space), real estate values increase and housing prices are pushed upwards. Residents unable to increase the share of their incomes spent on rent are pushed out of their neighborhoods, increasing the gap between the socioeconomic haves and have-nots" (Gould & Lewis, 13-14). The Gowanus Canal exemplifies the typical scenario of environmental redevelopment, where a policy or project improves the environmental quality of an urban region, the increase in rent increases in communities adjacent to the improvement, and the residents unable to meet the higher rent are displaced. This pattern, from redevelopment to displacement, is standard for urban environmental gentrification.

Early studies of urban gentrification in America are limited, and the earliest studies approach the concept from either theoretical or narrative perspectives. Only a select few early studies on the topic push past theory and narrative to employ empirical research. Published in 1982, an article in *The Urban Lawyer* identifies the shortcomings of prior urban gentrification research: "recent city and neighborhood studies of gentrification-caused displacement are important because debate about the nature of gentrification displacement in the United States has thus far

proceeded in an evidentiary vacuum" (LeGates & Hartman, 31). LeGates & Hartman noted that in 1979 the U.S. Department of Housing and Urban Development contracted private research institutions to develop a *Displacement Report* for Congress, which concluded that very little was known about the displacement phenomenon (ibid., 45). To provide empirical research on the topic, LeGates and Hartman compiled sixteen studies of gentrification-caused displacement performed between 1977 and 1980 to obtain "demographic profiles of the inmovers to gentrifying neighborhoods, to profile outmovers and to determine the location, cost, and adequacy of outmovers' post-move shelter" (ibid., 33). Despite their research being largely outdated, the study provides the basis for the current approach to studying gentrification-caused displacement, focusing on key demographic attributes for those being displaced and for those moving into the gentrified neighborhood. Still outdated, however, their use of the terms "inmover," referring to those moving into a neighborhood during gentrification, and "outmover," referring to those displaced by gentrification, do not appear in any other research on the topic.

At the time of their analysis, modern urban gentrification was just beginning; the authors conclude that "the majority outmovers are white, but the number of minorities is substantial and growing. Most outmovers are lower middle income" (LeGates & Hartman, 45). Gentrification at the time had not yet occurred in neighborhoods consisting primarily of a single minority group, only neighborhoods of mixed ethnicity and race. More than three decades later, the typical modern 'outmover' is still lower middle income, but recent gentrification occurs in neighborhoods primarily consisting of minority groups (Checker, 211-212). The study also prescribes for future studies to focus on microlevel analysis, the analysis of specific gentrifying neighborhoods at development, census tract, block, and even building level.

This microlevel approach to studying gentrification has since become integral to most modern gentrification analyses. By breaking down urban populations into specific regions and neighborhoods, researchers are better able to isolate demographic changes and the variables that cause them. In the case of the San Francisco Bay region, for example, research on redevelopment has focused on individual communities throughout the region. In an article written for a general audience by the Urban Habitat Program, researchers have found the same pattern in multiple Bay communities of disinvestment, public investment, and displacement: "new high priced housing subdivisions driving up rents in many neighborhoods in Richmond, real estate speculators and developers buying up land in San Francisco's Bayview District, [and] a shopping mall displacing 100 low income families in East Palo Alto" (UHP Report, 29). Increased investment in neighborhoods, like a 30% increase in businesses in the Mission District between 1997 and 1999, has increased demand for high-end housing. Researchers discovered a correlation in most neighborhoods between housing pressure and new job creation; in the Bay Area, only one home was built for every nine jobs created, while in Santa Clara County one home was built for every seventeen jobs created. Investment in redevelopment results causes pressure on housing, resulting in rising rent and home prices for current residents. Approaching the neighborhoods from a microlevel perspective, the researchers find that the communities most effected in the region are "people of color, and a high proportion are low income" and "receiving some form of public assistance" (UHP Report, 30). Community redevelopment in the region requires a new approach that honors low income communities of color.

Continuing the microlevel analysis of urban gentrification, research has narrowed neighborhood investment for redevelopment to the construction of Large Green Infrastructure Projects, largescale environmental projects that also link commerce, recreation, tourism, and real

estate development. These projects are a catch-all for city governments in that they both improve the urban environment while also "intended to stimulate private development by connecting people to destinations and increasing local quality of life" (Rigolon & Nemeth, 71). At the same time, however, these projects lead to environmental gentrification, which the authors define as "the influx of affluent residents to historically disadvantaged neighborhoods due to investments that improve environmental quality, which may result in the displacement of long-term low-income residents" (ibid., 72). Exploring the actors and creators behind these projects, their research shows that the large-projects are planned in underserved areas with low property values, where investors can take advantage of rent gaps and attract newcomers to make the most profit. Focusing on Chicago's 606 Trail, a three-mile and $95 million bicycle and pedestrian path opened in 2015, the project connects affluent White areas on its north side to low-income minority dominated areas to the west: "Logan Square and Humboldt Park are lower-income majority-Latino neighborhoods experiencing advanced gentrification" (ibid., 74). The natural real estate market following the 606 Trail resulted in the expansion of the affluent neighborhoods from the north to the west, with affordable rental units being replaced by single-family homes. Properties near the 606 Trail were downzoned to include fewer residential units than before redevelopment, resulting in a shortage of housing units, an increase in rent costs, and the displacement of low-income residents from the region. Comparing the income and demographic makeup of the 606 Trail region before and after its opening, the authors have found a large increase in median household income, an increase in median gross rent cost, and an increase in Non-Hispanic white residents. The study's results are displayed in the table below:

Table 2. Change in demographic and housing variables between 2010 and 2016[a].

	Tracts bordering the 606 (average)	Neighborhoods along the 606 (average)[b]	City of Chicago (average)
Change in median household income	+$14,682	+$8422	+$3557
Change in percent of people with a bachelor degree	+6.95%	+6.39%	+4.35%
Change in percent of Non-Hispanic White residents	+4.83%	+3.41%	+0.56%
Change in median gross rent	+$201	+$122	+$102

a Values calculated as follows: estimates from the 2012–2016 American Community Survey (ACS) minus estimates from the 2006–2010 ACS.

b Average values for Tracts in Bucktown, Wicker Park, Logan Square, and Humboldt Park.

Most recent research on environmental gentrification discusses the profit-oriented side of redevelopment and its ignorance of potential displacement. In their discussion of the 606 Trail constructed in Chicago, the authors identify that "investments in green spaces provide cities with capital through increased property tax revenues, and developers are able to charge substantial premiums for real estate located in close proximity to new green amenities" (Rigolon & Nemeth, 72). The same conclusion is found in analyzing the redevelopment of Prospect Park in Brooklyn, New York. Research done in 2014, aimed at quantifying displacement in the area, found that "following the park's restoration, rents increased and housing became less accessible to minority and poor populations" (Mohtadi, 23). Following the redevelopment of Prospect Park, rent costs in nearby low-income neighborhoods significantly increased and displaced long-term residents. Research done at Queens College and the City University of New York substantiate the displacement by redevelopment in Prospect Park: "restoration of Brooklyn's Prospect Park led to a massive increase in new construction in certain areas around the park and corresponding decrease in the race and class mix of those areas" (Checker, 216). Profit driven forces support the negative socioeconomic process of green gentrification, where the benefits of urban green space

improvements are concentrated to the wealthy who can afford the rising prices near the improvements. The planning process, when focused on profit-centric goals, foregoes community specific needs and desires (Mohtadi, 24). Large Green Infrastructure Projects, like the 606 Trail in Chicago and Prospect Park in Brooklyn, exemplify the profit-oriented goals of redevelopment and the displacement of low-income residents that is caused.

