Houston-Galveston Area Council

High Capacity Transit Task Force
for the 2045 Regional Transportation Plan

FINAL SUMMARY REPORT

Revised July 29, 2019

h-gac.com/high-capacity-transit-task-force

High Capacity Transit Task Force for the 2045 Regional Transportation Plan

Final Summary Report

Revised July 29, 2019

Houston-Galveston Area Council

With consultant support from

Texas Southern University - Center for Transportation Training Research

Phoenix Infrastructure Group

Table of Contents

Attachments

Appendices

H-GAC Staff Contacts for this Summary Report and its Attachments:

Alan Clark, Director, Transportation Department
Thomas Gray, AICP, Principal Planner, Transportation Department
Sharon Ju, Senior Planner, Transportation Department

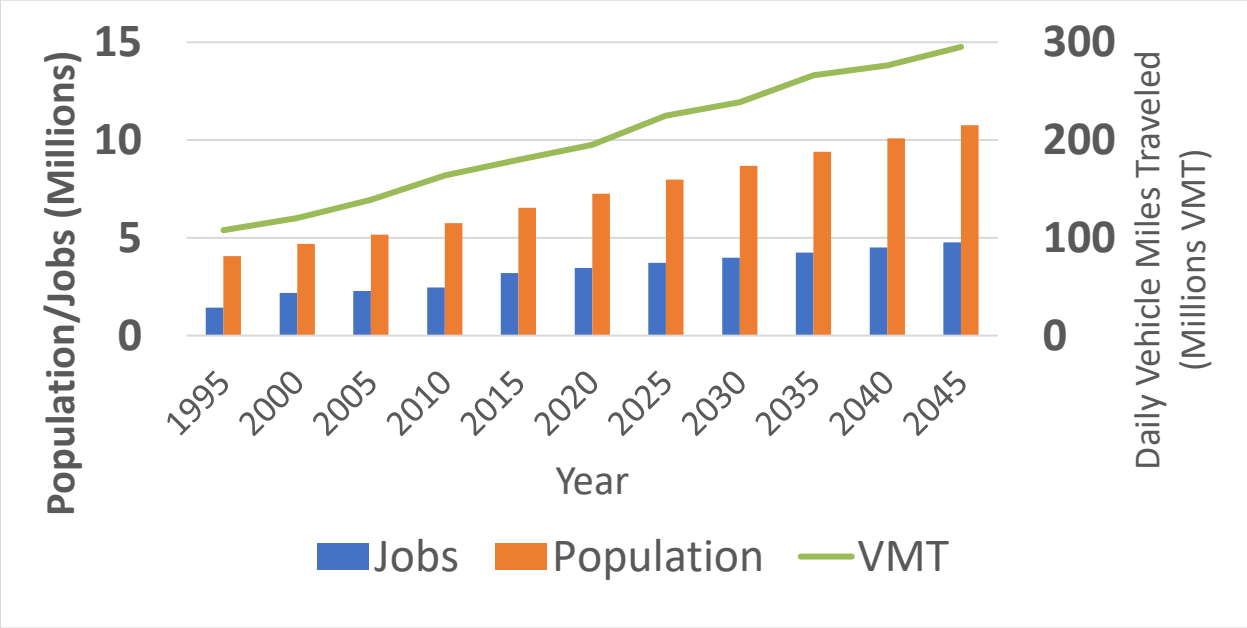
Introduction

As the Metropolitan Planning Organization for Harris and the adjacent seven counties, the Houston-Galveston Area Council's (H-GAC) Transportation Policy Council (TPC) is charged with collaboratively establishing priorities for state and federal transportation investment through a long range, multi-modal Regional Transportation Plan (RTP). The RTP, which is currently in the process of being updated for 2045, envisions reconstruction and capacity improvements to many of the region's thoroughfares, freeways and toll roads. Future growth in the region's population and economy will result in increased personal and freight travel. The impending increase in travel will surpass this region's ability to meet mobility needs solely with increased roadway capacity.

The economic success of the region and its communities will depend on transit services focused on efficiently moving large numbers of travelers. As the region grows from seven to nearly eleven million residents over the next twenty-five years, it will be essential to create convenient, effective transit alternatives to traveling alone in individual vehicles, as depicted in **Figure 1**. To do so, the existing transit system requires significant improvements to be safer and more reliable, provide competitive travel times and be accessible to a high percentage of the region's population.

To that end, the TPC created the High Capacity Transit Task Force ("Task Force") to "*identify regional benefits, funding solutions and policy considerations to advance High Capacity Transit throughout the region, and to provide recommendations that could be included in the 2045 RTP"*.

Figure 1: Anticipated Growth in Population, Jobs and Vehicle Miles Traveled (VMT)



Source: H-GAC

What Is High Capacity Transit and Why Is It Needed?

High Capacity Transit (HCT) is any form of public transportation that can move a large number of people at higher average travel speeds, typically by utilizing a combination of dedicated right-of-way, larger vehicles, and more frequent service. HCT can be any technology (e.g. bus or rail) or alignment (e.g. at-grade, elevated or underground), but it generally has an exclusive transitway (such as a rail line, busway, or high-occupancy vehicle lane) that is separated from other traffic, thereby allowing it to operate unimpeded by normal traffic congestion. The region has multiple examples of existing HCT in the form of the Metropolitan Transit Authority of Harris County's (METRO) light rail network (vehicle shown in **Figure 2**), as well as the regional suburban park and ride network which uses express buses that travel in High Occupancy Vehicle (HOV) lanes or managed lanes that control vehicular congestion through pricing mechanisms. Additionally, METRO is currently participating in the construction of a Bus Rapid Transit (BRT) line along Post Oak Boulevard in the Galleria area. The Post Oak Boulevard BRT line will utilize bus-only lanes within the center of the boulevard as well as an exclusive transitway parallel to Loop 610.

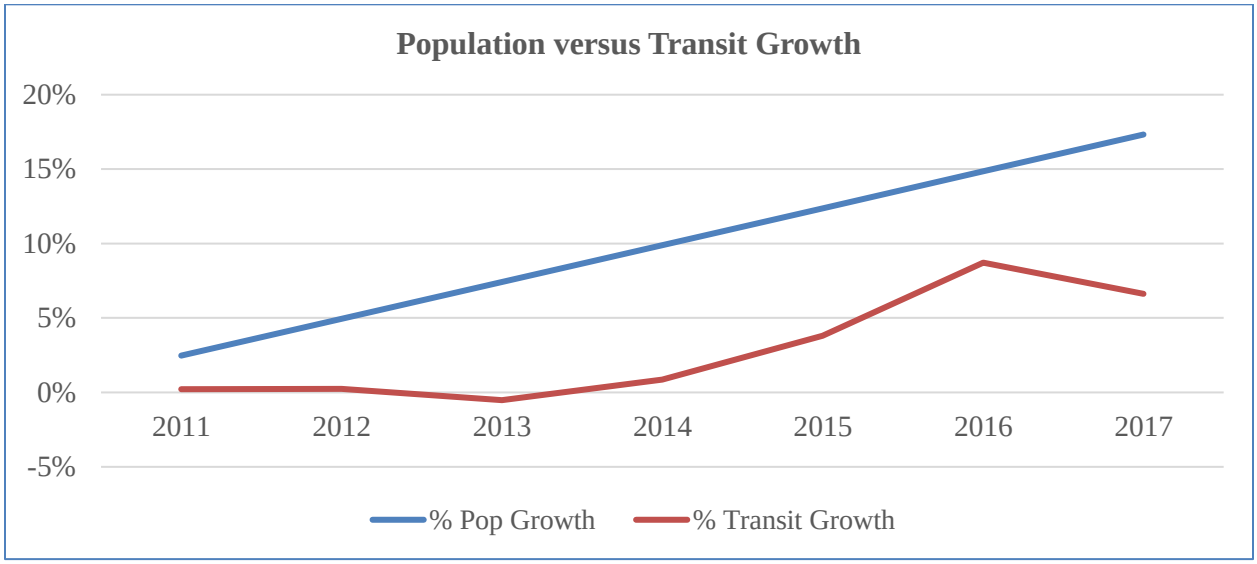
Figure 2: METRORail Light Rail Vehicle

Source: METRO

The region is expected to add an additional 4.2 million people and 1.6 million jobs between now and 2045. Much of this growth will occur in areas of the region not currently served by, or with limited access to, transit. Existing transit service has already fallen behind regional growth, as indicated in **Figure 3**, due at least in part to the fact that region's transit network still favors traditional commute patterns to the region's core even as a growing number of regional workers engage in nontraditional travel patterns, such as reverse commutes to reach suburban employment centers, or suburb-to-suburb commutes.

In order for the region to flourish, additional HCT services are necessary because widening highways alone cannot accommodate anticipated population and employment growth. The solution to avoid impending regional gridlock is to develop a transportation network that can move large numbers of people within limited public right-of-way.

Figure 3: Regional Population Growth vs Transit Growth, 2010-2017



Source: National Transit Database, US Census Bureau

High Capacity Transit Task Force Purpose and Membership

The Task Force was created by the TPC in Spring 2017 for the purpose of investigating the need and opportunity for HCT in the Houston-Galveston region. Building on previous transit planning work conducted by H-GAC, METRO and other agencies, the Task Force was assigned to answer the following questions:

1. What is the importance of high capacity transit to the region's future? How will it support regional mobility, growth and quality of life?

2. What current and future travel corridors would benefit most from new high capacity transit services?

3. What are the opportunities to obtain additional federal, state or other funds that could be used to develop and sustain high capacity transit projects?

The Task Force's charge is to:

"Coordinate with regional stakeholders to identify regional benefits, funding solutions and policy considerations to advance High Capacity Transit throughout the region."

The Task Force is comprised of members of TPC, transit providers, and other key stakeholders. It is directed by three Task Force officers:

- Rusty Senac, Commissioner, Chambers County
- Amanda Edwards, Councilmember at-Large, City of Houston
- Carrin Patman, Chairman, Metropolitan Transit Authority of Harris County, Texas

The Task Force includes three Workgroups, each charged with investigating in detail the focused topics of:

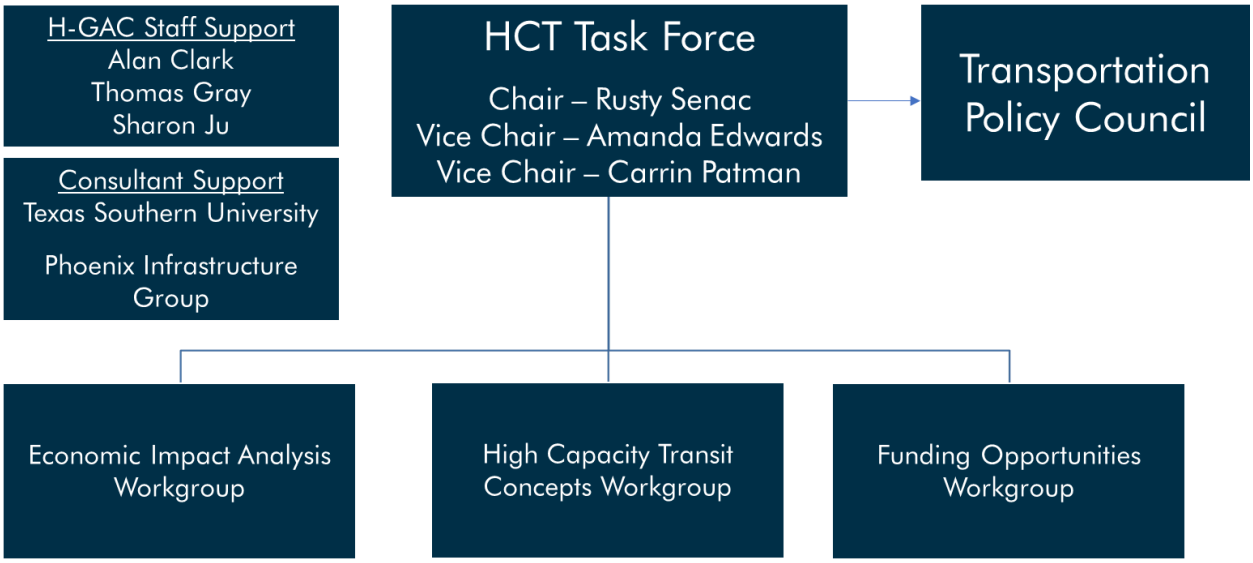
- **Economic Impact:** What are the potential costs and benefits?
- **Service Concepts:** Based on our travel needs, what services are needed, where and at what level of service?
- **Funding Opportunities:** What potential funding and financing mechanisms are available?

