Needs Assessment

H-GAC Regional Goods Movement Study

submitted to

Houston-Galveston Area Council

submitted by

Cambridge Systematics, Inc.

with

Halcrow, Inc.
Dannenbaum Engineering Corporation
Knudson, LP
Alliance Transportation Group
American Transportation Research Institute

August 2011

Table of Contents


Regional Goods Movement Needs Assessment

List of Tables

TABLES **TABLES**

List of Figures

Figures

FIGURES

Executive Summary

To address goods movement in a comprehensive manner, H-GAC is undertaking the development of a data-driven, policy-based Regional Goods Movement Plan for the eight-county MPO region. The purpose of the study is to identify and prioritize strategies that enhance mobility of both people and goods while mitigating negative impacts.

The H-GAC Regional Goods Movement Needs Assessment report is one in a series of reports to be developed as part of the study. The purpose of Needs Assessment is to document existing conditions, forecast future demand, and assess regional freight transportation deficiencies and bottlenecks. Findings from this task will lay the groundwork for developing solution packages and recommendations which will be documented in the Strategies and Recommendations Report and ultimately, the final H-GAC Regional Goods Movement Plan.

Why Is Freight Planning Important to the Region?

The incorporation of freight issues into the regional transportation planning processes is important because it is critical to public policy goals in the following areas:

Economic Competitiveness – Freight movement is important to the economy because the higher the cost of moving goods, the higher the price of the products we buy and the higher the cost of doing business, resulting in lower ability to attract and retain jobs in the region. Additionally, businesses directly involved in moving freight account for more than 100,000 jobs in the region.

Congestion – Significant portions of the region's primary freeways and major arterials operate near or above capacity, leading to significant delay. Freight is a contributing factor and it is projected that for every 100 trucks on the region's roads today, there will be 177 trucks in 2035.

Air Quality – Emissions from the movement of freight can have serious impacts on public health, environmental, and health concerns and the region's economy. Annual truck-related emissions in the eight-county Houston-Galveston region account for more than half of the region's transportation-related NO_x, $PM_{2.5}$ andCO_2.

Safety – Safety concerns arise from several sources, including trucks on the roadways, at-grade rail crossings and the transport of hazardous materials. Nearly one-third of all highway crashes in the metro area involve a truck.

Community Impacts – Freight transportation and facilities give rise to other negative community impacts if not properly planned, including noise, light and pollution, excessive vibration and wear and tear on roadways. Environmental justice communities often are more adversely impacted by freight transportation activities.

How Significant Is Goods Movement in the Region?

The Houston-Galveston region is a freight hub of national importance. The region ranks first in pipeline volumes, second in port volumes, fourth in truck volumes and eleventh in air cargo volumes. In addition, the Houston-Galveston region is a critical node in the national rail system and home to a major rail carload market. The region's system, which moves about 1.2 million tons of freight annually, consists of more than 24,000 miles of roadways, three Class I railroads,

four deepwater ports, two major air cargo facilities and more than 21,000 miles of pipelines. See Figure E-1. (Note: Pipelines are displayed in Figure 2.8.)

What Are the Freight-Significant Roadways?

The freight-significant roadways are the portion of the regional roadway network that is critical to freight and logistics activities. The importance of the freight significant roadways is that they can be distinguished from the rest of the network and invested in, strengthened, and managed for efficient performance. The current freight-significant roadway system is depicted in Figure E-2. It includes the heavily traveled routes necessary, it serves the critical segments and centers of the economic geography, it reaches the key intermodal transfer points; and it ties together the eight-county area of greater Houston with multiple and cross-regional routes.

Figure E-1 Regional Multimodal Transportation System

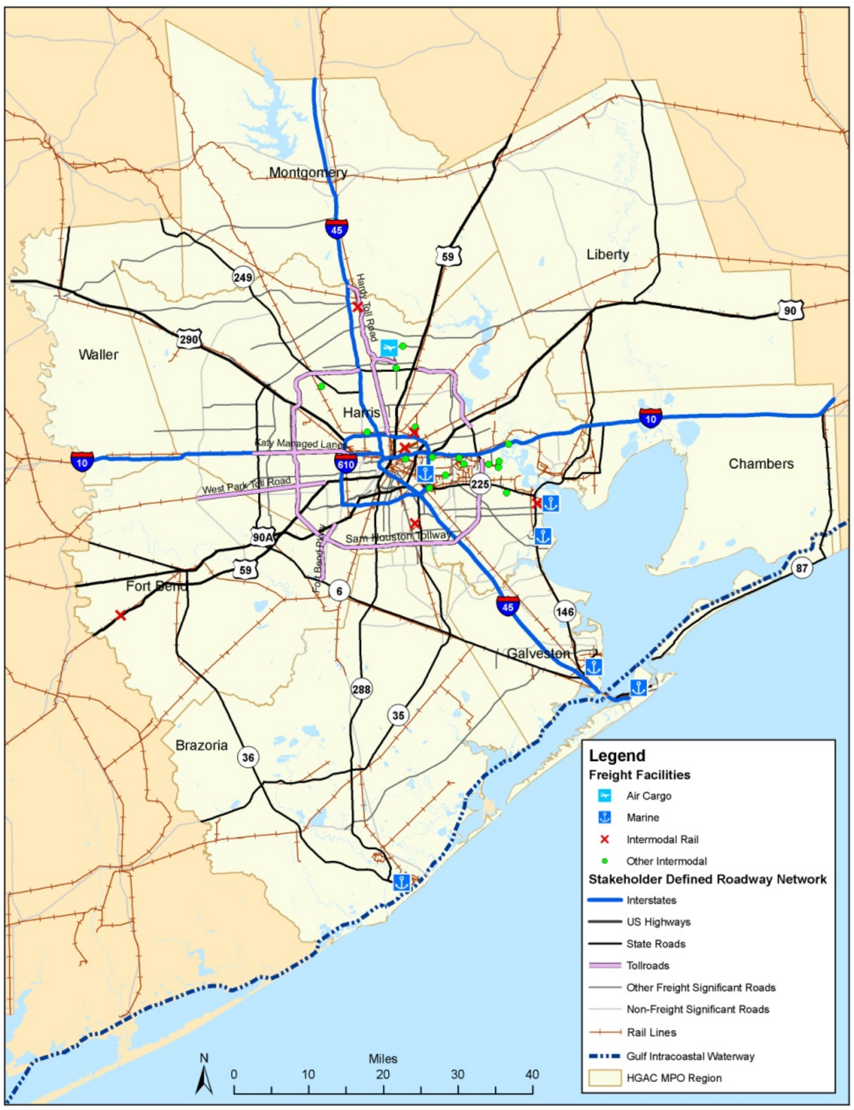
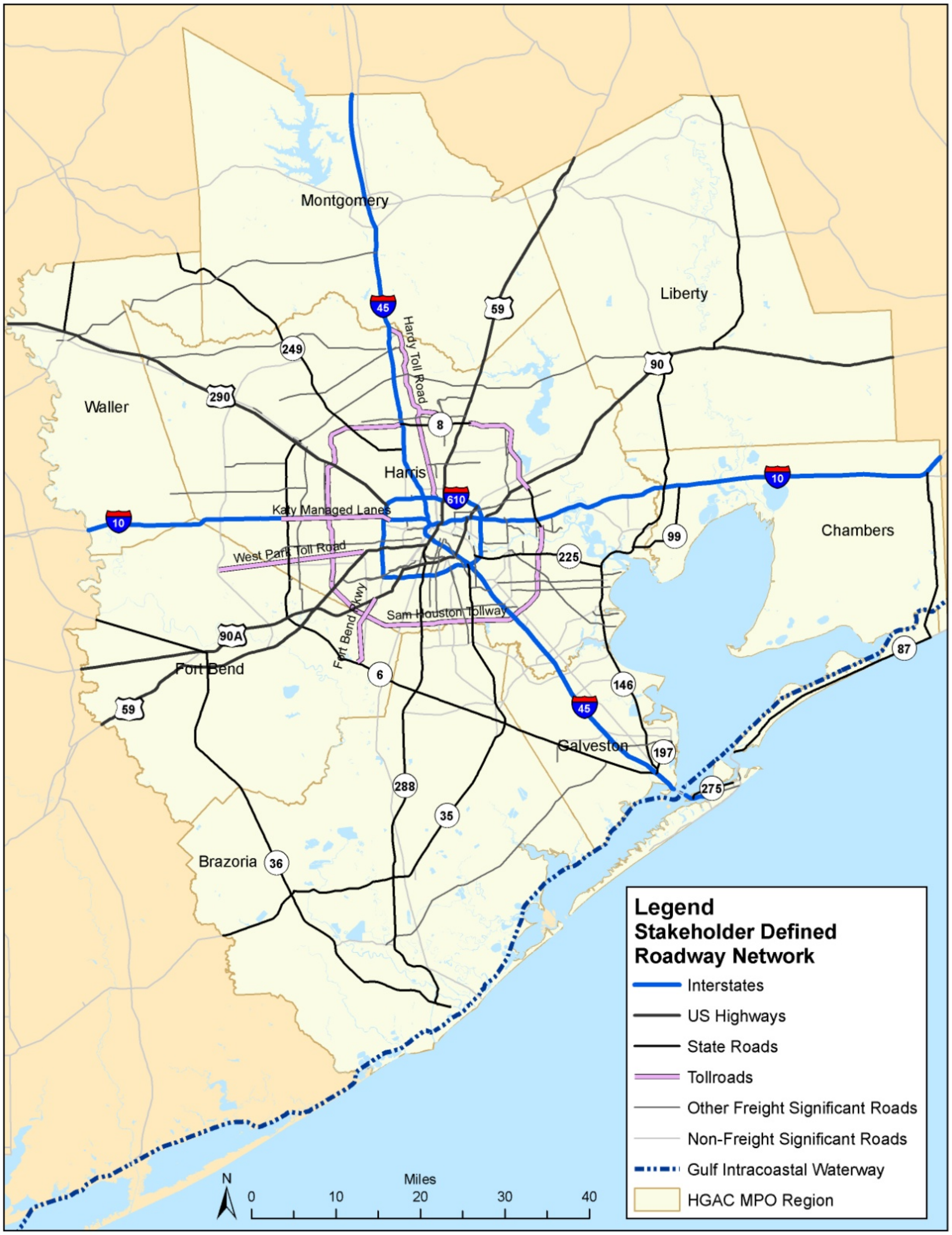


Figure E-2 Freight-Significant Roadway System



Source: Stakeholder interviews and consultant team analysis.

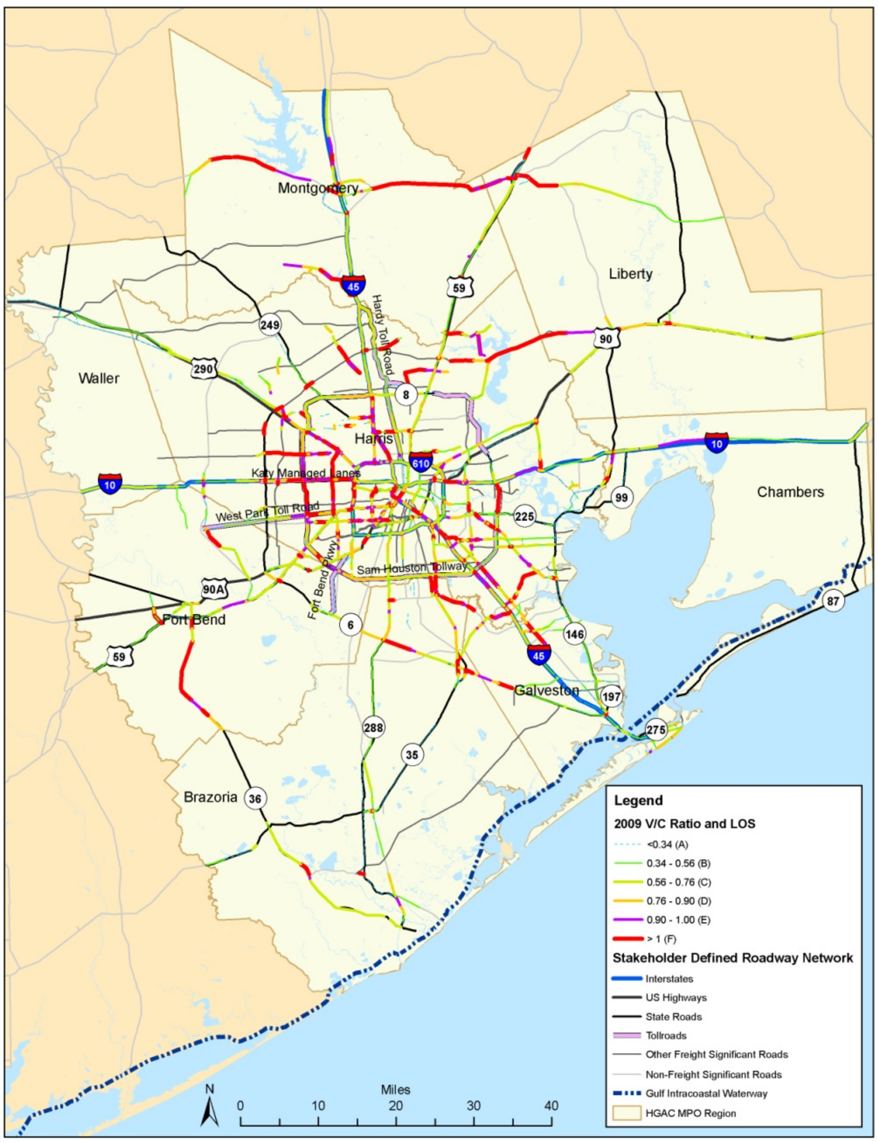
What Are the Most Significant Modal Deficiencies?

The most commonly-cited concerns by freight stakeholders and elected officials were congestion, bottlenecks on intermodal connectors and freeway interchanges and rail constraints.

How much of the roadway system experiences congestion?

A common measure of congestion is level of service which is based on the ratio of traffic volumes to capacity. The majority of the freight-significant corridors, especially inside Beltway 8, operate at or above capacity. (See Figure E-3.)

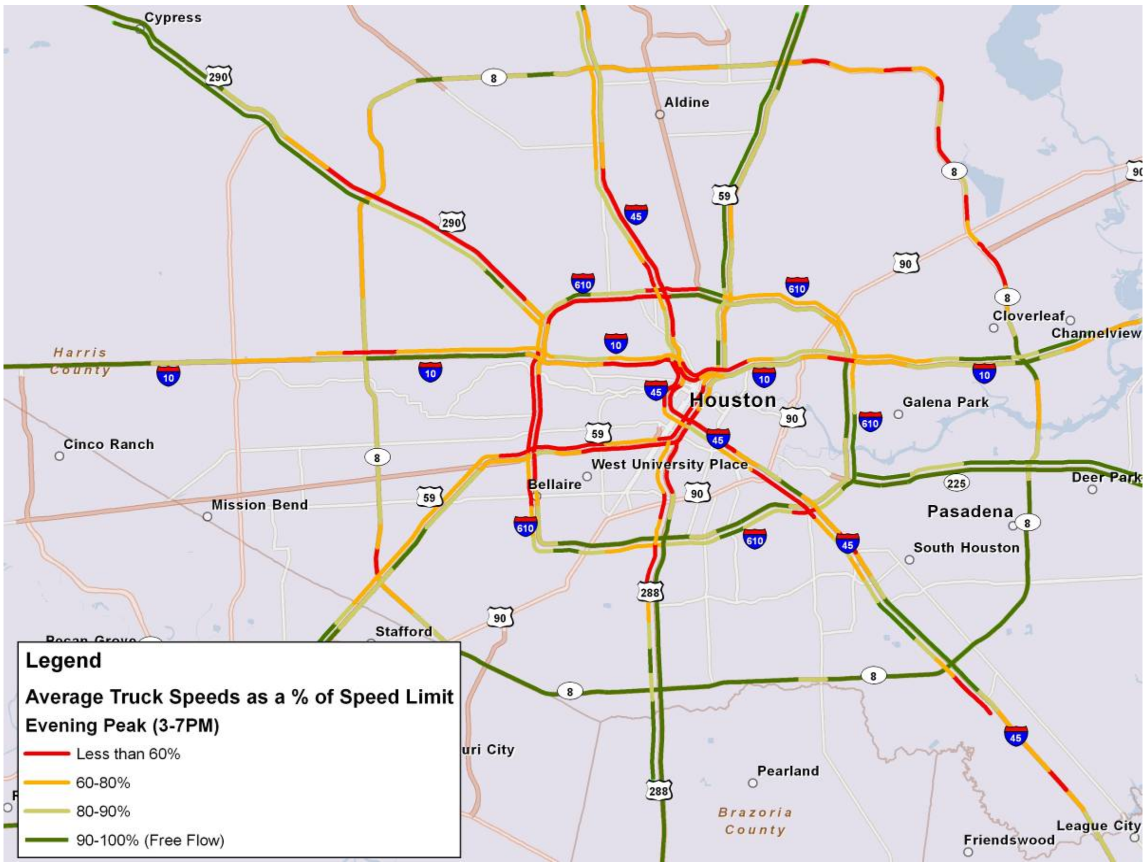
Figure E-3 Average Daily Level of Service 2009



Source: H-GAC.

Congestion leads to reduced speeds and longer commute times. In fact, trucks traveling on the freeways inside Beltway 8 are often slowed to less than 35 miles per hour during the evening peak period especially in proximity to interchanges. Although not as severe, trucks experience similar slowdowns during morning peak and midday timeframes. (See Figure E-4.)

Figure E-4 Average Truck Speeds as a Percent of Speed Limit, Evening Peak
Limited Access Highways



Source: ATRI.

Where are the biggest interchange bottlenecks?

An area of particular concern from a congestion and safety perspective is interstate interchanges. This is a well known issue, yet these hotspots often cannot be avoided by the trucking community.

Table E-1 displays the top 10 interchange bottlenecks in the region based on the ratio of non-peak average speed to peak average speed combined with the volume of trucks at an interchange. The higher the ratio, the greater the difference in average speeds during peak and non-peak periods and the higher the level of congestion.

Table E-1 Top 10 Freight Interchange Bottleneck Locations in the Houston-Galveston Region Based on Truck Delay

Rank	Location	Average Speed	Peak Average Speed	Nonpeak Average Speed	Nonpeak/ Peak Speed Ratio
1	Houston: IH 10 at U.S. 59	38.6	29.5	43.5	1.48
2	Houston: IH 45 at U.S. 59	37.1	29.4	40.7	1.38
3	Houston: IH 10 at IH 45	39.6	29.7	44.6	1.50
4	Houston: IH 45 at IH 610 (N)	41.5	33.8	45.2	1.34
5	Houston: IH 610 at U.S. 290	44.6	35.3	49.1	1.39
6	Houston: IH 45 at IH 610 (S)	49.3	41.7	53.1	1.27
7	Houston: IH 10 at IH 610 (E)	49.8	45.1	51.9	1.15
8	Houston: IH 610 at U.S. 59 (W)	43.8	38.3	46.0	1.20
9	Houston: IH 10 at IH 610 (W)	50.4	43.6	53.2	1.22
10	Houston: IH 45 at Sam Houston (N)	51.1	44.4	54.2	1.22

Source: ATRI.

How widespread are deficiencies on critical intermodal connectors and arterials?

Intermodal connectors provide critical connections between freight nodes and their users. The primary points of concern are the ports, air cargo facilities at IAH, rail intermodal terminals, and key industrial districts. There are more than 50 intermodal connectors and key freight arterials with existing or near-term deficiencies identified throughout the region. Projections of freight flows in 2035 indicate that deficiencies spread significantly throughout the region, especially in the fast growing outer areas.

What are the major freight rail deficiencies?

Congestion on the region's rail system results in 300 daily train hours of delay[2] which leads to increased cost and shipping times for regional shippers. Capacity pinch points include single track mainlines and bridges, inadequate siding lengths and rail yards at or nearing capacity. In addition to the service capacity concerns, the region has car storage capacity challenges.

Despite continued improvement, at-grade rail crossings are an issue throughout the region. There are an estimated 1,200 at-grade rail

[2] Houston Region Freight Study, TxDOT 2007.

crossings in the Houston-Galveston region, with a daily road volume approaching five million cars and trucks.[3] Between 2003 and 2007, the region experienced a total of 315 crashes at rail crossings, highlighting the safety risks to the traveling public. At-grade crossings also impose traffic delays.

What are the major challenges for the region's ports?

Future growth at the region's ports will, in large part, depend on the ability of the region's highways and railroads to accommodate the additional traffic. Other issues impacting the ability of the seaports to expand are the increasing competition for waterfront property for various commercial, industrial, and residential uses and increasing environmental and industry regulations.

What are the primary community concerns?

Aside from congestion, perhaps the two most frequently cited freight impacts from the community are safety and air quality. Safety concerns arise from several sources, including trucks on the roadways, at-grade rail crossings and the transport of hazardous materials. There were 30,000 truck-involved crashes in the region in 2007, representing about 30 percent of all crashes. These crashes resulted in more than 100 fatalities, 15,000 injuries and thousands of hours of delay. The highest concentrations of crashes throughout the region are at major intersections and most commonly where major highways interchange with IH 610, the inner loop. This is a critical issue in route planning and is important in the terms of hazardous materials flow, since these facilities are also designated hazmat routes.

The Houston-Galveston region has localized air emission concentrations that are of significant concern to public health and economic competitiveness. Annual truck-related emissions in the eight-county Houston-Galveston region shows that trucks emit 72 percent of the region's transportation-related NO_x, 68 percent of the transportation-related $PM_{2.5}$, and 53 percent of the region's transportation-related CO_2.

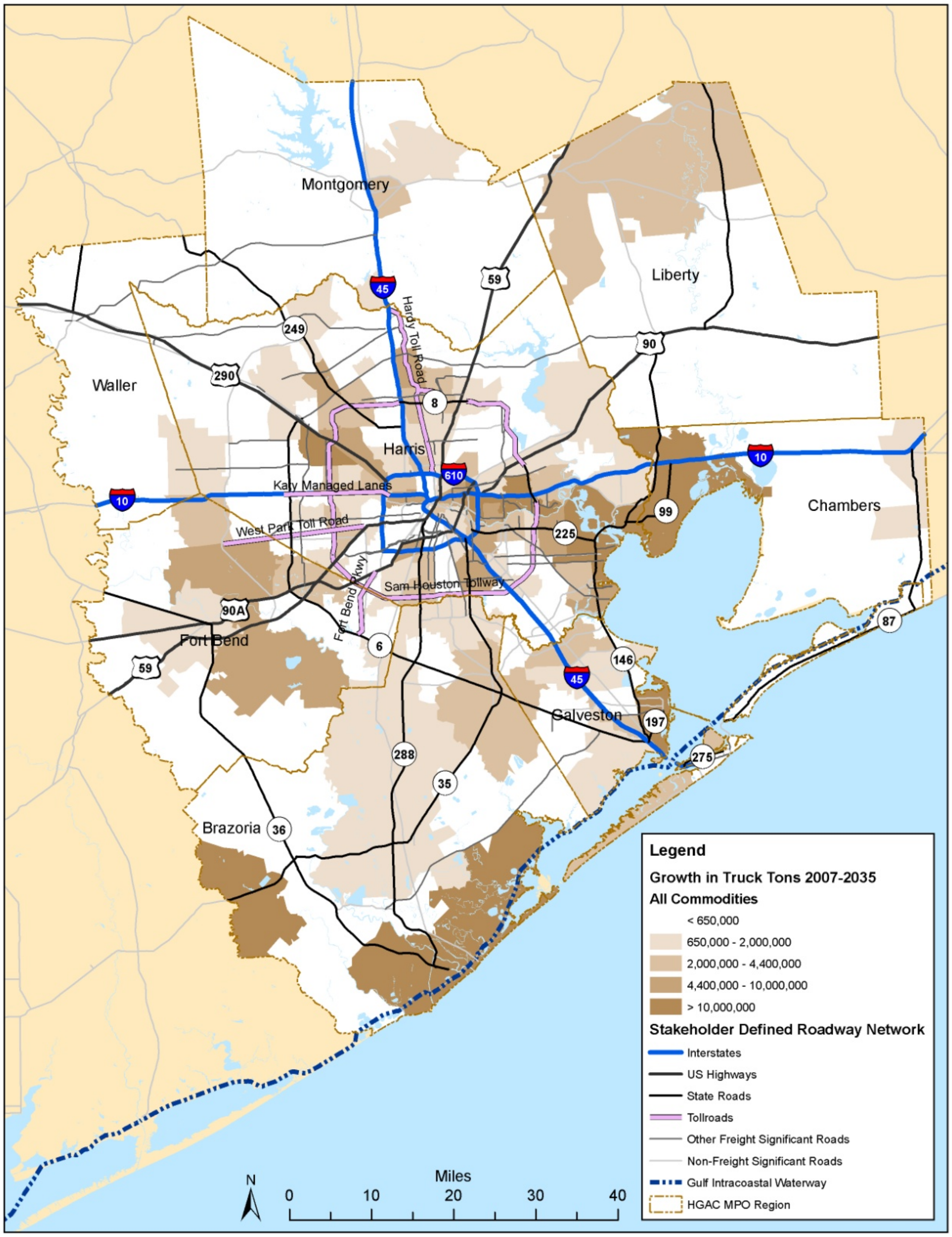
Other concerns include noise, state of repair, lighting, vibration, and environmental concerns.

How Much Freight Will There Be in the Future?

There are numerous trends that are likely to impact future freight traffic in the region, including population and employment growth, and the expansion of the Panama Canal and NAFTA. Total freight volumes are projected to grow by nearly 60 percent throughout the region, with truck traffic projected to increase by nearly 77 percent. County growth in freight tonnage for all commodities was evaluated in two forms: the total incremental tonnage or "new volume" from 2007 to 2035 (Figure E-5), and the rate of growth in percentage terms (Figure E-6). The total tonnage provides insight into which counties will have the most freight traffic overall while percentage growth tells us which counties will experience the biggest increase in freight traffic. Harris County will continue to have the total highest volume of freight, while the fastest growth in freight volume will occur in Montgomery and Brazoria Counties.

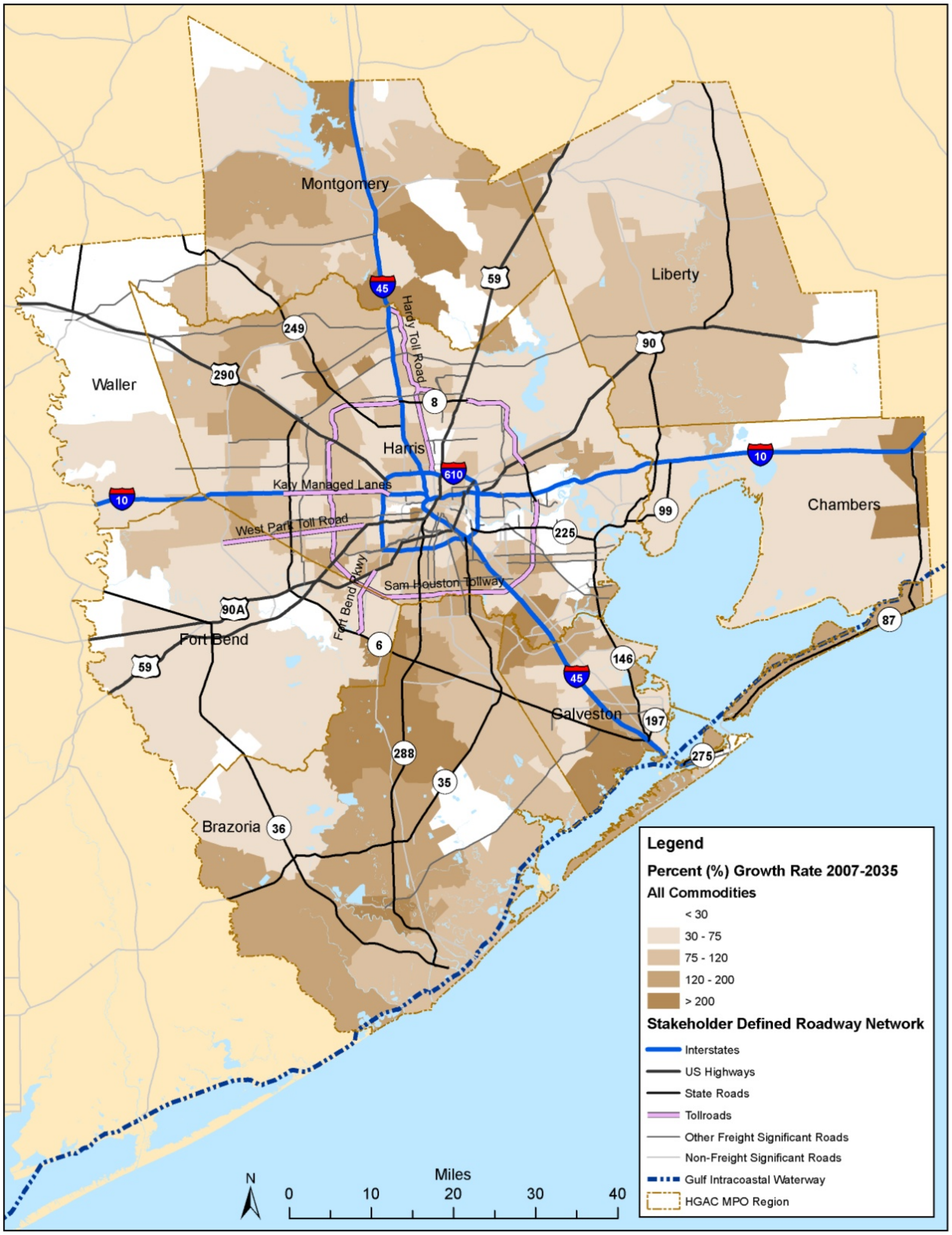
[3] The Houston Region Freight Study, TxDOT, 2007.

Figure E-5 Growth in Inbound and Outbound Freight Tons
All Commodities, 2007 to 2035



Source: IHS Global Insight.

Figure E-6 Growth Rate in Inbound and Outbound Tons
All Commodities, 2007 to 2035



Source: IHS Global Insight.

What Are the Regional Goods Movement Needs?

Freight mobility needs, both existing and future, were identified based on data, technical analysis and private and public sector stakeholder input. The systemic needs for current and future freight mobility in the Houston-Galveston region fall into three broad categories: Capacity, Community Impacts, and Institutional.

System Capacity – System capacity was the chief complaint of both private and public sector stakeholders. Generally enhancing capacity benefits both goods and people movement and can be accomplished through infrastructure, operational and institutional improvements. The six areas where capacity constraints most significantly impact freight mobility include inside the urban core and access to regional areas of growth, bottlenecks at key interchanges, rail single track lines and bridges and yard and car storage, at-grade crossings, and intermodal connectors and key arterials.

Operational issues that give rise to capacity constraints include the need for updated infrastructure design, development of heavy-haul and hazmat networks and expanded truck staging and parking facilities.

Community and Environmental Impacts – In addition to congestion, goods movement gives rise to significant community and environmental impacts, including safety, air and water quality issues, and excessive noise, vibration, or lighting from freight movements and freight industries, all of which result from land use conflicts and tend to result in a disproportionate impact on communities with environmental justice concerns. A major positive community impact is the enormous economic impact for the region and the State.

Improving safety is a major concern for both public and private sectors. The highest concentrations of crashes throughout the region are at major intersections and most commonly where major highways interchange with IH 610, the inner loop. There is essentially no way to avoid these points in the network. Therefore safety improvements have to rely on changes to the existing infrastructure and processes, including community education, to create a smoother flow of traffic in the transitions.

Economic growth and competitiveness is directly related to the region's freight transportation system. As one of the nation's fastest growing regions, the Houston-Galveston metropolitan area is expected to add another three million people by 2035. Employment is projected to increase by 1.25 million jobs over that same period. The Houston-Galveston region's deepwater ports and international airport make it not only a regional economic powerhouse, but also a global gateway. Investing in an efficient freight transportation system will better position the region to realize its economic growth potential.

Institutional Bottlenecks – A modern freight transportation system requires modern infrastructure and modern governance. Many of the laws, regulations, and arrangements governing freight transportation have not kept pace with the rapidly changing trends shaping the industry. Four categories of institutional and regulatory issues are creating widespread challenges for the region's freight-related industries. These include funding, industry regulations, governance, and lack of public awareness.

How Will This Report Be Used?

The Needs Assessment report is one in a series of reports to be developed as part of the study. The purpose of the Needs Assessment report is to document existing conditions, forecast future demand, and assess freight transportation deficiencies and bottlenecks. Findings from this task will lay the groundwork for developing solution packages and performance measures which will be documented in the Solutions and Recommendations report and ultimately, the final H-GAC Regional Goods Movement Plan.

1. Introduction

Goods movement is a derived demand meaning that freight volumes grow as population, income, and employment grow. The Houston-Galveston region is growing significantly in all three categories, with predictions that between 2005 and 2035, the region will add 3.5 million people and 1.5 million jobs.[3] This rapidly growing local demand, as well as accompanying projected growth through the region's global gateways (i.e., the deepwater marine ports and airports), means that freight's presence in the region will increase. In fact, freight movements are expected to grow 58 percent (to 1.2 billion tons yearly) by 2035.[4] Simply put, in the future there will be more trucks, railcars, airplanes, and ships vying for space on the regional transportation network.

Purpose

Identifying and implementing improvements to accommodate increasing demand for freight and goods movement in the Houston-Galveston region is critical to the region's economic vitality and quality of life. Maintaining the competitive edge in terms of its freight transportation system requires the region to integrate freight concerns into its planning process. To address goods movement in a comprehensive manner, H-GAC is undertaking the development of a data-driven, policy-based Regional Goods Movement Plan for the eight-county transportation management area region. The purpose of the study is to identify and prioritize improvements and strategies that accommodate and enhance mobility of both people and goods while mitigating negative impacts on congestion, safety, environment, and quality of life.

The Needs Assessment report is one in a series of reports to be developed as part of the study. The purpose of the Needs Assessment is to document existing conditions, forecast future demand, and assess freight transportation deficiencies and bottlenecks in three key areas: 1) Physical, which are related to the condition or capacity of the transportation infrastructure; 2) Operational, which relate to how the transportation system is being utilized; and 3) Institutional, which relate to the policy and regulatory environment. Findings from this task will lay the groundwork for developing solution packages and performance measures which will be documented in the Strategies and Recommendations report and ultimately, the final H-GAC Regional Goods Movement Plan.

Methodology

The framework for conducting the Needs Assessment, shown in Figure 1-1, provides the building blocks necessary to identify the key elements of the Houston-Galveston region's freight transportation system and how they relate to one another and to the economy.

---

3 http://www.HGAC.com/community/socioeconomic/forecasts/archive/documents/2035_regional_growth_forecast.pdf.

4 H-GAC Commodity Flow Analysis, Cambridge Systematics, Inc. 2011.

Figure 1-1 Needs Assessment Framework

Source: Cambridge Systematics, Inc.

The needs assessment framework integrates five primary areas of research:

1. **Economic Structure.** Developing an understanding of which economic sectors generate demand for goods movement in the region, what their growth prospects are, and what they contribute to the regional economy is a critical first step. This can include the international trade sector that simply moves goods through the region, as well as local industries. The goods movement systems of each of the critical industry sectors are defined so that the impacts of infrastructure investments, operational strategies, or regulatory approaches can be assessed from the users' perspective.

2. **Industry Logistics Patterns.** The industry supply chains and logistics patterns of each of the critical demand sectors are characterized. These logistics systems describe which modes are used, locations of major distribution facilities, key corridors that link to supply and distribution markets, and the performance characteristics of the infrastructure that matter most to the shippers. Understanding these logistics systems allow for the evaluation of system bottlenecks and improvements from a freight mobility perspective. It also assists in defining performance measures in the recommendation development task.

3. **Freight Infrastructure.** The critical infrastructure that comprises the goods movement system for each of the critical demand sectors is defined, and its current condition and performance is assessed against the industry needs. These systems are multimodal and they consist of terminals, mainline corridors, and connectors. The operational characteristics of these key infrastructure elements are defined. The H-GAC Regional Goods Movement Profile Report provides in-depth documentation of the freight system inventory, operational profile, and challenges. Gaps and weak links in the system networks identified in the Goods Movement Profile are assessed in more detail in the current report.

4. **Commodity/Vehicle Traffic Flows.** In order to fully assess the performance of the critical infrastructure, the goods movement system demand must be converted to traffic estimates and forecasts by mode on the critical infrastructure. With traffic information, all of the key performance metrics, including recurrent delay, travel time reliability, throughput, and safety can be determined in order to identify bottlenecks. Understanding industry logistics patterns also provides a sense of which carrier market segments serve the critical demand sectors, and what performance measures are important to the carriers in order to meet customer expectations. The Commodity Flow Analysis provides detailed information on freight flows while the Needs Assessment provides information on traffic levels and network performance.

5. **Organization and Public Policy.** The final box in the framework recognizes that the goods movement system operates within a matrix of institutional and commercial relationships, regulations, and public policies that govern the decisions of all the players.

Data Collection

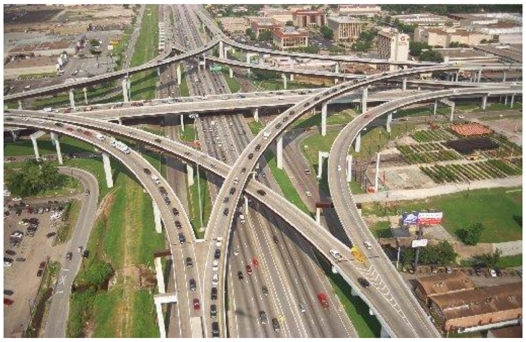
This needs assessment makes use of a variety of sources to detail the existing condition of the Houston-Galveston regional transportation network, including IHS Global Insight TRANSEARCH database, H-GAC's Ttaffic model, data from TxDOT, information gleaned from interviews and surveys, and various previous reports. The main sources of information include the following.

Commodity Flow Data. IHS Global Insight's TRANSEARCH database was used to characterize and quantify freight demand and traffic. The base year is 2007 with a forecast for 2035.[5] TxDOT's count data, collected as part of this effort and H-GAC's traffic model are used to quantify truck volumes, percentages, and levels of service. There are other commodity flow data sources that may offer more accurate information for certain modes but TRANSEARCH is generally regarded as the best overall source of multimodal commodity flow data. It is also provides the most detail, especially for trucking data, which is a focus of the H-GAC study effort. However, there are shortcomings with the TRANSEARCH data and these are discussed in more detail in the H-GAC Commodity Flow Analysis.

Highway Facilities Inventory Data. Various data sources were used to identify and characterize the region's freight highway system, including H-GAC, TxDOT, Federal Highway Administration, Highway Statistics 2008, Research and Innovative Technology Administration's Bureau of Transportation Statistics, Federal Motor Carrier Safety Administration/Research and Innovative Technology Administration, Highway Performance Monitoring System (HPMS), State of Safety in the Region: 2009, Houston-Galveston Area Council, and American Transportation Research Institute.

Previous Studies and Resources. A comprehensive review of previous studies and existing data and resources was conducted as part of the data needs assessment. Existing resources, including H-GAC's extensive GIS library, were used where possible and cited accordingly throughout the documents. Economic and demographic data were drawn from the U.S. Census Bureau, H-GAC, and Woods & Poole Economic Forecasting Services.

[5] See the H-GAC Commodity Flow Analysis for detailed commodity flow data.



Primary Data Collection. Significant original data collection has been completed for the needs assessment. This includes origin and destination surveys and gate counts at key freight facilities, truck counts along key freight corridors, and GPS data from trucks traveling within the H-GAC region which provides information on travel times, speeds, routes, and delay.

Private Sector Outreach. During the summer and fall of 2010, an extensive outreach effort targeting private sector freight stakeholders was conducted. Stakeholders included shippers, carriers, terminal and facility operators, logistics service providers, developers, and receivers. The outreach effort consisted of carrier surveys, break room mapping exercises, and field interviews. A survey of carriers operating in the region was conducted by the American Transportation Research Institute. The survey consisted of two components, a web-based survey and a XM talk radio show inviting drivers to call in with their comments on operating in the Houston area. Another effort aimed at truck drivers was the placement of regional maps in the break rooms of area trucking companies, providing drivers an opportunity to identify bottlenecks and hot spots as well as potential solutions. Also, interviews were conducted with private sector stakeholders throughout the region, including local drayage operators, regional and national long-haul carriers, freight expeditors, developers, and regional and national manufacturing and retail shippers. The purpose of the interviews was to collect both qualitative and quantitative data regarding freight demand (current and future), operations, bottlenecks, recommendations, and the regional competitive position. The firms interviewed include:

- Gulf Winds
- Palletized Trucking, Inc.
- PepsiCo
- Sysco Corporation
- Academy Sports
- BNSF Railway
- Jones Lang LaSalle
- Linden Bulk Transportation SW, LLC
- Pinch Flatbed
- Trimac, Inc.
- WalMart
- ExxonMobil
- Freeman Decorating
- Methodist Hospital System
- Mission Foods
- Osprey Line
- Port Terminal Railroad Association
- Union Pacific
- Flexicore
- UPS
- Whole Foods
- Waste Management
- FedEx Freight
- Halliburton

Public Sector Outreach. Various efforts to solicit input from elected officials and the general public have been employed. This includes interviews with elected officials in each of the eight counties in the Houston-Galveston region, TxDOT, and key freight facilities and agencies, including the Port of Houston Authority, Port Freeport, Port of Galveston, Gulf Coast Rail District, Harris County Fire Marshall, and City of Houston planning staff and enforcement officers. In

addition, two rounds of public meetings, each consisting of four meetings spread throughout the region, have been conducted to date.

Chapter Summaries

The report summarizes the data, information, and findings from the various elements in the Needs Assessment Framework used to identify existing and future goods movement needs at the regional level. The report is organized as follows:

Chapter 2 – Regional Goods Movement Overview. The Houston-Galveston region is a freight hub of national importance. It ranks first in pipeline volumes, second in port volumes, fourth in truck volumes and eleventh in air cargo volumes. Clearly, the Houston-Galveston region is a critical node in the national system and home to a major rail carload market.

Chapter 3 – Freight-Significant Roadway Corridors Identification. The freight-significant roadway corridors are the facilities in the regional transportation network that are most critical for freight and logistics activities.

Chapter 4 – Community Impact Assessment. Goods movement, if not carefully planned for, may have serious impacts to the region's communities and natural environment. In order to lessen these potential impacts, it is essential that the scope of the problem, and likely areas of conflict, are fully understood.

Chapter 5 – Public Policy Profile. Public policies can significantly impact freight demand and the planning, operation, and investment in the freight transportation system. Developing a better understanding of the national, statewide, and metropolitan policies that may impact demand and operations on the freight system will be critical in helping the region make more informed public policy and investment decisions.

Chapter 6 – Future Freight Demand. Economic growth, changes in international trade patterns and supply chain practices will clearly impact the way goods flow within the Houston region. Understanding freight demand requires an understanding of changing regional, national, and international markets, and demographic and socioeconomic forces. It also requires an understanding of how regional industries and supply chain strategies are evolving to address these forces, with an understanding of the strategies and investments being considered by other regions in the United States.

Chapter 7 – Needs and Deficiencies. Freight mobility needs, both existing and future, were identified based on data, technical analysis, and private and public sector stakeholder input. The needs presented in this chapter focus on those of regional significance (as opposed to local) and on the regional freight subsystem.

2. Regional Goods Movement Overview

The Houston-Galveston region is a freight hub of national importance. Houston ranks first in pipeline volumes, second in port volumes, fourth in truck volumes and eleventh in air cargo volumes.[6] Precise data on the volume of rail freight moving through all the metropolitan areas of the United States are not available, but clearly the H-GAC region is a critical node in the national system and home to a major rail carload market.

Figure 2-1 displays the Region's multimodal goods movement system (with the exception of pipelines which are displayed in Figure 2.8).

This chapter presents a summary overview of regional commodity flow and the multimodal transportation systems used to transport those goods. It draws from two previous technical reports – the Regional Commodity Flow Analysis and the Regional Goods Movement Profile, both of which provide significantly more detail. The material presented here and the other two referenced reports represent existing conditions.

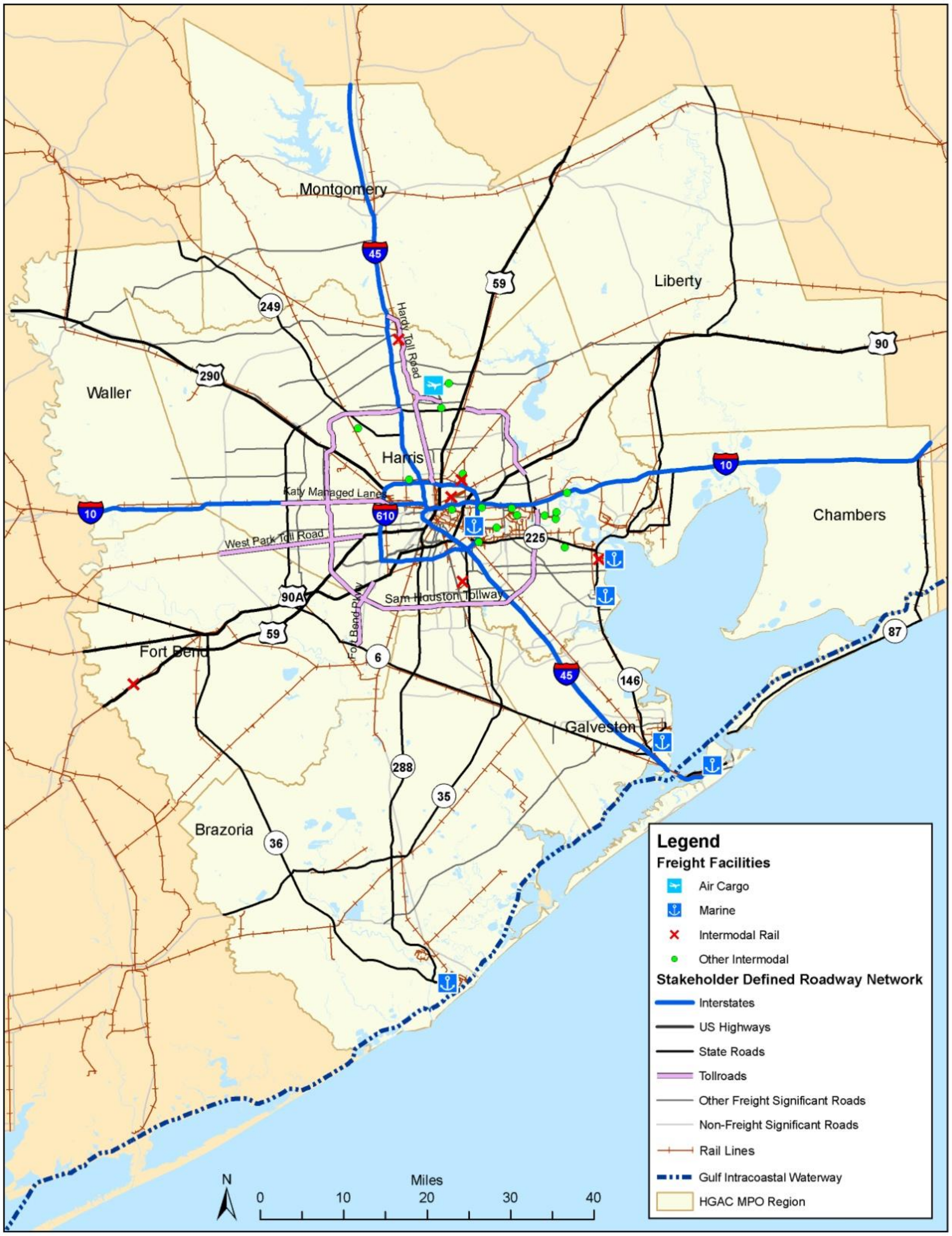
Commodity Flow Summary

In 2007, 761.3 million tons of freight moved into, out of, within, or through the H-GAC region. These shipments had an estimated value of $1.5 trillion.[7] Approximately 362 million tons (48 percent) traveled inbound, 231 million tons (30 percent) traveled outbound, and 100 million tons (13 percent) traveled from one point within the region to another point within the region. Through freight accounted for 68 million tons or nearly nine percent of the total. This means that more than 90 percent of all freight moving across the region's transportation infrastructure is servicing the regional economy and is not simply passing through the region. Every freight shipment can be categorized as moving in one of four directions: inbound, outbound, intraregional, or through. Figure 2-2 graphically displays the proportion of regional freight tonnage by direction.

[6] Truck, pipeline and air cargo data based on FHWA FAF3 (2007 base year) and port rankings obtained from American Association of Port Authorities.

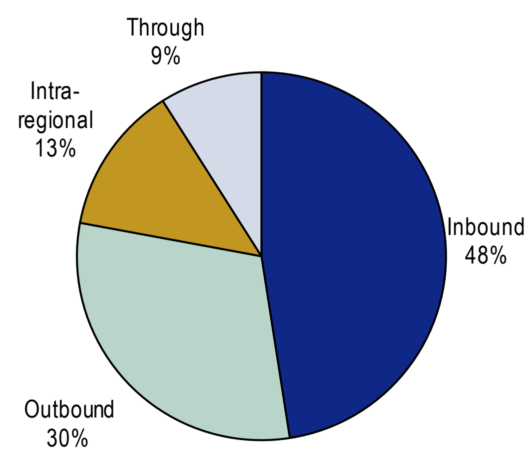
[7] All value figures in this report refer to current year dollars. 2007 figures are in 2007 dollars and 2035 figures are in 2035 dollars as estimated in the TRANSEARCH data.

Figure 2-1 Houston-Galveston Regional Multimodal Freight Transportation System



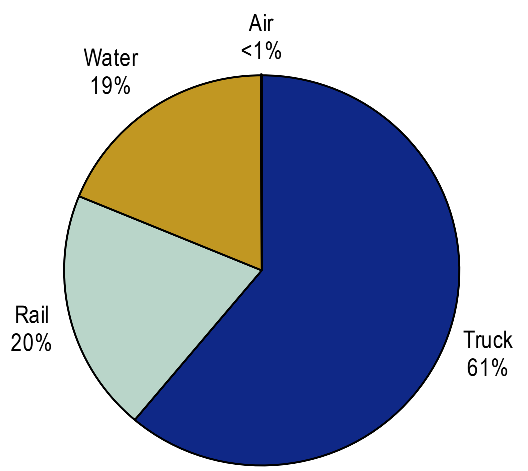
Source: Cambridge Systematics, Inc.

Figure 2-2 Direction of Total Freight Flows by Weight
2007



Source: IHS Global Insight.

Figure 2-3 Mode Share by Weight
2007



Source: IHS Global Insight.

Freight utilizes five modes of transportation; roadways, railways, water, air, and pipelines.[8] Mode share analysis enables better understanding of how the region's transportation infrastructure is impacted by freight movement.

Figure 2-3 displays the volume of goods movement by mode. Trucks are the dominant mode of freight transportation throughout the region, both by weight and by value. About 61 percent of all freight tonnage was moved by truck in 2007. The rail and water modes handled 20 and 19 percent of total regional freight, respectively, in 2007.

The top three commodities in 2007 are petroleum and coal products, chemical products, and secondary traffic. Combined they account for nearly half of total freight tonnage in 2007.

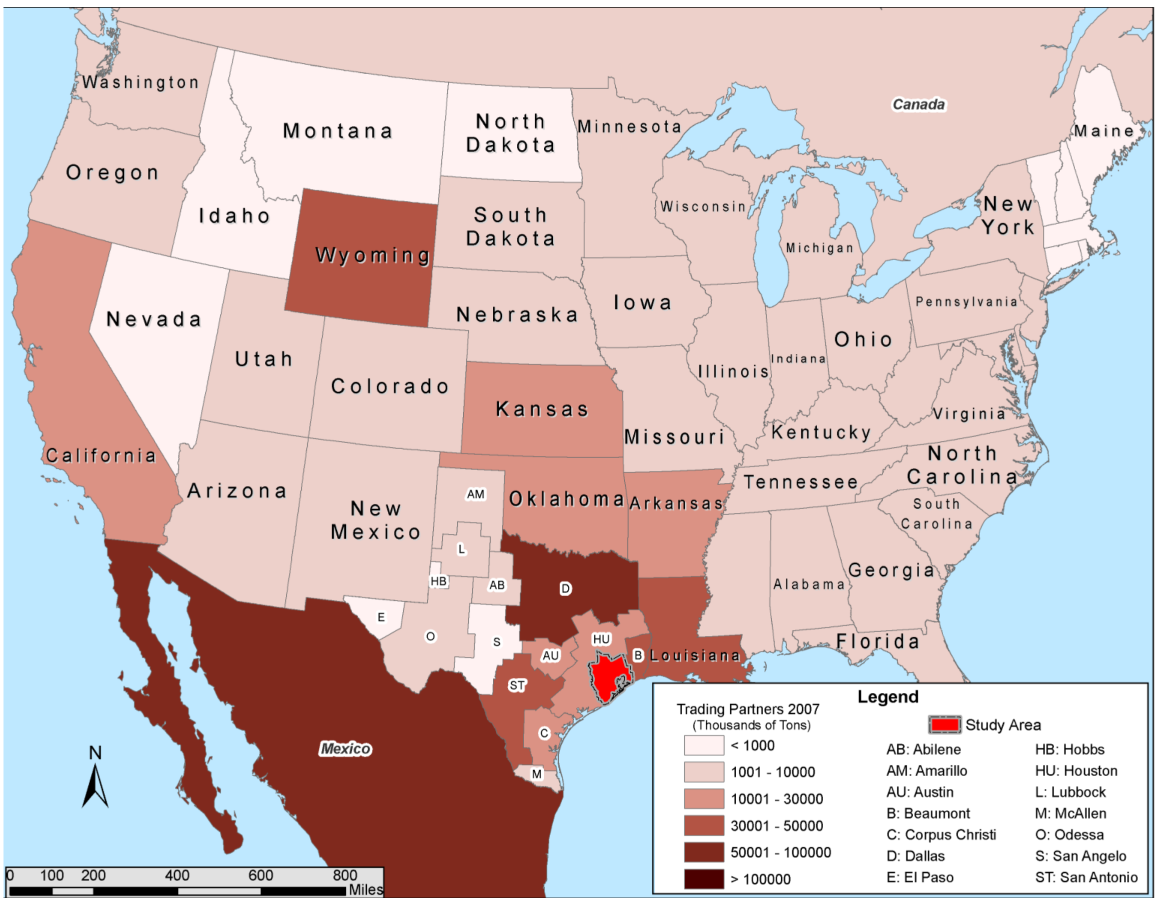
Commodity types provide insight into modal choice. For example, shippers of basic materials, such as coal, tend to be more concerned with minimizing the cost of transportation rather than speed of delivery, while shippers of manufactured goods tend to emphasize travel times and reliability over per-ton mile transport cost.

8 Pipeline data are not available in the TRANSEARCH database and is not included in this Technical Memorandum. The pipeline mode will be addressed within the Modal Profile Technical Memorandum.

Identifying the region's major trading partners helps planners (and others) understand the Houston-Galveston region's place in the larger national economic landscape and its role within the national and global freight transportation system by identifying critical corridors.

Figure 2-4 display North American trading partners for freight movements into and out of the Houston-Galveston region by weight in 2007. The top three North American trading partners – Mexico, the Dallas Region, and Louisiana – account for about 29 percent of total flows by weight. The fact that 6 of the top 10 trading partners are other regions within Texas and 2 more (Mexico and Louisiana) are adjacent to Texas is evidence that the Houston-Galveston region is particularly important economically to the State of Texas and to the south-central region of the United States.

Figure 2-4 North American Trading Partners by Weight
2007



Source: IHS Global Insight.

Regional Modal Overview

Roads, rails, water, and airport infrastructure each play key, distinct roles in the multimodal freight system, yet they must work together to create an efficient system that drives the economy. Cost, weight, and time sensitivity of the shipment are primary factors influencing modal choice as there are tradeoffs between costs per-ton mile and speed and reliability.

While each mode's role is distinct, most often goods are shipped on multiple modes and multimodal connectivity is critical. Clearly, freight movements utilize a wide array of infrastructure components. While much of the non-highway freight system has been developed by and evolved using private sector investment, the public sector has an interest in making sure infrastructure continues to provide for efficient goods movement because of its direct impact on the region's highway system, its effects on economic vitality, and the impacts on quality of life. The following sections provide a high-level overview of all modes, including privately owned and operated facilities. Additional detail on the modes is provided in the Regional Freight Profile.

Highway Mode

Although freight in the H-GAC region moves by five major modes – truck, rail, water, air, and pipeline – in various combinations,[9] highways and the trucks that use them play an especially important role because they provide door to door service for the region's businesses and consumers. This means that although thousands of tons of commodities are handled in the region by the other modes, they often depend on trucks for pick-up and delivery operations. Highways provide connections to and among every other mode of transport, along with warehouses, distribution centers, manufacturing plants, and other freight hubs.

The region is served by more than 24,000 miles of roadways of which 566 are interstates or other expressways and 781 are principal arterials. The roadway system experiences average traffic volumes (including trucks) in excess of 109 million vehicle miles per day.[10] In 2007, a majority of all freight (61 percent or more than 780 million tons) that moved across the region was hauled by truck,[11] highlighting the importance of highway facilities to the region's economy and the quality of life for its residents.

A brief overview of the highway system demand and challenges is provided in this section as an in-depth discussion of the region's freight highway system is provided in the Regional Goods Movement Profile report and in Chapter 3 of this document.