The profit-oriented goals of redevelopment, ignoring the risk of low-income and minority displacement, are largely the result of fragmentation between redevelopment agents and housing sectors. Most Large Green Infrastructure Projects are coordinated and overseen by park non-profit groups, such as the Trust for Public Land that was responsible for construction of the 606 Trail in Chicago. Redevelopment projects are tasked to park non-profits because of the singular nature of the organization: "community outreach and fundraising, their track with donors and foundations, and their capacity to engage communities more effectively than what public agencies can be capable of" (Rigolon & Nemeth, 75). Park non-profits are employed to prevent the bias of a profit driven approach in redevelopment; however, these groups do not take into consideration matters of housing or housing affordability in redevelopment. For instance, the Trust for Public Land literally stated, in regard to the 606 Trail, that "we are not in the business of housing; we are in the business of conservation and building parks" (ibid., 76). At the same time, Chicago's Department of Planning and Development stated, "the housing bureau was not involved in planning for housing around the 606. This idea that you were planning for all of these things at the same time was not happening" (ibid., 76). City governments approve redevelopment projects and allocate responsibility to a park non-profit; that park non-profit does not take displacement and affordable housing into consideration, and the public housing department has passed off responsibility after approving the project for its profitability. The

result is fragmentation between the project overseers and the housing sector, and reduced accountability for affordable housing or displacement. Similar issues of fragmentation and reduced accountability for housing have been identified in other urban redevelopment projects across the country, such as the Friends of the High Line in New York City, The Atlanta Belt Line Partnership in Atlanta, and the Friends of the Rail Park in Philadelphia (Rigolon & Nemeth, 77).

With fragmentation between the project developers and public housing sectors, the most popular solution for voicing projects' risks of gentrification is the bottom-up approach of public activism. Profit-oriented city governments place park non-profits in charge of redevelopment projects, and these non-profits do not account for affordable housing or displacement, so other public groups arise to fill the gap: in the analysis of displacement surrounding Prospect Park displacement in Brooklyn, research prescribes for "grassroots discourse and collectivist-driven strategies [are necessary] to ensure that local communities can fully utilize the space" (Mohtadi, 24). Multiple methods of discourse strategies have been employed and studied in regard to environmental gentrification such as coalition building, collective neighborhood action, community organizing, lawsuits, and leveraging environmental regulations (Pearsall 2016, 2). There is little to no consensus on which methods work best. In Austin, Texas, a community coalition formed to increase residents' participation in governmental decisions that impact their neighborhoods, and the coalition recommended the City of Austin to create a "Community Land Trust where land is purchased and set aside for communities to decide the use" and "inclusionary zoning and housing/rent control" (Almanza, 63). However, Texas has legally prohibited inclusionary zoning and the coalitions' recommendations have since gone ignored. However, protestation of the city's Smart Growth Plan in 2015 for its inequality has been successful, and "community engagement has been highlighted as a key component of redevelopment measures"

(Pearsall & Anguelovski, 2). Coalitions like the Morgantown Project, the Dudley Street Neighborhood Initiative, the Burlington Community Land Trust, and the New Columbia Community Land Trust have proven successful to "improve the quality of life in low-income neighborhoods while giving the resident the ability to regain control of the land" (Lawrence, 369). Some research has also shown that partnership and state intervention in mediation between redevelopment agencies and long-term community residents supports meaningful community participation. However, to determine the best methods for public activism and opposing displacement-causing projects, "in-depth assessments are needed to compare cities and determine which ones are more equal than others as they implement greening agendas – and for what reasons" (Pearsall & Anguelovski, 4). To study and understand the best methods for the public to oppose environmental projects and subsequent gentrification, more research is necessary to understand the implementation of such projects.

The quantitative measurement and analysis of urban gentrification, especially that due to environmental projects or policies, is an area of controversial research. Some research has focused on identifying factors that influence gentrification as a means of policy or planning intervention. Referred to as neighborhood early warning systems, toolkits of either reports or online guides aim to identify changes within a neighborhood as well as neighborhoods in decline and neighborhoods experiencing redevelopment, both at risk of experiencing significant gentrification (Chapple & Zuk, 110). In an analysis of these systems, research published by the U.S. Department of Housing and Urban Development states that "displacement – when households are forced to move out of their neighborhoods – can be a negative outcome of gentrification but may also precede it" (ibid., 112). Creating a set of indicators for neighborhoods in decline and neighborhoods in development both are necessary to determine where

displacement will occur. However, current early warning systems are not reliable or easily applicable. There are a myriad of indicators and sources of data, and that data on the drivers and impacts of gentrification are difficult to obtain and quantify; research on a multitude of existent warning systems categorizes the indicators and sources of data into a chart of advantages and disadvantages, and conclude that "data on gentrification and displacement underrepresents the most disadvantaged populations and presents a mismatch between data and lived experience" (Chapple & Zuk, 115). Data availability and methodologies for characterizing gentrification have been lacking for previous research done on the topic, and better methodologies are necessary going forward. The multitude of neighborhood early warning systems are not consistent with one another and are not able to reliably predict displacement: "they are not able to predict the displacement impacts of specific developments or to identify which of the many antidisplacement policies is useful in different contexts" (Chapple & Zuk, 127). As explained earlier, applying a microlevel analysis specific to individual developments within neighborhoods is important in preventing environmental gentrification, and current research is lacking in this sense.

Hypotheses:

Creating an Environmental Gentrification Methodology:

There are a multitude of neighborhood early warning systems that have previously been designed and researched but are not able to reliably predict displacement. Prior research on indicators for predicting displacement do not focus on predicting the impact of specific developments. By focusing on environmental projects, specifically Large Green Infrastructural Projects (LGIPs), I aim to isolate variables specific to environmental development that could be

used to predict the impact of environmental projects on displacement. The majority of previous research does not analyze indicators that are specific to such a narrow form of development within a community, especially indicators unique to environmental projects, and my research will serve to fill this gap in the evaluation and prediction of environmental gentrification. The variables will evaluate the risk of displacement for environmental projects being implemented in communities in decline as well as in communities where environmental projects are underway. I hope to create a collection of variables that when understood in combination with each other can be used as an indicator of gentrification taking place.

Methodology Applied to Case-Studies:

Following my creation of a reliable set of variables for environmental projects, I aim to conduct a comprehensive study of existent environmental projects and their associated risks of displacement. In essence, I aim to compile a representative list of recent LGIPs, like the 606 Trail in Chicago or Prospect Park in Brooklyn, and evaluate them in regard to a methodology of demographic variables that indicate the occurrence of gentrification. This manner of evaluation for a project will be similar to the research of Rigolon & Nemeth and their analysis of the 606 Trail, focused on changes in demographic and property values surrounding an environmental project. When applied to several LGIPs in American cities, the methodology will potentially provide evidence of whether gentrification is occurring, and as a result the methodology can be used to evaluate displacement risk associated with different urban environmental projects. By applying this set of variables to several LGIPs, I hope to provide quantitative evidence that changes in these variables can together indicate a significant demographic change occurring that can be understood as gentrification.

Methodology:

Project Selection:

The previous literature on urban gentrification typically approaches the issue with a broad focus applied generally to an entire city or region. As explained in the literature review, the purpose of my research is to provide a microlevel analysis that experts have directly indicated is lacking within the literature. The microlevel analysis of this research focuses on LGIPs and the immediately adjacent neighborhoods that are theoretically impacted by the project construction.

To begin the analysis, it is necessary to formalize a list of LGIPs that will be the subject of my data collection and methodology. This process remains fairly subjective, as there is no formal list of LGIPs and no established qualifications for a project to be considered an LGIP. The initial collection of projects stems from the existent literature where previous authors specifically reference projects as LGIPs. Multiple sources compiled for the literature review have made brief mention of LGIPs throughout the country that could potentially exhibit significant gentrification and should be the subject of future analysis. These LGIPs are ideal to use in my analysis, as they have been deemed in previous scholarly research as significant and supported by the theories concluded in that research.

Previous research has been conducted to analyze gentrification surrounding the 606 Trail LGIP in Chicago, Illinois (Rigolon & Nemeth). Within their research, the authors reference several projects in comparison to the 606 Trail as either similarly largescale, environmentally oriented, or infrastructurally related. For a project to be included as a subject, it must be directly identified as an LGIP within previous literature just as the 606 Trail has been. If not directly considered an LGIP by experts in the literature, a project then must be explicitly compared in

relation to an LGIP as similarly largescale, environmentally oriented, and infrastructurally related within previous research. Projects that experts reference as similar to a stated LGIP warrant being considered as an LGIP themselves since no formal criteria exist for establishing LGIP status.

The subjects of my research will include any project that an expert refers to as an LGIP or considers similar to a stated LGIP as largescale, environmentally oriented, and infrastructurally related. Authors Alessandro Rigolon and Jeremy Nemeth have conducted an analysis on the 606 Trail in Chicago, Illinois and directly refer to the project as an LGIP; furthermore, they reference several projects as similar in size, orientation, and type. These projects include the New York City High Line, the Atlanta Belt Line, and the Philadelphia Rail Park. Official descriptions for each of these related projects confirm that each is similar to Chicago's 606 Trail within the parameters of an LGIP. Each project is officially considered as largescale, as they span several city blocks, environmentally focused, as they directly involve and affect environmental factors, and infrastructurally related, as they create a socioeconomic component within their cities.

