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Leveraging Transit-Based Investment to Retrofit Urban Corridors in Houston, Texas

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Leveraging Transit-Based Investment to Retrofit Urban Corridors in Houston, Texas

By

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Report

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Dedication

To my grandmother Pushpalata, my late father Sunil and mother Meenal, and brother Sushrut for their unwavering support and belief in me.

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Finally, I would like to thank my family in India and U.S.A. for keeping me motivated and strong towards fulfilling my goal of obtaining a graduate degree at the University of Texas at Austin.>

Leveraging Transit-Based Investment to Retrofit Urban Corridors in Houston, Texas

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The University of Texas at Austin, 2017

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Public transportation and infrastructure development continue to be a part of the evolving agenda in growing cities. Despite projects in the past and ongoing efforts, public transportation has been only limited success in its assimilation in the lifestyle of Americans. I take the example of Houston, where there are already existing rail lines through downtown and the existing bus service has just been revamped. In addition, planning efforts towards a bus-oriented Transitway through the Post Oak boulevard project seem to be incorporating transit oriented infrastructure.

In this report, I investigate the relationship between transit and development along Houston's Westheimer Road corridor through analysis of the existing conditions and framework. I assimilate the necessary components to create the structure of a successful project. I do so by researching the existing literature and the best practices to understand the framework and nature of Bus Rapid Transit and its financial implications. Building on those lines, I strategize to create a structure of stakeholder involvement through collaboration to achieve a successful corridor project.

In this study, I add on to the ongoing transit oriented development movement in Houston by proposing a Bus Rapid Transit corridor along Westheimer Road. In addition, I propose street infrastructure development to support and enhance the quality of the public realm in the corridor. Through this approach I explore the intersection of urban design and transportation planning, and their significance to a holistic approach. Further, I analyze this proposal for financial feasibility through proforma research and corroborating strategies for implementation. Finally, I make the case that to be successful, transit projects need to involve a critical component of design and finance.

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Chapter 1: Introduction

The City of Houston and its metropolitan area have been a center of mass migration since the beginning of the 20th century. This migration, along with the impact of automobile-centered planning, has had an adverse effect on the urban structure of the city, giving rise to a fragmented middle landscape. This expanded condition has affected the metropolitan structure of Houston by enabling low-density residential and commercial greenfield development around the entire periphery, resulting in the second longest work commute in the South (Houston Business Journal, 2013). According to Allstate Best Driver's Report in 2016, Houston ranks 166th out of 170 cities in terms of driver's safety in the United States. This in turn affects the built environment and creates an unsafe environment for pedestrians and bicyclists. The reduced housing options, and longer commute times spent in automobiles has generated a situation that has resulted in an acute rise in health related problems as well.

The post-World War II outward expansion of Houston's neighborhoods has resulted in a landscape primarily comprised of single-family dwelling units. These communities, planned with separated land uses, require their residents to be dependent on cars for their work-related commutes and other daily activities such as shopping and socializing. This, in turn has generated political and economic pressure to provide critical infrastructure for the city and its local jurisdictions, thereby increasing the cost of living, limiting the housing choices across all demographic groups, and leading to the homogenous nature of the housing stock. These dynamics affect the lifestyle of many in the United States, with a pronounced effect in Houston, affecting residents' health, stress levels, commute times, and productivity of the communities.

BUS RAPID TRANSIT:

Bus Rapid Transit (BRT) is a low-cost bus-based alternative to subway and light rail systems. BRT emulates the performance and amenities of modern rail-based transit, including segregated rights of way, closed stations, and pre-board ticketing. However, it has major advantages over rail-based transit, like substantially lower construction costs, short implementation periods (one to three years after conception), accommodation of many route permutations, and flexibility to adapt to a range of urban conditions. In the last few decades, BRT has become widely used for urban mass transit globally, especially in cities in the developing world. More than 40 cities on six continents have implemented BRT systems, and at least as many systems are either in the planning or construction stages (Global BRTData 2016).

UPTOWN HOUSTON:

The City of Houston and its metropolitan area have begun moving in the direction of having an efficient, affordable, safe and environmentally responsible transportation system for both people and goods (Houston RTP-2025). Moving in that direction, Uptown Houston is a leading economic driver of the City of Houston and the largest business center in the nation outside of a traditional downtown. The greatest challenge facing Uptown is the lack of effective commuter transit service. Houston has an excellent commuter bus service on its comprehensive HOV network which penetrates the heart of the suburban communities in which most Uptown's employees live. This commuter bus system connects into the dense Central Business District. However, it lacks a system to connect the other nodes in Houston like Uptown Houston.

However, Uptown Houston has a plan, the Uptown Dedicated Bus Lanes Project, which is designed to get these employees to and from work using Houston's successful busway system. This busway system is intended to preserve six existing auto traffic lanes and signalized left turn lanes; maintain signal operations; add dedicated bus lanes; remove buses from general traffic lanes; enhance pedestrian access; and preserve the existing oak trees that give character to the street. Uptown Houston proposes to rebuild Post Oak Boulevard into an exquisitely designed "Grand Boulevard" while preserving existing automobile access, substantially improving transit service and creating a beautifully landscaped pedestrian environment.

Figure 1: Dedicated BRT route through Post Oak Blvd. (Uptown BRT)

WESTHEIMER BRT PROPOSAL:

A hot topic of conversation amongst developers and other stakeholders in Houston is currently the substantial shift in its transit planning as seen through the Post Oak BRT project and the reimagined bus routes. The METRO transit agency runs a system currently of three light rail lines primarily serving the downtown, as well as a web of bus lines through the region. According to the Federal Transit Administration the agency's average monthly ridership rose by 3.3 percent in the past 10 months after the overhaul, even as ridership dropped during the same period in most of Houston's peer cities.

METRO board's Chairwoman Carrin Patman said that one of her top priorities is to increase collaboration towards public-private partnerships. In addition, part of the reconstruction of the bus service spaced the bus stops farther apart in some areas, primarily in residential areas outside the city. This allows greater penetration of the bus system into the communities.

Westheimer Road bus service is currently the busiest route in METRO's network of lines. It consists of a daily average of 12,000 passengers through the one and half hours end-to-end journey from downtown Houston to Gessner Road. In addition it has a high mix of uses from multifamily residential to commercial areas and point attractions like the Houston Galleria. It crosses through a variety of neighborhoods and office centers.

However, the current level of service is not sufficient to enhance the bus system along the corridor. Therefore, I propose a full service Bus Rapid Transit system with a dedicated right-of-way along this corridor through this report. The proposal investigates three sites along the corridor and studies the impact of the potential build out of more intense built programs on the adjoining privately-owned parcels. These sites represent sections of the corridor that are unique in their composition. In addition, strategies for alternate transit are also proposed in the report to enhance travel mode choice.

The proposed Westheimer Road BRT system is coupled with street infrastructure improvements along the corridor creating attractive places. In addition, distribution of uses along the route maintains diversity and distributes ridership even during the non-peak hours, by creating a number of origins and destinations. To supplement, a financial feasibility proforma analysis of the proposed build out is also calculated. Through this proforma the appraised value of the developed properties will contribute repayment of the capital investment for the upfront costs. In addition, strategic implementation of the proposal is also carried out through the report along with a plan for public-private partnership. Hence, this proposal approaches the issue of transit planning through a holistic lens in order to make it feasible and successful.

METHOD:

This design-based research will focus on the development of a proposal for implementing lifestyle changes by proposing the retrofitting and stitching together of a representative urban corridor and by proposing improvements to the infrastructure of the public realm that capitalize on the missed opportunity of location. It intends to investigate the role of public transportation, specifically Bus Rapid Transit (BRT), which has been strategized with investors through a Public-Private Partnerships (PPP) model in order to create a better public realm in Houston. It will explore the influence of government-led initiatives that collaborate with private enterprises like developers, real estate companies, and universities, to develop inclusive environments for transit, walking and biking. In addition, this proposition will be tested out through urban design interventions in different transect zones that have been chosen to demonstrate potential growth models in critical nodes along the corridor. The research will also consider alternate modes of transit like walking and biking in order to catalyze healthier lifestyle choices. Furthermore, the research will form a cohesive strategy from a financial feasibility standpoint in order to establish the project's viability for development.

Chapter 2: Literature Review

In this section, the report assesses BRT systems from various perspectives from their necessary preconditions to the impact. It analyzes the factors that are critical for decision-making and for implementation of the BRT. The review shows that the land-use and value impacts are sensitive to the access to the BRT stations and physical environments around them. The study also delineates the importance of land use regulation and zoning in the implementation of BRT systems. In addition, it illustrates the significance of understanding the market demand and direction of growth and shaping policies in the service of a comprehensive strategy. The analysis points towards the impacts BRT systems have on the existing community through a desired increase in land-value, albeit with possible displacement impacts on existing residents and businesses. The investigation also elucidates mechanisms to preserve the existing community through financing and policy interventions.

LAND VALUE:

The land-rent theory has been a core to understanding the relationship between accessibility and land values. Therefore, access to a BRT station is expected to provide advantages to certain parcels over others (Rodriguez &Targa, 2004). However, the degree to which accessibility benefits of transportation investments will be capitalized in land values will depend on the sensitivity of users to the access improvements and on the types of prices by use (residential, commercial, office etc.) that are being investigated (Rodriguez & Mojica, 2009). This implies that the land value increase to be studied will depend upon rent prices and sales prices of the communities affected by the BRT system. In addition, it will also depend on the accessibility to the BRT station from the various uses like biking, walking, or taking other means of transportation to get to the station. There is evidence that creating pedestrian-friendly environments near BRT bus stops can further increase land-value benefits (Estupinan and Rodriguez, 2008).

This evidence suggests that for the proposed BRT route in Houston it is imperative that the transit stops should be accessible in order to capitalize on the high land values. In addition, it suggests that the alternate modes of transportation working in tandem with the BRT route also play a key role. All these factors, in addition to creating a walkable environment, will contribute to getting higher return-on-investment making the Westheimer BRT project a success.

CATCHMENT AREA:

Catchment area is defined as the area of influence of the BRT in which it is accessible through walking and biking. Deng and Nelson (2010), Cervero and Kang (2011) reference that high-quality public transport systems can greatly improve the accessibility of its catchment area by shortening travel time. Therefore, the impacts of transport improvements on land development are likely to include both property value increases and accelerated development of land use (Deng & Nelson, 2010). Cervero and Kang (2011) refer to both land price and use changes that are expected to occur in spite of different times of a BRT's life. This implies that the BRT life cycle will have a significant impact on the land value in the catchment area during the phases of construction which will significant drop in the price, and a gradual increase as the service begins. Bocarejo et al. (2013) hypothesize that the real estate market response will reflect relatively higher willingness to pay for access by office and commercial tenants as compared to residential ones. The catchment area of the proposed Westheimer BRT as well will have be affected with the cycle of price variation during the various phases of construction. This would affect some of the decisions and the financial modelling which are critical in determining the success of the project.

NUISANCE:

One of the themes that appear in some but not all of the studies is the potentially confounding effect of the various negative effects, or nuisances associated with BRT corridors —primarily noise and pollution. In general, while evidence of nuisance effects is inconclusive (Parsons Brinckerhoff, 2001), studies that do not separate nuisance effects from price increases potentially underestimate the latter (Wardrip, 2011). Some studies even show a property value-dampening effect of transit presence in lower-income neighborhoods (Hess & Almeida, 2007). The study by Rodriguez and Mojica (2009) hypothesize that the effects related to proximity to the right-of-way are negatively capitalized into land values. In contrast, according to Cervero and Kang (2011) the higher-end residential property conversions in Seoul were less likely to occur within the immediate vicinity of a BRT stop. These contrasting opinions of the impact of the BRT systems on property values may be related to the geography of the case studies – Latin America and Seoul. In addition, it may also vary on the pressure of development on the city in the study and the factors affecting the dependence on public transit as compared to other modes for transportation.

GROWTH IMPACT:

Bus-based systems are thought to have weaker city-shaping effects partly because they confer fewer regional accessibility benefits relative to faster, more geographically extensive rail operations (Vuchic, 2007). Los Angeles, land value impacts were very small and accrued only for commercial parcels (Cervero, 2006). In addition, a study by Ma et al. (2013) in Beijing similarly found no appreciable capitalization benefits on residential properties by the city's BRT system, whereas property adjacent to the city's rail stations had an average premium of five percent. In contrast, studies of the more substantial BRT system in Bogota have found appreciable land-value benefits (Rodriguez and Targa, 2004; Rodriguez and Mojica, 2008).

PUBLIC-PRIVATE PARTNERSHIPS:

Another important theme in the development of BRT systems is that of public-private partnerships. These partnerships can take place through value capture (such as Tax Increment Financing) mechanisms for capital costs or for operation and maintenance of the transit system. However, according to Cervero (2013), the absence of a fixed guideway or high-profile infrastructure is thought to dilute bus-transit's development potential in the minds of real-estate developers, who never can be sure of service of future transportation. This ties back into the return-on-investment (ROI) models which developers use to project the development's financial performance and the level of risk associated with it. Therefore, in order to have a better perception in the developers' and investors' perspective on Westheimer Road, dedicated right-of-way for the BRT system will be significant to their decision. There are certain benefits associated with partnerships for developers such as reduced parking requirements or expanded buildings (increased FAR) to promote it (DeCorla, 2005). However, in a car-oriented city like Houston these may be less likely, but provision of shared and off-site parking spaces would be feasible and agreeable to the communities. In addition, PPP models for operation and maintenance of BRT systems are in place through using smart cards, managing schedules and optimizing the routes.

CAPTIVITY:

Another theme that emerges in some of the reviewed studies is that of BRT captivity - the availability of transportation alternatives (Beimborn, Greenwald, & Jin, 2003). Captive users are more likely to live close to bus stops; among choice transit users, differences in travel times between automobiles and BRT, for instance, are not as important as walk access (Beimborn, Greenwald, & Jin, 2003). The extent of transit captivity in a given corridor will presumably also affect the real estate market dynamics and the types of land-use changes that take place when the BRT systems are put in place (Stokenberga A., 2014). Bocarejo et al. (2013) suggest that the system has significantly improved transit coverage in peripheral areas which is inhabited by low-income, 'transit-captive' segments of Bogota's population. The evidence to transit captivity suggests that better place-making yields in increased ridership and user experiences. In addition, integration of the system with the built environment to improve the user experience will also result positively.

POLICY IMPACT:

Another important difference across the reviewed studies is the extent to which they consider the role of supportive land-use and transport policies in bringing about land-use changes along BRT corridors. It has been argued that complementary local policies which support high-density and mixed developments increase the extent to which BRT systems can in fact facilitate transit-oriented development (TOD) and increase property values (Wirasinghe et al., 2013). Cervero and Landis (1995), too, have suggested that it is in combination with policies such as supportive zoning and government-assisted land assembly that transportation investments shape urban patterns. FTA (2009) reviewed the policies in support of TOD near BRT in a number of US cities, concluding that policies and the local political climate may be more important factors than the systems' physical permanence. According to the study, California appears to be the front-runner on legislation and policies that support BRT, with no noticeable differences between the incentives offered for BRT and LRT. In addition, Deng and Nelson (2010) claim that the BRT's potential to stimulate land development will depend on government collaboration to facilitate improvement of the integration of BRT and land development. Rodriguez and Mojica (2009) explained the policy relevance of their study by suggesting that the capitalization of BRT expansion in the prices of properties already served by the system will determine the viability and extent of using value capture techniques to recoup some of the price increases. Bocarejo et al. (2013) analyze in Bogota the most critical of the lack of supportive policies in the implementation of the BRT system. In contrast, in Curitiba, the government instituted strong land-use controls and was thereby able to effectively guide growth to encourage development patterns along arterial corridors that reinforce and encourage use of the bus system (Miller & Buckley, 2000).

ZONING AND REGULATIONS:

Levine (2006), has emphasized the limited power of zoning and other regulations, arguing that while requirements for dense development can accommodate market forces that are present, they cannot force a product the market is not willing to provide. Bocarejo et al. (2013) explicitly discuss the role of institutional regulations versus market power in inducing the changes observed along BRT corridors. According to the study, administrative acts reveal that most of the significant changes introduced to regulations in Bogota´ were proposed and supported by the private sector. This implies that zoning regulations should be in tandem with the planning out of the BRT corridor, while also should take into consideration the market forces and demand. In turn, it will lead to a more comprehensive strategy which backed by regulation and the direction of development. However, in the case of Houston, the city lacks a zoning ordinance. Therefore, the creation of a Transportation Reinvestment Zone (TRZ) in collaboration with neighborhood plans would be necessary on Westheimer Road. This will ensure that there is coordination at different levels of planning and assure the success of the BRT corridor.

DISPLACEMENT:

The potential displacement effects of BRT systems are also acknowledged in only a few of the reviewed studies. Hidalgo and Graftieaux (2008) consider displacement in the immediate sense, advocating the use of existing right-of-way to reduce land acquisition and involuntary displacement. Cervero and Kang (2011), on the other hand, consider the possibility of lower-income households being displaced as a result of the very land price increases that are often portrayed as a benefit of BRT investments. The authors suggest redressing such inequities through the use of the revenues recaptured from benefitting property-owners to underwrite the costs of affordable housing for the displaced residents. An addition to the suggestion mentioned above could be that the redevelopment take place in situ, adding more density to the corridor and potentially increasing ridership while rehabilitating the displaced residents, especially along Westheimer Road owing to its existing density.

MERITS AND DRAWBACKS:

As the literature suggests Bus Rapid Transit has a number of characteristics and details (goals and objectives) that have significant impacts. The effects on property values are the most significant indicators towards understanding them. Carrigan et al. (2013) suggest the cost and benefits of implementing BRT systems can be broadly categorized into four criteria: travel time savings, reduction in vehicle operating costs, efficient capital and urban infrastructure and transportation reform. BRT can significantly reduce the travel time compared to that of the regular bus or driving an automobile, especially at peak time. In addition, it is a more efficient way of transportation. According to the Carrigan et al. (2013) study, using Ahmedabad's example, 150 people are moved in one BRT lane in each direction taking up to 84 sq. m. compared to mixed traffic that only moves 45 people, using 3 lanes, or 486 sq. m. (Swamy, 2013). This demonstrates efficiency of using the right-of-way for movement of greater number of people using a BRT system, especially during peak hours of traffic along Westheimer Road.