Highway Freight Demand

In 2007, more than 465 million tons of freight, valued at more than $1.3 trillion, was hauled by truck over the region's highways. Thirty-five percent of this volume flowed into the region, 32 percent flowed out from the region, 18 percent moved from one point within the region to another point within the region, and 15 percent passed through the region (i.e., had both an origin and a destination outside of the region). Trucking accounts for 57 percent of the total volume freight tonnage in the region, compared to 22 percent for rail, 21 percent for water, and less than one percent for air.[12]

9 Pipelines are especially important to the Houston-Galveston region and are considered in a later chapter in this document. Due to data limitations, the figures in this chapter do not include pipeline traffic.

10 Federal Highway Administration, Highway Statistics 2008. Calculated as the sum of the Houston and Texas City Federal aid urbanized areas.

11 HIS Global Insight's TRANSEARCH data.

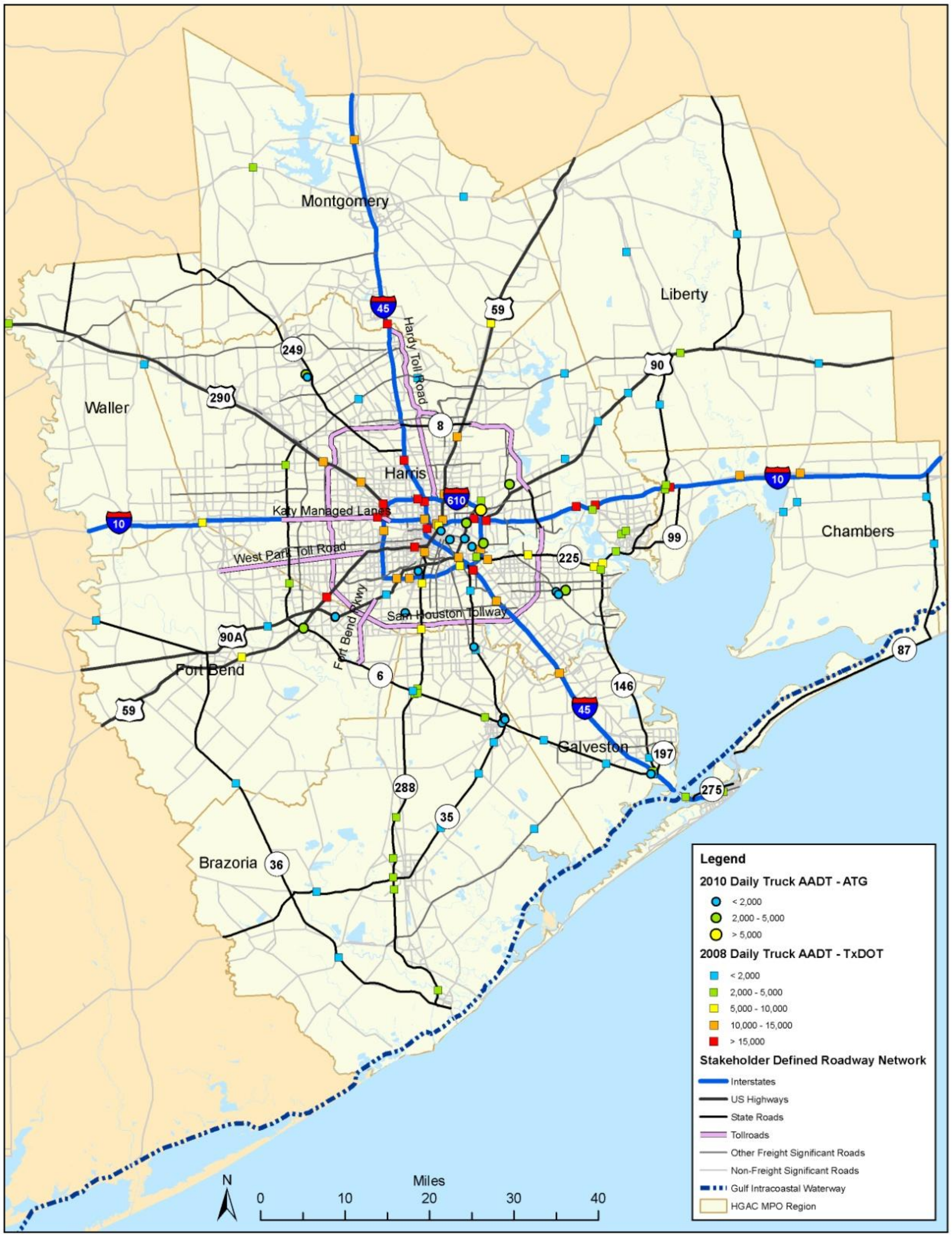
12 H-GAC Regional Commodity Flow Analysis.

The most common measure of truck volume is average annual daily truck traffic (AADTT). AADTT refers to the average number of trucks using a given roadway segment per day and it indicates the level of freight demand being placed on the various regional highway facilities. Figure 2.5 shows AADTT information as point counts at specific count locations. The data indicate that the highest volumes of truck traffic occur on roadways that already experience a high level of overall traffic, with the highest truck volumes on I-10, I-45, and U.S. 59.

Challenges

The region's highway system faces numerous challenges in meeting the ever growing demand of both passenger and freight highway users. Meeting these demands and managing the shared use of the system is critical to the future economic competitiveness and quality of life in the region. While regional freight stakeholders generally view the highway network as good and report that they are able to overcome and work around any difficulties present in the system, several challenges to truck freight operations were noted. Similarly, public sector stakeholders noted system deficiencies and community needs. The needs identified by these stakeholder groups include congestion, safety, operational inefficiencies, increasing demand for permitted loads, air quality and other environmental and community impacts. These challenges will be explored in detail in Chapter 3.

Figure 2-5 Daily Average Annual Daily Truck Counts



Source: TxDOT and ATG.

Rail Mode

In 2007, more than one-fifth of the freight volume moving to, from, and around the Houston metropolitan region was transported by rail, accounting for 153 million tons and 22 percent of all its freight activity, excluding pipelines. Nationally in 2007, rail represented 18 percent of such tonnage, indicating that Houston with its huge petrochemical industry is a relatively heavy user of the rail mode. Some 2,200 trains of all types move weekly in the region, more than 1,000 miles of track with exposure to approximately 1,200 roadway-railroad crossings. Two Class I railroads (UP and BNSF), and the Port Terminal Railroad Association (PTRA), account for 96 percent of these trains.

At least one-third of Houston regional freight tonnage is on through or "overhead" trains, according to the Houston Region Freight Study (HRFS),[13] carrying shipments that begin and end outside the area. The remaining two-thirds of Houston rail tonnage either originates or terminates in the Houston region. This implies that Houston is an originating and terminating point in the national rail network, and not a hub or transit point for continuing service with the exception of traffic bound for Mexico. It is a major producing market for bulk industry and a receiving market for industrial supplies and consumer goods because it is home to the U.S. petrochemical business and to one of America's biggest urban populations.

The Houston Regional Rail Network

The majority of Houston rail freight traffic is carload service direct to customers and port facilities. Intermodal trailers and containers as well as new automobiles are trucked to and from rail terminals, but unit trains proceed on rail to customer sites, and manifest trains combined with locals provide most of their service right to industry doors. Manifest, or trains with a mixture of cars and loads, and local trains form the majority at 51 percent, trains that support yard work account for another 27 percent, unit trains (including coal and grain) are 13 percent, and intermodal and autos are just 7 percent of the activity.

The volume of direct service that Houston enjoys is high for an urban area. While many cities have grown dependent on truck drayage to connect to train service, Houston has retained much of its rail infrastructure on carrier and private property.

The Houston-Galveston Region's rail network is shown in Figure 2-6.

Challenges

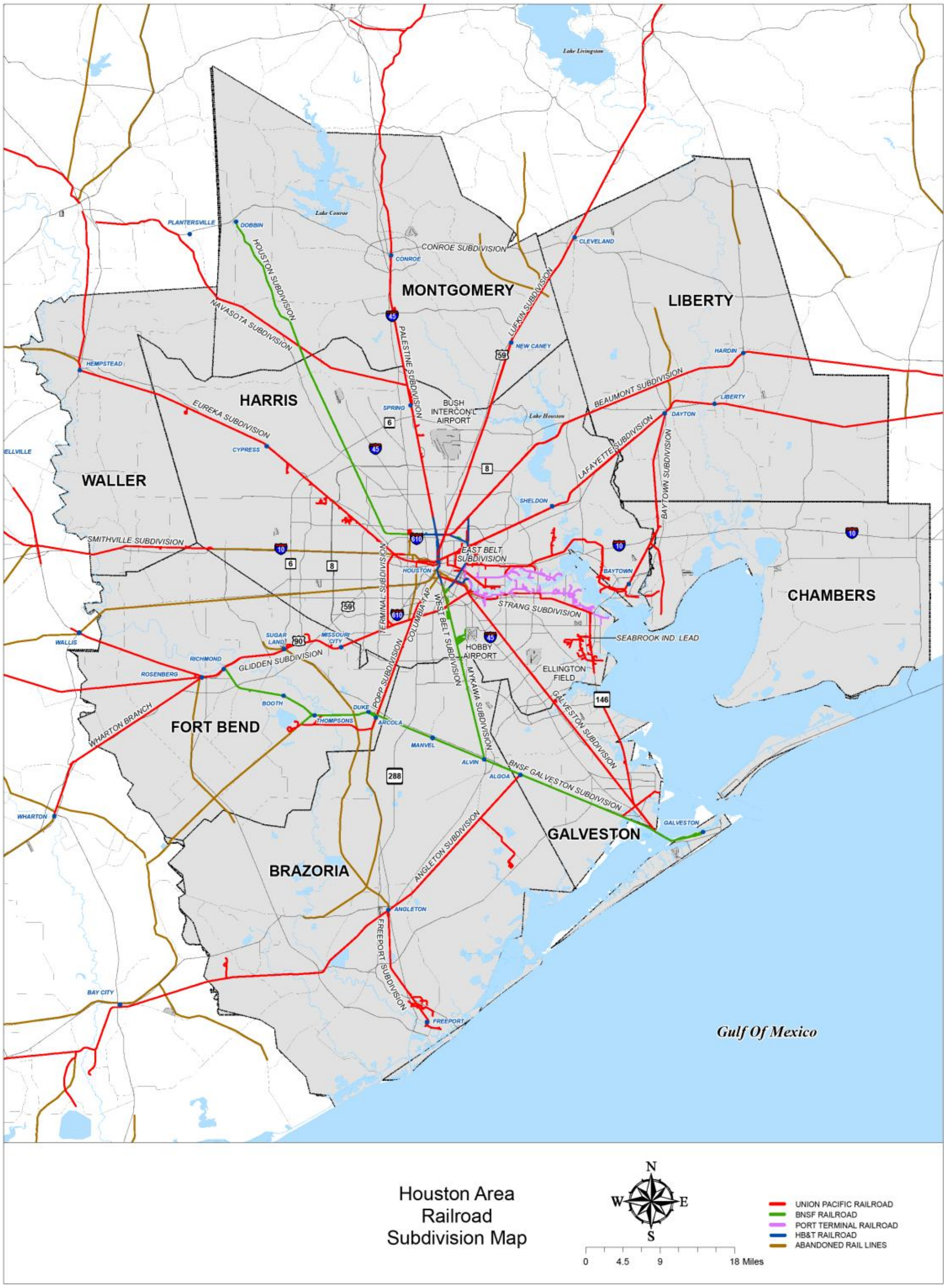
The rail system in metropolitan Houston faces a series of challenges in preparing a network established in a bygone era for the business and environment of tomorrow. It is a modern system today in that it can handle contemporary equipment, yet the legacy of its original design gives rise to inefficiencies, much as the road network also does in any evolving city. Some concerns are about sustaining capacity and performance, and some about integration with the surrounding community.

Exacerbating the national rail system issues are local rail bottlenecks that are hindering efficient movements into and out of Houston metro region. Critical rail access issues include:[14]

[13] HRFS Tables 3-7 and 3-8.

[14] Detailed rail bottleneck information can be found in the TxDOT Houston Region Freight Rail Study (http://www.txdot.gov/project_information/projects/houston/railway/default.htm), and the Corpus Christi-Yoakum Regional Freight Rail Study.

Figure 2-6 Houston-Galveston Region Rail Network



Source: TxDOT Houston Region Freight Study.

- **Single Track Lines and Bridges –** Single track lines and bridges force trains to wait for oncoming trains to pass, creating pinch points in the system which lead to significant delay. There are several such bottlenecks in the H-GAC region with the most notable being two bridges over the Buffalo Bayou – Bridge 16 and Bridge 5A and single track segments along the West Belt Junction and on the PRTA from Sinco Junction and Deer Park Junction.

- **Grade Crossings –** Safety at rail grade crossings is a major issue for the greater Houston area and several crossings have been identified as "hot spots" for auto-train collisions. There are more than 1,200 at-grade crossings throughout the region, including several on port access roads for all the Region's port facilities.

- **Sidings –** Longer and heavier trains also are being used by the railroads to maximize existing capacity and improve efficiency. For example, the BNSF prefers that all their international intermodal shipments be handled in 40-foot well cars and all their intermodal trains be 8,000 feet in length. These changes will allow the BNSF to increase the amount of freight that can be handled over its mainlines without increasing the number of trains. However, the longer trains cannot be handled without lengthening sidings to permit trains to meet and pass; and without providing the corresponding yard capacity to assemble and hold the longer trains.

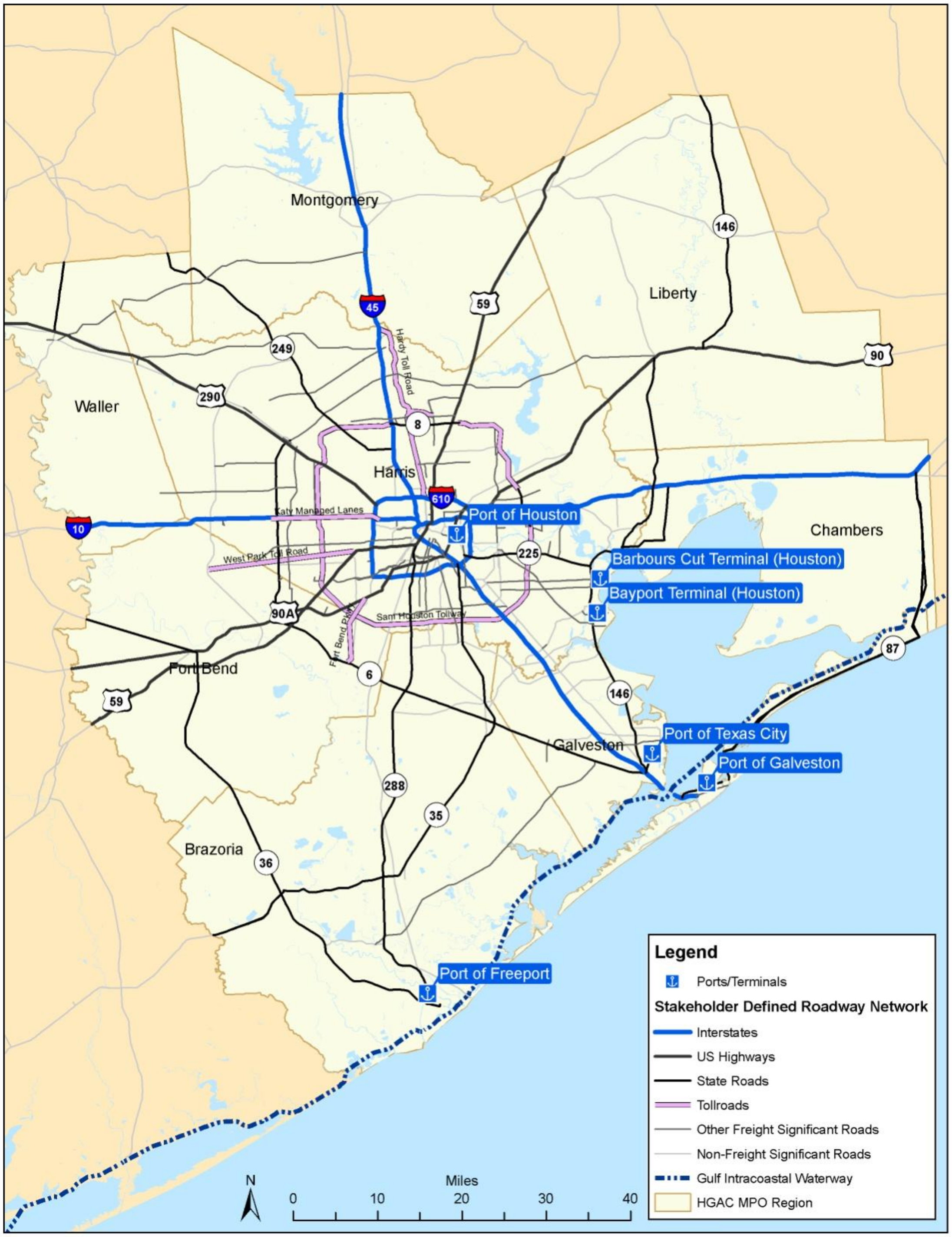
- **Rail Yard Capacity –** Increasing amounts of freight are straining capacity at rail yards. For instance, more than 95 percent of all freight trains moving in the Houston region must stop to pick up or drop off cars. This leads to rail-yard capacity constraints.

Regional Port System

The ports, ship channels, and waterways of the Houston-Galveston area are of vital regional, national, and international significance, linking key Texas industries, particularly its chemical, oil, and agriculture industries, with markets and suppliers located throughout the world. They also serve industries and markets located in other parts of the country, particularly those in the central U.S. While chemicals and petroleum are responsible for making the region's ports among the largest in the nation, the system's importance in supporting the flows of containerized goods, grains, cement, and other commodities continues to grow. As a result, these ports and waterways are key contributors to the overall health and competitiveness of the economy. .

The Region's waterborne transportation system, shown in Figure 2-7, consists of a network of Federally maintained coastal and inland waterways, ports, and private terminals.

Figure 2-7 Major Houton-Galveston Region Ports and Terminals



Source: Cambridge Systematics, Inc.

Regional Port Challenges

While the H-GAC port and waterway system currently provides sufficient access to regional, statewide, national, and global markets, physical and operational chokepoints may prevent this system from effectively absorbing future growth in freight traffic and may lead to other economic, social, and environmental impacts.

Landside Chokepoints

Efficient landside access is a key factor in port competitiveness particularly in the heavily populated H-GAC region. However, the H-GAC port and waterway system is being impacted by three key landside issues: traffic growth along major trade corridors, lack of high-capacity port-access routes, and limited-rail access.

Trade Corridor Volumes

Ports and waterways in the H-GAC region are being impacted by highway bottlenecks at both the regional and local levels. Major highway-trade corridors in the region, including those directly serving major port facilities, already suffer from significant freight bottlenecks.

Truck volumes are expected to grow significantly along the major trade corridors serving the Houston-Galveston Area's port and waterway system, particularly the IH 10 and the proposed I-69 corridors, both of which are Federally designated "Corridors of the Future." Volumes along Interstate 10, which runs across the entire State of Texas, could rise to an average 85,000 average daily traffic (ADT) and 20,000 average daily truck traffic (ADTT) by 2035.

Continued traffic growth – particularly truck traffic growth – along these corridors will make it difficult for ports in the H-GAC region to access more distant markets and may also drive up costs for shippers, carriers, and ultimately consumers. The ability to efficiently reach the hinterland markets via truck will be critical to continued service to the greater Texas market, as well as expansion of the region's role as a gateway for the increase in Panama Canal trade.

Limited Port Access

At some of the Houston-Galveston area's largest ports, access roads often are not physically capable of efficiently serving large volumes of truck traffic, and many suffer from heavy traffic congestion, inadequate clearances, poor turning radii, and substandard pavement conditions.

Many of the access routes used most heavily by the Ports of Houston, Freeport, and Galveston are lower-capacity roadways which may not be sufficient to handle larger volumes of truck traffic and may limit the ability of these ports to attract new business. For instance, Port Freeport is served by State Highway 288 (which provides access to the Houston metropolitan area and IH 10) and State Highway 36 (which provides access to U.S. 59 and points south and west). Large segments of these corridors are low capacity (fewer than six lanes) with few access controls, which can reduce overall efficiency for movements into and out of the Port. This type of access may not efficiently support future growth at the Port, as full build-out of the Port's Velasco Terminal is expected to result in total annual capacity of 800,000 to one million TEUs.

Table 2-1 describes existing port access routes and capacity concerns identified by port and waterway stakeholders in the H-GAC region.

Table 2-1 Issues and Concerns of Port Access Routes

Port	Access Route	Key Issues
Freeport	FM 523	Poor pavement condition, limited capacity for trucks
	SH 36	Lack of access controls in many segments
	SH 288	Low capacity, lack of access controls in some segments
Houston	Jacintoport Blvd	Limited capacity, lack of median and shoulders
	Spencer Hwy and Red Bluff Road	Poor pavement condition, low bridge clearances along some segments, lack of access controls, poor turning radii
	SH 146	Poor pavement condition, congestion issues, grade crossings
	SH 225	Poor connectivity (IH 610, Beltway 8), safety issues
Texas City	Loop 197	Limited capacity, access control, poor geometrics for truck traffic

Regional Pipeline System

Pipelines carry more than two-thirds of all the crude oil and refined products in the United States. They are generally the most economical way to transport large quantities of oil, refined oil products, or natural gas over land. The Houston-Galveston region, where the heart of the U.S. oil industry is located, has a vast pipeline network. Pipelines are important to the region because they carry large volumes of product that would have to travel via another mode in the absence of pipeline capacity.

There are approximately 21,500 miles of pipelines across the H-GAC eight-county transportation region (see Figure 2-8). About 6.6 percent of these pipelines are abandoned (1,418 pipeline miles) and the rest are in service carrying liquids and gases, such as crude oil, refined product, and natural gas.

Pipeline Demand

The pipeline system in the H-GAC region carried more than 445 million tons of goods in 2007. Goods traveling into the region represented 41 percent of the pipeline volumes while those traveling outbound from the region comprised the remaining 59 percent. The overall volume of goods traveling via pipeline in the region is projected to grow by more than 20 percent to 540 million tons by 2035.[15]

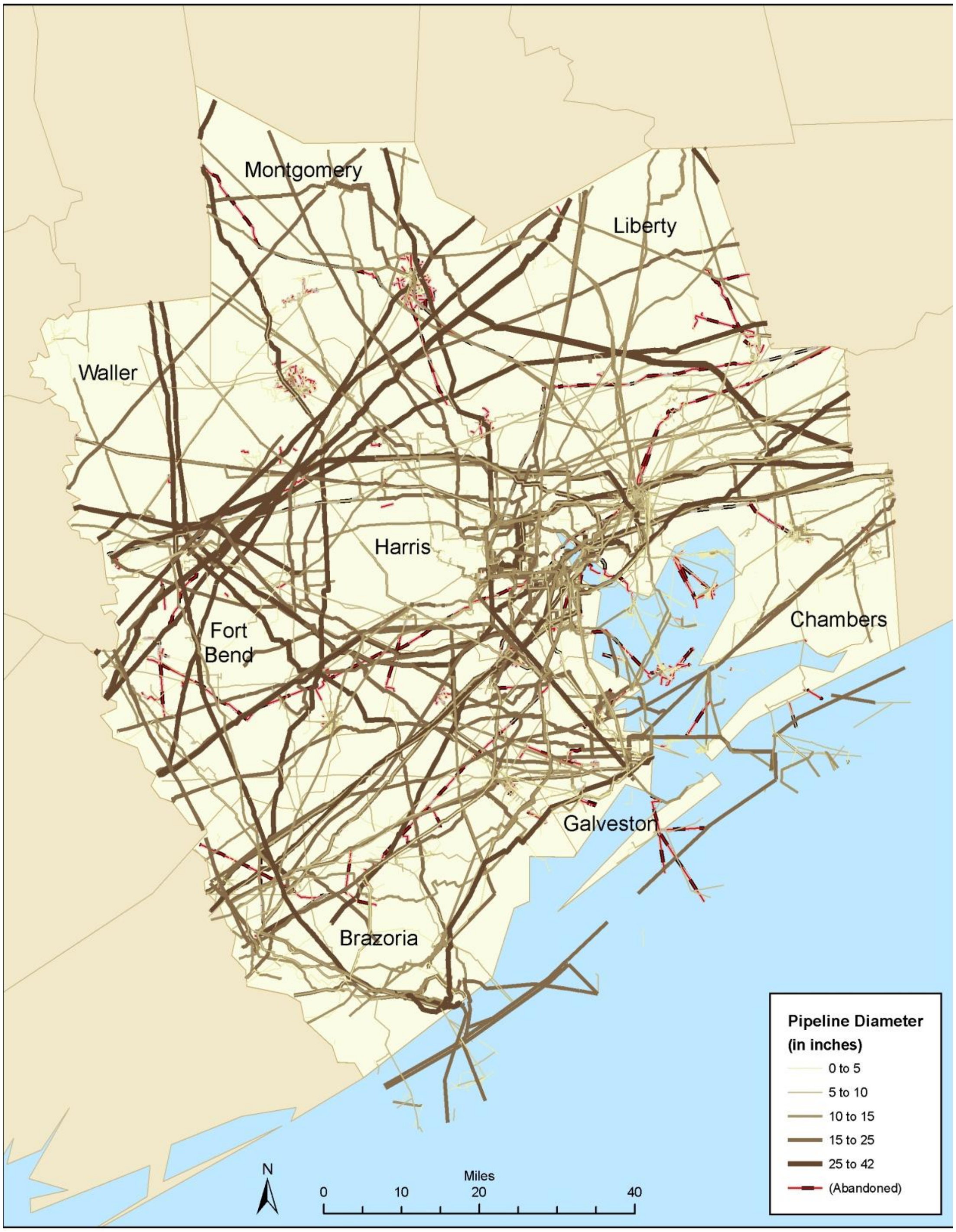
Challenges

Pipelines are a critical part of the H-GAC region's freight transportation network. The ability to efficiently handle the growth in the petrochemical industry will depend on the ability to accommodate the future pipeline demand. Data on pipeline operations are limited and the fact that the infrastructure is privately owned makes it difficult to obtain detailed information. Therefore, a full assessment of challenges could not be conducted. However, based on data and information available, the primary challenges are ensuring adequate capacity and intermodal access to the pipeline terminals. While conducting a full capacity analysis is beyond the scope of the Regional Goods Movement Study, the data suggest that additional capacity may be needed to accommodate future growth. In addition, as many of the pipeline terminals are located in the already congested east side of the Houston area, truck access to the terminals suffers from congested facilities and numerous facilities with at-grade crossings and community conflicts.

---

15 Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework 3.

Figure 2-8 Houston-Galveston Region Pipeline Network



Source: H-GAC Pipeline GIS Data.

Regional Air Cargo System

Air freight is a small yet critical component of the Houston metropolitan region's freight transportation network. Overall, less than one percent of total freight value moving to and from the region moves by air.[16] Although small in terms of value and volume, air freight provides expedited service for high-value shipments that many businesses and industries rely on to remain competitive. In turn, the Houston economy relies on air freight to serve time-sensitive industries that create jobs and income for residents in the region.

Houston's Air Cargo Facilities

Houston's air cargo system is a significant hub in the national freight network, both in terms of exports and imports. More than 830 million pounds of air freight were handled by the Houston Airport System in Fiscal Year 2010. In addition, 82 million pounds of airmail was handled. Approximately 98 percent of the air freight in the Houston region moves through George Bush Intercontinental Airport (IAH). While Houston Hobby (HOU) does move some freight on passenger flights (almost all on Southwest Airlines), all of the major cargo facilities and cargo airlines are based at IAH.

Challenges

The primary issues that impact goods movement between the airport cargo warehouses and the rest of the region include congestion on the primary IAH Cargo Center Access Road. Safety issues for truckers on Lee Road, and existing infrastructure (pipelines) make expansion more difficult.

Lee Road, which is currently the only route that serves the IAH Cargo Center, experiences significant congestion on northbound lanes. This is a result of heavy traffic volumes and left-turn volumes at the intersection of Lee Road and FM 1960. In addition, the bridge in the southern portion of Lee Road is in a floodplain. Replacing this bridge will be expensive. In addition, freight forwarders are concerned that the bridge on Lee Road is structurally incapable of handling very heavy cargo loads moving to the IAH Cargo Center, leading to a circuitous route for these transports.

It was mentioned by stakeholders that it is dangerous for truckers turning into IAH Cargo Center facilities from Lee Road.

Currently, pipelines run next to Lee Road, which prevents the construction of structures and roads. Without purchase of these pipelines and the land, expansion to the east of Lee Road becomes more difficult.

Summary

Roads, rails, water, pipelines, and airport infrastructure each play key, distinct roles in the multimodal freight system, yet they must work together to create an efficient system necessary to serve the needs of the economy. While air cargo is costly, it provides the most reliable service for time-sensitive transport. Truck, rail, and water (including barge) are used to move goods at a lower cost for less time-sensitive or bulk commodities. Pipelines also fall on this side of the continuum. While each mode's role is distinct, most often goods are shipped on multiple modes and multimodal connectivity is critical.

For the most part, modes other than highways are privately owned and operated. However, they still depend on publicly owned and operated highways to provide critical connections between modes and customers. Given its distinct and critical role, the next chapter focuses on the highway system and identifying the part of that system that is most important to goods movement.

---

[16] These calculations do not include pipeline volumes or value.

3. Freight Significant Roadways Identification

Definition and Purpose

Freight significant roadways are the portions of today's regional road network that are important to freight and logistics activities. The region's road system was designed to carry passenger vehicles and trucks, but it was not designed for the express needs of freight transportation. Passengers and freight together use a single network, yet they use it very differently. Identifying the roadways significant to freight allows its different needs to be considered individually, and is a step toward recommendations for design improvements and management that better meet those needs.

Roadway corridors are part of a multimodal transportation system. This means they have two aspects to be identified for goods movement: carriage of wholly over-the-road shipments, and road connection for marine and waterway, air, pipeline, and railroad intermodal shipments. A complete system of freight corridors encompasses the routes by rail and other modes. Those will be integrated as this Study moves forward (and the possible opportunity for expansion of rail is touched on later in this Chapter). However, for the publicly owned right-of-way serving the businesses and residents of greater Houston, linking modes to customers and to one another, roadways are the principal infrastructure. They are the key place to start.

Identification of significant roadways enables investments and practices to be focused on improving a set of facilities whose performance matters most to overall regional freight performance. This is desirable because:

1) It fosters better and more sustainable freight service, which in turn promotes economic vitality;

2) It supports productive use of limited public resources, by directing them to critical requirements; and

3) It leads to greater public safety because freight operations are improved on significant routes, and the improvement encourages freight to stay off other roads.

Combined into a coherent network, these roadways should: 1) provide service to the greater Houston region; 2) accommodate goods that simply pass through the area; and 3) emphasize routes that allow freight to travel efficiently from one part of the region to another. Loosely, these can be called "cross-town" or "cross-regional" routes, and they correspond to the "stem" routes that freight carriers travel on their way to points and pockets of pickup and delivery. In addition, these routes need to connect to each other, and reach the districts where freight is produced and consumed today and in the years ahead.

This Chapter begins by identifying significant roadway facilities based on the compiled reports of individual freight service providers, who together form a cross-section of users of the system. Users cited the roadways critical to their own operations, which extend to a variety of multimodal functions. Facilities identified by the stakeholders are aggregated into a composite set of highways and roads, and are supplemented with intermodal connectors defined by local facility operators and Federal sources. The result is a "stakeholder-defined" roadway network. The remainder of

the Chapter assesses this network using numerous criteria, including intermodal facility sites, level of service, truck accident location, hazardous material routes, and the presence of environmental justice communities. A substantial part of this analysis is devoted to the geographic concentrations of freight production and consumption for major sectors of the regional economy, and to associated commodity flow patterns over the region's roadways. It is presented for the recent historical year of 2007, and the forecast year of 2035. This accomplishes two things. First, it determines the completeness with which the stakeholder-defined network reaches the freight shipping and receiving points of the region. Second, it is an indication of additional or different routes than stakeholders identified, plus activity on those routes. Since the input from stakeholders relies on their operational experience but is not comprehensive, and regional freight patterns are more complete but rely on models, it is useful to compare and consider both kinds of information.

Roadway corridors throughout this Chapter are limited to existing facilities. This is because they are derived from current use, and also because the purpose of this Needs Assessment is to establish a foundation for recommending additions and improvements. Recommendations themselves are taken up in the next phase of the Study.

Overview of the Freight Significant Roadway Corridors

Goods movement makes extensive use of the primary highways that traverse Harris County and draw together the seven adjoining counties. These include the Interstates 10, 45, and 610, U.S. Highways 59 and 290, and State Highways 146, 225, 249, 288, and Beltway 8. The Beltway is utilized selectively because of its tolls, but nevertheless is a practical route that some fleets (particularly those with company drivers) use. The number of alternatives this set of highways offers was highlighted frequently by stakeholders as a major advantage. It covers the territory well with multilane facilities, and it offers more than one travel path for avoiding backups and sequencing a series of customer stops. Moreover, its parallel access roads offer relief routes in the event of incidents, and can be followed for miles. The Houston region freight system was called superior to Dallas in respect to these highways, and several stakeholders stated that their operations rely mostly upon them.

Two drawbacks of the primary highway network were identified: the routes funnel toward the city, and there is a shortage of well-developed east-west routes. These two drawbacks are related to a degree. As growth continues in the counties surrounding Harris, there will be a need for routes that link those points directly, in addition to the traditional southerly orientation toward business and population near the coast.

Within this framework of primary highways, there are numerous additional surface roads that freight operators depend on to do four things:

1) Link portions of the primary highways;
2) Connect between expanding communities;
3) Extend in directions the highways do not go and penetrate territory they do not fully reach; and
4) Offer alternate routes.

Examples of significant surface roads and the role they play in goods movement in the region include:

1) Westheimer Road travels through a notoriously congested, heavily accessed part of town, but it extends from Katy past the Galleria and joins many pockets of business;
2) Wallisville Road traverses between the Beltway, the Loop, key rail yards, and a variety of businesses, although its design is deficient and residences and schools also lie along its route;

3) Louetta Road in the northwest serves as an alternative to FM 1960 to link SH 249 and IH 45;

4) Further north, FM 2920 and FM 1488 tie the U.S. 290 Corridor together with Conroe and cross from 290 through SH 249 to IH 45 – although FM 1488 is described as difficult for truck passage;

5) Facilities like Spencer Highway and Fairmont Parkway connect plants and port terminals along SH 146 across industrial districts to the Beltway and IH 45, and to yards and businesses concentrated near Hobby Airport; and

6) FM 2004 is a two-lane road through open territory, and helps move freight between petrochemical regions along the coast.

Such surface routes knit together the strands of the primary highways and combine with them to make a more complete and intermodal set of freight service corridors. The highways bear the heavy traffic densities for overhead as well as for regional volume, but the surface roads link them and enlarge the regional coverage. They are less well defined, they are certainly not all good freight facilities, and the routes now in use ultimately may not be the best. Nevertheless, the joint result is an interactive group of cross-regional corridors and connections that move essential goods throughout the Houston-Galveston region.

The remainder of this Chapter depicts the freight significant roadway corridors as stakeholders have described them, examines their functionality from a variety of perspectives, and suggests conclusions of value for the formulation of network recommendations.

Identification of Data

Background

The groundwork for this phase of the project was laid during field trips to the Houston-Galveston area in 2010 by the project team. The purpose was to understand specific issues relating to the regional freight infrastructure as well as specific needs in order to develop proposals for a future system. The resulting recommendations were to be directed toward improving the efficiency and safety of freight transportation throughout the region.

In addition to attending industry meetings, the team interviewed key stakeholders in the region's stakeholder-defined network, including private logistics and transportation companies, retail/wholesale distributors and food conglomerates.

The interviews were supported by ground observations that the team completed either independently or as follow up to key points raised by interviewees. The process involved travel on all of the major highways and many of the secondary ones, focusing on the ones identified as critical and/or problematic to the freight community.

In addition to speaking with the personnel responsible for operations at these organizations and making independent observations, the team was also able to communicate directly with truck drivers from several fleets making deliveries throughout the region. This was accomplished by providing maps and comment sheets in break room areas. The drivers marked areas of concern and primary routes on maps and added comments to the worksheets. Additional input from drivers was obtained through carrier surveys and satellite call-in radio shows for truckers who drive in the Houston-Galveston region.

Stakeholder Interviews

The interviews and observations comprised the first step in defining freight corridors for the region, and provided descriptions of current conditions. This supplied information about bottlenecks and operational constraints as well as alternate routes and frequently used roads. The team noted the names of highways, roads, and areas that were referenced in the interview process and compiled any comments pertaining to these routes.

Table 3-1 lists the most frequently referenced routes. It includes several toll roads, which some operators carefully avoid, and others find efficient.

Stakeholder-Defined Network

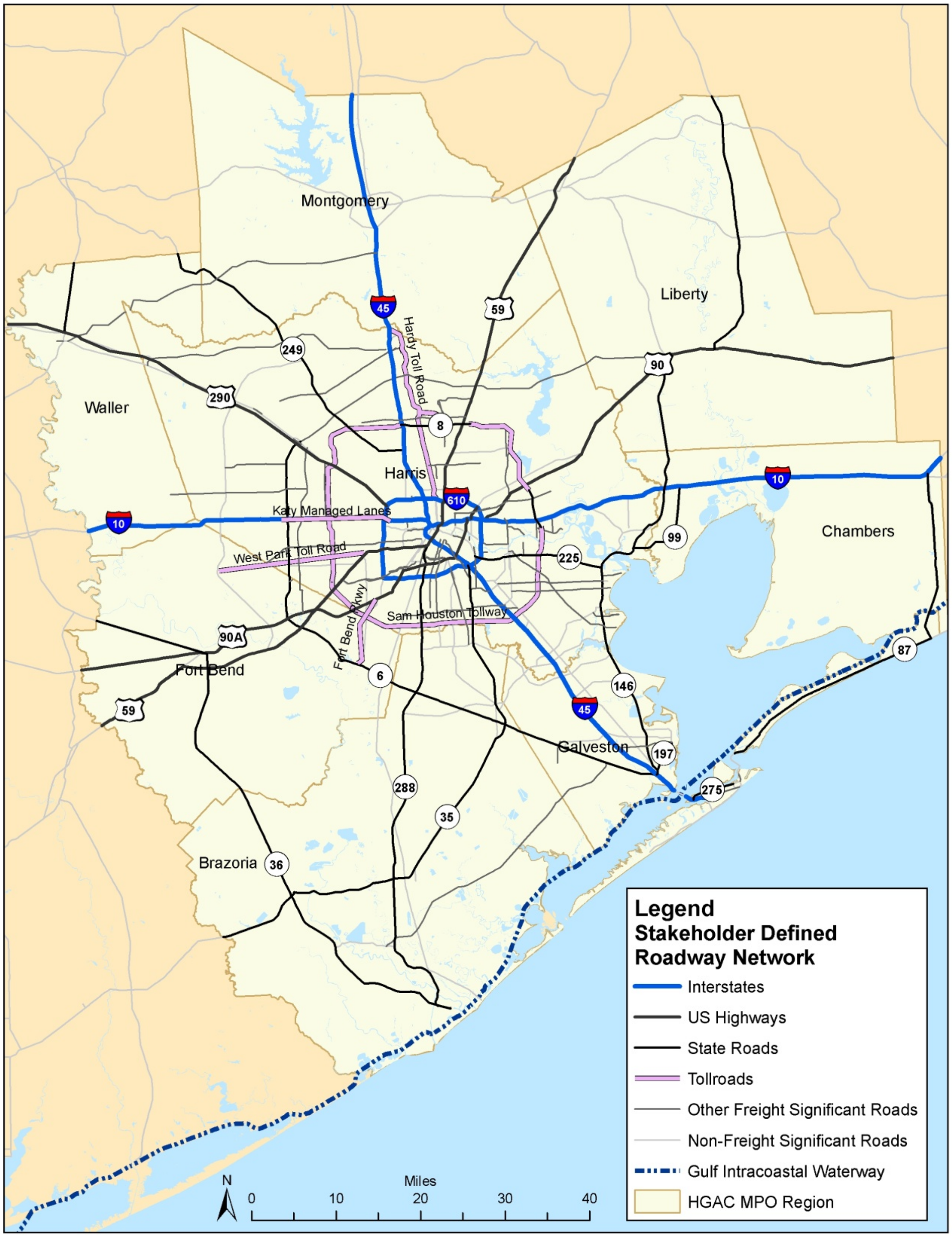
Figures 3-1 to 3-2 present the network of roadways identified by stakeholders as the significant corridors for regional goods movement. They display the routes that were referenced in stakeholder interviews as the principal ones for cross-regional travel and linkage, supplemented with intermodal connectors either mentioned in interviews, provided by or for facility operators, or published by FHWA for the eight-county region. The combination forms the baseline of corridors that will be evaluated throughout the remainder of this Chapter. Figure 3-1 presents the stakeholder-defined network at the regional level, and Figure 3-2 zooms in to show detail for the region's urban core around and inside Beltway 8.

Table 3-1 Top 15 Routes Referenced as Significant by Freight Service Providers

Facility		
IH 10	U.S. 290	SH 249
IH 610	SH 288	Wallisville Road
IH 45	SH 146	Hardy Tollroad
U.S. 59	SH 225	Westpark Tollway
Beltway 8	SH 6	Almeda Road

Source: Halcrow.

Figure 3-1 Stakeholder-Defined Freight Significant Roadway Network



Source: Stakeholder Interviews.

Figure 3-2 Stakeholder-Defined Freight Significant Roadway Network in the Region's Urban Core

Source: Stakeholder Interviews.

Factors for Examination

Table 3.2 lists the factors used to examine the stakeholder-defined network along with data source(s) for each. Each of them brings a different perspective to the identification of freight significant corridors, and helps determine modifications needed and issues posed for the baseline network identified by stakeholders. Introduced as a series of "layers" overlaid on the stakeholder-defined network, these factors provide insights into whether there are gaps in service or important routes unmentioned, whether alternatives are present, and challenges in mobility, safety, and equity that may affect the main corridors of the region.

Table 3-2 Factors for Examining the Stakeholder-Defined Network

Type of Factor	Source
Traffic Counts/Truck Percentage	Alliance Transportation Group, TxDOT
Multimodal Facilities (Ports, airports, and rail terminal locations)	TxDOT
Key Industry Establishment Data	IHS Global Insight
Commodity Flow	IHS Global Insight, H-GAC
Crashes/Accidents	H-GAC
Level of Service	H-GAC, ATRI
Hazardous Materials Routes	TxDOT
Environmental Justice Communities	H-GAC

This Study originally planned to use an upgraded and detailed model of regional freight traffic for the examination of industrial concentration and network flows. The freight model is under construction in a parallel project and is not available for the current analysis. To avoid duplicating efforts of the model development project, this study developed more sketch-level approximations using data collected to date and existing network models. In brief (and utilizing the sources named in the table), the approximations employ county-to-county commodity data, convert it to flows by 5-digit zip code based on separate data for industry establishments overlaid on GIS parcel data, and then assign those flows to the road network with H-GAC's existing traffic model. There are a number of limitations imposed by this method that affect the information presented in this Chapter. The important ones are:

- Suppliers of establishment data intend their coverage of regional businesses to be complete, but the data are imperfect in practice. The legitimacy of larger establishments as locations for freight have been validated, but omissions and errors likely still exist.

- Traffic flow data are reasonably substantiated at the county level, but not when fragmented to individual establishments. For this reason (and in the absence of the new traffic model), zip codes have been used to maintain a measure of aggregation.

- Zip codes are much smaller than counties but still relatively large. Also, there are more of them toward the center of the region, while those toward the periphery are fewer and larger. This gives rise to two misleading visual impressions: zip codes with more land area appear to have relatively more traffic when they do not, and traffic volumes appear spread across the whole area of the zip code when they may be restricted to certain locations.

- The size and number of zip codes also affects the function of the H-GAC traffic model. The selection of routes and the volumes assigned to them may be over or under-stated, because of the magnitude of the geographic units. In cases where the traffic activity is clearly associated with a particular facility (such as drayage from a rail ramp), the route selection has taken advantage of this, but in most cases the data do not support this specificity.

- The route assignment process itself is constrained by the model's current design, which lacks the custom freight features planned for the new version. The results of the current assignment show a proliferation of lightly traveled routes, which may be accurate in many cases or may reflect a modeling limitation in some. If model limitations are suspected, it is noted within the analysis of findings. Toll roads for the most part have been disallowed and while the total number of trucks projected to use toll road facilities may be in line with actual volumes, the distribution by commodity type is not accurate. A more discrete assignment related to fleet types and commodities would come closer to capturing the differences in actual truck behavior but the limitations of the existing model does not allow for this level of detail.

- Forecasts are projections from 2007. They incorporate economic growth and shifts but not new land uses and facilities.

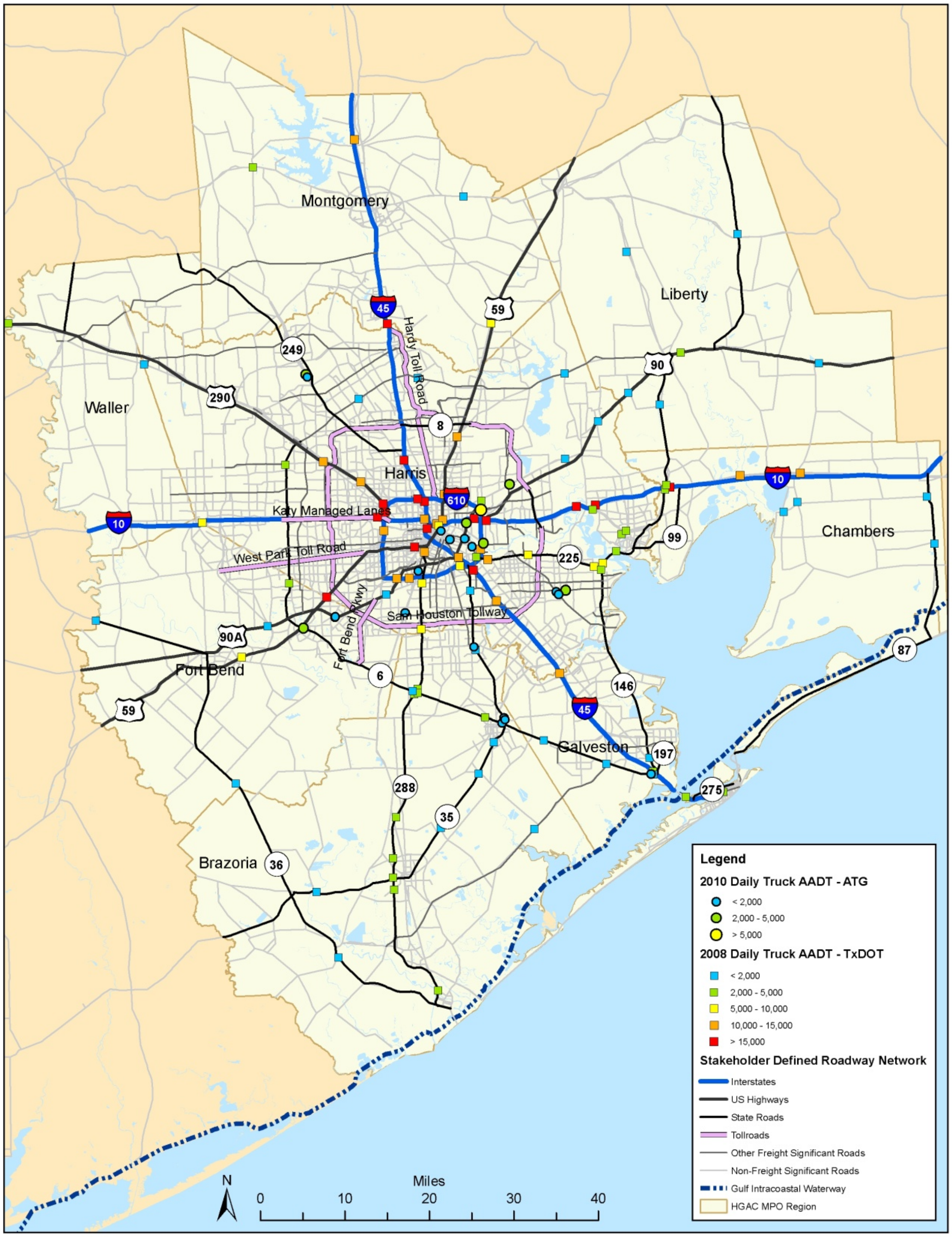
Comparative Analysis

Traffic Counts

Figures 3-3 and 3-4 present absolute truck volumes and truck percentages of total vehicles for road locations where this information is available from the past several years. and the data are displayed on the stakeholder-defined network. Both figures are averaged from the two directions on each route, and volumes are expressed as average daily counts. While data for some facilities are not available, there are measures for all of the major freeways, for a number of non-freeway roads, and from all counties.

From a count perspective, the high volumes appear on the primary highways – including non-interstates like SH 225 and U.S. 59 – which the stakeholder-defined network includes. SH 6 displays moderate volume on the west side, but traffic tails off as it merges into the east/west route FM 1960. Stakeholders reported a real need for east/west corridors but many say they avoid FM 1960 because of its frequent lights and heavy retail traffic. Fairmont Parkway and Red Bluff Road in the industrial district of the southeast show a cluster of activity. Relatively light activity appears on roads like SH 35 and 36, but these are connecting routes for Brazoria County and volumes are expected to grow. While there is a scattering of counts in Chambers, Liberty, and Montgomery counties that fall on routes not mentioned by stakeholders, they have light volume except for more moderate activity on SH 105 at FM 149 in the northwest. The overall impression is that the roads identified by stakeholders are reasonably well used, to the extent they have been measured, and there are few prominent exceptions.

Figure 3-3 Regional Truck Counts

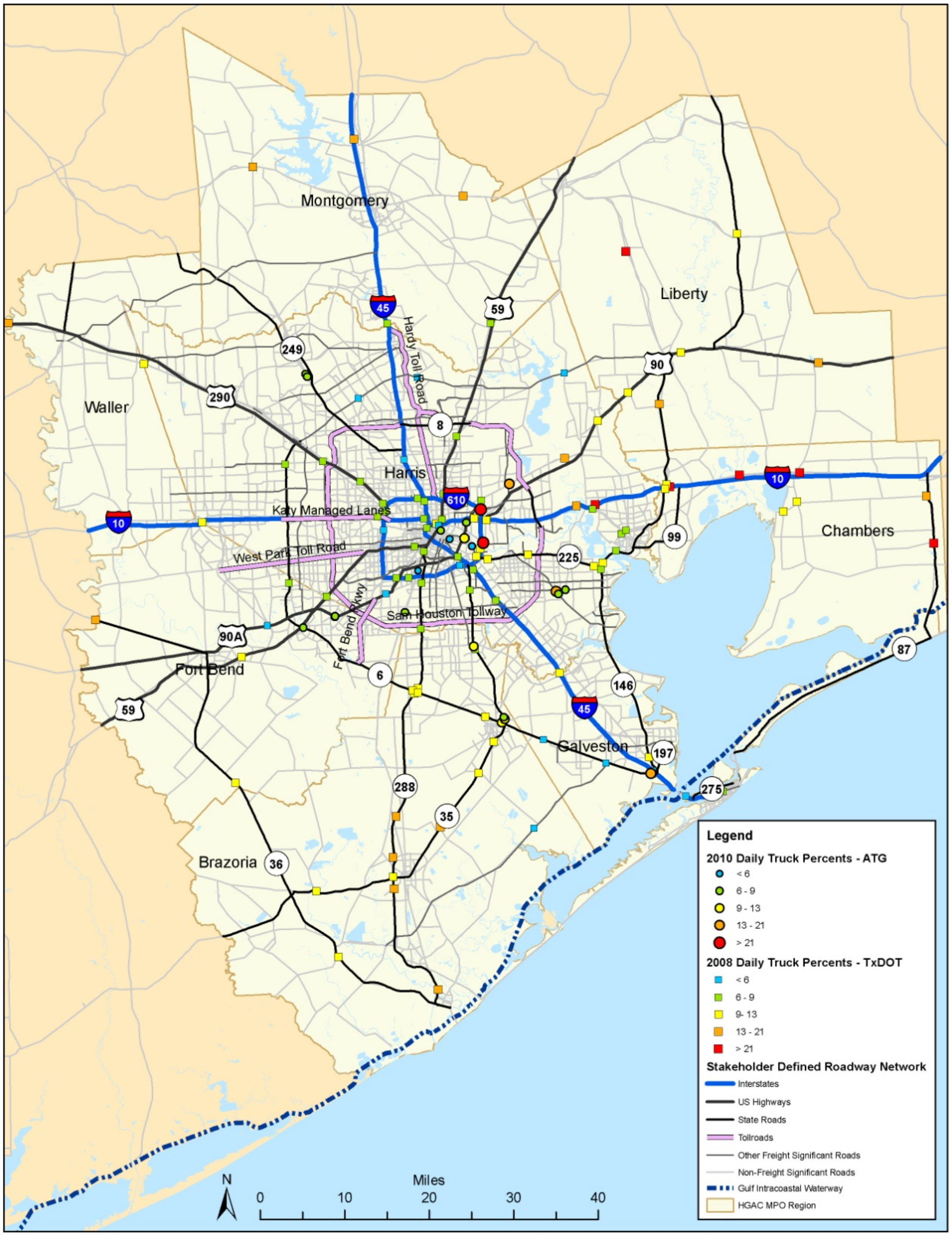


Source: ATG, TxDOT.

Truck Percentage

Since truck percentages of vehicular traffic are recorded for the same facilities, they do not point out new routes, but they do provide different points of views. Despite healthy freight volumes on the primary highways, trucks are a low proportion of total activity except on IH 10 and IH 610 in the east. However, the significance of the Brazoria County routes SH 288 and SH 35 begins to stand out, as well as SH 87 in Chambers County and the extension of SH 146 northward in Liberty County. Connecting routes like Red Bluff Road and C E King Parkway in Harris County also underscore their importance. Here again, the utility of the stakeholder-defined network as a depiction of important freight corridors appears reasonable.

Figure 3-4 Trucks as Percentage of Total Traffic



Source: ATG, TxDOT.

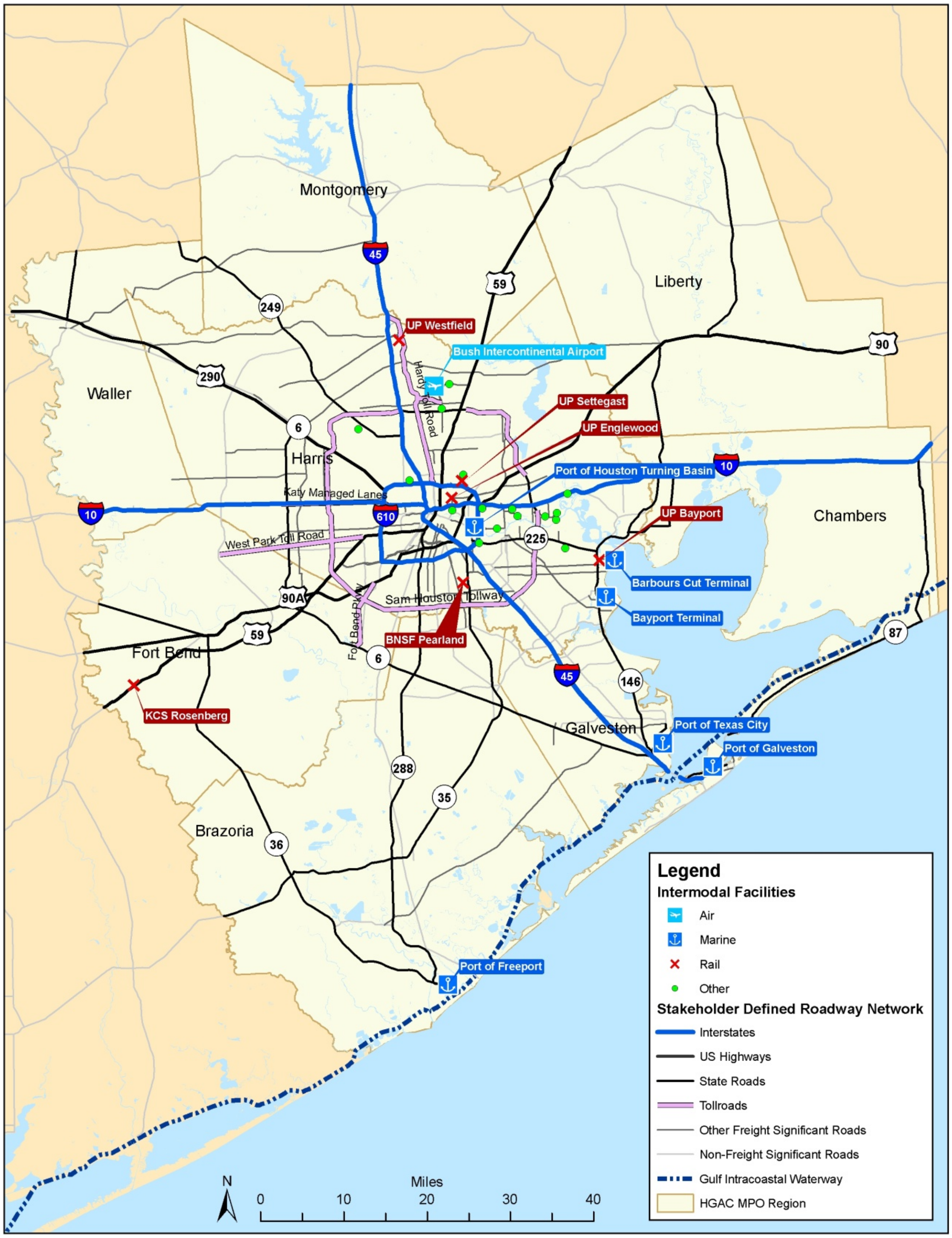
Intermodal Facilities

One of the principal functions of roadway corridors is to create connection for other modes. Seaport traffic needs to be carried inland, rail and air shipments need to accommodate off-rail and off-airport customers, and pipelines need to join facilities like tank farms to service stations. Each of these modes may also require connection to one of the others, and roads are a common way this is accomplished. Roadways are thus a foundation for the multimodal freight system, and their linkage to intermodal facilities is vital.

