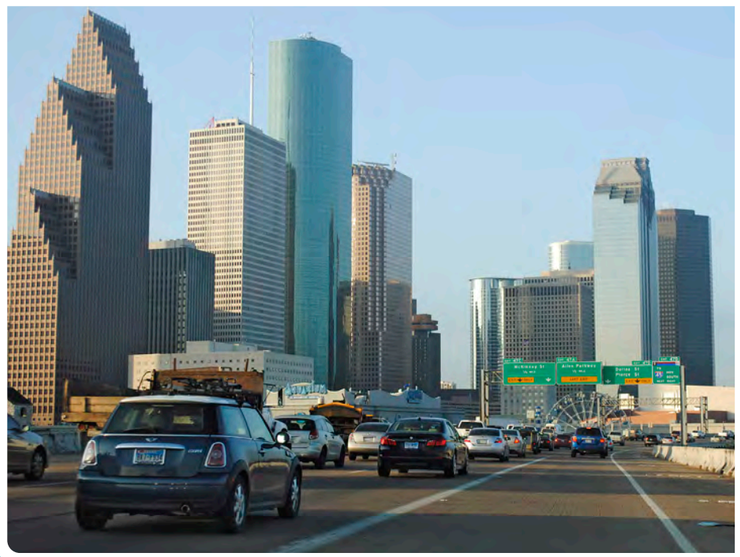
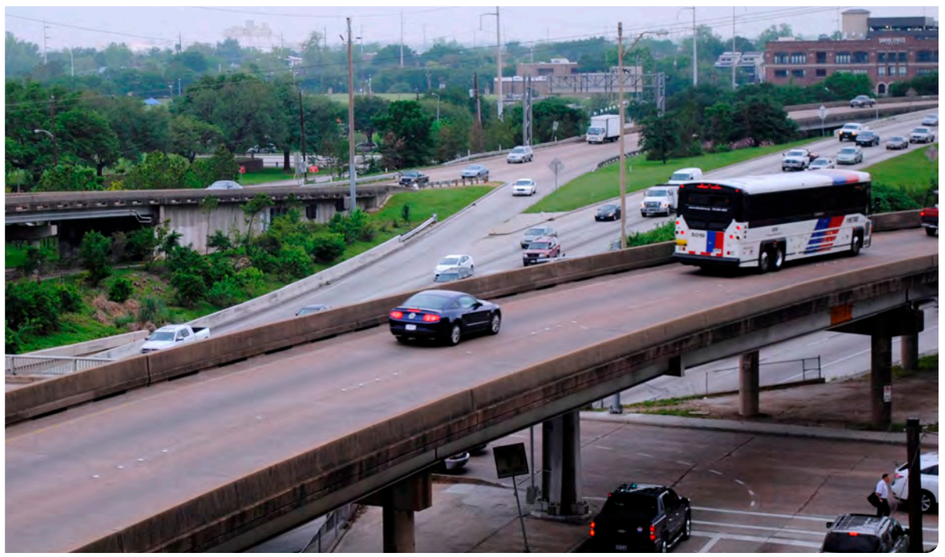
I-45/Hardy Corridor Study Update

DRAFT REPORT
AUGUST 2014

Texas Department of Transportation





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AUGUST 2014

Prepared for:

Texas Department of Transportation

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Chapter 1
Existing Conditions

This report is an update to the I-45/Hardy Traffic Study completed in September 2006. The purpose of this study is to re-evaluate the existing and future transportation conditions along the I-45 and Hardy Toll Road corridors based on the latest available information. The study area for this update includes the existing I-45 and Hardy corridors from Sam Houston Tollway/Beltway 8 to Downtown Houston including the Downtown loop system which consists of I-45/I-10/US 59, and US 59 from the I-45/US 59 interchange to Spur 527. The study corridors are illustrated in **Figure 1-1**.

Study Background and Purpose

This report is presented as part of an overall study sponsored by the Texas Department of Transportation (TxDOT) to evaluate alternative transportation improvements along the I-45 and Hardy Toll Road corridors including the Downtown loop system. The existing and future traffic analysis, conducted as part of this traffic study update, will be used in the development of transportation improvements and evaluation of traffic/mobility impacts associated with these various alternatives.

A major component of this study includes the development of a traffic simulation model, using VISSIM software, to evaluate the existing and future traffic operations. The model was developed for the Downtown loop system (I-45/I-10/US 59) and US 59 from I-45 to Spur 527 including the US 59/SH 288 and US 59/ Spur 527 interchanges. This model incorporates detailed roadway geometry, traffic flow characteristics, and driver behavior parameters to assess existing and future traffic operations, and also evaluates operational impacts of various transportation improvements developed for the Downtown loop system. A detailed model development process is discussed in Chapter 2 of this report which includes model parameters, input data, and calibration results.

This chapter discusses existing conditions including roadway facilities, transit system rail facilities, roadway functional classifications, existing traffic characteristics including traffic volumes, level-of-service and crash history, and a regional travel demand model that was utilized to forecast future travel demands and patterns in the study area.

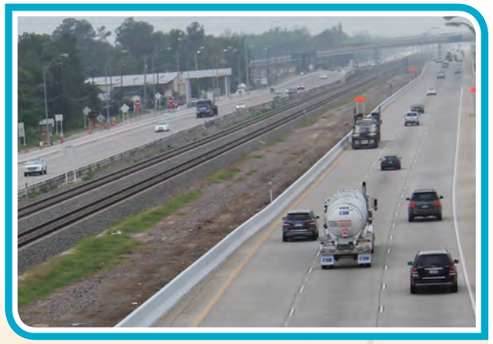
Roadway Facilities

This section describes the freeway facilities within the study area including I-45, Hardy Toll Road, I-10, US 59, Sam Houston Tollway/Beltway 8, I-610, SH 288, and Spur 527 as well as a brief discussion of major arterials within the I-45 and Hardy Toll Road corridors.

I-45

I-45 is a major north-south freeway within the Houston metropolitan region. The northern portion of I-45 within the region is commonly referred to as the "North Freeway", and the southern portion connecting Downtown Houston with Galveston is referred to as the "Gulf Freeway". Within the study area, I-45 generally carries three to five general purpose (GP) lanes in each direction with one-lane reversible barrier-separated High Occupancy Vehicle (HOV) lane in the center. The number of travel lanes along the freeways within the study area is shown in **Figure 1-2**. North of Sam Houston Tollway/Beltway 8, I-45 is an 11-lane section with 10 GP lanes plus one HOV lane, between Sam Houston Tollway/Beltway 8 and I-10, I-45 is a nine-lane section with eight GP lanes and one HOV lane, and in the Downtown area there are six GP lanes between Allen Parkway and US 59.

The posted speed limit along I-45 in the study area is 60 miles per hour (mph). Within the study area, I-45 has one-way two-lane frontage roads on both sides from north of Sam Houston Tollway/Beltway 8 to North Main Street. Currently there are no frontage roads through the I-610 North interchange. Transportation of hazardous cargo is prohibited on I-45 in the Downtown area between I-10 and US 59. I-45 serves as a major route and provides access to major destinations in the region such as Downtown Houston, Bush Intercontinental airport, Texas Medical Center, The Woodlands, and The Port of Houston. In addition, this freeway serves long distance travel from Houston north to Dallas and south to Galveston.

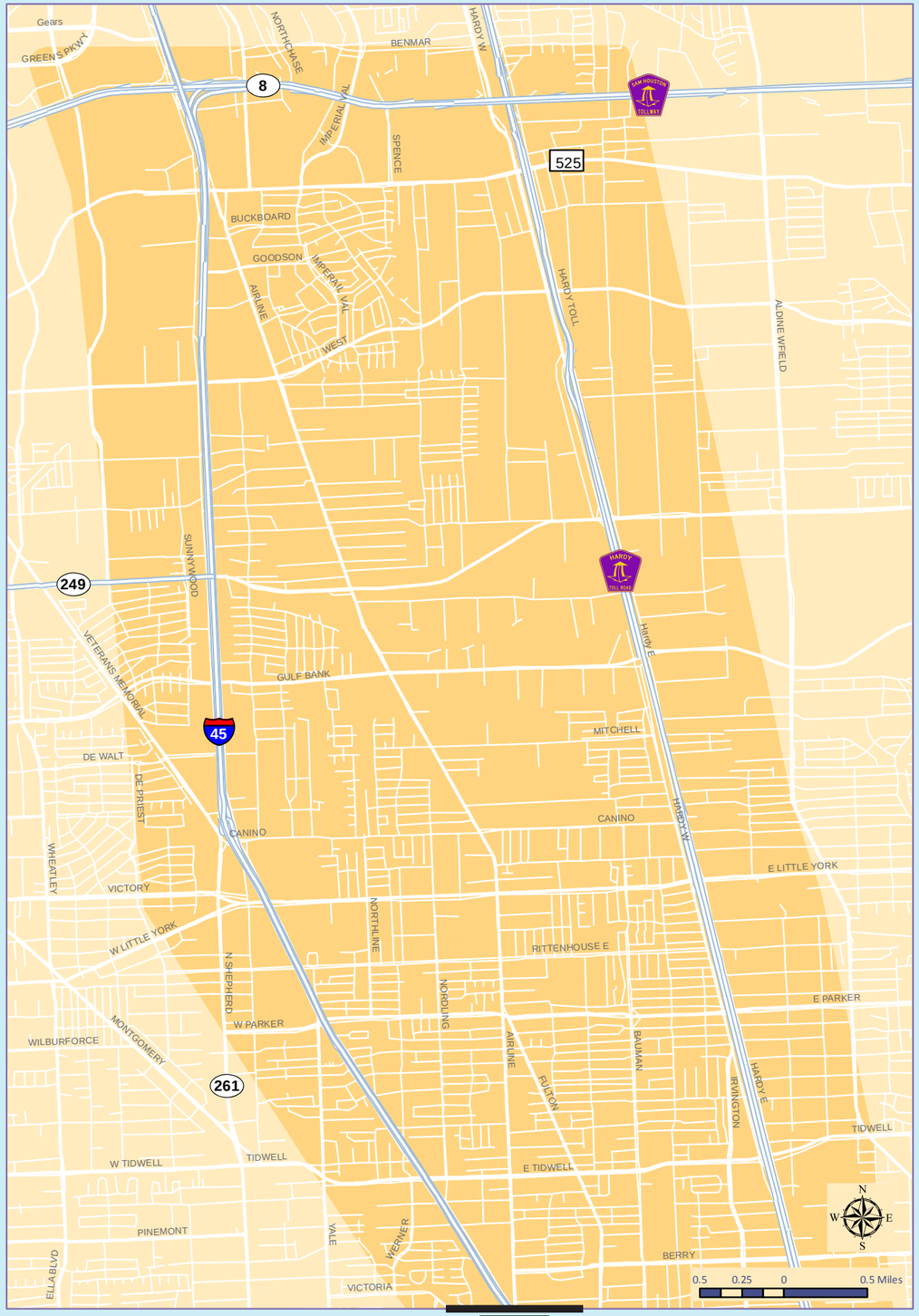


Hardy Toll Road

Hardy Toll Road is a four-lane section north of Beltway 8 and a six-lane section between Beltway 8 and I-610. It generally runs parallel to