Another important benefit of BRT systems is the significant reduction of vehicle emissions contributing to Green House Gases (GHG). BRT reduces the overall amount of Vehicle Miles Traveled in a city by carrying more commuters, thus reducing congestion (WRI, 2013). The incorporation of modern fuel efficiency technologies into BRT buses and better driver training can also contribute to lower fuel consumption and emissions.

Implementing BRT systems contributes to reduction in traffic crashes and fatalities. The dedicated bus lanes reduce the interaction between buses and other vehicles, minimizing the risk for traffic crashes. In addition, BRT can change bus drivers' behavior by reducing on-the-road competition with other vehicles and providing opportunities to improve driver training. According to WRI (2013), the case in Latin America showed the safety benefits: streets with BRT systems saw an average 40 percent reduction in fatalities and injuries. However, if there are design failures it can lead to dire situations like pedestrian injuries or even death as in the case of Rio de Janeiro where there were four accidents and five collisions in the first three months of operation (Rio Times, 2012).

Another important merit for the BRT is the increase of physical activity for passengers like longer walking distances compared to their use of private vehicles and other motorized modes of transport. According to WRI (2012), Mexico City's Metro-bus passengers walk an average of 2.75 minutes more per day than before the city implemented the BRT system. This will benefit the passengers in maintaining better health and in the long term reduce the health costs.

BRT creates a dilemma through the impact it causes on the implemented neighborhoods. On the one hand it creates situations which increase property values around an accessible radius, while on the other displacing the existing community due to failure to keep up with the rising prices. Thus, it raises question that still largely remains to be answered concerns the actual user groups that have benefited the most (Stokenberga, A., 2014). In addition, it is critical to serve areas of low-income households and disadvantaged communities. If this is not adhered to, it will cause unintended consequences to the system like reduced ridership leading to loss of revenue, reduction in federal funding and subsidies, and lack of local support for future transportation projects.

Chapter 3: Research Context

In this section, the report assesses the current context in Houston and presents an analysis on the region. It investigates the various perspectives and factors that are critical for decision-making and for implementation of a BRT corridor in Houston along Westheimer Road.

HOUSTON:

Demographics:

The City of Houston has undergone rapid growth in the recent past, resulting in its current population of 2.196 million (US Census). The projections for its population through 2040 suggest that it will cross 3 million over that period (Fig.2). This suggest that there will be a demand for additional services for housing, transportation, infrastructure etc. over the coming decades. In addition to the population projections, the median age is 32.6 years, four years lower than the national average and the median household income is $ 61,465 as of 2017, about $ 5,000 more than the national average (US Census). Thus, on an average, Houston has a young-ish and higher income population compared to the rest of the US.

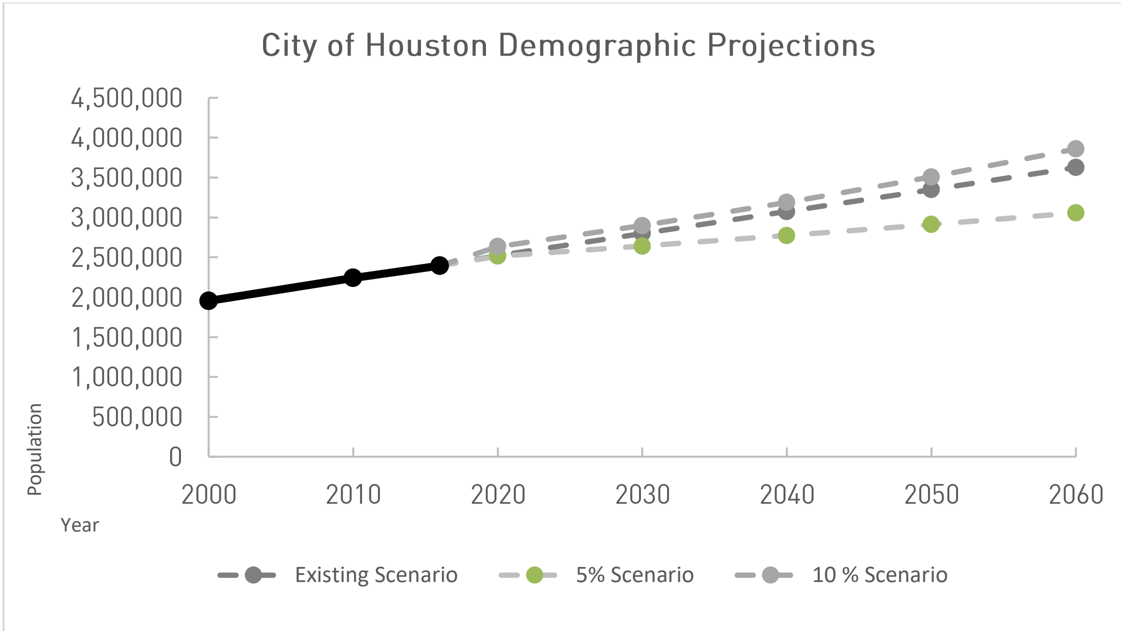

Figure 2: Projected demographic for the City of Houston (US Census)

Travel Mode Share:

The City of Houston have a high percentage of single – occupancy vehicle commuters (HGAC Travel Survey) (Fig.3). However, owing to METRO's active efforts to increase the ridership, there is a high percentage of daily commuters that use the park and ride option. As seen in the figure, about 25.8 percent of the commuters that commute mostly into downtown use do so by the park and ride. In addition, as the distance increases within the range of 20-50 miles, there is a high percentage of park and ride commuters. Westheimer Road, which is the corridor of interest, is about 20 miles in length and has a significant percentage of commuters that use the park and ride facility accessed by its current bus service.

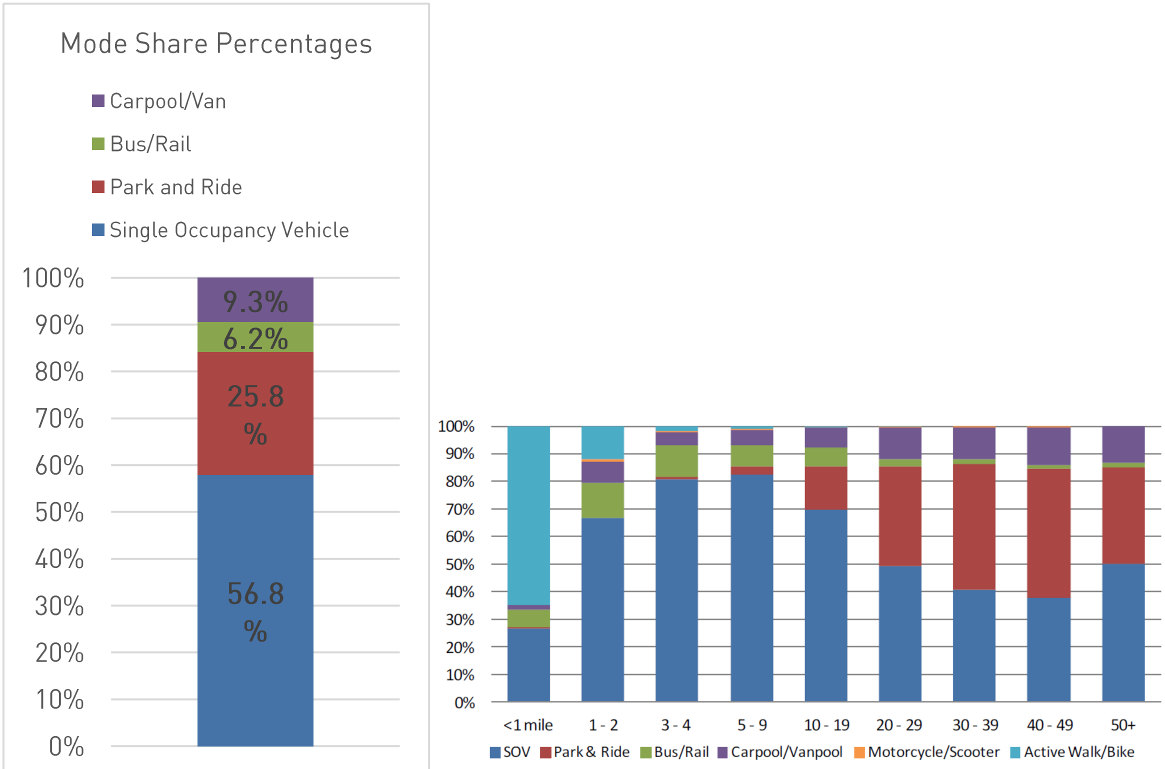

Figure 3: Mode share percentage and change in share by distance (HGAC Survey)

Housing Stock:

The City of Houston's current housing stock is quite diverse in comparison to the national average. The majority of the housing is single-family detached, making up 61 percent of the housing stock, or 1.1 million units, compared to the national average of 64 percent (US Census). However, multi-family units in buildings of 5 or more units amount to about 619,000, making up the second largest share of the housing at about 26 percent. In comparison to the national average, which is about 18 percent for multifamily housing units, it is a significant percentage of the housing stock in the City of Houston (US Census).

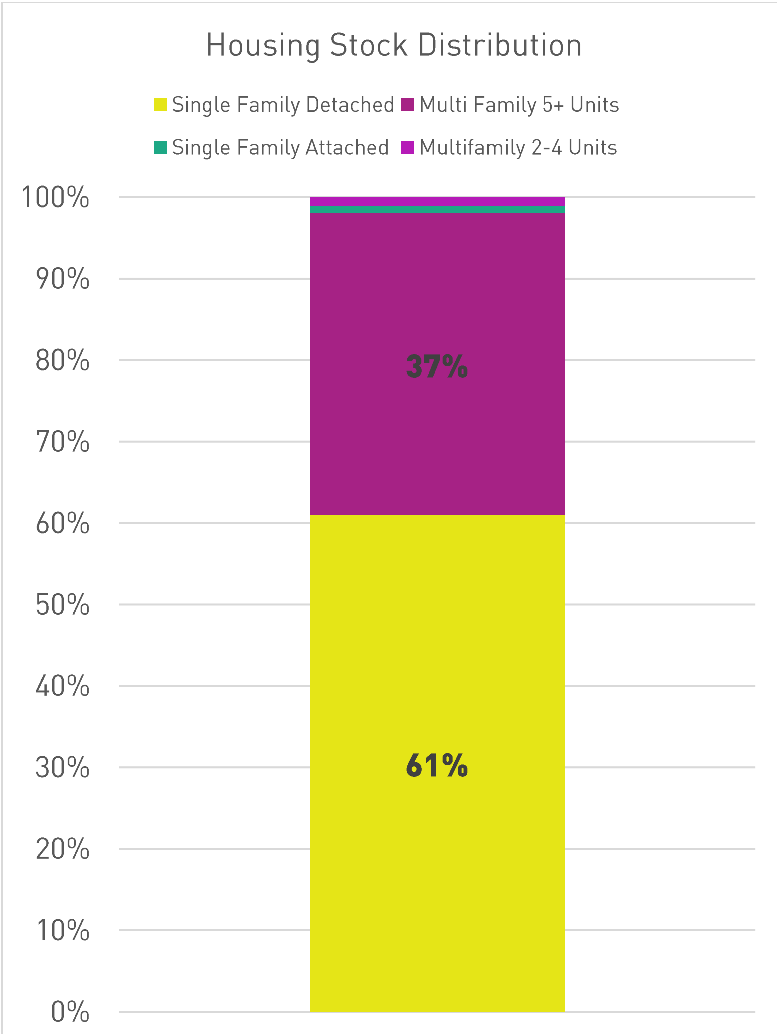

Figure 4: Housing stock has a significant percentage of multifamily 5+ units

As Cervero and Guerra in 2011 analyzed through their working paper on housing densities and transit, the associations of denser housing types to transit ridership is significant. In the context of the City of Houston, higher than national percentage share of the 'Multifamily 5+' housing types bode well for future transit interventions. The research also analyzes and suggests densities for successful BRT and Light Rail are around 30 units per acre while that for heavy rail is about 50 units per acre.

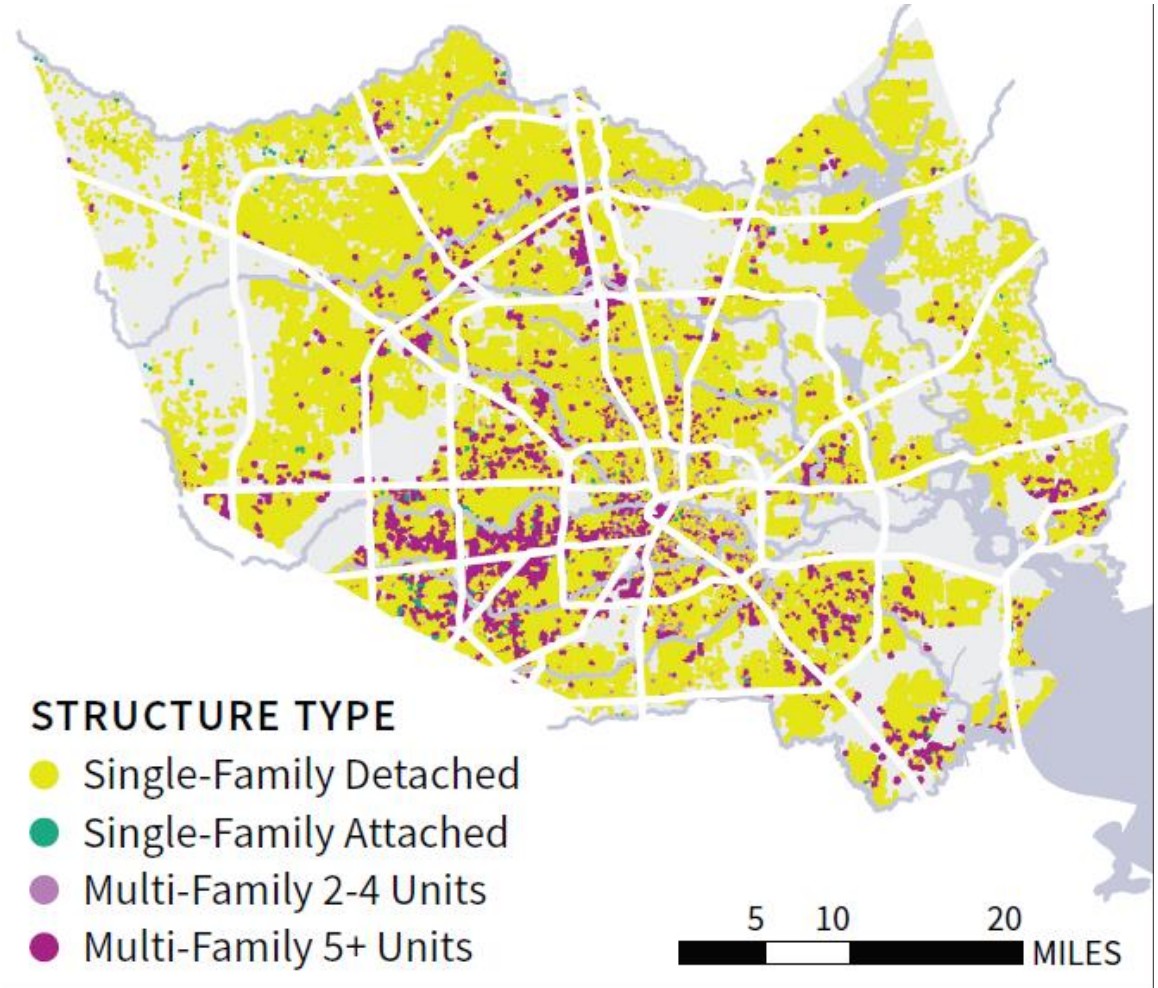

Figure 5: Distribution of housing types across Houston (Rice Institute for Urban Research)

A significant percentage of the higher density housing stock is present in the western part of the City of Houston (Fig. 4). The neighborhoods that have a higher concentration of the 5+ multifamily housing units include Montrose, River Oaks, the Galleria, Briar Grove Park, West Chase and the Energy Corridor area. A significant number of these neighborhoods abut Westheimer Road, which is the corridor of interest to this proposal.

WESTHEIMER ROAD:

Westheimer Road is an east-west arterial in the City of Houston. It runs from Bagby Street in downtown Houston in the east and terminates in Westpark Tollway on the southern edge of George Bush Park. The overall length of the corridor is about 19 miles, extending from the Central Business District in the east to George Bush Park to the west. My area of research is the first 12.6 miles out of downtown Houston, given the existing context that has pre-existing conditions for the BRT corridor.