Task Force Workgroup Leaders are:

- Economic Impact: Bob Eury, President, Downtown Houston Management District
- Service Concepts: Amanda Edwards, Councilmember at-Large, City of Houston
- Funding Opportunities: Tom Lambert, President and CEO, Metropolitan Transit Authority of Harris County, Texas

The Task Force was supported by both agency staff and contractors as depicted in **Figure 4**.

Figure 4: High Capacity Transit Task Force Structure



Example Regions and Workgroup Findings

The three Task Force Workgroups kicked off the study with an investigation into relevant examples and practices from other regions of the country and world. A list of twelve "example cities" in the United States, Canada and the United Arab Emirates was developed based on whether they had one or more characteristics in common with Houston-Galveston region, such as urban form, climate and/or geography. Transit service, ridership data, and other criteria relating to the service, funding and economic impact of HCT in those cities were surveyed and reported back to the full Task Force. A list of the example cities and regions is shown in **Table 1**, and a

complete summary of those findings is available in **Attachment One: Phase I Analysis and Deliverable** appended to this document.

Table 1: Example Regions Investigated by the HCT Task Force Workgroups

Country	City or Region	Economic Impact	Service Concepts	Innovative Funding
	Atlanta	☑	☑	
	Austin		☑	
	Cleveland	☑	☑	☑
	Dallas/Fort Worth	☑	☑	
	Denver	☑		☑
	Los Angeles		☑	
	Miami		☑	☑
	Seattle	☑		☑
	Washington, DC	☑	☑	☑
	Ottawa			☑
	Vancouver		☑	
	Dubai		☑	

Key overall findings of the three Workgroups from this review of example cities and regions are as follows:

- Continued economic success and quality of life of a burgeoning region requires new transportation and land use development solutions.
- Residents within these cities and regions developed very high demand for expanded access to transit and improved quality of transit service (frequency, speed, etc.).
- Economic benefits can be identified for individual citizens, employers, and the community at large.
- These and other regions are using both traditional and non-traditional funding sources, including public-private partnerships, to expand transit.

In August 2018, the Task Force hosted a panel organized by Rail~Volution, a national transit resource and information organization. It invited speakers from Minneapolis, Los Angeles, Denver and Atlanta to share their experiences in seeking approval for and implementing HCT solutions in their respective regions. Some key takeaways from the panel were:

- The need to build diverse coalitions (using an inclusive process rather than a top-down approach),

- The value of creating confident and expansive plans ("fortune favors the bold"), and
- Changing demographics and household economics are translating into greater preference for expanded transit services and less dependence on personal auto travel, which can be used to a region's advantage when seeking to promote high capacity transit.

The three Task Force Workgroups took an inventory of the challenges, needs and opportunities regarding the provision of HCT in the H-GAC region, which can be summarized as follows:

Economic Impact:

- There are three types of economic benefits: individual/social, business, and regional/community benefits;
- Residents and businesses must acknowledge that this region is going to "pay" for congestion through increased costs associated with greater travel times and higher living costs, as a result of more limited housing options; and
- Alternatively, residents and businesses can choose to invest in alternatives like HCT and improve residents' quality of life and the region's economic vitality.

Service Concepts:

- Significant demand for HCT exists today or will soon exist in all eight counties;
- When speaking with residents and businesses, the conversation should focus on transit needs and various transit solutions in addition to HCT;
- People need to have access to transit service to be able to use it; and
- Equity is a critical consideration as the different transit needs of communities within the region require appropriate transit services. Services should be prioritized by need rather than type (e.g. a community may need local bus service long before it needs HCT).

Funding Opportunities:

- Any significant expansion of HCT will require revenue sources that do not currently exist in the Houston-Galveston region;
- Every transportation investment should be viewed as a potential opportunity to expand transit accessibility, remove barriers to transit services and advance a Regional HCT vision;
- No single revenue source is a "magic bullet" – multiple strategies are required; and
- The region must "speak with one voice" to fiscal decisionmakers (i.e. lawmakers at the federal and state levels).

The Vision Network

The Vision Network was developed by the Service Concepts Workgroup and presented to the full Task Force for input and concurrence. The Vision Network is a comprehensive, financially-unconstrained network aimed at meeting all the region's forecasted transit needs by the year 2045. It incorporates planning efforts undertaken by other agencies, such as the METRONext Vision Plan currently under development by METRO. This network could be used to identify priorities for potential inclusion in the 2045 RTP as well as provide a basis for coordination with regional transit providers on long-range planning efforts and funding.

The Vision Network Map, shown as **Figure 5**, contains a variety of service types, including HCT Peak, HCT All Day, and Express Bus. These service types are a refinement of a service typology originally created by the Service Concepts Workgroup, as shown in **Table 2** below. Potential technologies exist and can be applied to the listed service types as indicated. HCT services are assumed to operate along dedicated transitways, such as exclusive bus lanes or railways. In addition to its HCT elements, the Vision Network contains a supportive background of local and regional bus routes, on-demand services, park and rides, transit center facilities, and operating and maintenance facilities. These services are explained in greater detail below.

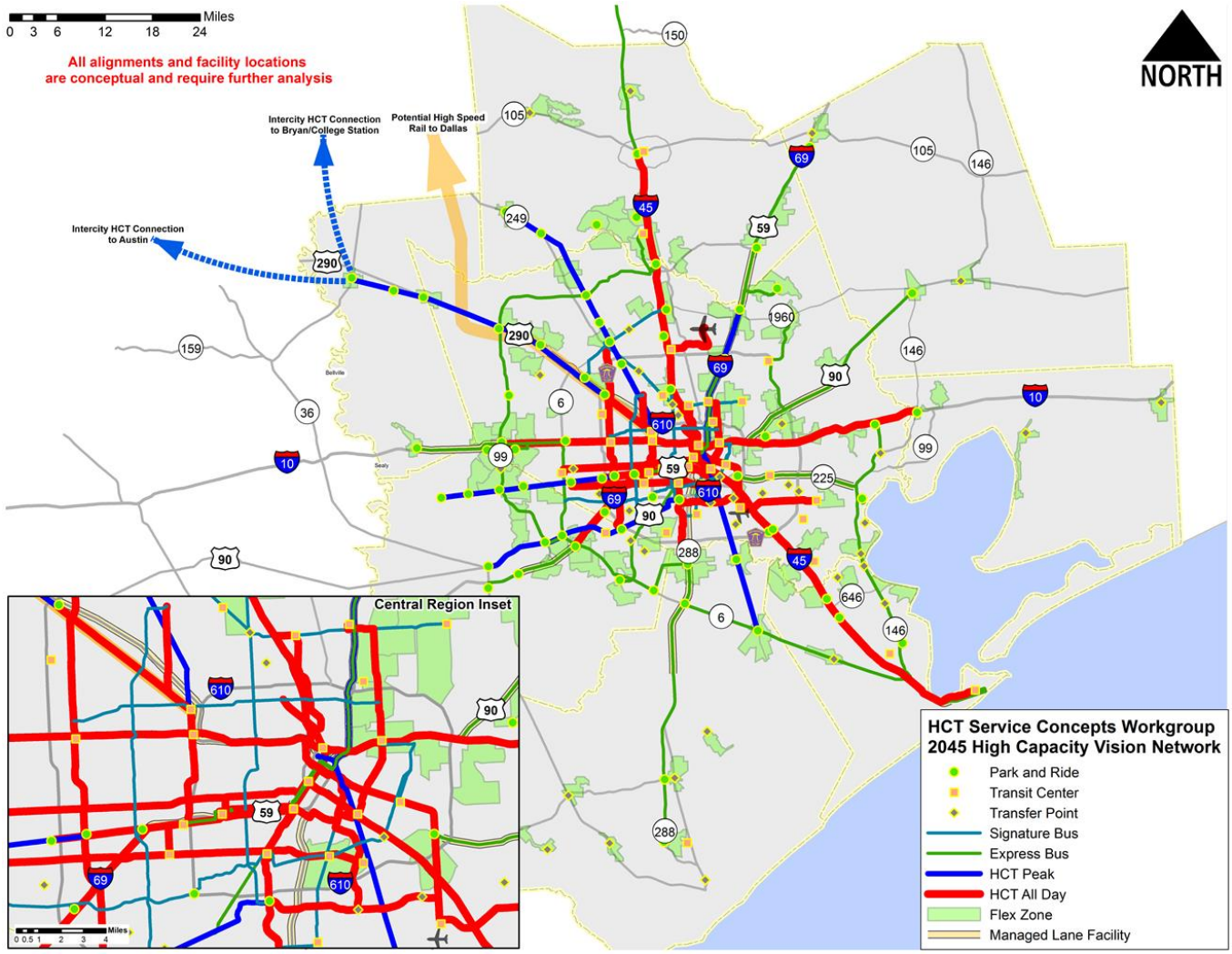
Table 2: Service Types and Potential Technologies of the Vision Network

Vision Network	Service Concepts Workgroup	Potential Technologies
Flex Zone	District Circulator First Mile/Last Mile	Deviated Fixed Route; Demand Response
Local and Regional Bus	Local Circulation and Connectivity	Local Fixed-route Bus; Deviated Fixed Route; Bus Rapid Transit (arterial)
Signature Bus		
Express Bus	Regional Commuter/Express	Express/Limited-stop Bus; Bus Rapid Transit; Light Rail Diesel Multiple Unit, Heavy Rail, Commuter Rail
HCT Peak		
HCT All Day	Sub-Regional Corridor and Internodal Service	Bus Rapid Transit; Light Rail; Heavy Rail; Automated Transit System

The service types depicted in the Vision Network are mode-, technology- and alignment-neutral; decisions as to the type of technology (e.g. light rail or bus rapid transit) or alignment (e.g. at-

grade or grade-separated) require further analysis and should be specific to each corridor as well as the communities served.