FIGURE 1-1

Study Area



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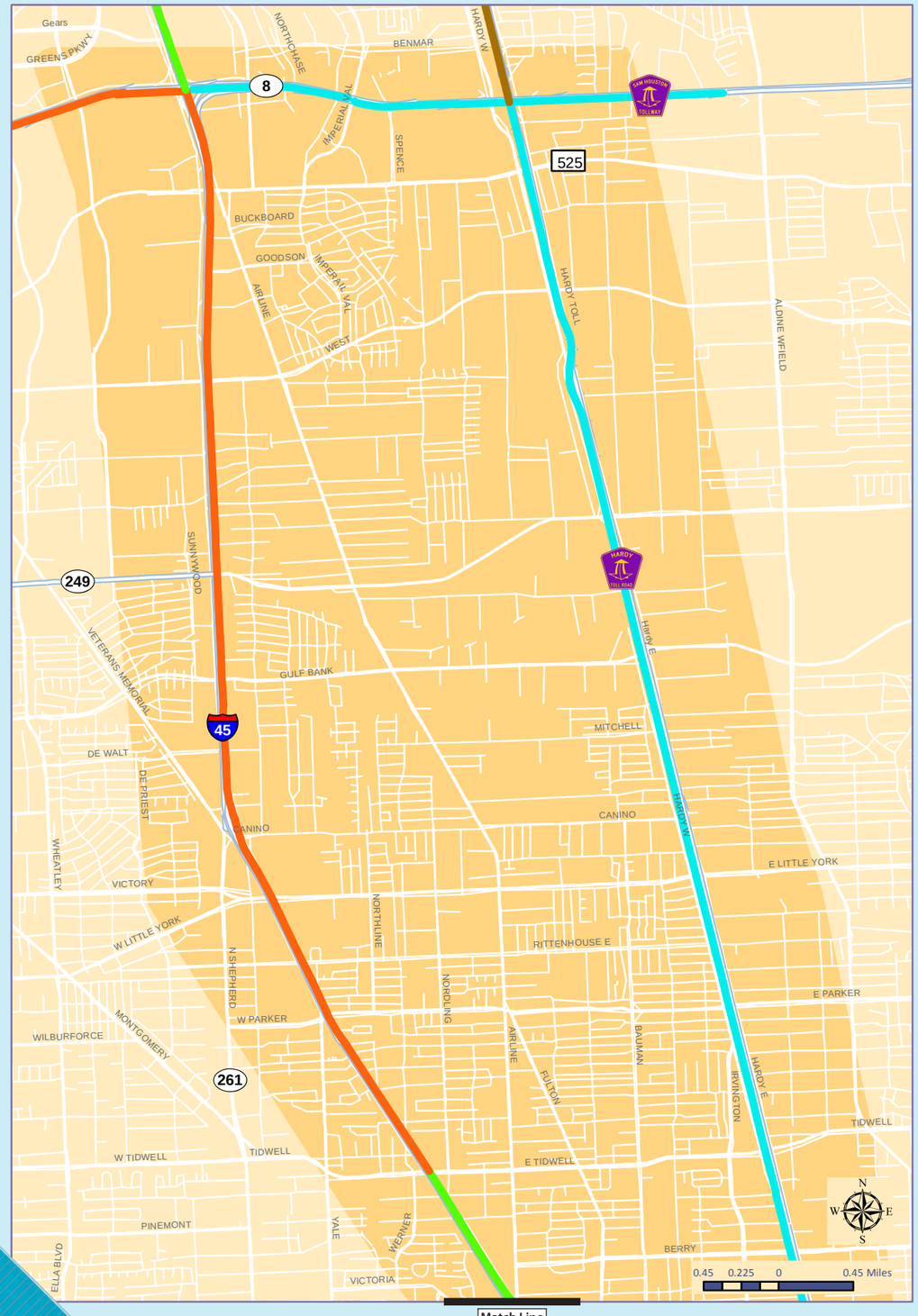
IH 45 / Hardy Traffic Study Update Area

FIGURE 1-2

Existing (2011) Number of Travel Lanes



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- 4 Lanes
- 5 Lanes
- 6 Lanes
- 8 Lanes
- 10 Lanes
- 11 Lanes

NOTE: Does not include HOV lane

SOURCE:
CDM Smith field inventory, 2013

I-45 corridor connecting to I-45 south of The Woodlands. The posted speed limit along this facility is 55 mph. There are Union Pacific Railroad tracks along the Hardy Toll Road corridor. The road is named for the nearby Hardy Street, which in some areas serves as the frontage road for the Toll Road. Inside the study area, Hardy Street serves as the frontage road between Greens Road and Crosstimbers Street. There is one mainlane toll collection plaza located inside the study area, just south of Aldine Bender Road. South of this toll plaza, in the southbound direction, all entrance ramps are tolled and exit ramps are free (no toll). In the northbound direction, it's the reverse, with all entrance ramps free and exit ramps tolled.

The Harris County Toll Road Authority (HCTRA) has proposed Hardy Toll Road Downtown Connector project, which is currently under the design phase, that will extend the Hardy Toll Road from its current terminus at I-610 to Downtown Houston and will consist of a four-lane toll facility with two lanes in each direction.

Sam Houston Tollway/Beltway 8

The Sam Houston Tollway currently serves as the second circumferential facility in the Houston region. The other two circumferential loops are I-610 around Downtown Houston and the Grand Parkway (SH 99) which is the outer most loop facility. The tolled portion of this facility is operated and maintained by HCTRA and is referred to as the Sam Houston Tollway. The frontage roads along Sam Houston Tollway and the non-tolled sections of this facility are known as Beltway 8 (BW 8) and are maintained by TxDOT. Within the study area between I-45 North and US 59 North, this facility is an access controlled non-tolled freeway referred to as Beltway 8. Within the study limits, between I-45 and Hardy Toll Road, this facility is a six-lane non tolled section with one-way two-lane frontage roads on either side and has a posted speed limit of 65 mph.

In 2011, a 13-mile section of this facility between US 59 and US 90 was opened with all-electronic tolling i.e. there are no toll booths, and no cash payment is accepted; only EZ TAG or other interoperable Texas toll payment tags are accepted.

I-610

I-610 is a heavily traveled circumferential (loop) freeway primarily serving the inner Houston metropolitan area. I-610 along with Beltway 8 currently provides the only access-controlled connectivity between the I-45 and Hardy Toll Road corridors. Within the study area, I-610 is a 10-lane section with five general purpose lanes in each direction with a 60 mph posted speed limit, and has one-way frontage roads that primarily include three travel lanes on either side.

I-10

I-10 is the major east-west interstate highway in the southern United States extending from Florida to California. Within the Houston region, this facility is known as Katy Freeway and serves both regional as well as interstate travel. The study limit of this corridor is from west of I-45 to east of US 59. Within the study limits, I-10 is an eight-lane section with four general purpose lanes in each direction and has a posted speed limit of 60 mph. Currently along I-10, there is a bidirectional two-lane direct connector for high-occupancy vehicles from west of I-45 connecting to Franklin Street in the Downtown area. Within the study area, there are intermittent one-way two-lane frontage roads on either side of I-10.

US 59

US 59 is a major controlled-access highway traversing the Houston region generally in a north-south direction. North of Downtown Houston, US 59 is referred to as the Eastex Freeway and south of Downtown it is known as the Southwest Freeway. Within the study area, this corridor extends from north of I-10/US 59 interchange to just south of Spur 527. There is one reversible HOV lane along this facility from Smith Street in the Downtown area that follows Spur 527 as it connects to US 59. There are no frontage roads through the Downtown area. North of I-10, US 59 is an 11-lane section with five general purpose lanes in each direction plus one reversible HOV lane in the center connecting to Jackson Street in Downtown Houston. Between I-10 and I-45, it is generally an eight-lane section with four general purpose lanes in each direction and from I-45 to Spur 527 there are three general purpose lanes in each direction. The posted speed limit along this facility is 60 mph. Hazardous materials are prohibited on US 59 from its intersection with I-45 to just south of its intersection with I-10.

SH 288

SH 288 is a major north–south highway that extends from Downtown Houston to Freeport. The study limit of this corridor includes the section between US 59/SH 288 and I-45/US 59 interchanges. Within the study area, SH 288 has three general purpose lanes in each direction with no frontage roads and has a posted speed limit of 60 mph.

Spur 527

Spur 527 is a controlled-access facility that spurs off from US 59 serving the Midtown and Downtown areas of Houston. Spur 527 is a five-lane section that includes two general purpose lanes in each direction and one reversible HOV lane. This facility has a posted speed limit of 60 mph.

Other Major Area Roadways

Major roadways in the study area that parallel I-45 and/or Hardy Toll Road corridors include Airline Drive/Fulton Street, Aldine-Westfield Road, Hardy Street, and N. Shepherd Drive. Additional roadways include:

- Aldine Bender Road
- West Road
- SH 249
- Gulf Bank Road
- W. Little York Road
- Parker Road
- Airline Drive
- Tidwell Road
- Crosstimbers Street

Major arterials that provide access to I-45 between I-610 and I-10 include:

- W. Calvacade Street/Calvacade Street
- W. Patton Street
- N. Main Street
- Quitman Street