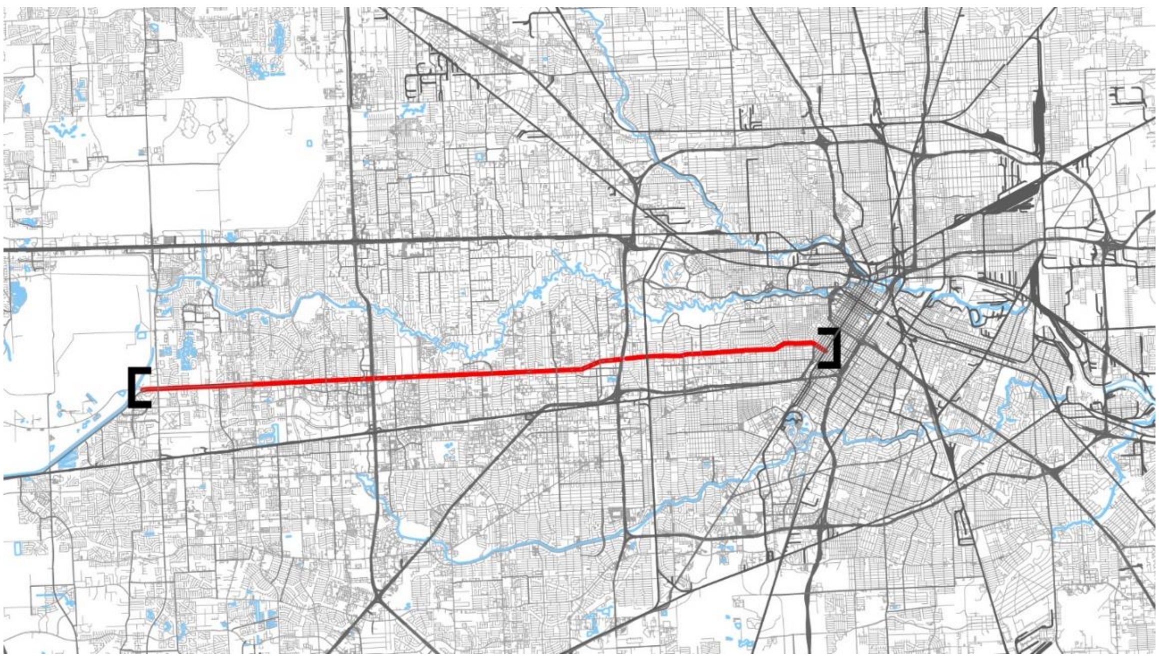

Figure 6: Westheimer Road highlighted extending from the CBD in the east to Westpark Tollway in the west.

Characteristics:

John Nova Lomax of the Houston Press in 2006 article said that Westheimer Road, "more than any other thoroughfare, embodies Houston's car-enamored, zoning-free ethos, a damn-near 20 mile phantasmagoria of strip malls, storage facilities, restaurants, big-box retail, office parks, apartment complexes, supermarkets and the occasional church."

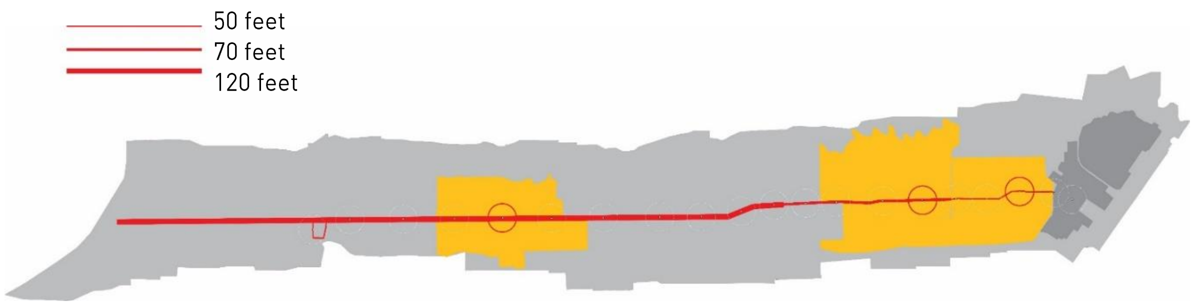

Figure 7: Westheimer Road with varying right-of-way from 50 feet to 120 feet.

The region of the corridor of interest is 12.6 miles which varies in the right-of-way width. Towards the downtown in the east of the corridor, the width is 50 feet which mainly runs through the Montrose neighborhood. As the corridor progresses westward, the right-of-way increases from 50 feet to 70 feet at the intersection of Westheimer Road and Shepherd Drive. Further west, the corridor grows to a width of 120 feet in right-of-way where there are currently 6 lanes with a turning lane for the most part of the road.

POST-OAK BOULEVARD BRT PROPOSAL:

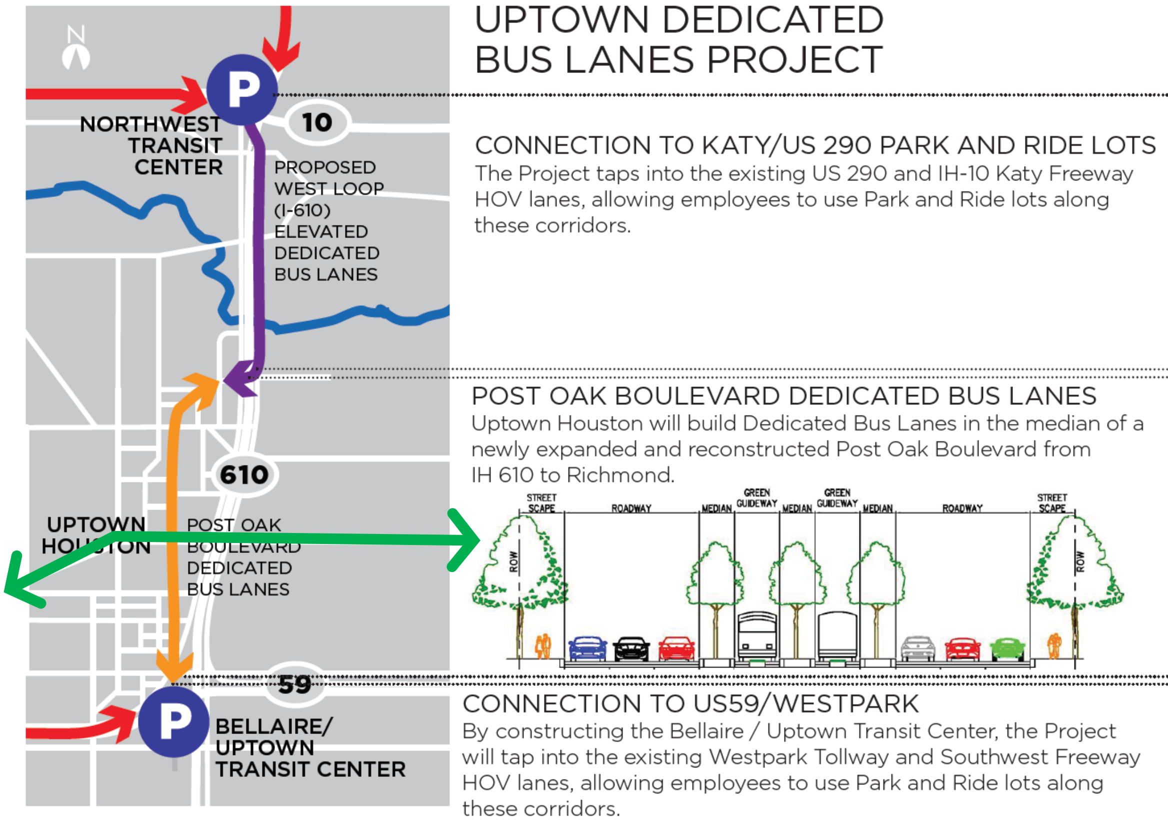

Figure 8: Proposed BRT along Post Oak Boulevard with Westheimer shown in green (Uptown Houston)

The Uptown Development Authority's (UDA) Post Oak Boulevard project, with an estimated cost of $192.5 Million, calls for a dedicated bus lane for a bus rapid transit system with a median. The planned bus lanes will run from Loop 610 at Richmond, connecting on the north side to the Northwest Transit Center at 290 and I-10, and, on the south end, to a yet-to-be-constructed Bellaire Uptown Transit Center at Westpark Tollway and Southwest Freeway. Suburban commuters will be able to use the Park and Ride lots along those corridors. Eight stops are planned for the bus line, which the Metropolitan Transit Authority will operate and for which it will provide special, three-door vehicles (Houstonia Magazine, 2017).

The Texas Department of Transportation project will allow the buses to travel along Loop 610 with a dedicated lane segment from Post Oak to the Northwest Transit Center. In addition to the dedicated bus lanes, the UDA project aims to widen Post Oak Boulevard's sidewalks to up to 12 feet, plant approximately 800 live oak trees along the boulevard, and increase pedestrian lighting along the walkways.

Chapter 4: Case Studies

In this section, the report assesses the impact of BRT systems that currently function with similar characteristics to that of Westheimer Road. The study emphasizes the perceived impacts on the surrounding real estate and development. Three case studies representing distinct BRT lines across North America provide an assessment of the impacts of implementation of BRT lines over a period of time. BRT systems are used as a catalyst in most systems to spur additional development and promote denser, more walkable environments.

OTTAWA, CANADA – BRT TO DOWNTOWN:

Ottawa's Transitway consists of nine separate BRT lines servicing different parts of the Ottawa metropolitan area. In total, the Transitway has 32 miles of roadway, of which 30 miles are dedicated for BRT use. The Transitway has a long operational history, having been built in stages from 1978 through 1996, with the first line opening in 1983. It includes an 18.6 mile long dedicated bus road leading to the central business district. Upon arrival in the central business district, the Transitway segues to exclusive bus lanes on city streets. By design, the Transitway was constructed on rail rights-of-way, and was planned as a lower-investment incremental plan that starts as BRT with the possibility of future conversion to rail should ridership warrant. This is critical to note, especially in the context of Houston where there is an already existing rail system in Downtown to which the Westheimer Road BRT can be linked. Ottawa's Transitway was also designed to allow the flexible incorporation of existing city streets as needed, in order to extend its reach.

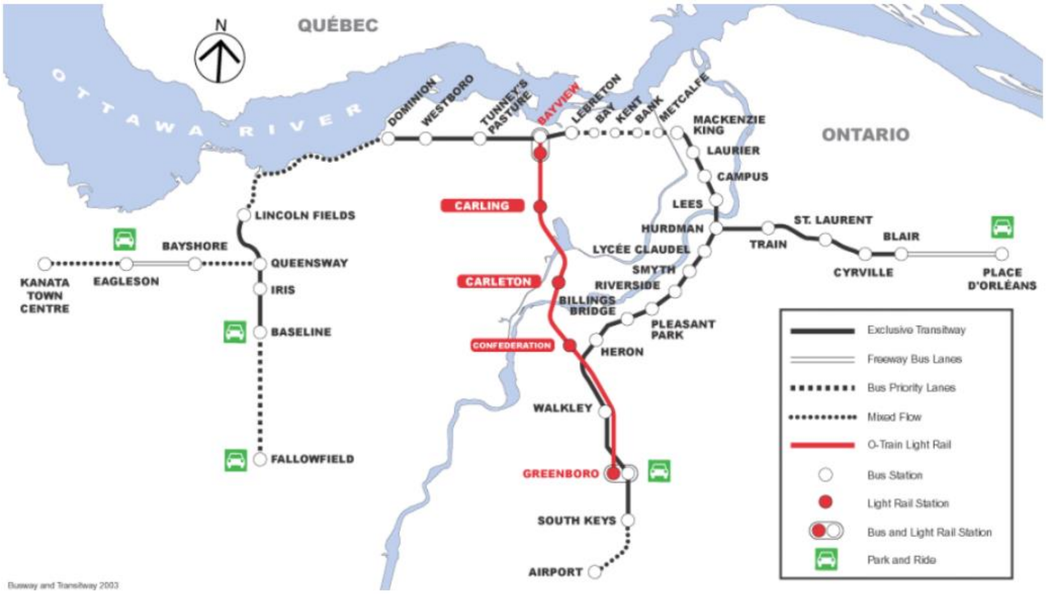

Figure 9 Ottawa Transitway Route (Colfax Economic Development Impacts)

The main goal of the Transitway was to ease congestion along key routes from suburban communities into downtown Ottawa. It has largely succeeded and is currently capturing 75 percent of all bus passenger trips. It has achieved what this professional report envisions for Westheimer Road. The early planning and rollout of the Transitway also developed with an eye towards future growth and development of communities served by its stations. Ottawa has experienced a significant level of development activity around its busway stations. Commuter-friendly features have been implemented, such as using proof-of-payment fare collection to speed boarding. Feeder buses operate on a timed transfer system, and with only one quarter of riders paying cash, transfers are reasonably quick (Uptown Houston Report).

Impact on Surrounding Development:

- The total cost of the project was $435 M, at about $22 M/mile. Out of this $278 M was invested in the street infrastructure to put in the dedicated right-of-way, and sidewalk improvements.

- The ridership increased at about 6% per year since the beginning of the project and is currently at 10,300 per day.
- The project has increased the overall jobs by 8,700 and increased housing by more than 3,500 units along the route with an estimated overall investment of $1 billion.

CLEVELAND, OHIO – THE HEALTHLINE:

Figure 10 The Healthline route from downtown Cleveland to University Circle (RTA Healthline)

The HealthLine, formerly known as the Euclid Corridor Transportation Project, is a BRT line that runs along Euclid Avenue, the main downtown thoroughfare, from Public Square in downtown Cleveland to University Circle and East Cleveland. Opened in October 2008, HealthLine is 9 miles long, of which 4.5 miles are exclusive bus lanes, with 59 stations. The HealthLine BRT development also included complete streetscape renovations along Euclid Avenue. HealthLine connects the city's cultural and education institutions and medical and business centers to the regional rail transit and bus network. It has enabled passengers to travel between downtown Cleveland and University Circle, the city's major employment centers, in 20 minutes (ITDP, 2012).

The HealthLine was promoted as a way to revitalize this blighted downtown corridor. Euclid corridor had experienced significant investment even before the BRT line was fully operational. While the new investment is not all due to the BRT project (a host of financing incentives was available to developers), it is supporting intensification by providing a much-needed connection among disparate areas along the corridor. The streetscape renovation has also helped create a more attractive environment and is supporting efforts to turn Euclid Avenue into a lively, pedestrian and transit corridor. This factor is critical to the proposed Westheimer Road BRT project due to the permanence of the route as well as the placemaking it brings with it.

Figure 11: Summary of economic benefits resulting from the Euclid Av. streetscape and The Healthline BRT Project (RTA Healthline)

Impact on Surrounding Development:

- The total investment of $200 M in the streetscape for 9 miles of BRT resulted in a connection between disparate communities along the corridor.
- This investment attracted $ 5.5 billion in new investments along the corridor of which $2.8 B were in new construction alone and $2.7 B were in rehabilitation of the existing sites.
- The HealthLine has resulted in average travel time savings of 12 minutes and increased bus ridership along the corridor by 60 percent, to 14,400 passengers per weekday.
    - By 2025, 7.9 million SF in commercial development, over 5,400 new or renovated residential units, and 13,000 new jobs are anticipated in this corridor in part as a result of HealthLine (Uptown Houston Report).

KANSAS CITY, MISSOURI – MAX BRT:

In July 2005, the Metro Area Express (MAX) BRT system was introduced in Kansas City, Missouri, by the Kansas City Area Transportation Authority (KCATA). The MAX system is a six-mile line that runs north and south between two major park-and-ride lots. The MAX links dense, important areas in downtown Kansas City to one another, and is part of a 12-year comprehensive collaborative plan for transit in the Kansas City metropolitan area called Smart Moves. The Smart Moves plan sets out a metro-wide transit expansion that would involve additional BRT, commuter rail, local buses, trolleys, and express freeway buses.

The plan is based on five specific measures to improve pedestrian level of service: directness, continuity, street crossings, visual interest, and amenity and security. Out of these five measures in mind, three were tailored for use in station access planning, directness, continuity, and street crossings. Directness is how well the key destinations are connected to the transit facilities via pedestrian network. It is based on a ratio of actual distance and minimum distance between two points. Continuity is the measurement of the completeness of the pedestrian network with avoidance of gaps and barriers. The measure considers not only accessibility for physically disabled individuals, but also the condition of the pedestrian pathways and whether there are barriers in the pathway. Street crossings is the measurement that predicts how easy and safe it will be for a pedestrian to cross various types of streets with various designs to reach a transit facility based on the pedestrian level of service. The pedestrian level of service is dependent on the type of crossing, the number of lanes to cross, lane widths, parking lanes, travel speed and the presence or lack of attributes listed (ITDP BRT Guide).

Figure 12: Interactive design of infrastructure creates better spaces for users at bus-stops (Kansas City Area Transportation Authority)

The MAX was planned with a budget of $21 million, with $17 million from federal funding (New Starts and other programs), and $4 million from local funding. Kansas City contributes $48 million annually to the operation and maintenance costs associated with the transit system, because two local, dedicated transit taxes are the primary source of funds for the transit system; a ½-cent sales tax was initiated in the early 1970s, and an additional 3/8-cent sales tax was implemented in 2004. The 3/8- cent tax, which expired in March 2009, provided almost half of the $48 million. The KCATA recognizes that losing the 3/8-cent tax will have a negative impact on the transit agency's general progress and policymakers are currently scrambling to find alternative funds (CPW Report – Univ. of Oregon, 2009). This is critical to note as keeping the BRT system afloat through taxes generated through sales will have a different impact than those generated through property taxes. In the case of the Westheimer Road BRT, the upfront capital invested in the infrastructure and development is paid for by the developer but the operations and maintenance will rely on similar taxes generated through sales taxes levied region wide. Therefore it is imperative to have a diverse source of uses along the corridor to generate alternate streams of revenue for the system.

LESSONS LEARNED:

The case studies above illustrate different approaches to the development of BRT, based on the context, priorities and goals. They also illustrate that BRT is fundamentally incremental, meaning that it is a bundle of characteristics subject to implementation in many combinations, with additional variations possible. However, some of the important best practices for design and strategy considerations can be summarized as follows:

- *Permanence of BRT service* (exclusive busway, streetscape improvements, station quality). The permanence of the service also assures investors and developers in the regions of their return on investment in the longer term creating a more permanent infrastructure for communities.
- *Streetscape improvements that accompany the BRT* (particularly important for corridor revitalization). The streetscape improvements are critical in providing more pedestrian traffic along the street frontages. This traffic is critical for providing sources of revenue for commercial and retail along the frontages.