Figure 5: The HCT Task Force Vision Network



Services in the Vision Network include:

HCT All Day (also known as Sub-Regional Corridor and Internodal Service): services operate frequently throughout the day along high-demand corridors between major trip generation centers. Stations are generally spaced less than three miles apart. Example potential services include extensions of existing METRORail corridors and new lines along high-volume corridors such as Bellaire, Beltway 8/Gessner or Westheimer. Additional services along freeways could be realized by converting existing one-way, reversible HOV lanes to a two-way, all-day network that features additional passenger facilities.

HCT Peak (also known as Regional Commuter/Express Service): services operate at higher speeds and along longer distances between population centers and high employment or activity centers. Station spacing is generally greater than 3 miles. HCT Peak typically operates more frequently during the morning and afternoon commute periods with a less frequent service at midday and evening. Example potential services include lines connecting residential communities in Fort Bend, Montgomery, Waller and Brazoria Counties to the region's core.

Express Bus (also a subtype of Regional Commuter/Express Service)**:** like HCT Peak services, Express Bus service operates longer-distance, peak-focused travel along lower-volume corridors, with limited stops. While HCT Peak service generally requires an exclusive right-of-way, Express Bus can operate along the region's existing roadway system, using HOV and managed lane facilities to the extent possible. Express Bus services in the Vision Network include those originating from emerging population centers in eastern Harris County, Liberty County, southern Waller County, and southern Brazoria County to the urban core. Reverse commute services to peripheral activity centers, such as to downtown Galveston or The Woodlands Town Center, are also included, as are suburb-to-suburb services connecting Pearland to Alvin and Galveston, Sugar Land to the Energy Corridor, or the Energy Corridor to The Woodlands. These suburb-to-suburb commute patterns are becoming more commonplace as the region continues to grow.

Signature Bus (also known as Local Circulation and Connectivity Service)**:** an enhanced local bus service operating along high-volume corridors. By taking advantage of limited stops and time-saving measures such as signal priority systems, all-door boarding, designated lanes, and off-board fare collection, Signature Bus service operates at higher speeds than standard local service. In the Vision Network, Signature Bus arterials include Bingle, Braeswood, Hillcroft, Kirby, Tidwell and Old Spanish Trail.

Additional Services: A successful transit vision must have a supportive network of local service to provide access to and distribution from the high capacity system. The Vision Network includes these additional elements:

- Expanded local bus services, especially in areas indicating high transit need that do not currently have service, such as Pasadena, Channelview, northwest Harris County, northeast Fort Bend County, and NASA/Bay Area.
- Regional bus services, which are lower-volume, lower-frequency routes that connect outlying communities to each other as well as the urban core.
- Flex Zones, which are geographically-defined demand response zones serving suburban communities, small towns and other areas where there is transit need but where traditional fixed-route bus is not appropriate. Flex Zone services are shared-ride and are arranged in advance by calling a dispatcher or using a smartphone app; they can provide first mile/last mile service to and from HCT stations.

In addition to the Vision Network, the Task Force also recommends that the region consider a set of supporting policies and concepts that would increase the usability and effectiveness of the network. These policies and concepts include:

- A regional fare system allowing transit users to pay a single fare and use one fare media to travel throughout the region on multiple transit providers;
- Regional marketing campaign aimed at conveying the benefits of regional transit to existing and potential transit users;
- Universal Accessibility, which focuses on the availability of safe, barrier-free access to transit services for all users, regardless of ability. This includes, for example, Americans with Disabilities Act (ADA)-accessible sidewalks, crosswalks and ramps, bicycle infrastructure, lighting and other elements that allow people to safely access transit services. In fact, if adequate access is not provided, new transit services should not be provided, as people can't use what they can't reach;
- First Mile/Last Mile relates to the ability for transit users to get to the transit station from their origin, or from the transit station to their final destination; and
- Transit-supportive land use and urban design which prioritizes the creation of walkable, transit-friendly spaces. Examples include "Complete Streets" that allow the safe use of all modes (such as College Street in Toronto, shown in **Figure 6**) and Transit-Oriented Development (TOD).

Figure 6: College Street, Toronto, Canada

Source: Complete Streets for Canada

A detailed listing and explanation of these supportive policies and concepts is available in **Attachment Two: Policy Recommendations**, which is taken from Chapter 13 of the *Regional Transit Framework Study 2017 Interim Report*, an internal H-GAC planning document that was one of the previous studies upon which the Task Force effort was based.

Finally, the Task Force considered the potential effects of automated vehicles on the Vision Network. Automated vehicles (aka "driverless cars") are currently in advanced stages of testing and are anticipated to become fully integrated into the region's transportation networks by the

year 2045. Their arrival will create a multitude of opportunities and challenges; on one hand, automated vehicle technologies could substantially reduce the cost of providing transit service and expand access to it. On the other hand, the potential proliferation of driverless vehicles for ride-sharing and delivery could worsen congestion as vehicle miles traveled increases with the convenience of automation. The region must monitor new technologies and develop effective policies to prepare for the effects of its implementation, especially in regard to transit, HCT or otherwise.[1]

Design Criteria for the Vision Network

Concurrent with development of the Vision Network, the Service Concepts Workgroup generated a list of design criteria by which the conceptual applications of technologies and modes will be developed for regional transportation corridors, urban centers and major activity centers. These criteria have not been established as "pass" or "fail" criteria, but rather as points of consideration, and are as follows:

1. Does the proposed option improve access and mobility to and from major activity centers such as:
    - Workplaces/Employment Centers?
    - Health and Education Centers?
    - Economic Centers?
    - High Capacity Transit Hubs?
2. Does the proposed option present the best travel alternatives to heavily congested freeways and roadways?
3. Does the proposed option contribute to the economic development of the region or its standing as an international City/Hub?
4. Does the proposed option enhance the full spectrum of livability (live, work, play; see H-GAC Livable Centers studies) for people of all incomes, abilities and ages?
5. Does the proposed option allow sufficient flexibility to change service patterns as warranted by evolving demand?

[1] J. Sam Lott, who was a consultant for the Task Force, has developed an opinion paper regarding challenges and opportunities related to high-capacity transit and automation, the executive summary of which is available as **Appendix A: *High Capacity Transit for the Houston Region – Creating a Multimodal System Approach for the 21st Century*.** The concepts and opinions included in the paper do not represent the work of the Task Force or its recommendations but are nevertheless valuable to consider as the H-GAC region faces the twin prospects of the need for more High Capacity Transit and the advent of vehicle automation.

6. Does the proposed option provide connectivity for an integrated multimodal HCT system with system-wide, cohesive connections from start-to-finish (for the maximum span of service hours possible)?
7. Does the proposed option make the transit system more resilient in the event of extreme demand or catastrophe?
8. Does the proposed option allow transit users and non-users to travel safely?
9. Does the proposed option contribute to emissions reductions?

Travel Demand Modeling

The Vision Network was modeled using travel demand modeling software to determine the potential transit demand for the included services. The travel demand model ("model") uses H-GAC's population and employment forecasts for 2045 by traffic analysis zone (TAZ) to project transit patronage. The model is calibrated to consider multiple variables related to transit demand, including travel time (average speed), roadway congestion, tollway revenue, transit fares and parking costs. The travel demand analysis process for the Vision Network produced forecasted ridership (unlinked trips) for fixed route services only. Demand response, ADA paratransit and vanpool services are beyond the modeling software's capabilities. Therefore, estimates were based on the region's current ratio of non-fixed route to fixed-route boardings, according to the most recent National Transit Database (NTD) data. The ridership forecast results are as follows:

Annual Boardings, Fixed Route:	804,957,050
Annual Boardings, Demand Response and ADA Paratransit:	20,928,883
Annual Boardings, Vanpool:	26,904,099
Annual Boardings, Total:	**852,790,031**

For purposes of comparison, the most recent NTD data in 2017 reported[2] that the region's transit network carried 90,447,627 boardings for all services. The model projects annual boardings to increase to 852,790,031 unlinked trips, which is an almost tenfold increase in regional transit ridership from 2017.

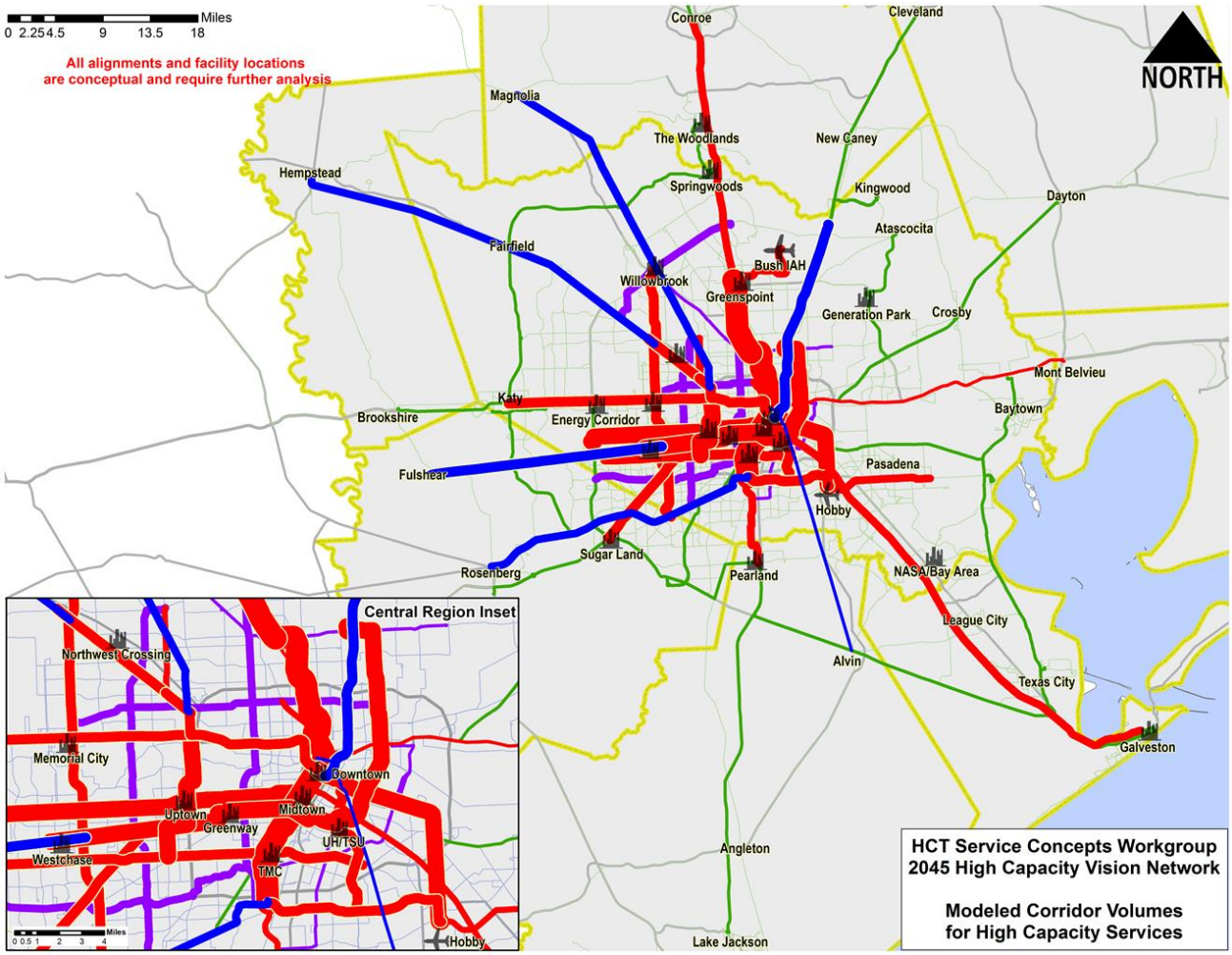
It should be noted that these numbers are not capacity-constrained; that is, they do not consider a maximum number of passengers a given service can accommodate due to vehicle capacity and service provision constraints. Capacity-constrained demand was analyzed for alternate capital expenditure scenarios of the Vision Network, as explained in the following section.