High Occupancy and Transit Facilities

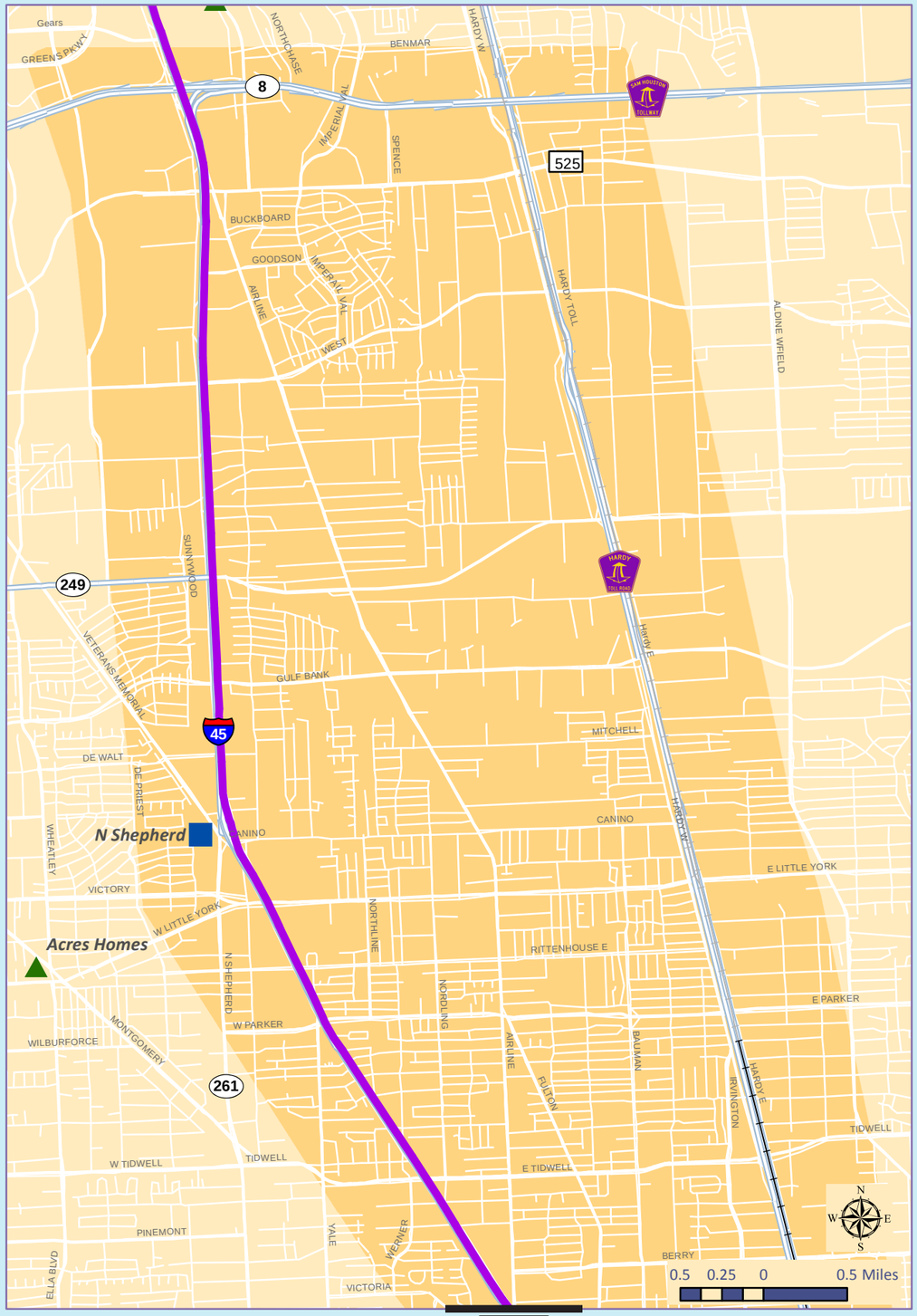
This section describes existing and planned transit facilities in the vicinity of the study area and any planned transit related improvements by the Metropolitan Transit Authority of Harris County (METRO). Existing transit system with HOV lanes and park-and-ride facilities along with proposed transit system and facilities are illustrated in **Figure 1-3**. As shown in this figure, I-45 has a barrier-separated reversible HOV lane extending from south of FM 1960 to I-10 and connecting to Smith/Louisiana Street in Downtown Houston. This HOV lane was constructed within I-45's existing right-of-way by utilizing the facility's inside shoulder. I-10 has a two-lane direct connector 'HOV only' access from west of I-45 to Franklin Street in the Downtown area.

Park-and-ride facilities are mode transfer points that allow patrons to park their vehicles and ride a bus to their destination. The only park and ride facility within the study area is at Veterans Memorial Drive, just west of I-45.

Transit centers provide sheltered waiting areas for commuters and are utilized by several bus routes. They allow bus riders from various locations to assemble at a central point to continue on an express trip or other route-to-route transfers. There are three transit centers within the study area (shown in Figure 1-3). They are as follows:

FIGURE 1-3

Existing HOV, Transit, and Rail System



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- Reversible Barrier Separated HOV Lane
- METRORail Red Line
- Rail System
- Park & Ride Facility
- Transit Center Facility

SOURCE:

Metropolitan Transit Authority of Harris County website, 2014

- **Greenspoint Transit Center** – A transit facility is located on Greenspoint Drive south of Greens Road. It is at the northeast end of the Greenspoint Mall parking lot with parking available at the mall.
- **Heights Transit Center** – A transit facility is located between North Main Street and Studewood Street north of East 20th/W. Calvacade Street. There is no parking at this location.
- **Downtown Transit Center** – A transit facility is located on the block of Main Street, Pierce Street, Travis Street, and St. Joseph Parkway. There is no parking at this location.

METRO currently operates one light rail line, called the "Red Line" in the Downtown area. The METRO light rail line began operation on January 1, 2004. The first-phase 7.5 mile transit line runs along Main Street from south of Reliant Park to the University of Houston-Downtown, with 16 total stops along the way. The construction of the 5.3 mile North/Red Line extension began in 2009 and the extension segment opened in December, 2013. It connects the University of Houston-Dowtown to Northline Transit Center. With the additional eight stations, currently Red Line serves a total of 24 stations.

METRO is continuously expanding the light rail system. The 3.3 mile East End/Green Line which connects the Downtown area to Magnolia Transit Center and the 6.6 mile Southeast/Purple Line which connects the Downtown area to Palm Center Transit Center are expected to open in Fall 2014. The METRO light rail system in Houston is projected to expand to 73 miles long by the year 2025.

Rail Facilities

There are three freight rail lines, as shown on Figure 1-3, that traverse the study area:

- The **Union Pacific Railroad (UPRR)** parallels the Hardy Toll Road from north of BW 8 to I-610, parallels the Elysian Viaduct, continues to I-10 and US 59 where it is an underpass, and then veers in an easterly direction near Franklin Street west of US 59.
- The **Southern Pacific Railroad** has two lines entering the study area. One north-south line enters just south of I-610 to the west of US 59 and runs parallel to the UPRR tracks. It has an underpass with I-10 and veers west paralleling Washington Avenue to outside the study area. Another line enters the study area approximately half a mile north of I-10/US 59 and continues westward north of I-10.
- The **Chicago Rock Island and Pacific Railroad** is an east-west rail line paralleling I-610 just to the north.

Functional Classification

Functional classifications of transportation facilities describe the hierarchical arrangement and interaction between the various roadways. These classifications may change over time, as the function of roadways changes to serve different land uses or other transportation facilities. The functional classification of the study area roadways are shown in **Figure 1-4** and are derived from H-GAC's facility type classification system maintained for various roadways in the regional travel demand model. This classification system is consistent with TxDOT functional classification for the study area roadways. There are three primary classification systems within the study area and include:

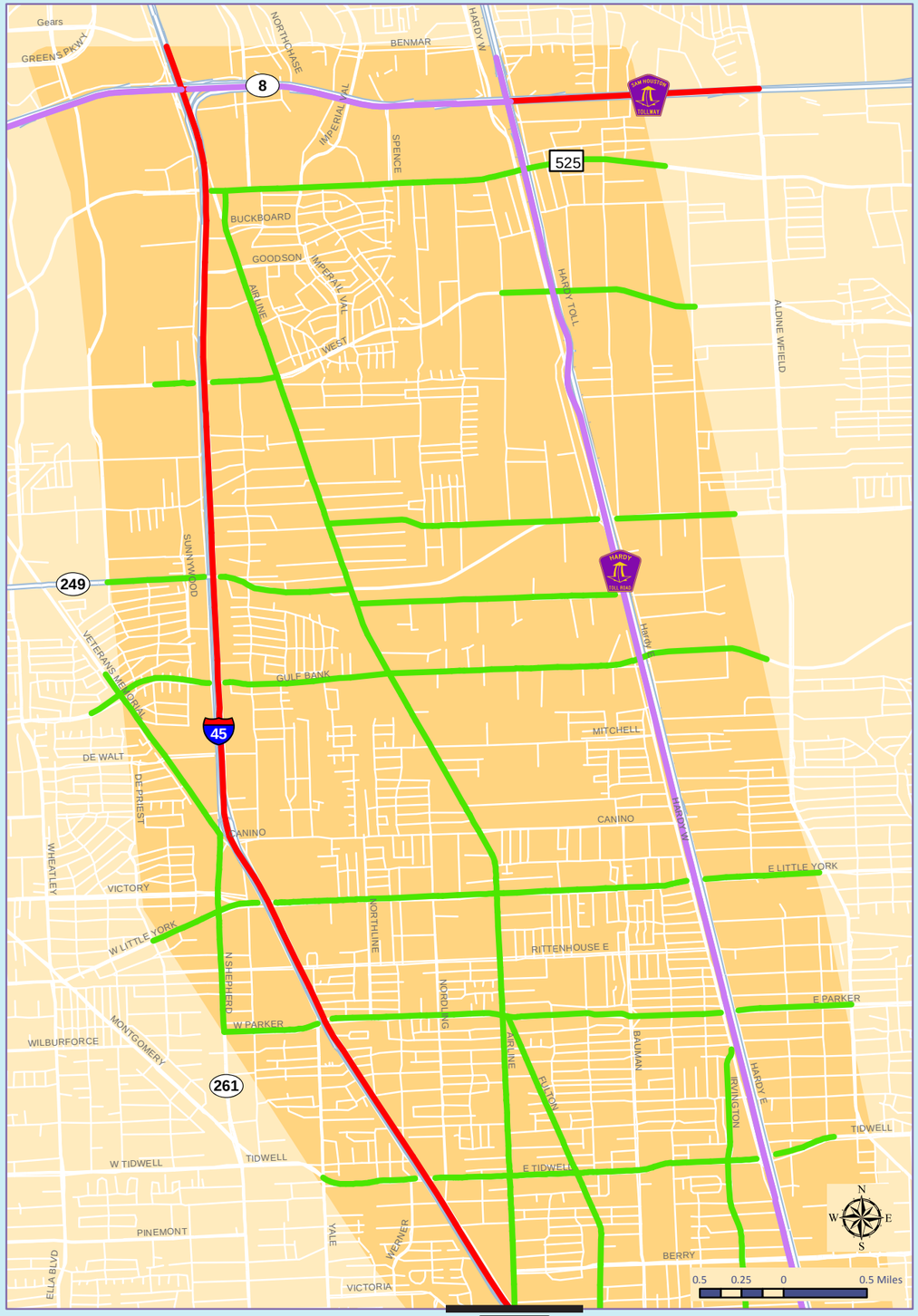
- Interstate Freeway (with and without frontage roads)
- Tollway
- Arterial (includes principal and other)

As illustrated in Figure 1-4, roadways with interstate freeway classification include highways with interstate designations (I-45, I-10, and I-610), national and state highways (US 59 and SH 288) and other controlled-access highways (Sam Houston Tollway and Spur 527). The freeways traversing primarily through urbanized areas including Downtown have no frontage roads. The freeway sections without frontage roads within the study area include I-10, US 59, Spur 527, SH 288, and I-45 from north of I-10 to south of US 59. I-45 only has frontage roads from north of Sam Houston Tollway/Beltway 8 to north of I-10. Hardy Toll Road is a toll facility with Hardy Street serving as frontage roads between Greens Road and Crosstimbers Street within the study area.