- *Aesthetically appealing and visually prominent profile, particularly in station design*. The appearance of the station areas and their design is a vital factor in attracting more ridership and building a positive image of transit. In addition, the design of the station is important in making the station a better user experience and provide additional comfort while using transit.
- *The corridors must be amenable to high-density development*. The development density is vital in supporting the ridership for the BRT systems. Higher density corridor also generate additional tax dollars that help in paying for the BRT system implementation, operations and maintenance. The density also provides for access to additional options and choices for riders along the corridor, reducing the need and number for overall trips.
- *Diversity of uses*. The uses along the corridor support the system through generating property and sales tax. In addition, the uses create destinations and origins resulting in ridership for the BRT. This adds to the non-peak hour trips and maintains a demand for transit throughout the day.

Chapter 5: Westheimer Road – An Illustration

In this section of the report, a development scenario will be tested through Westheimer Road at three different sites. Before the build-out is tested through the corridor, key strategies are laid out for the overall development of the project. These strategies are intended to be long-term throughout the life-cycle of the project.

KEY STRATEGIES:

I. Public – Private Partnerships:

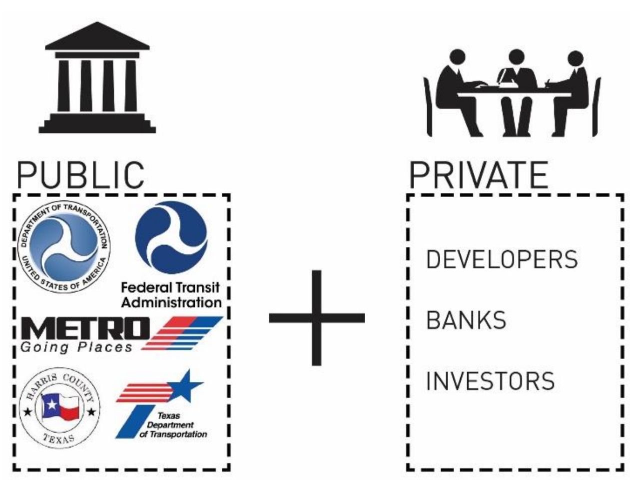

Figure 13: Public-private partnerships are critical to large-scale projects like the BRT.

Public-private partnerships (PPP) offer several benefits, especially for long-term infrastructure projects:

- Better infrastructure solutions: The collaborative nature of PPPs offers a better outcome by assigning each participant a particular role in which they excel.
- Faster project completions: PPPs usually reduce performance delays on infrastructure projects by including time-to-completion as a measure of performance. In the proposed route through Westheimer Road, this aspect will play an important role given the prominent real estate along it. As the research suggests, the delays in construction can

have a significant effect on the project cycle and can affect the existing business along the corridor. Hence, in order to avoid such measures, time-to-completion should be monitored and followed as set out.

- Return on Investment: A PPP's return on investment may be greater than a traditional private or government method given that innovative design and financing approaches become available through collaboration. For the BRT project on Westheimer Rd., having private investment along the corridor will generate tax dollars critical in maintaining and re-investing.
- Shared Risks: Risks are fully appraised at the beginning of the project, and can be shared depending on the project layout. Using that strategy for Westheimer Road BRT, it also allows the government investment to be redirected to other socio-economic projects.

II. Activity Oriented Design:

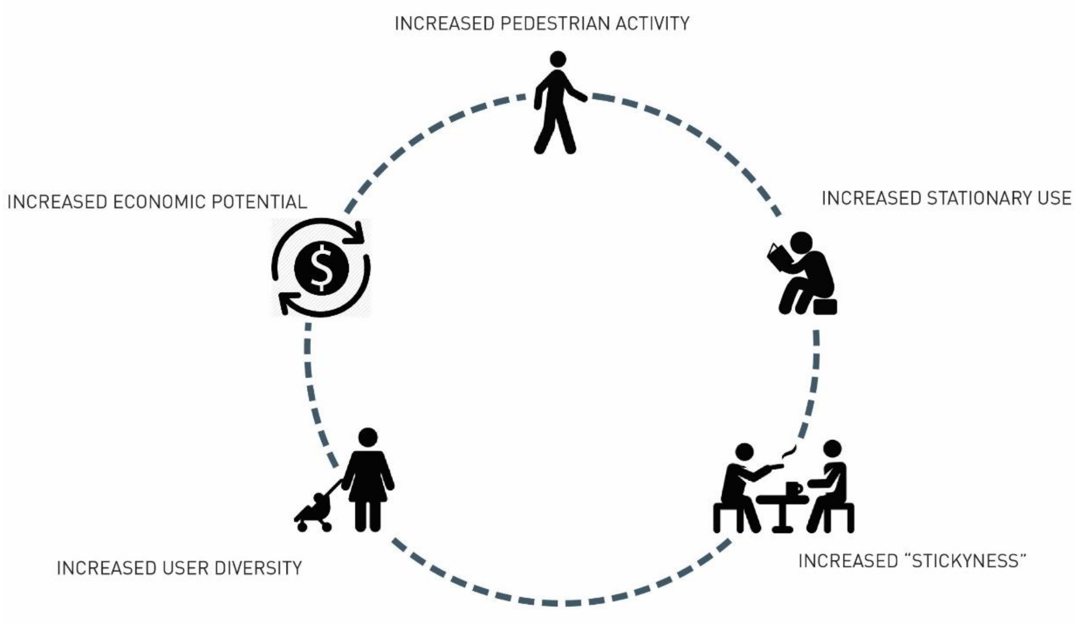

Figure 14: Activity Oriented Design illustration

Using activity oriented design instead of traditional use based design has many advantages in achieving a better lifestyle for the users. Traditional use based urban design deals with place-making strategies with an activated street-level creating vibrant, attractive and walkable places. The main idea of activity oriented design is to have a higher retention of users for public spaces by making them walkable and comfortable for use. This phenomenon is achieved by having conducive design conditions at the street-level to have increased pedestrian activity. In turn, this pedestrian activity invites the users to have a higher stationary use at the street level causing increased 'stickyness.' This significantly affects the user diversity by creating choices for different users. Eventually, this leads to increased economic activity for commercial and retail at the street level leading to tax generation for paying back into the investment. This strategy should be critical in creating walkable places throughout the Westheimer Road BRT corridor.

III. Corridor Planning:

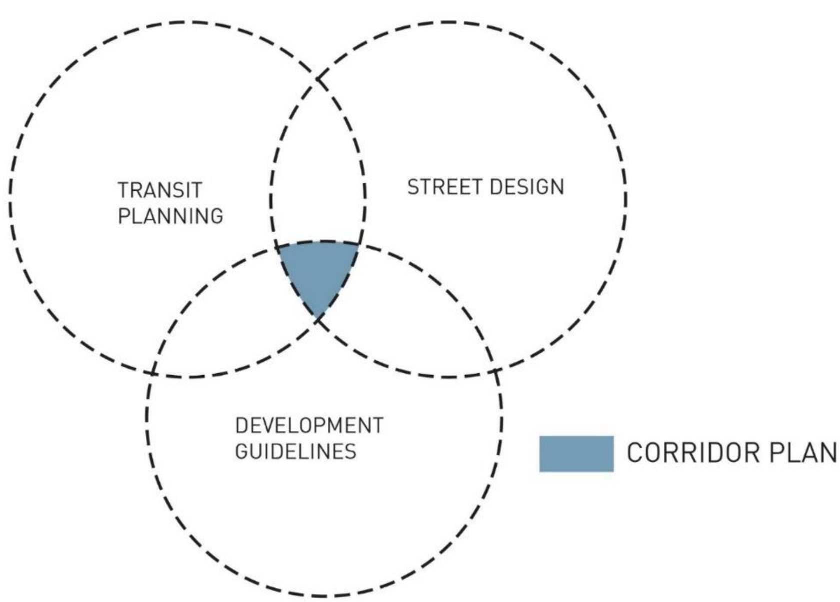

Figure 15: Integrated framework for corridor planning

Integrated processes for corridor planning significantly affect the outcome of the product. As assessed through the case studies, a cohesive approach towards corridor development by combining transit planning, street design and development guidelines for the form will help create a successful project. Creating a transit plan with nodes and right of way design through a street design will create an integrated network for accessibility. In addition, development guidelines for form-based coding with regulating street frontages, edges and built-to requirements will create an integrated built environment. An integrated framework towards a better built environment will yield better return on investment over a period of time and create a walkable environment.

GUIDING PRINCIPLES:

In addition to the key strategies, guiding principles for design are critical in creating a holistic approach to the project.

I. Series of Experiences:

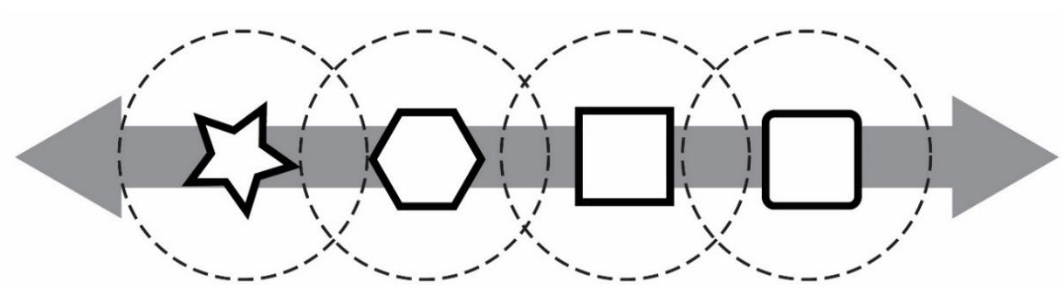

Figure 16: Series of Experiences create cater to a larger demographic resulting in lively places

In order to have a successful activity oriented design, creating a series of experiences for users is vital. Having a variety of uses that go along with the built form and environment are vital for place-making. These uses, when integrated with the Westheimer Road BRT corridor along station areas will play an important role in making a successful project.

II. Transportation Choices:

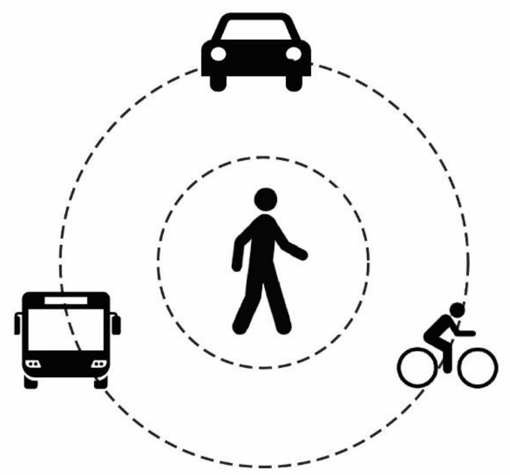

Figure 17: Providing users with travel options increases the user diversity.

Providing the users with alternate transportation choices will attract a larger demographic to the BRT service. On Westheimer Road, having a dedicated bike lane and bike parking at station areas will have a great impact on the ridership for the route. This in turn will help in reducing and diversifying the PMT (person miles travelled) to a large extent.

III. Wider Network of Investment:

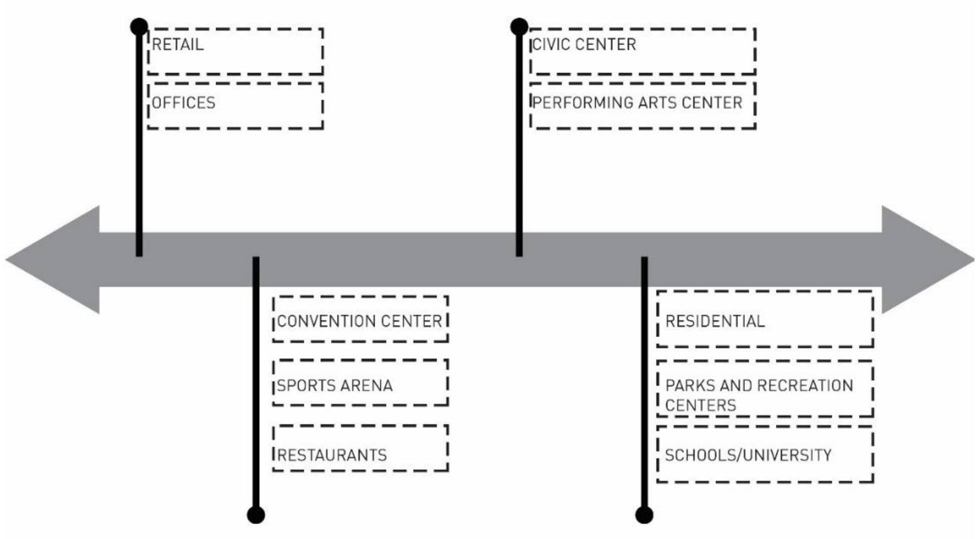

Figure 18: Developing a variety of investments creates diversity along a corridor.

Developing a wider network of investment creates additional opportunities for businesses to locate along the corridor. This also allows for a better variety of options to users and creates more origins and destinations along the corridor. Further, this strategy helps access to and from the origins and destinations reducing the PMT. This allows for diversity of live-work-play environments across the corridor generating ridership while distributing the activities. In addition, it creates opportunities for investors to capitalize on multiple sites making the corridor complete and diverse. Using this strategy on the Westheimer Road Corridor will also diversify new developments creating a successful project.

IV. Integrated Network:

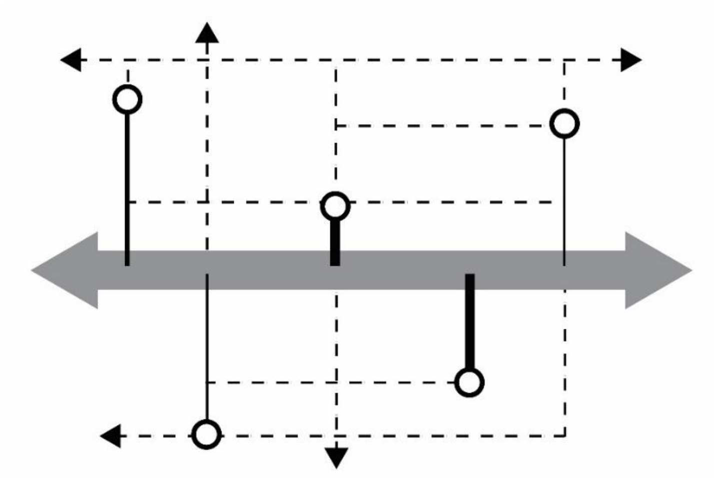

Figure 19: Integrated network allows easier and faster movement of goods and people.

Creating a successful network of roads and other systems substantially increases the movement of goods and people through the area. This creates a better environment for the user and makes the developments more attractive by providing a mode choice. In addition, it provides for various pathways to connect into and out of the neighborhood to allow porosity between the elements.

V. Lively Edges:

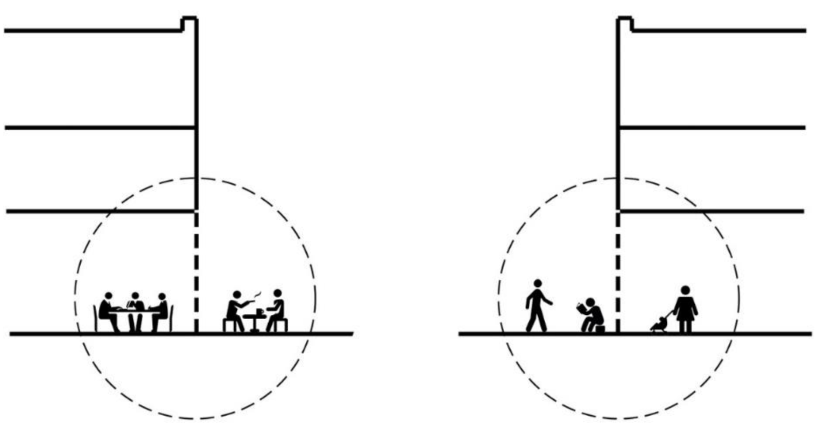

Figure 20: Lively edges develop anchors along the edge creating attractive places.

Active edges are the key to fostering life on the street. Along the Westheimer corridor, the street edges at the station areas will be significant in creating lively spaces. In order to achieve that goal, providing spaces that spill out onto the street is vital. It also implies that there should be associated uses that complement the edge conditions. This in turn will attract a variety of demographic to make a successful project.

VI. Evolving Process through feedback loops:

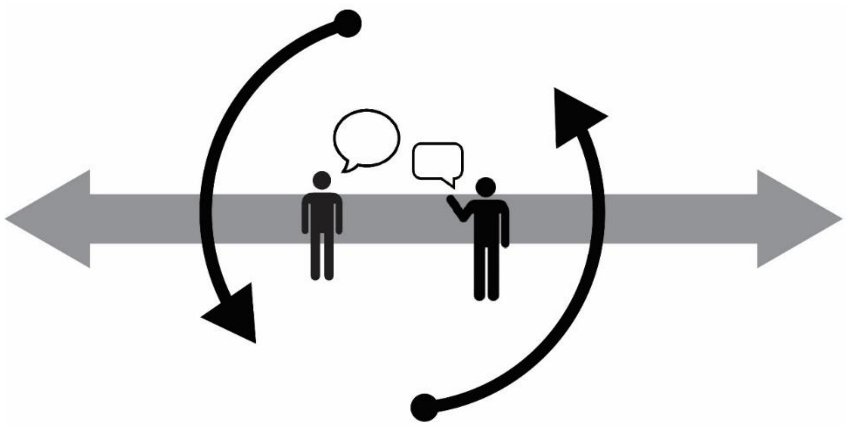

Figure 21: A continuously evolving dialogue with stakeholders yields better results.

As with any successful project, having a dialogue as an evolving process is key to understanding the successes and failures. This approach creates an evolving system making it better with time. In addition, engaging the public in the process also creates a relationship between the user and the service that is provided creating a successful project.