The accompanying map depicts the relationship of the stakeholder-defined road network to the chief intermodal facilities in the region, among them the major seaports, the airports with reported cargo activity, the rail transfer points for containers, trailers, and automobiles, and a variety of pipeline and other private terminals. Each intermodal facility has connector roads that join it to the surrounding system and constitute essential extensions of the network of significant corridors.

The concentration of these facilities in the east and southeast of Harris County signals the importance of such primary highways as SH 146 and SH 225 for total system function. Intermodal facilities already are substantial generators and consumers of freight and their contribution to carriage is expected to grow. Trade activity at the seaports in traditional and new locations, and rail transfers in long-standing and new operations create continuing and emerging pressures on connectors themselves and the arteries they feed. Moreover, if rail traffic is able to grow beyond the economic forecast with greater penetration in interstate highway markets, the ability of roadways to absorb connection volume becomes more critical still. As much as 18 percent of the region's inbound/outbound truck traffic travels the thousand-plus miles that are the bread and butter of the rail business, according to the TRANSEARCH database used in this Study. While this figure does not prove the potential for rail to divert such traffic (and there will be reasons why that has not happened to date), it is suggestive of a possibility that freight planning can anticipate.

Figure 3-5 Intermodal Facilities and the Stakeholder-Defined Roadway Network



Source: TxDOT.

Key Industry Traffic

The stakeholder-defined network is complete relative to the selected stakeholders representing a broad cross-section of shippers and transportation service providers. This network definition is useful but does not paint the complete picture. A more comprehensive view of the freight system has been developed by including the geographic concentrations of freight production and consumption for major sectors of the regional economy.

In this section the commodity information will be displayed on maps that indicate clusters of industry in total and then individually by commodity group. This map view is overlaid with the commodity flow data in order to show the freight movement from these industry clusters across the region's roadways. The maps have been developed for 2007 and for the forecasted information for 2035. The map view presents the geographic concentrations of commodities and the routes that are used by firms transporting them. The results both reinforce and enhance the stakeholder-identified network.

In addition to supporting regional traffic the roadways must also serve traffic moving through the region. It is important that the aspect of through traffic be considered in infrastructure planning. Through traffic plays a role in wear and tear and in air quality. Through traffic is significant in the region as the IH 10 corridor is a primary route running east west across the nation. The IH 10 volume can be seasonal, increasing in winter months when traffic moves south from other primary routes outside the region, such as I-40.

Table 3-3 depicts the analysis for the key industrial groups. They present the directional flow – inbound, outbound, and through with the volume for each of the key industrial groups and in total. In these tables the volume for imports and exports is separated from the specific commodity flow. It is interesting to note that while there is a significant increase in volume in the 2035 table, the split among the commodity groups remains relatively stable.

The volume of distribution goods nearly doubles reflecting the population growth in the region in addition to the growth of regional warehousing and distribution activity. Some of this growth is also attributable to the increase in imports and exports, again nearly doubled. This growth can be in part attributed to the canal expansion and new opportunities for international freight at the Gulf Coast ports.

Table 3-3 Total Truck Traffic by Tons, 2007 and 2035

Year 2007	Tonnage by Direction				
Commodity Group	**Inbound**	**Intraregional**	**Outbound**	**Through**	**Grand Total**
Food and Agriculture	18,616,698	3,381,568	10,788,139	6,560,901	39,347,307
Aggregates	49,983,258	23,034,826	9,975,525	4,015,043	87,008,651
Petrochemicals	28,292,121	31,934,367	71,803,760	21,460,054	153,490,302
Other Manufacturing	34,286,217	3,651,828	34,778,824	25,719,553	98,436,421
Distribution Goods	29,579,138	15,120,063	21,508,393	10,032,738	76,240,332
Port and Airport Drayage	1,511,219	5,589,874	1,189,912	3,647	8,294,652
All Commodities	**163,324,594**	**82,794,267**	**150,943,502**	**68,401,834**	**465,464,197**
Import and Export	14,334,547	10,416,528	31,790,465	18,055,699	74,597,239
Year 2007	**Percentage of Tonnage by Direction**				
Commodity Group	**Inbound**	**Intraregional**	**Outbound**	**Through**	**Grand Total**
Food and Agriculture	47%	9%	27%	17%	100%
Aggregates	57%	26%	11%	5%	100%
Petrochemicals	18%	21%	47%	14%	100%
Other Manufacturing	35%	4%	35%	26%	100%
Distribution Goods	39%	20%	28%	13%	100%
Port and Airport Drayage	18%	67%	14%	0%	100%
All Commodities	**35%**	**18%**	**32%**	**15%**	**100%**
Import and Export	19%	14%	43%	24%	100%
Year 2035	**Tonnage by Direction**				
Commodity Group	**Inbound**	**Intra-Regional**	**Outbound**	**Through**	**Grand Total**
Food and Agriculture	25,366,802	3,146,861	15,888,386	11,374,648	55,776,697
Aggregates	61,859,183	30,193,502	12,003,289	5,320,130	109,376,104
Petrochemicals	35,597,706	31,596,872	95,892,441	30,912,196	193,999,214
Other Manufacturing	59,245,881	6,056,263	88,294,795	64,195,345	217,792,284
Wholesale and Retail	60,617,133	40,020,895	59,747,782	20,963,237	181,349,048
Port and Airport Drayage	3,464,345	12,453,290	2,666,828	8,017	18,592,481
All Commodities	**247,997,877**	**123,553,712**	**276,050,730**	**133,884,255**	**781,486,574**
Import and Export	34,174,334	14,810,982	91,875,117	57,629,934	198,490,367
Year 2035					
Commodity Group	**Inbound**	**Intra-Regional**	**Outbound**	**Through**	**Grand Total**
Food and Agriculture	45%	6%	28%	20%	100%
Aggregates	57%	28%	11%	5%	100%
Petrochemicals	18%	16%	49%	16%	100%
Other Manufacturing	27%	3%	41%	29%	100%
Wholesale and Retail	33%	22%	33%	12%	100%
Port and Airport Drayage	19%	67%	14%	0%	100%
All Commodities	**32%**	**16%**	**35%**	**17%**	**100%**
Import and Export	17%	7%	46%	29%	100%

Source: IHS Global Insight

Figures 3.6 to 3.9 provide a geographic view of the commodity information in total showing the strong pockets of freight generation through the region and in the urban core. Volumes are stated in annual inbound/outbound truck tonnage by zip code, which by definition excludes through traffic.

The flow maps were prepared in the following manner:

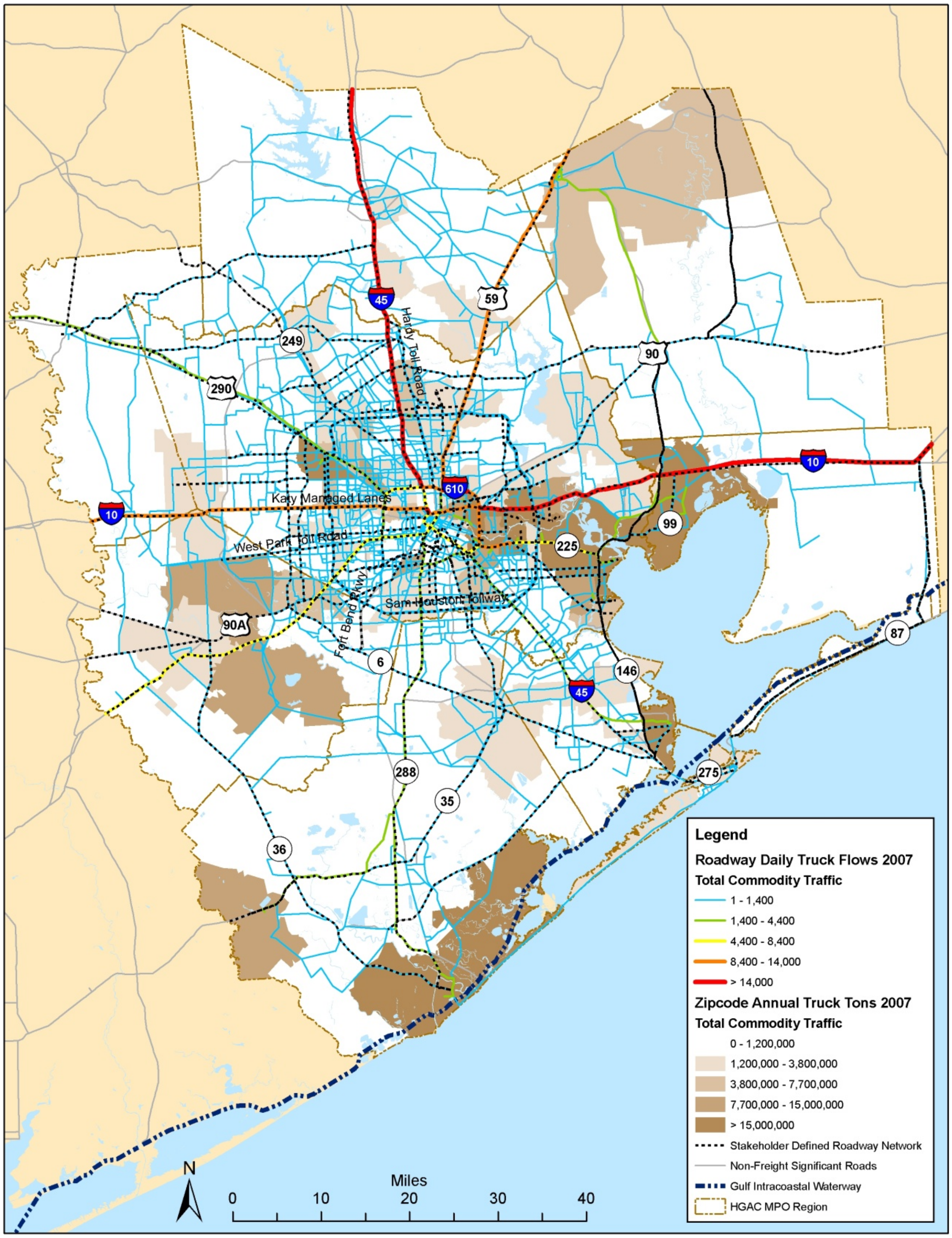
1. Converting TRANSEARCH to a table which is compatible with the H-GAC travel demand model.
2. Disaggregating TMA County zones in TRANSEARCH to Zip Code origins and destinations using FreightFinder™.
3. Associating these Zip Codes with an important TAZ within that Zip Code.
4. Assigning the resulting freight trip tables using the full H-GAC travel demand model.

The maps also display the truck flow data expressed as truck volumes on specific roadway facilities. These are stated in numbers of trucks per day, and include through traffic but do not include service trucks such as UPS and secondary trips. The 2007 data, shown in Figures 3.6 and 3.7, shows the concentrations of freight where they might be expected, near the ports and the traditional industrial areas on the east side. All of the freeways are utilized in routing this freight. Figures 3.8 and 3.9 display the data for 2035. The geographic clusters remain the same but reflect strong growth in freight tonnage.

The highway patterns remain similar while the flow is stronger. Some new routes are added, perhaps showing the effects of congestion and new patterns of use. All of the primary freeways have a role in freight movement. Prominent is IH 10 as both a regional and through artery, linking via IH 610 to IH 45, the route to Dallas. U.S. 59 and SH 225 also stand out, again with a connection on IH 610. All of these routes see strong gains by 2035, particularly in the northeast quadrant, and the flow on SH 225 gains strength due to expanded traffic at the Port of Houston. SH 288 from Freeport and IH 45 from Texas City and Galveston also show growth.

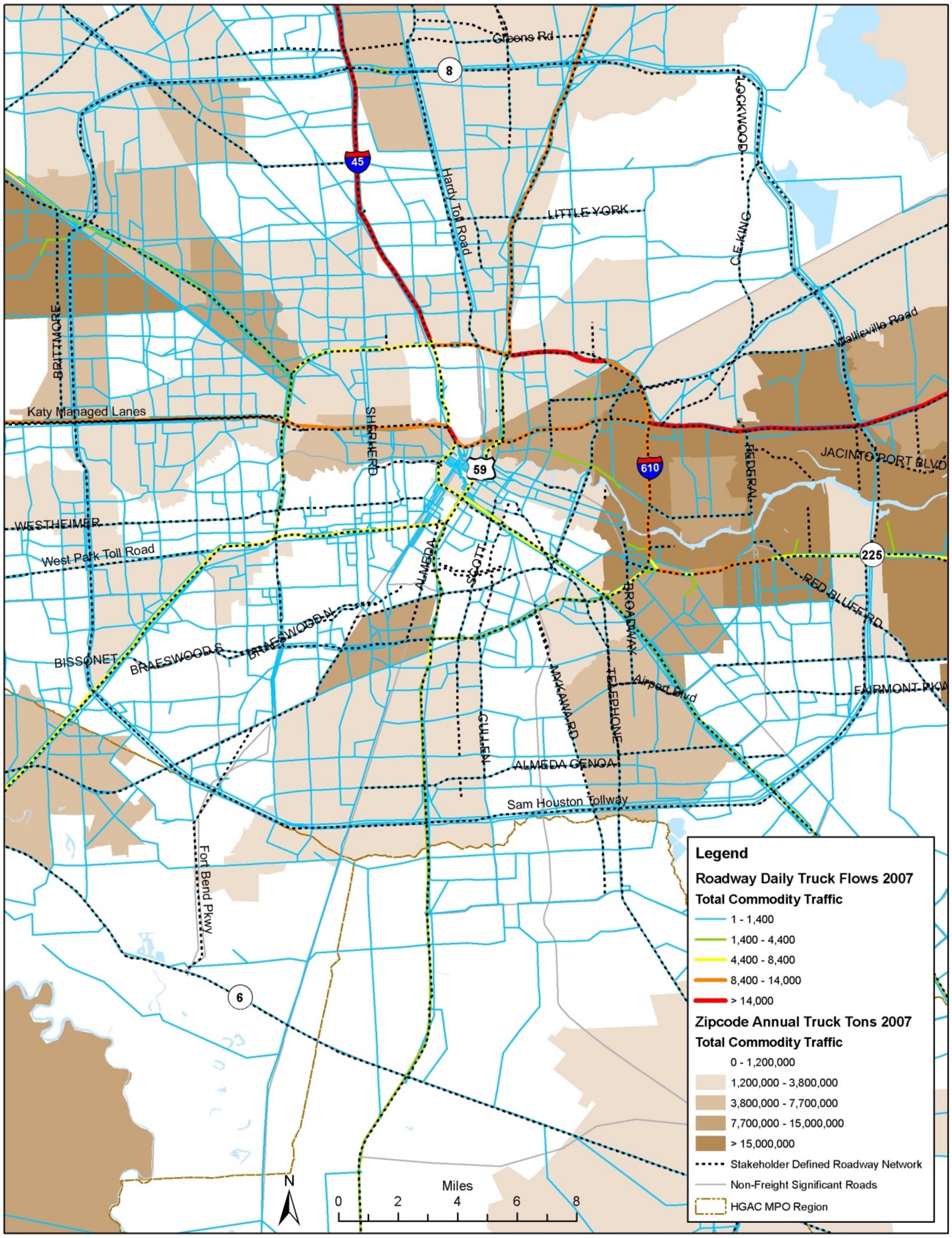
Overall patterns of roadway utilization correspond well with the stakeholder-defined network, and hold up fairly well in the forecast. There are a few notable routing differences. For example, Spur 330 near Baytown is favored as a bypass and receives particularly heavy use as time progresses. FM 1764 is used instead of FM 1765 into Texas City, and FM 521 appears as a shortcut between SH 288 and SH 35 in Brazoria County. Additional routes appear in Liberty County, first currently as SH 321 making a northward extension of SH 146 toward SH 105, then moving eastward by 2035 toward routes like SH 61 near the county line. Much of this shift relates to Petrochemicals and Other Manufactured products, and marine trade. Surface route selection is especially susceptible to modeling limitations. The urban core views show utilization of many but not all stakeholder-defined surface roads. They also identify Clinton Drive as a useful addition, attracting notable volumes in both the current and forecast periods.

Figure 3-6 Total Commodity Flows and Tons, 2007



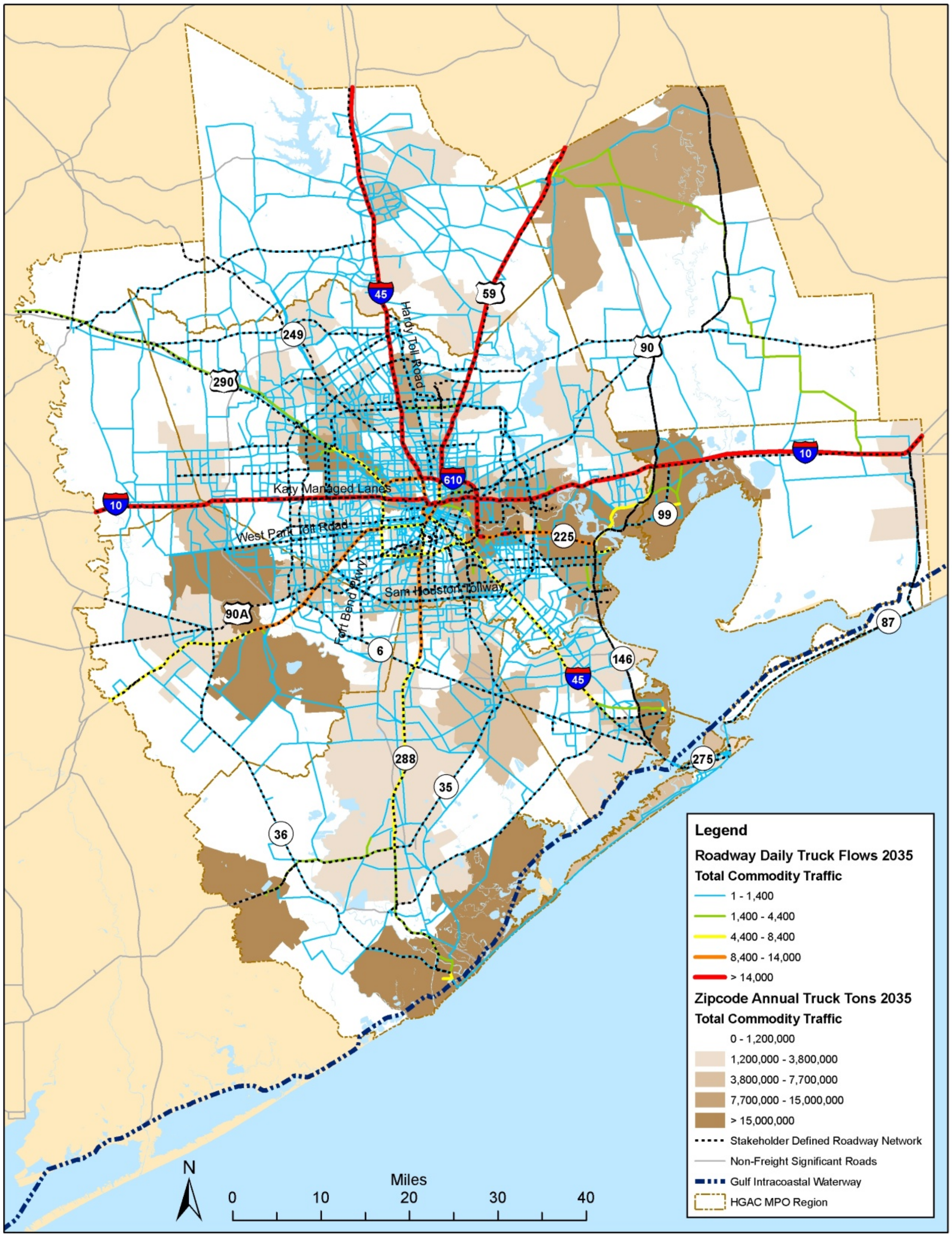
Source: IHS Global Insight/H-GAC.

Figure 3-7 Total Commodity Flows and Tons Traffic (Urban Core), 2007



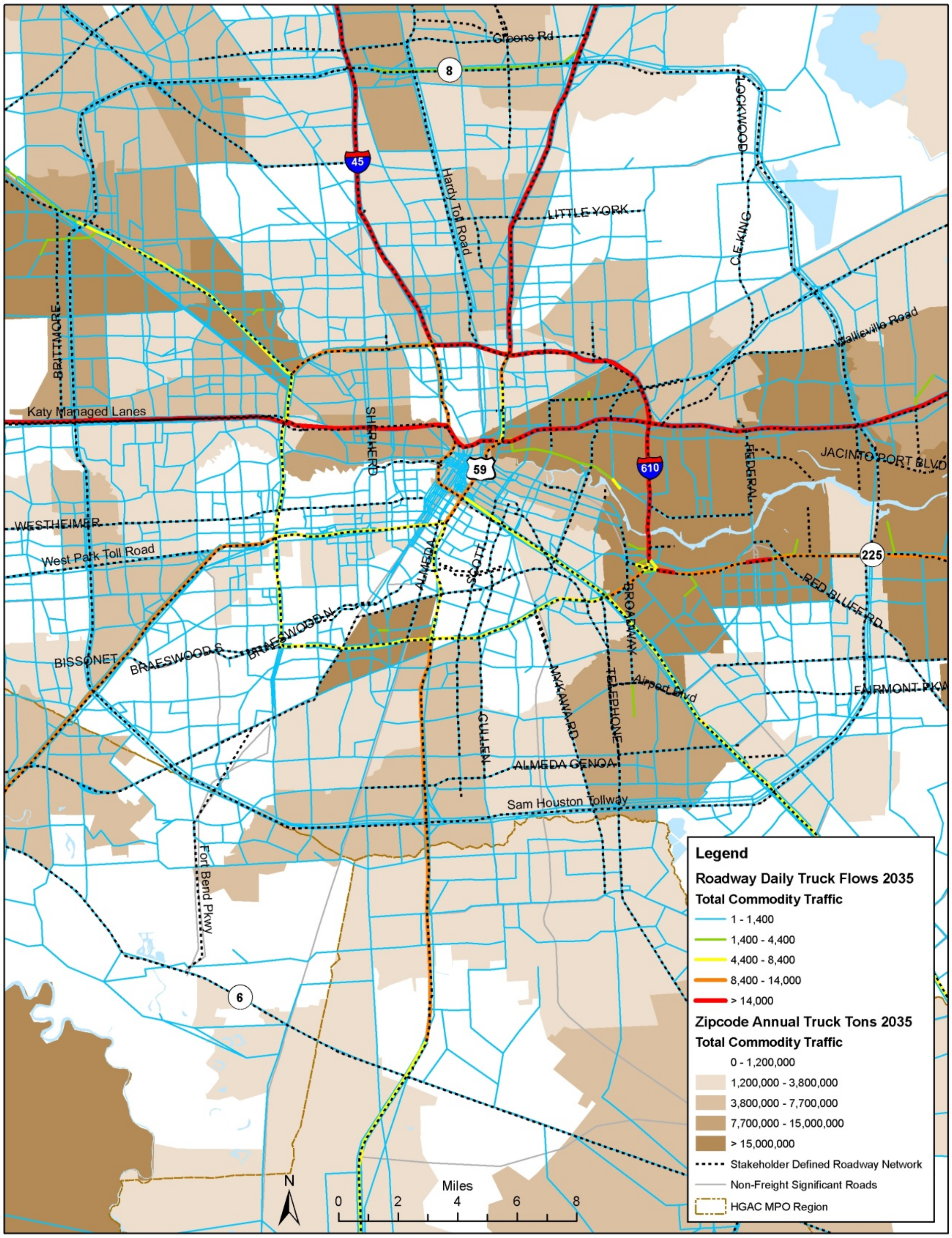
Source: IHS Global Insight/H-GAC.

Figure 3-8 Total Commodity Flows and Tons Traffic, 2035



Source: IHS Global Insight/H-GAC.

Figure 3-9 Total Commodity Flows and Tons (Urban Core), 2035



Source: IHS Global Insight/H-GAC.

Patterns of roadway use vary by commodity type. Given the objective to accurately define the primary stakeholder-defined network it makes sense that the commodities be represented and discussed not only in total but also as groupings of key industries. In addition to representing major employers, firms in these industries are freight intensive meaning freight transportation represent a significant cost of doing business. The location of establishments for these key industries and the resulting freight demand is presented in the sections below as data for the individual commodity groups is displayed. Each map in these sections has an individual scale so that volume distinctions are visible.

The contribution of each commodity group to the total volume is shown in Table 3.4. It is noteworthy that petrochemical and aggregates traffic represent a declining proportion of total truck volumes, while distribution goods, other manufacturing, and port-based trade represent a rising proportion. A detailed discussion of the logistics patterns and supply chains for these and other selected industry sectors is provided in Appendix A.

Table 3-4 Truck Traffic by Commodity Group as Percent of Total, 2007 and 2035

Commodity Group	2007 Percent of Total	2035 Percent of Total
Food and Agriculture	6%	5%
Aggregates	23%	18%
Petrochemicals	36%	26%
Other Manufacturing	15%	20%
Distribution Goods	18%	27%
Rail IMX and Air Drayage	3%	4%
Total All Traffic	**100%**	**100%**
Import and Export	14%	20%

Source: IHS Global Insight.

The key industry groupings have been defined to be Petrochemicals; Distribution Goods (wholesale and retail distribution of consumer goods and other industrial products); Aggregates; Agriculture and Food production; and Other Manufacturing (that is not directly related to the aggregates, food, and petrochemical industries).

In addition to the commodity-based patterns there are other specific freight movements which have unique characteristics to integrate into the network, specifically those related to multimodal transfer.

Truck drayage to and from airports and rail intermodal ramps, and the import export trade moving to and from port locations are the key aspects captured in the data. Each of these segments is presented individually ahead of the commodity groups. While toll roads have been excluded from route modeling for most groupings, they have been allowed for the drayage operations. This is partly a proxy for the real but not predominant usage of toll roads by trucks in general, and partly because some dray companies (such as large national fleets engaged in rail and air transfer) have their drivers employ them.

Drayage

The term "drayage" refers to the movement of freight from its source to a point of intermodal connection such as a rail hub, or from the intermodal connection to a final destination or distribution point. Such activity in the Houston region will be dominated by and concentrated around local transfer facilities, but also will include some traffic for facilities outside. The drayage data included here is intermodal (IMX) rail and air freight. It does not include the traffic on and off the port which is classified as Import Export traffic and will be covered in the next section of this chapter. However, this does include drayage associated with international cargo being railed into the region from external ports and delivered in the Houston region.

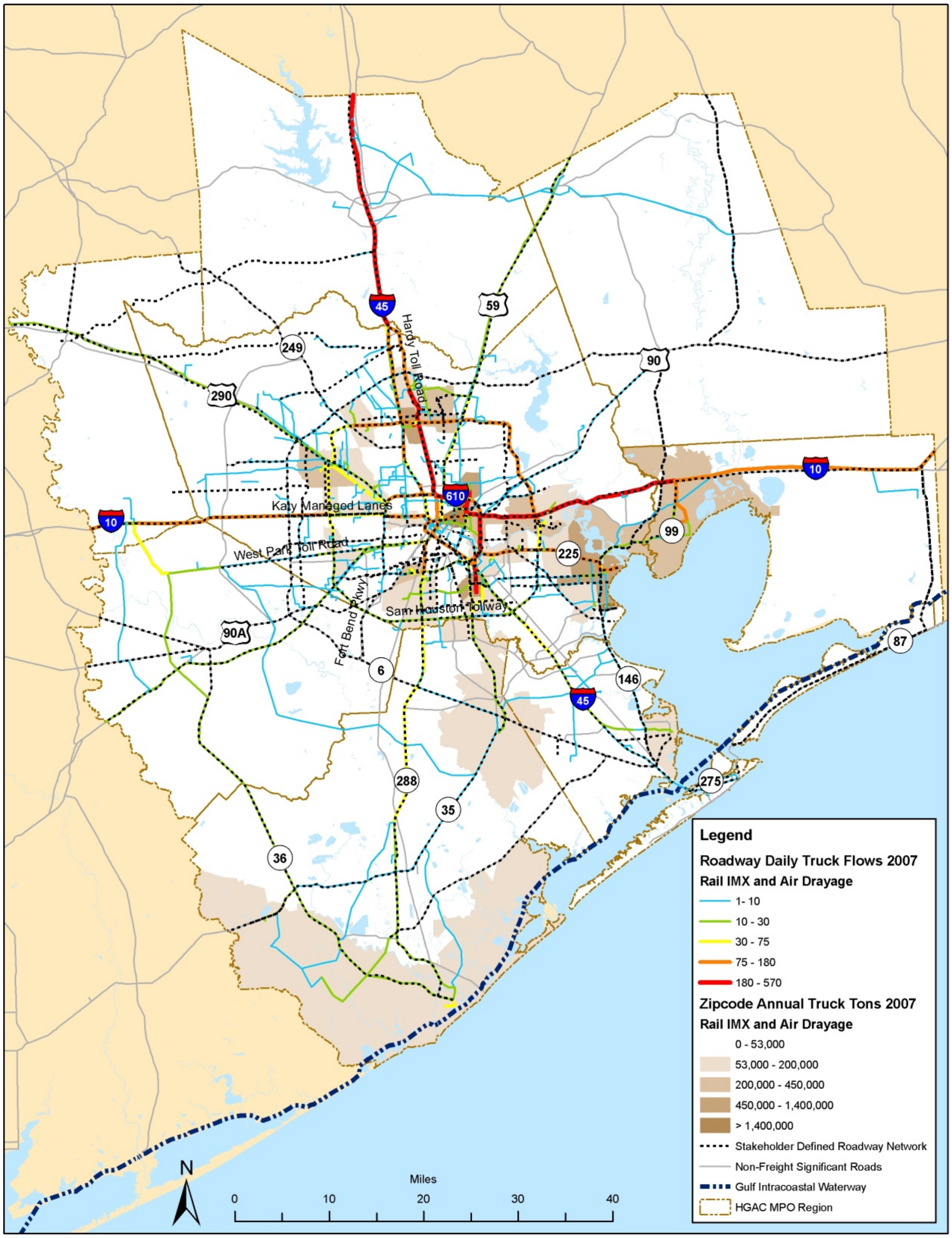
The new Kansas City Southern facility at Rosenberg is not included in the data and is therefore not included in the forecast. There are estimates for the container lift total to be 20,000 in 2011 plus new automobile traffic, with expectations of strong growth. This facility is restricted to NAFTA trade, but it carries the potential for additional import/export business from ports on the Pacific coast of Mexico.

Figures 3-10 and 3-11 illustrate the drayage traffic and indicate commodity volumes located in areas related to two primary classifications, industrial goods and distribution, that being largely consumer products. The clusters of volume are shown in the older industrial and petrochemical areas and then in the newer distribution zones to the north and west of the urban core. The volumes to the north also represent traffic into George Bush Intercontinental Airport which serves as the freight airport for the region. These maps reflect materials originating in or destined to the region, moving via intermodal transportation over one of the identified gateways.

Figures 3-10 and 3-11 indicate significant growth in intermodal activity in the future. This is consistent with the idea that rail intermodal traffic will increase as the price of fuel and the driver shortage create an attractive pricing climate for modal conversion, road to rail, even in shorter lengths of haul. As regional industries refine into producing more specialized products, another national trend, the need for air freight for high-value and service-sensitive products will also increase.

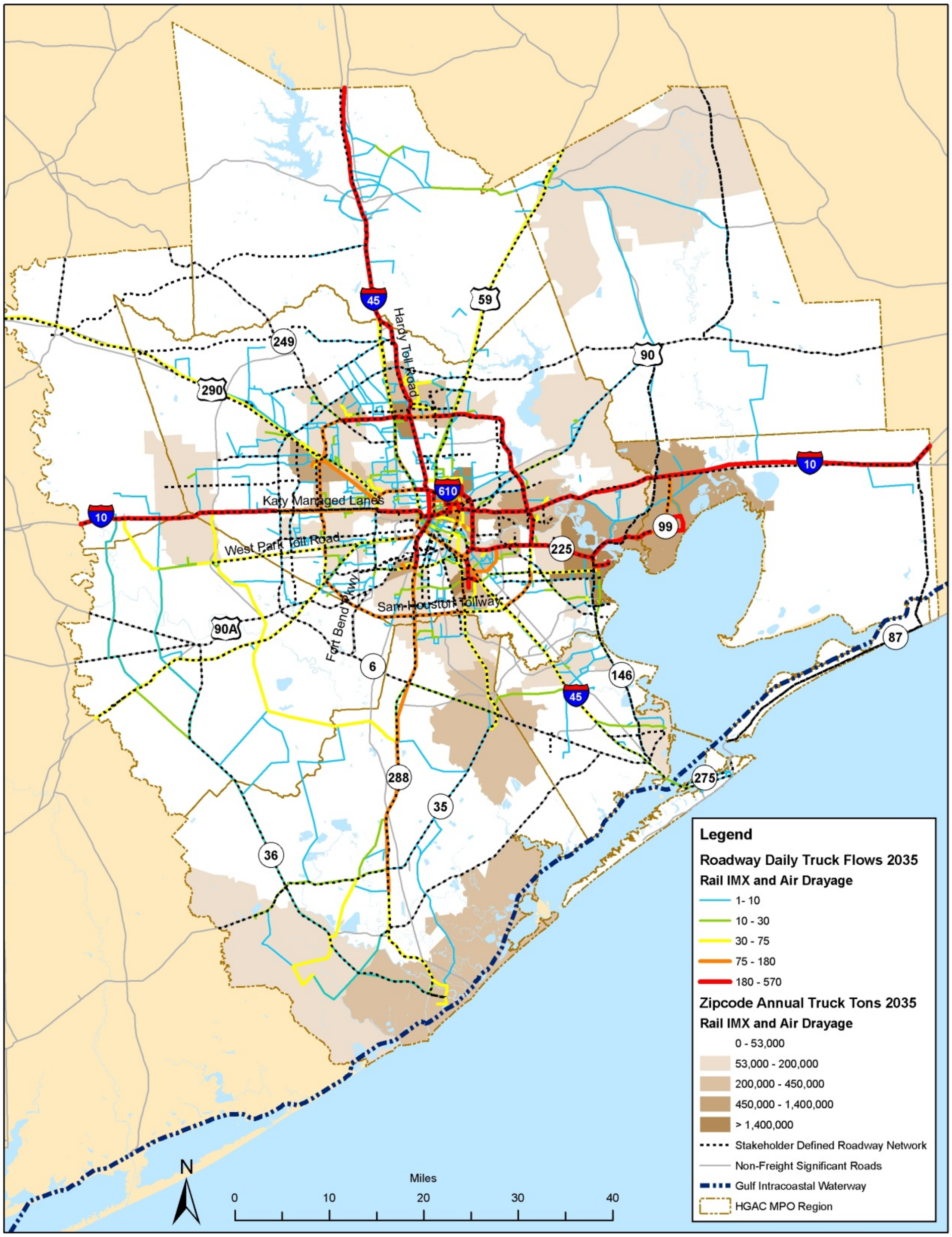
The pockets of intermodal activity do not shift in the future and conform largely to the stakeholder-defined network. This is partly due to the permanence of the facilities as well as the continued concentration of key industrial groups. The flow follows the same roadway patterns, again largely due to facility location. However the volume does increase in the southwest and western area. This is consistent with the anticipated growth in that region. There is utilization of roadways which are not defined in the stakeholder network. One of these in particular is the previously mentioned link along SH 1462 and SH 762. This is an area that will see additional growth with the development of the KCS facility at Rosenberg. Other routes in this area will also see increased traffic not currently reflected in these maps.

Figure 3-10 Rail Intermodal and Air Drayage Flows and Tons, 2007



Source: IHS Global Insight/H-GAC.

Figure 3-11 Rail Intermodal and Air Drayage Flows and Tons, 2035



Source: IHS Global Insight/H-GAC.

Import/Export

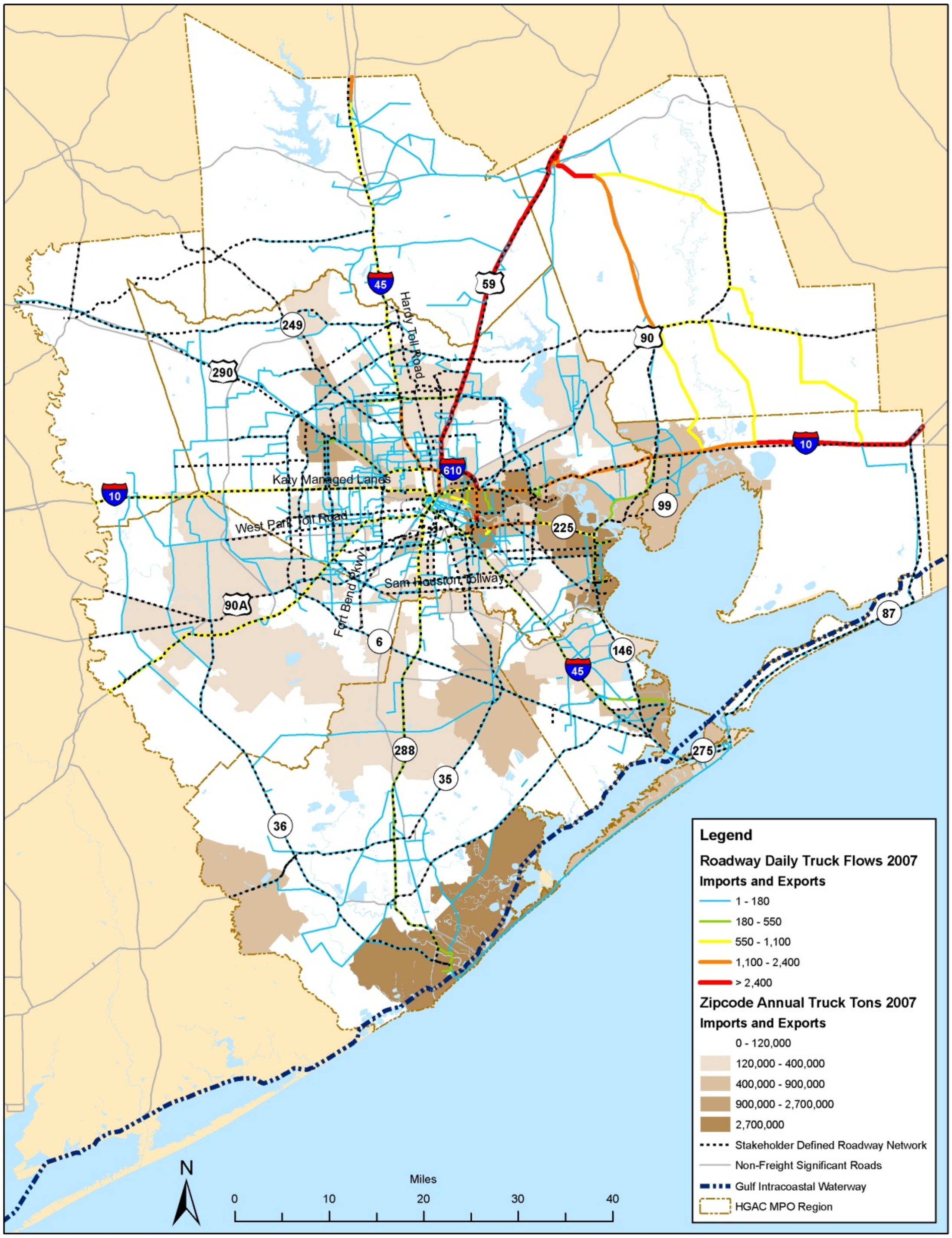
The history of Houston and Galveston is built upon the development of the maritime ports. The growth of the region is as much linked to the ports as it is to the oil industry, the two going hand in hand. The import/ export freight volume around those ports has increased organically and will continue to do so in the future. Additionally there are expectations that the expansion of the Panama Canal will create further demand on the regional ports.

Freight movements classified as import/ export are those which move to and from the ports and in some cases the airports directly to or from international locations. Traffic which come into the west coast ports from Asia and is railed into the region is not included in this traffic. Figures 3.12 and 3.13 display import and export volumes and traffic for 2007 and 2035, respectively.

The flow volumes on these maps link to the ports, both container and bulk, and to George Bush Intercontinental Airport and not to the rail intermodal locations. As expected the volume is heavily concentrated on the roads leading directly to the ports and then out to the industrial and distribution zones. The flow is strongest on the eastern quadrants. U.S. 59 connecting to the port districts via IH 610 and SH 225 exhibits strong import export traffic.

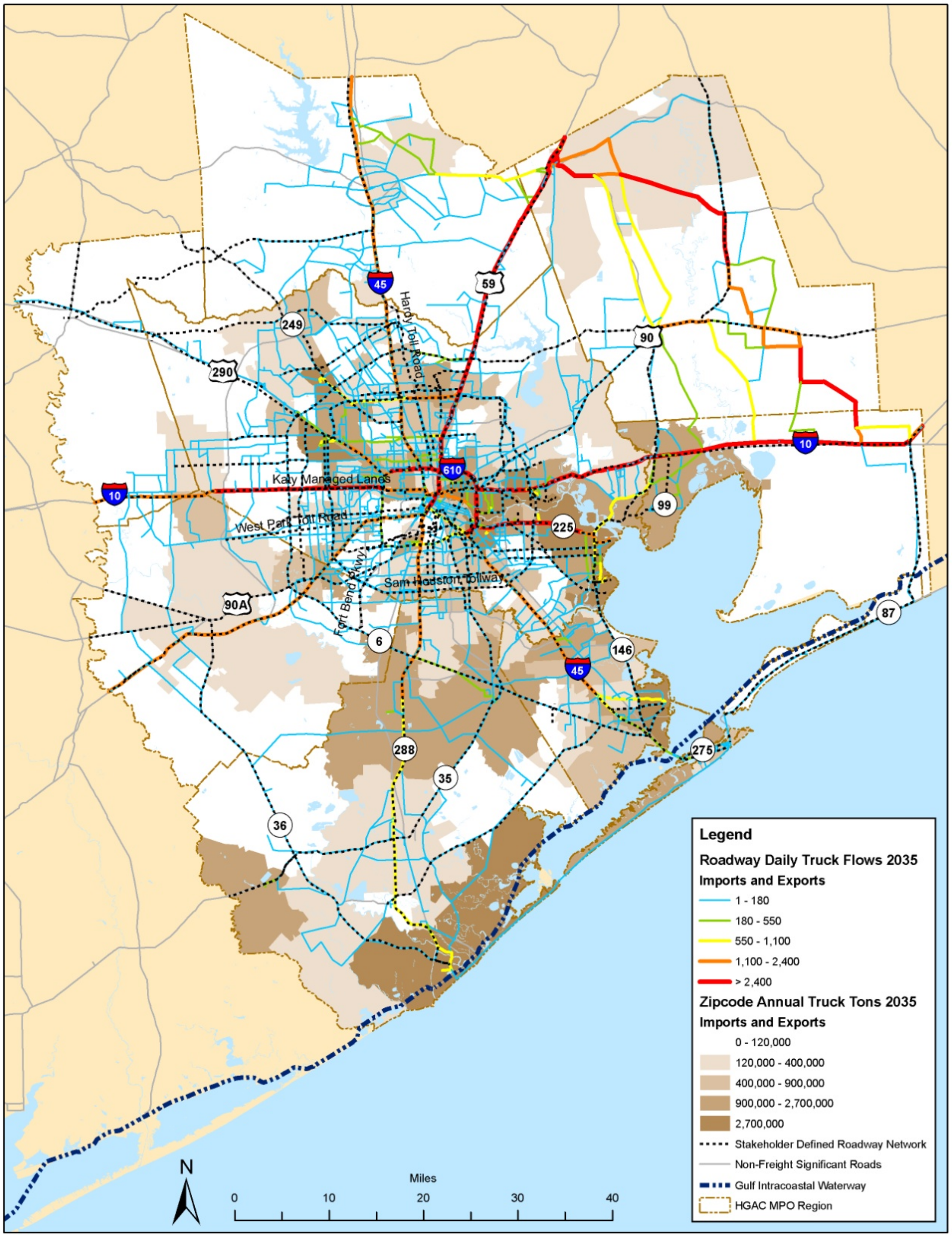
In 2007, the outstanding differences from the stakeholder-defined network are in Liberty County, beginning with SH 321 extending north from SH 146, but, as shown in Figure 3.13, this proliferates by 2035. These connect to industrial activity in the county, and especially to U.S. 59. Apart from this, the 2035 map does not change in geographic structure or in the use of specific roadways but the volumes do show significant increase. The volume changes reflect not only local growth but also the potential for the region to become a gateway for cities to the north replacing some of the West Coast port volume in the supply chain.

Figure 3-12 Imports and Exports Flows and Tons, 2007



Source: IHS Global Insight/H-GAC.

Figure 3-13 Imports and Exports Flows and Tons, 2035



Source: IHS Global Insight/H-GAC.

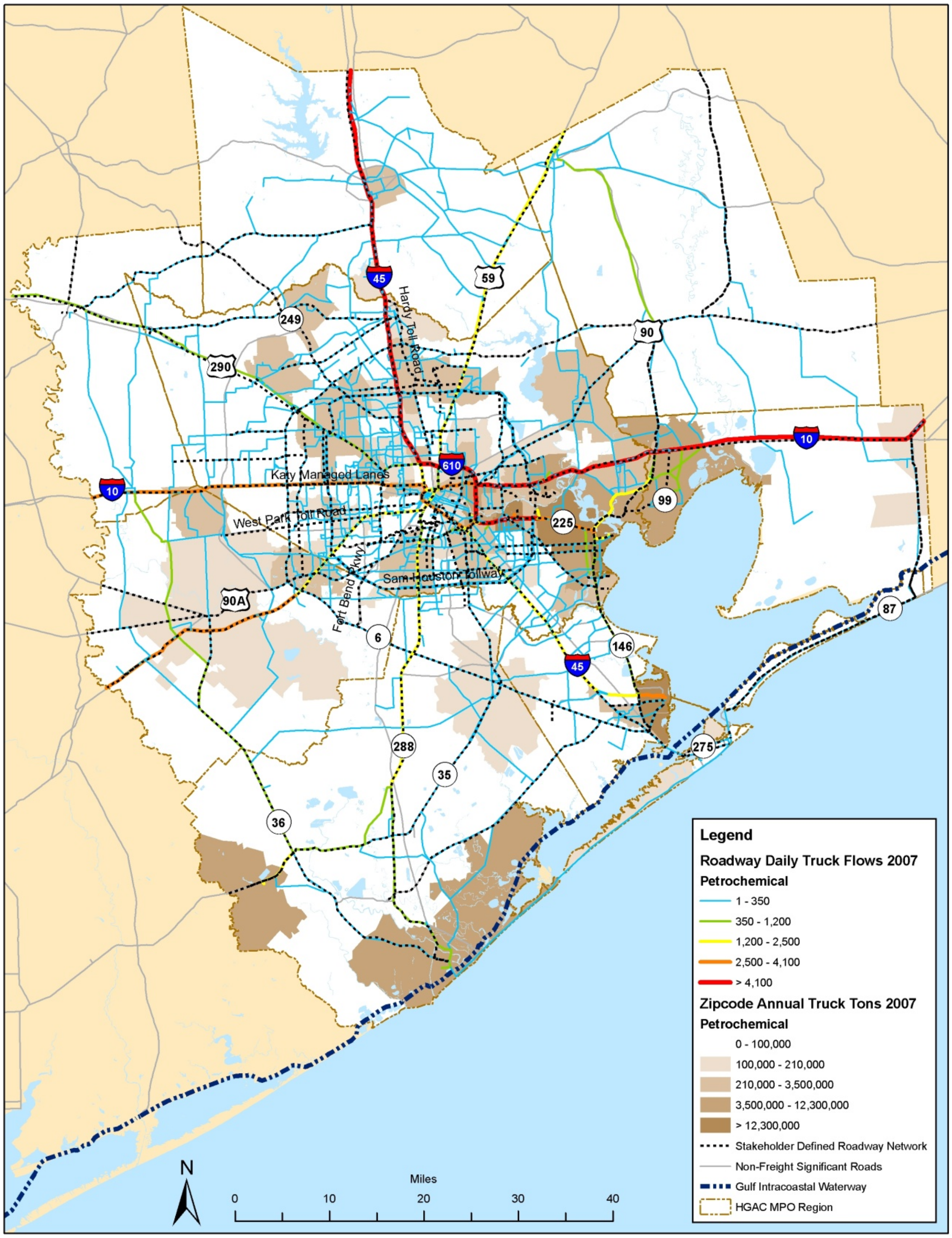
Petrochemicals

Figure 3-14 displays tons of petrochemical production per zip code as well as daily truck flows per roadway in 2007. Figure 3-15 displays projections for the same data in 2035. These maps show the alignment of the industries in certain segments of the city and are therefore quite useful in examining the potential flow of freight to and from these facilities.

The largest concentration of the petrochemical facilities is in the older areas to the east around the port and the bay. This is significant in that the infrastructure in this area is some of the oldest in the region, the city is crowding in from the west, and the water provides a natural barrier on the east. This makes issues of expansion and improvements particularly difficult. This also is an area with a high concentration of hazardous materials and over-dimensional loads which will be discussed in a separate section.

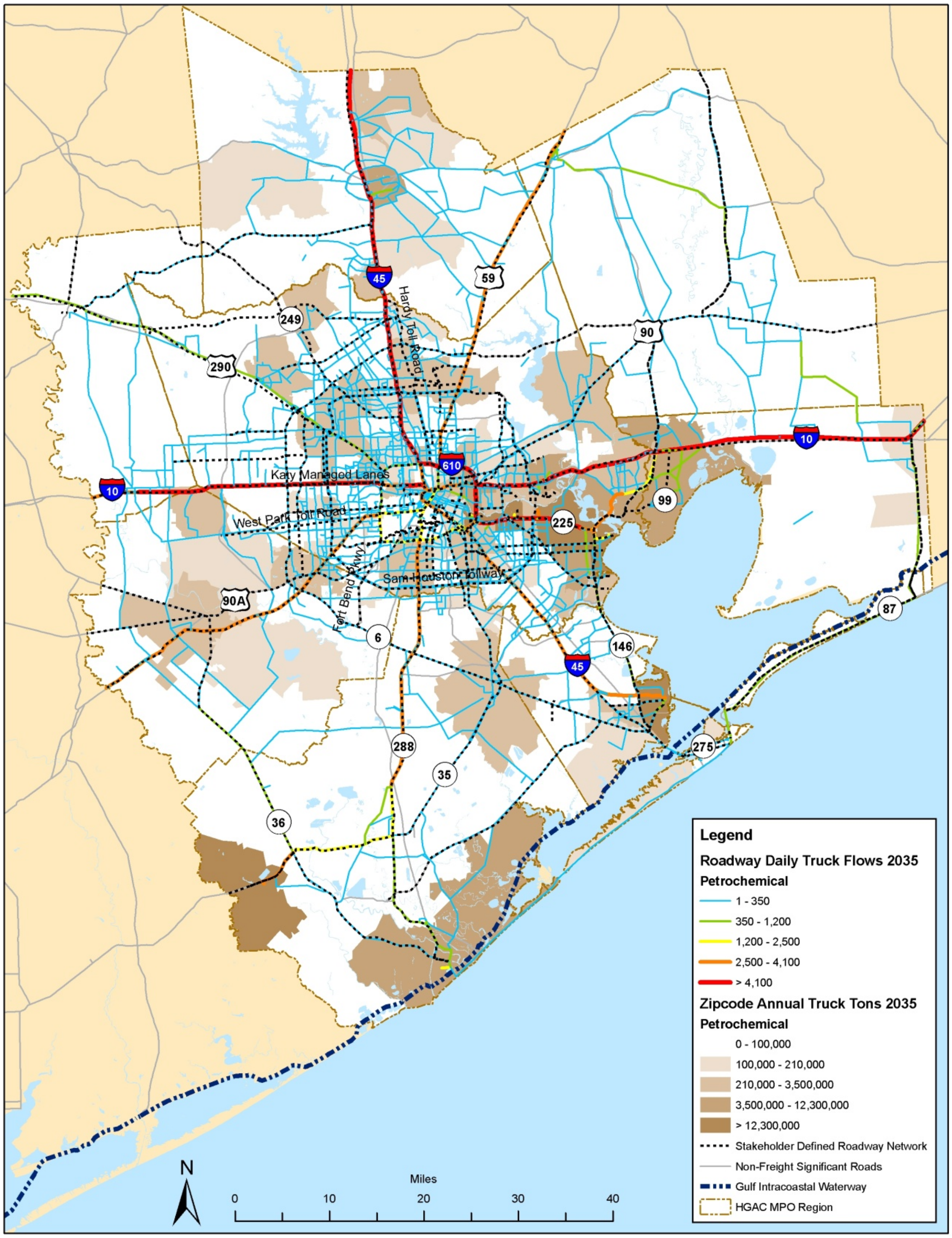
The combinations of SH 225 and IH 610 with U.S. 59 and the northern section of IH 45 are crucial routes and remain so through 2035, although U.S. 59 volume moves ahead of IH 45 in the later year. Other petrochemical clusters appear near Freeport and Texas City. This is to be expected given the link between the industry and the use of the ports. SH 288 and the southern section of IH 45 provide connection, and see notable volume growth. Liberty County routes additions appear as SH 321 in 2007 and move eastward by 2035.

Figure 3-14 Petrochemical Truck Flows and Tons, 2007



Source: IHS Global Insight/H-GAC.

Figure 3-15 Petrochemical Truck Flows and Tons, 2035



Source: IHS Global Insight/H-GAC.

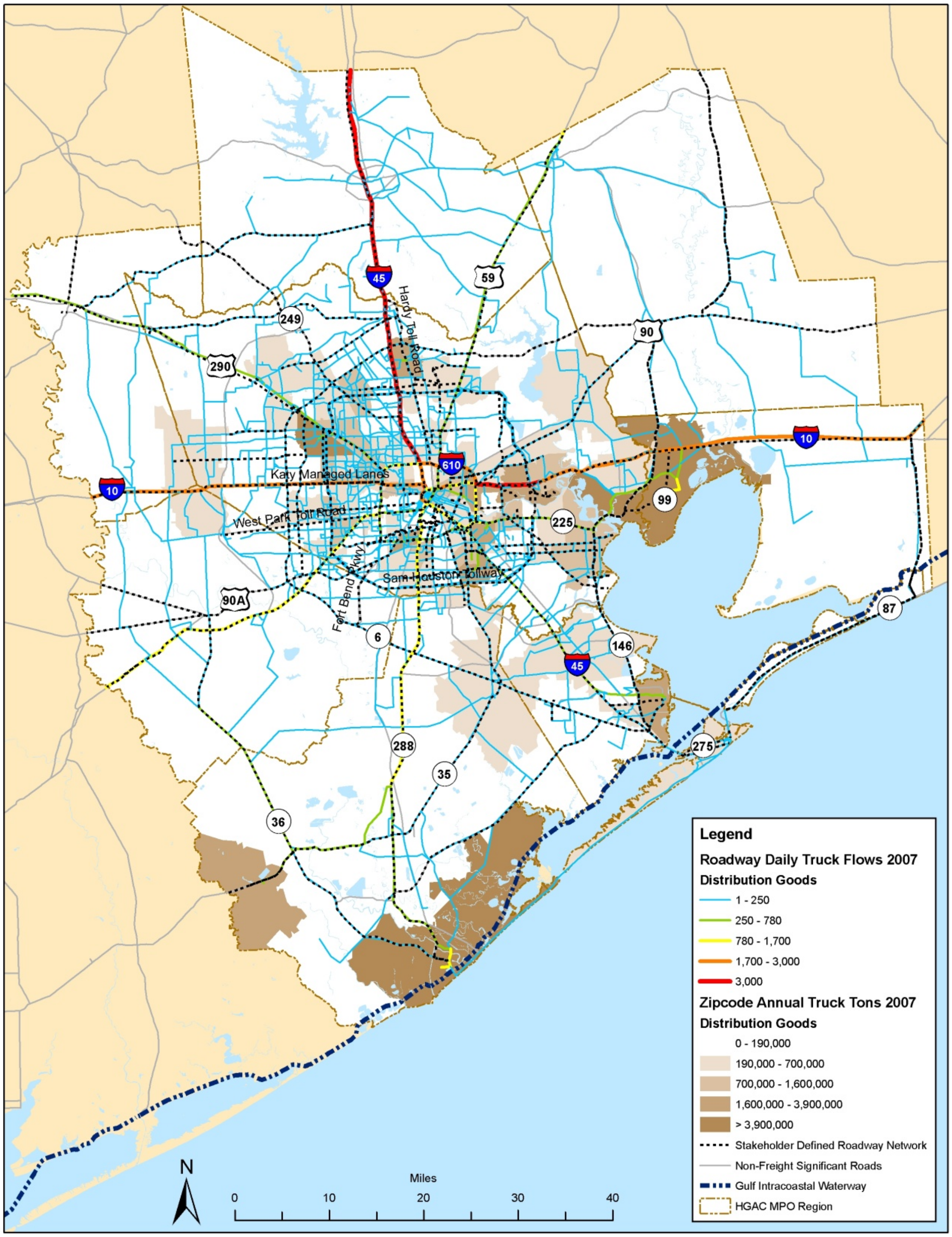
Distribution Goods

In this context, distribution goods are defined as products that leave the warehousing and distribution centers for retail establishments or other points of consumption such as manufacturers. In one sense this is secondary traffic, having already completed a primary move to reach the warehouse. Distribution activity occurs throughout the city, moving from the central city out along the major arteries mirroring the movement and growth of the population.