Freeways provide interstate and regional connectivity and typically carry long distance travel demands. Contrary to the freeway classification system, the arterial roadways have no control of access. Their primary function is to provide access to the freeways. Arterials serves the long distance travel demand in the regional context and serve as alternative routes to commuters particularly when freeways get congested during peak periods.

FIGURE 1-4

Current Functional Classification System



LEGEND

- *Interstate Freeway With Frontage Roads*
- *Interstate Freeway Without Frontage Roads*
- *Tollway With Frontage Roads*
- *Arterial*

SOURCE:
Harris-Galveston Area Council (H-GAC) Regional Travel Demand Model; CDM Smith

Regional Travel Demand Model

Primary components of this study include evaluation of existing and future travel demand and patterns using the regional travel demand model. Travel demand models are one of the preeminent forecasting tools available to forecast future travel patterns and transportation demands based on the transportation system improvements, land use developments, and demographic forecasts. Travel demand modeling is a necessary component in evaluating the need for and usage of any transportation improvements such as constructing a new freeway, widening existing roadways, or making a major investment in new transit facilities.

For this traffic study update, H-GAC's regional travel demand model in *Cube Voyager* software was utilized. The regional travel models are cooperatively developed and maintained by H-GAC, TxDOT, and METRO. Existing year 2011 and future year 2035 travel demand model scenarios were obtained from H-GAC. The model networks were reviewed for any coding errors within the study area and corrected as necessary. The regional model was utilized to conduct daily and peak period model runs for existing and future years to evaluate future travel patterns and demand on various sections of the study corridors.

The regional travel demand model encompasses the eight-county Houston-Galveston-Brazoria Consolidated Metropolitan Statistical Area (CMSA) that has been federally designated as the Transportation Management Area (TMA) for the Houston-Galveston region. The Houston-Galveston TMA extends over an area of 7,800 square miles. Land use and demographic forecasts for the TMA are developed by H-GAC. The counties include Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller.

Traffic Analysis Zones (TAZs) define geographic areas (typically the size of a census block group), which are used to relate travel demand with socioeconomic characteristics. Under Year 2000 (census-related) geography, H-GAC has designated 3,000 detailed TAZs in the Houston-Galveston TMA. **Figure 1-5** shows the eight-county region within H-GAC's Transportation Management Area and the TAZs. This includes 2,954 internal zones and 46 external stations. The internal zones are entirely within the TMA and the external stations are used to capture external-external and external-local trips through the TMA. For this study, there were no refinements made to the regional TAZ structure and associated socioeconomic (population and employment) data variables.

Existing Transportation Demand

Historic Traffic Growth

In the past decade (2000–2010), the Houston metropolitan area has experienced one of the highest population growths in the nation. The population of the metropolitan area grew from 4,715,407 in 2000 to 5,946,800 in 2010 (U.S. Census), which equates to an average annual growth rate of 2.4%. This has resulted in significant increase in travel demand on roadways in the region which is directly related to population growth and in turn land use development.

Based on TxDOT Houston District's traffic maps, the annual average daily traffic (AADT) volumes for 2000 and 2010 for the study corridors, and the resulting compounded annual growth rate (CAGR) is presented in **Figure 1-6**. The daily traffic volumes shown includes the frontage road volumes. Within the study area, I-45 north of Sam Houston Tollway/Beltway 8 has experienced the highest CAGR of around 3.3 percent with traffic volumes increasing from 143,000 vehicles per day (vpd) in 2000 to 198,000 vpd in 2010. US 59 south of I-10 also experienced a high CAGR of 3.0 percent with traffic volumes increasing from 153,000 vpd in 2000 to 206,000 vpd in 2010. Some roadways in the study area, particularly near Spur 527/US 59 and I-10 east of I-45, showed a reduction in traffic volumes in the last decade. This trend is not necessarily due to decreased travel demand, but mainly resulting due to changes in travel patterns over the last several years. Hardy Toll Road north of I-610 experienced a significant growth in travel demand with CAGR of 5.5 percent, resulting in traffic volume increase from 46,500 vpd in 2006 to 61,000 vpd in 2011. However, it should be noted that the historic volume for Hardy Toll Road was based on a 5-year old count (2006) compared to a 10-year old count (2000) for rest of the study area locations.

Existing Traffic Volumes

Detailed daily traffic volume counts were conducted in September of 2011 along freeways, ramps and direct connectors along the Downtown loop system (I-45/I-10/US 59) and US 59 from I-45/US 59 Interchange to Spur 527. This detailed traffic count data was primarily utilized in the development of VISSIM model, discussed in Chapter 2. These traffic counts were supplemented by traffic count information obtained from TxDOT along the different sections of the study corridors and they are shown in **Figure 1-7**. Daily traffic volumes along I-45 ranges from approximately 301,000 vpd south of Sam Houston Tollway/Beltway 8 to 163,000 vpd west of US 59, along Pierce Elevated in Downtown Houston. Hardy Toll Road experienced traffic volumes ranging from 68,000 vpd south of Beltway 8 to 61,000 vpd north of I-610.

Daily traffic volumes range on I-45 range from 282,000 vpd to 306,000 vpd between Sam Houston Tollway/Beltway 8 and I-610; from 249,000 vpd to 257,000 vpd between I-610 and and I-10; and from 163,000 vpd to 248,000 vpd between I-10 and US 59 in Downtown Houston.

Existing daily traffic volumes along other study corridors are as follows:

I-10 – 141,000 vpd

US 59 – 210,400 vpd

SH 288 – 193,000 vpd

I-610 – 161,000 vpd

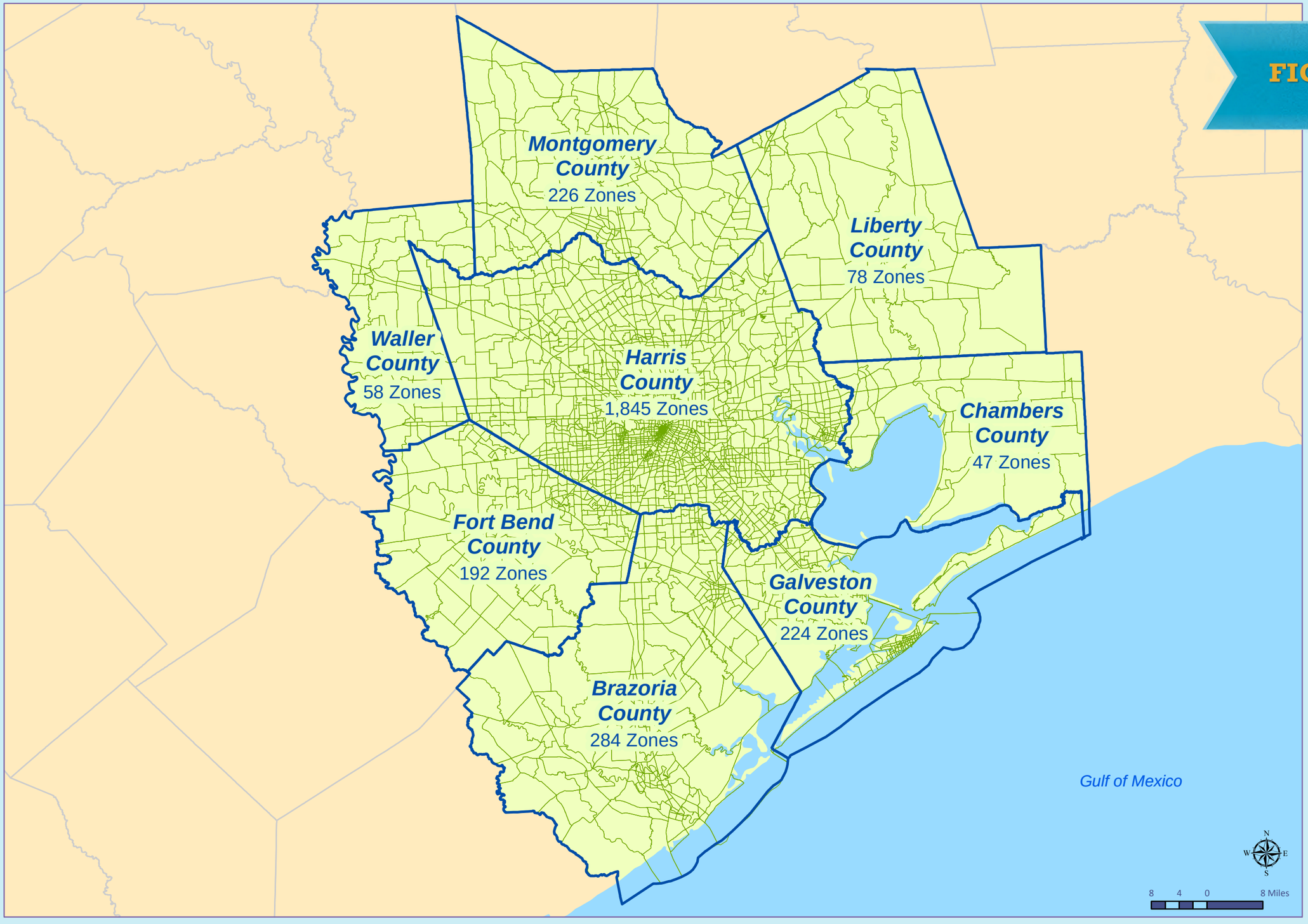
BW 8 – 177,000 vpd

Spur 527 – 76,500 vpd

The percentage of trucks along I-45 ranges from four percent to five percent of the total daily traffic volume.