The authors also reference Boston's Dudley Street Neighborhood, although it is referenced in regard to the usage of affordable housing nonprofit organizations. Considered within relation to the 606 Trail and the three factors that consider it an LGIP, Boston's Dudley Street Neighborhood is largescale, but it does not focus on environmental quality and does not create a component of infrastructure. This distinction enables me to confirm my methodology for considering LGIPs as a subject of my research; while Boston's Dudley Street Neighborhood is referenced in relation to an explicitly stated LGIP and relates directly to the LGIP in terms of size, it does not relate to the LGIP in terms of environmental focus and infrastructural role as well.

The initial review of the literature has identified four projects as explicitly LGIPs or similar enough to an LGIP to be considered one itself. These four projects are Chicago's 606 Trail, New York City's High Line, Atlanta's Belt Line, and Philadelphia's Rail Park.

The self-identification of LGIPs is necessary since there is no formal system of criteria to be considered an LGIP and no formal listing of LGIP projects within the United States. However, there does exist a formal collaboration of American projects related to New York City's High Line. Following the construction and popularity of New York City's High Line, its leading nonprofit *Friends of the High Line* created an informal communication network for sharing advice on "infrastructure reuse" projects similar to the High Line. The network has transformed into a formal collaboration known as the High Line Network, consisting of eighteen American projects that can be considered LGIPs:

> "All projects in the network reclaim infrastructure and reimagine it as public space. Projects were chosen based on alignment with the network's mission, commitment of leadership to network activities, and geographic representation" (High Line Network).

Within my methodology for selecting projects to analyze as LGIPs, each of the eighteen projects within the High Line Network easily fulfill my selection methodology considerations. First, each project is referenced as similar to an expert-identified LGIP. Authors Rigolon and Nemeth explicitly consider Chicago's 606 Trail as a LGIP (Rigolon & Nemeth). The 606 Trail is one of eighteen collaborative projects within the High Line Network, as are the New York City High Line, Atlanta Belt Line, and Philadelphia Rail Park which have already been considered LGIPs by association. Since the purpose of the formal network is to unite the leaders of similarly focused projects, each of the projects within the collaboration can be identified as an LGIP by

association as well. Without consideration by similarity, the eighteen projects of the High Line Network still fulfill my three criteria to be an LGIP subject. The formal organization consists entirely of largescale projects, and the organization states that these projects are all infrastructure related. Further research on the High Line Network's official descriptions for each project and the official documentation for each project identifies a prominent environmental focus behind each project, fulfilling my third criteria for LGIP consideration.

For my methodology, I am considering projects as LGIPs if they are referred to as an LGIP or considered similar to a stated LGIP in regard to largescale size, environmental focus, and infrastructural status. The literature review has enabled me to self-identify several projects as LGIPs in addition to those explicitly stated. A formal, collaborative network known as the High Line Network categorizes eighteen projects together based on their largescale size, environmental focus, and infrastructural status, and these projects overlap with those identified in the literature review. The selection methodology for determining subjects to use in my research has identified the following nineteen American projects as Large Green Infrastructural Projects:

11th Street Bridge Park Washington, DC	Klyde Warren Park Dallas, TX	The Underline Miami, FL
Atlanta Belt Line Atlanta, GA	Lowline New York, NY	Trinity River Park Dallas, TX
Bayou Greenways 2020 Houston, TX	Presidio Tunnel Tops San Francisco, CA	Waller Creek Austin, TX
Buffalo Bayou Houston, TX	QueensWay Queens, NY	Waterfront Seattle Seattle, WA
Crissy Field San Francisco, CA	Rail Park Philadelphia, PA	
Dequindre Cut Detroit, MI	River LA Los Angeles, CA	
High Line New York, NY	The 606 Trail Chicago, IL	

From the eighteen projects that can be considered LGIPs for my research, I must then identify projects that have been in existence long enough for gentrification to have begun and for data on that gentrification to be available. The initial narrowing of the eighteen projects is straightforward: those that have not yet been constructed or have opened extremely recently cannot yet show signs of gentrification. The Bayou Greenways project completion date is set for 2020, the 11th Street Bridge date set for 2023, the Lowline project set for an undetermined date, the Presidio Tunnel Tops project set for 2019, the QueensWay project set for as early as 2020, the River LA project set for an undetermined date, the Underline project set for an undetermined date, the Trinity River Park project set for 2021, the Waller Creek project set for 2019, and the Waterfront Seattle project set for 2022. These projects have either not begun or have just entered construction; gentrification as a result of the projects would have not yet occurred at a significant degree. The Philadelphia Rail Park project finished its first phase of completion in January of 2018, and as a result there would be little occurrence or evidence of gentrification approximately one year after the project has been completed. The projects selected for use in this study must have completed construction at least two years prior to the current date.

Based on the elimination of incomplete projects, as well as a project completed within the past two years, there remain seven selected LGIPs to study the effects their implementation has had on urban gentrification. The remaining seven projects have all been completed, at least the first phase or section of each, between 1986 and 2015. While some of these projects have been planned in phases and others have been expanded upon following completion, each of these projects has been significantly completed enough to be considered an LGIP that would have an effect on the surrounding neighborhoods. These projects, their locations, and their dates of completion are as follows:

Buffalo Bayou (1986) Houston, TX	Dequindre Cut (2009) Detroit, MI	The 606 (2015) Chicago, IL
Crissy Field (2001) San Francisco, CA	High Line (2009) New York, NY	
The Atlanta Belt Line (2008) Atlanta, GA	Klyde Warren Park (2012) Dallas, TX	

Methodology Foundation:

Gentrification is unique, in that no single demographic or statistic exists that directly provides a quantitative measurement of the process occurring. Previous research and studies related to gentrification employ different variables and statistics that are associated with gentrification, such as average mortgage cost or tenure of residence. Recent studies have even employed a Starbucks method, calculating the rate at which Starbucks corporation outlets are established in neighborhoods previously lacking similar corporate enterprises. Multiple variables, be it costs of mortgage or number of Starbucks, can provide a conceptual idea of gentrification in an area. For my purposes, however, I have chosen to employ a group of demographic variables that together can summarize a quantitative analysis of gentrification around Large Green Infrastructure Projects beyond the conceptual idea that variables in previous research have provided.

The basis for this gentrification analysis if found in research taken up by Allesandro Rigolon and Jeremy Nemeth in 2018. In their research on urban gentrification, the authors aim to identify the role and impact of nonprofit organizations in the construction of a single LGIP, Chicago's 606 Trail. While the purpose of their study is focused on a qualitative analysis of the LGIP's design team and leadership, the authors additionally employ a quantitative analysis to

supplement their canvassing, media, and leadership-structure findings. Their quantitative analysis of gentrification in neighborhoods surrounding Chicago's 606 Trail resulted in confirmation of the process occurring as a direct result of the LGIP construction, and the results of their quantitative analysis are entirely backed by a qualitative analysis undertaken in the same neighborhoods surrounding the project. As the authors state, their quantitative and qualitative analyses in their research corroborate each other's findings: "these qualitative analyses corroborate claims by several interviewees that although neighborhoods along the 606 had started to see gentrification in the 2000s, the trail's construction served to accelerate these trends, particularly in close proximity to the project itself" (Rigolon & Nemeth, 74). This corroboration, in which canvassed interviews align with statistical measurements, proves the validity of the quantitative methodology used by the authors in their gentrification analysis. For my research, employing a qualitative analysis of interviews surrounding seven national LGIP projects is not feasible. However, since the quantitative findings of Rigolon and Nemeth are corroborated by qualitative evidence, their quantitative methodology can be understood as accurate and valid.