Figure 3-16 displays tons of production per zip code as well as daily truck flows per roadway in 2007. Figure 3-17 displays projections for the same data in 2035.

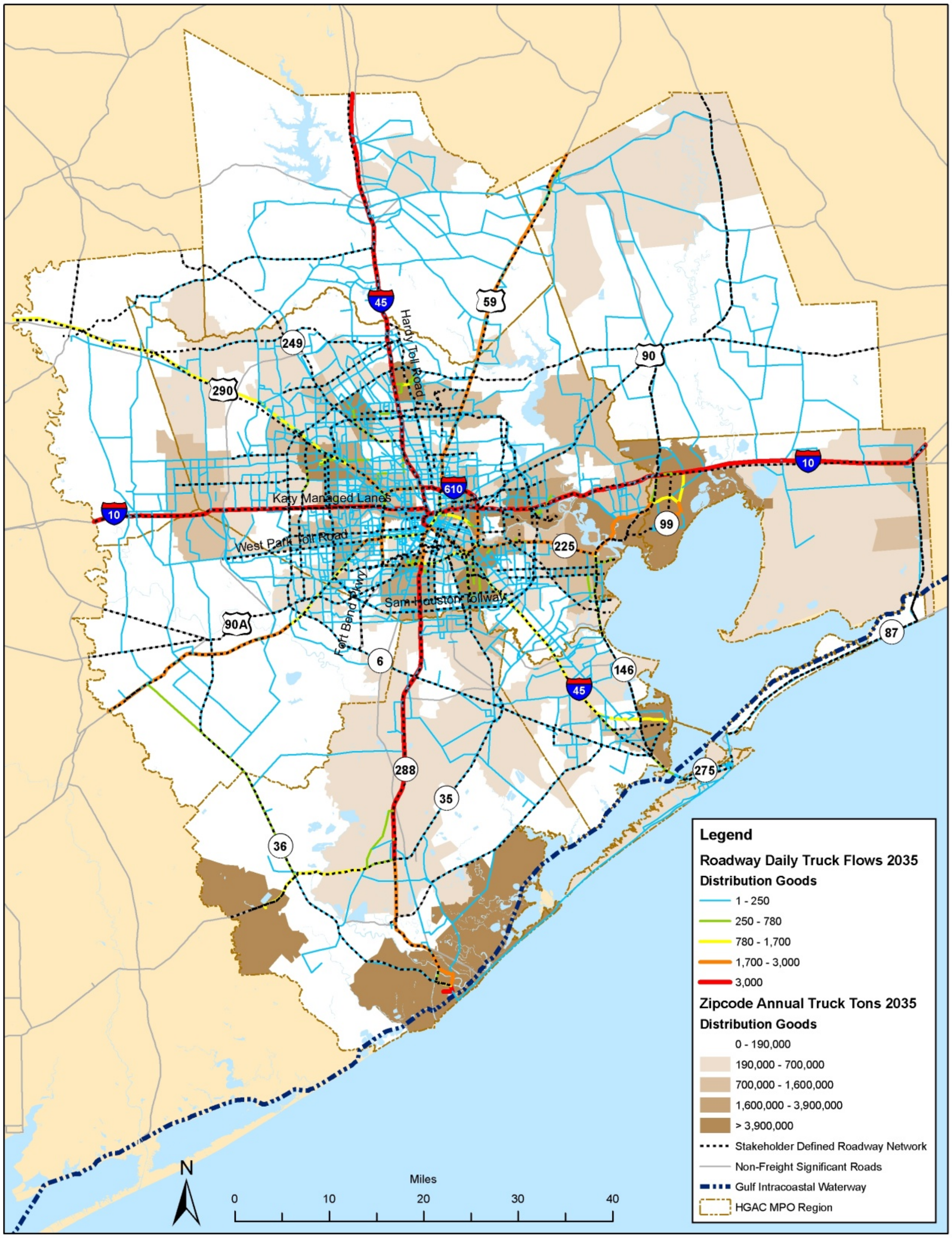
The highest concentrations of the flow of distribution products are to the north and the northwest. This is the region where the distribution centers, third-party logistics services, and other consumer goods suppliers are located. There also is a large concentration to the east of the urban core near Cedar Bayou and newly developing facilities to the west along IH 10 and highway 290. Several large retailers including Wal-Mart and Academy Sports have located large facilities in the region. If the Gulf Coast ports increase in volume with the widening of the Panama Canal, as is expected, this trend will continue increasing the role that distribution plays in the economic development of the region. Cedar Bayou and the routes that serve it and cross it show strong growth in the forecast.

Figure 3-16 Distribution Goods Flows and Tons, 2007



Source: IHS Global Insight/H-GAC.

Figure 3-17 Distribution Goods Flows and Tons, 2035



Source: IHS Global Insight/H-GAC.

Aggregates

Aggregates establishments include construction aggregates, cement production, and quarries. Aggregates are largely used in the construction industry and so the flow from these facilities would be toward the areas of growth and development, potentially away from the center city and outward toward the newer areas.

Figure 3-18 displays tons of production per zip code as well as daily truck flows per roadway in 2007. Figure 3-19 displays projections for the same data in 2035.

The 2007 map shows that the IH 10, IH 45 and U.S. 59 all experienced high truck flows of aggregates outside the IH 610 loop with growth to the north by 2035. On the west side, there is strong flow in a crescent described by U.S. 290 and U.S. 59 headed south, with growth on U.S. 59. Finally, there is concentrated and rising activity along the ship channel and SH 225. The increases in tonnage can be attributed to the expected population growth and to the expansion of imports over the Gulf.

SH 105 emerges in Liberty County, and the western part of Little York Road attracts consistent volume throughout the period.

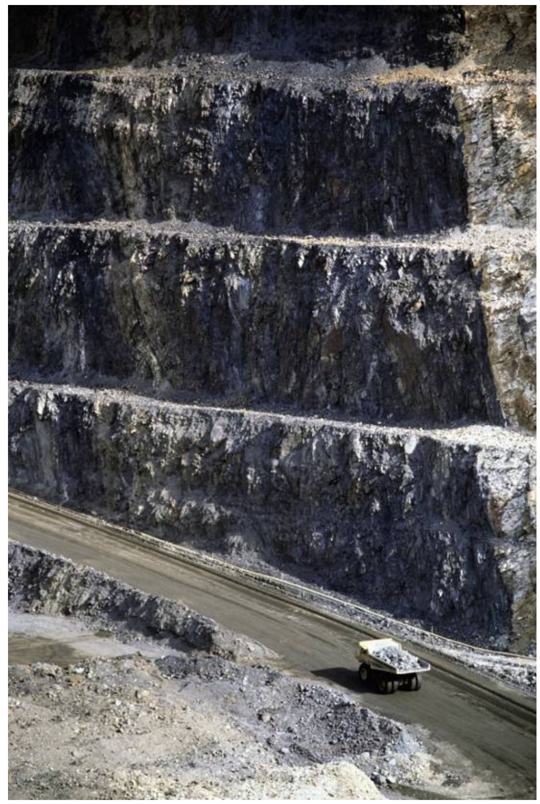
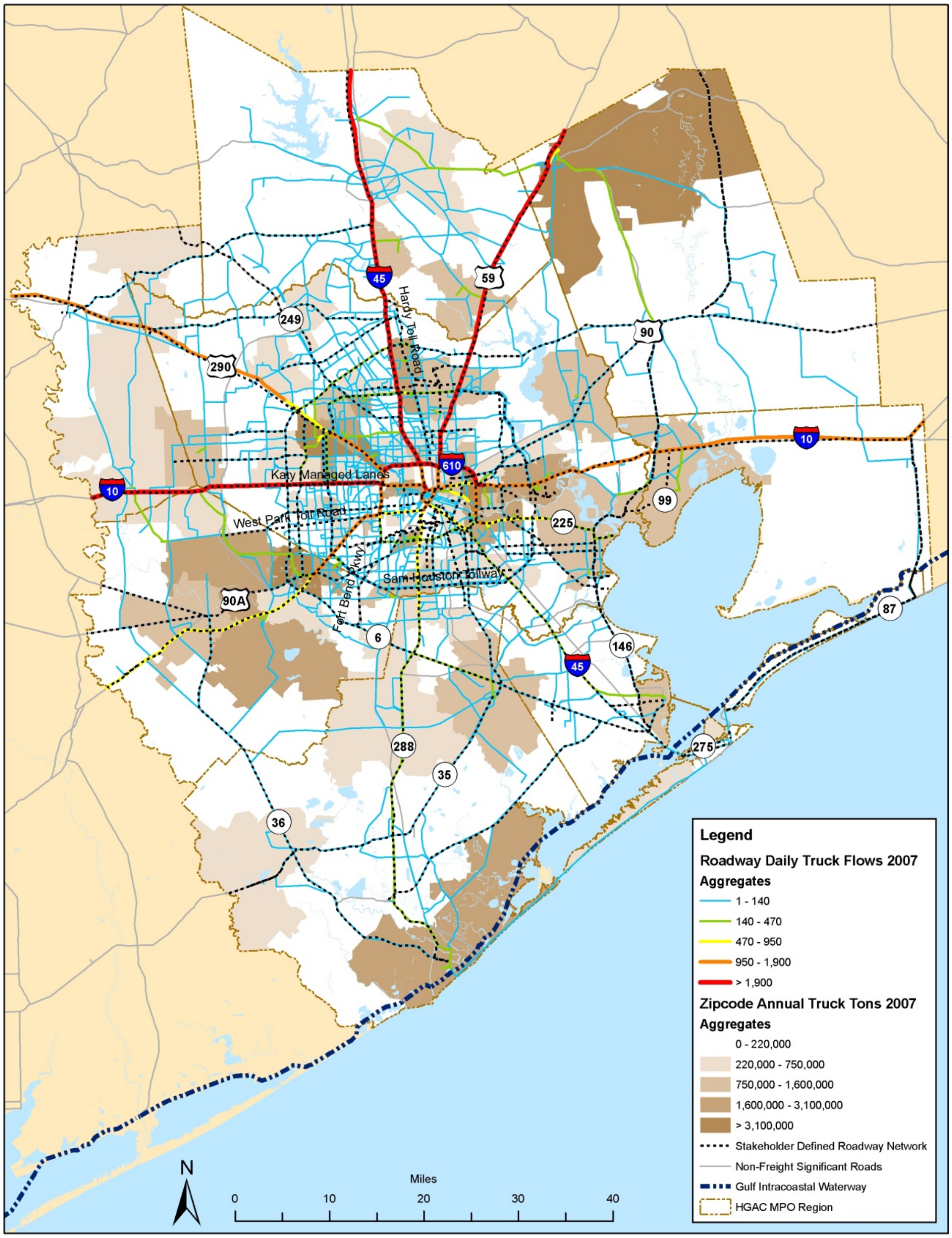
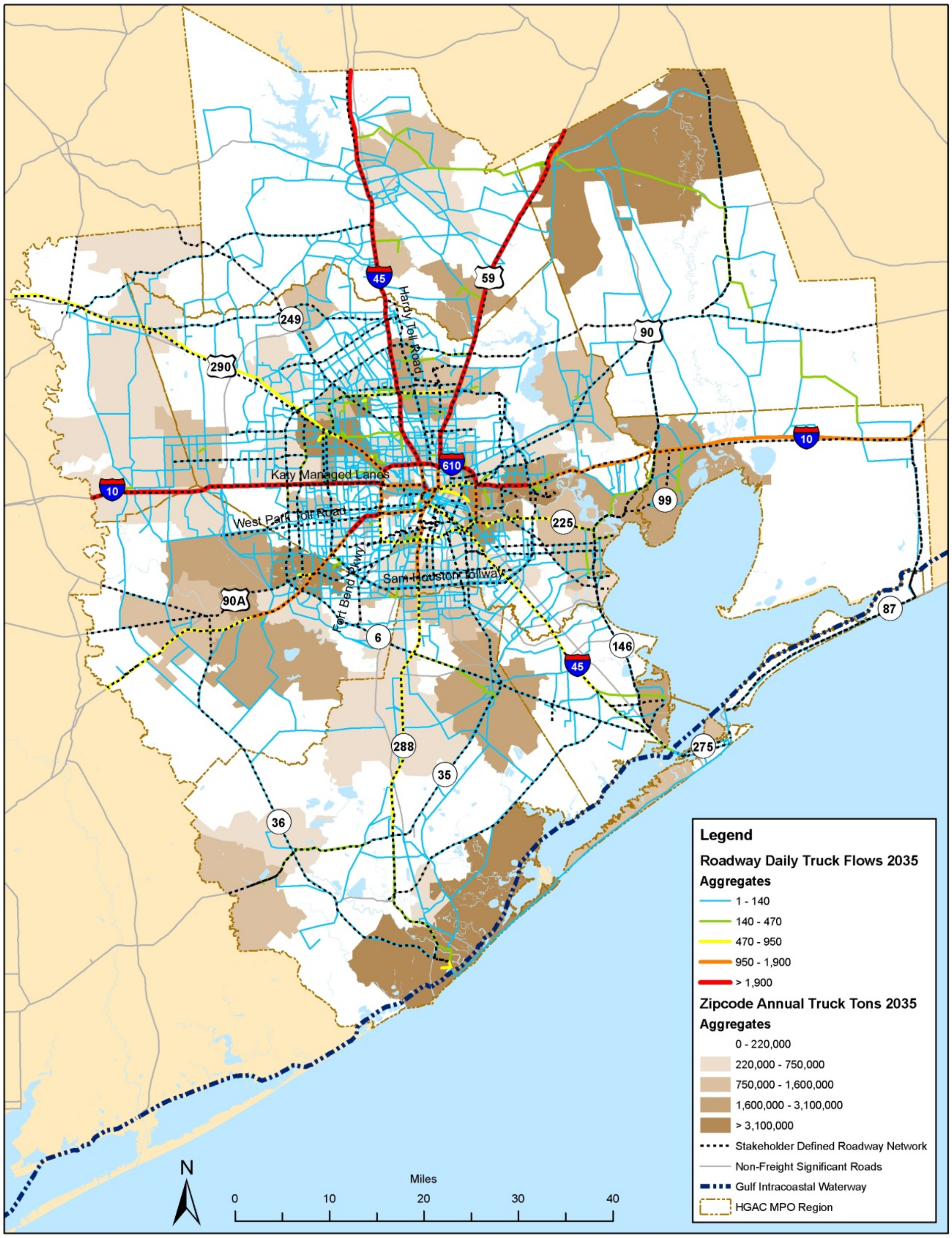


Figure 3-18 Aggregates Flows and Tons, 2007



Source: IHS Global Insight/H-GAC.

Figure 3-19 Aggregates Flows and Tons, 2035



Source: IHS Global Insight/H-GAC.

Agriculture and Food Production

Agriculture and food production establishments include dairy, other food processing and production.

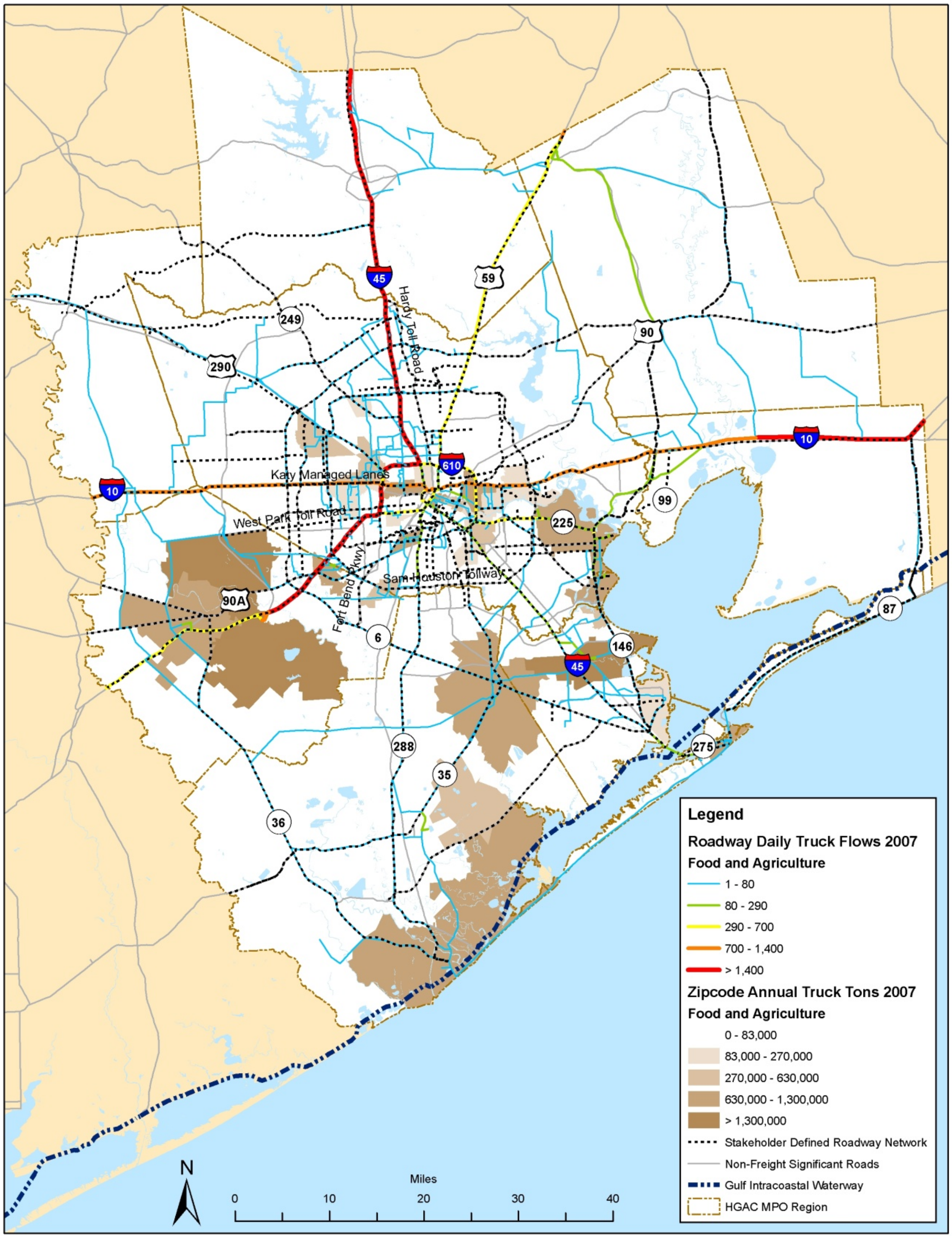
Figure 3-20 displays tons of production by zip code as well as daily truck flows over the roadways for 2007. Figure 3-21 displays projections for the same data in 2035. Volume concentrations are spread broadly to the south of IH 10, most notably in Fort Bend County.

The 2007 map shows that IH 45 and U.S. 59 to the north and south of the region, experienced the highest truck flows of agriculture and food production. IH 10 is active as well. The 2035 map shows very similar truck flows across highways in the region, with heavier traffic evident on U.S. 59 and the eastern section of IH 10.

With regards to truck tons, the key difference between the 2007 and 2035 maps is a reduction in tonnage in the south-central part of the region, contrasted with heavier tonnage in the central area, reflecting consumption as well as port activity.

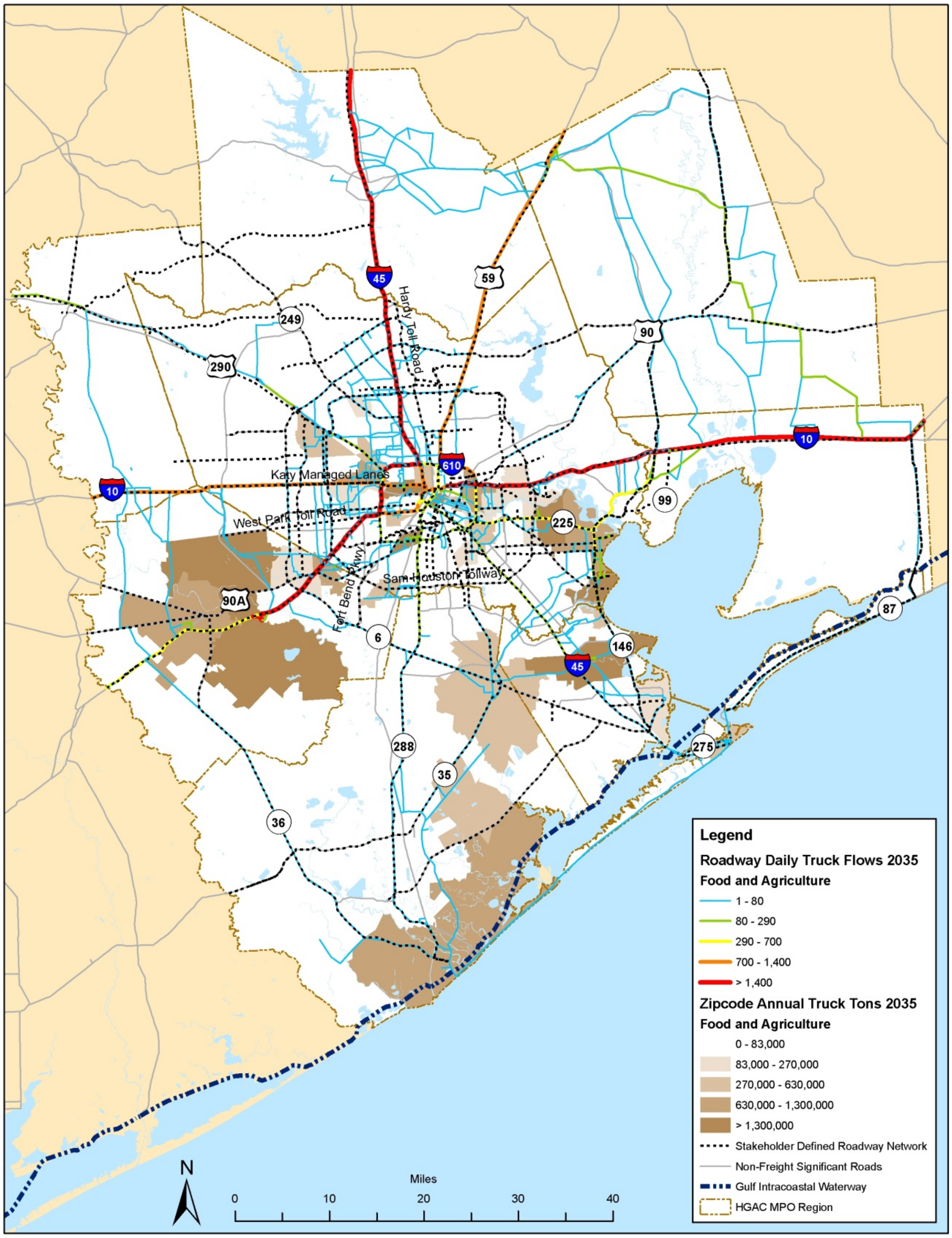
These maps show areas of concentration split both away from the city and more centrally, particularly in the southeast around IH 10/IH 610 junction. This reflects the position of food production in the more rural areas and food processing in the more traditional industrial zones of the region's urban core. Grocery warehousing is strong along the south side of IH 610. The flow of materials would come from the outer perimeter toward the interior processing areas and then back out throughout the region for distribution.

Figure 3-20 Food and Agriculture Flows and Tons, 2007



Source: IHS Global Insight/H-GAC.

Figure 3-21 Food and Agriculture Flows and Tons, 2035



Source: IHS Global Insight/H-GAC.

Other Manufacturing

"Other manufacturing" includes production for products other than food, petrochemicals, and aggregates. Steel, machinery, and project cargo for the petrochemical industry are included in this category.

Figure 3-22 displays tons of production by zip code as well as daily truck flows over selected roadways for 2007. Figure 3-23 displays projections for the same data in 2035.

The 2007 map shows that the central and northeast parts of the Houston-Galveston region experience the highest volume of truck tons. This is to be expected as these are the traditional manufacturing areas developed over time. The 2035 map shows more truck tons in the central area, with a shift of tonnage from the northeast to the south part of the region, reflecting perhaps a shift in production or consumption of these products. There is also greater growth on the whole east rather than west of a line sketched by SH 288 and the northern section of IH 45.

The stakeholder-defined network is regularly used. Routes in Liberty County noted previously are the salient exceptions, and these grow with time. The western part of Little York Road also attracts rising volume through 2035.

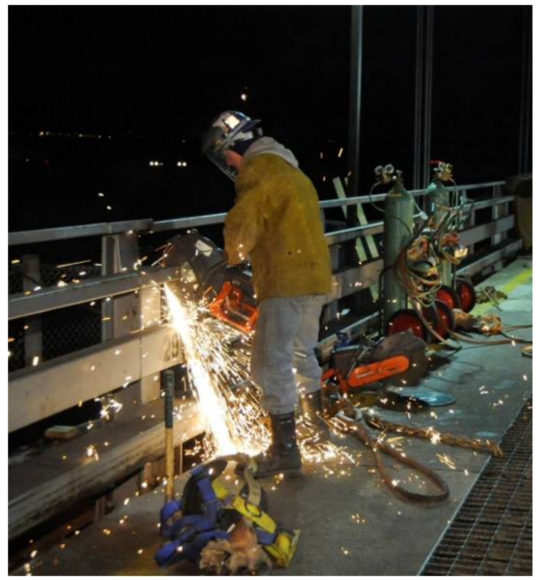
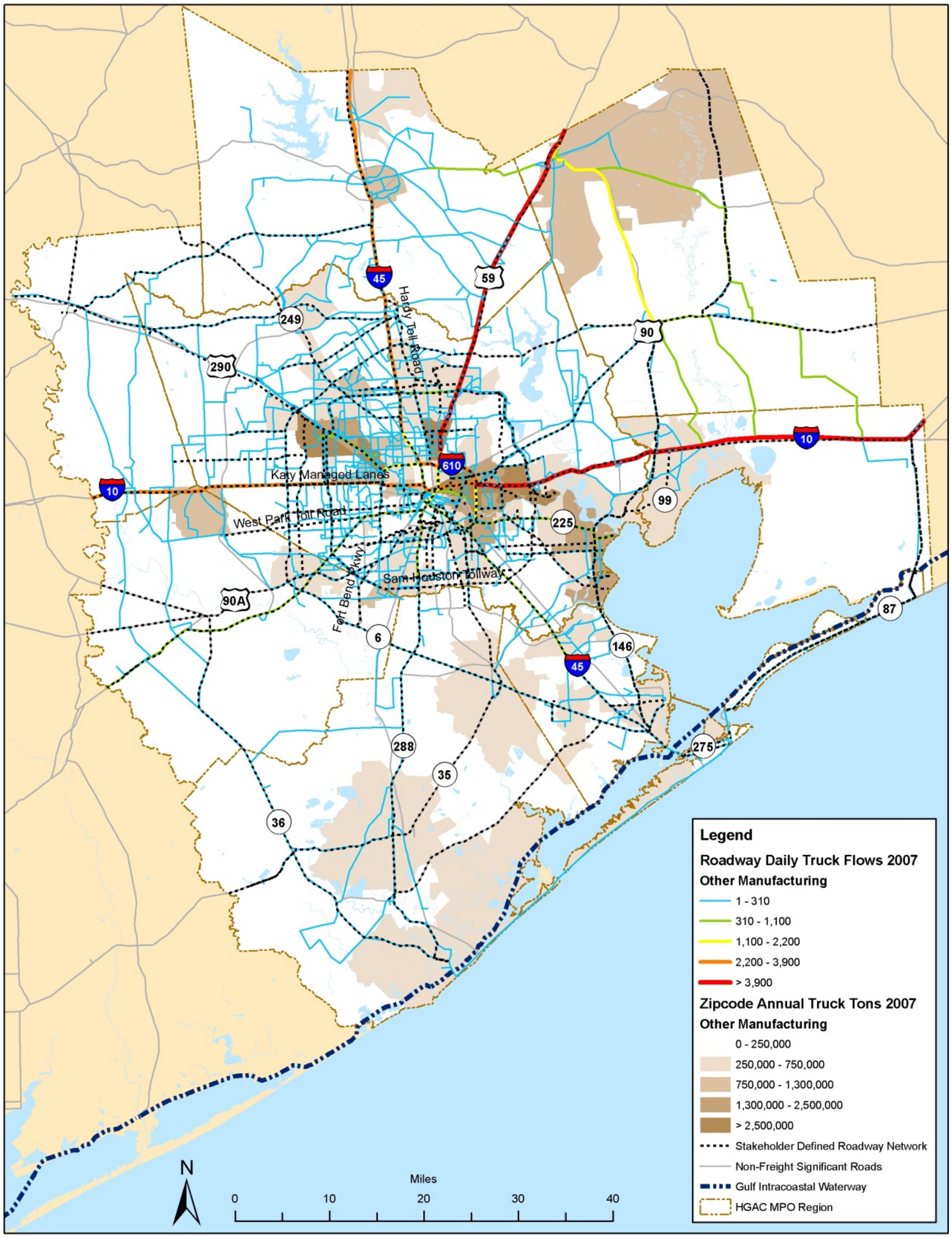
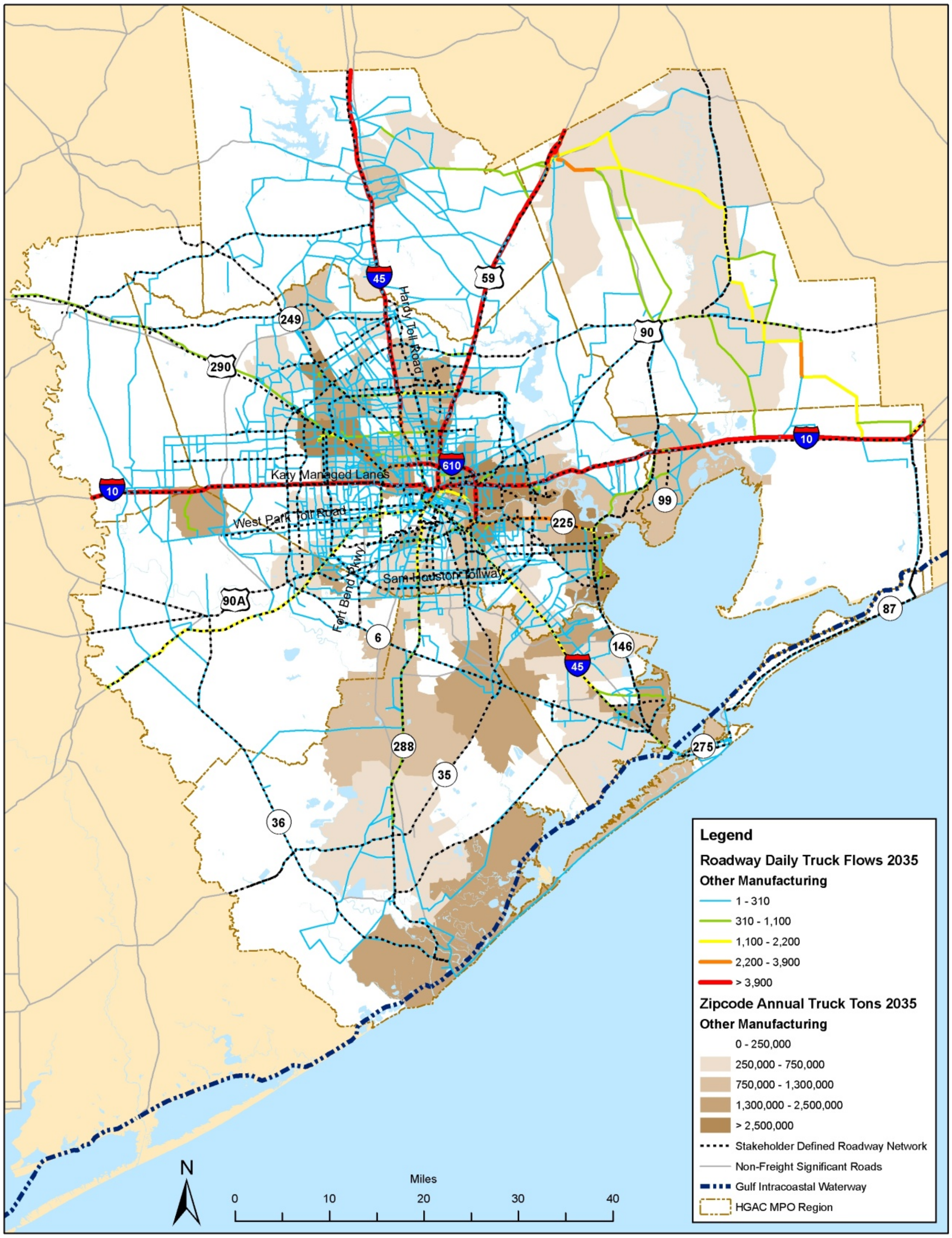


Figure 3-22 Other Manufacturing Flows and Tons, 2007



Source: IHS Global Insight/H-GAC.

Figure 3-23 Other Manufacturing Flows and Tons, 2035



Source: IHS Global Insight/H-GAC.

The key industry traffic analysis taken as a whole reveals that the network as outlined by stakeholders does a reasonably good job of reaching to the critical segments of economic geography and tying them together across the region. Principal additions revealed by industrial traffic activity include roadways in Liberty County, and connecting routes like Clinton Road, West Little York Road, and Spur 330.

Crashes and Accidents

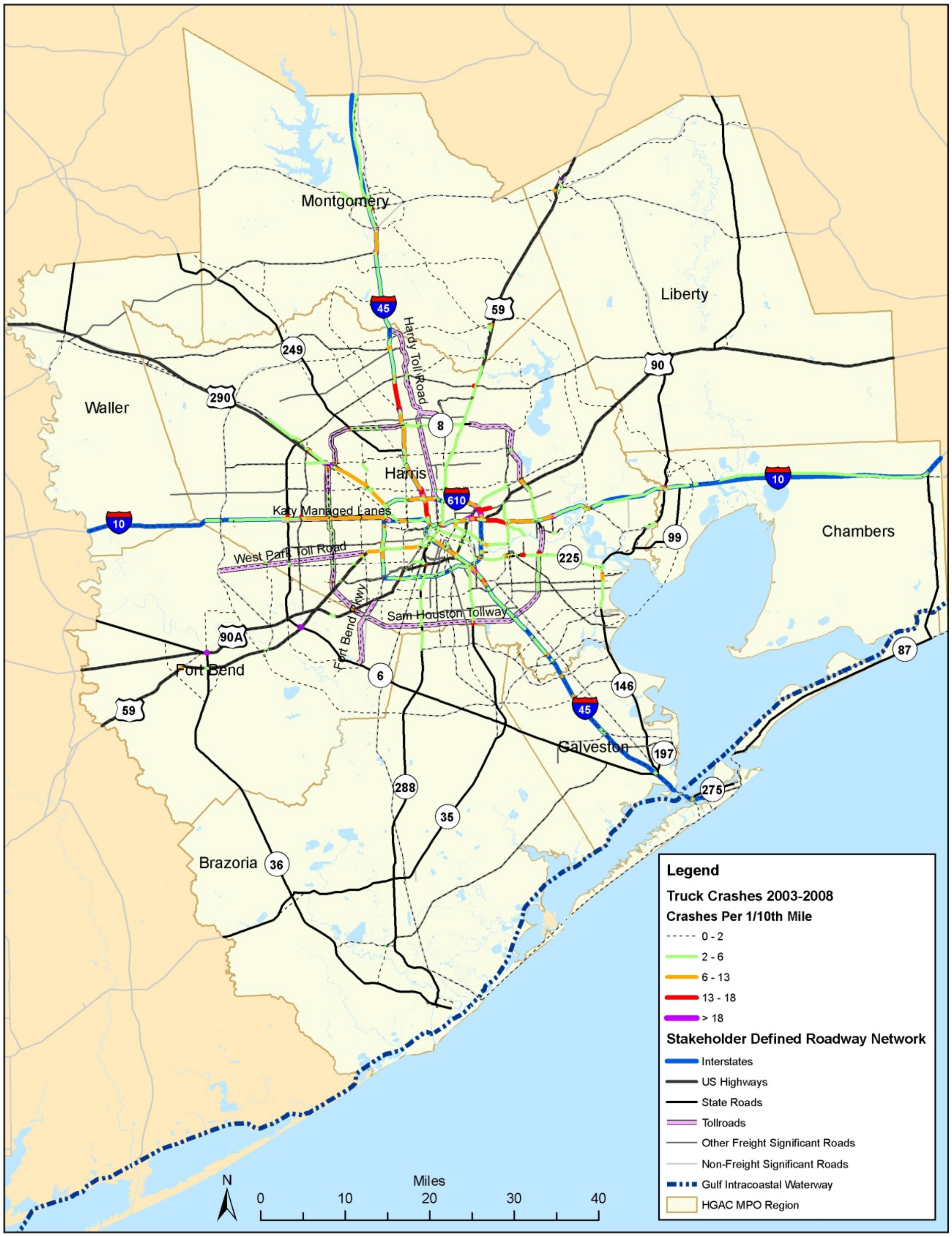
Safety is a priority for both carriers and the traveling public, and heavy truck traffic generates safety concerns on the part of the general public. Figure 3-24 shows truck crashes per one-tenth mile from 2003-2008, based on data from H-GAC. This map provides strong evidence of the effects of concentrated traffic and highway interchange on accident frequency.

The highest concentrations of accidents throughout the region are at major intersections and most commonly where major highways interchange with IH 610, the inner loop. There are also "hot spots," on U.S. 6, U.S. 59, U.S. 36 and IH 610.

As a consequence of heavy truck traffic, the stakeholder-defined network also experiences high volume of truck crashes, and therefore safety management will be critical on such routes as IH 10, IH 45, IH 610, and Beltway 8.

This is a critical issue in route planning and will certainly be important in the discussion of the hazardous materials flow. There is essentially no way to avoid these points in the network. Therefore safety improvements have to rely on changes to the existing infrastructure and processes to create a smoother flow of traffic in the transitions.

Figure 3-24 Truck Crash Volumes, *2003-2008*



Source: H-GAC.

Level of Service

Congestion is a top complaint from both freight stakeholders and the traveling public. A common measure of congestion is level of service (LOS, see discussion in Section 3). Figure 3-25 displays roadways levels of service derived from 2009 volume/capacity ratios based on data provided by H-GAC. As can be seen, the majority of the stakeholder-defined network, especially inside Beltway 8, operates at or above capacity.

LOS has direct impacts on achievable speeds and thus travel times and reliability. ATRI conducted an in-depth analysis of the Houston-Galveston region's major limited-access and signalized highways using truck position data derived from wireless on-board communications systems. The data used for this analysis represent weekday trucking activity during a two-year time period (7/01/2008 to 6/30/2010).

The quantitative results produced by this analysis included average speed. The speed profiles show the scale by which average speed consistently deviates from free-flow speed across various segments of the study corridors.

The analysis examines the annual average speeds for the entire 13-county region, as well as the urban core inside Beltway 8 (Sam Houston Tollway), during the four weekday-time classes:

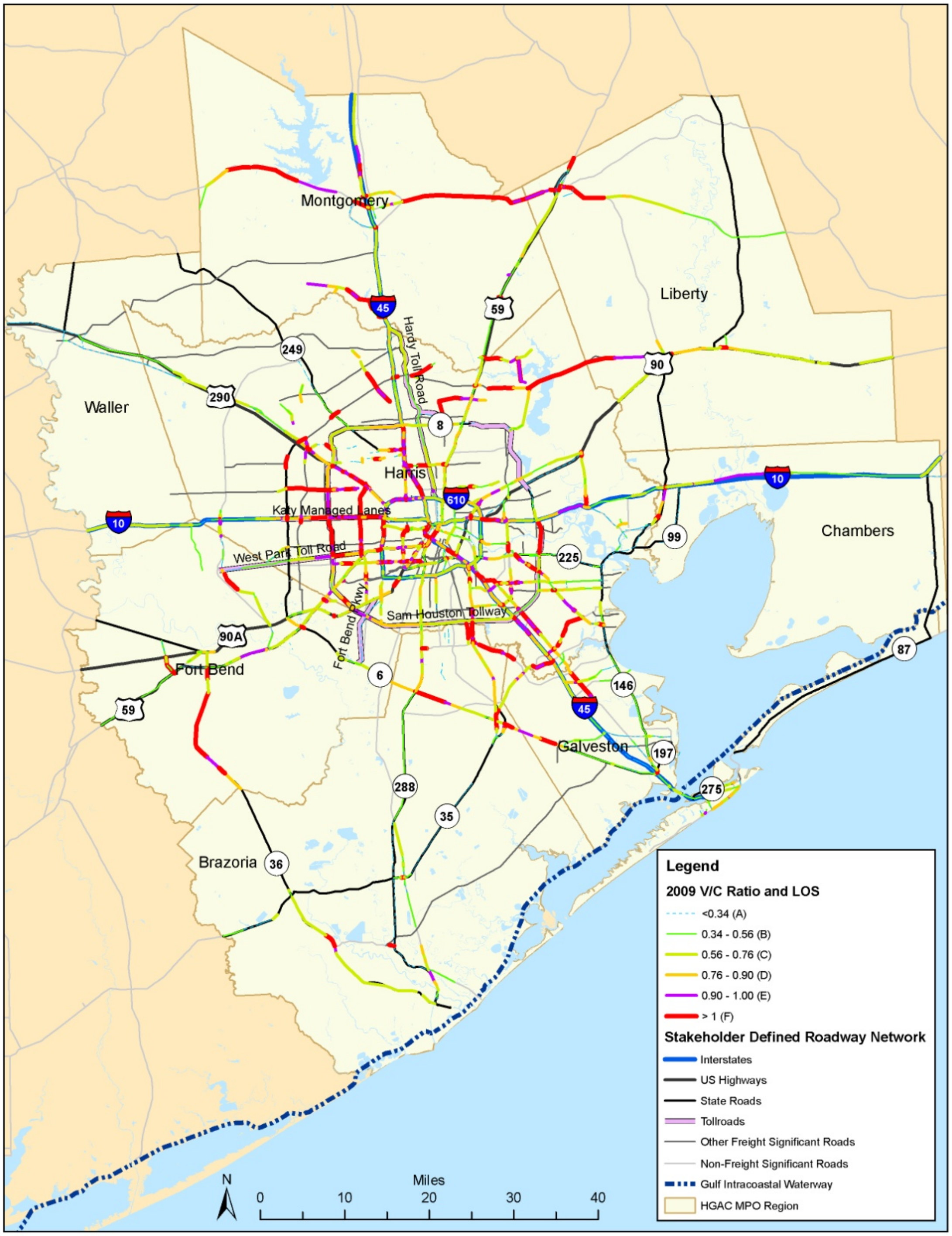
- Off-Peak (7:00 p.m. to 6:00 a.m.);
- Morning Peak (6:00 a.m. to 10:00 a.m.);
- Midday (10:00 a.m. to 3:00 p.m.); and
- Evening Peak (3:00 p.m. to 7:00 p.m.).

Off-Peak

The off-peak timeframe, which is defined as 7:00 p.m. to 6:00 a.m., is the first period presented in the "time-of-day" analysis. Figure 3-26 displays a regional map of average truck speeds as a percent of the posted speed limit for the eight limited access highways analyzed.[19] Figure 3-27 offers a more detailed look at those highways in the Houston urban core. Figure 3-28 is a regional average speed map of the four signalized highways that were studied. The off-peak analysis is helpful in identifying areas where there are slow average speeds due to factors other than congestion (e.g., night-time construction zones, large truck stops, and traffic signals).

[19] This can also be interpreted as "percent of free-flow speed." Please note that this is based on two year's worth of data (7/01/2008 to 6/30/2010) and does not include weekends. Additionally, in areas of the region where the highways were analyzed in both directions of travel (rather than combining both directions into one lump average), Figure 3.25 is depicting the direction of travel with the lowest speed. For example, if IH 10 at mile 80 has an average speed of 50 miles per hour in the eastbound lanes, and an average of 60 in the westbound, this map will plot the 50 miles per hour for that segment.

Figure 3-25 Average Daily Level of Service, *2009*

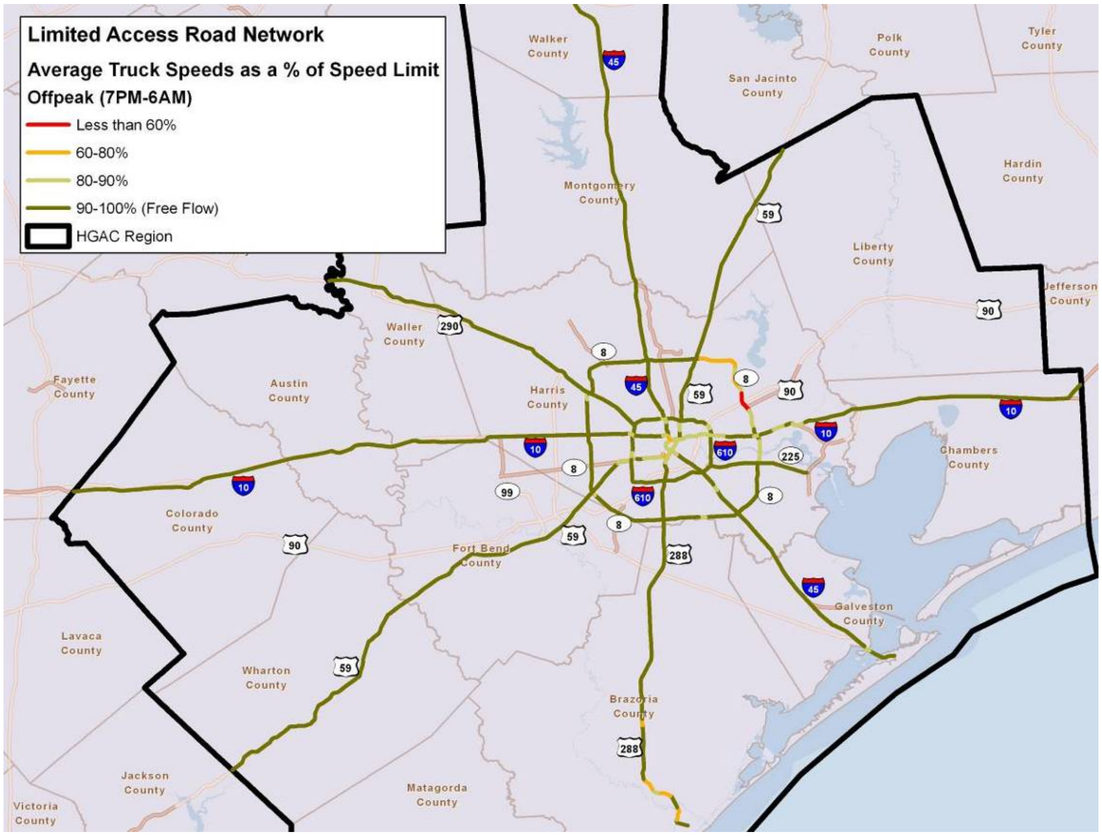


Source: H-GAC.

For the limited access highways (shown in Figure 3-26) there are a few areas that appear to have less than free-flow speeds. The most noticeable area is the northeast quadrant of Beltway 8 where a portion of the highway had average truck speeds of less than 60 percent of free-flow speeds. This portion of the roadway was under construction during the period of analysis, as the road was being converted from signalized to limited access.

Portions of SH 288 in Brazoria County show low-speeds for off-peak hours, but this is again due to the fact that the first 11 miles of SH 288 is signalized. However, further north on SH 288 there is a marked slowdown at mile 20 due to the interchange with SH 35.

Figure 3-26 Average Truck Speeds as a Percent of Speed Limit, Off-Peak



Source: ATRI.

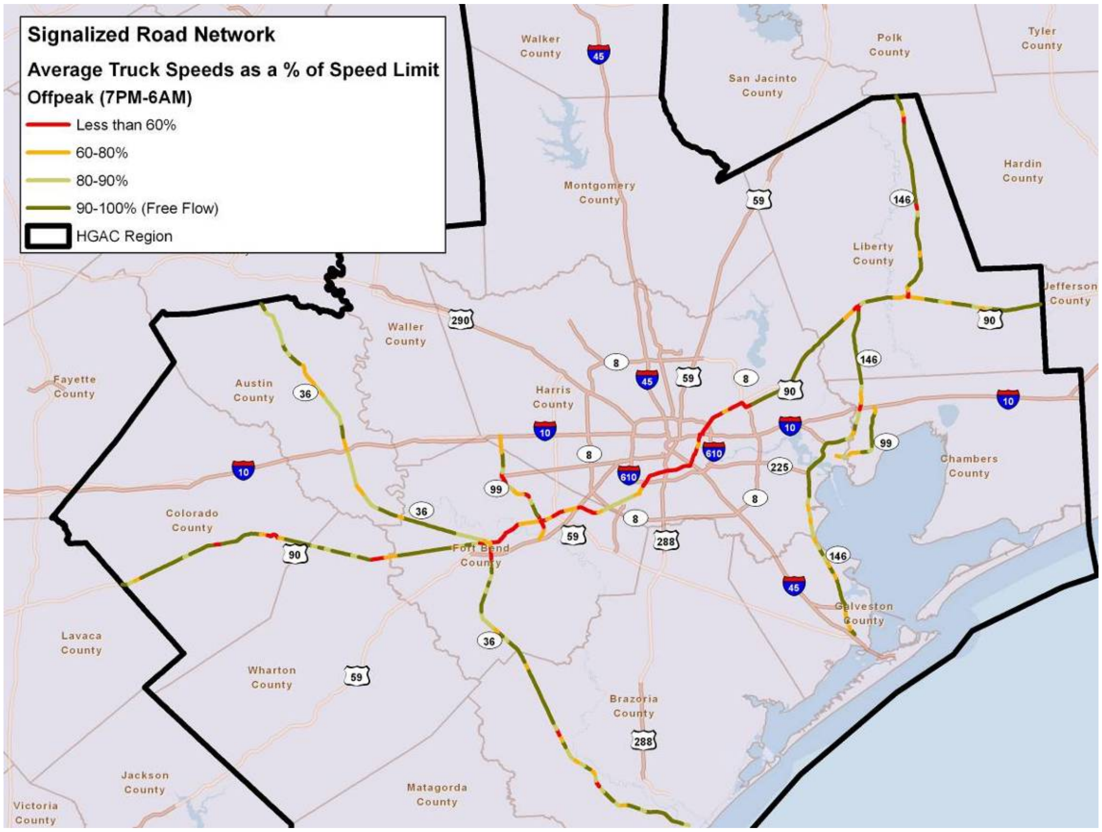
Moving to the urban core areas, Figure 3-27 highlights the off-peak average speeds for both directions of travel for the limited access highways inside of Beltway 8. The two largest slowdowns occurred on IH 10 near the IH 45 merge, as well as on U.S. 59 near the SH 288 and IH 45 interchanges. If these areas are not reaching 80 percent of free-flow speeds during off-peak hours, there may be limited opportunities to utilize operational strategies aimed at truck traffic to off-peak timeframes and requires further investigation.

Figure 3-27 Average Truck Speeds as a Percent of Speed Limit, Off-Peak

Source: ATRI.

Identification of congested areas of the signalized highways shown in Figure 3-28 is difficult due to multiple traffic signals along these highways. By looking at the off-peak performance of these roadways, the heavily signalized areas can be identified more easily.

Figure 3-28 Average Truck Speeds as a Percent of Speed Limit, Off-Peak *Signalized Highways*



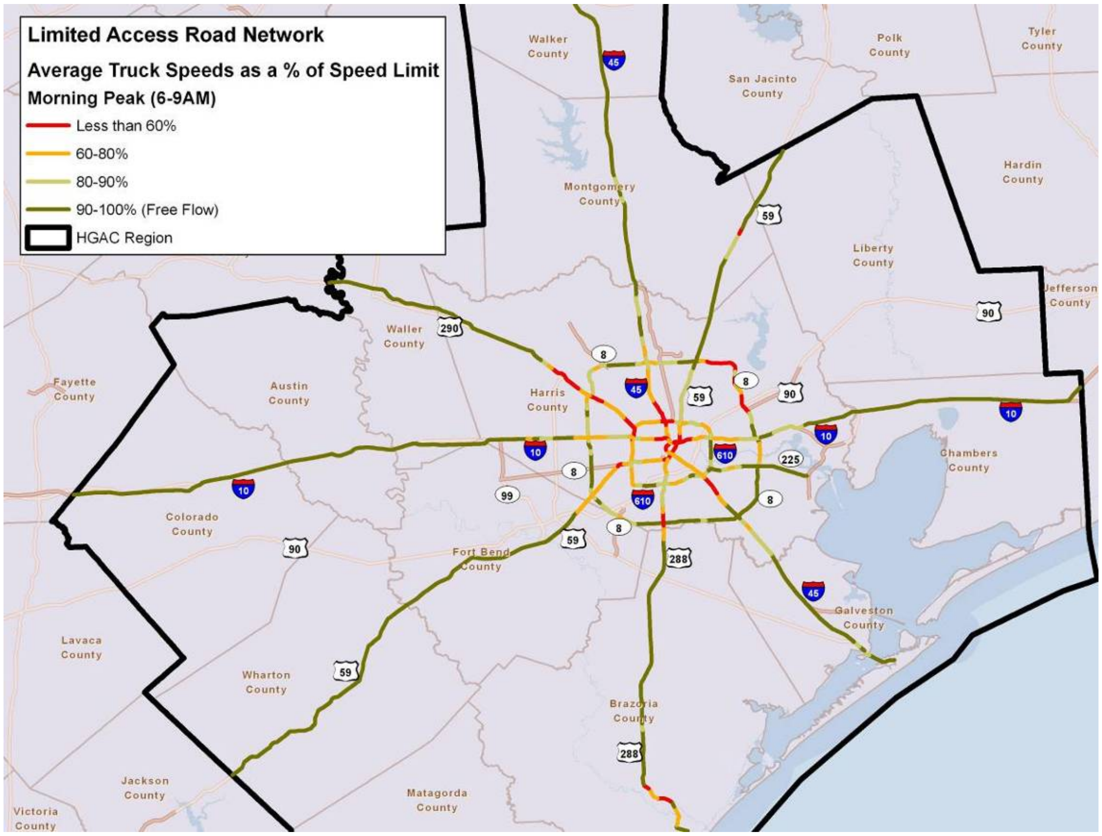
Source: ATRI.

Morning Peak

The morning peak timeframe is defined as 6:00 a.m. to 10:00 a.m. Figure 3-29 displays a regional map of average truck speeds as a percent of the posted speed limit for the limited access highways that were analyzed. Figure 3-30 is a more detailed look at the limited access highways within the Houston urban core. Figure 3-31 is a regional average speed map of the signalized highways that were analyzed.

Not surprisingly, as Figure 3-29 shows, nearly all of the major slowdowns are located inside Beltway 8. Outside of Beltway 8, the two major areas of congestion are on U.S. 290 (which is a major commuting corridor) and the limited access portion of SH 288. Further studies may be warranted to determine the benefits converting the first several miles of SH 288 from signalized to limited access.

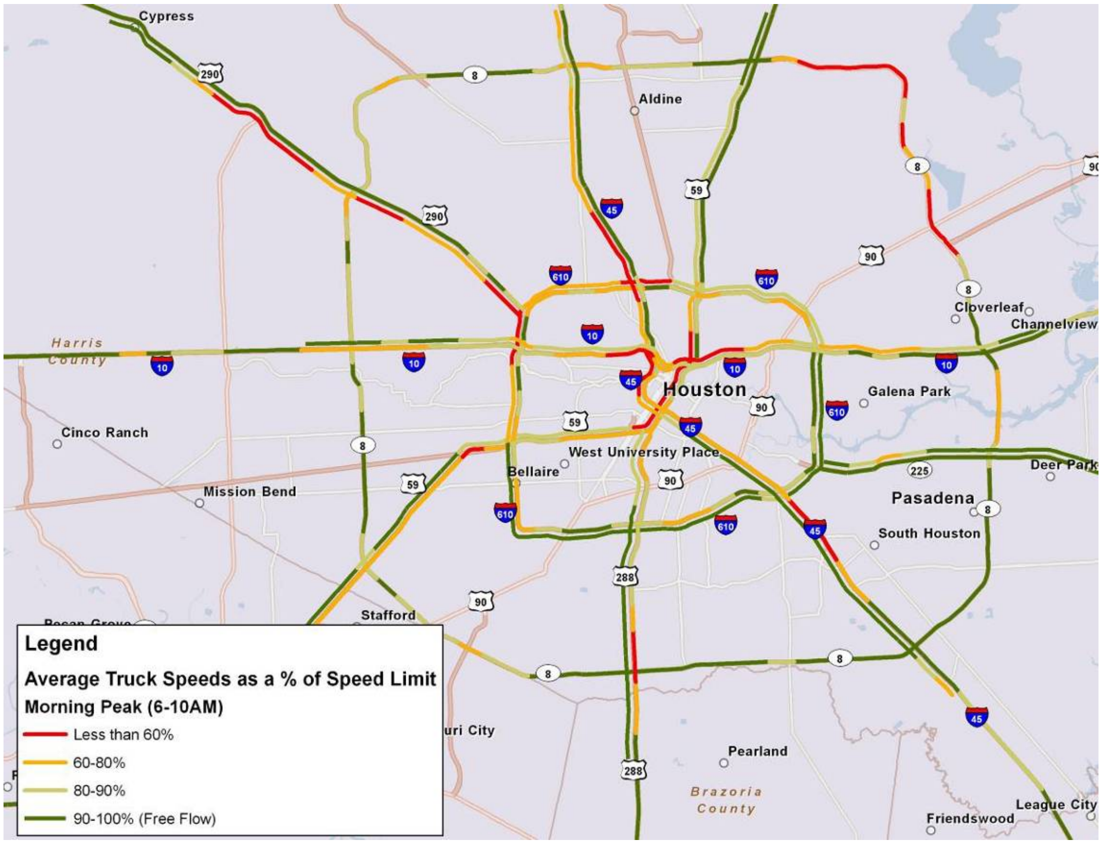
Figure 3-29 Average Truck Speeds as a Percent of Speed Limit, Morning Peak
Limited Access Highways



Source: ATRI.