FIGURE 1-5

Transportation Management Area (TMA) and Traffic Analysis Zone (TAZ) Structure



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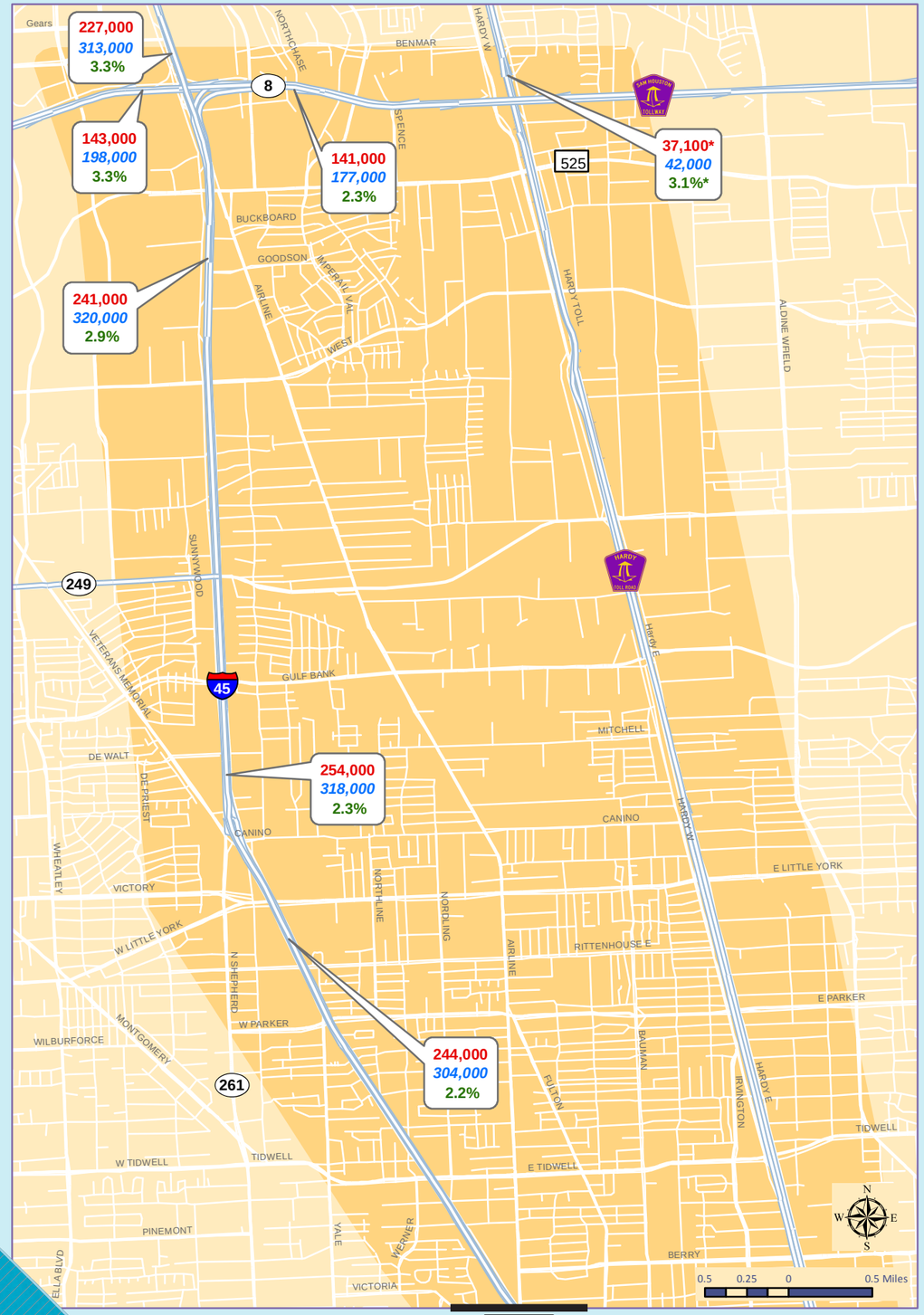
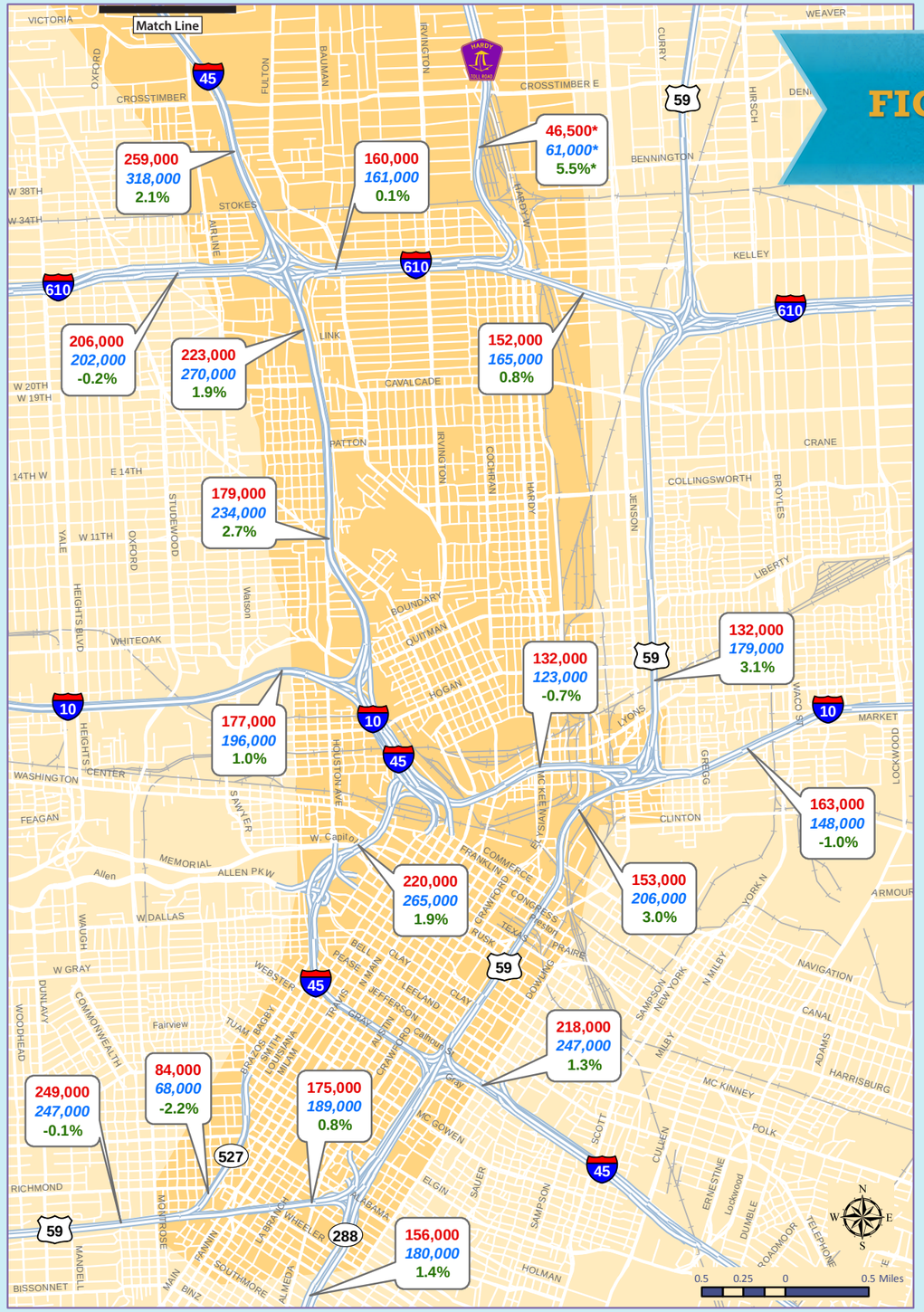
- Transportation Management Area
- Traffic Analysis Zone 3

SOURCE:
Harris-Galveston Area Council (H-GAC) Regional Travel Demand Model; CDM Smith

FIGURE 1-6

Historic Traffic Growth (2000-2010)





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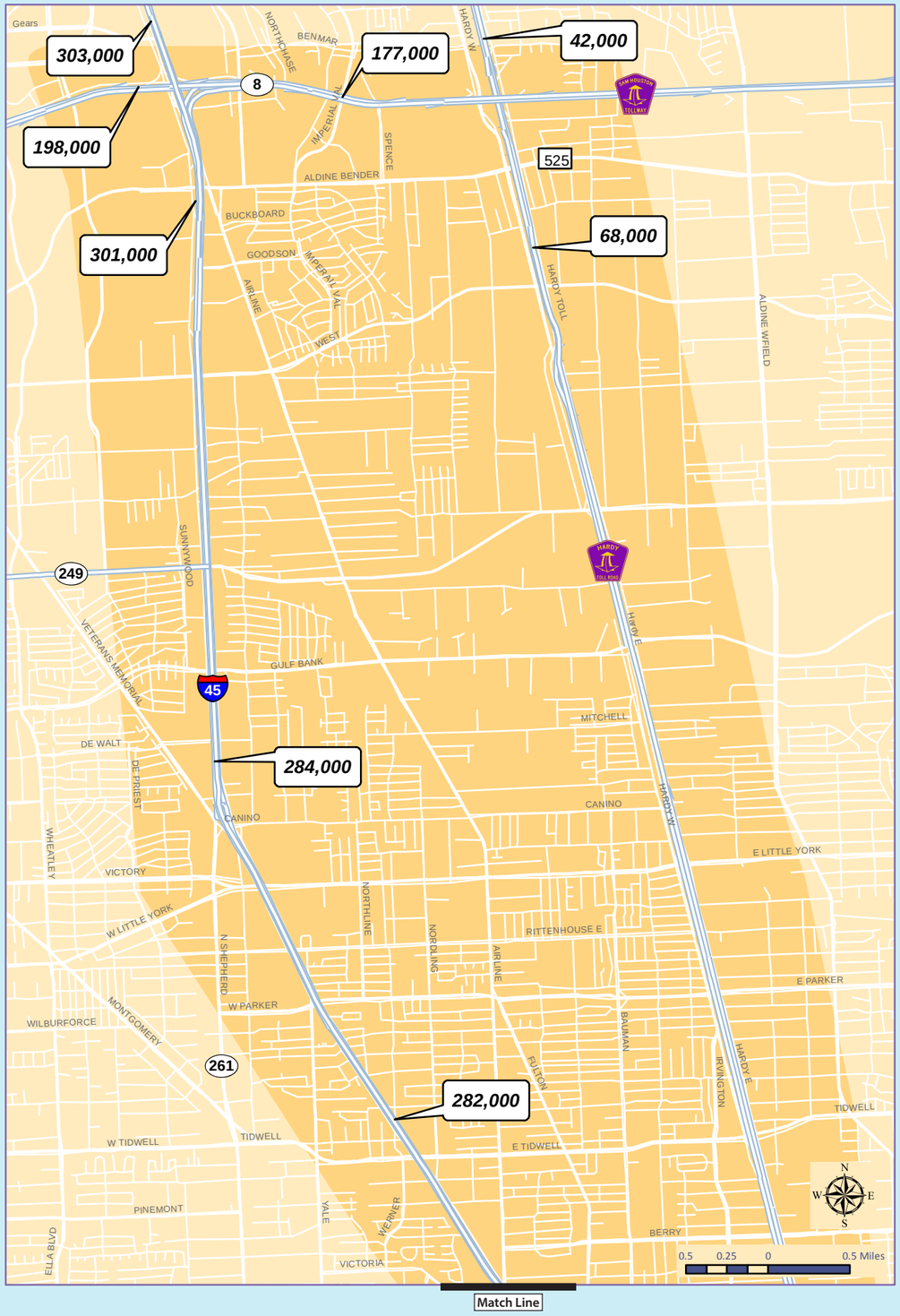
- XXX = *2000 Average Daily Traffic Volume*
- XXX = *2010 Average Daily Traffic Volume*
- XXX% = *Compounded Annual Growth Rate*

** Data for Hardy Toll Road is for years 2006 and 2011, and growth rate is calculated for the five year period from 2006 to 2011.*

SOURCE:
TxDOT Houston District Traffic Maps 2000, 2010; CDM Smith

FIGURE 1-7

Existing Year 2011 Daily Traffic Volumes



LEGEND

X,XXX = Average Daily Traffic Volumes

NOTE:
Traffic volumes include mainlanes and frontage road volumes. Does not include HOV lane volume.