The results from the model can be further broken down by route showing which individual services in the network are carrying the highest amount of boardings. Relative demand for HCT

[2] 2017 NTD reports for all ten of the region's transit providers can be found in **Appendix B** of this document. This is the most recent year for which NTD data is currently available.

services included in the Vision Network is shown in **Figure 7**. Where thicker lines indicate greater demand, model results show significant boardings on both existing (e.g. Main Street METRORail Line) and proposed HCT services within the region's core, with significant amounts of travel in both the north-south and east-west directions.

Figure 7: Relative 2045 Corridor Demand of the HCT Task Force Vision Network



Capital Expenditure Scenarios

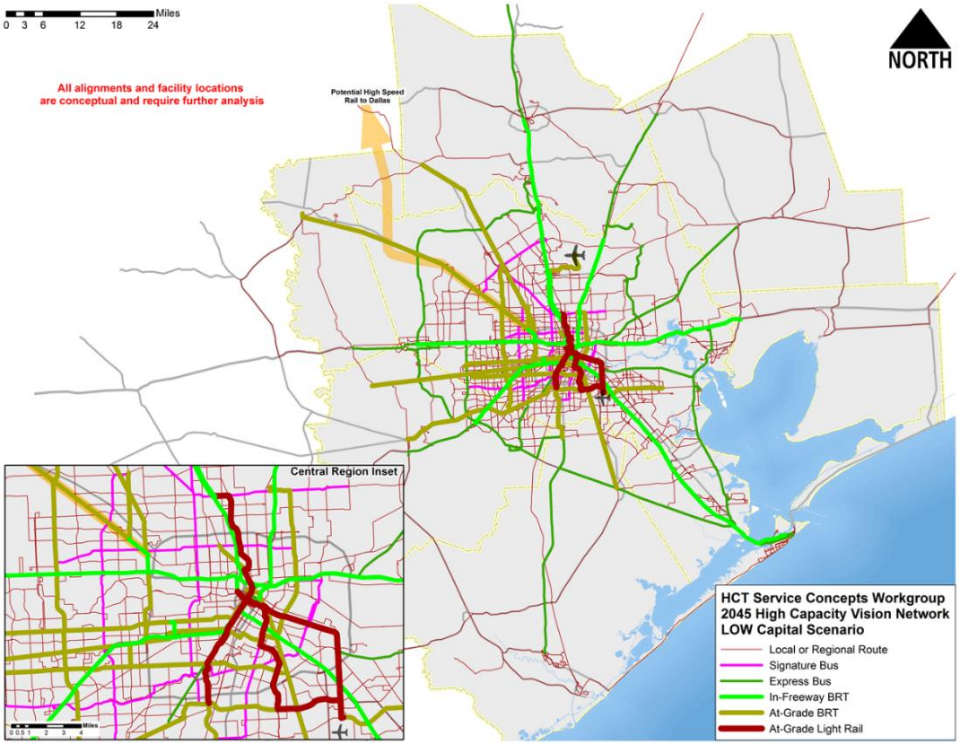
While the services in the Vision Network are intended to be mode- and technology-neutral pending future and more detailed analysis, it is important to consider what the costs and ridership of the network might be if certain assumptions about mode and technology were made. Theoretically, a higher level of capital investment is likely to result in greater benefits than a network with a lower level of capital investment, based on varying efficiencies and costs of mode choice and technology. For example, greater capital investment in rail instead of bus, or grade-separated transitways rather than at-grade dedicated transit lanes, results in faster average travel speeds, more capacity, more reliability and increased safety.

To test this theory, four capital expenditure scenarios ("CE scenarios") were developed using recommendations included in the Vision Network. Each CE scenario depicts a low to high level of investment based on the cost of specific modes and technologies. Capital costs were calculated using the same unit costs as the METRONext long-range planning effort and are in 2018 dollars. Passenger facility, O&M facility, and fleet costs (non-HCT) were the same across all scenarios, and all scenarios include allowances for State of Good Repair and Universal Accessibility. All four CE scenarios assumed highway expansion. More details about the assumptions of the four scenarios, as well as the unit costs used for calculating the estimated costs for each scenario, is appended to this summary in **Attachment Three: HCTTF Vision Plan Capital Cost Scenarios**.

Below are brief descriptions and illustrations of each of the four CE scenarios:

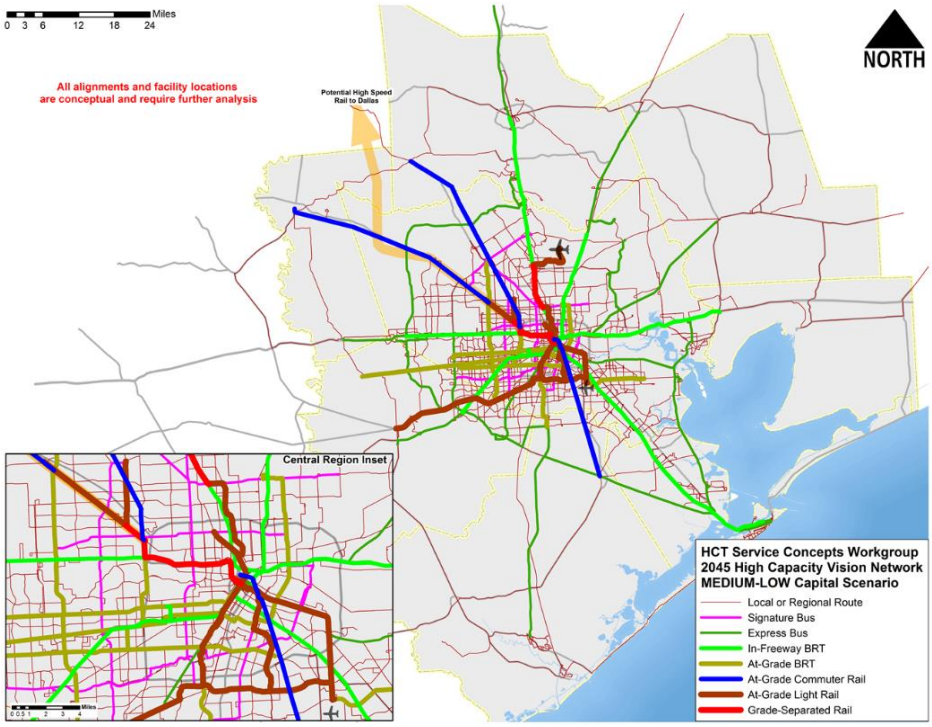
- **Low:** Assumes at-grade or in-freeway bus rapid transit on all HCT Peak and HCT All Day corridors with the exception of extensions of existing METRORail corridors, which are assumed to be light rail. Total capital cost: $34.675 billion. See **Figure 8**.

Figure 8: Low Capital Expenditure Scenario



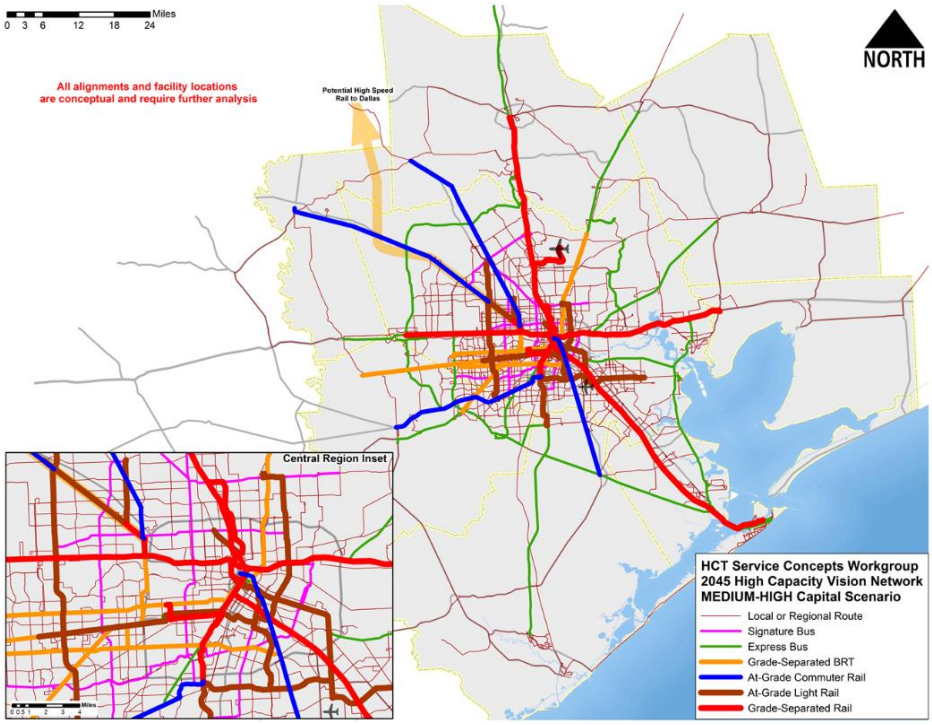
- **Medium-Low:** Assumes a mix of at-grade or in-freeway bus rapid transit, at-grade light rail, and at-grade commuter rail on most HCT corridors, with a small amount of grade-separated rail. Total capital cost: $42.239 billion. See **Figure 9**.