Figure 3-30 depicts the congestion level in both directions of travel in some of the most urbanized parts of the region. The areas with the highest level of congestion appear to be (in no particular order): U.S. 290 East, IH 45 South from Beltway 8 to U.S. 59 on the north side, IH 45 North from Beltway 8 to IH 10 on the south side, U.S. 59 North near IH 10 and IH 45, IH 10 East from IH 610 to U.S. 59, IH 10 West from IH 610 to IH 45, SH 288 North near Beltway 8, and Outer IH 610 from U.S. 59 on the north side to U.S. 59 on the west side. As discussed in the off-peak analysis, the issues on the northeast quadrant of Beltway 8 are related to construction and traffic signalization.

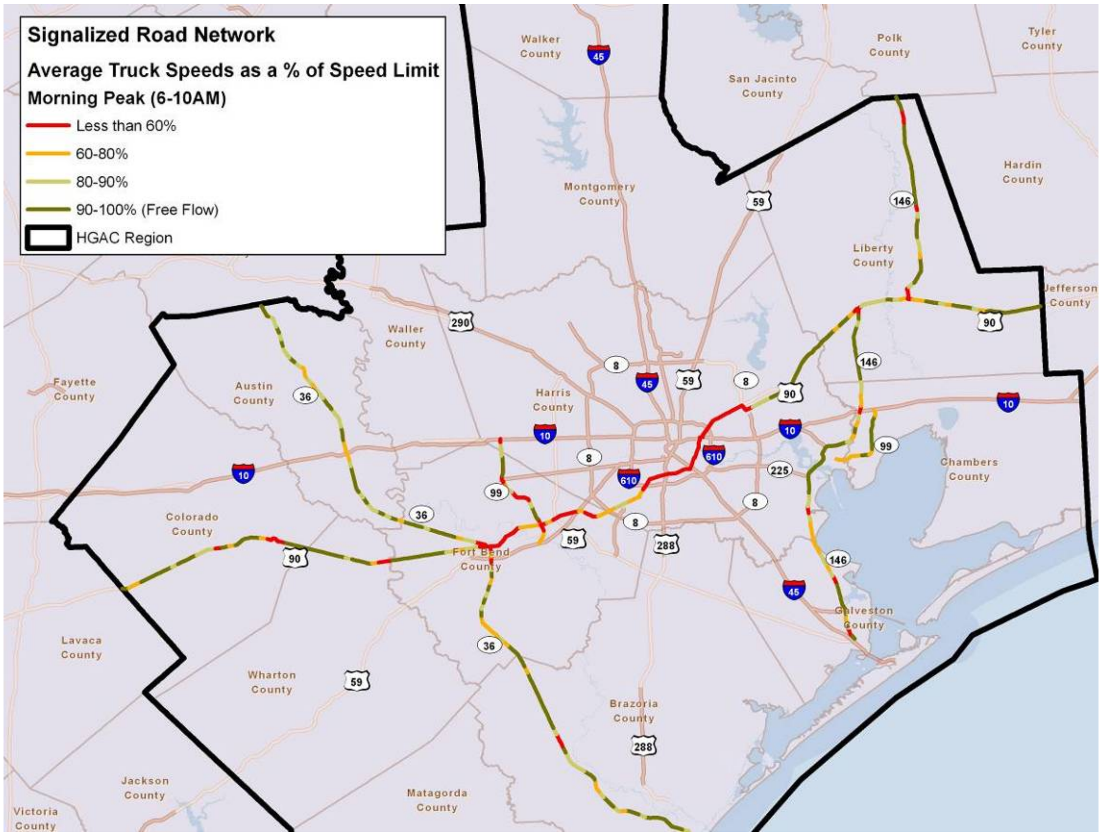
Figure 3-30 Average Truck Speeds as a Percent of Speed Limit, Morning Peak
Limited Access Highways, Urban Core



Source: ATRI.

Figure 3-31 displays the average speed data for the signalized highways. There does not appear to be a significant change in the severity of the congestion in most areas, which supports the discussion in the off-peak analysis that the slowdowns identified are mostly due to traffic signals rather than traffic congestion. However, the southern third of SH 146 appears to be an exception, as this area sees a noticeable increase in congestion between off-peak and morning peak hours. This section of SH 146 is a critical freight corridor due to the ports and other industrial activity centered along Galveston Bay.

Figure 3-31 Average Truck Speeds as a Percent of Speed Limit, Morning Peak
Signalized Highways



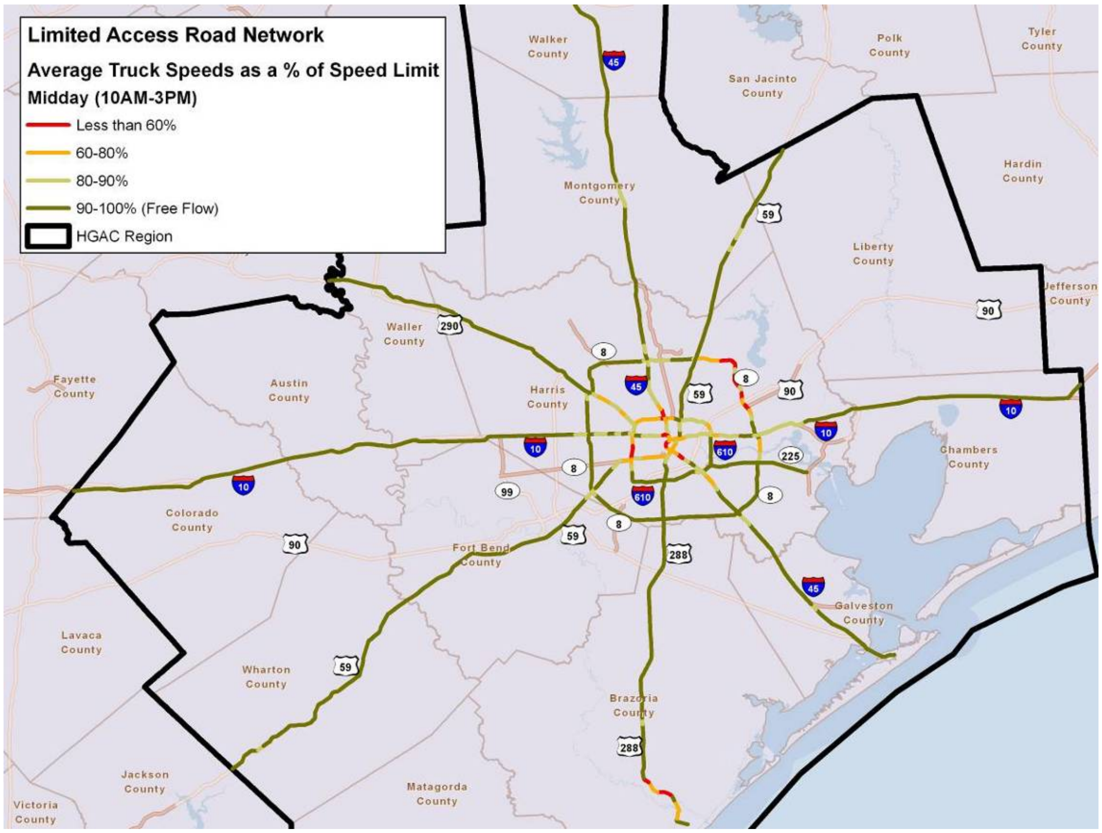
Source: ATRI.

Midday

The next period studied is the midday time-frame, from 10:00 a.m. until 3:00 p.m. Figure 3-32 displays a regional map of average truck speeds as a percent of the posted speed limit for the limited access highways that were analyzed. Figure 3-33 is a more detailed look at the limited access highways within the Houston urban core. Figure 3-34 is a regional average speed map of the signalized highways that were analyzed.

A review of Figure 3-32 shows that most of the congestion that is found outside of Beltway 8 during the morning peak period no longer exists during the midday hours (with the exception of the first several miles of SH 288). This is not surprising given normal daily commuting patterns.

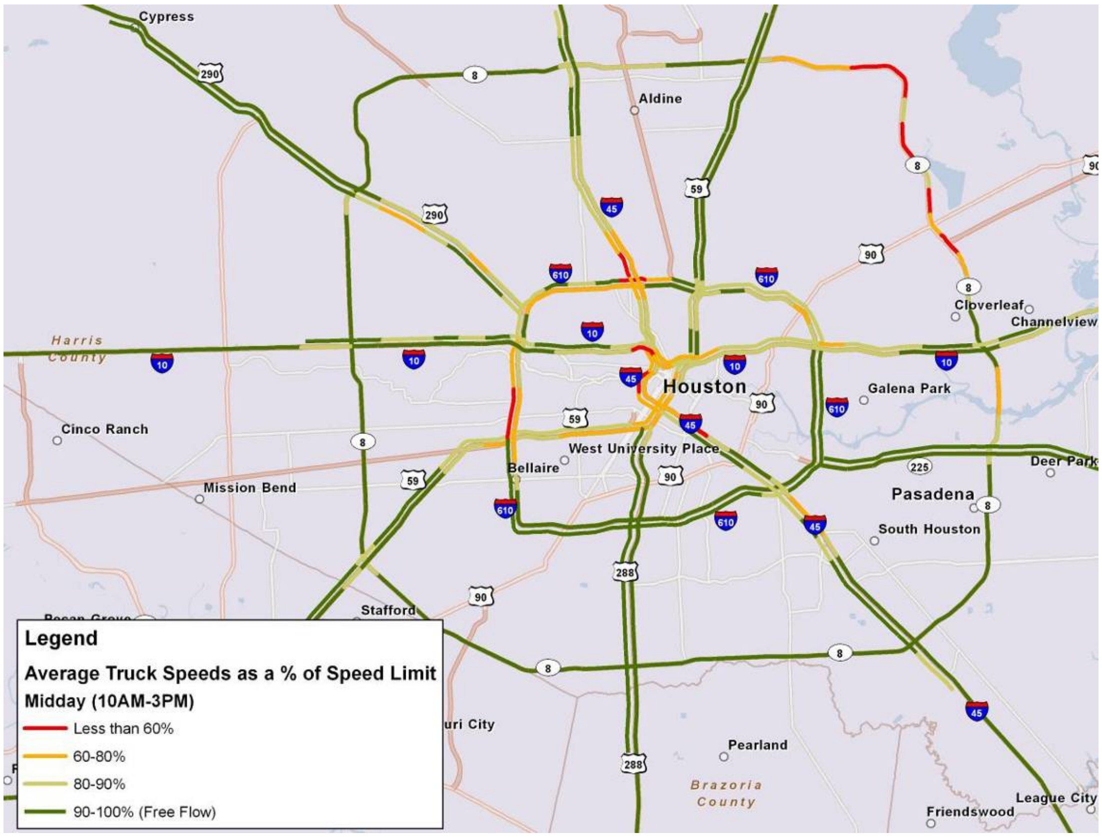
Figure 3-32 Average Truck Speeds as a Percent of Speed Limit, Midday *Limited Access Highways*



Source: ATRI.

A more detailed look at the limited access highways inside Beltway 8, shown in Figure 3-33, finds that, as expected, congestion has lessened in most areas. However, some problem areas still exist. Most notably the outer lanes of IH 610 approaching U.S. 59 on the west side continue to see low-average speeds. The same holds true for IH 610 near IH 45 on the north side, IH 45 South at IH 610 on the north side, and between IH 10 and U.S. 59, and IH 10 East at IH 45. Many other areas inside Beltway 8 remain well below free-flow as well. When highways are not given the chance to "recover" during the midday lull in traffic volumes, it can compound issues when the evening peak hours are encountered.

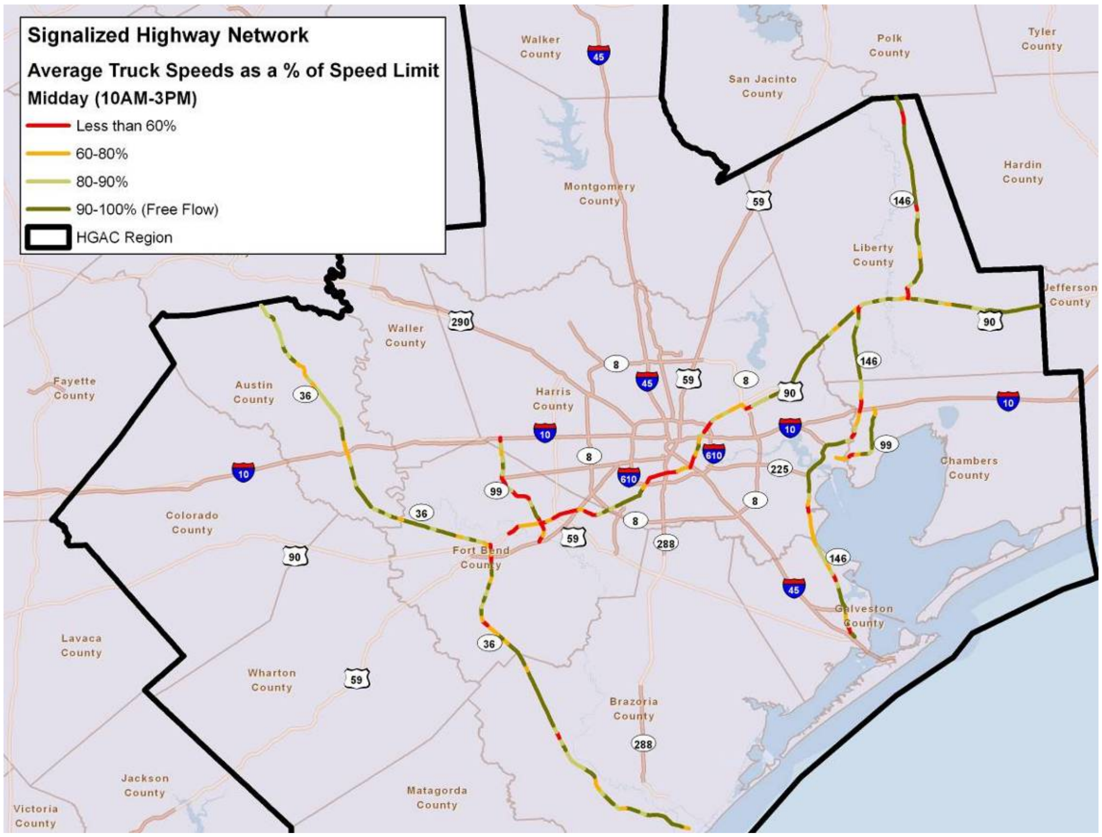
Figure 3-33 Average Truck Speeds as a Percent of Speed Limit, Midday
Limited Access Highways, Urban Core



Source: ATRI.

For the signalized highways depicted in Figure 3-34, there is very little difference between the average speeds from the morning peak hours and those found during the midday hours. This again indicates that slowdowns in average speeds are more likely attributable to traffic signals than to high levels of congestion.

Figure 3-34 Average Truck Speeds as a Percent of Speed Limit, Midday
Signalized Highways



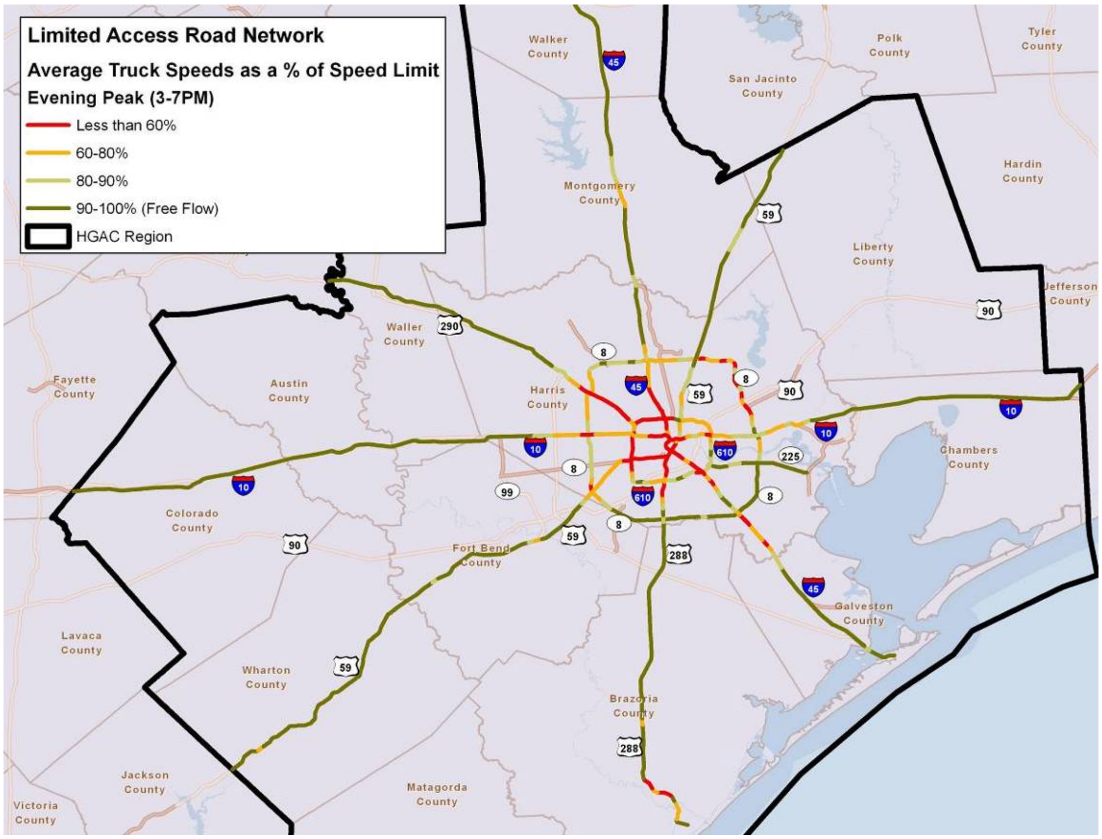
Source: ATRI.

Evening Peak

The evening peak timeframe is defined as 3:00 p.m. until 7:00 p.m. Figure 3-35 displays a regional map of average truck speeds as a percent of the posted speed limit for the limited access highways that were analyzed. Figure 3-36 is a more detailed look at the limited access highways within the Houston urban core. Figure 3-37 is a regional average speed map of the signalized highways that were analyzed.

Beginning with Figure 3-35, and the analysis of the regional limited access highway network, a significant decline in average speed performance is immediately noticed. Looking first at the segments outside of Beltway 8, the worst areas of congestion appear to be IH 45 south of Beltway 8, the southern terminus of SH 288, IH 10 (both on the east and west sides) and U.S. 290.

Figure 3-35 Average Truck Speeds as a Percent of Speed Limit, Evening Peak
Limited Access Highways



Source: ATRI.

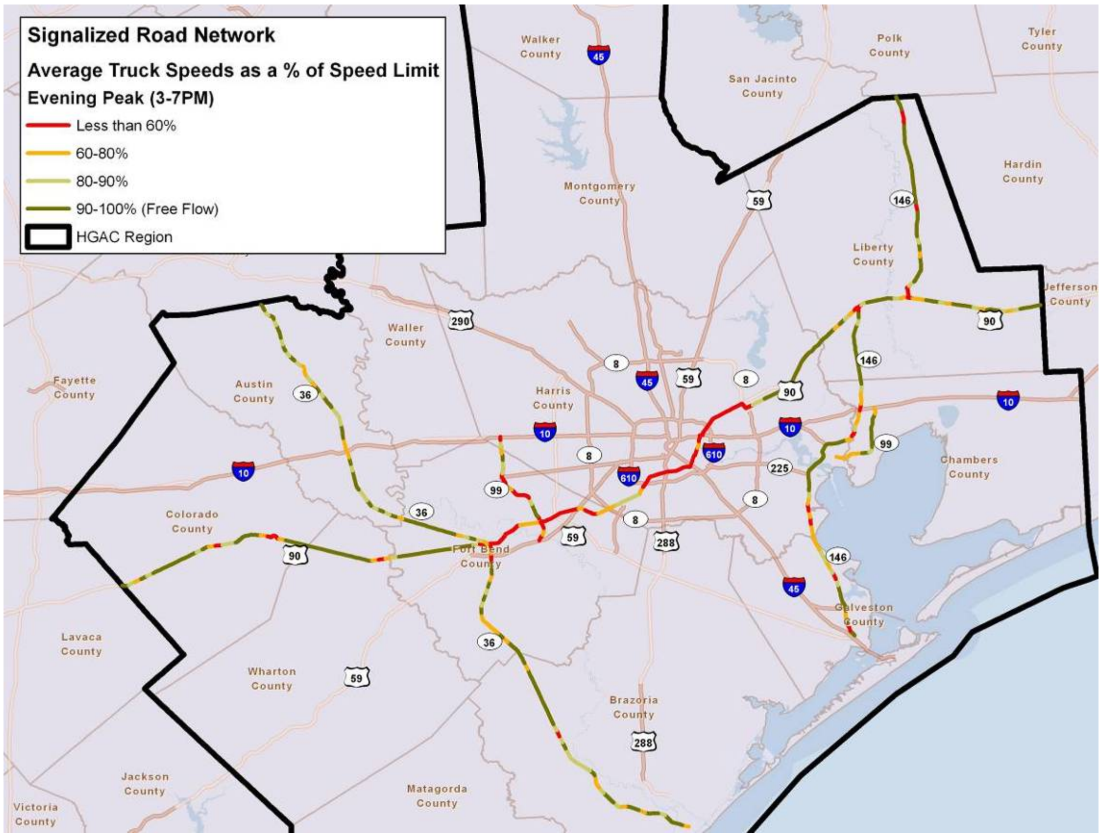
A more detailed, directional analysis of the limited access highways, shown in Figure 3-36, highlights the most congested sections of highway. The worst performing sections of highway include (in no particular order): U.S. 290 North; IH 45 North particularly from U.S. 90 to Beltway 8; IH 45 South at IH 610 on the north side and also from IH 10 to IH 610; IH 10 East from IH 610 to U.S. 59 and again at IH 610 on the east side; U.S. 59 North from Beltway 8 to IH 10; U.S. 59 South from IH 10 to IH 610; and the northeastern third of Beltway 8 between the intersections with U.S. 59. The congestion in the evening hours appears significantly worse than the morning peak hours. This is likely due in part to the inability of some of these highways to "recover" to near free-flow speeds during the midday hours.

Figure 3-36 Average Truck Speeds as a Percent of Speed Limit, Evening Peak
Limited Access Highways, Urban Core

Source: ATRI.

Figure 3-37 illustrates the average speeds for the four signalized highways that were analyzed. As was found in the morning peak and midday analyses, there is little deviation between off-peak performance and evening peak performance for these highways. However, the southern third of SH 146 continues to perform noticeably worse in the evening peak when compared to off-peak performance. As was stated earlier, this part of the region is critical for moving freight to and from the ports. Of all the signalized corridors that were analyzed, this section of SH 146 may be most worthy of further study for improvement.

Figure 3-37 Average Truck Speeds as a Percent of Speed Limit, Evening Peak *Signalized Highways*



Source: ATRI.

From the analysis of LOS and its impact on speeds, two clusters of problems can be observed with multiple routes at or approaching Level of Service F one on the west side from the Loop outward to Katy, and another in the southeast generally from Hobby Airport to League City. Both these districts are areas of growth. FM 1960 shows constraint over long sections in the east and at multiple intersections further west. SH 6 is limited as it crosses SH 288 at Iowa Colony, and continues in that condition most of the way toward Galveston. Difficulties also are visible on the two-lane SH 36 south of Rosenberg. The incidence of poor levels of service is greater on the whole as routes converge in Harris County, although the success of improvements made around and inside IH 610 also is evident.

This analysis is of existing conditions and does not include further stress under forecast volumes.

Driver Observations on Key Corridors

During the course of field interviews, stakeholders reported bottlenecks and other operational issues affecting the regional highways and roads their drivers frequently use. These are summarized in Table 3-5. While these comments provide insight into conditions on the ground, many of the challenges they reveal affect primary roadways that are basic to the region's stakeholder-defined network. Thus, their value is less for the appraisal of viable routes, and more for the suggestion of the kinds of improvements that will be required to render the existing freight system fluid and efficient. While specific bottlenecks

are noted below, it should be recognized that many of these same types of issues are systemic, meaning that they are common throughout the region.

Table 3-5 Summary of Stakeholder-Identified Bottlenecks

IH 45	• Intersection with IH 610 is the "Second Worst Spot" in the region. • Bottleneck at 45S from downtown to NASA. • On the 45N from IH 10 to IH 610 to Tidwell: prior to Tidwell, no on-ramps so the traffic speeds up, then shuts down to a standstill by Godley Furniture. It fakes the driver out; unsafe. • SH 6 not an alternative to IH 45 – all stoplights – rather use IH 10 or SH 146.
IH 10	• IH 10 and 330 (northwest of Baytown) is bad headed west to south and north to east: stop signs, narrow roads. Usually backs up at intersection of SH 146 and IH 10, due to plants and residential (people use 146 as alternate to Beltway as route to 45S). • Bottleneck at IH 10W and IH 45. • Many accidents on IH 10 toward Baytown, "shut down don't know how many times due truck accidents," then slow to clear.
IH 610	• Section of IH 610 from U.S. 225 to IH 45 is a parking lot at rush hour. • Hot spots anywhere major roads enter IH 610; IH 610 into SH 35/IH 45 is especially bad. • Exit from 610 onto Kirkpatrick is a safety issue: steep downhill, many near misses here. Dead man's turn at Manchester under IH 610, rolled a truck there. • Service Road for IH 610, after light at McCarty, is a section with no marked lanes and a merge – it's dangerous. • If stuck on the IH 610, use Holcomb: wide, runs east/west, connects nicely north/south. Also Westpark Tollway is a good east/west option. • Bottleneck at intersection with SH 288.
U.S. 59	• Big bottleneck: U.S. 59 feed into IH 610 on return from Sugarland (use 90 instead). • Bottleneck between Shepherd and Downtown. • U.S. 59S to Rosenberg at rush hour is "horrible."
U.S. 290	• U.S. 290 is always backed up 6-7 miles from Bingle to SH 6; clears past 6. Multiple huge subdivisions may explain it; also overpass looks right in the sun. • Lane markers poor in rain and dark; at one exit, two lanes go off, forced to exit if not aware. • Barker Cypress exit always backed up to ramp, maybe due timing of lights • Bottleneck from IH 610 to Jones Road – "290 is a nightmare all day long." • Traffic is always slow.
Wallisville Road	• Area around McCarty road is disliked for number of trucks and difficult conditions. The physical condition of the road is poor. • Wallisville Road is a major route with lots of industry. Federal Road (runs north/south, becomes Shaver) is used a lot as an alternative. There is much business and though it is not a good road, it is in better condition than Wallisville. • Community college causes lots of slow downs. • Wallisville Road to McCarty is a nightmare any time-of-day. Wallisville going west before South Basin is a bad grade crossing, can wait 45 minutes.
SH 288	• "Don't use U.S. 35, but if SH 288 is backed up, 35 is an alternative." • Bottleneck at IH 610. Traffic also backs up at intersection with 595.

Hazardous Materials, Heavy-Haul, Permitted Loads

The trucking operations in the Hpuston-Galveston area include a significant amount of specialized traffic. The overwhelming reason for this volume is the importance of the petrochemical industry through the region. This specialized traffic includes hazardous materials and shipments of oversize and overweight cargo.

Hazardous Materials

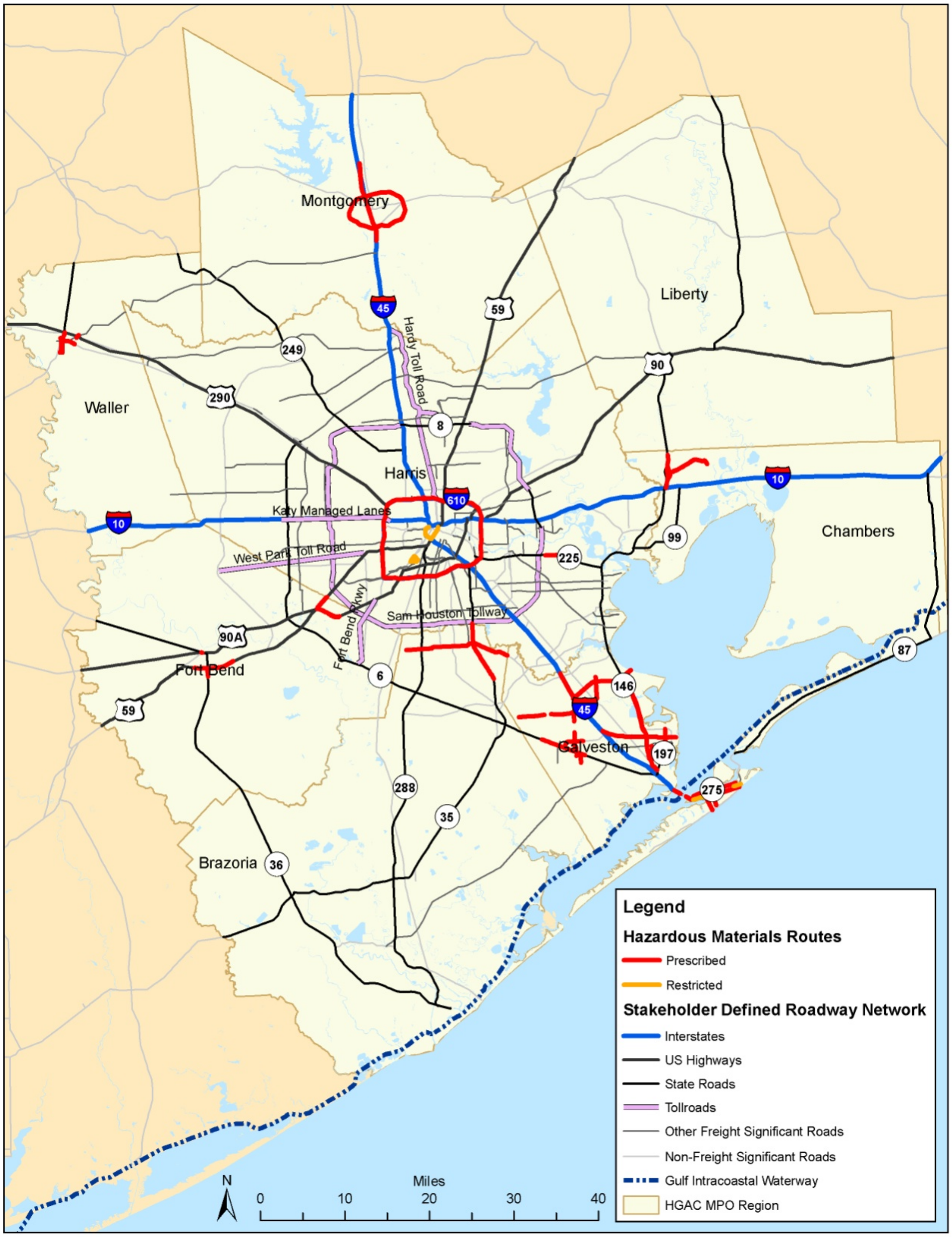
The Department of Transportation's Bureau of Transportation Statistics' The *Hazardous Materials Highlights – 2007 Commodity Flow Survey* (CFS) covers 2.2 billion tons of hazardous classified materials that moved on the nation's transportation network in 2007, 54 percent of which moved by truck. Pipeline transport was the next highest at 28 percent with other modes each accounting for less than 7 percent of the total.

The largest concentration of the petrochemical industry in Texas is in the area around Houston, Galveston, and Baytown. Thus, it stands to reason that the biggest share of the Texas hazardous materials shipments are directly in the Houston-Galveston area and must be considered a significant portion of the truck traffic.

Concerns over the transport of hazardous materials of all types are increasing and extending from the Federal level to state and local responsibilities. The states are in varying stages of development in the process of designating and publishing routes. Some states have no routes designated and others are finely differentiated.

Figure 3-38 displays the current published hazardous material map for the counties within the Houston-Galveston area compared to the stakeholder-defined network. The red routes which are the prescribed or preferred routes do not form a continuous network. The routes shown in purple are restricted. These are the toll roads and two areas within the 610 Loop in the city center. The roads shown are those that have been published to the U.S. DOT.

Figure 3-38 Designated Hazardous Material Routes



Source: TxDOT.

The IH 610 route is shown as the bypass for through hazardous traffic and as the primary artery for moving around the city with localized shipments. The smaller red areas show disconnected pieces of routes that are favored for hazardous material routing. Galveston County shows more defined routes than the other counties in the region. Some counties have no designated routes at all. It is particularly interesting that the area with the highest petrochemical composition along SH 146 around the ship channel and up toward Baytown has virtually no specific routes defined.

When comparing the location of truck crashes (see Figure 3-24) to the hazardous materials map it can be seen that the highest concentrations of accidents are directly on the preferred hazardous map. The primary risks are the volume of mixed use traffic coupled with the intersection and merging of the major highways. The north section of IH 610 shows the most frequency, and this is the most used by through traffic as the distance is shorter than the southern loop. As a priority, the areas around the junctions of IH 610, IH 10, and U.S. Highway 90 are particularly critical.

Connection of the designated routes via the other unrestricted facilities in the network suggested by stakeholders is a practical beginning and essentially a reflection of what happens. However, a more risk-sensitive evaluation is desirable – and whatever the approach, the need exists to improve the density of the route definition in a way that promotes safety while preserving the operational efficiency of the carrier as much as possible. For the Houston-Galveston region, this process is particularly important due the volume level and the related exposure.

Oversize/Overweight Cargo (Heavy-Haul Loads)

The oversize and overweight (OS/OW) or heavy-haul cargo is largely comprised of components used in the oil industry, on platforms, and drilling operations which are either manufactured in the Houston area or imported from elsewhere, including internationally as project cargo over the port. The endpoint for this shipping is at major petrochemical sites around Houston, within the U.S. such as New Jersey, off-shore in the Gulf of Mexico, and other international locations. There are heavy and oversize loads moving that are not petrochemical in nature, including frequent deliveries of items like large concrete structures for construction and less frequent but growing shipments like wind mill blades.

Trucks are involved in moving this specialized cargo both through and within the region. Connections are made to the port for international shipments and to the barge terminals and rail facilities. Dimensional loads are completely prohibited from Beltway 8, implying that they cannot employ one of the principal means of circumnavigating the region. Overweight and oversize loads require special permits that are issued by the states that are traversed in the shipment, and these are normally restrictive as to routes allowed.

This discussion has focused on permitted loads. This category of traffic creates additional wear on the highways and increases the need for maintenance. This problem is exacerbated by additional loads that are not permitted, those being containers that come into the port that are over the legal weight limits. This is a common problem that is difficult to control and manage.

Dimensional cargo is often very time-sensitive. This happens because cranes and crews with other specialized equipment are often required for unloading the freight. The hourly cost of the crane and crew can be very high with serious delay penalties. This timing aspect adds another dimension to the level of detailed planning that must be done in order to complete these movements. Any of these loads requires careful consideration and planning. One carrier interviewed indicated that for some shipments a six-month lead time is necessary to make the plans and have all of the pieces in place. Obviously this is an extreme circumstance. Nevertheless, it points out the sensitivity of this cargo to

changes in routing requirements and delays in the overall process of securing the permits and planning the movements.

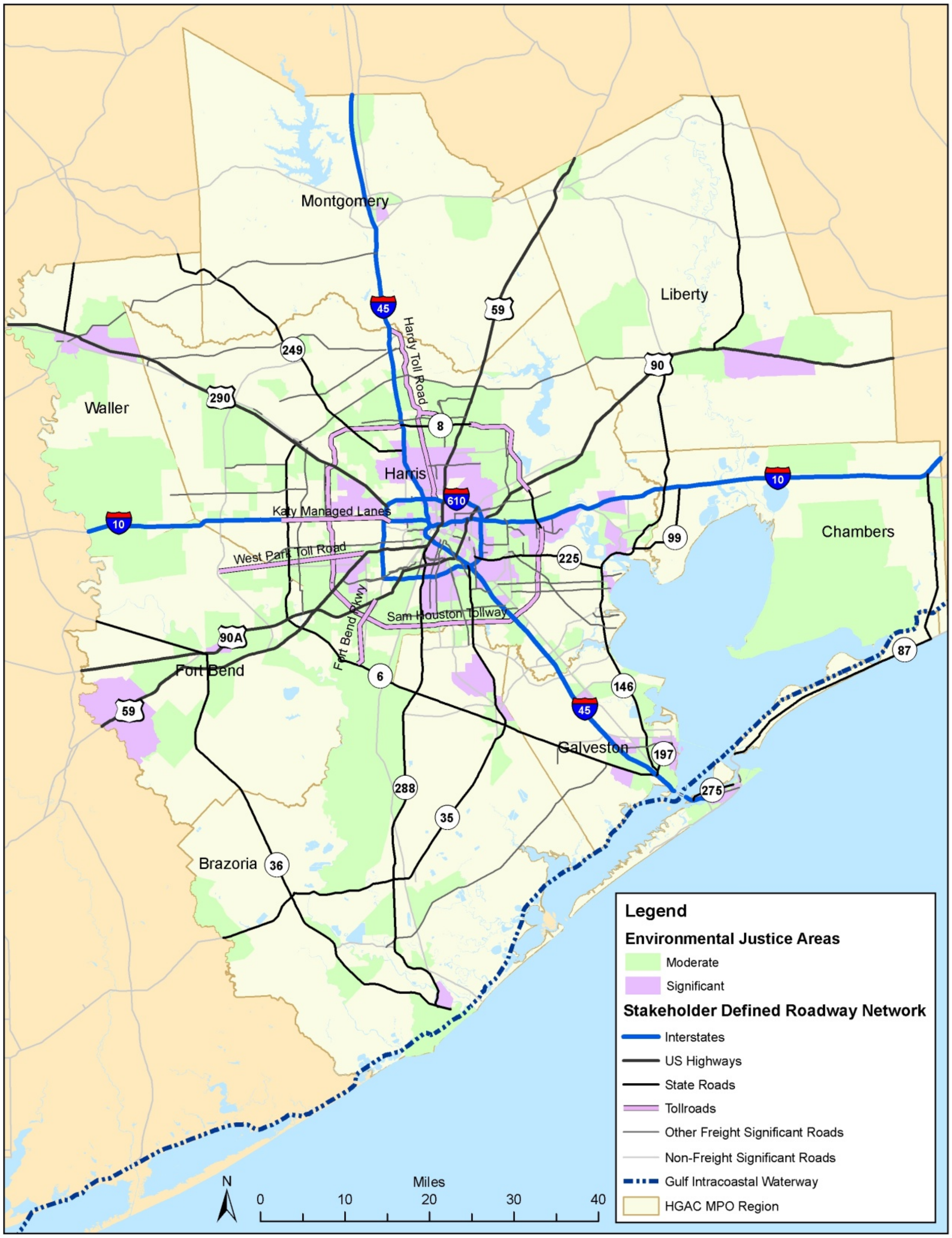
Environmental Justice Communities

Communities that are economically or socially disadvantaged and subject to adverse effects from the environment are referred to as Environmental Justice (EJ) areas. Exposure to industrial and diesel emissions is one such effect, and common for lower-income, elderly, and minority neighborhoods that typically will adjoin or be intermixed with heavily commercial districts. (EJ issues will be examined in more detail in Chapter 4). Figure 3-39 plots locations with moderate and significant environmental justice concerns, alongside the stakeholder-defined roadway network.

The fact of proximity to freight routes does not constitute environmental adversity by itself; still, it is a condition giving rise to the question. The first impression conveyed by this map is how pervasive the EJ areas are, especially those of moderate degree, which implies that a transportation network covering the region may be unable to avoid them. Several of them surround such primary thoroughfares as SH 288, and the outer reaches of U.S. 59, 90, and 290. Second, many of the more significant areas coincide with important industrial zones, particularly for the petrochemical and port cluster to the east, and the distribution goods and other manufacturing activity focused in Harris County. The interspersion of residential with industrial buildings that is widespread through the region again makes it unlikely that businesses can receive freight services without imposing neighborhood effects. A number of the presently prescribed hazmat routes lie in the midst of significant EJ communities. In view of the volume of such activity in the greater Houston region and its connection to a principal driver of the economy, it presents a challenging concern.

These points suggest that the network of freight significant corridors mainly will not answer environmental justice needs by rerouting transport, but rather by aggressive management of the safety and emissions profile of the activity. Because a well-defined network develops routes that are appropriate to large commercial vehicles and fosters fuel-efficient operations throughout the territory, in actuality it is a means by which safety and emissions objectives can be reached.

Figure 3-39 The Stakeholder-Defined Network and EJ Populations



Source: H-GAC.

Identification of Freight Significant Roadway Corridors

For corridor identification, the stakeholder-defined network compiled from roadway usage by freight stakeholders stands up under examination from a range of perspectives. It includes the necessary heavily traveled routes, it serves the critical segments and centers of the economic geography, it reaches the key intermodal transfer points, and it ties together the eight-county area of greater Houston with multiple and cross-regional routes.

It also faces a number of challenges – safety exposure for some highly active roadways and interchanges, risks from hazardous materials traffic that is nevertheless necessary to Houston industry, and potential for environmental justice concerns. There are level of service strains on primary highways in the region's center, on such east-west routes as SH 6 and FM 1960, and on emerging routes like SH 36 that will rise with growth.

Additions to the stakeholder set could include the northward extension of SH 146 along SH 321 in Liberty County, although this routing moves further east by 2035. The forecast in general promises great volumes on major highways and the SH 225 corridor reaching to Spur 330, swinging below IH 10 to the east. This combination serves industry, but in part it serves as alternative routing to IH 10 – and for 2035 traffic levels, the availability of alternatives will be critical. The 2035 outlook also underscores the rising importance of SH 288 for service to Freeport and connections throughout Brazoria County.

The role of the lesser roadways in creating alternatives is important. They establish formal and informal bypasses and redundancies, they bridge between segments, and they open up routes between expanding communities. A few additional facilities, such as extending Little York Road to the west and adding Clinton Road, seem to make sense for connection. Overall, the set of these roads as defined by stakeholders receives fairly thorough use, according to the commodity flows depicted by the H-GAC model, and the utility of the intermodal connectors is clear. The difficulty for other roads is that the model equally depicts a great many facilities with equivalent volumes, and it cannot be said that the case is clear for identifying one as significant over another. It could be that this derives from modeling limitations that the model upgrade will rectify, and limitations certainly exist. However, what can be said is that the stakeholder routes suggest vectors of need, and corridors in those vicinities and performing comparable functions should be sought to address them.

Identification of significant roadway corridors is the foundation for developing recommendations for a core multimodal freight network serving the region. For road facilities in that network, the next steps in preparing recommendations an examination of the physical qualities of facilities and alternatives and assessment of potential improvements. Definition of improvement projects, costs, financing and management methods will follow, which together can convert the set of roads into a functioning freight transportation system.

4. Community Impact Assessment

Goods movement is critical to the region's economy and resident's everyday life as freight transportation is necessary to provide inputs for the manufacturing, office, medical and other business which provide employment to the region's residents. Goods movement also provides the day-to-day necessities such as food, clothing, household goods, and all other consumer products. However, despite all the benefits freight transportation provides, it gives rise to serious negative impacts to the region's communities and natural environment. Issues such as truck safety, hazardous materials (hazmat) and truck parking concerns, air and water quality issues, excessive noise, vibration, or lighting from freight movements and freight industries, pavement deterioration, and land use conflicts can all negatively impact the communities and natural environment. In order to mitigate these potential impacts, it is essential that the scope of the problem, and likely areas of conflict, are fully documented and understood.

This chapter will present an overview of key regional concerns and challenges, documenting the scope of the issues. This will facilitate the development of mitigation strategies to enhance livability in the recommendations phase of the study. The keys areas examined include air quality, safety, congestion, light, and noise pollution, incompatible or encroaching land uses, water pollution, loss of green space and the impact on environmental justice populations.

Air Quality Concerns: Public Health and the Economy

The Issue

Emissions from the movement of freight can have serious impacts on public health, property, and the natural environment. From a public health perspective, there are six common air pollutants defined as "criteria pollutants"[20] by the U.S. EPA and the Clean Air Act: 1) Ozone (O_3); 2) Particulate Matter ($PM_{2.5}$ and PM_{10}); 3)Carbon Monoxide (CO); 4) Nitrogen Oxides (NO_x); 5) Sulfur Dioxide (SO_2); and 6) Lead (Pb).

Increased presence of these six criteria pollutants have been linked to a variety of health conditions, including: reduced lung function, asthma and other respiratory illnesses, increased risk of cancer, and premature death (especially in vulnerable groups such as children and the elderly).

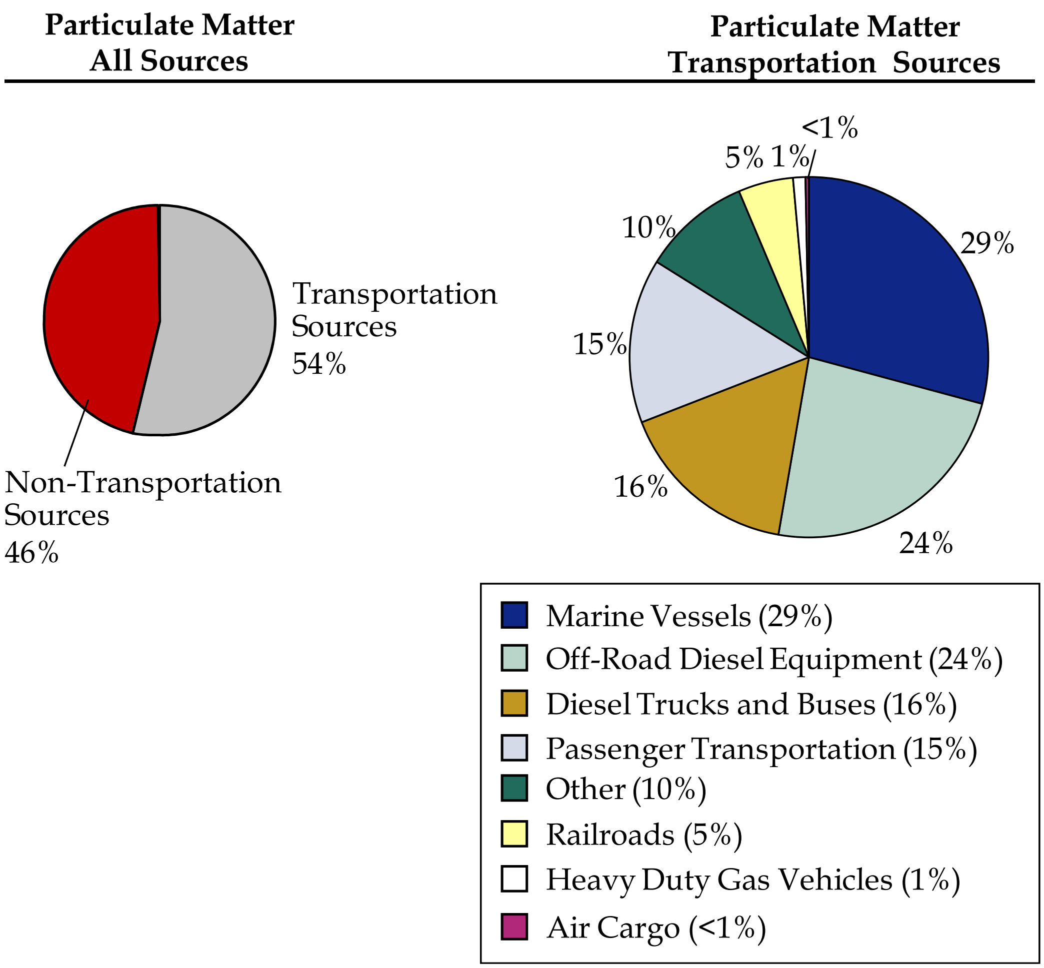
Emissions from freight movement also lead to the formation of Ozone (O_3). Ozone is formed when emissions of NO_x chemically react with VOCs under conditions of heat and light (i.e., sunshine).Ozone is linked to a variety of public

[20] http://www.epa.gov/oaqps001/urbanair/.

health impacts, including chest pain, coughing, throat irritation, and congestion. Long-term exposure can worsen existing afflictions like asthma or bronchitis, or even lead to permanently scarred lung tissue.[21]

PM is divided into two subcategories: PM_{10} (particles between 2.5 and 10 microns in diameter); and $PM_{2.5}$ (particles less than .5 microns in diameter). Freight is a significant source of PM. As shown in Figure 4-1, the transport sector is responsible for more than one-half of all PM_{10} emissions, and freight sources comprise 51 percent of that total (not including off-road diesel equipment, some of which is used for freight applications).

Figure 4-1 Sources of Particulate Matter Pollution
2005



Source: U.S. EPA 2005 National Emissions Inventory.

[21] http://www.epa.gov/air/ozonepollution/health.html.

In addition to these public health impacts, freight emissions comprise close to one-third of U.S. transportation greenhouse gas (GHG) emissions, and have grown by more than 50 percent since 1990.[22] According to the U.S. Environmental Protection Agency, there are six key Greenhouse Gases (GHG) emitted from transportation that threaten the public health and welfare of "current and future generations":

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFC);
- Perfluorocarbons (PFC); and
- Sulfur hexafluoride (SF_6).[23]

The emission of GHGs contributes to global warming concerns. They are linked to regional and atmospheric changes that can exacerbate acid rain, ozone depletion, and damage to crops, plants, and property.

Recent estimates (see Figure 4-2) suggest that direct transportation emissions are responsible for 29 percent of total U.S. GHG emissions. Of that total, approximately one-third comes from freight sources,[24] through key emissions, including:

Carbon dioxide (CO_2) accounts for 95 percent of total transportation-related GHG emissions. Most human-produced CO_2 is the product of fossil fuel combustion.

Hydrofluorocarbons (HFC) comprise 3 percent of overall transportation-related GHGs. HFC are used extensively in truck and rail refrigeration systems.

Nitrous oxide (N_2O) is an ozone-depleting compound that represents approximately 2 percent of total transportation GHG emissions.

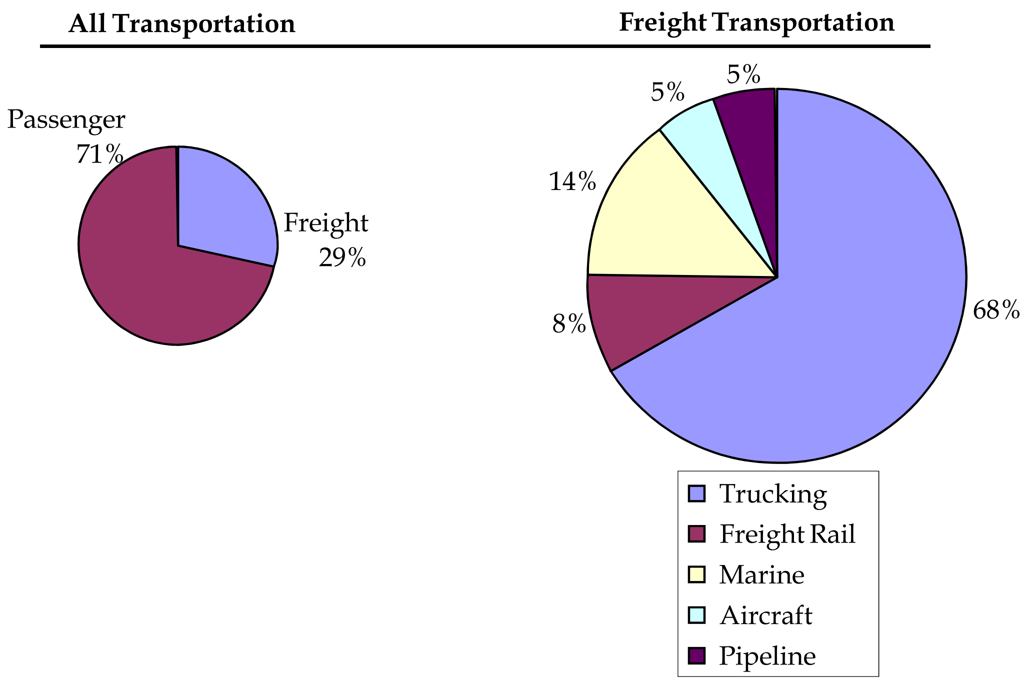
Methane (CH_4) is a potent GHG (it has more than 20 times the heat-trapping capability of CO_2). Even though it represents less than 1 percent of transportation-related GHG emissions, it can have a significant effect on climate change patterns.

[22] Federal Highway Administration. *Freight and Air Quality Handbook*, May 2010.

[23] http://epa.gov/climatechange/endangerment.html.

[24] Cambridge Systematics analysis of the U.S. EPA emissions data.

Figure 4-2 U.S. Transportation-Sector GHG Emissions by Mode
2006



Source: Cambridge Systematics, Inc. Analysis of U.S. EPA emissions data.

In addition to public health, environmental, and health concerns, air quality nonattainment has the potential to impact the region's economy. Some of the types of requirements that are required under the Clean Air Act can make it more costly to live or conduct business. A sampling of the requirements that have been observed across the nation include:

- More stringent and costly emissions control equipment for new or expanding industry (such as requiring industrial facilities to install pollution control equipment or limit their production);
- Higher energy costs due to requirement for cleaner burning fuels;
- More stringent automobile inspection and maintenance requirements; and
- Transportation control measures such as reduced speed limits, peak-time penalties, and congestion mitigation measures.

The Scope of the Problem in the Houston-Galveston region

The Houston-Galveston region has air emission concentrations that are of significant concern to public health. In fact, the region currently exceeds the limits for eight-hour Ozone set by the U.S. EPA under the Clean Air Act.[25] These limits (known as National Ambient Air Quality Standard (NAAQS)) represent the level at which a pollutant is considered harmful to public health and the environment. The region has until June 15, 2019[26] to reduce the level of Ozone in the atmosphere and meet the NAAQS standard.

[25] http://www.epa.gov/air/ozonepollution/pdfs/fs20100106std.pdf.

[26] http://www.tceq.texas.gov/implementation/air/sip/texas-sip/hgb/sip-hgb/.

Calculating the annual truck-related emissions in the eight-county Houston-Galveston region (Table 4-1) shows that trucks emit 72 percent of the region's transportation-related NO_x, 68 percent of the transportation-related $PM_{2.5}$, 37 percent of the region's VOCs, and 53 percent of the region's transportation-related CO_2. Harris County has the highest amount of annual emissions than any other County in the Houston-Galveston region. This is a result of the density of population, industries, and freight-generating facilities in Harris County.

Table 4-1 Truck-Related Emissions by County
Tons

County	Annual Emissions* (Tons)							
	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	NH_3	SO_2	CO_2
Brazoria	531	2,043	7,711	55	38	80	17	650,636
Chambers	240	1,113	4,400	22	15	33	4	267,122
Fort Bend	737	2,948	10,565	83	57	118	26	976,788
Galveston	512	1,945	7,144	54	37	78	17	639,098
Harris	9,519	35,608	130,933	972	662	1,432	304	11,561,102
Liberty	265	840	3,996	21	14	31	3	249,994
Montgomery	872	3,776	12,851	102	71	141	32	1,182,813
Waller	227	856	3,719	19	13	27	6	219,798
Truck Total	**12,902**	**49,127**	**181,319**	**1,328**	**907**	**1,941**	**408**	**15,747,351**
All Vehicle Total	**35,027**	**68,046**	**468,202**	**2,262**	**1,336**	**5,730**	**674**	**29,486,685**
Percent Share of All Vehicles	**37%**	**72%**	**39%**	**59%**	**68%**	**34%**	**60%**	**53%**

Source: 2008 Texas Statewide on-road Consolidated Emissions Reporting Rule (CERR).

It is difficult to measure the impact of increased GHGs and climate change on the Houston-Galveston region. However, it is possible to assess the types of impacts that may occur from climate change. The increasing amount of GHGs in the atmosphere has been linked to environmental trends, including: sea level rise, shifts in ocean currents and ecosystems, increasing unpredictable weather patterns, ocean acidity, and, potentially, increased hurricane intensity. These trends could have significant impact on freight movement. Sea level rise may inundate coastal areas, including critical freight infrastructure, such as ports, rail yards and corridors, and highways. A recent study[27] examined the potential for flooding and damage associated with storm surges from hurricanes along the entire Gulf Coast.

Using a modeling technique to simulate a 23-foot storm surge found that a substantial portion of the Gulf Coast's infrastructure would be impacted: 41 percent of rail miles operated, 64 percent of interstate miles, 57 percent of arterial highway miles, and virtually every port along the U.S. Gulf Coast were vulnerable to flooding.