The gentrification analysis of the seven LGIPs in urban areas across the United States employs a methodology founded within the 2018 analysis of Chicago's 606 Trail. As the 606 Trail is one of the seven projects chosen to be included within the scope of my research, the findings of my gentrification analysis on this project are expected to be similar to that of the original study; the 606 Trail acts as a type of control. If the findings of my analysis accurately represent the findings of Rigolon and Nemeth's analysis of the same project, then my analytical process can be understood as valid. If the findings of my analytical process do not accurately represent the findings of Rigolon and Nemeth's analysis on the same project, then my analytical process cannot be understood as reasonably valid. My analysis of the 606 Trail should provide

findings similar to the findings of the original research on the same LGIP project. This pseudo-control project will enable me to assert the validity of my analysis and methodology when applied to the remaining six LGIPs that the original research did not focus on.

Rigolon and Nemeth identify four variables in their research that they associate as indicators of gentrification occurrence: median income, percentage of people with a bachelor's degree or higher, percentage of Non-Hispanic White residents, and median gross rent. These demographic variables, when measured over time, are understood together as primary indicators of gentrification. The variables are compared over a period of time, several years prior to the project's construction as compared to several years post construction. A significant increase seen in each of the variables within neighborhoods adjacent to a project indicates a significant change in demographic taking place around the time of an LGIP's construction. The change in these variables over time within project-adjacent neighborhoods is then compared to the change in these variables over the same period of time occurring within the respective city as a whole. For Rigolon and Nemeth, their research states "tracts bordering the 606 had much larger increases in median household income, the percentage of Non-Hispanic White people, and median rent, compared to citywide changes between 2010 and 2016" (Rigolon & Nemeth, 74). The change in these four variables for project-adjacent neighborhoods, when significantly different than the change citywide, indicates that the project-adjacent neighborhoods experienced change at an accelerated rate. Comparing change from a date prior to project construction to a date after project construction identifies a likely cause of that accelerated rate, the project itself.

The results of their research on the 606 Trail should only be similar to my own analysis of the 606 Trail, and my results should only reflect their findings rather than exactly replicate them. The first main difference between their foundational methodology and my own is the difference

in time periods being compared. The subject of the original research, the 606 Trail, was completed by the year 2015 which makes their comparison of data from 2010 and 2016 suitable; data from 2010 represents demographic statistics prior to project construction and data from 2016 represents demographic statistics post construction. The original research focused solely on one LGIP to analyze, while this research will focus on seven individual LGIPs each constructed during a different year. The 2010 and 2016 comparison might be adequate for analyzing the 606 Trail, but other projects were completed outside of this period of time.

Time Period Selection:

Since the time period of the original research is unsuitable for my methodology, there are two options: either create a unique time period to analyze for each individual LGIP or create a consistent time period that includes the construction of all seven LGIPs. The aim of my research is to analyze the affect that LGIPs as a category have on gentrification in their surrounding neighborhoods, rather than to analyze the affect that each individual project has on its area. While the scope of my research may be on a microlevel analysis of each project, the goal is to tie LGIPs as a category of project to urban gentrification. For that reason, my methodology will be based on a single chosen time period that encompasses the construction of all seven projects.

A single time period does complicate my analysis in terms of acquiring data relative to each project for the period, as some projects may have data available for periods different than the one chosen. Additionally, the results of Rigolon and Nemeth's study will differ than my results that use a different time period, which makes the comparison of my results to those of Rigolon and Nemeth difficult. Regardless of the complication, a single time period is an asset since it will apply an analysis consistent for all LGIPs in general, rather than analyze gentrification around

each project individually. The usage of a singular time period different than that of Rigolon and Nemeth will better support the main purpose of my research.

The time period chosen for the change in each variable is bounded by the earliest year of 2000 and the latest year of 2018. These dates were chosen based on two factors: the date that the LGIP's construction was completed, and the availability of demographic statistic data. The data must reflect the variable statistics in neighborhoods prior to the project being established as well as following its establishment; the earliest date must represent a year prior to the seven projects' construction and the latest date must represent a year following the seven projects' construction. Choosing a latest date is simple, as all of the seven projects have been finished and opened for several years. Based on this, the date chosen to be the latest bound of the time period is present day, 2018. All seven of the projects have been constructed by the present day, so quantitative data collected in the year 2018 represent demographic statistics that have theoretically been affected by the seven projects' completion.

The earliest bound of the time period chosen is more difficult to determine, since the seven projects were each completed over a broad span of time. While all of the projects have been completed by 2018, they were each begun and finalized at different times. Six of the seven projects were completed in 2001 or after, but the Buffalo Bayou LGIP in Houston, Texas was begun in 1986. Aside from the six projects completed after 2001, the Buffalo Bayou project is an outlier completed at a date much earlier than the others. At first, this complicates the determination of a bounding early date for our analysis's time period. However, after further research, only one small section of the Buffalo Bayou project was completed in 1986. The majority of the project, consisting of several small parks, was completed in the early 2000s. The masterplan of the project, focused on expanding Buffalo Bayou over one-hundred-forty-five

acres, was completed in 2002. The largest section of the project, including of its largest park and promenade, was completed by year 2015. As a Large Green Infrastructure Project, the factors that earn Buffalo Bayou a place in this category were completed in 2002 and 2015; the 'large' and 'infrastructure' aspects of the project were not included in the series of small parks completed much earlier. Based on this research, I have concluded that the majority of the Buffalo Bayou LGIP was completed around the same time as the other six projects, the early 2000s and 2010s. As a result of this research, the final time period chosen to analyze across all seven projects is between 2000 and 2018.

The chosen time period from 2000 to 2018 then is limited by the availability of statistical data on the four demographic variables chosen to indicate gentrification. The original research study performed by Rigolon and Nemeth relies on data collected from the 2012-2016 and 2006-2010 American Community Survey. The American Community Survey (ACS) is formally described as "is an ongoing survey that provides vital information on a yearly basis about our nation and its people" (American Community Survey, 2019). The survey is given to 3.5 million Americans across the United States each year to create up-to-date statistics on community demographics, compiled together for different areas and regions, such as state-wide or city-wide. The ACS provides an annual estimate of demographic information that is more accurate and contemporary than information collected in the census. The survey collects information from American households on population, age, industry, education, government, housing, income, language, poverty, race, and veterans. The four variables analyzed by authors Rigolon and Nemeth, as well as by myself in this research, fall within the survey parameters of the ACS study.

The most recent ACS data available comes from the 2013-2017 ACS survey. Currently, the results of the ACS including the year 2018 have not yet been compiled and published by the

United States Census Bureau. This changes the latest boundary of the study's time period from 2018 to 2017. This does not affect the study's accuracy in any way, as the seven LGIPs were all completed by the year 2015. Data on median household income, percentage of people with a bachelor's degree or higher, percentage of Non-Hispanic White residents, and median gross rent for the year 2017 is available and accessible at the level of individual neighborhoods and city-wide.

ACS data for the year 2000 is not available. The ACS survey was not conducted within this year since the official U.S. census is distributed for collection of the same data from a larger sample size. The difference in sample size is the only legitimate difference between ACS and census data, which for the purposes of this research study does not have a drastic effect on the analysis. The official 2000 United States census provides the data necessary on the four variables for the earliest boundary of the studies time period, 2000. The monetary values of this data, relevant for median household income and median gross rent, are calculated for inflation which enables a comparison to be directly made between the 2017 and 2000 values. The 2000 census data is available for the exact same locations that the 2017 ACS provides, also making a direct comparison possible.

Variable Selection:

The 2000 census data does present a large obstacle to the methodology of this study. Unlike the 2017 ACS, used as the data source for the upper date of our time period, the 2000 United States census does not provide readily accessible data for all four of our demographic variables. The 2000 census does provide neighborhood and city-wide data for median household income, percentage of people with a bachelor's degree or higher, and percentage of Non-Hispanic White residents but does not provide the appropriate data for the fourth variable of the study, median

gross rent. It is unclear why the ACS provides a monetary value for the median gross rent while the official census does not. A potential reason that came to mind was the age of the data, but the most recent official census in 2010 similarly does not include a monetary value for median gross rent. The median gross rent appears to be a statistic measured only in the ACS and not in the official census. Unfortunately, the oldest available ACS data is from the year 2010 which would drastically alter the time period of our study since five of the seven LGIPs were completed prior to the year 2010.

No variable in the official census serves as a close equivalent to median gross rent. The census provides housing data primarily focused on race, age, and level of occupancy, all of which are not monetary variables that could be used in place of median gross rent. Since the only sources of demographic data specific to individual zipcodes are the ACS and U.S. census, and median gross rent is not available from these for 2000, the only remaining option would be to remove the variable from being analyzed in this study. As a result, data availability limits our analysis to median household income, percentage of people with a bachelor's degree or higher, and percentage of Non-Hispanic White residents for 2000 and 2017.