Figure 9: Medium-Low Capital Expenditure Scenario



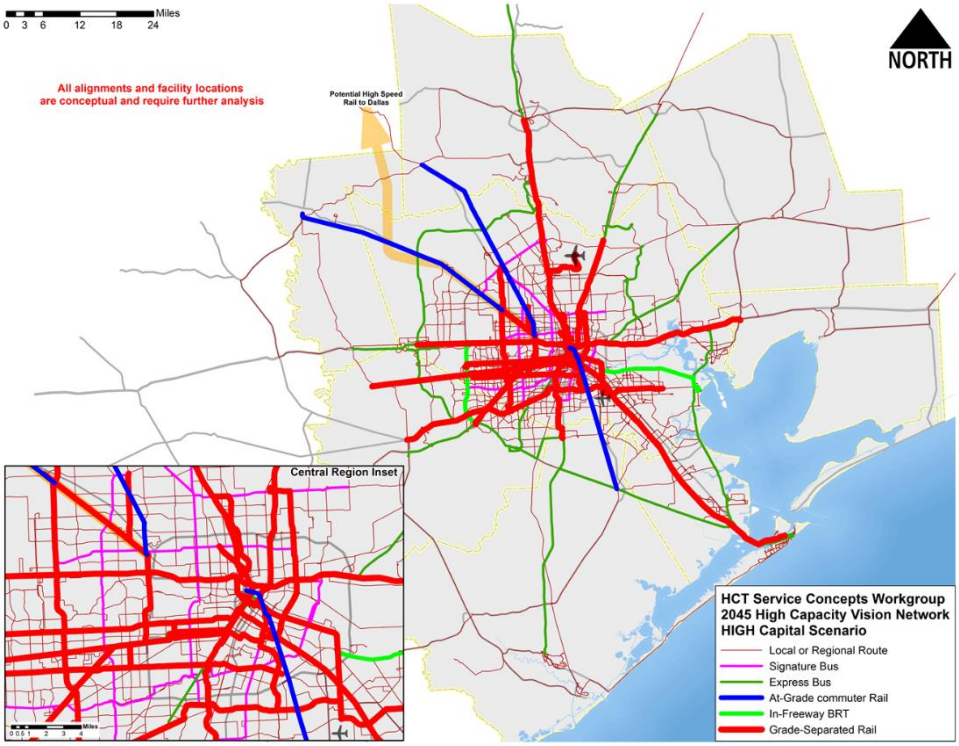
- **Medium-High:** Assumes a mix of grade-separated rail, grade-separated BRT, at-grade light rail and at-grade commuter rail on most HCT corridors. Total capital cost: $81.326 billion. See **Figure 10**.

Figure 10: Medium-High Capital Expenditure Scenario



- **High:** Assumes grade-separated rail on almost all HCT corridors, including the replacement of the existing at-grade Main Street METRORail line with a subway from north of downtown to south of the Texas Medical Center and the conversion of some Express Bus services to true BRT. Total capital cost: $100.402 billion. See **Figure 11**.

Figure 11: High Capital Expenditure Scenario



The CE scenarios were then analyzed using travel demand modeling software, with the model adjusted to assume slower speeds for at-grade services and capacity constraints for vehicle sizes and train consist lengths. The High CE scenario was assumed to be capable of carrying the total projected travel demand of the Vision Network in order to provide a realistic comparison of the impact of each scenario. The model results, and other selected characteristics, for the four scenarios are shown in the **Table 3**.

Table 3: Capital Expenditure Scenarios: Selected Ridership & Cost Characteristics

Capital Expenditure Scenario	Low	Medium Low	Medium High	High
Annual Boardings, All Services	**515,153,585**	**542,678,428**	**636,250,959**	**852,790,031**
Fixed Route	492,028,257	518,317,506	607,689,550	804,957,050
Demand Response, Paratransit and Vanpool	23,125,328	24,360,923	28,561,409	47,832,982
Annual Passenger Miles, All Services	**2,700,696,565**	**2,967,766,399**	**3,699,973,053**	**5,563,669,897**
Annual Passenger Hours, All Services	**155,304,181**	**164,686,091**	**176,399,017**	**251,235,482**
Annual Transit Vehicle Revenue Miles, All Services	**220,063,071**	**220,063,071**	**220,058,813**	**220,058,813**
Annual Transit Vehicle Revenue Hours, All Services	**13,293,913**	**13,293,913**	**12,962,273**	**12,939,654**
Capital Cost, Cumulative 2020-2045	**$ 34,675,017,500**	**$ 43,238,367,500**	**$ 81,325,517,500**	**$ 100,402,027,500**
Annual Net O&M Cost, All Services, Full Buildout	**$ 1,408,788,116**	**$1,408,788,116**	**$ 1,358,961,265**	**$ 1,358,495,074**
Boardings/revenue mile	2.3	2.5	2.9	3.9
Boardings/revenue hour	38.8	40.8	49.1	65.9
Net cost/boarding	$2.73	$2.60	$2.14	$1.59
Transit Mode Share: Home-Based Work Trips	**11.5%**	**12.3%**	**14.2%**	**20.2%**
Comparable City/Metro (per US Census ACS Data)	Chicago	Boston	Washington, DC	2nd only to NYC

As **Table 3** illustrates, higher capital investments are more cost effective in terms of operating costs, boardings per revenue mile and hour, and cost per boarding. This is to be expected because a higher level of capital investment results in higher speeds and capacities, and therefore more passenger throughput. Additionally, all four CE scenarios significantly increase the percentage of commute trips (home-based work) made by transit to be comparable to mode shares seen in cities with significant existing transit infrastructure. Currently, the H-GAC 8-county region's work commute mode share is 2.3%. Such a relatively low transit mode share for commute trips foreshadows future gridlock as the region grows and as the need for commuter solutions grows in areas not adequately served by the existing transit network.

In addition to the four CE scenarios, two no-build scenarios were created for purposes of comparison, especially as it relates to benefit-cost analysis as described in the following section. The first no-build scenario ("No-Build") assumes no new highway or transit expansion between now and 2045, and the second scenario ("2040 Highway") assumes highway expansions but no change in the transit network between now and 2045. A table including these additional scenarios, as well as current (2017) NTD data for the region, and additional cost and ridership statistics is appended to this summary as **Attachment Four: Scenario Comparison Table**.

Benefit-Cost Analysis and Economic Impact

The economic benefits and costs of the four CE scenarios, as well as the two no-build scenarios, were estimated using the Regional Economic Modeling Inc.'s (REMI) benefit-cost analysis tool, which evaluates the cumulative economic effects of changes to transportation systems. The REMI tool indicated that substantial benefits in excess of costs were found for all scenarios investing in additional high capacity transit infrastructure and services, compared to no-build scenarios.

Description of Benefits

Benefits can be broadly categorized into two classes: societal (user) benefits, such as travel time savings, safety improvement, or lower vehicle operating costs and impacts, such as employment, personal income, regional product, property value, and productivity.

Societal Benefits

Societal (user) benefits for the no-build and CE scenarios are shown in **Figure 12** and include:

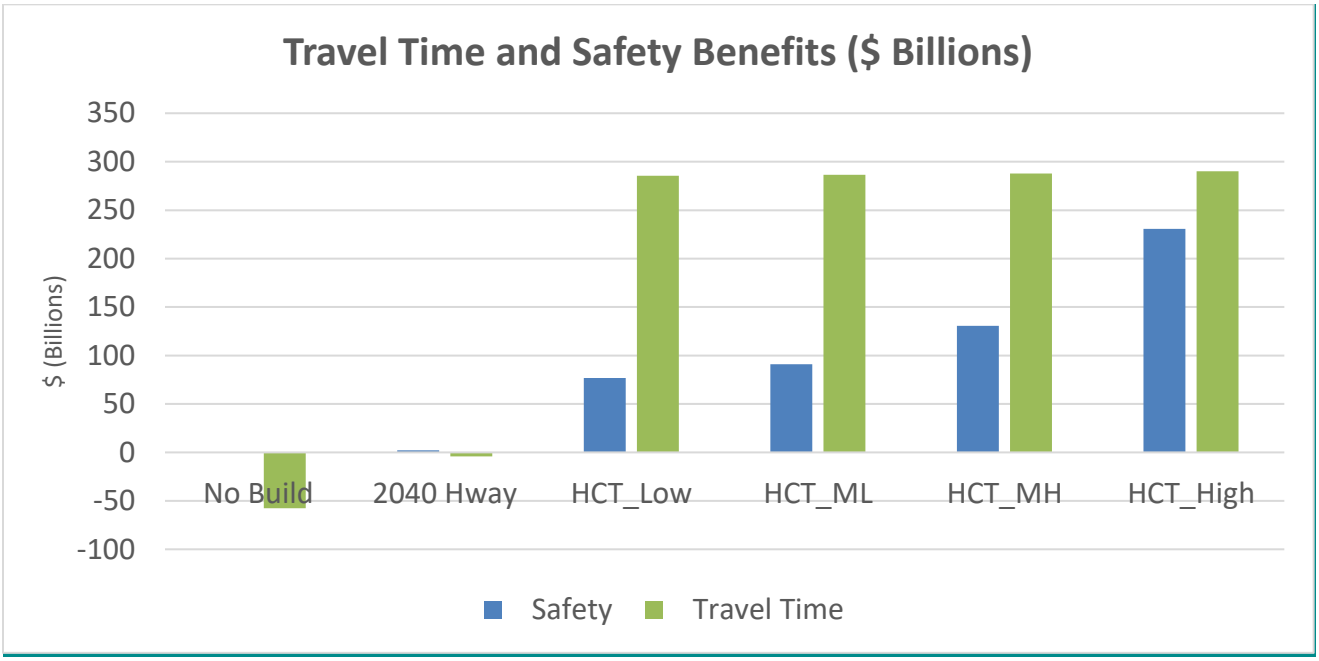
- **Travel Time Savings** represent the present value of user benefits from changes in travel time and delay. A positive value represents a decrease in travel time and delay and a negative value indicates an increase in travel time and delay. Travel time benefits include not only the time saved by the travelers, but also changes in costs to employers for travel time associated with business trips or commerce (delivery of goods).

  Travel efficiency benefits accrue for both transit users and non-users. Transit riders benefit from transit improvements reducing their door-to-door trip time. Increasing transit ridership also reduces highway traffic for both vehicle miles and vehicle hours traveled. Both motorists and industries, such as freight, that rely on free-flowing highways may benefit from increased transit use and services.

- **Safety Benefits** have been estimated based on the present value of changes in the number or severity of crashes. Safety benefits include changes in medical, property, and legal costs associated with accidents, as well as monetary value assigned to fatalities and injuries. It should be noted that vehicle crashes are also one of the leading factors in increased traffic congestion; however, the congestion-related benefits from crash reduction were not included in the analysis shown in **Figure 12**.

As **Figure 12** shows, all capital expenditure scenarios generate travel time savings and safety benefits well in excess of their costs, while the no-build and highway-only scenarios either have a disbenefit or a very minor benefit.