Safety Concerns

The Issue

Community safety-related impacts from freight movement include injury, crashes, and crashes, the transport of hazardous materials, and security concerns. Safety concerns associated with the various transportation modes can vary. Trucks create concern about crashes and the transport of hazardous materials. On the rail side, safety concerns tend to be concentrated around at-grade crossings (where the potential exists for vehicular/train interactions) as well as the issue of rail carrying hazmat material. Pipelines carrying oil and other potentially hazardous material transverse through residential areas, creating a situation that is generally safe but does carry the potential for catastrophic failure.

The Scope of the Problem in the Houston-Galveston region

Truck Crashes

Of the roughly 100,000 vehicle crashes in the region in 2007, about 25,000 (one-quarter) involved trucks.[27] This ratio has stayed roughly the same in the last few years, though overall the rate of serious crashes has gone down in each of the last five years (2002-2007). The locations of most truck – involved crashes occur on freeways and origins and destinations of freight means that most truck travel must occur on the larger roads. In fact in 2001, an estimated 35 percent of truck-involved crashes occurred on H-GAC freeways, with 59 percent on the state road system.[28]

From a community impact point of view, truck crashes give rise costs, delay, injuries, and fatalities regardless of where they occur. However, the higher percentage of trucks traveling on major highways in the Houston-Galveston region at least limits the number of facilities that are significantly affected. Therefore, it seems that existing truck routes may be focusing the impact of trucks (and therefore the potential for truck-related crashes) to the major freeways and interstates.

Transport of Hazardous Materials

Hazardous materials fall into three broad categories; chemicals, petroleum products, and "other."[29] Due to the heavy concentration of petrochemical industries in the Houston-Galveston region; over 130 million tons of petroleum products, chemical products, crude petroleum, and natural gas were moved in the region in 2007.[30] The FMCSA identifies 38 designated Hazardous Materials routes and six restricted routes for Hazardous Materials in the Houston-Galveston region.[31] Discussions with the Harris County Fire Marshall's office revealed concern about the spreading of activities associated with the transport of hazardous materials outside the region's

---

27 H-GAC Report, State of Safety in the Region: 2009.

28 H-GAC Report, Freight Safety: 1999-2001.

29 Coast Study, March 12, 2008. "Other" includes hazardous waste, medical waste, and radioactive materials.

30 IHS Global Insight (excluding pipelines).

31 http://www.fmcsa.dot.gov/safety-security/hazmat/national-hazmat-route.aspx.

core to suburban counties. The concern focused on the ability to respond to hazmat incidents given the current location of response centers. Should this activity continue to spread throughout the region, location of additional response centers should be considered.

Rail Safety Issues

In terms of rail safety, the Houston-Galveston region has about 1,200 at-grade rail crossings, 900 of which are located in Harris County. Though the Federal Railroad Administration (FRA) has not categorized any of these intersections as particularly bad,[32] the presence of any incidents is enough to cause community concern. As shown in Table 4-2, at-grade rail/highway crossings have been responsible for 315 crossing incidents and 90 injuries in the years from 2003 to 2007, mostly concentrated in Harris County.

Table 4-2 Total Crashes at Rail-Grade Crossings in the Houston-Galveston Region

	Total Crashes at Rail Crossings					
County	**2003**	**2004**	**2005**	**2006**	**2007**	**Total**
Brazoria County	5	6	6	4	4	25
Chambers	0	1	1	3	0	5
Fort Bend County	5	4	2	6	10	27
Galveston County	1	1	1	6	3	12
Harris County	37	37	54	34	45	207
Liberty County	4	1	2	2	2	11
Montgomery County	5	6	7	4	3	25
Waller County	0	0	0	0	3	3
Total	57	56	73	59	70	315

Source: Federal Railroad Administration.

Congestion

The Issue

Congestion is a recurrent problem in many metropolitan regions throughout the nation. Apart from the economic cost of time lost to delay, there also can be public health consequences. Traffic congestion has been linked to negative health effects caused primarily by stress – hypertension, headaches, and weakened immune system. Traffic congestion also results in localized "hot spots" from the high concentration of idling engines which increases the exposure of air pollutants to the occupants of vehicles and residents in surrounding areas.

[32] H-GAC Report, State of Safety in the Region: 2009.

The Scope of the Problem in the Houston-Galveston region

Congestion impacts everyone living in the Houston-Galveston region. Delay caused by congestion is costly: traffic congestion (including nonrecurring congestion caused by traffic crashes) caused an estimated $2.5 billion in losses in 2007.[33] The Houston-Galveston region is home to many of the most congested roads in Texas. IH 45 between SL 8 North and IH 610 (Harris County) was the most congested roadway in the entire State, with an estimated 484,630 hours of delay at a cost of approximately $98 million dollars.[34].

Though caused by a combination of many factors, including passenger vehicles, freight vehicles, roadway design, weather, and crashes, the movement of freight does contribute to congestion. This is partially because the highways that comprise the most significant freight routes are also major commute corridors. Some of these corridors (such as IH 10 and IH 45) see more than 15,500 trucks daily. With truck traffic projected to increase by nearly 77 percent by 2035, congestion and delay will worsen for both passenger and freight transportation.

Light and Noise Pollution

The Issue

Noise pollution is described by the U.S. EPA as "unwanted or disturbing sound." In terms of freight movement, noise pollution complaints generally focus on truck sounds (including braking, loading, and engine sounds); train whistles, horns and movement, the sound of air cargo planes, or the sounds that tend to accompany industrial land uses. Noise pollution can have major consequences to people's health. Problems can include annoyance, sleep disturbance, reduced productivity, hearing loss and tinnitus, cardiovascular disease, and effects on the immune system, among others. Noise Induced Hearing Loss (NIHL) is the most common health impact,[35] though research has shown that there are numerous other negative impacts on public health.

Light pollution causes such adverse health outcomes as headaches, carcinoma and other cancers, sleep deprivation and associated health effects such as decreased mental capacity, a compromised immune system, depression, hypertension, and weight gain. Light pollution also can have environmental consequences such as disrupting delicate ecosystems by confusing animal navigation or changing predator-prey relationships. It can also waste energy if not being used for an active and necessary purpose.

The Houston-Galveston region is home to a diversity of industrial land uses, including warehousing and manufacturing facilities, several deepwater ports, transload and intermodal facilities, and many other goods-dependent land uses. Industrial land uses help to sustain the region's economy and quality of life. In fact, manufacturing alone provides over 217,000 regional jobs in 1,800 manufacturing firms, paying regional wages of almost six billion dollars. Industrial land use is distributed among the counties as shown in Table 4-3. The most industrial land acreage is in Harris County, which has almost 80,000 acres of industrial land, or 7 percent of the Harris County total landmass. Fort Bend County has the second highest percentage of industrial land, with almost 29,000 acres of industrial land (or 5 percent of its total landmass).

---

33 H-GAC Report, State of Safety in the Region: 2009.

34 TxDOT: 100 Most Congested Roadway Segments in Texas.

35 http://www.epa.gov/air/noise.html.

Table 4-3 Freight Land Use Totals in Acres for the Study Region, by County

County	Industrial Acres	Total Acres	Percentage Industrial of Total
Brazoria County	35,819.55	1,031,959	3.5%
Fort Bend County	28,806.44	566,073	5.1%
Galveston County	15,026.84	558,146	2.7%
Harris County	79,761.52	1,131,352	7.1%
Liberty County	18,493.48	763,106	2.4%
Montgomery County	14,298.08	687,169	2.1%
Walker County	2,148.88	522,291	0.4%
Waller County	4,399.00	331,430	1.3%
Total	**198,753.8**	**5,591,525**	**3.1% (Average)**

Source: 2008 H-GAC Socioeconomic Data.

The Scope of the Problem in the H-GAC

Instances of noise and light pollution are very difficult to depict on a regional scale. However, it is possible to observe the spatial allocation of industrial land uses, which will likely have higher noise and light impacts on their neighbors than other types of land uses. In the Houston-Galveston region, industrial land uses are clustered in several places, in particular in the eastern portion of the City Houston. Other pockets of industrial land uses also exist around the Ports of Galveston and Texas City.

Incompatible or Encroaching Land Uses

The Issue

Industrial land uses and residential land uses are not traditionally thought of as "good neighbors." Residents living near freight facilities tend to be sensitive about truck traffic, noise, safety considerations, and night-time operations, as well as raise issues of environmental and air pollution. Increased volumes and freight movement and passenger vehicles can lead to safety and capacity issues on shared infrastructure. Similarly, industrial land uses and other freight businesses often find themselves constrained by encroaching residential or commercial land uses, or find their operations harmed by constrictive roadway geometric design, inconsistent regulations, or the inability to expand.

The Scope of the Problem in the Houston-Galveston region

The region recognizes the issue and is working to address it. Nevertheless, the Houston-Galveston region has several examples of incompatible land uses and land use conflicts.

Cargo volumes through the Port of Houston are anticipated to grow, in particular when the Panama Canal widening project is complete in 2014. This will likely lead to an expansion in industrial land uses clustered near the Port. The need for industrial land will stretch northeast to Baytown, northwest to Wallisville Road near IH 10 and IH 45, and south through Texas City.[36] This area includes pockets of residential and commercial establishments that will see increasing industrial activity, truck, and rail movements in close proximity.

The Gulf Intracoastal Waterway (GIWW) is more than 50 years old, and is in need of widening and dredging to allow modern barges to use safely. However, any expansion of the GIWW meets with fierce competition for waterfront property from various commercial, industrial, and residential uses.

Approximately 98 percent of the region's air freight moves through the George Bush Intercontinental Airport (IAH) in northern Harris County. The IAH Cargo Center is served by a single route, Lee Road, which sees high volumes of trucks mixed with passenger vehicles. This creates a safety and capacity concern.

Loss of Greenspace

The eight-county Houston-Galveston area has several ecoregions that traverse its jurisdiction and are connected to broader natural systems. These ecoregions are vital in preserving the economy and ability of the Houston-Galveston area to support human populations. Specifically, the ecoregions, when uncorrupted by human development, provide specific infrastructural benefits that preserve life, property, and enjoyment for the residents of the Houston-Galveston region. The greenspace that remains in these ecoregions is critical to current and future residents of the Houston-Galveston area.

Value of Greenspace

Greenspace is a valuable commodity, especially in growing urban regions, and can be used to counteract many of the impacts from freight movement discussed in this chapter. Greenspace can prevent soil erosion and absorb rainwater, and help to improve drainage and avoid flooding.

Flood Abatement Value

In 2000, Houston and Harris County ranked third and fourth, respectively, in the United States in FEMA claims for repetitive flood damage, with Montgomery County and Friendswood sixth and tenth (National Wildlife Federation, *Higher Ground*, 2000).

This flooding is a consequence of the region's development pattern, which has been primarily "upwatershed" into its historic water catchment and filtration area: an area that served as a natural sponge. The greenspace in the upstream plains served as infrastructure to reduce downstream flooding. That greenspace and green infrastructure in the form of depressional wetlands within the prairie ecosystem has been replaced by roads, parking lots and other nonpermeable elements of urbanization. As a consequence, previously absorbed rains now inundate Houston.

[36] H-GAC Regional Goods Movement Profile.

Additionally, Hurricane Ike caused more than $30 billion in damage to developed areas when it made landfall in 2008. Four days after Ike's passage, water was still draining back to the Gulf from the marshes and prairies. The greenspace of the coastal prairies and marshes served as green infrastructure and absorbed the surge tide, and helped to diminish some of Ike's ferocious damage.

Water Quality Value

The City of Houston and other area water authorities obtain a significant percentage of their drinking water from Lake Houston. Recent documentation suggests that this drinking water source may be vulnerable to pollution. At least 200 wastewater plants discharge treated effluent into the six major tributaries flowing into Lake Houston. Each of these water bodies is experiencing impaired water quality due to violation of bacterial standards. Additionally, there are numerous "emerging pollutants" that are not removed by either traditional wastewater or drinking water treatment technologies.

Research has shown that wetlands adjacent to affected water bodies can remove certain emerging pollutants not removed by existing treatment technologies. Furthermore, benefits to water quality also are provided by nonwetland natural areas near water bodies. Natural areas increase the amount of relative clean runoff that enters the Lake and helps to guarantee continued spring flows in Peach Creek, Caney Creek and others that currently are dominated by spring flow.

Carbon Management

Harris County ranks number one among U.S. counties in terms of carbon dioxide emissions, of which 49 percent are industrial. The ecological capital of the Houston region is uniquely suited to provide carbon sequestration services to the businesses and governments of the region and to aid an overall strategy of carbon abatement. The forests, wetlands, and prairies have the capability to be integrated into an overall carbon management strategy.

Recreation, Health, and Eco-Tourism

Public health value is well served when air and water quality are improved and public access to greenspace is created. Furthermore, the need for space to be active to combat obesity and weight-related health problems is met by parks and open greenspaces.

Finally, there are tremendous economic benefits to preserving greenspace. In 2005, the National Park System generated some $12 billion in revenues from visitation fees and associated sales in parks and their surrounding communities. The Outdoor Recreation Foundation estimates that outdoor enthusiasts spend more than $280 billion nationwide, on an annual basis. Preservation of greenspace could ensure that some of that economic impact would accrue to the Houston-Galveston region's benefit.

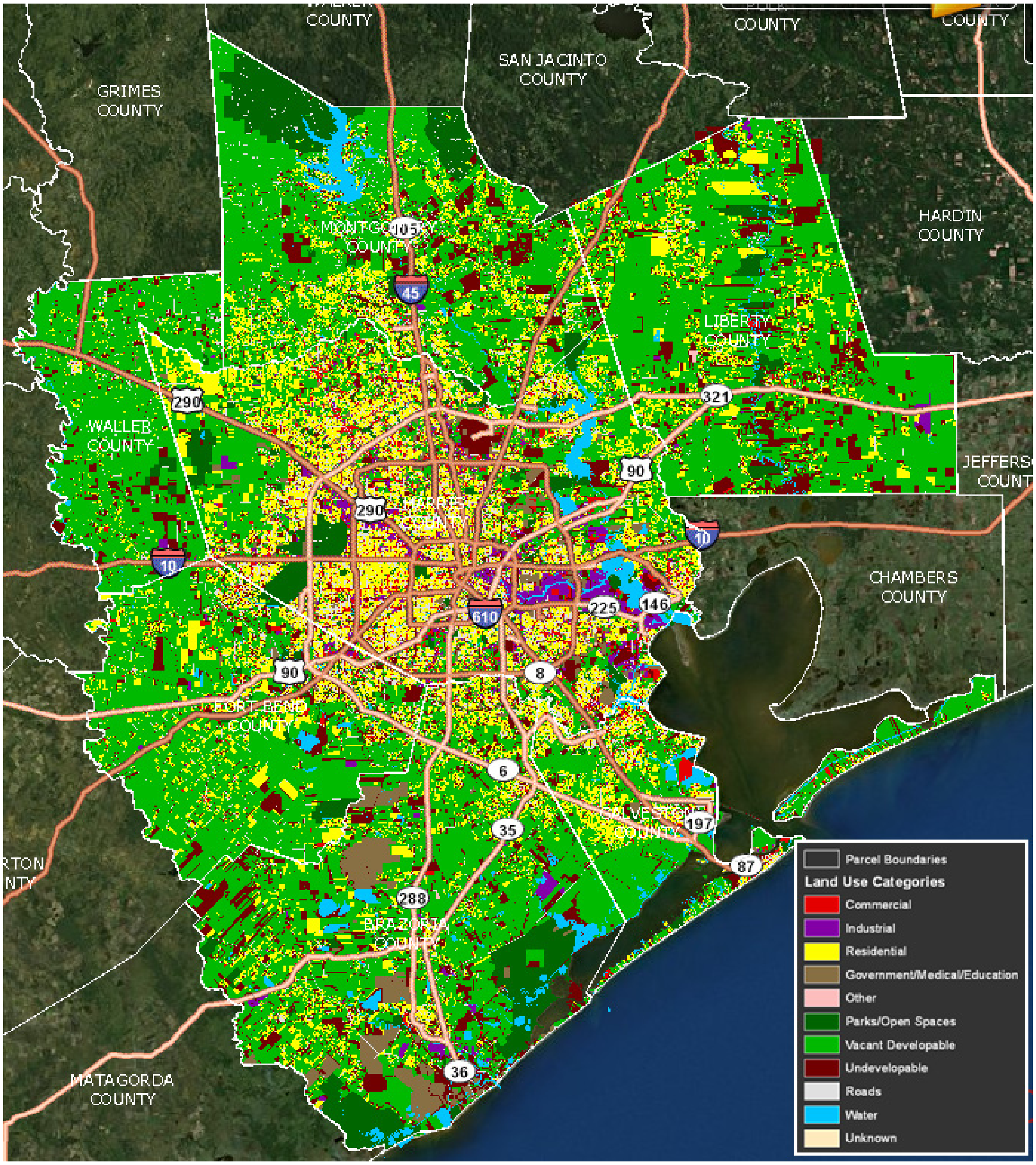
The Issue

Unfortunately, these benefits do not lend themselves to simple quantification or economic evaluation. Too often, preservation of greenspace loses to more tangible land use needs, including housing, businesses, schools, public institutions, and transportation infrastructure.

The amount of greenspace in the Houston-Galveston region is projected to decrease rapidly in the coming years. The 2010 regional land-use map (Figure 4-3) compared to the 2035 regional land use map (Figure 4-4), illustrates that greenspace, parks, and open space are all projected to be drastically reduced by 2035. Greenspace is projected to be lost to residential, commercial, and industrial land uses to help sustain the anticipated population and employment growth anticipated in the region by 2035.

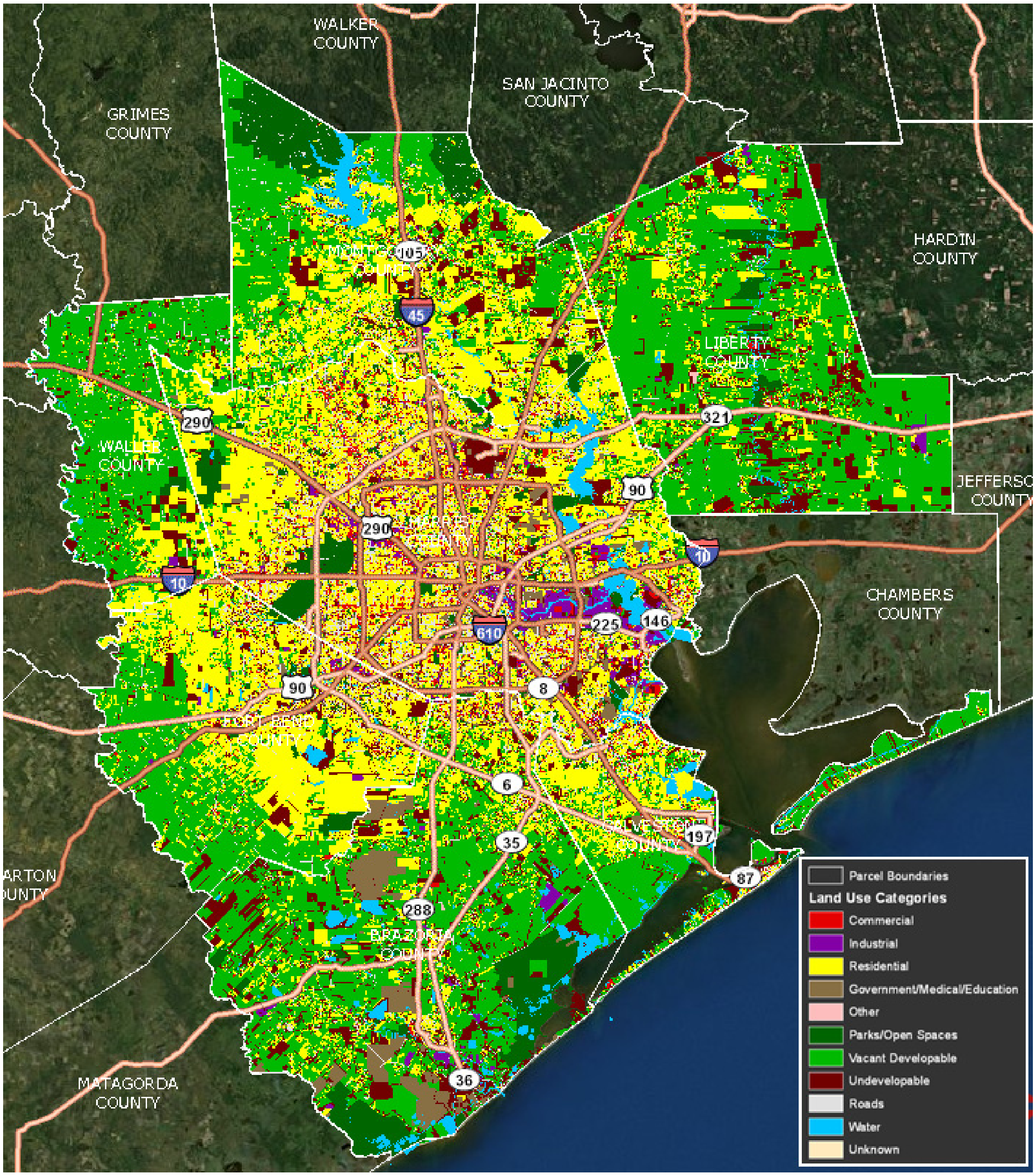
In summary, by 2035, the eight-county Houston-Galveston area is projected to have lost significant natural land to development across several ecoregions. Specifically, the area will have lost 51 percent of the Big Thicket, 17 percent of the coastal marshes, 40 percent of the Columbia Bottomlands, 57 percent of the piney woods, 34 percent of the Post Oak Savannah, 51 percent of the coastal prairie and 12 percent of the Trinity Bottomlands.

Figure 4-3 Houston-Galveston Region Land Use
2010



Source: H-GAC Regional Land Use Information System, http://ArcGIS02.h-gac.com/RGF_2040/.

Figure 4-4 Houston-Galveston Region Projected Land Use *2040*



Source: H-GAC Regional Land Use Information System, http://ArcGIS02.h-gac.com/RGF_2040/.

Capturing Greenspace's Multiple Benefits

The ecological capital of the Houston-Galveston region, if managed appropriately, has the ability to significantly mitigate our flooding problems, improve our water quality and to save billions of dollars in the process. As a matter of Federal and local government policy, it makes sense to purchase and set aside, in fee-simple or through easements, as many acres of the prairie and coastal marsh ecosystems as possible, and to manage these areas for their flood abatement value.

Additionally, governmental entities should protect the green infrastructure represented by wetlands adjacent to water bodies in order to take advantage of this filtration benefit. Specifically, acquiring and protecting – in fee simple or by easement – wetlands adjacent to Cypress and Spring Creeks, the West Fork of the San Jacinto River, Caney Creek, Peach Creek, and the East Fork of the San Jacinto River as well as the main body of Lake Houston is a sound strategy for this purpose.

From a cost standpoint, protection and preservation of greenspace and green infrastructure will likely be less expensive than responding to flooding, public health, and water quality disasters.

Water Pollution

The Issue

H-GAC Report: "How's the Water: 2010 Basin Highlights Report." Land uses associated with freight facilities and corridors can negatively impact water supply in several ways. Fueling, maintenance, cleaning and other routine operational activities can lead to pollutants in surrounding surface and ground waters and soils. Additionally, the land uses associated with freight facilities and movement often consist of large amounts of impervious surfaces which can lead to increased nonpoint source storm water runoff into surrounding waterways.

Rail lines and rail yards have environmental impacts as well. Spills from maintenance work and fueling of trains, particulate matter that contaminates the air typically from diesel engines and equipment utilized in rail yards, fluids generated from the cleaning of equipment that contaminate ground water, and chemicals used for vegetation management that leach into the water all have health implications for surrounding water and the communities that depend on the water.

The Scope of the Problem in the Houston-Galveston region

The H-GAC Clean Rivers Program assesses the region's water quality for a variety of factors, including levels of bacteria, nutrients and dissolved oxygen, and Dioxin/Polychlorinated biphenyls (PCB) in fish. In 2010, their findings concluded that "most" water bodies in the Houston-Galveston region are considered unsuitable for recreational activities like swimming, and in fact only six stream segments within the region are considered acceptable for recreation.[37] More than half of the waterways are classified as unsafe due to elevated levels of bacteria, and nearly 75 percent of the region's tidal waterways are impaired by dioxin or PCBs in fish tissue.

Many activities contribute to this poor regional water quality. The Clean River Program cites sources, including failing septic tanks, poorly maintained waste water treatment plants, agriculture, and livestock as contributing factors. However, freight movements and runoff from industrial land uses likely play a part. With the regional water quality already in a degraded situation, every land use must do what it can to minimize runoff and help bring regional waterways up to an acceptable level of cleanliness.

H-GAC Environmental Justice Characteristics

The Issue

Environmental Justice (EJ) is the term used to describe the condition that over time, communities with large proportions of dis-

advantaged populations tend to suffer disproportionate negative environmental impacts. In 1994, Executive Order 12898 defined Environmental Justice (EJ) as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative consequences resulting from industrial, municipal, and commercial operations."[38] The U.S. Department of Transportation (U.S. DOT) therefore requires MPOs and other government agencies to identify and address potential or actual disproportional adverse environmental effects on minority and low-income populations.

For the H-GAC 2035 Regional Transportation Plan, the MPO developed an Environmental Justice Index (EJI) as their methodology to identify EJ and non-EJ communities. There are three variables in the EJI (as defined by the U.S. DOT):

Poverty – A person whose median household income is at or below the Department of Health and Human Services poverty guidelines. For a family of four in the Houston region, this threshold was $19,356 for the year 2005.

Minority – Black, Hispanic, Asian American, American Indian, or Alaskan Native.

Elderly – Over 65.

This EJI is then used to measure the percentage of minority, low-income, and elderly residents in each unit of measurement (in this case Census Block Groups (CBG[39])) compared to the regional average. Block groups were assigned a score: 0 (low concern), 1 (moderate concern), or 2 (significant concern) for each category depending on whether the percentage was lower than the regional average, up to twice that of the region, or over twice that of the region. The scores were then tallied and the CBGs were labeled as low, moderate, or significant EJ concern.

The Scope of the EJ Issue in the Houston-Galveston region

Approximately 44 percent of the CBGs were considered to be of moderate EJ concern and nearly 11 percent were identified as being of significant EJ concern. The majority of the significant CBGs are located within Harris County and central City of Houston, in particular in the region that is East of IH 45 and within the Texas State Highway Beltway 8. Table 4.4 and Figure 4.5 displays EJ communities by county. The county with the highest percentage of overall EJ population as a percentage of its population is Galveston County, where nearly 12 percent of the population is characterized as significant EJ concern. 8.6 percent of Harris County, and 8.3 percent of Waller County also are characterized as significant EJ concern.

[37] How's the Water: 2010 Basin Highlights Report. HGAC Clean Rivers Program. Retrieved from: http://www.h-gac.com/community/water/resources/documents/crp_basin_highlights_report_2010.pdf.

[38] H-GAC Report: 2035 RTP Appendix C, *Environmental Justice*.

Table 4-4 H-GAC EJ Populations by County
2035

County	Percentage of Total Regional "Significant EJ" Population	Percentage of EJ Significant Population as a Total of County Population
Brazoria County	.5%	0.7%
Chambers	.1%	1.7%
Fort Bend County	1.1%	1.0%
Galveston County	8.8%	11.9%
Harris County	86.5%	8.6%
Liberty County	1.1%	5.3%
Montgomery County	1.0%	1.1%
Waller County	.79%	8.3%
Total	**100**	**7.3% (Average)**

Source: H-GAC 2035 RTP: Appendix C, *Environmental Justice*.

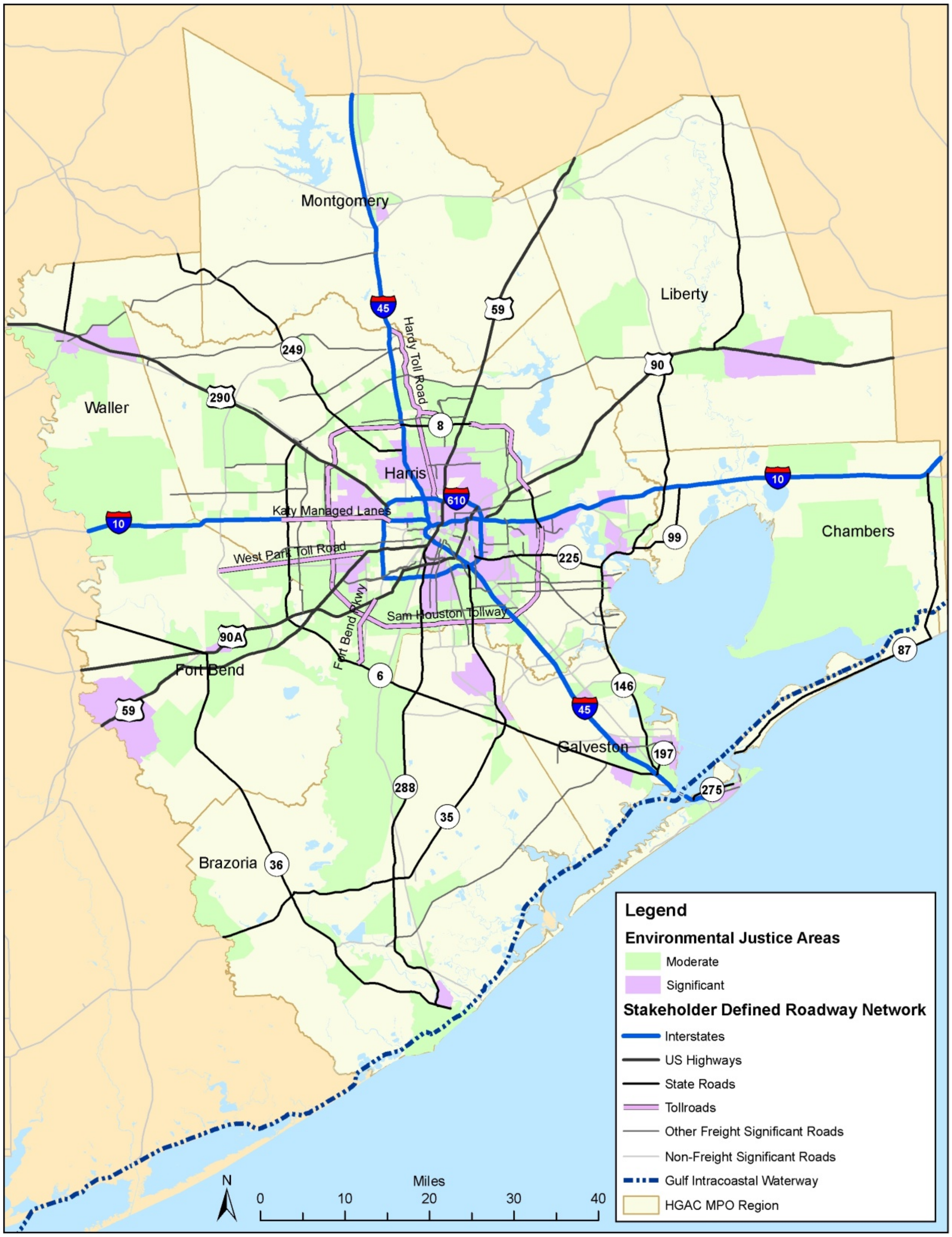
39 It should be noted that though the RTP process used Census Block Groups (CBG) as a unit of measure, the maps produced for this effort were using the H-GAC publicly available data, which is at the Traffic Analysis Zone (TAZ). Though the groups correlate fairly well, there are some minor differences between the appearances of the maps in this document and those in Appendix C of the H-GAC 2035 RTP.

To assess if EJ communities were disproportionately impacted by freight movement, an overlay of industrial land uses relative to communities of EJ concern was developed. Industrial land use was chosen as the criteria because the majority of freight movements in the Houston-Galveston region are driven by the petrochemical industry. Thus, those communities located in close proximity to industrial uses are more likely to sustain negative impacts such as air, water, noise and light pollution, congested roadways, safety hotspots and encroachment and loss of green space.

In the Houston-Galveston region, industrial land uses are clustered in several places, in particular around the Houston Ship Channel, the Port of Houston, and industrial land use parks such as the Brown Shipbuilding industrial park (Figures 4-6 and 4-7). Other pockets of industrial land uses also exist around the Ports of Galveston and Texas City.

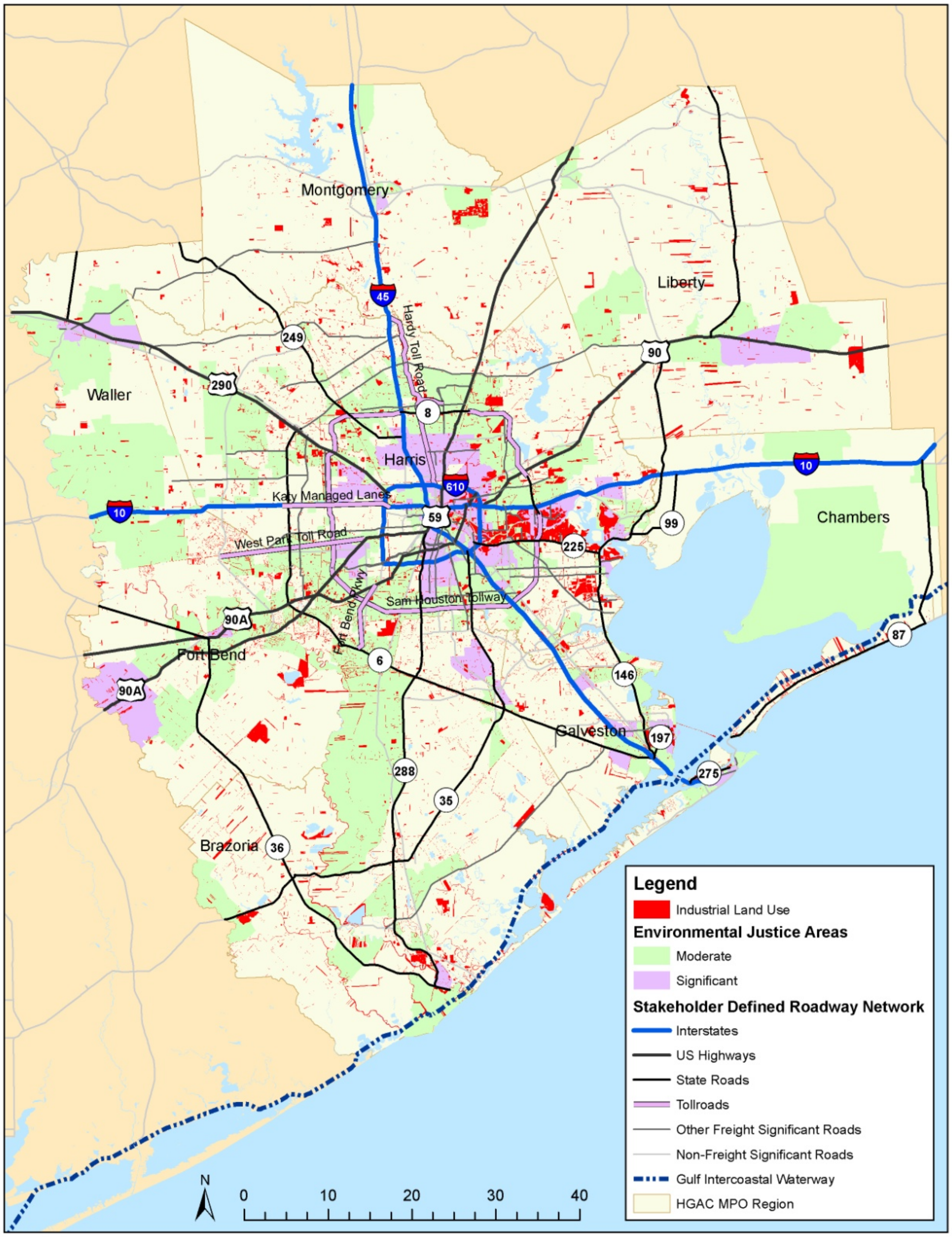
From these maps, it appears that many industrial land uses tend to abut areas of moderate or significant EJ concern. It is likely that residents surrounding these industrial land uses tend to be exposed to light and noise pollution at a higher rate than other H-GAC residents.

Figure 4-5 EJ Populations of Concern in the Houston-Galveston Region



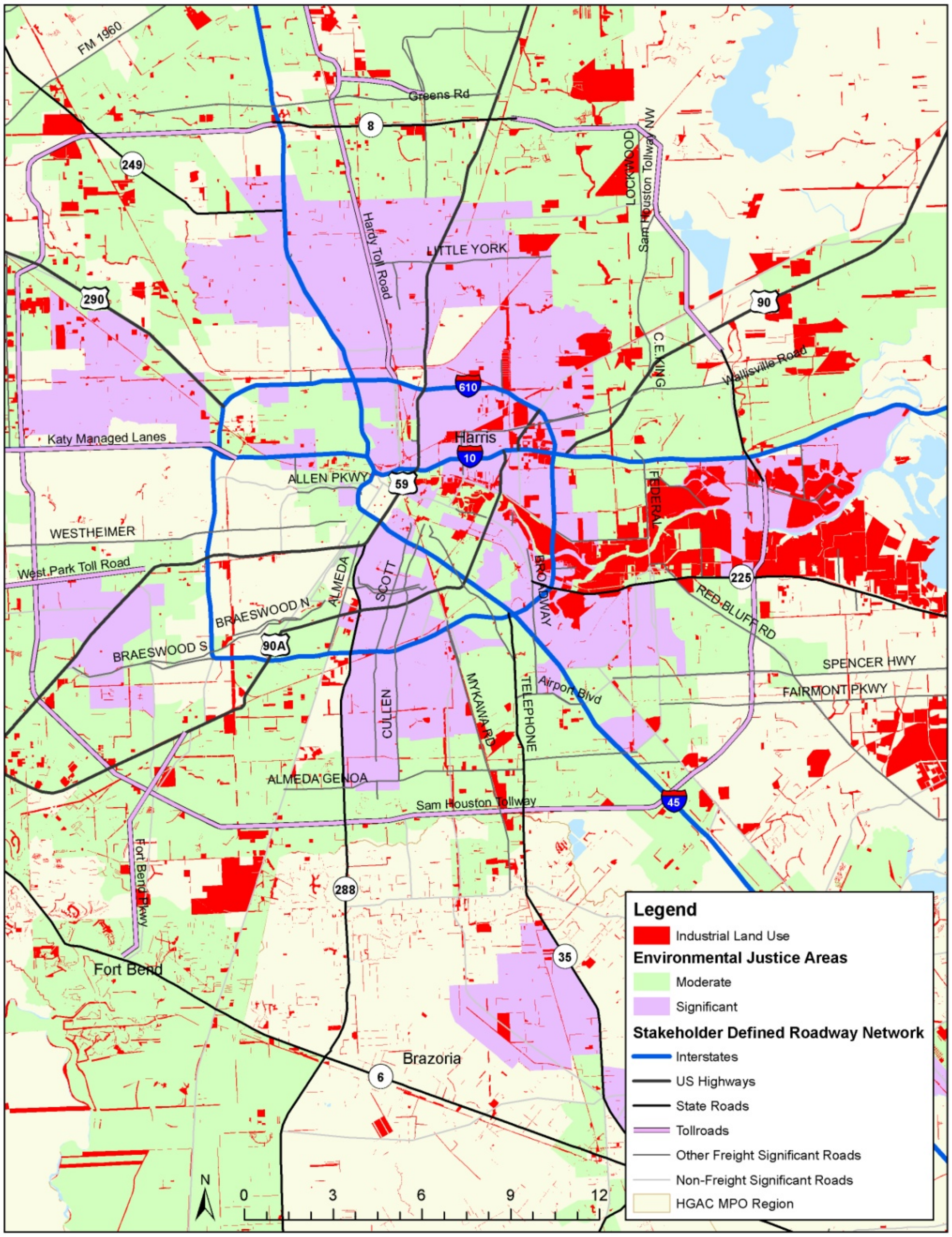
Source: H-GAC.

Figure 4-6 Industrial Land Uses in the Houston-Galveston Region *with EJ Areas of Concern*



Source: H-GAC.

Figure 4-7 Industrial Land Uses in Harris and Galveston Counties *with EJ Areas of Concern*



Source: H-GAC.

Summary

Freight transportation has increasingly invoked "not in my backyard" reactions from communities leading to concerns about the location of freight facilities and the movement of cargo. Despite community apprehension, there is a mutual understanding that freight transportation plays a vital role in the economic well-being of communities and businesses. Nationally, efforts have been made to balance the movement of freight with community goals by making freight transportation operations and facilities "good neighbors." This chapter has presented data regarding the community impacts arising from freight transportation and there is a need to identify and implement mitigation strategies for both existing and future impacts.

5. Public Policy Profile

Public policies – whether Federal, state, or local – can significantly impact demand on the H-GAC freight transportation system, as well as plans, operations, and investments in that system. Whether it be the changing Federal role in freight planning and infrastructure finance, the renewed emphasis on freight and rail planning, or the region's own local policies and processes, public policy influences many of the planning decisions that are faced by the Houston-Galveston region. Developing a better understanding of the national, statewide, and metropolitan policies that may impact goods movement will be critical in helping the region make more informed public policy and investment decisions.

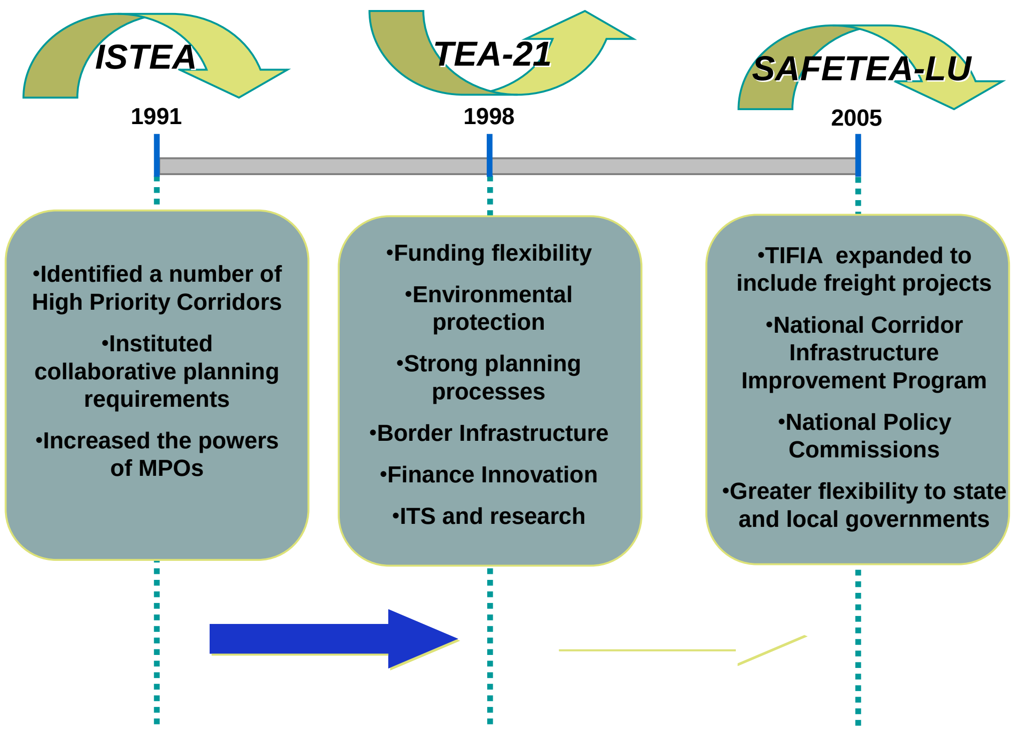
The most critical national, state, and local public policy issues influencing the regional goods movement, both now and in the future, are funding, safety and security, heavy haul routes, trucking regulations and local ordinances.

The issues discussed here have been drawn from a variety of sources, including current and proposed Federal transportation legislation, the Texas Department of Transportation (TxDOT), and interviews conducted with key freight stakeholders and public officials from across the region.

National Freight Legislation and Policies

The role of the Federal government in the planning and financing of freight projects currently is undergoing much debate and transformation. Traditionally, the Federal government has been fairly removed from freight planning discussions, choosing instead to let state and local governments and the private sector freight community plan for, manage, and implement freight improvements. However, there is growing sentiment that the multistate and cross jurisdictional nature of freight movements requires a strong Federal presence – and potentially a dedicated funding source – in order to effectively manage freight movements in a way that is beneficial to multiple stakeholders and to the nation's economy and global competitiveness. This movement is evidenced by the favorable outcome of freight rail projects in the recent TIGER grant program. The top money winners were freight rail projects in the first two rounds of the Federal grant program, including the Tower 55 rail interchange project in the Dallas region. The Federal government's role in transportation has been evolving over the last two decades with revisions and reauthorizations of Federal transportation legislation. As shown in Figure 5-1, there have been three major Federal surface transportation acts since 1991, authorizing programs across all modes of surface transportation and setting national transportation priorities.

Figure 5-1 Federal Surface Transportation Acts Since 1991 Impacts on Freight Planning



Source: Cambridge Systematics, Inc.

Funding for Freight Projects

There is growing awareness of the lack of diversity of funding sources for freight projects, in particular those that are multimodal in nature. For example, highway agencies, much of the trucking industry, and portions of the construction industry are opposed to opening the Highway Trust Fund for investments in nonhighway projects, fearing that this will aggravate the short fall in investments in highways. On the other hand, railroads continue to seek Federal funding through various mechanisms such as discretionary grants and tax credits while largely not participating at all in funding improvements for intermodal connectors serving rail facilities. The modal silo approach to financing our nation's transportation system continues to be an obstacle to an effective national funding program for freight. This modal silo approach spills over into the State and the Houston-Galveston region.

Though SAFETEA-LU did include some new provisions for freight, including expanding the Transportation Infrastructure Finance and Innovation Act (TIFIA) loans to allow funding of freight projects, but there are still very few Federal funding sources available for state or regional agencies to apply to fund freight projects. The following sections discuss funding sources for freight projects in more detail. A summary is provided in Table 5-1.

Table 5-1 Summary of Potential Funding Sources

Funding Category	Project Selection	Usual Funding
1. Preventive Maintenance and Rehabilitation	Projects selected by districts. Commission allocates funds through Allocation Program.	Federal 90%, State 10%; *or* Federal 80%, State 20%; *or* State 100%
2. Metropolitan and Urban Area Corridor Projects	Projects selected by MPO in consultation with TxDOT. Commission allocates funds through Allocation Program.	Federal 80%, State 20%; *or* State 100%
3. Nontraditionally Funded Transportation Projects	Project selection varies based on the funding source, such as Proposition 12, Proposition 14, Pass-Through Toll Finance, Regional Toll Revenue, and Local Participation.	Federal 80%, State 20%; *or* State 100%; *or* Local 100% Varies by agreement and rules.
4. Statewide Connectivity Corridor Projects	Projects selected by commission based on corridor ranking. Project total costs cannot proceed commission-approved statewide allocation.	Federal 80%, State 20%; *or* State 100%
5. Congestion Mitigation and Air Quality Improvement	Projects selected by MPOs in consultation with TxDOT and funded by district's Allocation Program. Commission allocates funds based on population percentages within areas failing to meet air quality standards.	Federal 80%, State 20%; *or* Federal 80%, Local 20%; *or* Federal 90%, State 10%
6. Bridges (*Federal Highway Bridge Program, Federal Railroad Grade Separation Program*)	Projects selected by the Bridge Division as a statewide program based on the Federal Highway Bridge Program and the Federal Railroad Grade Separation Program eligibility and ranking. Commission allocates funds through Statewide Allocation Program.	Federal 90%, State 10%; *or* Federal 80%, State 20%; *or* Federal 80%, State 10%, Local 10%
7. Metropolitan Mobility/ Rehabilitation	Projects selected by MPOs in consultation with TxDOT. Funded by district's Allocation Program. Commission allocates funds according to the Federal formula.	Federal 80%, State 20%; *or* Federal 80%, Local 20%; *or* State 100%
8. Safety (*Federal Highway Safety Improvement Program, Federal Railway-Highway Crossing Program, Safety Bond Program, Federal State Routes to School Program, and Federal High-Risk Rural Roads*)	Projects selected statewide by Federally mandated safety indices and prioritized listing. Commission allocates funds through Statewide Allocation Program. Projects selected and approved by commission on a per-project basis for Federal Safe Routes to School Program.	Federal 90%, State 10%; *or* Federal 90%, Local 10%; *or* Federal 100%; *or* State 100%
9. Transportation Enhancements	Local entities nominate projects and TxDOT, in consultation with FHWA, reviews them. Projects selected and approved by commission of a per-project basis. Projects in the Safety Rest Area Program are selected by the Maintenance Division.	Federal 80%, State 20%; *or* Federal 80%, Local 20%

Table 5-1 Summary of Potential Funding Sources (continued)

10. Supplementary Transportation Projects	Projects selected by districts. Commission allocates funds through Allocation Program.	Federal 80%, State 20%; *or* Federal 80%, Local 20%; *or* State 100%
11. District Discretionary	Projects selected by districts. Commission allocates funds through Allocation Program.	Federal 80%, State 20%; *or* Federal 80%, Local 20%; *or* State 100%
12. Strategic Priority	Commission selects projects which generally promote economic opportunity, increase efficiency on military deployment routes or to retain military assets in response to the Federal military base realignment and closure report, or maintain the ability to respond to both man-made and natural emergencies. Also, the commission approves pass-through financing projects in order to help local communities address their transportation needs.	Federal 80%, State 20%; *or* State 100%

Source: TxDOT.

Federal Funding

Federal funds for roadways are distributed to the various states by a formula established through the Federal Highway Administration (FHWA). There also are various discretionary programs that are distributed on a nationwide basis. Currently, the most recent such program is the Transportation Improvements Generating Economic Recovery (TIGER) program. Federal highway funds are dedicated to roadway purposes by the Texas State Constitution, as are state highway funds.

Federal Funding through H-GAC

Some of the Federal funds are further distributed to metropolitan planning organizations (MPO) by the Texas Transportation Commission. The State has 12 categories of funds and 3 of these are distributed to MPOs within the State. These are Category Two, Metropolitan and Urban Corridor Projects (added capacity projects); Category Five, Congestion Mitigation and Air Quality Improvement (projects to address attainment of a national air quality ambient standard in the nonattainment areas of the State); and Category Seven, Metropolitan Mobility and Rehabilitation (transportation needs located in a transportation management area which includes the eight county Houston-Galveston Area Council MPO region). The Transportation Policy Council of the H-GAC selects projects in these three categories. The Texas Transportation Commission has to approve only those projects selected in Category Two.

H-GAC, as the MPO for the eight-county Transportation Management Area, develops the transportation improvement program (TIP) in a collaborative effort with local governments, transit and transportation agencies, and TxDOT. Transportation improvements contained in the TIP are required to comply with air quality regulations for vehicle emissions. In addition to projects receiving Federal dollars, locally funded projects considered to be regionally significant also must be included in the conformity analysis requirements of the Clean Air Act.

Federal Funding through the State

The State (TxDOT) has responsibility for all of the Federal funds from the FHWA and the state funds appropriated by the Texas Legislature. The roadway funds are listed in their Unified Transportation Program and are listed in 12 funding categories. A listing of these categories and a description can be found at ftp://ftp.dot.state.tx.us/pub/txdot-info/fin/utp/exhibits/funding_cat_020211.pdf.

Federal Freight and Passenger Rail Funding

Most Federal funds for passenger and freight rail are distributed through discretionary programs, such as the intercity passenger rail grants authorized by the Passenger Rail Investment and Improvement Act of 2008 (PRIIA), the Rail Rehabilitation and Improvement Fund (RRIF) program of loans and credit enhancement, and the rail improvements eligible for grants through the TIGER program. These primarily discretionary programs, in which project funding decisions are made by Federal agencies on a national basis, are distinct from the formula-based Federal highway program, in which project funding decisions are made at the state and local level.

The Texas Rail Plan, recently adopted by TxDOT, outlines the possible Federal funding programs for rail in the Financing Chapter of the Plan (available at http://www.txdot.gov/public_involvement/rail_plan/trp.htm). This state rail plan is intended to meet Federal requirements which tie future intercity passenger rail funding to projects included in a Federally compliant state rail plan. The Texas Rail Plan also details the instances in which Texas applicants for discretionary funding have been successful. Some Federal funding also has been directed to rail projects through the Federal appropriations process, in which earmarks have directed funding to rail projects in Texas.

Federal highway funds are dedicated to roadway purposes by the State Constitution, but some Federal funds are made available to states with added flexibility. Surface transportation funds appropriated through the American Recovery and Reinvestment Act of 2009 (ARRA) were allocated to states with eligibility for multimodal purposes. Texas, like a number of other states, used this flexibility to allocate ARRA funds to railroads.

State Funding

The majority of state transportation revenues, through the motor fuels tax and motor vehicle registration fees, are dedicated to roadway purposes by the State Constitution. However, some general revenue funds have been appropriated to TxDOT for rail purposes in the past.

In 2005, Texas voters approved a constitutional amendment creating the state Railroad Relocation and Improvement Fund, a state fund to support rail relocation and capacity expansion projects for passenger and freight rail. In 2009, the Legislature appropriated $182 million into the Fund through a complicated set of contingencies which have led the State Comptroller not to direct any deposits of state money into the Fund as of February 2011.

The Texas Emissions Reduction Program allows state funds to be used to reduce air emissions of railroads through vehicle equipment replacement and possible rail relocation projects. The Texas Commission on Environmental Quality, the state agency responsible for the program, has funded railroad switching locomotive replacements in Texas nonattainment areas.

TxDOT also leverages Federal funds for highway-rail grade crossing safety improvements, an annual average of $31 million in state and Federal funds from 2003 to 2009. These funds are allocated on a risk-based formula informed by extensive grade crossing data to install and upgrade grade crossing protection devices. Fifty-six percent (56 percent) of Texas' public highway-rail grade crossings are protected with an active warning device.

Texas has made state economic development funding available for freight rail capacity expansion. In 2003, the Texas Legislature authorized $15 million from the State Smart Jobs Fund for construction of a new rail spur line from a new manufacturing plan for Toyota in southern Bexar County to the nearest BNSF Railway line. Toyota had required access to competitive rail service as a condition of location of the manufacturing plant in Texas. This state funding leveraged $5 million raised by the Bexar County Regional Rail Authority for construction of the line.

Local Funding

The Texas Legislature has authorized a number of local and regional entities that have authority to address rail issues. There are three kinds of regional entities that can be created and can address rail issues: freight rail districts, regional mobility authorities, and rural rail transportation districts. Each kind of regional government has different governance structures, have various authority to access capital funding, and usually share the problem of coming up with funding for their rail projects (organizations with revenue bond authority have to first have revenue producing projects).

In 2005, the 79th Texas Legislature authorized the creation of a Freight Rail District (FRD) by a county with a population of 3.3 million or more. Counties that are adjacent to the eligible county are permitted to join the FRD once it is established. A FRD has the power of eminent domain, the powers of Rural Rail Transportation Districts (RRTD), Regional Mobility Authorities (RMA), and Intermunicipal Commuter Rail Districts.

Early in 2007, Harris County, Fort Bend County, and the City of Houston created the Gulf Coast Freight Rail District as a result of this authority. The name has since changed to Gulf Coast Rail District (GCRD), and Galveston County, Montgomery County, and Waller County have joined GCRD. The board of directors is established, meets monthly, and has become a voting member of the H-GAC metropolitan planning organization. In 2008, the GCRD compiled a list of recommended projects selected from the Texas DOT and Harris County Freight Rail studies.

The GCRD has compiled a list of high-priority freight rail improvements projects selected from the TxDOT and Harris County Freight Rail studies. In partnership with the City of Houston, GCRD is studying the feasibility of grade separations and closures along the UP West Belt Subdivision as recommended in the TxDOT study. The GCRD has supplemented the previous rail infrastructure studies with analysis of rail congestion impacts on regional shippers.

Local Funding through Bond Programs

Many (and probably most) infrastructure projects at the local level are funded through voter approved bond programs. In some cases, there are other sources of local funds, through taxes or fees, but this is the excep-

tion to the funding of major roadway projects within this region.

Private (RR) Funding

Class I freight railroads are owned and operated by private companies that must build and maintain their networks through revenues paid by railroad shippers. This distinguishes railroads from other freight carriers. Houston is served by three Class I railroads, the BNSF, (formerly BNSF merger), the UP (formerly UPSP merger), and the KCS. UP and KCS are publicly traded and BNSF is owned by Berkshire-Hathaway. Service to the Houston region has been through conditions of two major railroad merger agreements.

There are 14 mainline tracks radiating from Houston. Combined, BNSF and UP operate over 96 percent of the Class I track mileage in the State of Texas. The widespread coverage of the BNSF and UP allows them to connect to most of the major markets statewide. There are five major ports in the region: Houston, Galveston, Beaumont, Texas City, and Freeport. The seaports are all served by one or more of these railroads as well as trucks.

Motor carriers operate over publicly owned and maintained freeways and major thoroughfare road networks; air cargo carriers land and take off at publicly owned and maintained airports controlled by a public air traffic control system; and ships and barges use publically maintained ship channels and canals. Being responsible for property and physical infrastructure, train control systems, power units, and rolling stock make railroads among the most capital-intensive industries in the national economy as measured by the ratio of the value of their assets to their revenues.