Chapter 6: Implementation on Westheimer Corridor:

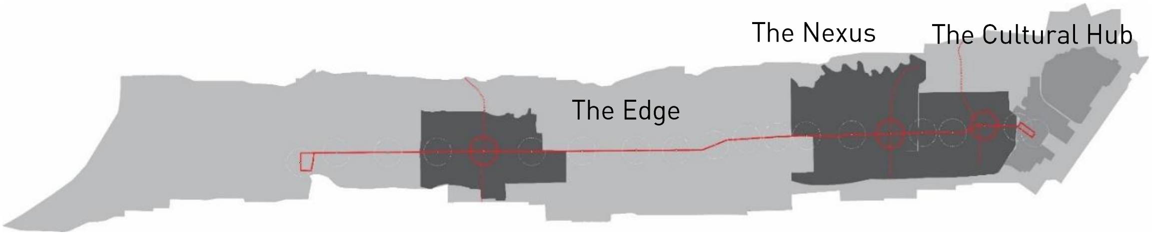

Figure 22: Study Zones along Westheimer Road

The Culture Hub – Westheimer and Montrose Boulevard
The Nexus – Westheimer and Shepherd Drive
The Edge – Westheimer and Gessner Road

The BRT proposal for Westheimer Road extends across 12.6 miles out of the 17 miles that the corridor extends. The BRT line begins from the Central Business District (CBD) in the east with a loop through midtown and traverses across different communities as it progresses. Some of those neighborhoods include Montrose, River Oaks, Briar Hollow, Upper Kirby, Galleria, and the West Chase area. Out of these communities, the impact of the route is tested out through different scenarios with varying conditions like the right-of-way, densities, housing types etc.

For this report, three scenarios are studies of particular stretches of Westheimer Road that I have dubbed The Culture Hub, The Nexus and The Edge. These communities lie at the intersection of Westheimer Road and Montrose Boulevard, Shepherd Drive, and Gessner Road, respectively. They are proposed with BRT stops within the section of Westheimer Road. The right-of-way varies from 50 feet to 70 feet from the culture hub to the nexus and from 70 feet to 120 feet from the nexus to the edge.

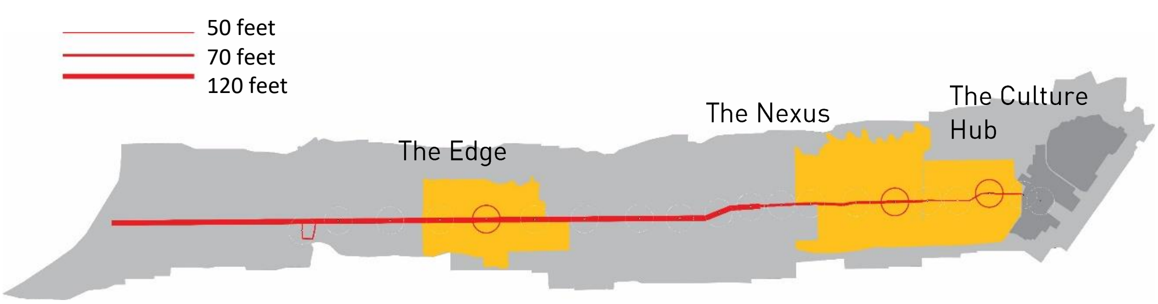

Figure 23: Changing right-of-way along Westheimer Road through study zones.

THE CULTURE HUB:

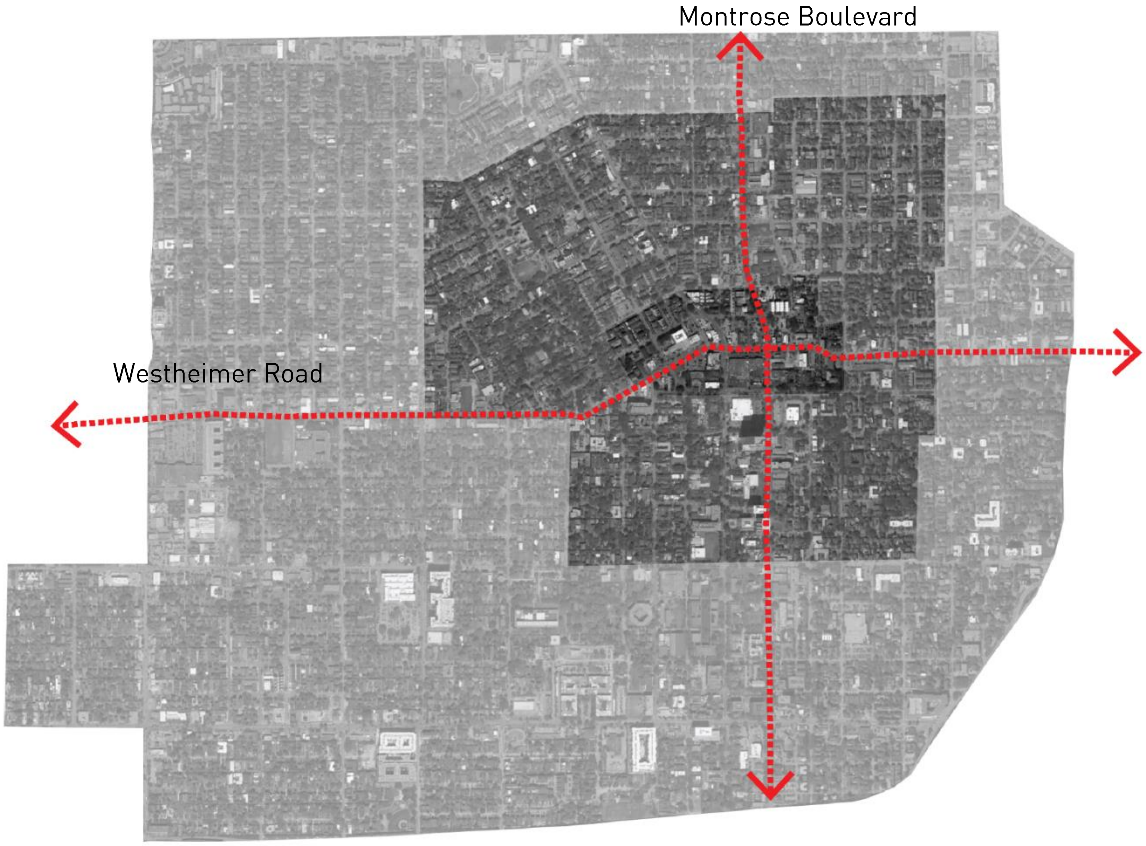

Figure 24: The Culture Hub study zone

Existing conditions:

The first site of intervention is in the Montrose neighborhood, which is 3.7 miles from Downtown Houston. The existing housing stock for this neighborhood consists of 32% single family homes, 11% 2-4 unit apartments, and 55% 5+ unit apartments. This implies that there is a high percentage of middle density housing units in the neighborhood whose residents are likely to use transit. In addition, the existing density is 7.5 units/acre and the street grid is 250 ft. x 670 ft. Although the current density is not sufficient to support transit, the high percentage of 5+ unit apartments indicates the potential for this condition to change in the future.

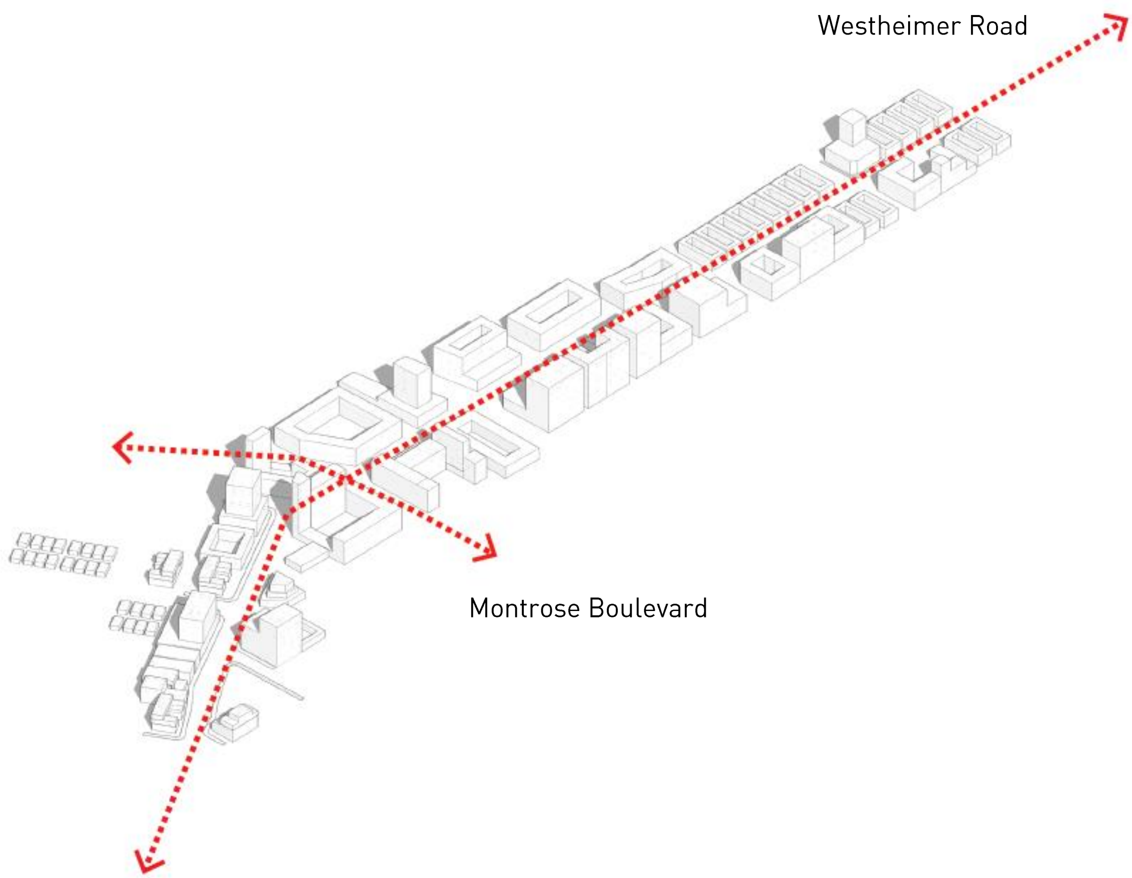

Figure 25: Proposed build-out in The Culture Hub

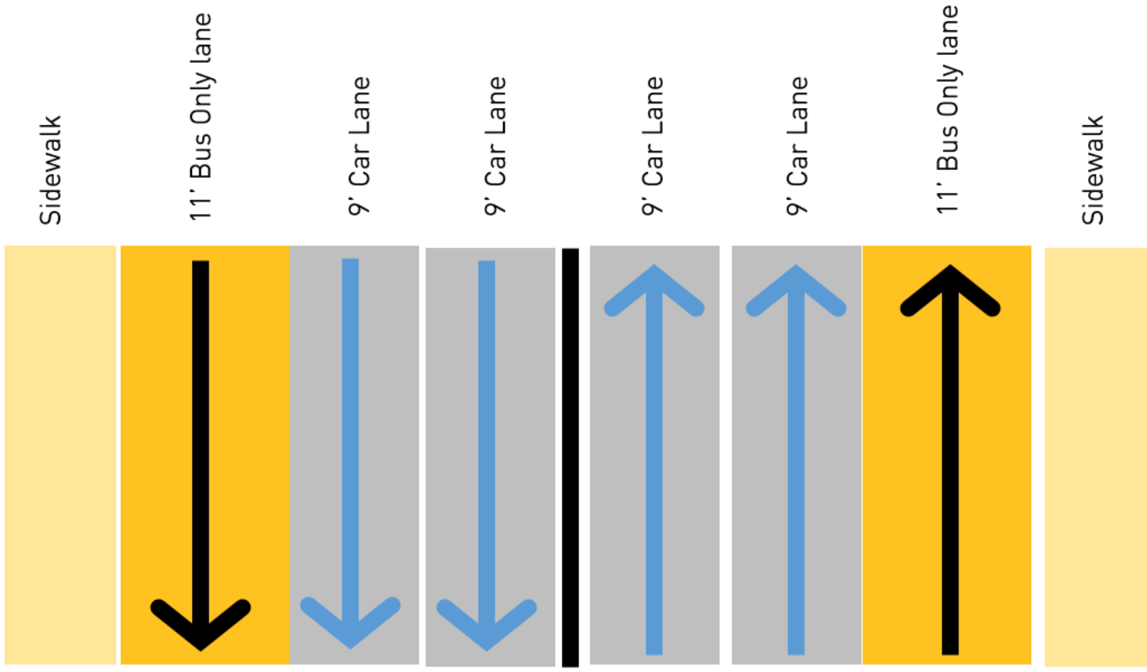

Figure 26: Right-of-way re-allocation in the Culture Hub

The proposed right-of-way re-allocation for the existing 70 feet includes a 6 ft. sidewalk on either side, abutting an 11 ft. bus only lane. The center lanes consist of two 9 ft. car lanes with a 6 ft. crossing island for pedestrians. The pattern of the urban built-form has a higher density at the center where the Westheimer zone is a mixed-use development with high density. This urban form scales down to the neighborhood through transition zones with sites for potential future development like existing big-box retail. This assures that the neighborhood will not directly perceive density encroaching into it although the overall density is to be proposed at 25-30 units/acre.

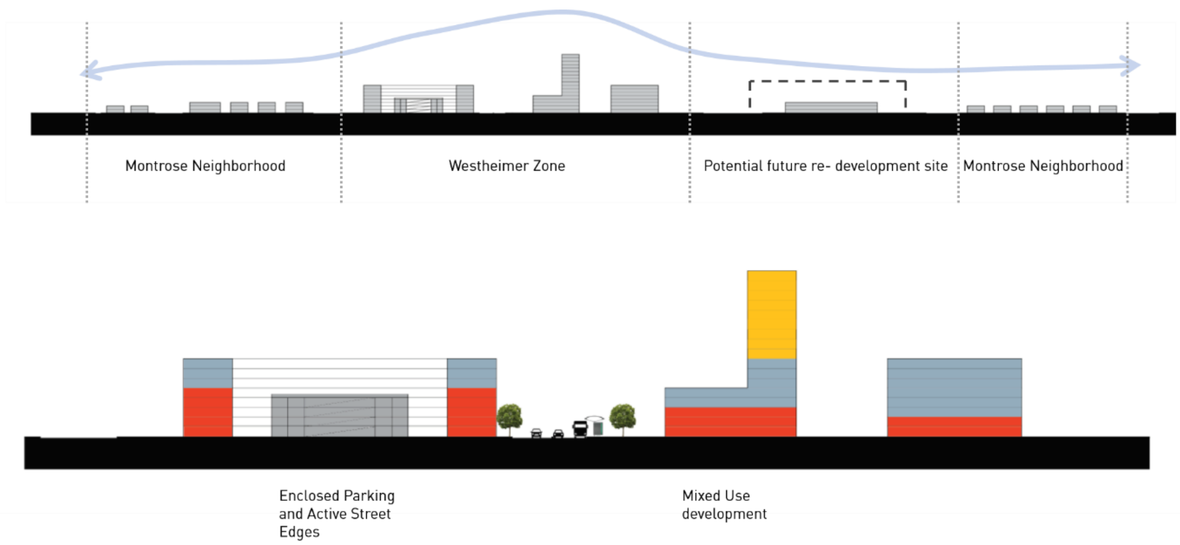

Figure 27 Section showing different zones along Westheimer Road at the Culture Hub.

The parking along the street for retail and commercial (red) and office (blue) buildings will be enclosed with a built structure (Fig. 27). The street edges will be activated by having retail and commercial at the ground level with a wide sidewalk that allows for spillover spaces. This will create a walkable, safe, and compact environment for the users of the BRT and the neighborhood.

In addition to the right-of-way allocation on Westheimer Road, it is critical to intervene in the streets in the surrounding neighborhoods. Providing for alternate routes for bicycle movement through the neighborhood allows for more travel choices. In addition, it adds to the safety of bicyclists.

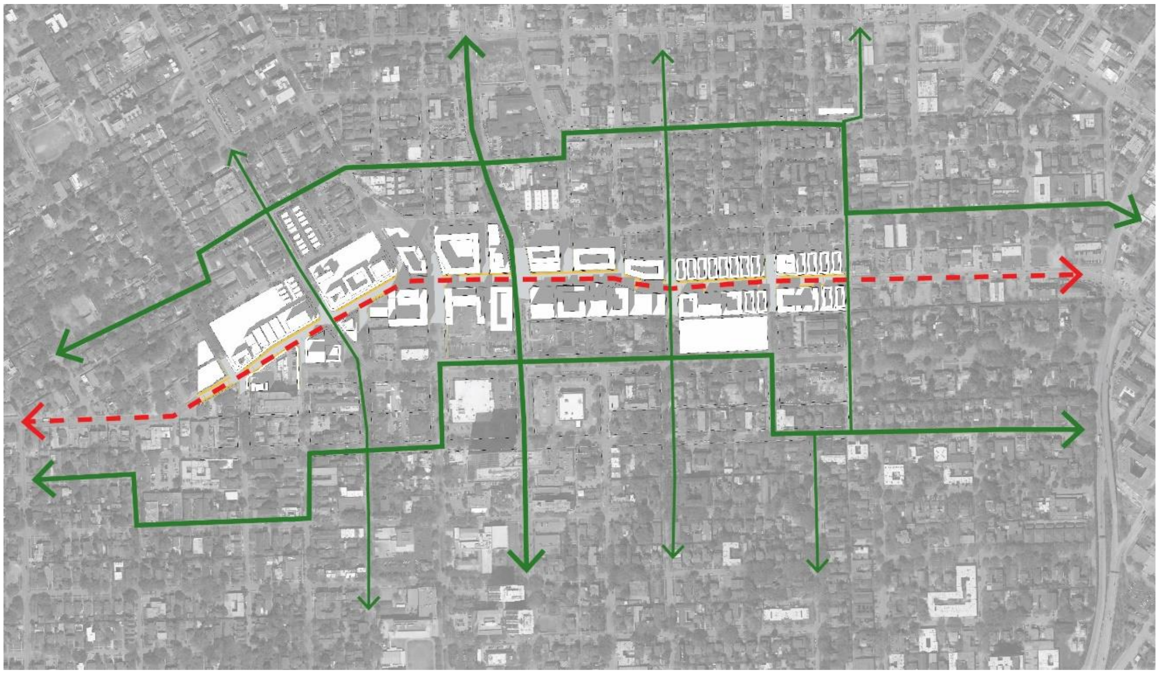

Figure 28: Alternate bike routes to provide mode choice.