Figure 12: Societal (Travel Time and Safety) Benefits of the No-Build and CE Scenarios



Economic Impact

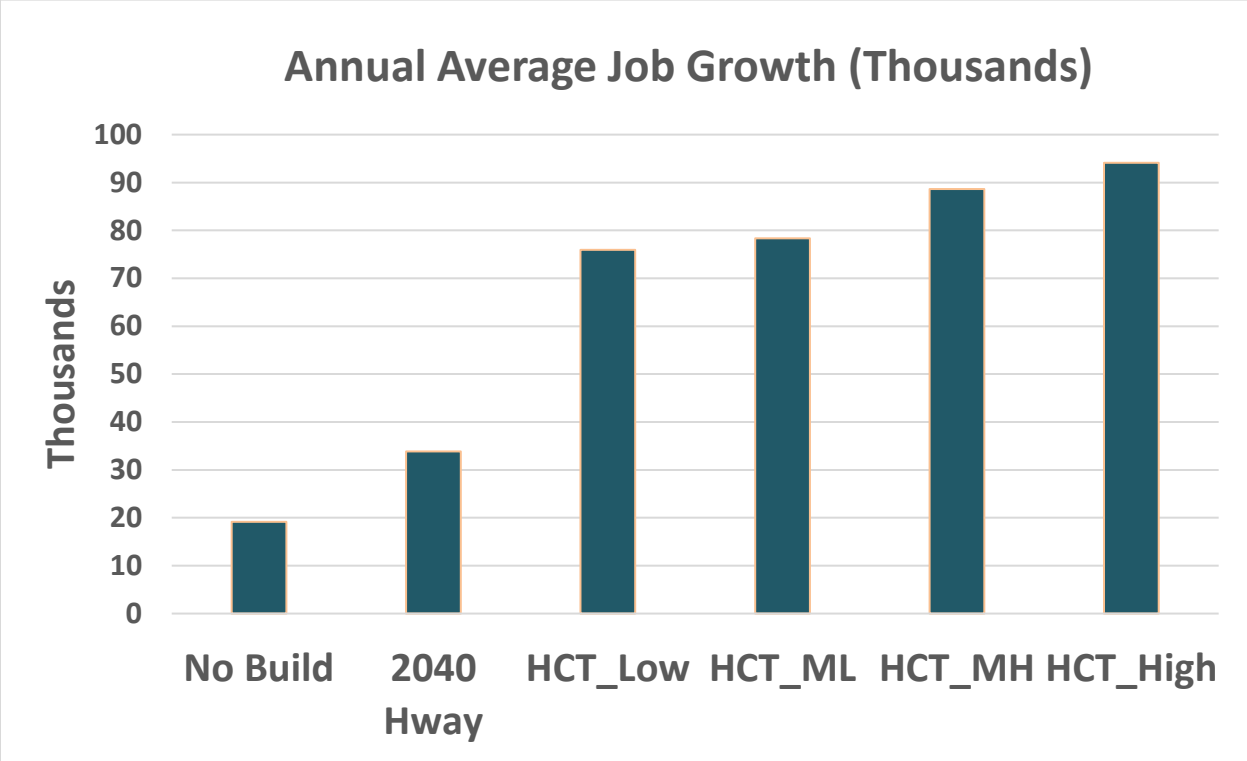
The Vision Network is expected to create positive economic impacts for the region because it provides better access to markets and labor force, reduces the cost of delay, and increases productivity. These economic impacts can be measured using four different criteria:

- **Total Employment:** estimates of the number of jobs, full-time plus past-time, by place of work. Full-time and part-time jobs are counted at equal weight. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are not included.
- **Gross Regional Product (GRP):** a monetary measure of the market value of all final goods and services produced in a region or subdivision of a country in a period (quarterly or yearly) of time.
- **Output:** the "quantity" of goods or services produced in a given time period, by a firm, industry, or country, whether consumed or used for further production.
- **Personal Income:** an individual's total earnings from wages, investment enterprises, and other ventures. It is the sum of all the incomes received by all the individuals or households during a given period. Personal income is often monitored as one of the many key economic indicators used to gauge the overall state of the economy.

Annual average employment growth for the no-build and CE scenarios are shown in **Figure 13.** More jobs are coming to the region regardless of transit investment, but the REMI analysis

suggests that annual average job growth could be substantially higher under any of the Vision CE scenarios than under either of the no-build scenarios.

Figure 13: Annual Average Job Growth of the No-Build and CE Scenarios

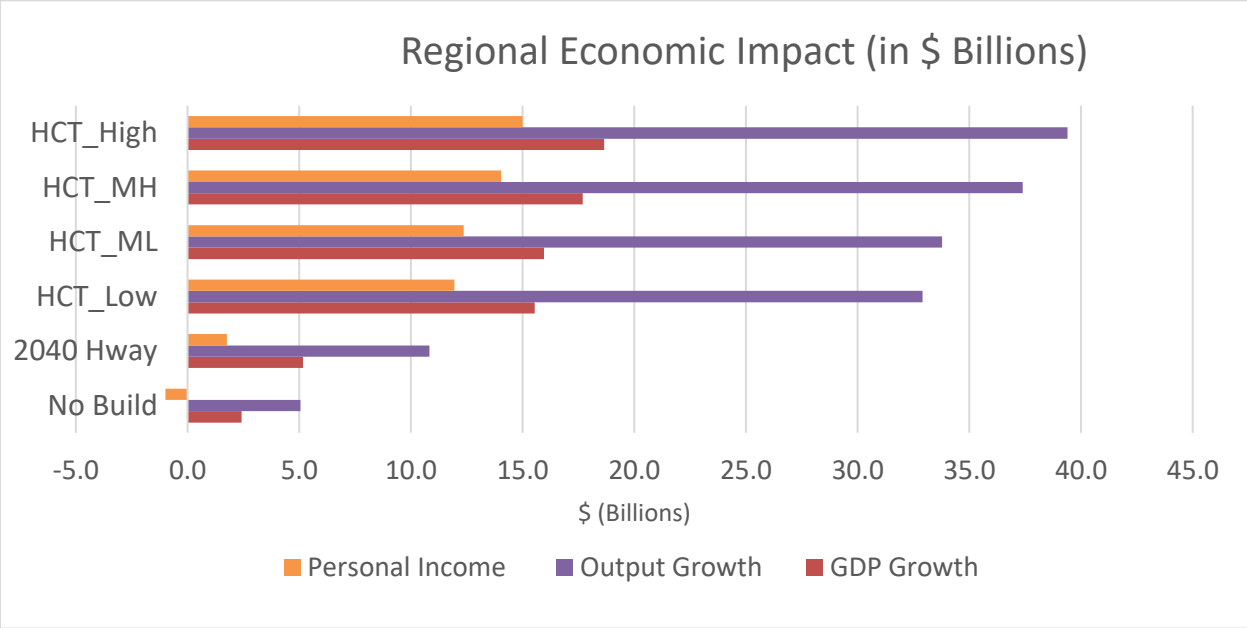


In addition to employment growth, The REMI tool estimated other regional economic impact criteria that are expected to be affected by the four CE scenarios; these are shown in **Table 14**.

As was the case with the societal benefits and costs, all four HCT CE scenarios generate regional economic impacts substantially greater than either of the no-build scenarios. For example, each dollar invested in the High CE scenario would generate $3.25 in increased GDP and almost $7 in increased regional economic output. Combined, the societal benefits and the economic impacts estimated to be created by any of the four CE scenarios suggest that investment in a comprehensive HCT network for the region will pay dividends for the region's economic competitiveness and quality of life. On the other hand, there is a "cost of doing nothing" if the region does not expand its transit network.

A more detailed presentation of benefit-cost analysis and an explanation of the REMI analysis tool is appended to this report as **Attachment Five: Economic Impact Analysis for HGAC's High Capacity Transit (HCT) Project**.

Figure 14: Annual Average Job Growth of the No-Build and CE Scenarios



Potential Funding Sources

Currently, the only transit provider in the H-GAC region with a dedicated funding source is the Metropolitan Transit Authority of Harris County, Texas (METRO), which collects a one percent sales tax. Twenty-five percent of that tax revenue is then diverted to discretionary use by the various municipalities for General Mobility projects. The region's other transit providers rely on discretionary apportionments from local and county general revenue funds, as well as federal and state grants, to operate and maintain their services. Securing a dedicated revenue source for non-METRO providers is not possible because almost every regional municipality has reached the 8.25% statutory local sales tax cap established by the State Legislature.

As was noted previously, the Funding Opportunities Workgroup determined that any significant expansion of transit service in the region, especially HCT, will require revenue sources that do not currently exist for the H-GAC region. Finding additional funding for regional HCT investment may require contentious political decisions at the local and state level. However, it must be emphasized that there is also a "cost of doing nothing" if the region does not expand its high capacity transit network to accommodate the coming growth and provide alternatives to increased traffic congestion.

The Funding Opportunities Workgroup considered several potential strategies regarding additional funding for transit in the region. Potential base strategies that the Workgroup identified for consideration include:

- Private sector participation, for example, through Public-Private Partnerships (P3s). The Federal Transit Administration (FTA) has encouraged private-sector participation in

transit by recently issuing new guidance regarding Private Investment Project Procedures (PIPP) intended to "address impediments to the greater use of public-private partnerships and private investment in public transportation capital projects". However, not all transit projects will be eligible or appropriate for P3s, and private-sector participation is oftentimes "the last dollar in the bucket" as opposed to the first.

- Federal discretionary funding for "New Starts" HCT investments, through the FTA's 5309 Capital Investment Grants program.
- Federal loan programs, such as Transportation Infrastructure Finance Innovation Act (TIFIA) and Railroad Rehabilitation and Improvement Financing (RRIF), both of which provide federally-secured credit assistance for qualified transportation projects.
- Value Capture strategies, including impact fees, Special Assessment Districts, Tax Increment Financing, parking and station revenues, naming rights, and joint development/TOD.

Potential local funding strategies identified include:

- Allowing transit projects to compete for highway funding based on performance criteria established by TPC.
- Increasing municipal and county funding support for transit outside METRO service area.

Strategies that would require State Legislative action include:

- Increasing transit projects' eligibility for state funding.
- Implementing a local/regional option tax.
- Raising the 8.25% local sales tax cap.
- Implementing congestion pricing programs.

The Funding Opportunities Workgroup recognized that no single revenue source alone will account for the additional funding that is needed to implement the large-scale expansion of HCT services in the region, and that multiple strategies are required.

A comprehensive list of these and additional traditional and innovative funding and financing tools, including their characteristics and their current legal applicability in Texas, is appended to this report as **Attachment Six: List of Financing Tools**.