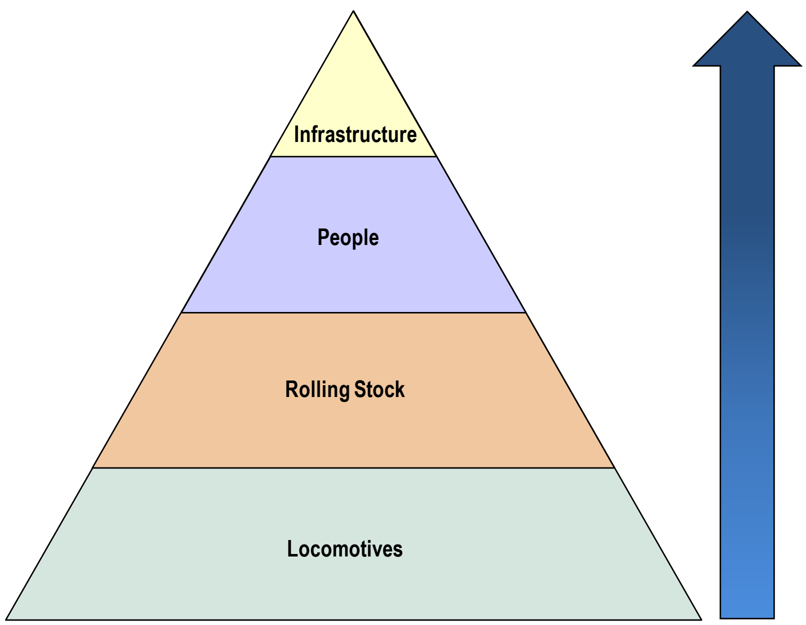
Railroad networks must be maintained to retain their functionality and fluidity, and a strict regimen of railroad operating rules and Federal safety regulations by the Federal Railway Association (FRA) establishes the relationships between maintenance practices and asset performance standards. Railroads spend most of their capital dollars on maintenance and replacement of existing structures and equipment – track, bridges, signal systems, locomotives and other rail-owned rolling stock, and maintenance of way. Railroads devote significant energy to identifying capital investments that offer the most positive returns, often focused on portions of the network that support higher traffic volumes or higher revenues. This investment analysis is concerned with overall market forces, and is influenced by competition with other railroads, competition with other modes, overall freight activity, and national economic trends.

The two western Class I railroads, the UP and BNSF, report that significant percentages of their capital budgets are devoted to maintenance of their current assets. Investments in capacity expansion or efficiency improvements (infrastructure and information technology) are at most 10 to 20 percent of capital spending. These capacity improvements, because they represent a smaller percentage of overall capital spending, are subject to even more careful examination by railroads. Competing investments are examined not only for their relative financial returns, but also to control risks.

The illustration in Figure 5-2, taken from presentations by the Norfolk Southern Railroad, represents how one railroad evaluates various capacity expansion alternatives. Part of the decision-making process assesses the relative risks and opportunities associated with investments – how many different ways an asset could be deployed to meet market opportunities and how the asset could be redeployed if traffic volumes fail to meet expectations. The pyramid in Figure 5-2 represents how that railroad assesses the relative risks of various investments: in this collection of overlapping triangles with a common point, the area of each triangle is a relative measure of the opportunity and risk associated with each type of investment – the bigger the area, the more flexibility.

Therefore, rising up the pyramid shows that overall risks increase. Investments in locomotives have relatively lower risks because they are easily relocated to portions of the railroad where they can add to revenues. Rolling stock also is portable, but the cars must be moved with motive power, and rail cars are typically tailored to certain commodities (trailers for intermodal containers, gondola cars for coal, and tank cars for particular chemicals), so their flexibility is limited in the face of changing market conditions. Expanding locomotives and rail cars will require more railroad employees to transport and maintain them, and labor can be added to match changing market conditions. But railroad employees require extensive training, can be specialized by expertise and by trades covered by collective bargaining agreements, and are more difficult to move across a railroad network's broad geography. Investments in physical infrastructure carry the highest risk, in that they are stranded assets dependent on revenues from traffic carried over the asset, they must be maintained over time, and cannot be relocated to other more profitable parts of the railroad's network.

Figure 5-2 Railroad Investment Risk Pyramid



Source: Norfolk Southern Railroad, 2009.

Safety and Security

Safety and security are top priorities for both the public and private sectors. However, it should be recognized that safety and security measures can impose considerable costs to the freight industry and ultimately our businesses and consumers. Following is a discussion of the some of the public safety and security policies that have the most significant impact on freight transportation.

Railroad Safety Legislation

Given the interests of Interstate commerce, Federal law vests primary rail safety enforcement authority with the Federal government, in particular with the FRA, part of the U.S. Department of Transportation. The

FRA is led by an appointee of the President confirmed by the Senate. Safety enforcement is carried out by the FRA Office of Safety, headed by a Chief Safety Officer, and enforced through safety inspectors across the country, organized into eight regional offices, including one in Fort Worth, Texas. The Federal rail safety program's primary concerns are enforcement of rail safety standards for track, locomotives, freight cars, signal and train controls, operating practices of employees, and transportation of hazardous materials.

Rail safety inspectors at the Federal and state level are qualified in one of the FRA's safety disciplines which include track (which also includes bridges); motive power and equipment (MP&E); operating practices (OP); signal and train controls (STC); or hazardous materials (HazMat).

TxDOT currently participates in a Federal program allowing state participation in Federal safety inspection.

In addition to this public sector safety enforcement, railroads incorporate safety practices into their operating rules and organizational culture, as safe railroads serve shippers more effectively and reduce costly property and personal losses associated with derailments and other accidents. Railroads will regularly inspect their facilities to ensure safe and dependable operations and also will ensure safe operations of locomotives and rail cars belonging to other railroads, shippers, and third-party lessors.

One other piece of Federal legislation of great importance is HR2095 – Railroad Safety Enhancement Act of 2008. HR 2095 was passed by the U.S. House of Representatives in September 2008, by the U.S. Senate in October of 2008, and by the President in November 2008. This legislation contains certain clauses that are especially important to freight or passenger rail planning goals.

HR 2095 reauthorizes the Federal railroad safety program for a total of $1.318 billion over the next five years, starting with $225 million in 2009, and growing to $293 million in 2013. It also provides an authorization of $13.06 billion over five years for Amtrak and other intercity rail. This includes over $9 billion for Amtrak capital, operations, and debt reduction. (Although Amtrak's yearly appropriations will be determined later in spending bills, the authorization allows Amtrak to make long-range capital-improvement plans.) HR 2095 authorizes $1.9 billion for state capital grants for intercity passenger rail, and $1.5 billion for high-speed routes to be awarded by U.S. DOT on a competitive basis. The bill also requires railroads to equip trains with positive train control by 2015 to help avoid crashes.

Hazardous Material (HazMat) Routes

As noted previously, the movement of hazardous materials is critical in the region. Following is a discussion of the public policies impacting the movement of these shipments.

Route Designation and Restriction

Highways

TxDOT has signed highways and mapped Non-Radioactive Hazards Material (NRHM) routes designated by local authorities. TxDOT may initiate the process of selecting NRHM routes but must coordinate with local governments. The procedures used by TxDOT are located in the Texas Administrative Code (TAC) Title 43, Part 1, Chapter 25, Subchapter F. For the H-GAC area this includes the cities of Conroe, Dickinson, Galveston, Hempstead, Houston, League City, Pearland, Rosenberg, Santa Fe, Stafford, and Texas City.

Storage and Handling

The storage and handling of non-radioactive material is generally regulated by the ordinance making authority of individual cities.

Rail

Congress also enacted the Implementing Recommendations of the 9/11 Commission Act of 2007, which required the U.S. DOT to adopt rules regarding routing of HazMat shipments through urban areas. The FRA and the Pipeline and Hazardous Materials Safety Administration adopted these rules in November 2008. Rules establish guidelines for railroads to use in studying hazmat shipping patterns, assessing alternate routes that minimize risk, and establishing procedures for reviewing routing decisions. These routing decisions are shared with state and local governments through intelligence fusion centers at the state level that work with the Federal Department of Homeland Security. The Texas Fusion Center is part of the Department of Emergency Management managed at the Texas Department of Public Safety (DPS); TxDOT participates through interagency Homeland Security committees.

State and local governments already work with railroads to prepare for possible HazMat releases through the Federal Emergency Planning and Community Right to Know Act of 1986, administered through the Environmental Protection Agency (EPA). Again, the DPS Division of Emergency Management serves as the state agency responsible for oversight and coordination of emergency response planning among local emergency planning commissions generally established at the county level in Texas.

Texas also has examined the issue of rerouting hazardous materials shipments. The analysis found that many hazardous materials movements are necessary on existing routes to serve customers or facilities (such as the Port of Houston and water purification facilities) located on those routes. The number of through-freight movements not destined for those areas are minimal and the cost of constructing bypass facilities are prohibitive. Relocation of a small percentage of hazardous materials movements to these bypasses does not significantly lower the risk of exposure in proportion to the cost of the bypass facilities. The study found that the risk of hazardous materials releases and the safety of rail operations could be more effectively improved by investments in upgrades to existing rail infrastructure.

Security

Highways

TWIC Card. TWIC (Transportation Worker Identification Credential) is a common identification credential for all personnel requiring unescorted access to secure areas of Maritime Transportation Securities Act (MTSA), regulated facilities and vessels, and all mariners holding Coast Guard-issued credentials. Individuals who meet TWIC eligibility requirements will be issued a tamper-resistant credential containing the worker's biometric (fingerprint template) to allow for a positive link between the card and the individual (homeport.uscg.mil).

This requirement results in additional costs and pressure on carriers to get drivers certified. In addition, it reduces the labor pool of potential drivers due to the fact that some may not want to share the information required to obtain a TWIC card while others may not qualify. Driver shortage is among one of the top industry concerns and this regulation has created even more constraints on the labor pool.

Rail

Rail security is primarily a Federal matter, led by the Department of Homeland Security through the TSA in cooperation with U.S. DOT through the FRA and the Pipeline and Hazardous Materials Safety Administration. While the FRA and TSA have regulatory authority over railroad security implementation plans, day-to-day actions to keep the railroad industry safe are the responsibility of Railroad Police Officers, authorized by Article 2.121, Code of Criminal Procedure. Prior to the increased national attention to security after September 11, rail security was primarily a concern of the railroads themselves and among the community of first responders responsible for addressing rail incidents involving hazardous materials. Railroads responded quickly after 9/11 to develop more robust security plans, and as the Transportation Security Administration (TSA) was created, the industry worked together with Federal agencies and other entities. These efforts were formalized through the enactment of the Implementing Recommendations of the 9/11 Commission Act of 2007, which established requirements for rail security planning, information sharing, and HazMat routing.

Final rules for rail security, published in November 2008, establish requirements for protecting security-sensitive information, identifying rail security coordinators at railroads and other hazardous materials shippers and receivers, reporting security incidents, and authorizing inspections of rail network facilities by TSA personnel. These rail security coordinators are required to coordinate security practices with appropriate law enforcement and emergency response agencies. The TSA reports that it has 175 freight rail security inspectors working out of 54 field offices around the country, but otherwise does not publish information about its security inspection personnel (e.g., numbers in particular states, activities by state). TSA also is responsible for coordinating security on passenger rail, commuter rail, and rail transit systems.

Heavy Haul Routes

The importance of the movement of oversight/overweight (OS/OW) shipments to the region's economy has been discussed in previous chapters. The ability to efficiently move these shipments will depend on local and state policies on designating and maintaining heavy haul routes.

Designation

Currently, there are no state designed truck heavy haul routes in the Houston-Galveston region. Some attempts have been made to get state legislation for such designation, but none have succeeded to date. Oversize and/or overweight (over 80,000 pounds gross) can be transported but require a state permit if hauled on the state system. Cities and coun-

ties also may have a permitting process, but there is no coordination between the State and localities.

Counties do not have the legal authority to designate truck routes, but cities do through their ordinance making authority. Truck routes are difficult to enforce since no government entity has the authority to prohibit trucks on a roadway if the trucker can demonstrate he has no other way to make a delivery.

Restrictions

On most roadways, there are no truck restrictions as long as the truck is within the legal weight and size restrictions. Gross weight restriction in Texas is 80,000 pounds (plus weight distribution on axles) and size restrictions of 14 feet in height, 102 inches in width, and 65 feet in length. These are very general and there are many exceptions depending on the time of day, type of vehicle, and even commodity hauled.

The State, cities, and counties can impose weight (and size) restrictions based on engineering studies and adopted by the governing body. Most often these are weight restrictions on bridges and in some cases on the roadway itself.

Permitting Process

Highways

The State (TxDOT) has a permitting system for oversize and overweight vehicle traveling on the state system of highways. Some cities and counties also have a permitting process, but none of these systems are coordinated with the others. All of the state permits are issued from a centralized center in Austin. TxDOT only issues permits for the state roadway system. They require the trucker to obtain any other needed permits from the local entity from the starting/ending point to/from the state highway system. The procedures can be found in the Texas Administrative Code (TAC) Title 43, Part 1, Chapter 28. For more details, see http://www.txdot.gov/business/motor_carrier/overweight_permit/default.htm

Certain counties and ports have been authorized by state law to issue oversize/overweight permits for preselected state routes. These are the Port of Brownsville (Texas Transportation Code §623.210), the Victoria Navigation District (TTC§623.230) and Chambers County (TTC§623.250).

TxDOT has a routing software system in the final stages of development called TxPROS, The Texas Permitting and Routing Optimization System. It is scheduled to be fully operational this year. This system will have the ability to store permits from local entities if that is ever required.

There also is a state permitting system for super heavy trucks with gross weights over 254,300 pounds. These permits require detailed analysis of bridges and roadways, thus requiring a longer period of time to obtain. TxDOT reported that 1,525 of these permits were issued in fiscal year 2009.

Enforcement of oversize/overweight permits are the responsibility of the Department of Public Safety and county and city law enforcement agencies. Several cities in the Houston-Galveston region have dedicated truck enforcement patrols, most notably is the City of Houston and the City of Pasadena. Most municipal law enforcement officers can enforce truck regulations if they are over 25,000 population are adjacent or within the boundaries of an international port. In addition of the enforcement of oversize/overweight permits, counties and

most cities can enforce truck safety and weight regulations.

Trucking Industry Regulations

Each year the American Transportation Research Institute (ATRI) conducts its "Top Industry Issues" survey and report which in part gauges the most critical policy issues facing the trucking industry. The result of this data collection and analysis effort is a ranking of top issues by roughly 700 trucking industry executives and stakeholders. Table 5-2 shows the top 10 issues identified through the survey in 2008, 2009, and 2010.

The following discussion offers greater details on several of the issues and discusses, in general terms, how each issue influences the trucking industry.

Table 5-2 Summary of United States Top Industry Issues

Rank	2008	2009	2010
1	Fuel Issues	Economy	Economy
2	Economy	Government Regulation	CSA
3	Driver Shortage	Fuel Issues	Government Regulation
4	Government Regulation	Congestion	Hours of Service
5	Hours of Service	Hours of Service	Driver Shortage
6	Congestion	Commercial Driver Issues	Fuel Issues
7	Tolls/Highway Funding	Environmental Issues	Transportation Funding/ Infrastructure (Congestion)
8	Environmental Issues	Tolls/Highway Funding	Onboard Truck Technology
9	Tort Reform	Size and Weight	Environmental Issues
10	Onboard Truck Technology	Onboard Truck Technology	Size and Weight

Source: American Transportation Research Institute.

Government Regulations. Regulation of the trucking industry is administered by numerous Federal, state, and local entities, including the Federal Motor Carrier Safety Administration (FMCSA). When regulations are stable, trucking companies can better anticipate future operating environments. When there are rapid changes in regulation, or when new regulations are introduced, long-term planning becomes difficult and future operating environments are uncertain. Additionally, research indicates that increased regulation raises industry operational costs and likely pushes certain carriers out of the marketplace; anecdotally, these carriers are most often small fleets or those with marginal safety ratings.

Hours of Service. The hours of service (HOS) regulations administered by the FMCSA set the number of hours a driver can operate, how much rest is required between

driving periods, and how many consecutive days a driver may operate a commercial vehicle. FMCSA has recently published a new HOS proposed rulemaking that could both decrease the number of driving hours and the consecutive days a driver can operate a vehicle without a 34-hour rest period. New regulations such as this could dramatically change the way the trucking industry operates, and could cost shippers and trucking companies billions more in costs annually and ultimately result in more trucks on the roadways to deliver the same volume of goods.

Key issues that result from such rulemaking for planners include the need for increased truck parking, more efficient intermodal connectors, and increased highway congestion during daytime hours (versus nighttime).

CSA. In December 2010, FMCSA deployed a new safety management program named Compliance, Safety, Accountability (CSA). This program uses an algorithm known as the Safety Measurement System (SMS) to derive scores for both motor carriers and drivers in seven safety-related categories known as "BASICs." Carriers with scores above a certain threshold in a given BASIC[40] can be classified as "deficient." If no improvements are made, FMCSA may choose to respond with further intervention, such as a compliance review, as appropriate. This new set of regulations has generated concern and uncertainty within the industry since the new rating system has flagged hundreds of carriers that were previously considered "safe." From an industry perspective, the final impacts of the new program are unclear, making resource allocation and operations management difficult.

Size and Weight. There is growing interest within the trucking industry for improvements in freight productivity vis-à-vis increases in Federal truck size and weight limits. While certain sectors, fleet sizes, and commodity haulers would not benefit from or would not choose to utilize larger or heavier vehicle configurations, research shows that U.S. trucking industry size and weight regulations are far more restrictive than most other G8 countries. Additionally, several studies have shown that changes in size and weight regulations could lower fuel consumption and emissions.

Local Ordinances

Local Ordinances often place specific conditions on commercial vehicle operations. In the Houston region, in most cases, the ordinances established are politically driven for that community or jurisdiction. The need to protect the community by restricting the presence of commercial vehicle travel addresses such things as safety and security; and uniformity and consistency. However, many of these local ordinances can have unintended consequences that may outweigh the benefits. This suggests that there are likely other options for mitigating the problems. Local officials should engage freight stakeholders regarding the issues prior to enacting ordinances impacting freight operations and transportation.

Appendix B consists of a Local Ordinances Table that offers a listing of current public policies or regulations that impact goods movement. The information listed by city is specific protection and control imposed at the local level. "In addition, the table indicates by an "X" whether enforcement occurs for route designations, storage restrictions, or overweight cargo. It also indicates if security measures are in place over and above Federal mandates."

---

40 The BASIC areas include unsafe driving, fatigued driving, driver fitness, controlled substances/alcohol, vehicle maintenance, cargo-related, and crash indicator.

6. Future Freight Demand

Freight demand is influence by numerous factors, many of which are subject to change substantially over relatively short periods of times. This section provides a discussion of the primary factors that impact freight demand in the Houston-Galveston region These factors can be broadly grouped into the following categories:

- Economic structure;
- Industry supply chains and logistics;
- Transportation infrastructure; and
- Public policy, regulation and governance.

An understanding of how the above factors impact freight demand is critical to understanding freight demand in a region and developing freight forecasts for planning purposes. Table 6-1 summarizes the factors impacting freight demand for each of the categories above. While all of the factors will influence overall freight volumes and patterns, the factors most significantly impacting freight volumes in the Houston-Galveston region are discussed in more detail below.

Economic Factors Influencing Freight Demand

Freight demand is directly and positively related with the type and amount of economic activity in a region. The amount and type of goods production and consumption in an area and the relationship between producers, consumers, and intermediate suppliers impact the volume and spatial distribution of freight flows. The following components of the economy have the greatest influence on freight demand:

- Types of industries;
- Personal consumption;
- Trade patterns; and
- Economic geography or land use.

Industry Composition

Freight demand is a direct function of the types of industries in a region. The types of industries in an economy can be broadly classified into goods-related and service industries, each having unique impacts on freight flows. In the Houston-Galveston region, goods production is dominated by the petrochemical and supporting industries. These industries tend to be freight intensive meaning they move substantial volumes of goods in and out of their facilities using various modes of transportation. Service industries such as warehousing and distribution activities, big-box retail, hospitals and other institutions also are major drivers of freight demand, especially in and around metropolitan areas.

Table 6-1 Factors Impacting Future Freight Volumes in the Houston-Galveston Region

Factors Affecting Goods Movement			Low Freight Demand Growth ≤ 40% Trend	Low Freight Demand Growth ≤ 40% Freight Implications	Base Case Demand Growth ≈ 60% Trend	Base Case Demand Growth ≈ 60% Freight Implications	High Freight Demand Growth ≥ 100% Trend	High Freight Demand Growth ≥ 100% Freight Implications
Economic Factors	Consumption	Population	No growth	Freight demand declines relative to economy	Moderate growth	Freight demand grows apace with economy	Robust growth	Freight demand grows faster than economy
		Households	Slight decrease		Moderate increase		Robust increase	
		Income	Flat or declining personal and income		Modest growth in personal and HH income		Significantly more disposable income	
		Lifestyle	Aging population; less consumption		Aging population with changing consumption patterns; greener lifestyle		Aging population; greener lifestyle; more leisure expenditures	
	Production	Industries	Industries less competitive; continuing shift to services	Less high-value, time-sensitive freight	Continuing shift to services and more growth in higher-tech manufacturing	More high-value, time-sensitive freight	Strong shift toward high-tech manufacturing economy; continuing shift to services	More high-value, time-sensitive freight
		Technology	Shift toward lower-energy technologies		Shift toward lower or renewable energy technologies		Shift toward lower or renewable energy technologies	
		Energy	Moderate increase in real energy costs	Diversion from long-haul truck to intermodal rail; more DCs	Steady increase in real energy costs	Diversion from long-haul truck to intermodal rail; more DCs	Big increase in real energy costs; more alternative sources	Diversion from long-haul truck to intermodal rail; more DCs

Factors Affecting Goods Movement			Low Freight Demand Growth ≤ 40% Trend	Low Freight Demand Growth ≤ 40% Freight Implications	Base Case Demand Growth ≈ 60% Trend	Base Case Demand Growth ≈ 60% Freight Implications	High Freight Demand Growth ≥ 100% Trend	High Freight Demand Growth ≥ 100% Freight Implications
Economic Factors (continued)	Trade	Demand	Pace of globalization declines due to political instability and low GDP growth rates	Shrinking trade volumes through the region's ports	Continuing globalization; slow return to long-term trend	Increasing trade volumes through the region's ports	Strong globalization; low dollar value encourages international trade	High and relatively balanced trade volumes through the region's ports
		Trade Partners/ Lanes	Greater diversity of trading partners		Greater diversity of trading partners; expanding exports		Greater diversity of trading partners; expanding exports	
	Economic Geography	Land Use	Slowing urbanization	More truck VMT in Houston metro area; rest of state in decline	Steady urbanization	More truck VMT in urban area and mega-region	Increasing urbanization; growth in metro area	Significantly more truck VMT in urban area and throughout state and mega-region
			Slow ex-urbanization of distribution centers		Continued ex-urbanization of distribution centers		Continued ex-urbanization of distribution centers	
Logistics Factors		Supply Chains	More robust (balancing just-in-time with just-in-case)	Travel time, reliability and cost of trucking remain critical	More robust (balancing just-in-time with just-in-case)	Travel time, reliability and cost of trucking remain critical	More robust (balancing just-in-time with just-in-case)	Travel time, reliability and cost of trucking remain critical
		Sourcing	Continued globalization; limited near- and in-sourcing	Dallas retains leadership in distribution industries	Continued globalization; selective near- and in-sourcing	Houston region gains as distribution and manufacturing center	Continued globalization; selective near- and in-sourcing	Texas expands major high-tech manufacturing source
		Packaging	Continued containerization	More intermodal freight moves	Continued containerization	More intermodal freight moves	Continued containerization	More intermodal freight moves
Logistics Factors (continued)		Networks	Consolidation of existing DCs to compensate for lower volumes	More DCs supplied by intermodal rail	Decentralization of DCs to serve higher-density markets	More regional and local truck traffic	Aggressive expansion and decentralization of DCs to serve higher-density markets	More out-state DCs and intermodal terminals; More statewide and local truck traffic
		Energy/	Moderate increase	Some shipment	Steady increase in	Some shipment	Volatile increases	Shipment consoli-

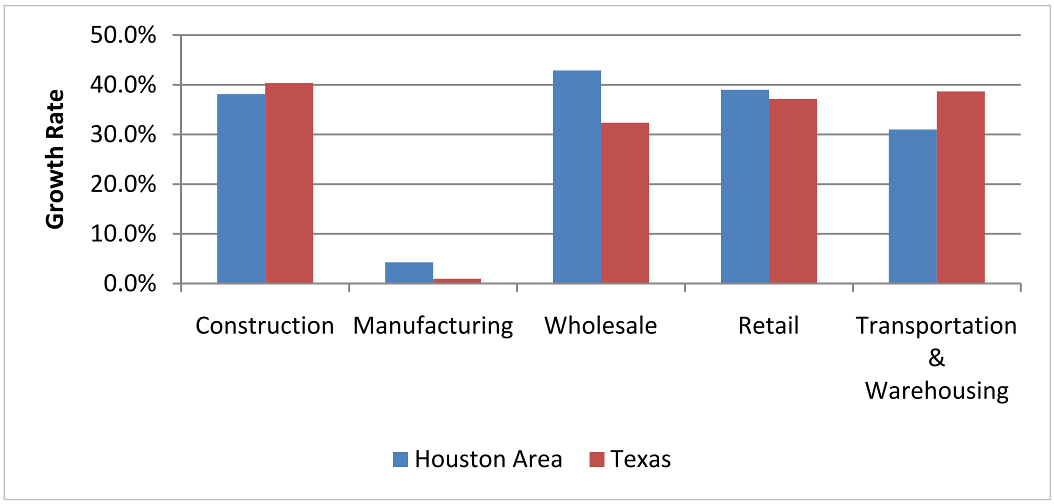
Factors Affecting Goods Movement			Low Freight Demand Growth ≤ 40%		Base Case Demand Growth ≈ 60%		High Freight Demand Growth ≥ 100%	
			Trend	**Freight Implications**	**Trend**	**Freight Implications**	**Trend**	**Freight Implications**
		GHG	in real energy costs; modest reduction in carbon footprint	consolidation	real energy costs; more focus on reduced carbon footprint	consolidation	in real energy costs; more alternative energy sources; reduced carbon footprint	dation; pricing increases to offset uncertain energy costs
Transportation Factors	Motor Carriers/ Highways	Business	Consolidation	More efficient routing and shipment tracking	Consolidation	More efficient routing and shipment tracking	Consolidation	More efficient routing and shipment tracking
		Services	More IT		More IT		More IT	
		Trucks	Conversion of urban trucks to hybrids	Limited greening of urban truck fleets	Conversion of urban trucks to hybrids	Some greening of urban truck fleets	Conversion of urban trucks to hybrids	Greening of urban truck fleets
			Increase in size and weight of long-haul trucks	Stable level of VMT and congestion	Increase in size and weight of long-haul trucks	More truck VMT, reduced growth in trucks and more congestion	Increase in size and weight of long-haul trucks	Significantly more truck VMT and number of trucks and more general congestion
		Highways	Declining investment in highways		Limited investment in highways		Increased investment in highways	
Transportation Factors (continued)	Railroads/ Rail Lines	Business	Class I RRs focus on long-haul; shortline RRs fold	Less long-haul truck traffic; more regional and local drayage traffic	Class I RRs focus on long-haul; expansion of shortline RRs	Less long-haul truck traffic; more regional and local drayage traffic	Class I RRs focus on long-haul and enter mid-haul market; expansion of shortline RRs	Less long-haul truck traffic; significantly more regional and local drayage traffic
		Services	Moderate growth in intermodal services		Growth in intermodal services		Strong growth in intermodal services; shortline RRs enter intermodal business	
		Rail lines	Investment declines to match market growth	Potential for delay in planned investments/ de-marketing of some services	Moderate to strong investment by Class Is; continuing choke points	Limited capacity; competition for time/space slots with pax rail	Increased investment to match market growth; new ex-urban terminals; some urban terminal retrofits	Limited capacity in urban areas; increasing competition for time/ space slots with passenger rail
	Shipping	Business	Consolidation of	Region's ports in	Consolidation of	More direct	Consolidation of	The region

Factors Affecting Goods Movement			Low Freight Demand Growth ≤ 40%		Base Case Demand Growth ≈ 60%		High Freight Demand Growth ≥ 100%	
			Trend	**Freight Implications**	**Trend**	**Freight Implications**	**Trend**	**Freight Implications**
	Lines/ Marine Ports		liner sector	completion for limited Gulf and Southeast port traffic	liner sector	competition with Mobile, FL and SE ports	liner sector	emerges as major load-center port for Gulf and southern portion of U.S.
		Services	Consolidation to 2-3 East Coast ports		Consolidation to 2-3 East Coast ports		Consolidation to 2-3 East Coast ports	
		Ships	Mostly feeder vessels calling at region's ports	Limited increase in regional and local drayage traffic	More high-TEU capacity vessels calling at region's ports	More regional and local drayage traffic	Significantly more high-TEU capacity vessels calling at region's ports	Major growth in regional and local drayage traffic
		Terminals						
Policy, Regulation, and Governance Factors		National	Reauthorization funds HTF and creates largely unfunded national freight program	Limited funding for highways and freight projects of regional and national significance; continuing devolution of funding responsibility to states	Reauthorization funds HTF and creates largely unfunded national freight program	Moderate funding for highways and freight projects of regional and national significance	Reauthorization funds HTF and creates national freight program	Moderate funding for highways and freight projects of regional and national significance
			Limited regulation of GHG emissions	Some urban trucks (MDV) go hybrid, no change in VMT; cost pressures on long-haul trucks (HDV) forces some freight to rail	Increased regulation of GHG emissions	More urban trucks (MDV) go hybrid, no change in VMT; cost pressures on long-haul trucks (HDV) forces some freight to rail	Increased regulation of GHG emissions	Most urban trucks (MDV) go hybrid, no change in VMT; capacity pressures on long-haul trucks (HDV) forces more freight to rail
		State	Less local financing of transportation (sales taxes, tolls, etc.)	Limited state investment in freight infrastructure	More local financing of transportation (sales taxes, tolls, etc.)	Some limited expansion of investment capacity	Substantial local financing of transportation (sales taxes, tolls, etc.)	Expansion of investment capacity
		City/Local	Limited coordination of transportation and economic development planning	Less attention to freight transportation at regional level	Better coordination of transportation and economic development planning	More attention to freight transportation at regional level	Better coordination of transportation and economic development planning	More attention to freight transportation at regional level

Factors Affecting Goods Movement			Low Freight Demand Growth ≤ 40%		Base Case Demand Growth ≈ 60%		High Freight Demand Growth ≥ 100%	
			Trend	Freight Implications	Trend	Freight Implications	Trend	Freight Implications
			Focus on jobs	"Beggar thy neighbor" economic devel-opment policies	Focus on sustainability	Increase in demand for mass transit and PAX rail. Increase in community resis-tance to freight activity	Focus on sustainability	Increase in demand for mass transit and PAX rail. Increase in community resis-tance to freight activity

Employment growth for key industries and freight intensive sectors are a key driver of freight demand. Figure 6-1 and Table 6-2 show the expected growth of major sectors in the freight-dependent industries through 2035. As seen in Table 6.2, retail trade will remain the top freight-dependent industry in the region through 2035, experiencing growth of 39 percent to about 443,600 employees. Construction will be the second largest with projected employees of 362,002, representing growth of 38 percent. Manufacturing is expected to grow slowly, expanding by only four percent.

Figure 6-1 Employment Growth in Freight-Dependent Industries
2007 to 2035



Source: Woods and Poole, Cambridge Systematics, Inc.

Table 6-2 Employment in Freight-Dependent Industries
2007 to 2035

Industry	2007	2035	Percent Change	CAGR
Retail Trade	319,170	443,600	39%	1.2%
Construction	262,087	362,002	38%	1.2%
Manufacturing	233,232	243,185	4%	0.1%
Wholesale Trade	151,765	216,846	43%	1.3%
Transportation and Warehousing	139,959	183,367	31%	1.0%
Total	**1,106,213**	**1,449,000**	**31%**	**1.0%**

Source: Woods and Poole, Cambridge Systematics Analysis.

Even with its modest performance, the manufacturing sector in the region is projected to outperform that of the rest of Texas by 2035. The State of Texas is projected to grow by only 1 percent, compared to 4 percent by the Houston-Galveston region. Also, retail and wholesale trade are projected to outperform the State of Texas by 2 percent and 10 percent, respectively, by 2035. The relatively higher growth rates in freight intensive sectors suggest that the Houston-Galveston region could experience faster growth in freight traffic relative to the rest of the State.

Personal Consumption

Personal consumption is another important component of an economy that has a major impact on freight demand. Personal consumption is driven by population and income growth which generates demands from households for goods and services. This demand translates to increased retail activity, which increases the demand for warehousing and distribution facilities. This results in greater demand for intermodal rail and local truck trips, especially in urban areas. In addition, population growth drives demand for construction activities and the transport of construction materials.

More than 5.7 million people currently live in the Houston-Galveston region, making it the fourth largest metropolitan region in the United States. Furthermore, the region is projected to be one of the fastest growing areas, adding another 3 million people by 2035. Employment in the region is expected to expand by nearly 46 percent over this same period, adding another 1.25 million jobs. Table 6-3 displays population and employment forecasts by county. Harris County is projected to continue to be the region's economic engine, accounting for nearly 60 percent of the projected population growth and about 70 percent of the new jobs in the region. However, the counties in the western half of the region, Fort Bend, Montgomery, and Waller Counties, will be the fastest growing counties, with population projected to expand by 83.5 percent, 94.3 percent, and 81.2 percent, respectively. The southern counties, Brazoria and Galveston, will enjoy robust growth, adding more than 171,000 and 117,000 additional residents, respectively. Employment growth will follow a similar pattern.

Table 6-3 Houston-Galveston Region Population and Employment Forecast ***2010-2035***

	Population			Employment		
County	**2010**	**2035**	**% Change**	**2010**	**2035**	**% Change**
Brazoria	298,057	469,304	57.5%	102,024	147,719	44.8%
Chambers	34,290	52,617	53.4%	8,825	12,779	44.8%
Fort Bend	509,645	935,102	83.5%	157,652	297,728	88.9%
Galveston	287,513	404,471	40.7%	117,061	169,492	44.8%
Harris	4,026,627	5,769,193	43.3%	2,260,128	3,144,992	39.2%
Liberty	81,216	119,810	47.5%	23,328	33,778	44.8%
Montgomery	441,374	857,637	94.3%	126,921	239,692	88.9%
Waller	41,722	75,618	81.2%	14,647	23,250	58.7%
Total	**5,720,444**	**8,683,752**	**51.8%**	**2,810,586**	**4,069,430**	**44.8%**

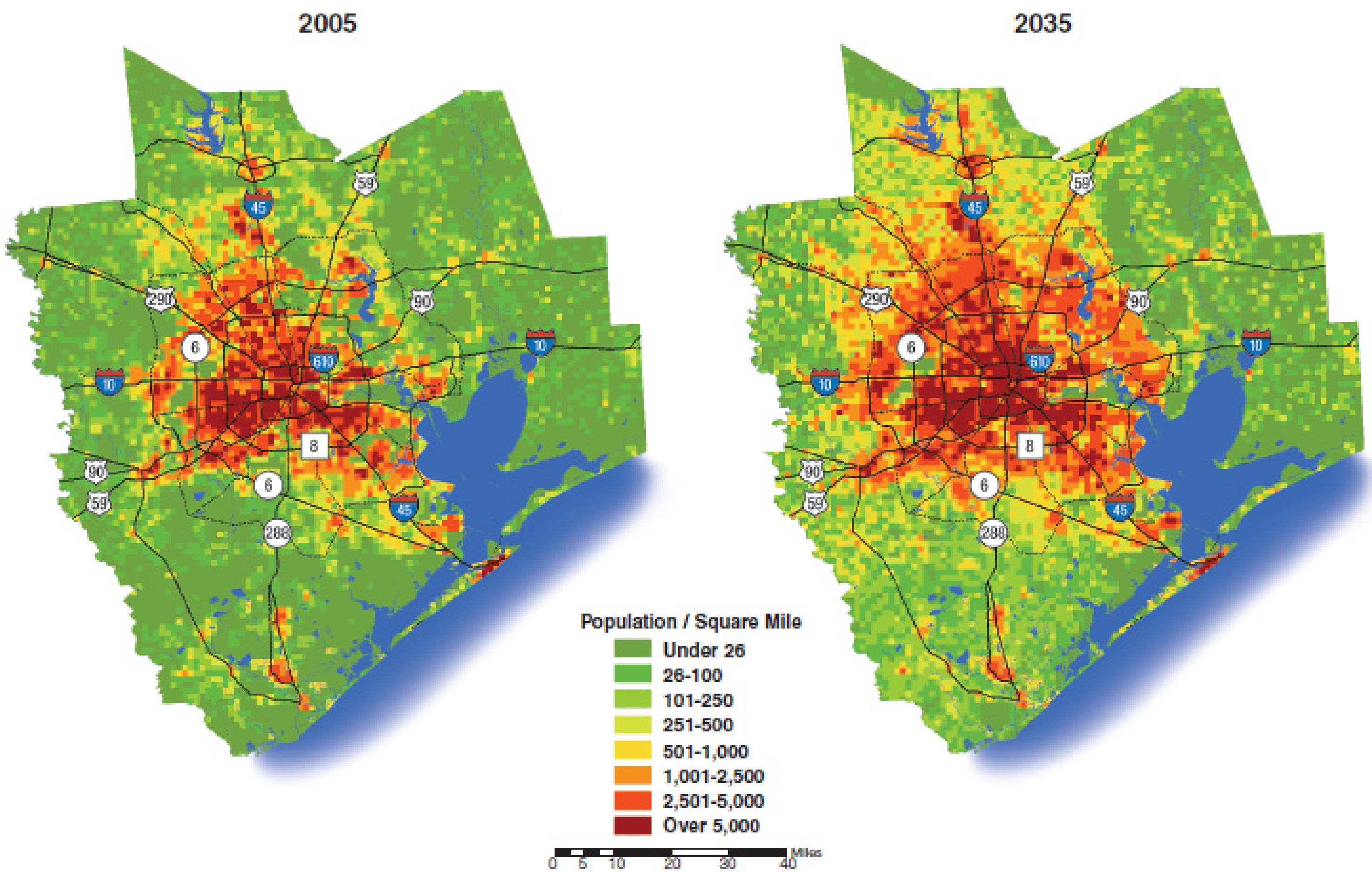
Source: H-GAC GIS and Data Services, accessed March 3, 2011.

For years, a strong sense of economic opportunity in the Houston-Galveston region has helped fuel the region's population growth. The combination of business, visitor, and resident demand then fuels demand for both freight and passenger transportation. The ability of the region to accommodate the varying transportation needs of both industry and residents will be an important factor in future competitiveness and job growth and this requires understanding where the growth will occur.

Figures 6-2 and 6-3 display changes in population and employment densities, respectively. The spatial pattern of population growth, suggests two major trends – continued in-fill and densification of the region's core and robust suburbanization, especially in the northwest portion of the region. Employment, while remaining more concentrated around the region's core relative to population, will continue to spread throughout the region, primarily along major roadways.

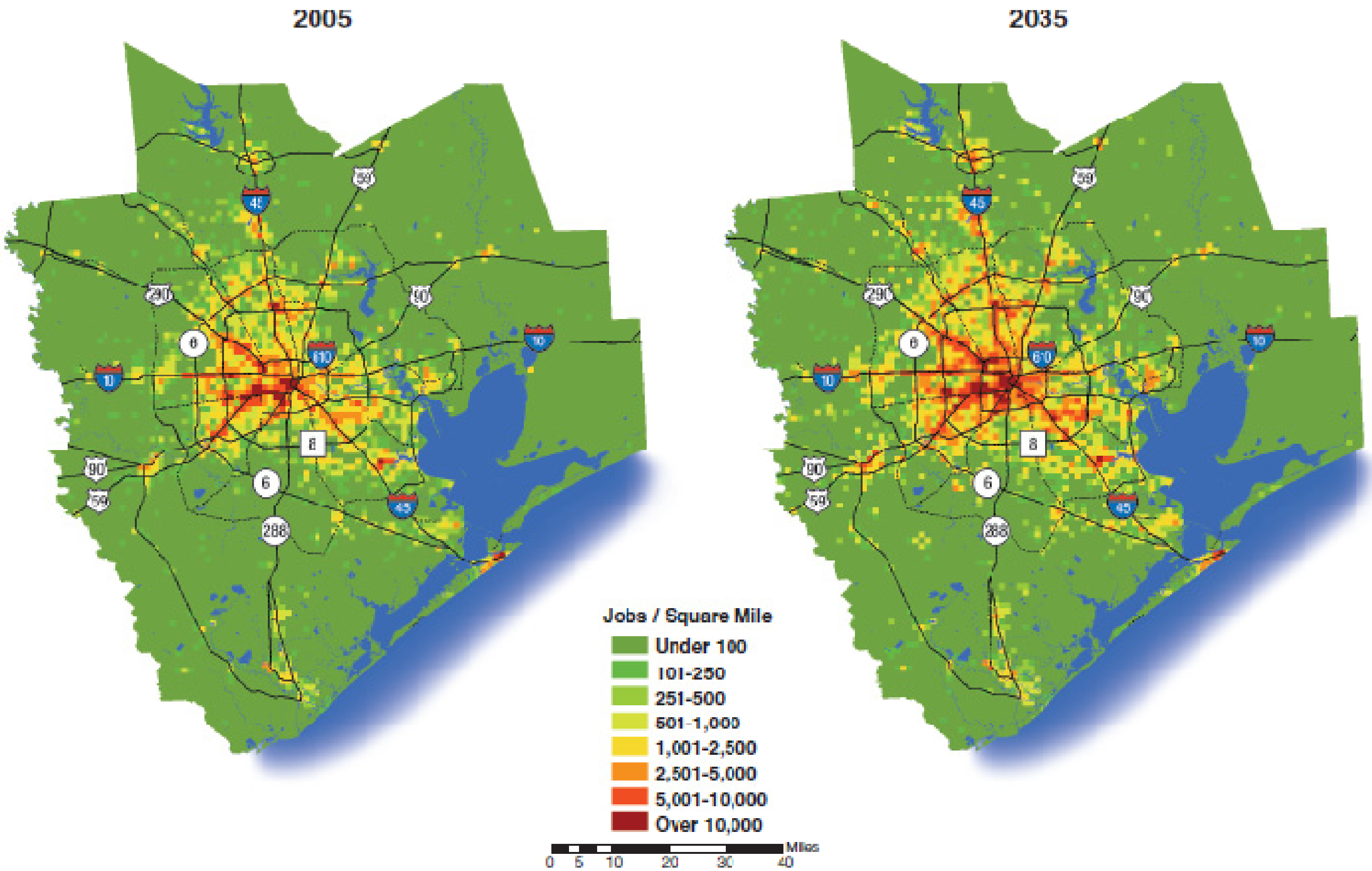
These growth patterns have significant implications on the demand for goods movement. As population density increases outside the urban core, so will the demand for retail goods. This translates into increased demand for warehousing and distribution facilities, such as the Wal-Mart distribution center in Sealy. All of this means that communities in the high-growth suburban counties that currently experience little freight activity and truck traffic will see significant increases over the next 20 years.

Figure 6-2 Population Density 2005-2035



Source: H-GAC 2035 Regional Growth Forecast.

Figure 6-3 Employment Density 2005-2035



Source: H-GAC 2035 Regional Growth Forecast.

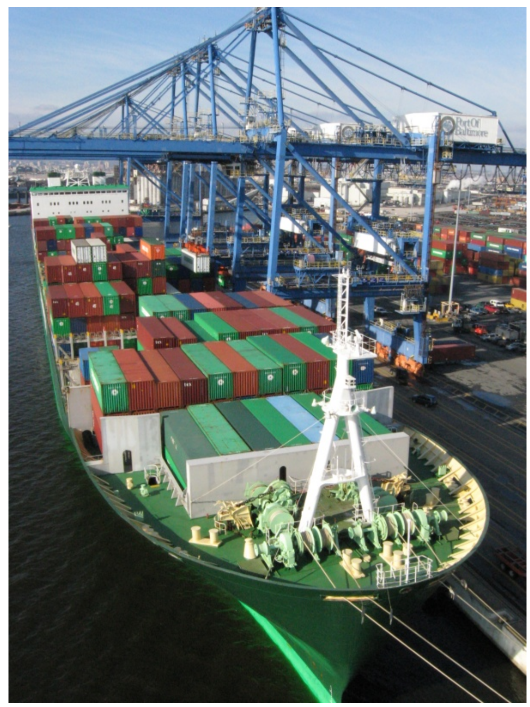
Global Trade Trends

Trade activity is a critical component of the economic structure of the Houston-Galveston region and can be divided into three broad categories – international, domestic, and local. Each of these trade categories have distinct freight demand characteristics in terms of the origin-destination (O-D) patterns of shipments, commodities handled, modes used, types of facilities used, length of haul, size of shipments, and time dependencies. For example, local trade in the region is dominated by trucking compared to international shipments, which depend heavily on marine, rail, and pipeline activity in addition to trucking,

The Houston-Galveston region's deepwater ports and international airport make the region a global gateway and opportunities exist for the region to expand its role in the global marketplace. However, positioning to take advantage of these opportunities requires an understanding of the global trade trends most likely to have the greatest impact on the region. These include the expansion of the Panama Canal and NAFTA and other trade agreements, especially with Central and South American countries.

Expansion of the Panama Canal, through the development of new channels and the widening and deepening of existing ones, will allow it to maintain and even enhance its market share for trade between Asia and the United States. This expansion, scheduled for completion by 2014, will offer opportunities for the intermodal transportation system in the Houston region by accelerating growth at the region's deepwater ports. In the short term, these impacts will be felt most heavily on and around the Port of Houston, the region's and State's largest container port and a key trading partner for goods shipped via the Panama Canal. Through joint marketing with the Panama Canal Authority, the continued development of the Bayport Container Terminal, and improvements to existing access routes, the Port already is preparing for the anticipated increase in container traffic resulting from the Canal expansion and other global maritime and trade trends.

The Panama Canal expansion will have other impacts to the region's transportation system, as the Ports of Galveston and Freeport make improvements to capture market share and shippers evaluate their supply chain and develop new distribution centers and warehouses.



While the widening of the Panama Canal offers opportunity to significantly increase the region's role as a national gateway, there are some challenges. First, there are incentives for the west coast ports and railroads to compete heavily to prevent the diversion of traffic through the Canal. They have made significant investments in the facilities serving these trade flows and long-term return depends on maintaining market share and volumes. They will compete by lowering prices and improving service. Given that the two main Class I railroads serving the

Houston region are the same two serving the west coast ports, makes this competition even more problematic for the region.

Second, the east coast and other gulf coast and Caribbean ports and railroads are making significant investment to capture traffic that is diverted through the Canal and many of these ports are closer to large population centers on the east coast and the county's midsection. In reality, the largest ships transversing the Canal will only call on a few number of ports regardless of the number of ports physically able to accommodate the vessels, and these decisions will be made by the steamship liners based on overall economic efficiency and profitability.

Third, there is likely to be intraregional competition between the deepwater ports for Panama Canal business. This means that the region's ports also are competing for funding to complete dredging and other improvements required to handle the larger vessels. The potential downside to this internal competition is that while more than one port is able to handle and attract the larger ships and increased Panama Canal traffic, the region is unable to make all the landside improvements necessary to develop the most efficient gateway possible because resources are spread between too many gateway options. This could result in lower returns to the ports and their local communities and to the region as a whole.

Adequate landside access and access to efficient domestic trade corridors is a major factor in determining port and gateway competitiveness. Many of the region's "last mile" intermodal connectors do not have sufficient capacity to handle expected increases in freight traffic. Although several ports, including the Port of Houston, have undertaken efforts to make improvements to these critical linkages, the capacity gains resulting from these improvements may not keep up with the increases in demand. Making improvements to these facilities can be challenging, as many are local roadways and some local agencies are hesitant to invest scarce transportation funds in improvements whose benefits accrue regionally, nationally, or to the private sector freight industry.

Rail is an important and growing port service alternative at larger ports, but high infrastructure development costs and network capacity bottlenecks both within and outside the region can limit its potential as a viable option to trucking for some ports. More fully capitalizing the Texas Rail Relocation and Improvement Fund (RRIF)[41] would allow railroads in the region to more effectively improve their infrastructure and operations, allowing them to retain or enhance their market share, expand the transportation options available to shippers, and improve overall mobility and economic competitiveness statewide.

Freight Infrastructure/Modes

Freight is transported via multiple modes and the choice of modes is influenced by many factors. The most important factors include:

- **Characteristics of Demand** – The origins and destinations served and the distance or length of haul of the shipment;
- **Characteristics of the Supply** – The capacity, frequency, cost, and special handling abilities of alternative modal services; and
- **Characteristics of the Shipments** – Size of shipments, pick-up and delivery times, special handling characteristics, shipment value and critical nature of the shipment.

The baseline freight forecasts used for this study are unconstrained forecast meaning that they simply reflect freight demand and assume that the supply of transportation infrastructure is sufficient to accommodate the growth. Therefore, if the region's highway or rail system or port terminals cannot provide efficient, competitive freight

[41] Texas Constitution, Article 3 Section 49.

transportation alternatives relative to other regions, it is likely that some of the freight and the associated economic activity will move out of the region.

Industry Supply Chains and Logistics

Industry supply chains and logistics have a major impact on freight demand and are critical considerations in developing freight forecasts. The most prominent elements include:

- Spatial Distribution Networks;
- Interactions between Logistics Players; and
- Supply Chain/Logistics Trends.

Industry supply chains are characterized by spatial relationships, which dictate the spatial distribution of commodity flows. These distribution patterns are typically influenced by market areas such as the location of distribution facilities close to customer markets or population centers.

Due to the dynamic nature of the freight logistics system, trends in industry supply chains need to be considered. For the Houston-Galveston region, an important supply chain trend includes shipper-carrier alliances impacting both gateway and mode choice. The existence of established alliances could provide an obstacle for the region to attract certain gateway traffic.

Regulations

Regulations have a significant impact on freight flows in a region. Key regulations impacting future freight flows and demand in the Houston-Galveston region include: truck size and weight limitations which influence modal choice, routing patterns of truck movements, types of equipment used, and number of truck trips; environmental regulations pertaining to GHG emissions which will impact the entire global supply chain by influencing sourcing decisions, modal choice, distribution networks and overall cost of goods; hours of service regulations which can have impacts on modal choice as well as the number of truck trips required to move the same amount of freight.

Freight Forecasts for the Houston-Galveston Region

In 2007, more than 760 million tons of freight moved over the region's transportation system (excluding pipelines). By 2035, total freight is projected to increase by nearly 60 percent to more than 1.2 billion tons. Table 6-4 displays growth in freight volumes from 2007 to 2035 by mode and direction. Growth will not be even across all modes. While air cargo is projected to increase by 169 percent, it should be noted that this will still represent less than 1 percent of the total tonnage of freight in the region. Trucking will experience growth as previously discussed; the growth will be more dispersed throughout the region as opposed to concentrated in the core.

The forecast represents unconstrained organic growth in freight demand based on macroeconomic projections. They are unconstrained in the sense that it is assumed the region's transportation will be capable of accommodating the increase in traffic. As discussed in previous sections, additional capacity is required to meet future internal demand. In addition, to the extent the region's ports are successful in attracting freight destined for beyond the Houston-Galveston region, additional pressure will be put on the region's transportation network.

Table 6-4 Summary of Regional Freight Flows by Weight
Tons in Thousands

Direction	Truck 2007	Truck 2035	Percent Change (2007 to 2035)	Rail 2007	Rail 2035	Percent Change (2007 to 2035)	Water 2007	Water 2035	Percent Change (2007 to 2035)	Air 2007	Air 2035	Percent Change (2007 to 2035)	Total 2007	Total 2035	Percent Change (2007 to 2035)
Inbound	163,325	247,998	51.8%	101,707	150,647	48.1%	96,728	149,001	54.0%	177	284	60.5%	361,937	547,929	51.5%
Outbound	150,944	276,051	82.9%	42,432	55,734	31.3%	37,525	49,159	31.0%	289	932	222.5%	231,190	381,876	65.2%
Intraregional	82,794	123,554	49.2%	8,415	11,572	37.5%	8,550	10,340	20.9%	–	–	–	99,759	145,466	45.8%
Through	68,402	133,884	95.7%	N/A[a]	N/A[a]	N/A[a]	–	–	–	–	–	–	68,402	133,884	95.7%
Total	**465,464**	**781,487**	**67.9%**	**152,554**	**217,953**	**42.9%**	**142,803**	**208,500**	**46.0%**	**466**	**1,216**	**160.9%**	**761,287**	**1,209,156**	**58.8%**

Source: IHS Global Insight.

[a] Through rail moves were not included in this TRANSEARCH dataset due to the inability to obtain the full Surface Transportation Board (STB) Waybill Dataset. Therefore, the total through tonnage shown here likely underestimates actual through tonnage.

Zip Code Level Forecasts

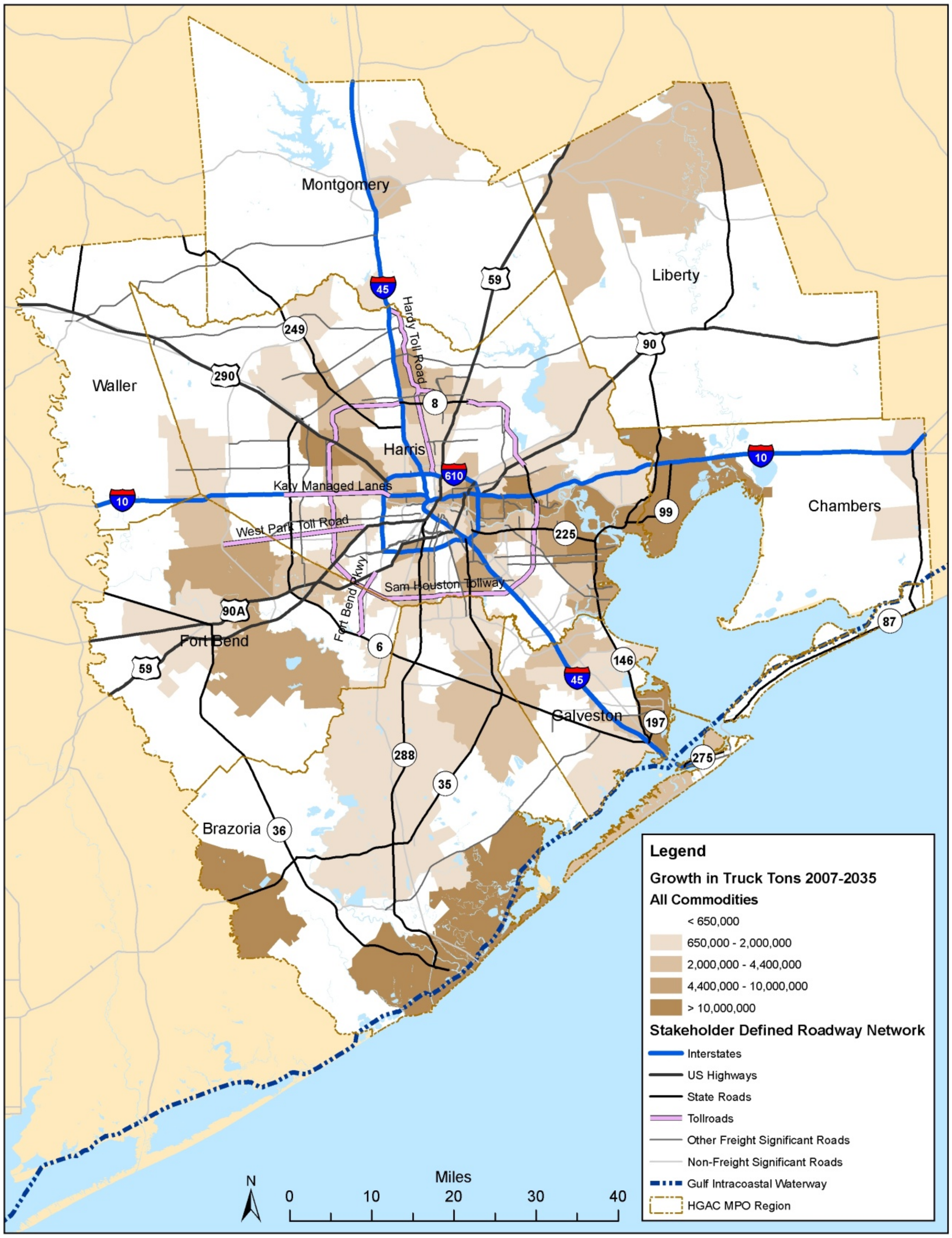
Projection of the long-range future requirements of the freight system is somewhat constrained by the level of detail of forecasts available. For the most part, they are limited to county patterns, which are not detailed enough to examine route demand requirements beyond the major highways. To facilitate more detailed assessment, the county-level forecasts were disaggregated to zip code level using industry establishment and land use data for the base year. While there are some shortcomings to this approach, the zip code projections still offer a number of insights into the geography of the growth, and were supported by stakeholder input.

Figures 6-4 and 6-5 depict county growth in freight tonnage for all commodities in two forms: the total incremental tonnage or "new volume" from 2007 to 2035, and the
.

rate of growth in percentage terms. This is strictly regionally based activity, or freight that originates and/or terminates in the eight-county area. Sources of the absolute quantity of new demand on the network are best seen in the first view in which slow growth against a large base can stand out. Fast growth is visible in the second.