The removal of median gross rent as a variable will have a minimal impact on the conclusions made from this analysis. Originally, the four variables together were understood as an indication of gentrification occurring; the removal limits the indication to a collection of three variables rather than four. On one hand, the change is minimal. The variable of median gross rent represents an economic characteristic under analysis in LGIP adjacent areas, as does the variable of median income. The variables do differ, as median gross rent directly refers to housing affordability while median income indirectly refers to housing affordability, both but variables do represent an economic factor of analysis. Since there is no collection of variables that has

definitively been established to indicate the occurrence of gentrification, the removal of one of four variables would not alter the conclusions of this study significantly. Each variable is independent of the other, and the remaining three still provide a comprehensive understanding of neighborhood demographics.

On the other hand, the removal of median gross rent as a variable in this study does lessen its comprehensiveness to some degree. The variables under consideration do lack any demographic that directly represents housing or housing values in the LGIP adjacent areas. Unfortunately, the 2000 census does not offer any statistic related or similar to median gross rent. The only related statistics available include percentage of vacant housing units, percentage of renter-occupied housing units, and percentage of housing units available for rent. An increase between 2000 and 2017 in percentage of renter-occupied housing units and percentage of housing units available for rent could easily be a result of more rental units being built, which would occur with or without the construction of an LGIP. Regardless of an LGIP's construction, the amount of rental housing available in urban areas is continuously increasing.

With the lack of an appropriate variable to replace median gross rent, I have decided to maintain only the three variables of median income, percentage of people with a bachelor's degree or higher, and percentage of Non-Hispanic White residents for the 2000 to 2017 period. However, I plan to still consider the variable of median gross rent for the seven LGIPs and their adjacent neighborhoods. Based on the availability of data, median gross rent will be analyzed for its own time period: the earliest available data year of 2011 to the most recent year 2017.

Unlike the other three variables, median gross rent will not be representing a comparison of demographic changes prior and post an LGIP's construction. Even if a neighborhood has a greater rate of increase in median gross rent than its respective city, there is no data to prove that

the neighborhood's post-2011 rate is different than its pre-construction rate. Without knowing data prior to 2011, I cannot determine if the rate accelerated due to a project. Instead, analyzing median gross rent in LGIP adjacent neighborhoods from 2011 to 2017 still can indicate if gentrification is occurring. The variable will not directly identify LGIP construction as a reason for gentrification occurrence, but rather identify that LGIP is occurring potentially as a result of prior LGIP construction.

The median gross rent variable is decidedly weaker than the other three variables for usage in my study. If data on the variable were available for the time period of 2000 to 2017, it would have been a strong addition to the collection of other variables being analyzed. Since the data is only available for 2011 to 2017, I will not be considering it within the collective of variables together being used as an indication of gentrification caused by LGIP construction. Alternatively, I will be considering median gross rent as a supplementary variable outside of the indicator collective. The variable will be used to understand whether or not there is sign that gentrification is occurring regardless of its cause. While it will not isolate LGIP construction as a reason for gentrification, the role of the other three variables together, median gross rent will still supplement my understanding of gentrification taking place in adjacent areas.

Neighborhood Selection:

Having concluded the time period and variables on which to collect data, I then must determine which individual LGIP adjacent neighborhoods to collect that data for. Theoretically, each project should provide a description of its location and its adjacent neighborhoods in its online information, formal description, or provided documentation. From these theoretical descriptions, I would collect the appropriate data for each neighborhood. However, when beginning to research each of the seven projects, most do not directly state which neighborhoods

they are present in or they border. Their websites and documentation lack any explicit statement of which neighborhoods they touch on or influence; none of the project descriptions include a statement similar to *this project borders the Apple Neighborhood and the Carrot Neighborhood*. This has made determining which neighborhoods to include in data collection difficult, since projects do not explicitly state which neighborhoods would be negatively or positively influenced by its presence. As a result, a large amount of research and effort had to be dedicated to determining the adjacent neighborhoods.

The simplest were projects that bordered very few individual neighborhoods: San Francisco's Crissy Field borders only the Presidio Neighborhood, while New York City's High Line borders only Chelsea and the Meatpacking District. Mentions of these neighborhoods were made on the project websites, and confirmation was made on maps of both projects. The difficult projects to determine were those that lacked direct listing of adjacent neighborhoods, and these projects typically bordered more than five individual neighborhoods.

The determined best way to clarify which neighborhoods to include in a project's study was to search through a project's official website for any and all mentions of neighborhoods bordered. The documentation on each project does not include a single full list of neighborhoods but does include several lists of some neighborhoods associated with different sections of the project. After compiling these lists together, I then compare the created list with the project's official map as well as a city map to verify that these neighborhoods are actually adjacent and that the list is not missing any neighborhoods. The Atlanta Belt Line, as an example, is comprised of seven parks and five trail parks; each of the parks exists within one neighborhood, while each trail runs through multiple different neighborhoods. The project website for each trail includes a mention of the related neighborhoods, and a map of each trail shows which

neighborhoods it runs through. The project's size, its division into sectional portions, and its lack of clear documentation complicates the determination of border neighborhoods. In depth research on its description and mapped location clarify which neighborhoods are adjacent despite no formal list being provided. In total, the Atlanta Belt Line touches on twenty-eight individual neighborhoods. Although tedious, this process enables me to make a thorough list of neighborhoods to analyze for each project and ensures my analysis of a project is comprehensive.

The selected neighborhoods are then matched with their appropriate United States Post Service Zone Improvement Plans, most commonly referred to as zipcodes. Most demographic data in the United States is accessed via a five-digit code used for census research and mailing services, rather than the name of the neighborhood itself; for example, data on New York City's Meatpacking District is not easily available under the descriptor 'Meatpacking District, New York City' but rather its allocated zipcode, 10014. After determining the neighborhoods adjacent to each project, the neighborhoods are then matched with their appropriate zipcode digits. When doing so, it becomes apparent that some individual neighborhoods are referenced with more than one zipcode; for example, New York City's Chelsea neighborhood is associated with zipcode 10001 as well as zipcode 10011. This issue exists for several of the seven projects, where one of the neighborhoods bordering the project is formally associated with more than one zipcode. Since data will be compiled by means of a zipcode allocation rather than a nominal neighborhood, a decision then has to be made on which zipcodes are appropriate for usage in data collection. The first obstacle is that projects are not explicitly associated with zipcodes, as they are not explicitly associated with nominal neighborhoods in addition. The second obstacle is that project descriptions do not specify which portions of a neighborhood, consisting of multiple

zipcodes, touch on the project; there is no formal description of a certain zipcode of a multiple zipcode neighborhood is relevant. Since projects' formal descriptions do not offer information on which zipcodes to include, the decision relies on projects' formal maps and official zipcode maps.

To determine which zipcodes are relevant to a project, referencing a project map against a map of zipcodes shows which zipcode boundaries run through the project itself. This methodology concludes that some neighborhoods consisting of multiple zipcodes only have one zipcode relevant to a project, while some neighborhoods consisting of multiple zipcodes have multiple zipcode regions adjacent to a project. The clarification of which zipcodes to include when multiple exist ensures that our final analysis of a project is as accurate as possible. If I had chosen to include all zipcodes associated with a neighborhood when only one of them is actually adjacent to a project, the collection of data and final results would inaccurately represent areas not directly bordering a project. The in-depth inspection of a project's location on a zipcode map verifies that the data collected is directly relevant to the associated project. The following figure displays each of the seven projects' adjacent neighborhoods and their zipcode allocation(s):

	Primary	Secondary
Atlanta BeltLine		
Parks		
Boulevard Crossing	30315	
Arthur Langford, Jr.	30315	
DH Stanton	30315	
Gordon White	30310	
Historic Fourth Ward	30308	
Historic Fourth Ward Skatepark	30312	
Perkerson Park	30310	
Trails		
Eastside		
Virginia Highland	30306	
Midtown	30308	30309
Poncey-Highland	30306	
Old Fourth Ward	30312	30308
Inman Park	30307	
Cabbagetown	30312	30316
Reynoldstown	30316	30307
Westside		
Oakland City	30310	
Capitol View	30310	
Adair Park	30310	
West End	30310	
Washington Park	30314	
Mozley Park	30314	
Westview	30310	
Northside		
Ardmore Park	30309	
Collier Hills	30318	
Collier Hills North	30309	
Southwest Connector Spur		
Beecher Hills	30311	
Westwood Terrace	30310	
West End		
West End	30310	
Mozley Park	30314	
Westview	30310	