2045 RTP and The Priority Network

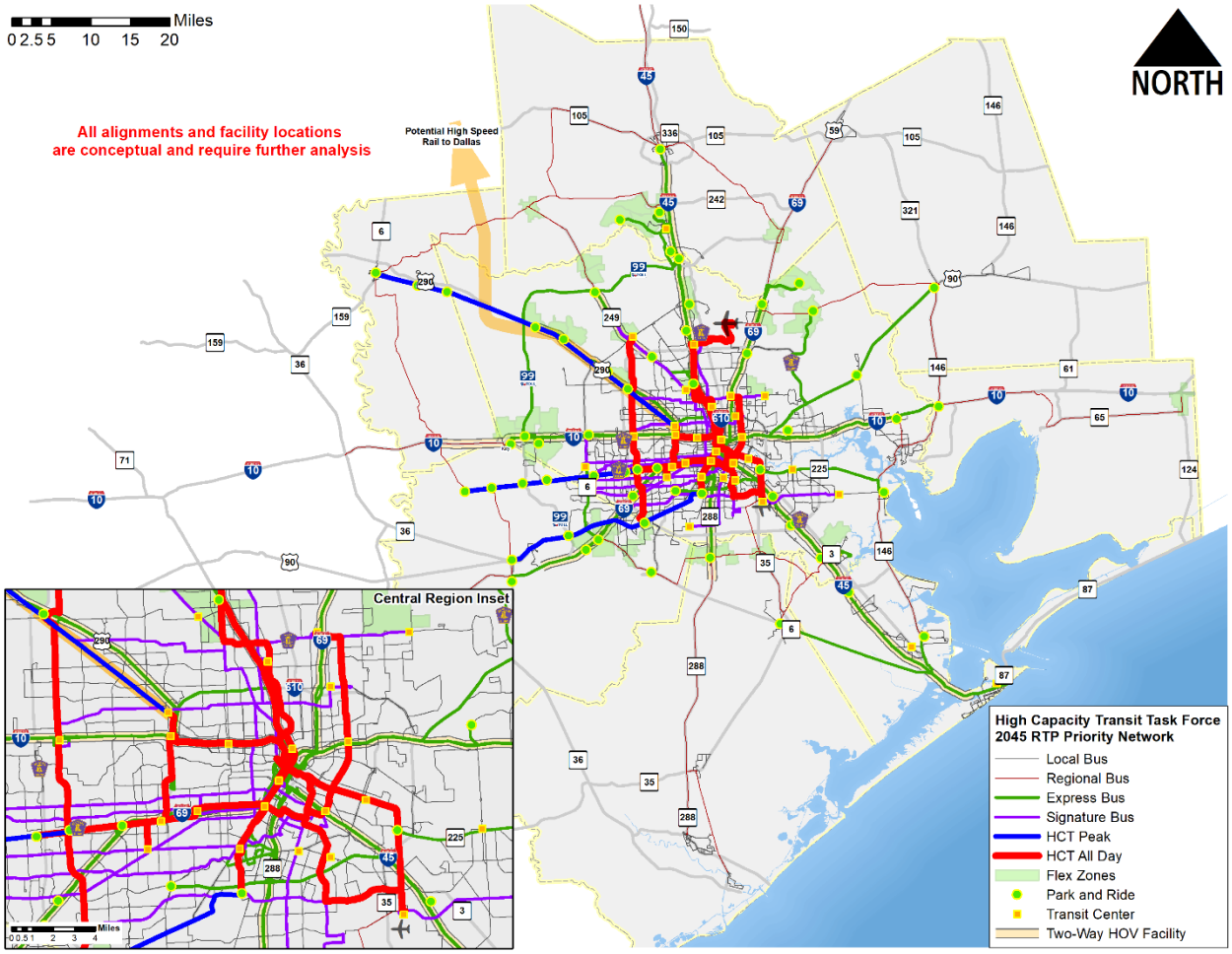
The Vision Network represents a *desired* level of investment in high capacity and local transit service, given its tremendous benefits. However, implementation would require revenue sources that do not currently exist. Therefore, elements of Vision Network were selected to comprise a financially-constrained Priority Network for inclusion in the 2045 RTP. The Priority Network consists of transit services and elements aimed towards meeting the region's most significant transit needs by the year 2045. The services and elements were selected through a variety of means, including travel demand modeling, the Transit Need Index (TNI) analysis undertaken by the Regionally Coordinated Transportation Plan, and other long-range planning activities such as the Metropolitan Transit Authority's METRONext plan.

The Priority Network contains a variety of HCT service types, including peak-focused, all-day, and express services. HCT services are assumed to operate along a dedicated transitway, such as exclusive bus lanes for Bus Rapid Transit, railways for light rail or commuter rail, or otherwise benefit from a treatment that allows the service to avoid congestion, such as HOV lanes for Express Bus services or bus priority measures for Signature Bus services. In addition to its HCT elements, the Priority Network contains a supportive background of local and regional bus routes, on-demand services, park and ride and transit center facilities, and operating and maintenance facilities. The policies and concepts supporting greater transit use across the region, described previously and detailed in **Attachment Two: Policy Recommendations**, are also considered to be part of the Priority Network.

The services indicated in the Priority Network are mode-, technology- and alignment- neutral. All recommendations in the Priority Network are conceptual and are subject to further analysis and design. A map of the Priority Network is depicted in **Figure 15**. Significant features of the Priority Network include:

- Service to all eight counties in the H-GAC transportation planning region;
- New HCT All Day services along major north-south and east-west corridors, including Westpark/Richmond, East Bellfort, Beltway 8/Gessner, Lockwood and Broadway;
- An expansion of HCT services to intermodal hubs such as Bush Intercontinental Airport, Hobby Airport, and the proposed Texas Central High-Speed Rail terminal;
- New Peak HCT services to rapidly-growing communities in western Harris, Fort Bend and Waller Counties;
- Filling the "Inner Katy Gap" in the region's HOV network (IH-10 West between downtown and Loop 610) with new HCT and HOV service;
- Conversion of all regional HOV facilities from one-way reversible service to two-way, all-day service, to better facilitate reverse commute patterns;
- New commuter services along corridors such as SH 288 from Pearland, SH 249 from Tomball, SH 225 from La Porte and US 90 from Crosby and Dayton;

Figure 15: The HCT Task Force 2045 Priority Network



- Suburb-to-suburb commuter services, including between Sugar Land and the Energy Corridor and the Energy Corridor and The Woodlands;
- Enhanced bus services (known as “Signature” or “BOOST” service) along multiple arterial corridors including Westheimer, Tidwell, Airline, Scott, West Bellfort, and Spencer Highway, featuring frequent service and bus priority treatments;
- New local bus services, especially in communities that exhibit high transit need;
- New Regional Bus services, which connect outlying communities to each other as well as to the urban core;
- An expansion of Flex Zones, which are geographically-focused demand-response services (known as “Community Connectors” within the METRO Service Area);
- An expansion of passenger facilities, such as park and rides and transit centers, necessary to support these new services;
- New operating and maintenance (O&M) facilities necessary to support the expanded services (locations to be determined); and
- Capital cost inclusions for State of Good Repair (SOGR) and Universal Accessibility.

Table 4 compares the components of the 2045 Priority Network to the region's current transit network to demonstrate the extent of service expansion proposed:

Table 4: 2045 Priority Network Compared to Today's Transit Network

	Today	2045 Priority
Routes	**157**	**244**
Local	114	140
Regional	2	22
Signature	1	14
Express	37	57
HCT Peak	0	3
HCT All Day	3	8
Flex Zones	**2**	**35**
Park and Rides	**36**	**59**
Transit Centers	**22**	**32**
Miles of HCT Transitway	**27.6**	**222.7**
HCT Peak	0	93.1
HCT All Day	27.6	129.6
Miles of Signature Bus Service	**8**	**270.8**
Miles of Two-way HOV	**67.5**	**210.8**

The capital components of the Priority Network are estimated to cost about $21.7 billion (2018 dollars), inclusive of new operating and maintenance facilities, fleet expansion and replacement, and allowances for State of Good Repair and Universal Accessibility. Detailed information about the capital projects and costs included in the Priority Network is provided in **Attachment Seven: Capital Components of HCT Task Force 2045 Priority Network** appended to this summary. The annual operating and maintenance cost for the Priority Network is estimated to be about $1.138 billion (2018 dollars) at full build-out.

Travel demand analysis of the Priority Network indicates that the network produces a capacity-constrained demand of 277 million annual boardings and 1.878 billion passenger miles traveled annually across all services, including fixed-route, demand response/ADA paratransit and vanpool. This represents over a three-fold increase in the number of fixed-route boardings the region's transit network carried in 2017 and 216 percent increase in passenger miles traveled. These and other figures for the Priority Network are included in **Attachment Four**, which allows comparison to the region's current transit profile as well as the two no-build and four Vison Network CE scenarios.

The same REMI economic benefit analysis tool that was used to evaluate the impacts of the Vision Network's four CE scenarios was used to analyze the Priority Network. As a direct benefit to travelers in the region, the total travel time savings, value of reduced vehicle crashes and increased personal income totaled over $520 billion. With an estimated total investment of

$73.3 billion (inclusive of capital and annual operating costs), the benefit-cost ratio is slightly greater than 7.

The average annual increase in employment is approximately 65 thousand jobs, as shown in **Figure 16**. Significant additional economic benefits accrue over the life of the Priority Network, as indicated in **Figure 17**. These values (as are all other transit investment scenarios shown earlier) are inclusive of highway investments already included in the 2040 Regional Transportation Plan.

Figure 16: Average Employment Growth Induced by 2045 Priority Network

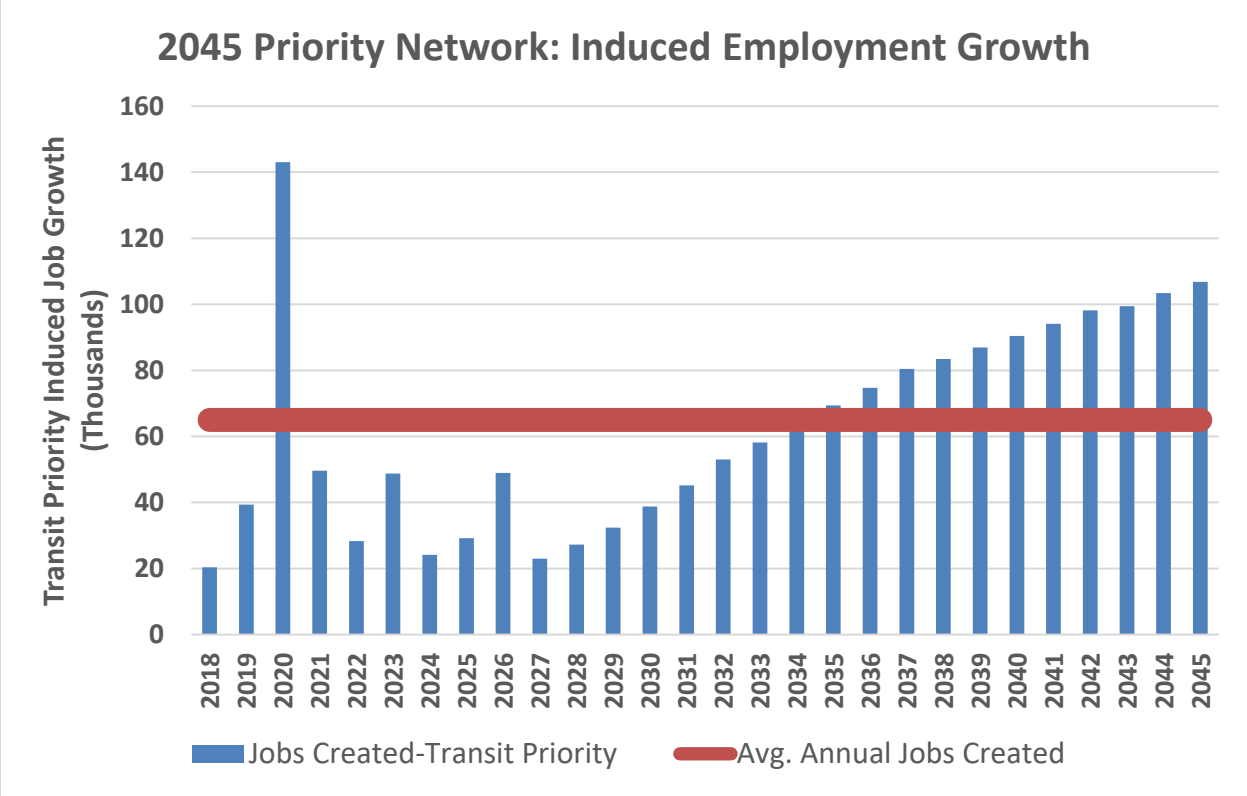
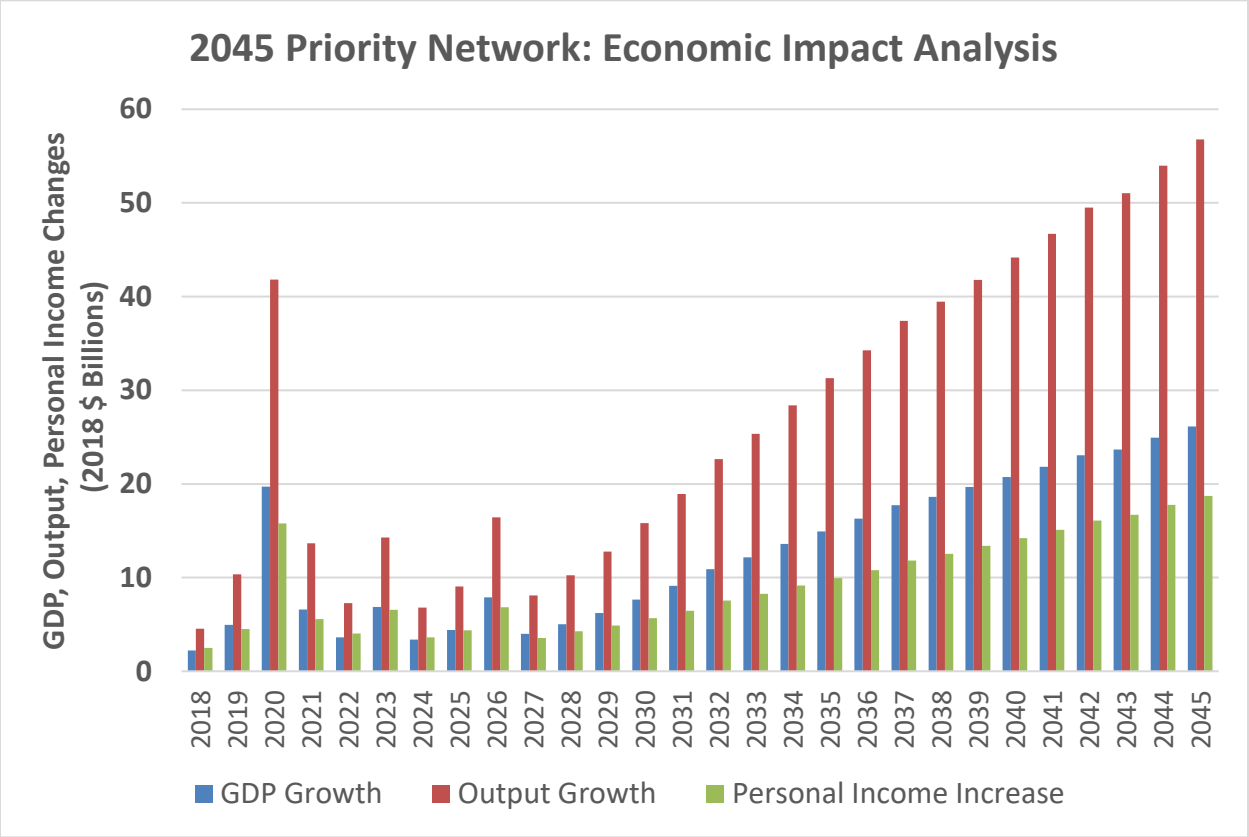