As Westheimer Road is an arterial with a BRT route with dedicated bus lanes, the movement of vehicular traffic should be unobstructed from breaks in the flow. In order to assist with that, the road will only allow turning lanes at specific locations rather than having them at every intersection. This will allow a faster movement of vehicles and the BRT service, especially during peak hours. Alternatively, the route for bike and pedestrian movement will also be safe with higher crossing points where turning is allowed. Thus, it will assist in creating a better environment for a choice of transit movement.

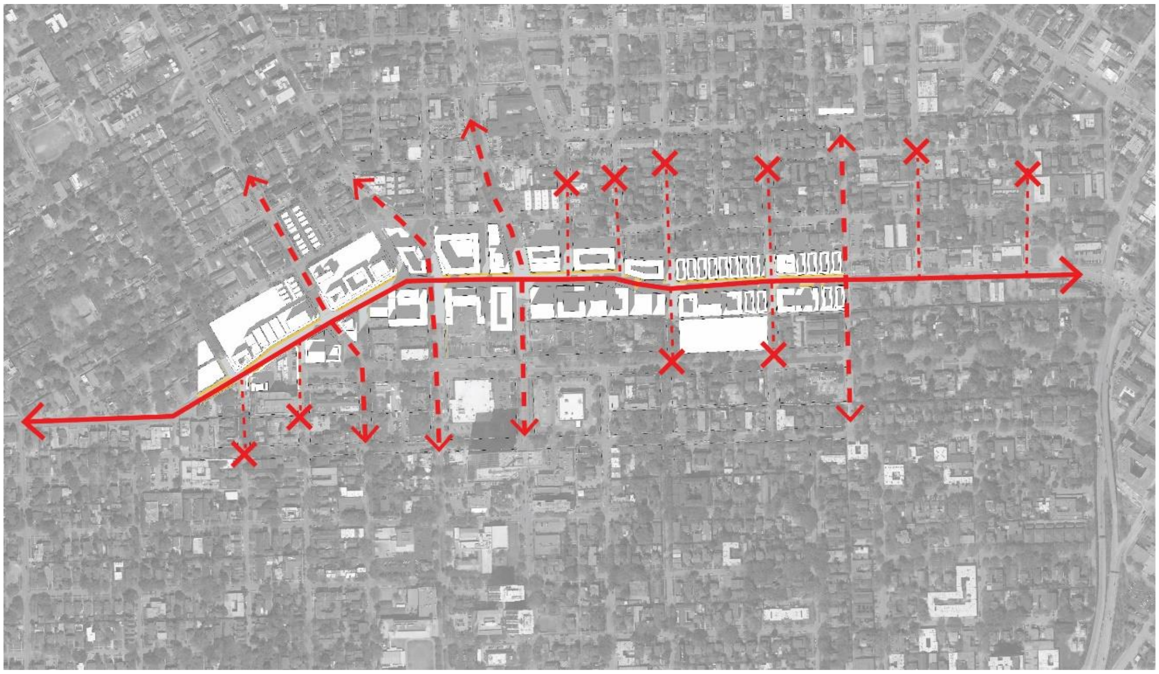

Figure 29: Left turn restrictions to improve flow of traffic

In addition to the scale and street designing, the edge conditions of the corridor are also critical in determining the activity. Therefore the built-to-edge requirements are introduced in regulating the edge conditions of the massing. This allows more active edges especially at corners, thereby also allowing a degree of freedom for variation in building façade articulation. In turn, this promotes a walkable environment allowing a better relationship of the built-form to that of the streets. Thus, it is a holistic approach by including the massing and street requirements by creating a regulating framework to complement the BRT route and the station areas.

Using the Urban Land Institute (ULI) table as a base for calculations and amending the numbers to fit the Houston context, the total cost of development per phase was estimated to be $189.4 Million (ref. table 2 – appendix). The total development of after reconstruction and assuming a density of 30 units/acre works out to be 4.5 Million square feet, including retail, commercial, office, and residential. Out of the total cost of development, using the metric in the Euclid Avenue BRT project, at $20 Million/mile, the cost of street infrastructure improvements is $30.4 Million. All the values are assumed to be in 2016 dollar. This implies that the ratio of the cost of street infrastructure improvements to the value that it brings to the development is far lower, i.e. the rate of return on the investment is high.

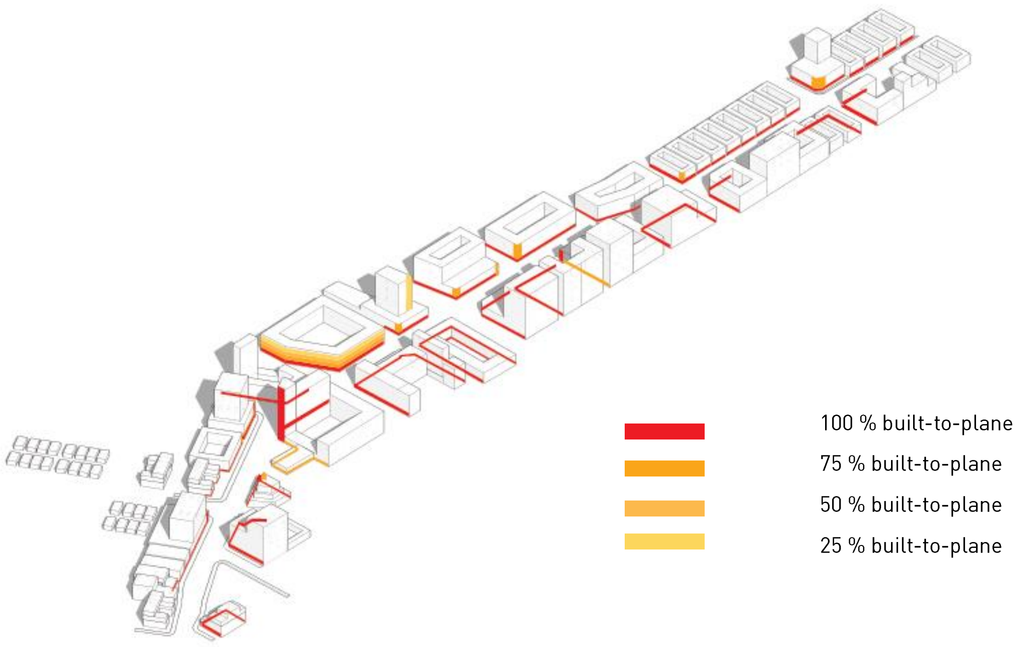

Figure 30: Built-to plane ensuring street edge conditions create active spaces.

Figure 31: View of proposed street build out in The Culture Hub.

THE NEXUS:

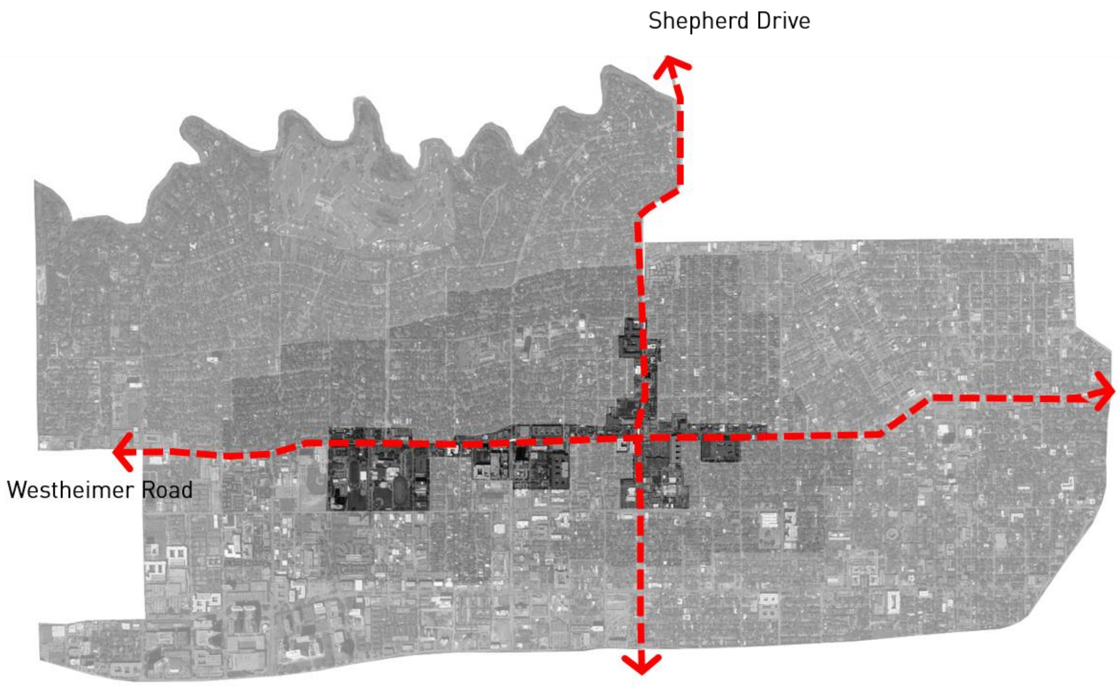

Figure 32: The Nexus study zone

Existing conditions:

The second site of intervention is in the River Oaks neighborhood, which is 7.2 miles from Downtown Houston. The existing housing stock for this neighborhood consists of 45% single family homes, 5% 2-4 unit apartments, and 32% 5+ unit apartments. This implies that there is a high percentage of middle density housing units in the neighborhood that are likely to use transit. In addition, the existing density is 3.5 units/acre which is lower than the Culture Hub, but the street grid 1,200 ft. x 275 ft., which has longer blocks with alleyways away from Westheimer Road creates a porous and walkable environment.

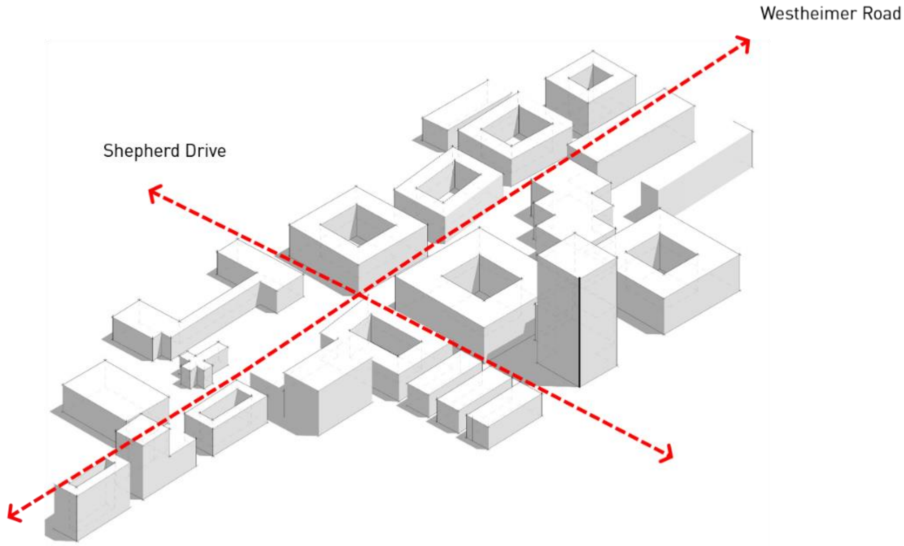

Figure 33: Proposed build out for The Nexus.

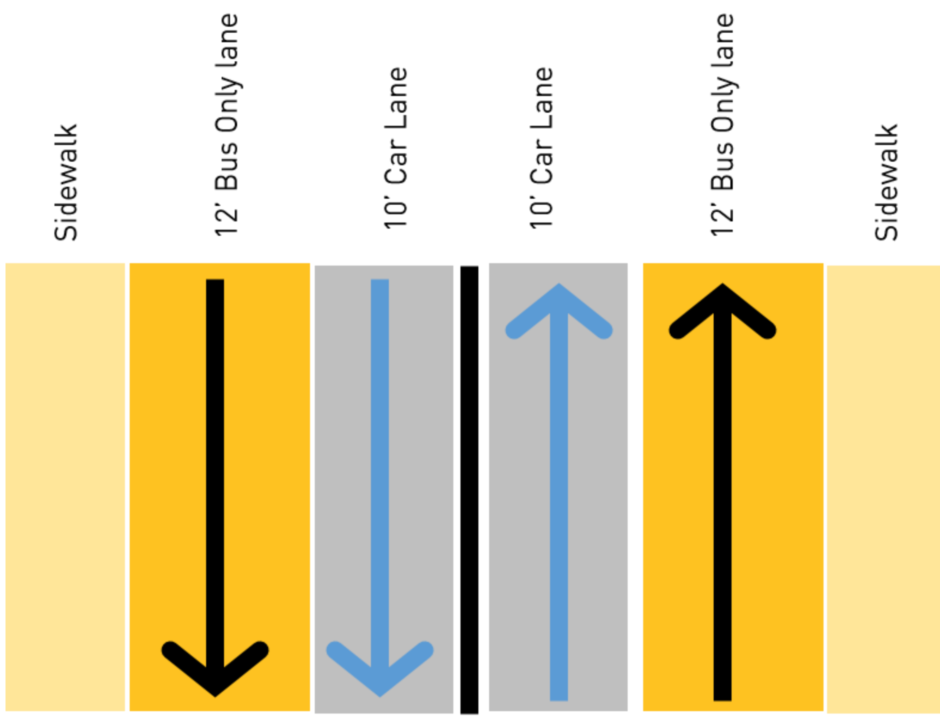

Figure 34: Re-allocation of the right-of-ay along Westheimer Road in the Nexus.

The right-of-way for the Westheimer Road in the Nexus is currently 50 feet. The proposed re-allocation distributes it into an 8 ft. sidewalk on either side with a dedicated 12 ft. bus lane abutting the sidewalk. The center vehicular lane is 10 feet with a 6 feet wide median island. The density of development is different from the Culture Hub, with distributed middle density instead of a higher density node. This allows the urban massing to blend into the existing fabric of the neighborhood. In addition, it allows for existing big-box retail sites to be developed achieving a target density of 25-30 units/acre to support transit.

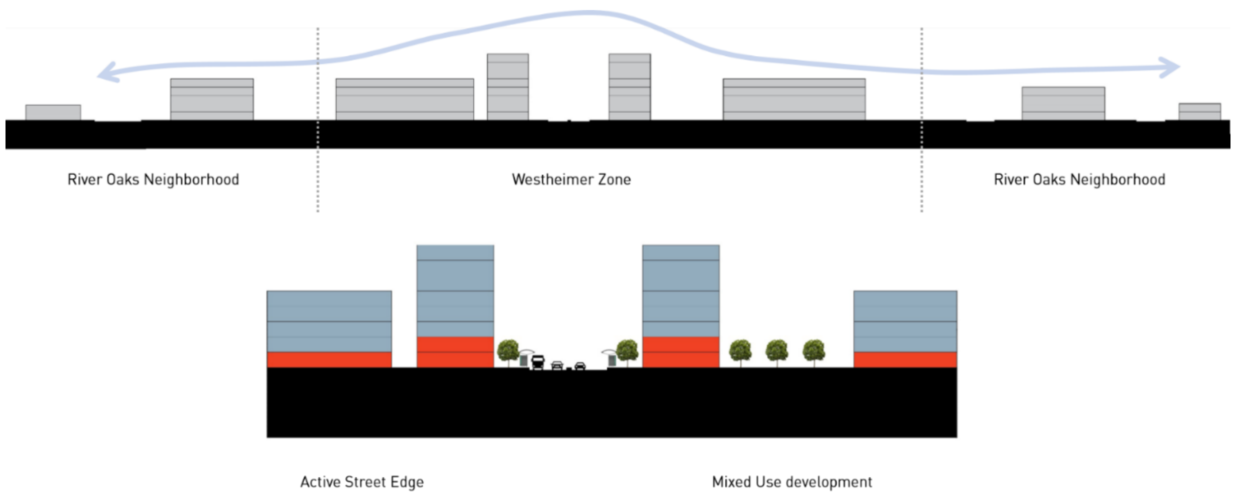

Figure 35: Section showing different zones along Westheimer Road at The Nexus.

In addition to the right-of-way allocation on Westheimer Road, it is critical to intervene at the streets in the surrounding neighborhoods. Providing for alternate routes for bicycle movement through the neighborhood allows for more travel choices. In addition, it adds to the safety of bicyclists.

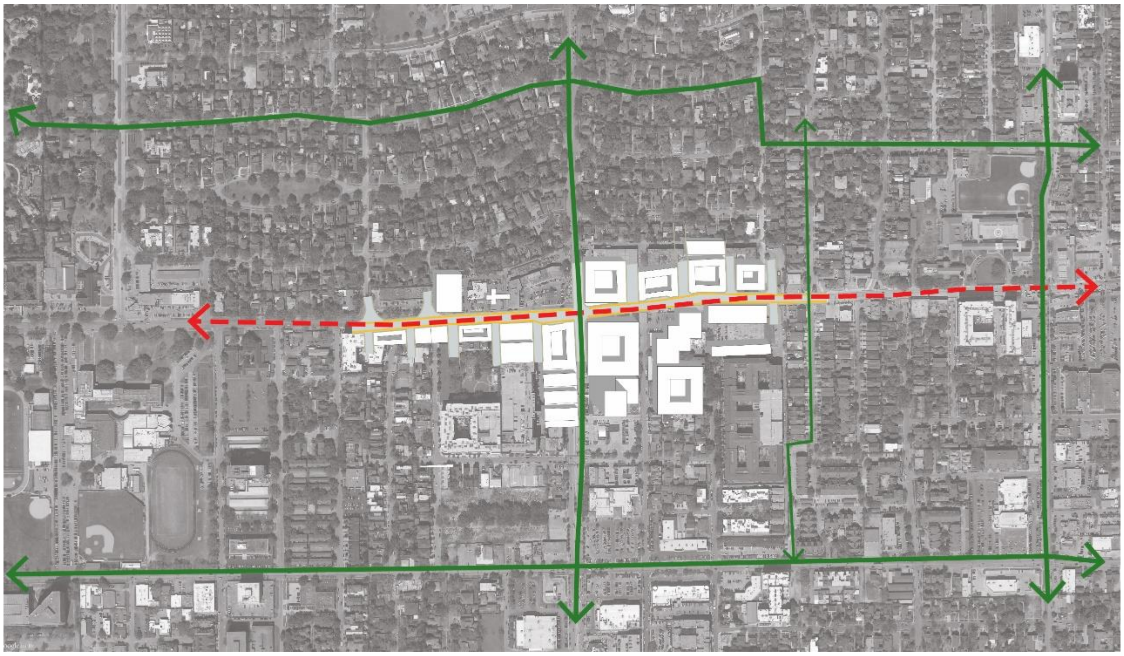

Figure 36: Proposed alternate bike routes through the neighborhood to provide non-motorized transportation.