	Primary	Secondary
Buffalo Belt Line		
Memorial Greenway	77046	
Eleanor Tinsley Park	77019	
Memorial and Heights	77007	
Allen Parkway at Taft to Sabi	77019	
Sam Houston Park	77002	
Allen's Landing	77002	
Sabine Promenade	77007	77002
Sesquicential Park	77002	
Yolanda Black Navarro Buffalo Bend Nature Park	77011	

	Primary	Secondary
Crissy Field		
Presidio	94129	

	Primary	Secondary
Dequindre Cut		
Eastern Market	48207	

	Primary	Secondary
High Line		
Chelsea	10001	10011
Meatpacking District	10014	

	Primary	Secondary
Klyde Warren		
Downtown	75201	

	Primary	Secondary	Tertiary	Quaternary
606 Trail				
Wicker Park	60622			
Bucktown	60622	60614	60647	
Humboldt Park	606047	60624	60622	60651
Logan Square	60647	60639		

Following the determination of the neighborhoods directly adjacent to each LGIP and the zipcode allocations associated with each of the neighborhoods, I am able to begin data collection. Data on each zipcode is necessary for this research analysis, as each zipcode represents a residential area bordering the LGIP projects. As seen in the table above, some projects have a singular zipcode that touches on its location, such as the Eastern Market Neighborhood, zipcode 48207, bordering the Dequindre Cut project in Detroit, Michigan. Other projects have multiple neighborhoods and zipcodes touching on its territory, such as the Belt Line in Atlanta, Georgia with twenty-eight adjacent neighborhoods and thirty-three relevant zipcode areas. The data collected for each zipcode represents demographic statistics for urban residents that live in direct proximity to the respective LGIP who theoretically have been affected by its location and construction.

Data Collection:

For the two years of 2000 and 2017, data is collected on median income, percentage of people with a bachelor's degree or higher, and percentage of Non-Hispanic White residents. The monetary and percentage values are compiled for each relevant zipcode from the 2017 ACS and the 2000 census. The difference between the 2017 and 2000 values is then calculated, and from those calculations an average is taken for median household income, percentage of people with a bachelor's degree or higher, and percentage of Non-Hispanic White residents surrounding each project. As an example, from the three zipcodes along the New York City High Line, the average change in median household income was $55,627.67, the average change in people with a bachelor's degree or higher was 16.7% and the average change in Non-Hispanic White residents was 9.03%. The calculations are done for all seven of the LGIPs, providing an average change in the variables over time for their surrounding neighborhoods.

The same process is done at a city-wide scale. Data on the three variables is collected for each city, rather than by zipcode, from the 2017 ACS and the 2000 census. The later and earlier values are then compared to provide a difference in these three variables over time for an entire city as a whole. As an example, New York City experienced a change in median household income of $19,580, a change in people with a bachelor's degree or higher of 9.3%, and a change in Non-Hispanic White Residents of -2.4%. The change in the three variables is calculated between 2017 and 2000.

For the two years of 2011 to 2017, data is collected on the variable of median gross rent to be used as a supplementary analysis of gentrification occurring. Data is collected from both the 2017 American Community Survey as well as the 2011 American Community Survey for all of the selected zipcodes. Within each project, the difference between the 2011 and 2017 median

gross rents is determined for each zipcode, and from these an average median gross rent change is calculated for project-adjacent neighborhoods. As an example, neighborhoods adjacent to the New York City High Line experienced an average increase in median gross rent of $361.33 between 2011 and 2017. The calculation was repeated for each of the seven projects under analysis.

The same process is done at a city-wide scale, just as it had been done for the three collective variables. From the 2011 and 2017 American Community Surveys, median gross rent values are compiled for each respective city as a whole. The city-wide difference in variable is calculated between 2011 and 2017. For example, New York City experienced an average increase in median gross rent of $215. The calculation is done for each of the seven respective cities.

From there, for the collective three variables and the supplementary variable, I will compare and analyze the calculated averages of LGIP adjacent neighborhoods against the averages of their respective cities.

Results:

Control Project:

As stated earlier, the 606 Trail in Chicago, Illinois serves as a control to ensure the validity of this research methodology. The results of my research on neighborhoods surrounding the 606 Trail should reflect findings similar to those of Rigolon and Nemeth in their original research; the results will not be exactly the same since the time period of my research differs from their own. The similarity of my findings to theirs would ensure that my methodology is valid for analyzing the variables' change over time in project-adjacent neighborhoods, their comparison to city-wide changes, and ultimately the occurrence of gentrification caused by LGIP construction.

My analysis shows that the neighborhoods adjacent to the 606 Trail experienced a change in median household income of $28,142.40, people with a bachelor's degree or higher of 19.23%, and Non-Hispanic White residents of 13.65% between 2000 and 2017. The city of Chicago, meanwhile, experience a city-wide change in median household income of $9,657, people with a bachelor's degree or higher of 3.9%, and Non-Hispanic White residents of 10.9%. This shows that ultimately neighborhoods along the 606 Trail experienced a change in median household income triple the rate of Chicago, change in people with a bachelor's degree or higher six-times the rate of Chicago, and change in Non-Hispanic White residents triple the rate of Chicago.

Rigolon and Nemeth's analysis of the 606 Trail, taking place between 2010 and 2016, concludes that neighborhoods along the LGIP experienced a change in median household income of $8,422, people with a bachelor's degree or higher of 6.39%, and Non-Hispanic White residents of 3.41%. Their analysis of Chicago over the same time period concludes that the city experienced a change in median household income of $3,557, people with a bachelor's degree or higher of 4.35%, and Non-Hispanic White residents of 0.56%. Their analysis shows that the median household income for adjacent neighborhoods increased triple the rate of Chicago, people with a bachelor's degree or higher double the rate of Chicago, and Non-Hispanic White residents seven times the rate of the city.

Overall, the results of my analysis on the 606 Trail in Chicago reflect the same findings of Rigolon and Nemeth's study on the LGIP. Despite the differences in time period being studied, both analyses conclude that the median household income for neighborhoods bordering the 606 Trail increased at a rate triple that of Chicago as a whole. The rate at which the number of people with a bachelor's degree or higher increased is shown to be higher than that of Chicago, although my analysis concludes a much higher rate than that of Rigolon and Nemeth. The rate at which

the number of Non-Hispanic White residents increased is shown to be higher than that of Chicago, although my analysis concludes a smaller rate than that of Rigolon and Nemeth. The overall conclusions of my analysis and the original is the same: change in the three variables is experienced at a much greater rate in neighborhoods along the 606 Trail than in Chicago as a whole. The disagreement in rates between my own analysis and Rigolon and Nemeth's is likely due to the different time periods being used in the analyses, rather than a more serious technical issue.

The findings of my own methodology for the 606 Trail LGIP are similar to that of Rigolon and Nemeth in the foundational research study, which indicates that my research process can be understood as valid. The original study concludes that the variables in project-adjacent neighborhoods increase faster than in the city of Chicago, which my methodology also confirms. As a result of the corroboration of my study of the 606 Trail by that of the original researchers, my methodology used to analyze the 606 Trail can be validly applied to the remaining six LGIPs I have chosen to study.

Collective Variables:

The application of my research methodology to the remaining six LGIPs shows similar trends to those seen surrounding the 606 Trail in Chicago. Across all seven of the LGIPs including in my study, there is an evident difference between the rate median household income increases for neighborhoods surrounding the project and the respective city as a whole. The neighborhoods surrounding five of the seven LGIPs experience a change in median household income of at least triple that of the city in which it is located. The Dequindre Cut project in Detroit increases at a rate double that of Detroit, which still supports a major trend in neighborhoods adjacent to LGIPs. The sole outlier to this trend is the Atlanta Belt Line, which experiences only a slightly

higher increase than Atlanta, the neighborhoods increasing by $21,897 from 2000 to 2017 while Atlanta increases by $16,931. The six projects that increase at a significantly higher rate of median household income represent a major disproportion in demographic change between project-adjacent neighborhoods and city-wide.