SOURCE:
TxDOT Houston District Traffic Map 2011; CDM Smith

Level-of-Service

Level-of-Service (LOS) is a qualitative measure of traffic operations, ranging from LOS A through LOS F. LOS A-C represents traffic ranging from free-flow conditions to stable flow conditions causing minor traffic flow disruptions. LOS D represents unstable traffic flow conditions with severely restricted travel speeds. LOS E represents noticeable traffic congestion with travel demand approaching or at roadway capacity and LOS F represents severe traffic congestion with travel demand exceeding roadway capacity causing stop-and-go traffic flow conditions. A quantitative measure to represent LOS is the ratio of traffic volume to the capacity (v/c) ratio of the roadway. **Table 1-1** describes the different levels of service associated with the maximum v/c ratio.

Table 1-1

Level-of-Service Definitions

LOS	MAXIMUM V/C RATIO	DESCRIPTION
A	0.29	**Highest quality of traffic service**; free-flow conditions; motorists drive at desired speed; minor traffic flow disruptions.
B	0.47	**Good quality of traffic service**; reasonable flow conditions; noticeable presence of other vehicles; ability to maneuver is slightly restricted.
C	0.68	**Stable traffic flow**; noticeable increase in platoon formation; ability to maneuver noticeably restricted; minor disruptions could cause traffic service deterioration.
D	0.87	**Approaching unstable traffic flow**; speed and ability to maneuver severely restricted; limit of acceptable operations.
E	1.00	**Unstable traffic flow**; travel demand approaching or at roadway capacity.
F	> 1.00	**Heavily congested flow**; traffic demand exceeds roadway capacity; forced or breakdown traffic flow.

Free Flow … *Severe Congestion*

Source: Highway Capacity Manual 2010

Capacity analysis was conducted to determine the level-of-service for the study corridors based on methodology stated in the 2010 *Highway Capacity Manual* (HCM). The average annual daily traffic volumes provided in **Table 1-2** were adjusted to remove the frontage road volumes and converted to design hourly volumes using K Factor (percentage of daily traffic occurring in peak hour) and D Factor (percentage of peak hour traffic occurring in peak direction) values obtained from the traffic count data. Capacity analysis for various study corridor segments are also presented in Table 1-2.

Most facilities in the study area including I-45, I-10 and US 59 currently operate at LOS E or worse during peak hours, with the exception of Hardy Toll Road.

It is apparent that the majority of the facilities are currently experiencing very high levels of congestion. If no transportation improvements are implemented, the traffic situation will only continue to exacerbate.

Table 1-2

Existing (2011) Daily Traffic Volumes and Volume-to-Capacity Ratios

ROADWAY	SEGMENT	LANES	ADT	K-FACTOR	D-FACTOR	DDHV	V/C RATIO	LOS
I-45	BW 8 – Shepherd Dr	8	219,500	8.2%	53%	9,500	1.03	E
	Shepherd Dr – I-610	8	220,500	8.0%	54%	9,500	1.03	F
	I-610 – I-10	8	202,500	7.0%	59%	8,400	0.91	E
	I-10 – Allen Parkway	10	248,000	6.5%	58%	9,300	0.81	D
	Allen Parkway – US 59	6	163,000	7.1%	56%	6,500	0.94	E
Hardy Toll Road	Beltway 8 – I-610	6	64,500	12.0%	70%	5,400	0.78	D
US 59	I-10 – I-45	8	219,500	7.9%	58%	10,100	1.10	F
	I-45 – Spur 527	8	239,500	7.9%	55%	10,400	1.13	F
I-10	I-45 – US 59	8	141,000	8.3%	60%	7,000	0.76	D
I-610	I-45 – Hardy Toll Road	8	170,000	8.4%	52%	7,400	0.80	D
Sam Houston Tollway	I-45 – Hardy Toll Road	6	177,000	8.0%	56%	7,900	1.14	F
SH 288	South of US 59	8	193,500	7.5%	53%	7,700	0.84	D

Source: 2010 Highway Capacity Manual, 2011 Traffic Count Data
Note: ADT = Average Daily Volume; K-FACTOR = Peak Hour Factor; D FACTOR = Directional Distribution Factor; DDHV = Directional Design Hourly Volume; V/C RATIO = Volume-to-Capacity Ratio; LOS = Level-of-Service

Although volume to capacity ratio is a standard indicator to measure level-of-service along a roadway, motorists generally experience level-of-service based on the speed at which they are travelling. Some segments of I-45 experiences lower travel speeds resulting in poor LOS caused due to geometric deficiencies and heavy traffic volumes. Using travel speed as a measure, the existing level of service along the study corridors is illustrated in **Figure 1-8**.

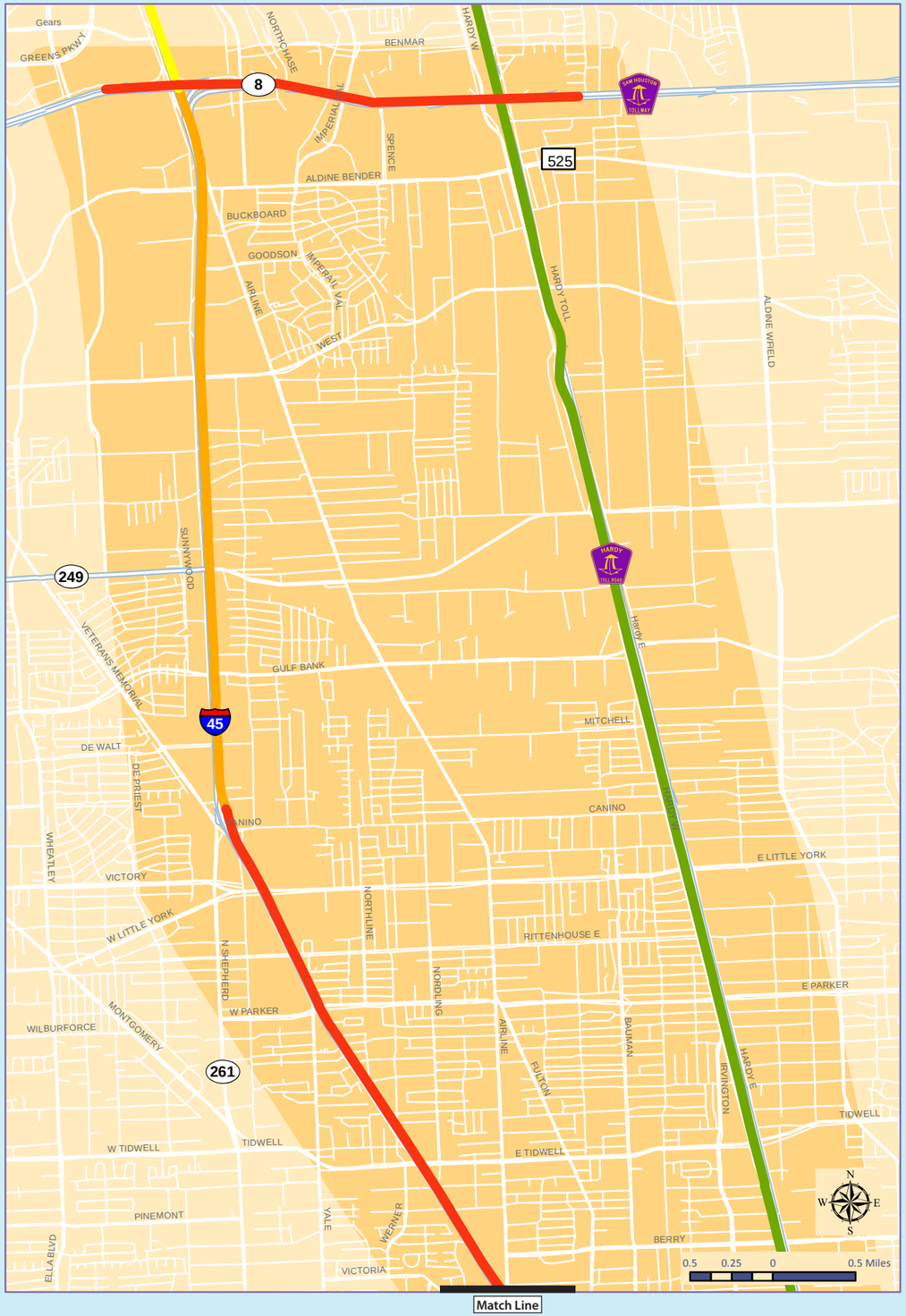
Travel Speeds

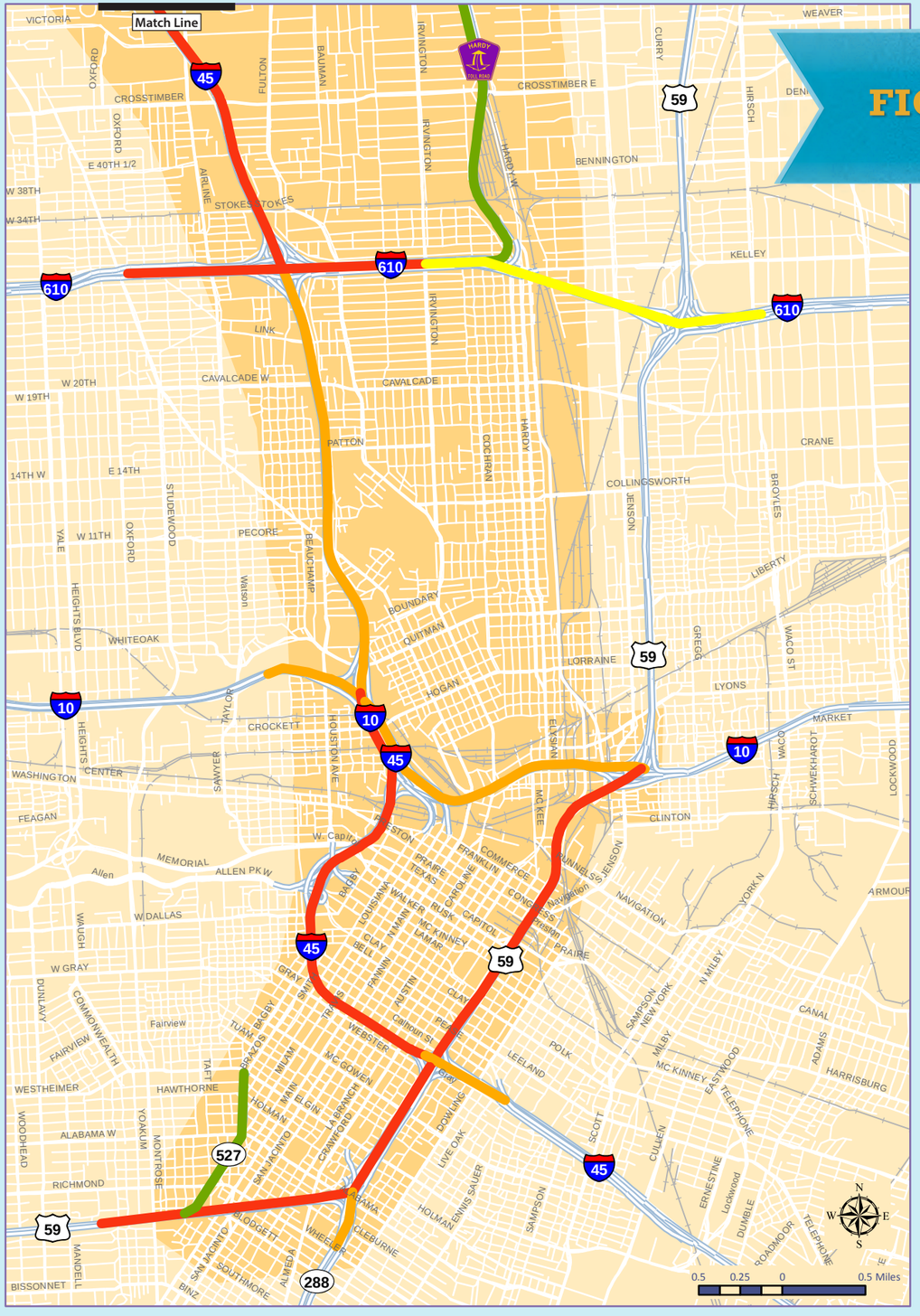
Year 2011 travel speed information was obtained from Houston TranStar for this study. The travel speeds were available by direction and by hour along the different segments of the study corridors. This data was supplemented by information obtained from AM and PM peak hour travel time runs conducted in September 2011 along the Downtown loop system. This information is illustrated in **Figures 1-9** and **1-10**.