Another strategy to increase movement of traffic and reduce travel times is to restrict the number of left turn lanes. This will create unobstructed flows specifically during peak hours, and allow for better movement of the BRT route. Further, it will make the option to use the BRT more attractive thus increasing ridership. Alternatively the bike and pedestrian flows will be much safer with fewer but well-designed points of crossing. Overall, it will create better and efficient movement of transit and traffic.

Figure 37: Restricting left turn lanes to enhance traffic flows.

In addition to the scale and street designing, the edge conditions of the corridor are also critical in determining the activity. Therefore the built-to-edge requirements are introduced in regulating the edge conditions of the massing. This allows more active edges especially at corners also allowing a degree of freedom for variation in building façade articulation. In turn, this promotes a walkable environment allowing a better relationship of the built-form to that of the streets. Thus, it is a holistic approach by including the massing and street requirements by creating a regulating framework to compliment the BRT route and the station areas.

Using the Urban Land Institute (ULI) table as a base for calculations and amending the numbers to fit the Houston context, the total cost of development per phase was estimated to be $70.7 Million (ref. table 3 – appendix). The total development of after reconstruction and assuming a density of 30 units/acre works out to be 940,000 square feet, including retail, commercial, office, and residential. Out of the total cost of development, using the metric in the Euclid Avenue BRT project, at $20 Million/mile, the cost of street infrastructure improvements is $15.2 Million for 3/4th of a mile. All the values are assumed to be in 2016 dollars.

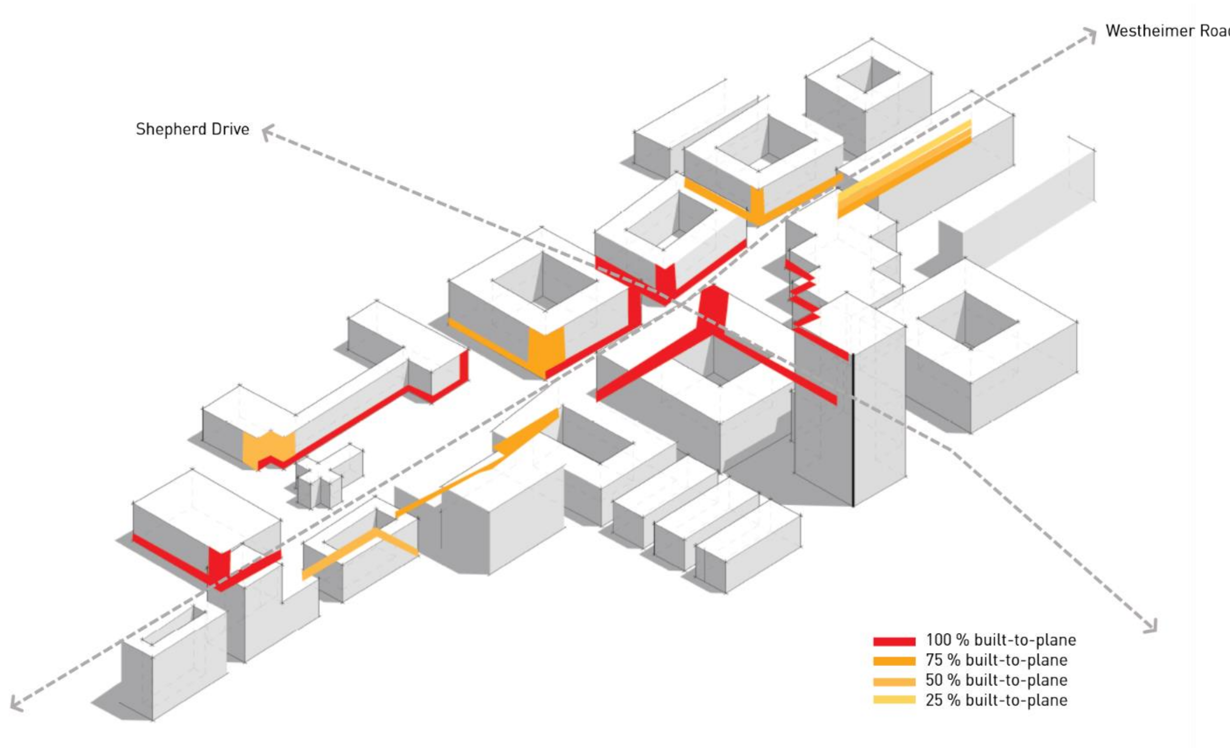

Figure 38: Proposed built-to planes to create urban frontages.

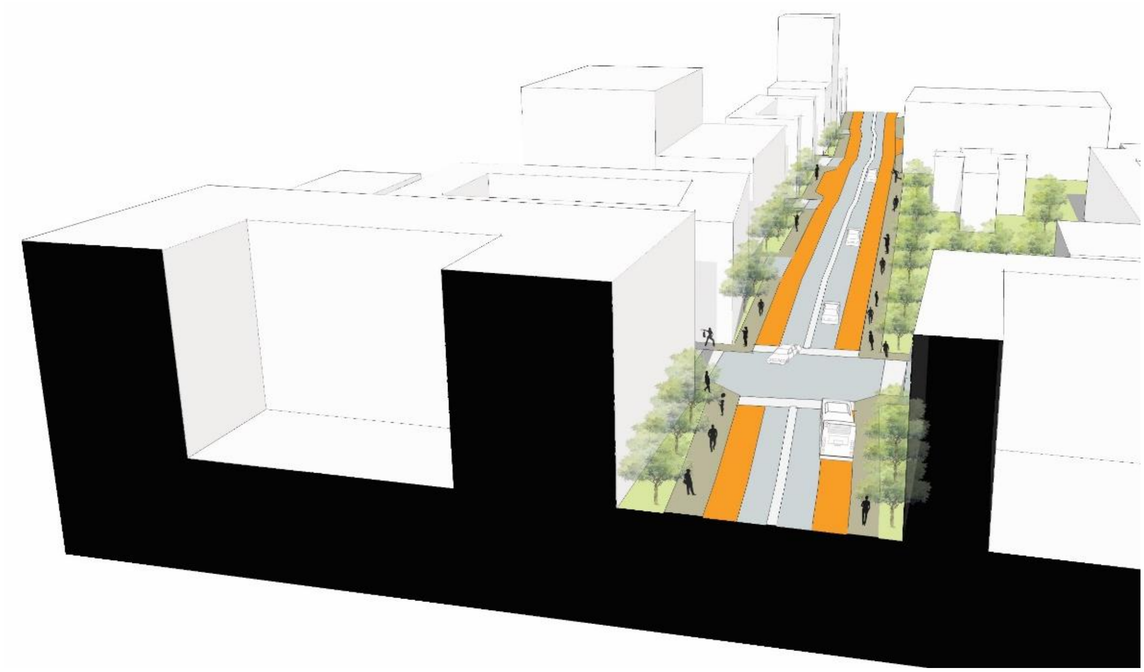

Figure 39: Proposed build out of the Nexus section of Westheimer Road.

THE EDGE:

Figure 40: The Edge study area.

Existing conditions:

The third site of intervention is in the Briar Forest and West Chase neighborhood, 15.6 miles from Downtown Houston. It is currently comprised of 42% single family homes, 8% 2 to 4 unit apartments, and 36% 5+ unit apartments. There is a budding presence of housing types likely to yield new transit riders, with potential for growth. The existing density is 2.5 units/acre with a street grid of 1,200 ft. x 275 ft. Although the current density is not high enough to support transit, given the right circumstances, there is potential for growth.

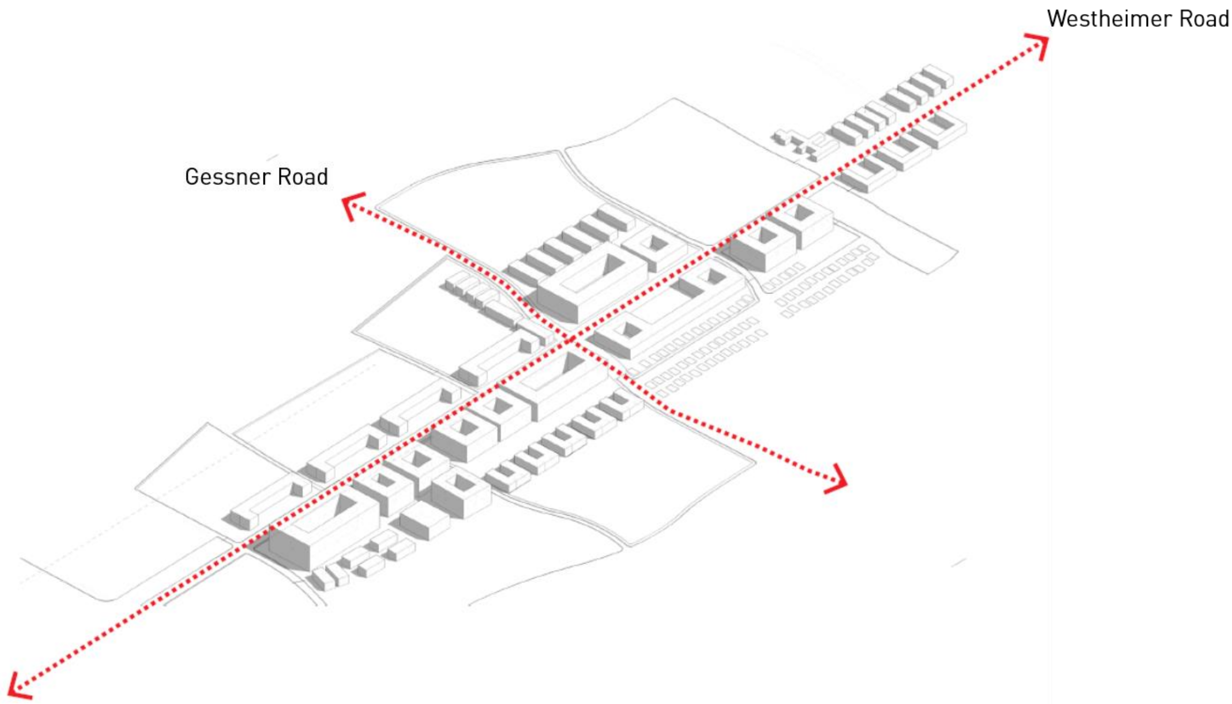

Figure 41: Proposed build out massing in The Edge.

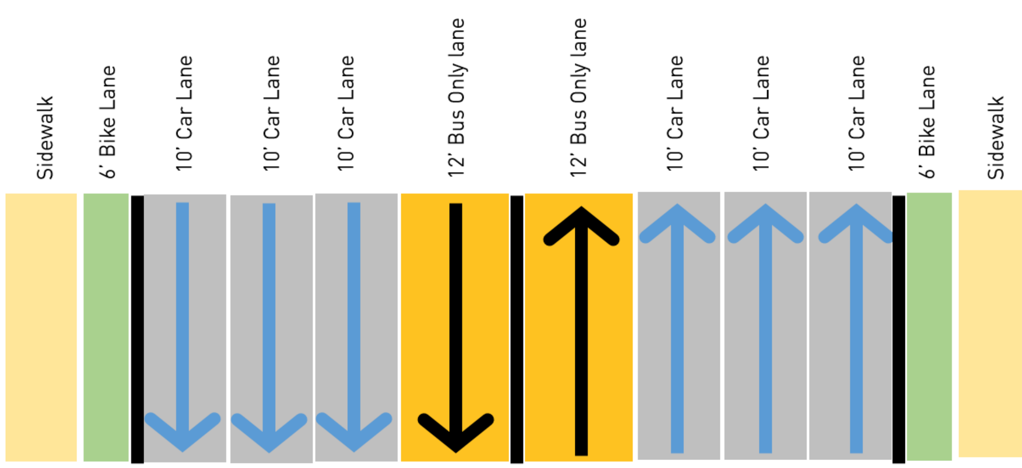

Figure 42: Re-allocation of the right-of-way for Westheimer Road in The Edge.

The right-of-way re-allocation of the existing 120 ft. sidewalk is largely geared towards a rapid movement of BRT and collection points along the corridor. The limit is a 12 ft. sidewalk abutting a 6 ft. bicycle lane on either side. Adjoining the bike lane are three car lanes of 10 ft. in width with a 10 ft. median island. In the center of the right-of-way is the 12 ft. dedicated bus lane running in either direction. The Edge is envisioned to be a mixed-use development with high density, strategizing multiple stakeholders to achieve the common vision. This urban form is complementary to the existing multifamily residential in the neighborhood and scales down into the single-family zones. This reduces the perceived density due to the setback and scaling down and is aimed at 25-30 units/acre.

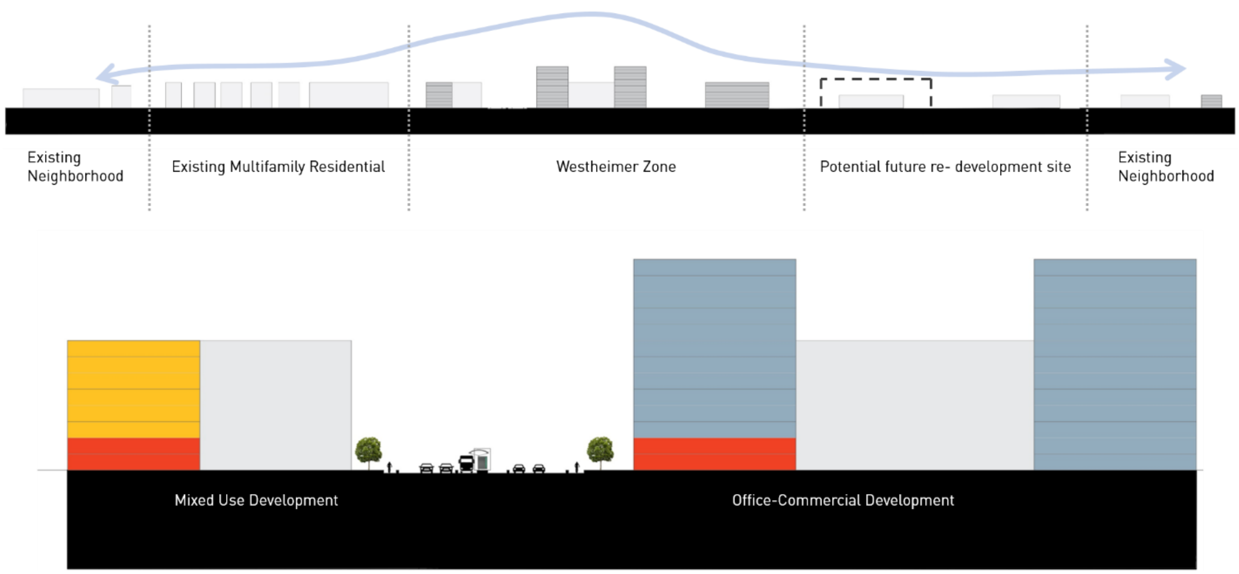

Figure 43: Section showing different zones along Westheimer Road at The Edge.

In addition to the scale and street designing, the edge conditions of the corridor are also critical in determining the activity. Therefore the built-to-edge requirements are introduced in regulating the edge conditions of the massing. This allows more active edges especially at corners also allowing a degree of freedom for variation in building façade articulation. In turn, this promotes a walkable environment allowing a better relationship of the built-form to that of the streets. Thus, it is a holistic approach by including the massing and street requirements by creating a regulating framework to compliment the BRT route and the station areas.

The total cost of development per phase was estimated to be $183.5 Million (ref. table 4 – appendix). The total development of after reconstruction and assuming a density of 30 units/acre works out to be 1.56 Million square feet, including retail, commercial, office, and residential. Out of the total cost of development, using the metric in the Euclid Avenue BRT project, at $20 Million/mile, the cost of street infrastructure improvements is $38.5 Million for 1.9 miles of this section. All the values are assumed to be in 2016 dollars.