The change in median household income appears to indicate the strongest trend in variable change in this study. The percentage of people with a bachelor's degree or higher shows a similar trend, in which project-adjacent neighborhoods increase at a greater rate than city-wide, although with more outliers. The Atlanta Belt Line project actually experiences a change in level of education at a rate less than that of Atlanta; Belt Line adjacent neighborhoods witness a 12.81% increase in people with a bachelor's degree or higher while Atlanta as a whole witnesses a 14.1% increase. The Crissy Field project in San Francisco is similar, where the bordering neighborhood experiences an 8.2% increase in people with a bachelor's degree or higher while San Francisco witnesses a 10.8% increase. Despite these two outliers, the level of education surrounding the remaining five LGIPs increases at a higher rate than their cities. Unlike with median household income, the difference in rate between project-adjacent neighborhoods and city-wide is not a similar difference throughout all of the projects. Buffalo Bayou, for example, increases at a rate triple that of Houston, Dequindre Cut seven-times that of Detroit, and the High Line double that of New York City. Although the rate of increase in people with a bachelor's degree or higher differs project to project, a trend still appears: the percentage of people with a bachelor's degree or higher increases at a much greater rate in project-adjacent neighborhoods than it does city-wide.

The third variable of this study, percentage of Non-Hispanic White residents, presents a subtle trend in the data, where project-adjacent neighborhoods experience an increase in this

demographic at a greater rate than the respective LGIP's cities. Four of the seven projects experience an increase in white residents at a greater rate than the city in which it is located. There is no consistent difference in rate that is apparent in the data. The Crissy Field project in San Francisco experienced a change nine-times that of San Francisco, while the High Line in New York City experienced a change five-times that of New York City. The 606 Trail in Chicago experienced a change of 13.65% and Chicago as a whole experienced only a slightly less change of 10.9%. These four projects still indicate that percentage of Non-Hispanic White residents increased at a rate higher in project-adjacent neighborhoods than it did city-wide. The remaining three projects, however, show an opposite trend where the city experienced a variable change at a rate higher than project-adjacent neighborhoods. Areas along Atlanta's Belt Line, Houston's Buffalo Bayou, and Dallas' Klyde Warren Park actually witnessed an increase in Non-Hispanic White residents at a lower rate than Atlanta, Houston, and Dallas respectively. The majority of the seven LGIPs study purport that change in the variable occurs greater in project-adjacent neighborhoods, while three of the seven assert the otherwise.

The following table summarizes the project-adjacent and city-wide changes in median household income, people with a bachelor's degree or higher, and Non-Hispanic White residents occurring between 2000 and 2017:

	Change in Median Household Income 2000-2017	Change in People with a Bachelor's Degree 2000-2017	Change in Non-Hispanic White Residents 2000-2017
Belt Line	$21,897	12.81%	6.97%
Atlanta	$16,931	14.10%	7.80%
Buffalo Bayou	$40,406.20	13.31%	6.00%
Houston	$12,783	4.70%	8.30%
Crissy Field	$116,596	8.20%	8.50%
San Francisco	$41,044	10.80%	-1.50%
Dequindre Cut	$1,884	28.10%	8.20%
Detroit	-$1,688	3.20%	1.70%
High Line	$55,627.67	16.70%	9.03%
New York City	$19,489	9.30%	-2.40%
Klyde Warren	$34,106	11.30%	0.80%
Dallas	$9,657	3.90%	10.90%
606 Trail	$28,142.40	19.23%	13.65%
Chicago	$9,657	3.90%	10.90%

The results of my analysis show several significant trends in the data. The median household income increases in all seven LGIPs at a greater rate in neighborhoods bordering the project, typically triple, than it does within the city as a whole. The percentage of people with a bachelor's degree or higher increases in five of the seven LGIPs at a greater rate than the city as a whole, although the difference in rate varies project to project. The percentage of Non-Hispanic White residents increases for four of the seven LGIPs at a rate greater than the city as a whole but increases for three of the seven at a rate less than the city as a whole.

Supplementary Variable:

The supplementary variable of median gross rent provides a further understanding that gentrification is occurring in project-adjacent neighborhoods, although no indication that it is due to an LGIP's construction. Neighborhoods adjacent to projects generally are shown to experience an increase in median gross rent at a greater rate than the increase in their respective cities. Three

of the seven projects show a significantly greater rate than the city: Buffalo Bayou approximately three times as much as Houston City, Crissy Field approximately four times as much as San Francisco, and the Dequindre Cut approximately seven times as much as Detroit. Three other projects show a much smaller and potentially non-significant difference in rate than their cities. One project, the Atlanta Belt Line, experiences an increase in median gross rent at a rate less than the city of Atlanta – project-adjacent neighborhoods increasing by $144 and Atlanta by $153. The difference between the neighborhood and city rates is minimal, similar to the three other projects. The following table summarizes the project-adjacent and city-wide changes in median gross rent between 2011 and 2017 to use supplementary to my collective variables:

	Change in Median Gross Rent 2011-2017
Belt Line	$144
Atlanta	$153
Buffalo Bayou	$342.90
Houston	$120
Crissy Field	$1,250
San Francisco	$321
Dequindre Cut	$83
Detroit	$12
High Line	$361.33
New York City	$215
Klyde Warren	$334
Dallas	$126
606 Trail	$166.30
Chicago	$113

For the supplementary variable of median gross rent, three projects experience a significant different between the rate of change in project-adjacent neighborhoods and their respective cities. This trend does show that the neighborhoods do experience a change in median gross rent

between 2011 and 2017 that is much greater than the change in their cities. To better understand the occurrence of gentrification in these areas, three projects offer a trend.

Conclusions:

The purpose of this research seeks to determine if gentrification occurs as a result of Large Green Infrastructure Project construction within an urban area. From a network of eighteen LGIPs throughout cities in the United States, seven have been chosen that have already been completed and opened to the public, and that have been in existence long enough to have had a potential impact on their surrounding area. The neighborhoods directly adjacent to and bordering on each project were compiled through each project's formal description, its official documentation, and its location on a city map. A compiled list of the zipcodes relevant to each neighborhood was created by means of project descriptions and their location on a zipcode map.

A time period of 2000 to 2017 was selected that encompassed the construction of all seven LGIPs and that would reflect city demographics prior to and shortly following the seven projects' construction. Three of the four variables employed in the original research study – median household income, percentage of people with a bachelor's degree or higher, and percentage of Non-Hispanic White residents – were chosen to act as indicators of gentrification, and data on these three variables were collected for each selected zipcode in the years 2000 and 2017. Data on the three variables for the seven cities hosting these LGIPs was also collected for the same two years. Due to data availability, the fourth variable of median gross rent is used as a supplementary variable to understand the existence of gentrification between 2011 and 2017 in project-adjacent neighborhoods. This understanding is independent of project construction and

the other collective three variables. The data on this supplementary variable is also collected for the seven cities hosting these LGIPs.

For each of the seven LGIPs, I used the data to calculate the average change that took place for the three variables in the appropriate zipcodes adjacent to a project's location. These LGIP variable averages were then compared to the relevant city's averages over the same period of time.

The data analysis indicates trends for each of the three variables that occur as a result of LGIP construction within a city. Median household income is shown to increase in project-adjacent neighborhoods at a rate triple that of its host city. As a result of this trend, I am able to conclude that the construction and presence of a LGIP within a city correlates to a significantly drastic increase in median household income.

Correlation does not prove causation; however, I can likely assume that the project's construction has caused the significant increase in median household income in bordering neighborhoods. Most of the LGIP projects included in this study border on several neighborhoods, and the only shared characteristic of these neighborhoods is their direct proximity to the project boundaries. All of the neighborhoods in this proximity experience an increase in median household income around the time that the project is constructed, an increase that on average is greater than the rest of the city experiences over the same course of time. Since the only similarity in the neighborhoods is the project's construction, I am able to make a logical and founded assumption that the construction acts as the cause of the median household income increasing faster than it does throughout the rest of the city. The project's construction may not be primary or only cause of the increase, but statistically can be shown to have an effect on the rate median household income has occurred.