The I-45 corridor generally represents morning inbound and evening outbound peak travel patterns. As seen in Figure 1-9, during morning rush hours southbound traffic on I-45 travels at the consistently lower speeds (below 40 mph) from Sam Houston Tollway to the Allen Parkway exit in the Downtown area. In the northbound direction, travel speeds along I-45 in the AM peak period ranges between 30 to 50 mph in Downtown Houston, and increases to between 50 and 60 mph as traffic moves north of Downtown. North of I-610, travel speeds continue to range between 50 and 60 mph.

Based on the speed data, traffic is generally free-flowing on the Hardy Toll Road with speeds recorded over 60 mph. During the AM peak hours, I-10 experiences eastbound congestion with travel speeds between 30 and 40 mph, and US 59 experiences congestion in the southbound direction with travel speeds of 30 mph or less. I-10 westbound and US 59 northbound traffic travels at 40 mph or higher during the morning peak hours.

FIGURE 1-8





LEGEND

Existing Level-of-Service

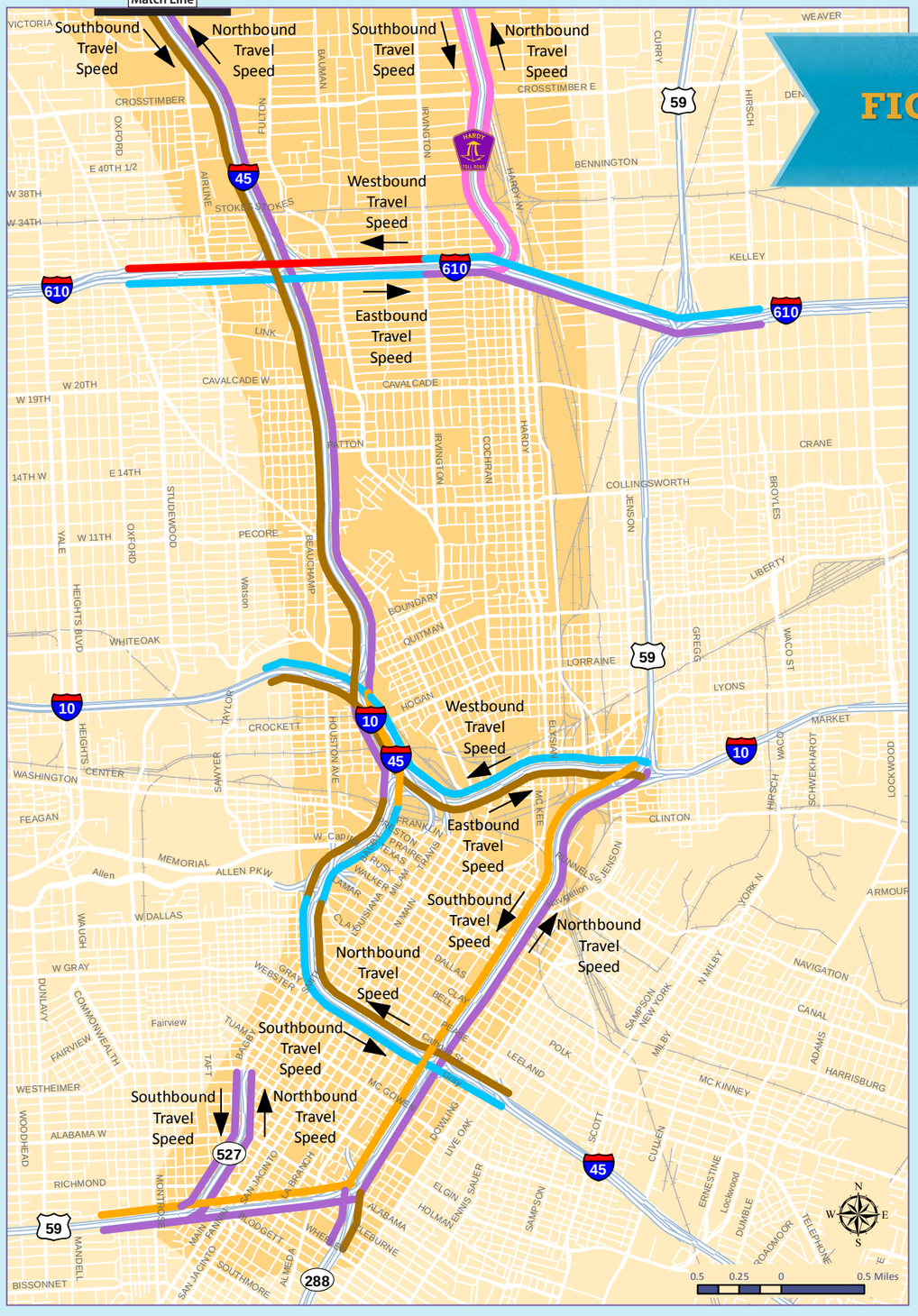
- *A/B/C (> 50 mph)*
- *D (40 - 50 mph)*
- *E (30 - 40 mph)*
- *F (< 30 mph)*

Existing (2011) Peak Hour Level-of-Service

SOURCE:
Houston TranStar, 2011
Field Investigation, 2011

FIGURE 1-9

Existing (2011) Morning Peak Period Travel Speeds



LEGEND

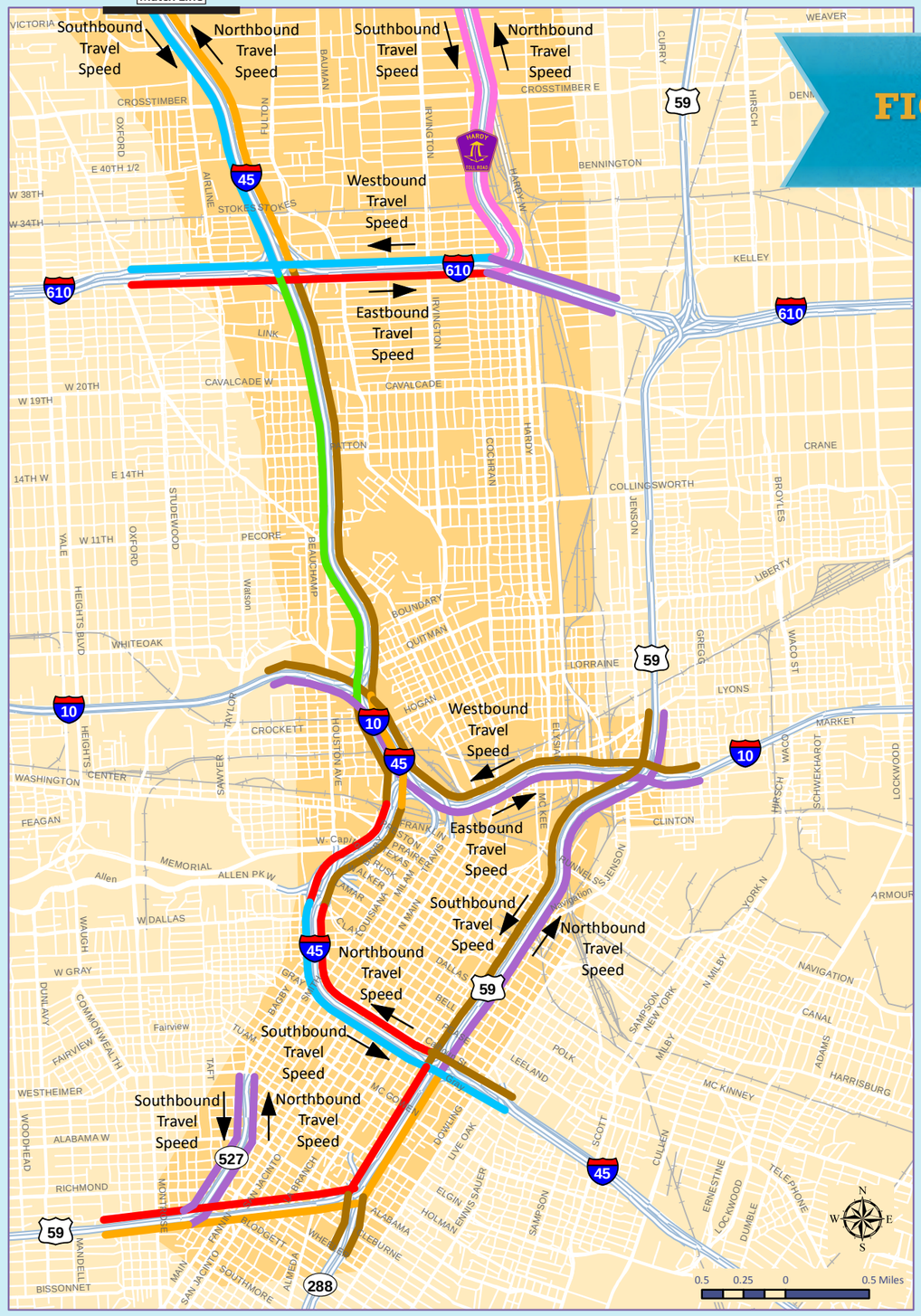
- < 20 mph
- 20-30 mph
- 30-40 mph
- 40-50 mph
- 50-60 mph
- 60-70 mph
- 70-80 mph

SOURCE:

Houston TranStar, 2011; Field Investigation, 2011

FIGURE 1-10

Existing (2011) Evening Peak Period Travel Speeds



LEGEND

- < 20mph
- 20-30 mph
- 30-40 mph
- 40-50 mph
- 50-60 mph
- 60-70 mph
- > 70 mph

SOURCE:

Houston TranStar, 2011
Field Investigation, 2011

As shown in Figure 1-10, during the PM peak period, the I-45 segment between I-10 and US 59, and US 59 between I-45 and Spur 527 experience the worst congestion levels with lowest travel speeds in the study area of 20 mph or less. Outside the Downtown, outbound traffic on I-45 experiences travel speed speeds in the range of 20 to 40 mph. North of Shepherd Drive, speeds increases to 40-50 mph.