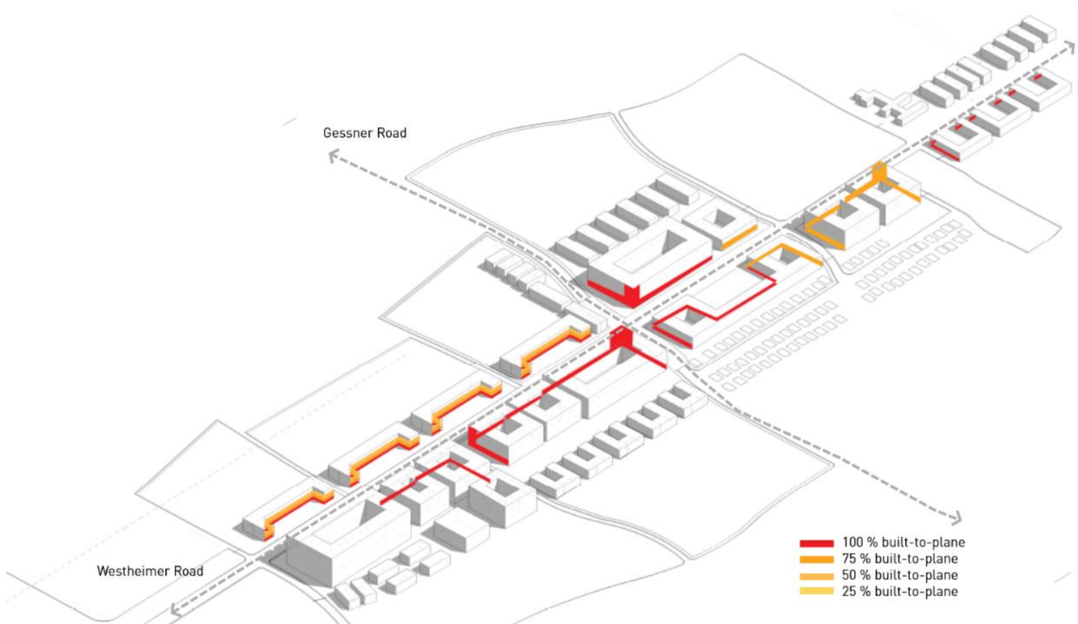

Figure 44: Proposed built-to edges to have better urban frontages along the street.

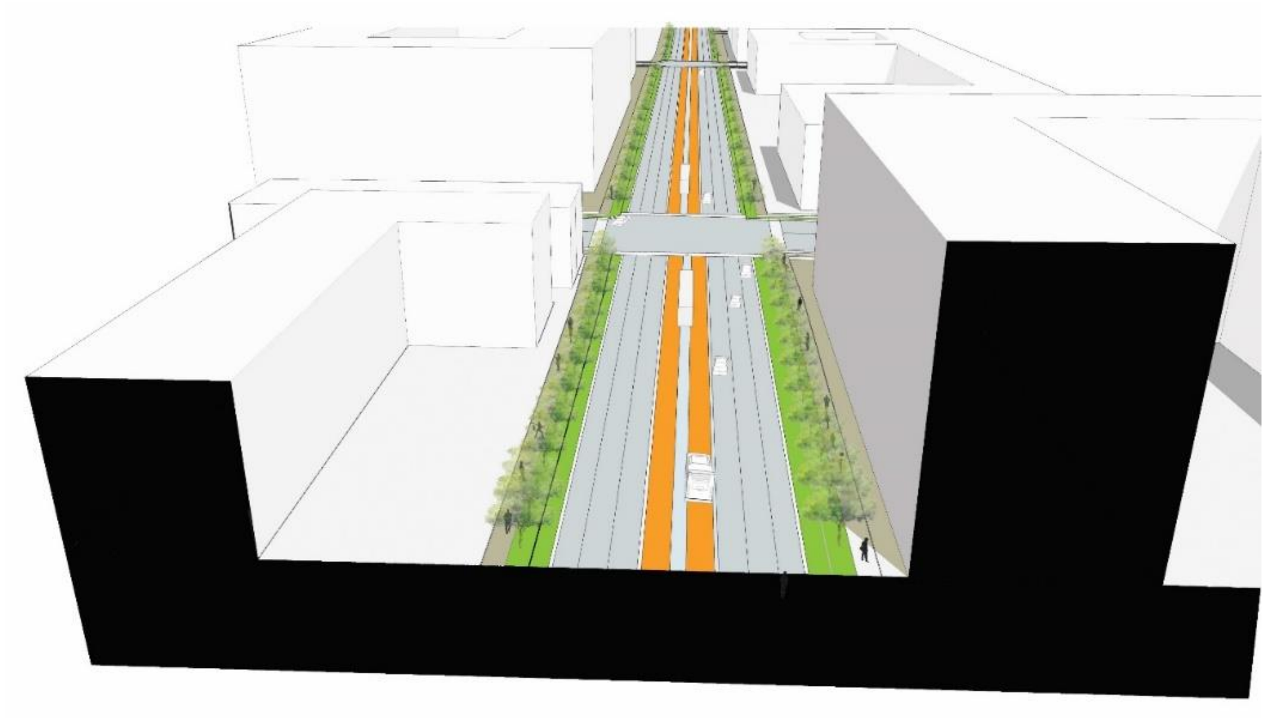

Figure 45: Proposed build out along Westheimer Road in The Edge.

Chapter 7: Implementation Strategy and discussion

REPAYMENT THROUGH TRZ

In order to implement the project, collaboration through public-private partnerships is critical. The project life-cycle depends on the return of investment and re-investment of the profits back into improving the project. The project funding through the federal, state and local level works through the public agencies. Therefore, collaboration between different public entities is also important due to the nature of their various roles during the implementation process.

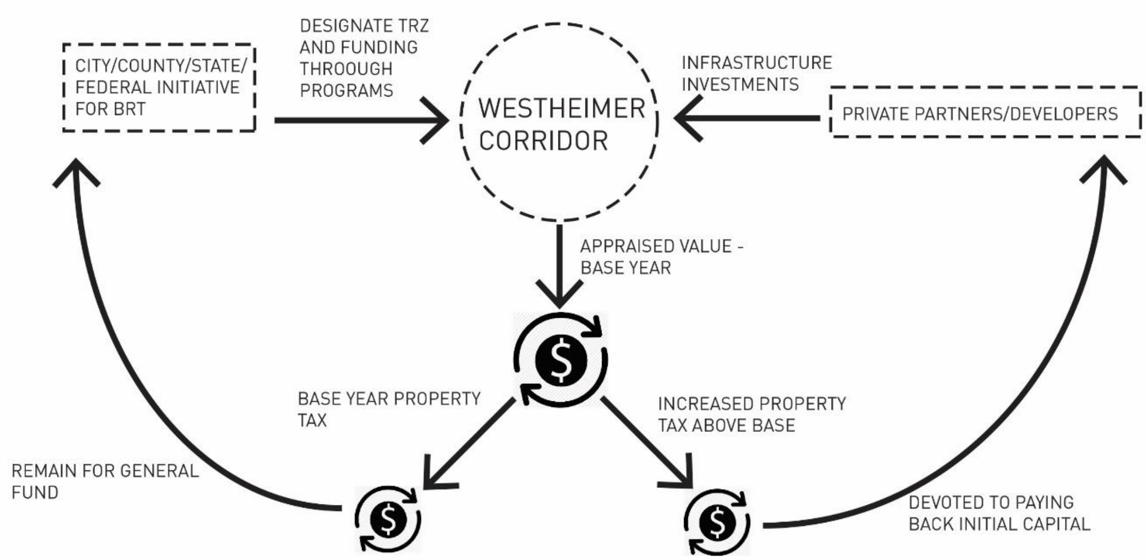

Figure 46: Proposed PPP model for repayment of capital investment

- The primary steps in planning out the BRT project from a financial viability point-of-view will be to designate the corridor as a Transportation Reinvestment Zone (TRZ).

"Transportation Reinvestment Zone - The local governing body designates a zone in which it will promote a transportation project. Once the zone is created, a base year is established, and the incremental increase in property tax revenue collected inside the zone is used to finance a project in the zone." – Texas Department of Transportation.

- Once the zone has been established, various entities – public and private collaborate to provide inputs and designate their roles in the process, as the base year is set.
- This allows for different sources of funding to be allocated for specific parts of the budget giving private investors and developers' indications for investments into developing sites related to the project.
- As the project moves through the life-cycle, the base year property tax is channeled into the local government's general funds for further reinvestment into the project, and the additional revenue – surplus to the base year property tax is payed back to the private investors and developers.
- This additional funds is a channel to payback for the initial capital investment into the street and roadway infrastructure improvements that the developers have undertaken. In addition, it also provides for a return on investment as profit over a period of time.
- This allows the funds to recirculate to facilitate the cash flows throughout the life-cycle of the project making it financially viable to public and private entities.

KEY IMPLICATIONS:

Length of the Corridor	12.6 MILES
Costs of Infrastructure Investments	$ 386 M (2016 dollars)
Estimated Annual Property Tax	$ 50 M (2016 dollars)
Estimated share of revenue to pay back infrastructure costs (55% OF TOTAL PROPERTY TAX - ASSUMPTION)	$ 27.5 M (2016 dollars)
Estimated time to pay back project costs	~ 14 YEARS

Figure 47: Summary of the project's financial analysis.

Summarizing the project goals, expected outcome and key implications in the figure above, gives an insight into the scale of the project. The overall corridor length is expected to be 12.6 miles beginning from the downtown and extending into fringe areas of Westchase. The estimated cost of the infrastructure improvements for the entire length of the corridor are $ 386 Million (see table 1 in appendix). The estimated property tax on the developments at the 2016 rate is $ 50 Million, out of which the portion to be repaid to the private sector, based on a 55% assumption is $ 27.5 Million. The estimated time of the financial recovery for the infrastructure investments, based on the numbers above is 14 years. Given the current market standards, this project duration for recovery is typical.

FINAL THOUGHTS

Even though Houston lacks zoning, it is possible to create a holistic vision of a corridor plan through participation of different stakeholders, including citizens, transportation organizations, government entities and private developers. In order to achieve successful transit-oriented communities, the thought of transportation planning and urban design should go hand-in-hand for better user experience of transit. This will improve the perception of transit for most Americans and will be seen as a part of their lifestyle. In return, through value capture the project will also be financially sound and possibly provide a gateway for affordable housing opportunities.

APPENDIX

Study Area	Total Cost of Development	Cost of Infrastructure Development (at $20M/mile for entire 17 miles)
The Culture Hub	$ 796,189,539	
The Nexus	$ 295,243,909	
The Edge	$ 212,994,141	
	$ 1,304,427,589	**$ 386,746,746**

Study Area	Estimated Increase in Property Values	New Property Tax	Share of property tax to repay the Infrastructure Cost (55% of Total)	Number of Years to Payback the Infrastructure Cost
The Culture Hub	$ 1,035,046,401	$ 30,533,869		
The Nexus	$ 383,817,082	$ 11,322,604		
The Edge	$ 276,892,383	$ 8,168,325		
	$ 1,695,755,866	**$ 50,024,798**	**$ 27,513,639**	**14.06**

Table 1: Summary table of showing estimated cost of development and time to payback for the entire 17 miles of Westheimer Road BRT.

THE CULTURE HUB							
Quick and Dirty Analysis							
Total Ground Coverage (sq.m.)		105,049					
FAR		4					
Total Gross Area (sq.m.)		420,196					
Total Gross Area (sq.ft.)		4,522,948					
Development Progress - Phasing							
		Phase I	Phase II	Phase III	Phase IV		
Area (sq.ft.)		1,130,736.93	1,130,736.93	1,130,736.93	1,130,736.93		
Costs	**Percent Area of Total**	**Area**	**Unit Size**	**Number of Units**	**Price per sq. ft.**	**Unit Cost**	**Typical Phase Cost**
Office	25%	282,684	1,000	283	400	$ 400,000	$113,073,693
Commercial	15%	169,611	500	339	200	$ 100,000	$33,922,108
Retail	15%	169,611	1,000	170	100	$ 100,000	$16,961,054
Residential	45%	508,832	1,200	424	50	$ 60,000	$25,441,581
	1					**$189,398,436**	**757,593,744**
Average						**$ 273,731**	
Sales/Rent Revenue							
Types	**Unit Size**	**Price per sq.ft.**	**Unit Cost**	**Number of Units**	**Vacancy Rates**	**Rent Revenue**	
Office	6,000	20	$ 120,000	283	90%	$ 30,529,897.14	
Commercial	4,000	20	$ 80,000	339	90%	$ 24,423,917.71	
Retail	8,000	30	$ 240,000	170	90%	$ 36,635,876.57	
Residential	1,200	2	$ 1,800	424	85%	$ 648,760.31	
				1,216		**$ 92,238,452**	
Expenditures							
Land Cost (	104	acres @	225,000	per acre)		**$ 23,362,291**	$ 19,220
Development Costs							
Grading					$ 210,000		
Paving					$ 600,000		
Storm sewer					$ 250,000		
Water					$ 200,000		
Sanitary sewer					$ 180,000		
Power					$ 85,000		
Teledata/network					$ 160,000		
Off-site street improvements					$ 800,000		
Fees & permits					$ 800,000		
School fees					$ 350,000		
Indirect land development					$ 300,000		
Financing costs (			2.0%	of max loan)	$ 73,815		
Pursuit/transaction costs					$ 156,075		
Marketing (			6.0%	of sales)	$ 5,534,307		
Administration & contingency (			6.0%	of sales)	$ 5,534,307		
Total Development Costs						$ 15,233,504	$ 12,532.27
Subtotal						**$ 38,595,796**	$ 31,751.92
TOTAL COSTS (DEVELOPMENT+EXPENDITURES)						**$ 796,189,539**	

Table 2: Proforma calculations for The Culture Hub

THE NEXUS							
Quick and Dirty Analysis							
Total Ground Coverage (sq.m.)		39,256					
FAR		4					
Total Gross Area (sq.m.)		157,024					
Total Gross Area (sq.ft.)		1,690,192					
Development Progress - Phasing							
		Phase I	Phase II	Phase III	Phase IV		
Area (sq.ft.)		422,548.09	422,548.09	422,548.09	422,548.09		
Costs	**Percent Area of Total**	**Area**	**Unit Size**	**Number of Units**	**Price per sq. ft.**	**Unit Price**	**cal Phase Cost**
Office	25%	105,637	6,000	18	400	$ 2,400,000	$42,254,809
Commercial	15%	63,382	4,000	16	200	$ 800,000	$12,676,443
Retail	15%	63,382	8,000	8	100	$ 800,000	$6,338,221
Residential	45%	190,147	1,200	158	50	$ 60,000	$9,507,332
	1					**$70,776,805**	**283,107,220**
Average						**$ 1,655,821**	
Sales/Rent Revenue							
Types	**Unit Size**	**Price per sq.ft.**	**Unit Cost**	**Number of Units**	**Vacancy Rates**	**Rent Revenue**	
Office	6,000	20	$ 120,000	18	90%	$ 1,901,466.40	
Commercial	4,000	20	$ 80,000	16	90%	$ 1,140,879.84	
Retail	8,000	30	$ 240,000	8	90%	$ 1,711,319.76	
Residential	1,200	2	$ 1,800	158	85%	$ 242,436.97	
				200		**$ 4,996,103**	
Expenditures							
Land Cost (	39	acres @	190,000	per acre)		**$ 7,372,267**	$ 36,893
Development Costs							
Grading					$ 210,000		
Paving					$ 600,000		
Storm sewer					$ 250,000		
Water					$ 200,000		
Sanitary sewer					$ 180,000		
Power					$ 85,000		
Teledata/network					$ 160,000		
Off-site street improvements					$ 800,000		
Fees & permits					$ 800,000		
School fees					$ 350,000		
Indirect land development					$ 300,000		
Financing costs (			2.0%	of max loan)	$ 73,815		
Pursuit/transaction costs					$ 156,075		
Marketing (			6.0%	of sales)	$ 299,766		
Administration & contingency (			6.0%	of sales)	$ 299,766		
Total Development Costs						$ 4,764,422	$ 23,842.37
Subtotal						**$ 12,136,690**	$ 60,735.06
TOTAL COSTS (DEVELOPMENT+EXPENDITURES)						**$ 295,243,909**	

Table 2: Proforma calculations for The Nexus

THE EDGE							
Quick and Dirty Analysis							
Total Ground Coverage (sq.m.)		232,211					
FAR		3					
Total Gross Area (sq.m.)		145,131.50					
Total Gross Area (sq.ft.)		1,562,181					
Development Progress - Phasing							
		Phase I	Phase II	Phase III	Phase IV		
Area (sq.ft.)		390,545.24	390,545.24	390,545.24	390,545.24		
Costs	**Percent Area of Total**	**Area**	**Unit Size**	**Number of Units**	**Price per sq. ft.**	**Unit Price**	**cal Phase Cost**
Office	25%	97,636	1,000	98	200	$ 200,000	$19,527,262
Commercial	15%	58,582	500	117	200	$ 100,000	$11,716,357
Retail	15%	58,582	1,000	59	100	$ 100,000	$5,858,179
Residential	45%	175,745	1,200	146	50	$ 60,000	$8,787,268
	1					**$45,889,065**	**183,556,262**
Average						**$ 134,894**	
Sales/Rent Revenue							
Types	**Unit Size**	**Price per sq.ft.**	**Unit Cost**	**Number of Units**	**Vacancy Rates**	**Rent Revenue**	
Office	6,000	20	$ 120,000	98	90%	$ 10,544,721.43	
Commercial	4,000	20	$ 80,000	117	90%	$ 8,435,777.15	
Retail	8,000	30	$ 240,000	59	90%	$ 12,653,665.72	
Residential	1,200	2	$ 1,800	146	85%	$ 224,075.33	
				420		**$ 31,858,240**	
Expenditures							
Land Cost (	143	acres @	150,000	per acre)		**$ 21,450,000**	$ 51,091
Development Costs							
Grading					$ 210,000		
Paving					$ 600,000		
Storm sewer					$ 250,000		
Water					$ 200,000		
Sanitary sewer					$ 180,000		
Power					$ 85,000		
Teledata/network					$ 160,000		
Off-site street improvements					$ 800,000		
Fees & permits					$ 800,000		
School fees					$ 350,000		
Indirect land development					$ 300,000		
Financing costs (			2.0%	of max loan)	$ 73,815		
Pursuit/transaction costs					$ 156,075		
Marketing (			6.0%	of sales)	$ 1,911,494		
Administration & contingency (			6.0%	of sales)	$ 1,911,494		
Total Development Costs						$ 7,987,879	$ 19,026.18
Subtotal						**$ 29,437,879**	$ 70,117.54
TOTAL COSTS (DEVELOPMENT+EXPENDITURES)						**$ 212,994,141**	

Table 3: Proforma calculations for The Edge

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