The data collected on my second variable, percentage of people with a bachelor's degree or higher, offers less evidence that an LGIP's construction has an effect on the variable. The data shows a trend that the percentage increased at a greater rate in proximity to a project than it did within the entire city; two projects present an opposite trend where the city witnessed an increase at a greater rate than project-adjacent neighborhoods. With five of the seven projects supporting the trend, I am still able to make the assumption that LGIP construction has an effect the percentage of people with a bachelor's degree or higher living in proximity to the project. The assumption is well-founded by statistical data, but I am not able to state that project construction could be a direct cause of the demographic change since the change is not present in all seven LGIPs studied. I am able to assert that the presence of an LGIP within a city likely does influence the percentage of residents living in proximity that hold a bachelor's degree or higher or higher.

The data analysis of the third variable of this study, percentage of Non-Hispanic White residents, offers the weakest connection to be made between an LGIP's construction and the variable. Only four of the seven projects show an increase in percentage of Non-Hispanic White residents occurring at a greater rate than it does throughout an entire city; three of the projects show that the variable increases at a greater rate in the respective city than in project-adjacent neighborhoods. From these trends in the data, I am able to say that an LGIP's construction does hold some influence on the percentage of Non-Hispanic White residents living in proximity to the project. I would not say that an LGIP's construction has primarily or partially been the cause of that demographic change occurring, since three of the seven projects experience an opposite impact over the time period that the project was constructed. The data indicates that an LGIP's construction does likely have some influence on the percentage of Non-Hispanic White residents

living in the surrounding neighborhoods. Since three of the seven projects provide evidence that the city experienced a greater rate of Non-Hispanic White resident increase, other city-wide factors could influence the change in demographic instead of or in addition to an LGIP's construction. The presence of an LGIP within a neighborhood likely has some influence on the demographic change but is not a cause of the change occurring.

When understood in combination with each other, the three variables analyzed in this study can be interpreted as a collective indicator of gentrification occurring. As the literature has stated, there is no single statistic or variable that is an immediate cause of gentrification in an area. A combination of statistics, on the other hand, provides a comprehensive approach to understanding the demographic of an area. When considering the median household income, percentage of people with a bachelor's degree or higher or higher, and percentage of Non-Hispanic White residents, the changes occurring within a neighborhood are studied in terms of income, education, and race. Gentrification is not solely able to be defined as *wealthier people* or *more educated people* or *more white people*. However, if a demographic is shown to have become wealthier, more educated, and more white in combination it is likely that gentrification has taken place in some degree. The combination of a variety of demographic variables is able to better indicate gentrification occurring than any sole demographic variable.

When looking at the trends in median household income, percentage of people with a bachelor's degree or higher or higher, and percentage of Non-Hispanic White residents in combination with each other between 2000 and 2017, it is evident that the demographic altering of neighborhoods adjacent to LGIPs is statistically different than the demographic altering of cities as a whole. Seven groups of neighborhoods, in which LGIP projects have been constructed during this time, experienced drastic changes in income, education, and race while the seven

cities experienced much less drastic changes. Since one variable cannot directly indicate gentrification, projects that are outliers in terms of one variable still represent drastic changes in terms of the other two variables; for example, the Atlanta Belt Line still experienced a significant rate of increase for median household income and percentage of people with bachelor's degree or higher despite having a non-significant increase in percentage of Non-Hispanic White residents. Singularly the three variables can directly represent gentrification but taken together can be understood as quantitative evidence that the demographic population of an area has significantly changed in response to a cause.

Statistical data has shown that a significant demographic change has taken place within seven individual groups of neighborhoods, and the only factor all seven neighborhoods have in common for this time period is the construction of a Large Green Infrastructure Project in close proximity. For seven groups of neighborhoods, data shows that the demographic has changed significantly more than in the seven respective cities between 2000 and 2017, during which LGIPs were constructed within or adjacent to the neighborhoods. When the three variables' data are understood together for all seven projects, the data shows a direct correlation between a significant demographic change and the construction of an LGIP. The only thing common between these seven groups of neighborhoods that underwent a demographic change, understood to be gentrification, is the construction of their respective LGIPs. This indicates that an LGIP's completion is likely the cause of gentrification taking place in project-adjacent neighborhoods.

The overall conclusion that gentrification has taken place in neighborhoods adjacent to LGIPs as a result of their construction is further justified by the analysis of the fourth variable independent of the collective. Despite the data being unable to identify construction as the cause for change in rate, the data does indicate that adjacent neighborhoods typically experience an

increase in median gross rent faster than respective cities as a whole. This increase may be drastic, seen in three of the projects, or minimal, seen in three of the projects, but there is a difference nonetheless. These neighborhoods, in the years following an LGIP being built, are experiencing a rise in median gross rent more than the cities, which leads me to understand that there is a unique demographic change taking place in these neighborhoods different than their respective cities.

Without knowing the rate of median gross rent increase prior to the year 2011, I cannot assert that LGIP construction caused median gross rent to increase faster in adjacent neighborhoods than the city. However, I am able to assert that in years following 2011, adjacent neighborhoods do experience a demographic change faster than the city. This being the same conclusion made for the collective indicator of gentrification, the rate of median gross rent increase can also indicate that gentrification is taking place in adjacent neighborhoods. The collective indicator provides evidence of gentrification and a reason for its occurrence, LGIP construction, while median gross rent provides further evidence of gentrification continuing.

Implications:

From the results and conclusions of my analysis, recommendations can be made for future LGIP planning that minimizes the occurrence of gentrification and the displacement of low-income and minority residents. My research proves that project implementation causes a rise in income, a rise in education, and a rise in Non-Hispanic white residents in adjacent neighborhoods which policy changes in implementation can address.

Previous literature on gentrification caused by environmental projects has offered policy options that I fully support. The work of authors Rigolon and Nemeth, having also provided the

foundation for my methodology, asserts that the major issue of LGIP implementation is the fragmentation between park nonprofits and housing departments. In the case of the 606 Trail, the nonprofit responsible for the Trail's planning and construction explicitly stated, "we are not in the business of housing" and housing bureau representative explicitly stated, "the housing bureau was not involved in doing planning for housing around the 606" (Rigolon & Nemeth, 76). To avoid the displacement of residents surrounding LGIPs, communication must exist between those responsible for the project and those responsible for housing affordability.

The seven projects considered in my analysis are all members of a group network known as the High Line Network, as are eleven other urban projects across America. As of now, the *Friends of the High Line* group responsible for projects within the network does engage in civic engagement. Those responsible for LGIPs do communicate with the surrounding community to minimize negative effects such as displacement. However, there is no documentation on the extent to which the High Line Network communicates with local housing bureaus, such as the Department of Planning and Development in Chicago. To minimize the risk of gentrification surrounding projects, implementation groups like the High Line Network and more local groups like the 606's Trust for Public Land must directly communicate and engage with housing authorities and advocates.

Another policy option I would recommend based on the conclusions of my research would be for an increase in diversity initiatives during LGIP implementation and management. I have proven that the two variables of percentage of people with a bachelor's degree or higher and percentage of Non-Hispanic White residents significantly increase following a project's construction. Following an LGIP being built, low-income and minority residents represent the

demographic being displaced. Diversity efforts that decrease the rise in Non-Hispanic White residents and level of education will in turn minimize the degree of gentrification taking place.

Based on research done on the official websites for each of the seven LGIPs under analysis, there are already a multitude of community engagement programs underway that focus on diversity. These include camps, cultural events, education programs, and other efforts that are aimed at members of the local community aside from the incoming Non-Hispanic White and highly educated demographics. Strengthening and expanding these efforts will gradually resist against gentrification and lessen its effects.

Specific recommendations are difficult to make due to the broad understanding of gentrification, its causes, and its indicators. From my research, I have been able to prove that median income, percentage of people with a bachelor's degree or higher or higher, and percentage of Non-Hispanic White residents can together indicate the occurrence of gentrification. Policy efforts aimed at reducing an increase in these variables will directly minimize their rise and the rise in gentrification taking place. In addition, the frequent and thorough measurement of these variables in areas that surround LGIPs can also be used by implementation and housing authorities to better plan LGIP construction. The data availability issues encountered throughout my research exemplify the importance in bettering measurement systems and their applicability.

There is no complete and perfect approach to understanding gentrification, especially within a microlevel analysis focused on areas surrounding Large Green Infrastructure Projects. For the future construction of such projects in American cities, the risk of gentrification can be reduced by ensuring connections between implementation and housing authorities, increasing diversity efforts, and strengthening measurement capabilities.

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