Figure 17: Economic Impacts of 2045 Priority Network



Findings and Recommendations

The overall findings of the Task Force can be summarized as follows:

1. Roughly half of the work-related trips in the eight-county region cannot be effectively served by transit today. If transit service is not expanded, that percentage will only continue to grow over time.

2. Substantial demand for high capacity transit as well as expanded local transit exists in all parts of the eight-county region.

3. Increased benefits in terms of travel time savings, vehicle crashes avoided, and personal income growth can be realized through the development of a comprehensive, region-wide high capacity transit network, and these benefits outweigh the costs of constructing, operating and maintaining that network.

4. Positive impacts to the region's economy in terms of employment, GDP and output can be expected from investment in a comprehensive high capacity transit network. Conversely, failing to invest in the region's transit infrastructure will lead to unacceptable levels of congestion that could decrease the region's economic competitiveness.

5. Expansion of high capacity transit in the region must be accompanied by expansions in other transit services including local fixed routes, demand response and first mile/last mile options.

6. Increasing levels of investment in high capacity transit will result in a modest reduction of regional vehicle miles traveled (VMT), but significant reduction in regional vehicle hours traveled (VHT), as people are able to travel with less delay and at higher speeds.

7. The Vision Network represents a desired level of investment in high capacity and local transit service, given its tremendous benefits to both transit users as well as those who choose to remain in their automobiles.

8. Implementation of the Vision Network would require new sources of capital funding but would allow leveraging of increased federal discretionary funding in our region.

The Task Force's recommendations to the Transportation Policy Council are as follows:

1. Given current funding constraints, a prioritized level of investment in transit service contained in the HCT Task Force Priority Network, which includes services to all eight counties in the region, is recommended for inclusion in the 2045 RTP.

2. Concepts and policies that support the increased use of transit, such as those related to regional fare or Universal Accessibility, should be encouraged across the region.

3. Every investment in transportation that is made by the Transportation Policy Council should be viewed as an opportunity to advance high capacity transit concepts, either in support of transit priority on freeways and thoroughfares, or new transit services along freeways and tollways.

4. Development of any new transit service requires additional public engagement and planning, including that for financing and implementation.

5. Regional HCT requires regional cooperation; the region must work together to examine opportunities, set priorities, develop new funding sources and "speak with one voice" when discussing its needs with decisionmakers at the state and federal level.

6. A Phase II of the Task Force effort is recommended to continue examining in further detail issues related to regional transit priorities, implementation and funding.

"Make no little plans; they have no magic to stir men's blood and probably themselves will not be realized."

-Daniel Burnham

High Capacity Transit Task Force Membership

Chair – Hon. Rusty Senac, Chambers County Commissioner Pct. 4
Co-Chair – Hon. Amanda Edwards, Council Member, City of Houston
Co-Chair – Carrin Patman, Chair, METRO Board of Directors

Committee Members
Steve Ashy, Neighborhood Super Alliance
Rick Beverlin, City of Galveston/Island Transit
Jon Branson, Deputy City Manager, City of Pearland
Hon. Craig Brown, Council Member, City of Galveston
Karla Cisneros, City of Houston
Maureen Crocker, Assistant Director, Transportation & Drainage Planning at Houston Public Works
Jack Drake, Transportation Advocacy Group
Scott Elmer
Bob Eury, President, Central Houston
Ken Fickes, Director, Transit Services at Harris County
Felix Fraga, Vice President of External Relations, BakerRipley
Adam Jack, Director of Transportation Planning, TxDOT-Beaumont District
James Hollis, Gulf Coast Center
Tom Lambert, President & Chief Executive Officer, METRO
Chris LaRue, Senior Transit Project Manager, AECOM
Brenda Mainwaring, Asst Vice President Vice President, Union Pacific
Andrew Mao, Director, Transportation Planning, TxDOT-Houston District
Clark Martinson, Executive Director, BikeHouston
Hugh McCulley, BSNF Railroad
Hon. Pat McLaughlan, Council Member, City of Bellaire
Richard Petty, Director, National Center for Ageing and Disability (NCAD) at TIRR
Hon. Tricia Pollard, City of Bellaire
Paul W. Puente, Executive Secretary, Houston Gulf Coast Building and Construction Trades Council
Hon. Tom Reid, Mayor, City of Pearland
Hon. David Robinson, Council Member, City of Houston
Yancy Scott, County Engineer, Waller County
Kyle Shelton, The Kinder Institute of Urban Research
Paulette Shelton, Director, Public Transportation Department, Fort Bend County
Christof Spieler, Vice President and Director of Planning, Huitt-Zollars
Mike Waterman, President, Greater Houston Convention and Visitors Bureau
Jeffrey Weatherford, Deputy Director, Public Works, City of Houston
Charles Wemple, Executive Director, Houston-Galveston Area Council
Claudia Wicks, Assistant Director, Colorado Valley Transit
Hon. Joe Zimmerman, Mayor, City of Sugar Land

Economic Impact Workgroup
Emily Anderson, Halff
Rick Beverlin, City of Galveston/Island Transit
John Breeding, President, Uptown Houston District
Shawn Cloonan, Texas Medical Center
Maureen Crocker, Assistant Director, Transportation & Drainage Planning at Houston Public Works
Hon. Amanda Edwards, Council Member, City of Houston
Bob Eury, President, Central Houston
Chris LaRue, Senior Transit Project Manager, AECOM
Hon. Pat McLaughlan, Council Member, City of Bellaire
Bob Pertierra, Greater Houston Partnership
Hon. Rusty Senac, Chambers County Commissioner Pct. 4
Tom Lambert, President & Chief Executive Officer, METRO

Service Concepts Workgroup
Emily Anderson, Halff
Steve Ashy, Neighborhood Super Alliance
Katrina Bayer, Transportation Program Leader, Central Houston
Oni Blair, Executive Director, LINK Houston
Jonathan Brooks, Director of Policy and Planning, LINK Houston
Craig Brown, City of Galveston
Maureen Crocker, Assistant Director, Transportation & Drainage Planning at Houston Public Works
Perri D'Armond, Assistant Director, Fort Bend County Public Transportation
Fabiola Dagrin
Hon. Amanda Edwards, Council Member, City of Houston
Scott Elmer
Bob Eury, President, Central Houston
Ken Fickes, Director, Transit Services at Harris County
Chris LaRue, Senior Transit Project Manager, AECOM
Tom Lambert, President & Chief Executive Officer, METRO
Dominic Mazoch, Citizen
Hon. Pat McLaughlan, Council Member, City of Bellaire
Clark Martinson, Executive Director, BikeHouston
Aremu Moses
Richard Petty, Director, National Center for Ageing and Disability (NCAD) at TIRR
Philip Salerno, Super Neighborhood Alliance
Janis Scott, Citizen
Suzanne Set, Midtown Engineers
Paulette Shelton, Director, Public Transportation Department, Fort Bend County
Christof Spieler, Vice President and Director of Planning, Huitt-Zollars
Marcello Victorino, City of Sugar Land
Jay Washington
Mike Waterman, President, Greater Houston Convention and Visitors Bureau
Jeffrey Weatherford, Deputy Director, Public Works, City of Houston

Elijah Williams, Gulf Coast Rail District
Priya Zachariah, METRO
Hon. Joe Zimmerman, Mayor, City of Sugar Land

Innovative Finance Workgroup
Steve Ashy, Neighborhood Super Alliance
Raj Basavaraju, Transcend Engineers and Planners
Maureen Crocker, Assistant Director, Transportation & Drainage Planning at Houston Public Works
Hon. Amanda Edwards, Council Member, City of Houston
Ken Fickes, Director, Transit Services at Harris County
Vinio Floris, Veolia
Tom Lambert, President & Chief Executive Officer, METRO
Dr. Carol Lewis, Director of Transportation Policy, Texas Southern University
Beth Shelton, RPS Klotz Associates
Kyle Shelton, The Kinder Institute of Urban Research
Paulette Shelton Director, Public Transportation Department, Fort Bend County n,
Arthur Smiley, CFO, METRO
Christof Spieler, Vice President and Director of Planning, Huitt-Zollars
Jeffrey Weatherford, Deputy Director, Public Works, City of Houston