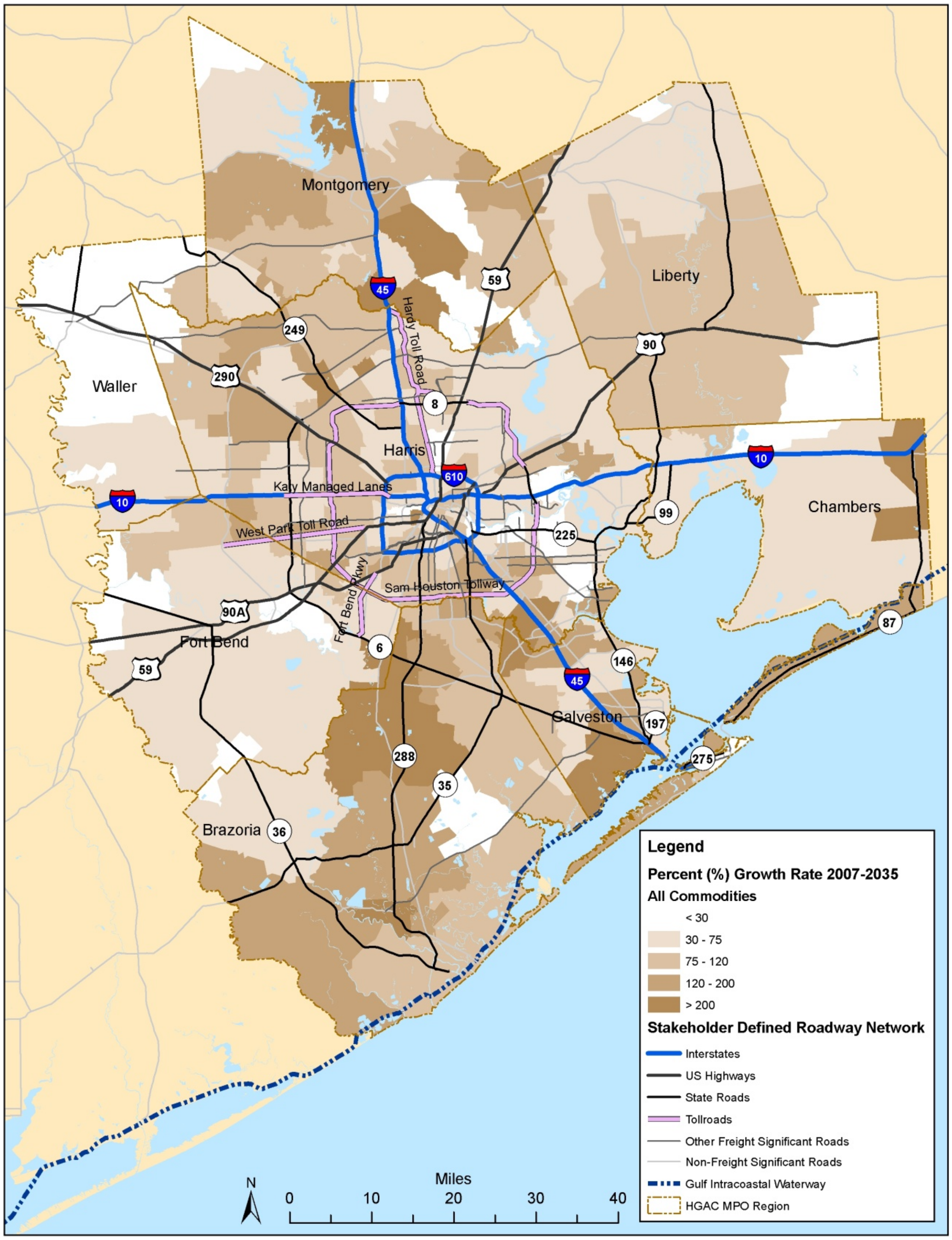
Figure 6-4 provides information on the absolute volume of new demand on the network, showing where the greatest volume of new freight movement will be generated. Figure 6-5 displays areas that will witness the fastest growth. This is important because while the total volumes may pale in comparison to the traditional freight centers in Harris and Galveston Counties, so will the infrastructure available to accommodate the increase in truck traffic.

Figure 6-4 Growth in Inbound and Outbound Freight Tons
All Commodities, 2007 to 2035



Source: IHS Global Insight.

Figure 6-5 Growth Rate in Inbound and Outbound Freight Tons
All Commodities, 2007 to 2035



Source: IHS Global Insight.

The new tonnage comes most heavily from traditional freight centers in Harris, Brazoria, and Galveston Counties where the ports are located and there is an existing and strong industrial base. The next tier is to the west in Fort Bend County, and to the north in Montgomery County. However, the rates of growth show a pronounced pattern of significant growth in zip codes toward the outer edge of the region. This includes Liberty and Chambers Counties to the east, but especially Montgomery and Brazoria Counties, where growth carries with it substantial amounts of new volume. The summary result gleaned from the direction of growth displayed in Figures 6-4 and 6-5 is that the existing network in the urban core of the region and on the coasts will remain under sustained pressure, but new patterns will arise crossing north/south and east/west that could benefit from roads that bypass the urban core.

Implications of Freight Growth on the Transportation System

These patterns in freight demand growth indicate that the interior of the highway network in Harris County will face sustained growth from multiple sectors, both from its own and from crossing traffic, but also that a system focused in Harris County will not be enough. Brazoria County emerges in every dimension as a center of freight expansion, indicating that its few network facilities of SH 288 and FM 2004 will require additional capacity and alternatives. Candidate facilities include SH 35 and SH 36. Capacity improvements to SH 36 will be especially important to accommodate this growth because it reaches the rail intermodal developments in Rosenberg and eventually connects to the Grand Parkway headed toward Katy and ultimately the 290 Corridor. Expansion in Montgomery County means that its southern connection to the region's west end on SH 249 will become important, in addition to IH 45 and U.S. 59, and that east/west routes will require development. Improved east/west routes could be based on existing but limited facilities like FM 2920 and 1488, or new sections of the Grand Parkway. Whatever options are chosen, improved east/west mobility ultimately will need to stretch from U.S. 290 across to Liberty County.

The pattern of growth in freight demand has three features: 1) a major western arc from the 290 Corridor south to U.S. 59; 2) a southeast salient toward League City; and 3) districts surrounding the ship channel.

Grand Parkway elements could play an important role in serving these three regions both east and west. In addition, a route that connects the region's deepwater ports and heavy industrial developments to key markets to the south and the north and bypasses the urban core could divert volume away from the highway funnel inside IH 610, and provide better routes between centers of growth.

Key Challenges

The Houston-Galveston region has enjoyed significant economic growth over the past decades and even though growth has slowed during the current economic recession, the region has outperformed much of the nation. This growth has resulted in significant increases in freight transportation demand, and projections suggest these volumes will expand by another 60 percent by 2035.[42]

The growth has led to increasing pressure on the region's freight transportation system. Some modes have responded better than others, but each faces some significant challenges going forward, and challenges for one mode ultimately spill over and impact other modes. Each of the modes is facing unique challenges but many of these challenges fall into three broad categories-capacity, community conflicts, and institutional/regulatory.

[42] Analysis of IHS Global Insight Inc. TRANSEARCH data by Cambridge Systematics, Inc.

Capacity

The inventory of the regional freight system revealed that many of the facilities and modes already are facing capacity constraints and suffer from significant congestion and delay. For example, the level of service (LOS) on significant portions of key freight highway corridors such as IH 10, IH 45, IH 610, and U.S. 59 is D or F, indicating volume to capacity ratio approaching or exceeding 1.0. Truck volumes are projected to increase by 77 percent by 2035. This means for every 100 trucks on the roads today, there will be 177 trucks in 2035. Furthermore, the growth in truck traffic is projected to be widely dispersed with higher growth rates in the south and northwestern portion of the region.

Congestion on the region's rail system results in 300 daily train hours of delay[43] which leads to increased cost and shipping times for regional shippers. Capacity pinch points include single track mainlines and bridges, inadequate siding lengths and rail yards at or nearing capacity. In addition to the service capacity concerns, the region has car storage capacity challenges. The railroads and shippers (such as the petrochemical firms) combined store upwards to 20,000 rail cars at any given time. The storage of these cars consumes valuable real estate and trackage, yet it is necessary to meet the market demands of key industries. Another important opportunity and challenge facing the region is the introduction of commuter rail. The challenge is that given the existing and future capacity constraints facing freight rail, commuter rail cannot become reality without key investments in the region's rail system. The opportunity is that investment necessary to implement commuter rail will also benefit freight rail as well as the region's highway network. This would give rise to significant public and private sector benefits.

Three of the region's four deepwater ports are planning container terminal expansions to accommodate the increase in local demand as well as to capitalize on the widening of the Panama Canal. The success of these expansions will, in large part, depend on the ability of the region's highways and railroads to accommodate the additional traffic. Another issue impacting the ability of the seaports to expand is the increasing competition for waterfront property for various commercial, industrial, and residential uses. Therefore, it will be important for communities to understand and to balance the tradeoffs of alternative development opportunities for this valuable asset.

Community Impacts

Efficient freight transportation in the Houston-Galveston region is necessary for the region's core industries and economy and to support the quality of life of its residents. However, along with these benefits come significant community impacts. In addition to congestion, community impacts include safety, air quality, noise, vibrations, water pollution, and wear and tear on the infrastructure. The various modes contribute to these community impacts to varying degrees, but addressing any of these impacts requires an understanding of the tradeoffs between the benefits and costs.

Aside from congestion, perhaps the two most frequently cited freight impacts from the community are safety and air quality. Safety concerns arise from several sources, including trucks on the roadways, at-grade rail crossings and the transport of hazardous

43 Houston Region Freight Study, TxDOT 2007.

materials. There were 30,000 truck-involved crashes in the region in 2007, representing about 30 percent of all crashes. These crashes resulted in more than 100 fatalities, 15,000 injuries, and thousands of hours of delay. There are approximately 1,200 at-grade rail crossings in the region, responsible for 300 crossing incidents and 90 injuries and fatalities in recent years. The movement and storage of hazardous materials occurs throughout the region via pipelines, water, truck, and rail. As the growth in the region spreads, there is growing concern that additional response centers will be required. Addressing the safety concerns on the region's transportation system requires understanding and mitigating the role of freight transportation.

Air quality is an important concern for the Houston-Galveston region for health and economic development reasons. Poor air quality gives rise to significant health costs for the region's residents, businesses, and property. It may even lead to increased restrictions on Federal funding if the region doesn't meet its eight-hour ozone Federal attainment date of June 15, 2019.[44] Trucks, trains, ships and barges and aircraft all contribute significantly to damaging emissions. Private carriers have made significant investments in cleaner technologies such as newer engines and locomotives, cleaner burning fuels and changes in operational procedures to reduce idling.

However, many of these changes are costly, both in terms of capital cost and ongoing operating costs, leading some companies to be slow to adopt. Because freight transportation is a significant contributor to poor air quality, mitigation strategies aimed directly at reducing its impact are necessary.

Community impacts give rise to community resistance. The Houston-Galveston region has enjoyed relatively broad acceptance from the community with regards to its continued development of freight intensive industries. One reason for this is the fact that a majority of the activity, and the most significant impacts have occurred in a relatively condensed area in east Harris County. However, growth projections suggest a spreading of both population and employment to the west and south. As these areas experience rapid growth, the demand for freight transportation to support businesses and residents also will increase. This will give rise to increased conflicts and competition for resources between freight and non-freight users. Therefore, steps to mitigate these potential impacts should be taken when planning for this additional growth.

Institutional and Regulatory

A modern freight transportation system requires modern infrastructure and modern governance. Many of the laws, regulations, and arrangements governing freight transportation have not kept pace with the rapidly changing trends shaping the indus-

44 National Ambient Air Quality Standard (NAAQS) standard. More information: http://www.tceq.texas.gov/implementation/air/sip/texas-sip/hgb/sip-hgb/.

try. The result is a series of institutional bottlenecks. While the specific laws and rules impeding the various modes are too numerous to name, there are four categories of institutional and regulatory issues that are creating widespread challenges for the region's freight-related industries. These include funding, security, environmental, and permitted loads.

Funding is a major challenge for freight transportation as the need for additional and more modern infrastructure quickly out-paces the funds available. Complicating the funding challenge is the multijurisdictional, multiparty (both public and private) and multimodal aspects of many of the necessary investments. Our public sector funding systems are not structured to recognize and respond to the nature of freight investments and their resulting benefit streams. This is true for Federal, state, and local funding. For example, improvements in one part of Harris or Brazoria County are likely to benefit the rest of that County, the Houston-Galveston region, the State of Texas and even other parts of the country. Therefore, it is not unreasonable to consider sharing the costs of those investments among the beneficiaries. Current funding systems often do not account for the allocation of benefits across multiple jurisdictions and are based solely on the geographic location of the improvement. Issues with Federal funding sources such as the Harbor Maintenance Tax continue to slow critical investments. There also is an increased need and desire for public-private partnerships (PPP) to address the mounting freight needs, giving rise to a different set of institutional barriers.

Growing security and environmental concerns are leading to significant new regulations on the transport of freight, from increased screening of cargo to restrictions on storage of certain materials to tighter emission and noise standards. While these new requirements may be necessary, they also are potentially very costly to both the freight transportation industry and the ultimate users – businesses and consumers. Understanding and balancing the tradeoffs of benefits and costs of proposed restrictions, whether they be Federal, state, or local is necessary to achieve the desired outcomes without undesirable implications.

A very specific regulatory bottleneck in the region is the movement of permitted loads. Permitted loads refer to the transport of loads that exceed Federal and state size and weight limits and are often called oversize/overweight (OS/OW) loads. These loads require a permit and are restricted to travel only on dedicated routes call heavy-haul routes. These restrictions are in place for safety and infrastructure preservation purposes. However, the designation of heavy-haul routes have not kept pace with the demand for transporting OS/OW loads. The region's key industries, including petrochemical and fabricated metals, and the region's deepwater ports depend on the transport of large pieces of machinery and raw materials. Increasing constraints, whether institutional or physical, hamper the ability to move permitted loads efficiently in the region, potentially putting some businesses and resulting economic benefits at risk. Ensuring regulation can effectively balance the public concerns with the business need for these shipments is critical.

The following chapter will examine more specific needs and deficiencies related to these challenges.

7. Needs and Deficiencies

Freight mobility needs and deficiencies, both existing and future, were identified based on data, technical analysis, and private and public sector stakeholder input presented in previous chapters and in the Commodity Flow Analysis and Regional Goods Movement Profile reports. The needs presented here focus on those of regional significance and on significant freight roadways and corridors identified in Chapter 3. In general, they represent systemic needs. Systemic needs can be defined as universal or general mobility issues that are broader in nature and may reflect infrastructure, operational, institutional, and/or regulatory deficiencies or inefficiencies. The systemic needs for current and future freight mobility in the Houston-Galveston region have been organized into three broad categories, including:

1. System capacity and congestion;
2. Community and environmental impacts; and
3. Institutional and regulatory.

The remainder of this Chapter will discuss these categories and specific deficiencies and issues associated with each. Recommendations for addressing these needs will be addressed in the next phase of the study.

System Capacity

Capacity constraints which rise to congested conditions throughout much of the region was identified as a primary concern by private sector freight stakeholders and public officials. Congestion on the region's surface transportation system has been widely documented. However, many of these previous efforts have focused on either passenger travel or on subregional impacts. The purpose of this analysis is to identify the deficiencies that have a regional impact for freight mobility.

The ultimate goal is not to identify projects that simply add additional capacity, but rather identify a combination of solutions that maximize the velocity or throughput of the region's multimodal transportation system. The first step in the process is understanding what is causing congestion since it is not always simply too much volume. The research conducted and documented as part of this needs assessment and in previous reports for this effort revealed three root causes of congestion, existing and projected.

First, there are widespread physical infrastructure constraints on existing freight-significant roadways. These range from the need for new capacity addition to operational improvements, including infrastructure management and business practices and institutional bottlenecks. While many of these facilities are located in the traditionally industrial districts along the ship channel and other deepwater ports, there are facilities throughout the region that are impacted.

Second, there are new growth patterns emerging that impact freight travel patterns currently and especially in the future. These include robust population growth in the Northwest quadrant, investment in intermodal and inland port facilities in Rosenburg and expansions of the regional port facilities in preparation for more and larger ships. While the existing system connects these regions, it does not do so in a direct manner, leading to spillover congestion issues to other parts of the region.

Third, to date the region's congestion issues have by in large been addressed through single mode solutions without accounting for spillover impacts across modes. The research points to several examples of how the interaction of these two systems result in chokepoints because planning of the two networks do not fully incorporate the systemwide impacts.

These three root causes of congestion impact freight travel throughout the region giving rise to significant needs which are discussed below.

Intermodal Connectors and Key Freight Arterials

A key part of the study effort has been to identify existing and near term needs that have significant impact on freight movements. These types of bottlenecks often include inefficient intermodal connectors and arterials serving historical and newly developed industrial and commercial areas. Focusing on these types of bottlenecks often leads to significant improvements to freight mobility and reductions in community impacts at relatively low costs. Additionally, improving throughput on these facilities can also lead to reduced pressure on other local and regional roadways.

Intermodal connectors provide critical connections between freight nodes and their users. They are a part of any freight system, but given the essential role they play in goods movement they deserve additional focus. The primary points of concern are the ports, the airports, with IAH being the dominant freight facility, and the rail intermodal terminals. Virtually all of these facilities lie along the major arteries. The issue then is ensuring the connections to those arteries can accommodate efficient truck operations and significant truck volumes. In addition, more direct connections may be needed.

Table 7.1 presents examples of intermodal connectors and freight arterials that have various deficient conditions. This list is not intended to represent the full universe of specific needs but rather focus on those having the most impact on the freight network examined in Chapter 3 of this report. Many of the facilities listed have numerous deficiencies, including physical and operational. Examples of the types of needs on these facilities include:

Wallisville Road – Poor pavement, at-grade crossing, lack of access controls, location of schools along route;

Spencer Highway – Poor pavement condition, low-bridge clearances along some segments, lack of access controls, poor turning radii; and

Lee Highway – General congestion due to high volumes of passenger vehicles, bridge limitations, safety hotspot.

Improving the velocity on these existing support facilities plays a critical role not only in addressing congestion, but also in mitigating community impacts (which will be discussed later in this Chapter). Additionally, although these facilities are generally wholly within a single jurisdiction, the impacts of their deficiencies are often felt regionwide.

Congestion in the Urban Core and Access to Regional Growth Areas

The Houston-Galveston region currently is well served by a robust freight network of highways and freeways. The system is organized such that freight traffic tends to be funneled into and then out of the urban core, which currently experiences heavy congestion with many segments of the freeway system operating at or above capacity as evidenced by the LOS on those links. Truck volumes are projected to increase by 77 percent by 2035. Figure 7-1 depicts projected growth in daily truck volumes by the year 2035. It should be noted that this represents the potential routing of trucks given the existing network. The parts of the region experiencing the

fastest growth tend to be in outlying areas to the north, west, and southwest of the region's core. These fast growing areas require good freight connections both among themselves and with existing regional freight clusters. It should be noted that because of the timing of when these forecasts were originally developed, they do not account for some significant new developments such as the Exxon Mobil headquarters in the northwest or significant freight facility developments in Fort Bend County including the Kansas City Southern intermodal terminal, the CenterPoint Inland Port and the potential new UP intermodal terminal. These new developments are, in part, occurring in reaction to the opportunity to expand the Houston-Galveston region's role as a gateway for North American trade.

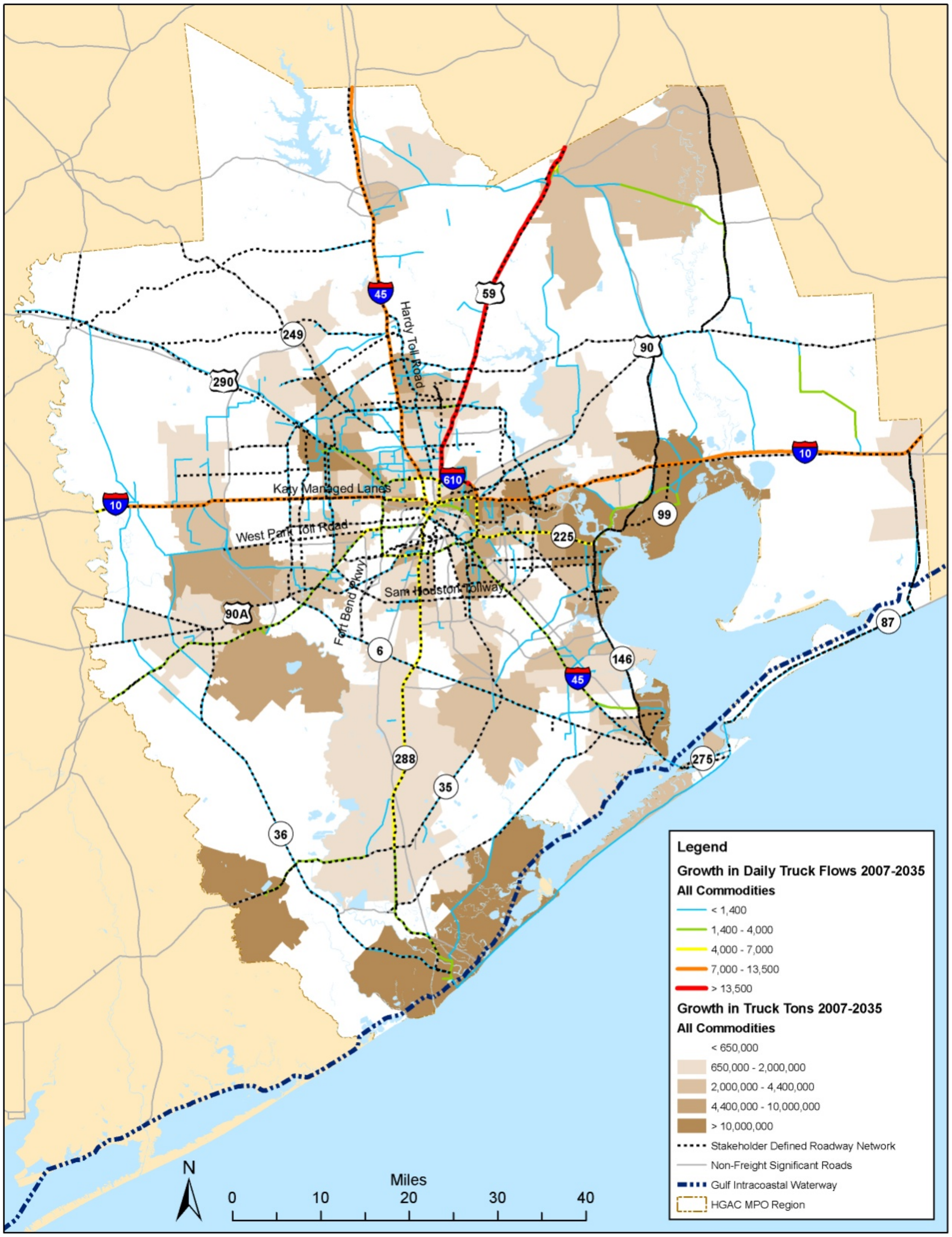
Table 7.1: Intermodal Connectors and Freight-Significant Roadways

Key Truck Route/Intermodal Connector	Key Truck Route/Intermodal Connector
75TH ST	KIRKPATRICK BLVD
AIRPORT BLVD	LANE STREET
ALDINE WESTFIELD	LEE ROAD
ALLEN PARKWAY	LITTLE YORK
ALMEDA	LOCKWOOD DR
ALMEDA GENOA	LOUETTA
BARBOURS CUT PARKWAY	MACGREGOR WAY N
BATTLEGROUND	MACGREGOR WAY S
BAY RD	MANCHESTER ST
BISSONET	MIDDLEBROOK DR
BRAESWOOD N	MYKAWA RD
BRAESWOOD S	NAVIGATION BLVD
BRITTMORE	NOLAN RYAN
BROADWAY	OLD PORT INDUSTRIAL BLVD
C.E.KING	PENN CITY RD
CENTER RD	PINE ST
CHOATE RD	PORT RD
CLAY RD	QUITMAN ST
CLINTON DR	RED BLUFF RD
CULLEN	SCOTT
DECKER DRIVE	SH 146
E. SAN AUGUSTINE ST	SH 35
ELDRIDGE	SHEPHERD
FAIRMONT PARKWAY	SOUTH SHELDON RD
FARRINGTON DRIVE	SPENCER HWY
FEDERAL	STEVENS ST
FERRY RD	SWEETWATER LN
GIN	TELEPHONE RD
GREENS RD	VOLTA RD
HARDY RD	W CANINO RD
HEMPSTEAD HWY	W. BARBOUR'S CUT BLVD
INDUSTRIAL BLVD	W. SAN AUGUSTINE ST
JACINTO PORT BLVD	WALLISVILLE RD
JEFFERSON RD	WILL CLAYTON PKWY
JOHN F KENNEDY BLVD	YALE ST
KENSWICK DR	

Given the current network, much of that traffic will be forced to travel into the core and then out to region fringe. However, the growing demand for freight in these areas is better served by providing linkages that bypass the congested regional core.

Patterns in freight demand growth indicate that the interior of the highway and rail networks in Harris County will experience sustained growth, but also that a system focused in Harris County will not be enough. The region will be well served by the development of viable freight routes and corridors that directly connect the surrounding counties and divert volume away from the highway and rail funnel inside I-610. This will require developing new highway and rail corridors through a combination of upgrading existing new facilities and adding additional facilities.

Figure 7-1 Growth in Annual Average Daily Truck Traffic, 2007-2035



Source: Cambridge Systematics, Inc., based on IHS Global Insight TRANSEARCH.

Bottlenecks at Key Interstate Interchanges and Freight Generators

An area of particular concern from a congestion and safety perspective is interstate interchanges. This is a well known issue, yet these hotspots often cannot be avoided by the trucking community. An analysis of 18 of the region's highest volume interchanges was conducted to identify the interchanges having the most adverse impact on goods mobility and to quantify the extent of that impact. As shown in Table 7-2, the I-10/U.S. 59 interchange received the highest congestion index score (based on number of trucks and differences in posted speed and achieved speeds), indicating that truck mobility is impacted at this location more severely than any other interchange bottlenecks included in this study.

Table 7-2 Freight Interchange Bottleneck Locations in the Houston-Galveston Region with Highest Truck Delay

Rank	Location	Average Speed	Peak Average Speed	Nonpeak Average Speed	Nonpeak/Peak Speed Ratio
1	Houston: IH 10 at U.S. 59	38.6	29.5	43.5	1.48
2	Houston: IH 45 at U.S. 59	37.1	29.4	40.7	1.38
3	Houston: IH 10 at IH 45	39.6	29.7	44.6	1.50
4	Houston: IH 45 at IH 610 (N)	41.5	33.8	45.2	1.34
5	Houston: IH 610 at U.S. 290	44.6	35.3	49.1	1.39
6	Houston: IH 45 at IH 610 (S)	49.3	41.7	53.1	1.27
7	Houston: IH 10 at IH 610 (E)	49.8	45.1	51.9	1.15
8	Houston: IH 610 at U.S. 59 (W)	43.8	38.3	46.0	1.20
9	Houston: IH 10 at IH 610 (W)	50.4	43.6	53.2	1.22
10	Houston: IH 45 at Sam Houston (N)	51.1	44.4	54.2	1.22

Source: ATRI.

In addition, issues such as lane drops and truck-automobile interactions that result from weaving are examples of issues leading to congestion at many of these interchanges and thus on the region's freeways. These issues represent systemic deficiencies and an analysis will be undertaken for example interchanges to develop a set of mitigation strategies for the recommendations development phase.

Rail Capacity Constraints

Congestion on the region's rail system results in 300 daily train hours of delay,[45] which leads to increased cost and shipping times for regional shippers. The volume of direct service that Houston enjoys is high for an urban area, after an era when rail sidings around the U.S. were pulled out of industrial

[45] Houston Region Freight Study, TxDOT 2007.

sites and new facilities were built without them. While many cities have grown dependent on truck drayage to connect to train service, Houston has retained much of its rail infrastructure on carrier and private property. It connects to more than 900 active customers, according to the HRFS. Direct rail service requires a substantial amount of supporting infrastructure and regional operation. The reason for this is to sort railcars between road and local trains at classification yards, to allow local and road trains to pass one another as the former make pickups and deliveries and the latter travel to intercity routes, and to manage equipment supplies at carrier and customer sites.

Capacity pinch points include single track mainlines and bridges, inadequate siding lengths and rail yards at or nearing capacity. According to the Houston Regional Freight Study conducted by TxDOT in 2007 and input from the Gulf Coast Rail District and representatives from the region's Class 1 railroads, top rail network deficiencies and bottlenecks in the region include:

- Single track bridges over the Buffalo Bayou (Bridge 16 on the East Belt Junction and Bridge 5A)
- Single track lines including on the West Belt Subdivision north from Freight Junction through Belt Junction, between Galena Junction and Manchester Junction, between Sinco Junction and Deer Park Junction, and east from Dawes to Sheldon;
- Capacity constraints at rail yards inside IH 610. The concentration of the region's rail yards, and the related concentration of traffic in a district whose infrastructure was designed many decades earlier, are conditions that create congestion and delay. The HRFS describes the essential difficulty as twofold- repetitive switching by yard engines competing for track space with local and road trains and the capacity consumed by the length of contemporary trains(more than a mile in many cases) and the time it takes to stage them;
- Numerous grade crossings on the West Belt subdivision which raise safety concerns and slow speeds for both trains and roadway traffics, thus reducing velocity on the rail line and numerous major thoroughfares; and
- Many of the networks' sidings and spurs serving major industrial customers are too short to accommodate today's longer trains. This results in excessive switching times and delay waiting for on-coming trains to pass, both of which constrain network capacity. In addition, it can lead to longer delays for roadway users and increased safety and air quality impacts due to increased blockage of at-grade crossings.

In addition to the service capacity concerns, the region has car storage capacity challenges. The railroads and shippers (such as the petrochemical firms) combined store upwards to 20,000 rail cars at any given time. The storage of these cars consumes valuable real estate and trackage, yet it is necessary to meet the market demands of key industries.

Rail tonnage is projected to grow by 65 million tons, or 55 percent, by 2035. Coal is the expected driver of rail growth, by itself accounting for almost one-half of the new tonnage and with all of it moving in the inbound direction. Chemicals grow slowly and petroleum products by rail remain steady. Intermodal traffic is projected to be the fastest growing, increasing 170 percent by 2035. Failure to invest in additional capacity, including yard and storage capacity, will result in increased inefficiencies and shipper costs as well as diversion to truck, all of which will decrease the economic competitiveness of the region. Concurrent with rail freight capacity issues is the potential future demand for increased rail passenger service in the region. The challenge for new passenger rail service is the need for right-of-way which is typically sought from the freight system. However, the already strained freight rail network has little if any capacity to spare. Planning and managing the rail system for shared usage will

be crucial for meeting the region's mobility needs for both goods and people, and this will require significant levels of public and private sector partnering and collaboration.

At-Grade Rail Crossings

Although there has been continued improvement in reducing and enhancing at-grade crossings, they continue to be an issue for local communities and shippers throughout the region. There are an estimated 1,200 at-grade rail crossings in the Houston region, with a daily road volume approaching five million cars and trucks.[46] Between 2003 and 2007, the region experienced a total of 315 crashes at rail crossings highlighting safety risks.

At-grade crossings also impose traffic delays causing trains to slow and cars and trucks to wait for them to pass. From a freight rail perspective, a single at-grade crossings usually does not have significant impacts on overall network operations. Thus, eliminating them via grade separation often is not a priority unless it is part of a program of multiple crossing eliminations (which can include closures as well as separations) that leads to a sealed corridor. In this case, the benefits to freight rail may justify investment.

However, from a truck perspective, the high number of at-grade crossings in the industrial and port districts of east Houston cause significant delays due to crossing queues that occur almost daily. A related concern is the high volume of hazardous materials shipped across the network by the petrochemical industry. The volume of hazardous truck and rail shipments, in a region where such movements often may cross, highlights the importance of addressing at-grade crossings. Additionally, from a community perspective, at-grade crossings raise significant concerns including travel delay, safety, air quality and noise.

Table 7-3 displays the busiest at-grade rail crossings for each county in the region based on the number of trains and average annual daily traffic at those crossings. Harris County leads the region in terms of both the number of crossings and the busiest crossings. Fort Bend County is second in terms of busiest crossings with Sugar Land and Stafford being home to significant crossings and resulting congestion, safety, and noise impacts. Montgomery County also has numerous busy crossings with the most notable in the Woodlands at SH 242 with about 41,000 vehicles and 31 trains crossing daily.

[46] The Houston Region Freight Study, TxDOT, 2007.

Table 7-3 Busiest At-Grade Crossings by County

County	City	Road Name	Railroad	AADT	Number of Trains
Brazoria	Pearland	Broadway Street	BNSF	24,000	32
Brazoria	Alvin	Gordon Street	BNSF	14,300	43
Brazoria	Clute	Bus 288	UP	13,600	12
Brazoria	Brazoria	Brooks Street	UP	13,300	16
Brazoria	Alvin	2nd Street	BNSF	8,560	43
Chambers	Baytown	Fisher Street	UP	9,100	3
Chambers	Mont Belvieu	FM 565	UP	7,400	3
Chambers	Mont Belvieu	FM 1942	UP	6,600	8
Chambers	Baytown	FM 1405	JSC	4,200	3
Chambers	Baytown	FM 1405	UP	4,000	6
Fort Bend	Sugar Land	SH 0006	UP	39,000	30
Fort Bend	Sugar Land	SH 6 Frontage Roads	UP	39,000	30
Fort Bend	Sugar Land	SH 0006	UP	34,000	30
Fort Bend	Stafford	FM 1092 SB Frtg Road	UP	26,000	30
Fort Bend	Stafford	FM 1092 NB Frtg Road	UP	26,000	30
Galveston	League City	Main Street	UP	31,000	6
Galveston	Dickinson	San Leon Street	UP	19,000	7
Galveston	La Marque	Texas Avenue	UP	15,500	12
Galveston	Galveston	Port Industrial	BNSF	14,100	17
Galveston	Alvin	CR 155	BNSF	710	34
Harris	Houston	I-610 WB Frontage Road	UP	193,380	4
Harris	Houston	Nance Street	UP	163,508	8
Harris	Houston	Avenue P	PTRA	118,140	8
Harris	Deer Park	Pasadena Freeway	UP	84,210	12
Harris	Houston	SH 249 SB Frontage Road	BNSF	82,270	14
Harris	Houston	Main Street	UP	64,000	28
Harris	Houston	Post Oak-West Junction	UP	54,460	33
Harris	Lomax	SB Frontage Road	UP	67,980	6
Harris	Tomball	FM 1960	BNSF	55,000	19
Harris	Missouri City	Fondren Road	UP	36,580	33
Liberty	Liberty	Old Spanish Trail	UP	20,000	0
Liberty	Cleveland	Houston Street	UP	19,400	10
Liberty	Dayton	U.S. 90	UP	13,600	11
Liberty	Liberty	SH 146	UP	10,100	13
Liberty	Liberty	Main Street	UP	7,900	16
Montgomery	The Woodlands	SH 242 EB Frtg.	UP	41,000	31

County	City	Road Name	Railroad	AADT	Number of Trains
Montgomery	Humble	Kingwood Drive	UP	38,610	10
Montgomery	Porter	Northpark Drive	UP	30,720	10
Montgomery	Conroe	SH 105 E.	UP	17,200	31
Montgomery	Conroe	FM 3083 N. of Conroe	UP	14,300	29
Waller	Hempstead	Austin Street	UP	9,800	10
Waller	Brookshire	Baines Street	UP	10,700	4
Waller	Waller	FM 362	UP	5,000	10
Waller	Hempstead	E. Hempstead	UP	4,300	10
Waller	Magnolia	Fetzer	UP	1,060	18

Source: TxDOT.

While there are plans to eliminate some of the crossings in the region, currently there is insufficient funding to complete many of the projects. With over 1,200 crossings in the region and limited funding, grade separation is not a feasible option for most crossings. A program is needed that identifies and prioritizes candidates for crossing safety enhancements, crossing closures and grade separations along priority corridors based on benefits and costs.

Regional Strategic Truck Route System

A cohesive and efficient regional truck route system is desirable because it fosters better and more sustainable freight service, which in turn promotes economic vitality; it supports productive use of limited public resources as well by focusing them on critical requirements; and it leads to greater public safety because freight operations are improved on high-traffic routes, and the improvement encourages freight to stay off other roads.

The stakeholder-identified network presented in Chapter 3 provides a good starting point for such a system. It includes the heavily traveled routes that trucks should be using, it serves the critical segments and centers of the economic geography, it reaches the key intermodal transfer points, and it ties together the greater Houston region with multiple and cross-regional routes. However, the system is incomplete in that it does not offer adequate capacity for future goods movement and many of the facilities are not "truck friendly."

The preliminary system has to be evaluated and improvements made to meet trucking needs including adequacy, including road geometry (for example, lane and shoulder widths, sight distances, and clearances), adjoining land use and operating conditions, In addition, the network as a whole must serve the needs of the freight industry while mitigating the negative impacts on the surrounding communities.

Design Standards to Accommodate Modern Freight Vehicles

The field work and interviews uncovered systemic issues related to inadequate design for efficient operations of modern day trucks and trains. On highways, the design deficiencies included inadequate turning radii at key intersections, on and off ramps on the areas freeways, bridge clearances and weight restrictions; pavement conditions and standards, lane drops and freeway access roads. On the rail system, inadequate siding and spur lengths and yard trackage create challenges in operating today's longer trains.

These types of issues were widely reported and observed throughout the region but are most prevalent on older infrastructure in the urban core. An often cited example is short ramp lengths on I-45 in downtown Houston. The short ramps create dangerous merging situations, particularly for heavy trucks entering and make it difficult to accelerate to highway speed. Also, the mixed use nature of these ramps puts trucks in jeopardy of merging passenger vehicles. Pavement conditions and standards in the heavy industrial area of east Houston also was referenced frequently. Poor road conditions give rise to increased wear and tear on vehicles as well as damage to the cargo. Inadequate turning radii and signal timing are common along signalized commercial routes such as Westheimer Road.

Design deficiencies can impose significant costs on operators and shippers in the region through increased travel times, increased safety hazards, wear and tear on vehicles, and inability to operate traditional fleet sizes. Mitigation measures for design deficiencies can range from being cost prohibitive to being relatively quick fixes.

Development of Heavy Haul and HazMat Networks

The oversize and overweight or heavy haul cargo is largely comprised of components used in the oil industry, on platforms, and drilling operations which are either manufactured in the Houston region or imported from elsewhere as project cargo through the port. There also are heavy and oversize loads that are not petrochemical in nature: such as large concrete members for construction and windmill blades.

Trucks are involved in moving this specialized cargo both through and within the region. Connections are made to the port for international shipments and to the barge terminals and rail facilities. Overweight and oversize (OS/OW) loads require special permits that are issued by the State of Texas, and are sometimes also issued by the communities where the shipment passes through. These are normally restrictive as to routes allowed. In February 2011, TxDOT announced a project to introduce a system for on-line permits and routing for overweight and over dimension traffic. This system will be available on the Internet to improve the efficiency of the permitting process. There is a need for further cooperation between TxDOT and other local jurisdictions that issue OS/OW permits to streamline the process.

While OS/OW shipments represent a relatively small portion of total truck movements, they are critical to the region's key economic engines – the ports and the petrochemical industry. A basic need is for heavy carriage to be able to connect the Port of Houston terminals that regularly handle "project cargo" to all quadrants of the region. To an extent, the interstates and a few other highways accomplish this, but a supporting system of connection somewhere outside of the I-610 loop is needed.

Improving the system for handling OS/OW cargo will require further research and careful planning. Houston has a relatively large proportion of freight requiring special permits, all of which moves in congested areas. More needs to be done to select and protect the routes best suited to meet both the safety and security requirements for the municipalities, the State, and the Federal governments, as well as the operational efficiency needs of the carriers and the shippers engaged in this business. One issue in par-

ticular that requires further analysis is that of maintaining clearances for cargo that is overheight. As more overpasses and underpasses are built to support regional growth, a potentially unintended consequence can be the closing off of key haul routes for overheight shipments.

Hazardous cargo is frequently generated by the petrochemical industry. Since this industry is particularly important to the region, being able to safely move this freight is therefore critically important. The U.S. DOT has published a list of prescribed and restricted hazardous materials routes that, when combined, present a collection of disconnected route segments. A higher density and better connected network of hazardous material routes based on the competing objectives of improving safety and preserving operational efficiencies would be beneficial to the region.

Expanded Truck Staging and Parking Facilities

Trucks require short-term parking for staging when they arrive early to their delivery destination and longer-term parking to comply with Federal hours-of-service regulations. Safety regulations imposed by the Federal Motor Carrier Safety Administration (FMCSA) limit the number of hours a driver can operate a truck in a 24-hour period and specify minimum off-duty requirements when operating a truck. To comply with these regulations, drivers need parking facilities along their routes to stop and rest. While full-service facilities (usually private and requiring a highway exit) can provide local economic benefits relative to public or "concessioned" roadside limited-service truck stops, the latter play an important role in improving safety and mitigating negative local impacts at highway exits by enabling combination trucks to stay on limited access highways.

Interviews, field observation, and collection of GPS data indicated a growing shortage of designated truck parking and staging areas in the Houston-Galveston region. This is due to an increased demand for the facilities and decreasing supply as a result of competing land uses and local ordinances. The shortage of designated areas leads to undesirable consequences such as spillover onto area roadways, shoulders, ramps, and trespassing on vacant lots.

Community and Environmental Impacts

Goods movement gives rise to significant community and environmental impacts, both positive and negative. The activities and facilities generating the majority of freight traffic gives rise to significant economic benefits. However, freight also gives rise to negative impacts including safety concerns, air and water quality issues, and excessive noise, vibration, or lighting from freight movements and freight industries, all of which result from land use conflicts. Another issue is the potential for disproportionate impact on communities with environmental justice populations.

Economic Benefits

As one of the nation's fastest growing regions, the Houston-Galveston metropolitan area is expected to add another three million people by 2035. Employment is projected to increase by 1.25 million jobs over that same period. The expected geographic distribution of this development suggests continued in-fill and densification on the one hand, and robust suburbanization, especially in the northwest of the region, on the other. Employment will remain concentrated in the region's core (Harris County will account for nearly 60 percent of projected job growth) but also dispersed throughout the region, primarily along major roadways. These growth patterns will tend to drive the demand for retail goods outside the core of Houston, thereby increasing the demand for warehousing and distribution facilities in the outer counties.

The Houston-Galveston region's deepwater ports and international airport make it not only a regional economic powerhouse, but also a global gateway. This provides the region with opportunities to expand its global economic position. The widening of the Panama Canal and the expansion of trade through NAFTA and other trade agreements are global trends most likely to impact the region.

Widening of the Panama Canal will, in the near term, likely accelerate growth at the Port of Houston's container terminals. In the longer term, as improvements at the Ports of Galveston and Freeport come online and shippers evaluate their supply chains and develop new distribution centers, the volume of intermodal freight through the region will grow significantly. This growth may further strain intermodal access to key port terminals and inhibit the ports from effectively serving key regional and national markets. Concurrently, growth in trade with Mexico and Central and South America will increase the flow of north-south truck traffic passing through the region, further straining the highway and rail systems. Completing the I-69 corridor will absorb some of this growth but it also is critical that the region undertake planning activities to ensure sufficient truck and rail supply are in place to handle this growth.

The potential increase in freight moving through the region's ports might be hampered by lack of capacity of key intermodal connectors. Improving these roadways is especially challenging since most of them are local roadways, and local agencies sometimes are hesitate to invest their scarce transportation funds on improvements that frequently benefit the regional and national economies more than local ones. In addition, improving rail capacity to accommodate the projected growth is difficult due to high infrastructure costs and network capacity bottlenecks on the national system that can limit the ability of rail to capture more of the freight generated by some ports.

Navigating these challenging issues is necessary for the region to capitalize on the economic growth potential inherent in these global trends.

Safety

Aside from congestion, perhaps the two most frequently cited freight impacts from the community are safety and air quality. Safety concerns arise from several sources, including trucks on the roadways, at-grade rail crossings, and the transport of hazardous materials. There were 30,000 truck-involved crashes in the region in 2007, representing about 30 percent of all crashes. These crashes resulted in more than 100 fatalities, 15,000 injuries, and thousands of hours of delay. There are approximately 1,200 at-grade rail crossings in the region, responsible for 300 crossing incidents and 90 injuries and fatalities in recent years. The movement and storage of hazardous materials occurs throughout the region via pipelines, water, truck, and rail. As the growth in the region spreads, there is growing concern that additional response centers will be required.

The highest concentrations of crashs throughout the region are at major intersections and most commonly where major highways interchange with I-610, the inner loop. This is a critical issue in route planning and is important in the terms of hazardous materials flow since these facilities also are designated HazMat routes. There is essentially no way to avoid these points in the network. Therefore, safety improvements have to rely on changes to the

existing infrastructure and processes, including community education, to create a smoother flow of traffic in the transitions.

Air Quality

The Houston-Galveston region has localized air emission concentrations that contain pollutants of significant concern to public health, including: Nitrogen Oxides (NO_x), Particulate Matter ($PM_{2.5}$ and PM_{10}), Carbon Dioxide CO_2, and Volatile Organic Compounds (VOCs). Trucks contribute a considerable share of pollutants to the regional atmosphere. Calculating the annual truck-related emissions in the eight-county Houston-Galveston region shows that trucks emit 72 percent of the region's transportation-related NO_x, 68 percent of the transportation-related $PM_{2.5}$, 53 percent of the region's transportation-related CO_2, and 37 percent of the region's VOCs. These pollutants also lead to excess ground-level Ozone. Ozone (O_3) is formed when emissions of NO_x chemically react with VOCs under conditions of heat and light (i.e. sunshine). The region has been designated as severe nonattainment in terms of the eight-hour ozone National Ambient Air Quality Standard (NAAQS) standard, and is facing a Federal attainment date of June 15, 2019.[47]

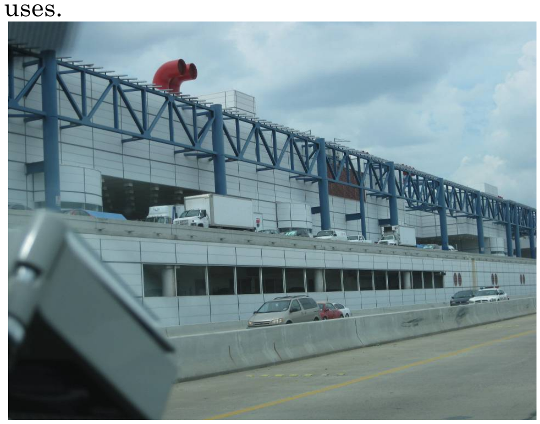
Poor air quality is a serious regional issue. It leads to significant impacts on the region, including increased health concerns and costs and increased business costs. Given the significance contribution of truck emissions, the success of mitigation measures depends on reducing emissions in this sector.

Land Use Conflicts

Industrial land uses and residential land uses are not traditionally thought of as "good neighbors." In addition to congestion, safety, and air quality concerns, residents living near freight facilities tend to be sensitive to light, noise, and excessive vibration.

The region has several pockets of development that give rise to these conflicts, including the east Houston area (including the City of Baytown where demand for industrial land continues to expand); along the Gulf Intercoastal Waterway where there is intense competition for waterfront property from commercial, industrial, and residential users; and in North Houston suburbs where there is demand for expanding warehousing and distribution facilities surrounding the IAH air cargo facilities.

Freight intensive land uses are an essential part of the region's landscape. The demand for new and expanding facilities will be robust in the future so it is important for local governments and H-GAC to plan for these activities. The planning should be structured in a way that promotes a peaceful coexistence between freight and nonfreight uses.



Environmental Justice

The impression conveyed by the analysis of the is that EJ areas are extensive especially those of moderate degree, and a transportation network covering the region may be unable to avoid them. Several of them surround such primary thoroughfares as SH 288, and the outer reaches of U.S. 59, 90, and 290. Additionally, many of the significant areas coincide with important industrial zones, particularly for the petrochemical and port cluster to the east, and the consumer product distribution and other manufacturing activity focused in Harris County. The interspersion of

47 http://www.tceq.texas.gov/implementation/air/sip/texas-sip/hgb/sip-hgb/

residential with industrial buildings is widespread through the region and makes it unlikely that businesses can receive freight services without imposing neighborhood effects. A number of the designated HazMat routes lie in the midst of significant EJ communities. In view of the volume of such activity in the greater Houston region and its connection to a principal driver of the economy, it presents a challenging concern. These points suggest that the environmental justice needs cannot be eliminated by rerouting transport, but rather they can be mitigated by aggressive management of the safety and emissions profile of the activity. Because a well-defined network develops routes that are appropriate to large commercial vehicles and fosters productive operations throughout the territory, it is in fact a means by which safety and emissions objectives can be reached.

Institutional and Regulatory

A modern freight transportation system requires modern infrastructure and modern governance. Many of the laws, regulations, and arrangements governing freight transportation have not kept pace with the rapidly changing trends shaping the industry. The result is a series of institutional bottlenecks. The primary categories of institutional bottlenecks for freight transportation are lack of awareness and integration into local and regional public policy and decision making, inadequate funding streams and financing mechanisms, and, spillover effects of industry regulation.

Education and Public Awareness

The lack of knowledge and understanding of the goods movement industry on the part of public sector planners and decision makers and the general public is a significant barrier to effective freight planning. In discussing the goods movement industry, the key problem is the belief that in exchange for limited economic rewards, the freight sector saturates our transportation infrastructure and cause enormous health and safety issues.

It also is commonly believed that the primary beneficiaries of the freight and logistics sector are private businesses who benefit from lower transportation cost while not paying their fair share for Houston's overburdened infrastructure. On the other hand, statements that the goods movement sector benefits the region's economy are generally so vague as to offer no direct answer to these objections or carry little credibility.

The ability to advance the need for more proactive freight mobility planning, and especially for freight-specific projects, will hinge on the level of public awareness with regards to the benefits of freight planning and the impact of freight mobility on overall system performance, regional competitiveness and quality of life. The benefits need to be communicated in a way that resonates with the general public in terms of how their daily life depends on freight movement. The communication of these benefits (as well as the cost of not providing for efficient freight mobility) is essential to move from a "not in my backyard" (NIMBY) mentality with regards to freight activity to one of accommodation while mitigating the negative impacts.

The need for communication and awareness goes the other way as well. The private sector, in large part, is not familiar with the public sector planning and decision-making process. As a result, they often do not know how to be involved or why they need to be. Given the prominence of the freight industry in H-GAC, there are several industry groups that facilitate a dialogue between the public

and private sectors, including the Gulf Coast Rail District, Greater Houston Partnership, and the Port Economic Alliance. These groups, along with the H-GAC, provide a good foundation for the development of effective and productive public awareness campaigns.

Regional Approaches

Freight movements are interstate and intraregional by nature. They cross jurisdictional boundaries and require regional corridors and systems that connect to freight facilities and customers, often via local roads. The multijurisdictional nature of freight flows means that bottlenecks or inefficiencies in one local community impacts communities throughout the Houston-Galveston region. In addition, because of the volume of goods flowing through the region to the rest of Texas, local bottlenecks and deficiencies can have much broader statewide impacts. While the analysis conducted for this study identified a myriad of needs, a common element was the regional nature of the impacts of the deficiencies and the need for regional approaches and cooperation in addressing those needs.

Just as the goods and costs of inefficiencies flow across jurisdictional boundaries, so do the benefits. One example is the significant cost of keeping roads in the heavy industrial east portion of Harris County in a state of good repair. The County must fund the repair of these facilities, yet the roads clearly benefit the whole region and much of the state as the roads serve the Port of Houston as well as the petrochemical industry, both of which are regionwide and statewide economic engines. Identification and allocation of benefits of investments is needed to understand who benefits and the magnitude of those benefits. This type of analysis could help inform and facilitate alternative approaches to financing the needed improvements.

Institutionalize Freight in Regional Planning Activities

Many of the specific bottlenecks and needs are either under local or state domain, thus making it more difficult to employ regional approaches. However, H-GAC is a regional planning agency and has the ability to influence local planning decision through various programs and processes. H-GAC is making strides in integrating freight into its planning processes as evidenced by the current study as well as the on-going development of a regional truck travel demand model. However, freight should be integrated into all of H-GAC's planning processes as it shares the system with passenger travel. For example, bicycle and pedestrian planning must consider the implications of freight travel when planning these facilities on routes used by trucks or unintended safety, mobility and potential health risks arise.

The goal is balancing the needs and tradeoffs so as to maximize the benefits while mitigating negative impacts to all users of the system. That means the real challenge for local and regional planners and decision makers is to plan for and manage a shared system which means freight has to be part of the on-going process.

Industry Regulatory Bottlenecks

The most critical national, state, and local regulatory issues influencing the regional goods movement, both now and in the future, are safety and security, trucking regulations; and local ordinances.

Chapter 5 provided a detailed discussion of specific regulations that give rise to unintended inefficiencies. The regulations having the most direct, significant impact on the region include:

- FMCSA Hours of Service and Size and Weight regulations have numerous direct impacts including the number of trucks on the roadway, the system state of repair, design standards for roadways,

bridges, tunnels, overpasses, etc., system safety, parking needs, location of distribution and warehousing facilities, air quality, economic competitiveness, modal choice and public revenues.

- State and local regulations for permitted loads has direct impacts on the region's ability to accommodate the movement of large pieces of equipment and materials critical for the region's petrochemical industry and port activity. In addition, there are implications for international container movements as many of those containers arrive at port heavier than what is allowed on the connecting roadways.

- Safety and security regulations at all level of government impact freight transportation. The primary avenues of impact for the Houston-Galveston region is the transport of hazardous material, due to the extremely large volume in the region, and increased cargo screening at port and rail facilities. The first has direct impacts on the location of certain types of activities that generate and store hazardous materials as well as modal and route choices. The second will have immediate impacts on throughput capacity at the regions terminals meaning reduction in productivity and increases in costs.

- Local ordinances and land uses can lead to unintended consequences for both businesses and residents. As discussed in Chapter 6, the primary drivers of freight demand are population and employment growth. Thus, where there are people and jobs, there will be freight and this can give rise to land use conflicts. In the absence of mitigation strategies, these conflicts can result in increased congestion, noise, lighting and vibration disturbances, health impacts and other community and environmental impacts. Often, these impacts lead to local communities passing ordinances that create additional costs for local businesses and even limit potential mitigation strategies. For example, one potential strategy for mitigating congestion on busy commercial/commuter corridors during peak times is for local businesses to move pick-ups and deliveries to off-peak. This reduces the number of trucks vying for space on the roadways during heavy commute periods. However, if a local community has enacted a noise ordinance restricting certain types of activities at businesses located near residential areas (such as grocery stores and retail outlets), off-peak deliveries may not be an option as a congestion mitigation strategy.

Freight Funding

There is growing awareness of the lack of diversity of funding sources for freight projects, in particular those that are multi-modal in nature. For example, highway agencies, much of the trucking industry, and portions of the construction industry are opposed to opening the Highway Trust Fund for investments in non-highway projects, fearing that this will aggravate the short-fall in investments in highways. On the other hand, railroads continue to seek federal funding through various mechanisms such as discretionary grants and tax credits while largely not participating at all in funding improvements for intermodal connectors serving rail facilities. The modal silo approach to financing our nation's transportation system continues to be an obstacle to an effective national funding program for freight. This modal silo approach spills over into the State and the Houston-Galveston region.

An overview of the various funding programs and financing mechanisms is provided in Chapter 5. Also discussed are some the advances the region has made in overcoming the institutional bottlenecks related to funding. However, more needs to be done and this require the engagement of the full spectrum of public and private sector stakeholders at the local, regional, state and

national levels in a discussion about who benefits from freight investments and how to pay for them. Without establishing a framework and environment to facilitate this type of dialogue and decision making, the chances of significantly enhancing funding available to address the needs discussed within this report are not bright. Meeting today's challenges and capitalizing on tomorrow's opportunities will require an open, honest and transparent discussion on funding options and cost sharing.

Summary

Goods movement needs represent the needs of private sector freight stakeholders, the region's businesses, residents and the public sector. The private sector freight stakeholders need to be able to move their cargo safely and efficiently. Businesses need to be able to receive their supplies on time, at the least cost possible and to be able to ship their products to their customers no matter where they are located throughout the world. Residents need to be able to purchase the goods they need and want and they need to be able to enjoy livable communities that preserve a quality of life and standard of living. The public sector needs to be able to provide a competitive environment for business, develop a healthy tax base and provide essential services for all it constituents including transportation infrastructure and services.

The needs assessment revealed three primary categories of needs and deficiencies: 1) Capacity and congestion; 2) Community impacts including air quality and safety; and 3) Institutional and regulatory bottlenecks. For each of these categories, specific infrastructure, operational and institutional deficiencies and bottlenecks were identified. The next phase of the study is to develop recommendations to address the current and future deficiencies.

The needs assessment and compilation of proposed improvements suggest three broad strategic directions for addressing existing and future freight infrastructure needs. Each of these strategic themes involves infrastructure, operational and institutional improvements that address a variety of capacity chokepoints, community impacts and institutional issues. The three strategic themes include:

1) Address existing deficiencies and near term needs;

2) Position for future growth by providing access to growing, maturing economic centers outside the urban core; and

3) Pursue multimodal opportunities that balance freight and passenger needs.

The needs and resulting strategic themes identified in this report will form the basis for developing regional recommendations. The recommendations will focus on systemic issues and bottlenecks by focusing on illustrative examples of specific projects. Recommendations will encompass solutions that focus on infrastructure enhancements, operational improvements, and institutional changes. The final recommendations will be derived through a combination of technical analysis and stakeholder and public input.