Along the Downtown loop, during the PM peak period, I-10 experiences congestion in the westbound direction and US 59 in the southbound direction with travel speeds between 30-40 mph. Hardy Toll Road continues to operate at speeds of 60 mph or higher during the PM peak hours.

Crash History

The following information on crash history was extracted from the Department of Public Safety records provided by TxDOT. Three-year crash data from 2010 to 2012 was analyzed for the following seven segments within the I-45/Hardy study area:

1. **I-45** – from Greens Road to Shepherd Drive
2. **I-45** – from Shepherd Drive to I-610
3. **I-45** – from I-610 to I-10
4. **I-45** – from I-10 to US 59
5. **US 59** – from Spur 527 to I-45
6. **US 59** – from I-45 to I-10
7. **I-10** – from I-45 to US 59

The crash records were sorted by crash severity including fatality, injury, or property damage only (PDO). A summary of the data is presented in **Table 1-3**.

Table 1-3

Years 2010-2012 Crash Summary for I-45/Hardy Study Area

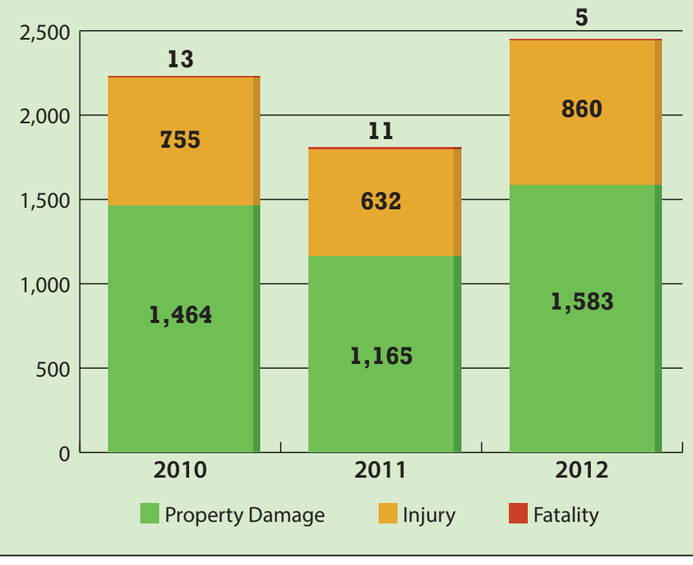
ROADWAY	LIMITS	FATALITY	INJURY	PROPERTY DAMAGE ONLY	TOTAL
I-45	Greens Road to Shepherd	6	550	972	1,528
	Shepherd to I-610	9	651	1,173	1,833
	I-610 to I-10	3	275	582	860
	I-10 to US 59	3	230	465	698
US 59	Spur 527 to I-45	1	273	483	757
	I-45 to I-10	4	122	250	376
I-10	I-45 to US 59	3	146	287	436

Source: Texas Department of Transportation
Note: Includes crashes along frontage roads where applicable.

Figure 1-11 illustrates the crash data by type from 2010 to 2012 for the I-45/ Hardy study area. The total number of crashes increased to 2,448 in Year 2012 from a total of 2,232 crashes in 2010.

Figure 1-11

Years 2010 - 2012 Crash History



The crash rate was calculated based upon the number of crashes per 100 million vehicle miles (100MVM). A review of the results indicate that the section of US 59 east from Spur 527 to I-45 has the highest three-year average crash rate of 191.58 100MVM, as shown in **Table 1-4**. The section along US 59 east from I-45 to I-10 has the lowest three year average crash rate of 76.91 100MVM.

Table 1-4

Crash Rates

ROADWAY	LIMITS	CRASH RATE 2010	2011	2012	AVERAGE	STATE-WIDE AVERAGE
I-45	Greens Road to Shepherd	87.65	80.40	116.56	94.87	103.03
	Shepherd to I-610	110.11	103.93	148.40	120.81	103.03
	I-610 to I-10	100.76	92.49	146.10	113.12	103.03
	I-10 to US 59	96.70	76.87	131.56	101.71	103.03
US 59	Spur 527 to I-45	210.71	138.22	225.80	191.58	143.38
	I-45 to I-10	75.77	69.75	85.21	76.91	143.38
I-10	I-45 to US 59	222.74	141.60	148.46	170.93	103.03

Source: Texas Department of Transportation

The statewide average crash rate for interstate facilities in urban areas was 105.05 in Year 2010, 95.68 in Year 2011, and 108.35 in Year 2012. Typically, roadway facilities are considered to have a significant crash problem when the crash rate is at least double the statewide average. The section of I-10 between I-45 and US 59 had crash rates more than double the statewide average in 2010 posing some significant safety issues. None of the other sections along US 59 and I-45 are close to double the statewide average.

Existing Travel Patterns and Traffic Characteristics

This section of the report discusses the existing travel patterns and traffic characteristics along the study corridors. In coordination with TxDOT, 14 locations along I-45, Hardy Toll Road, Sam Houston Tollway/Beltway 8, I-610, I-10, US 59 S and SH 288 were selected to evaluate existing origin-destination travel patterns and traffic characteristics. These locations, referred to as the "Select-Link" locations, are illustrated in **Figure 1-12**.

Travel Patterns

Select-link analysis technique was utilized to analyze the origin and destination travel patterns for selected segments within the study area. H-GAC's regional travel demand model was used to conduct select-link modeling. Select-link analysis identifies where traffic is coming from (trip origin) and going to (destination or trip-end) on any selected roadway link. As shown in Figure 1-12, five locations were selected on I-45, two each on I-10, US 59 and Hardy Toll Road, and one each on Sam Houston Tollway, I-610 and SH 288. The select-link analysis was conducted for the AM peak period to analyze the traffic patterns of vehicles traveling inbound towards Downtown Houston along the study corridors.

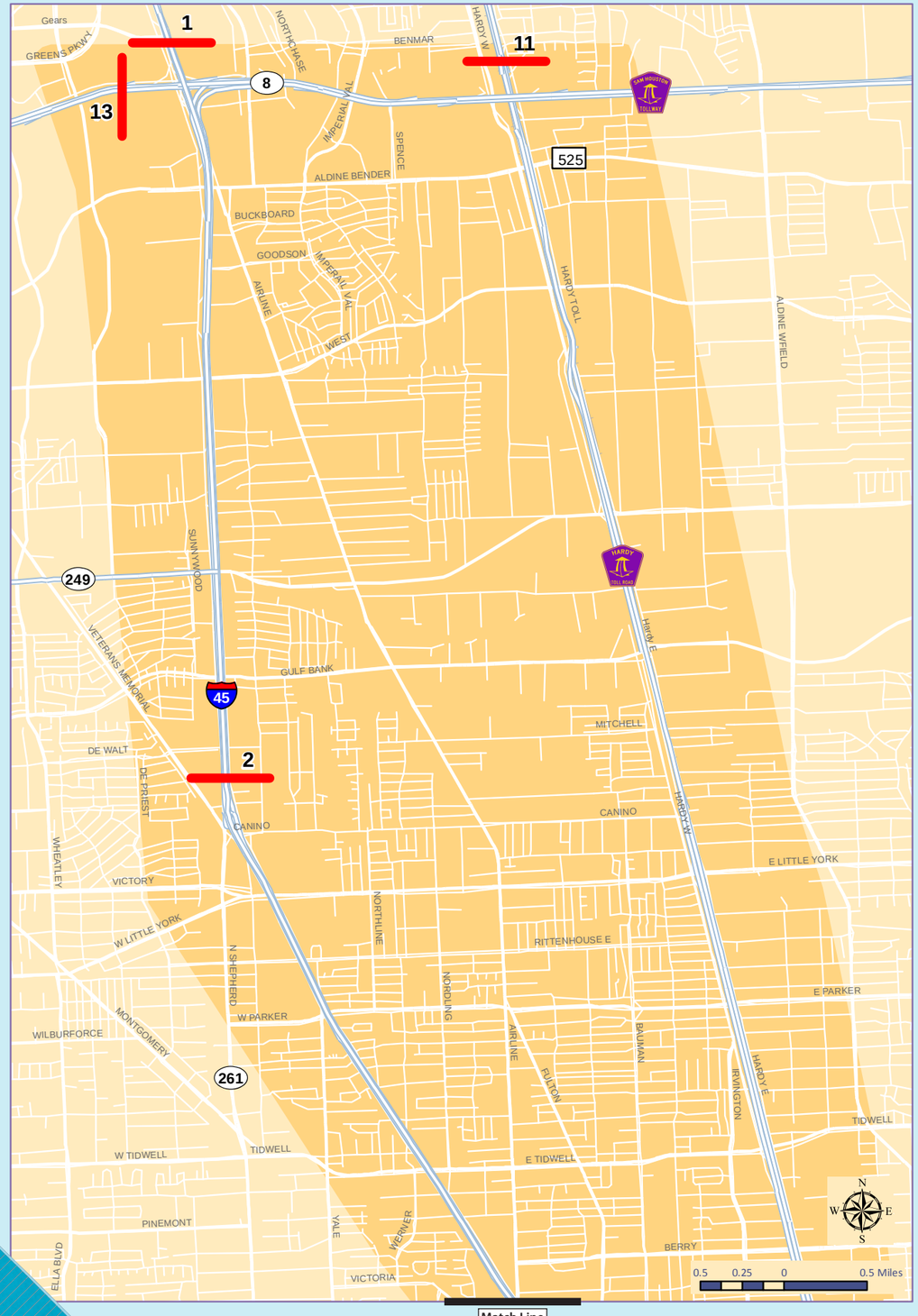
Origin-destination information obtained from the select-link results was validated with real world traffic data collected from the field along the Downtown loop (I-45/I-10/US 59) and US 59 segment from I-45 to Spur 527. The traffic data included detailed traffic counts along freeways, ramps, and direct connectors, and a limited license plate based video survey to determine origin-destination type traffic patterns between US 59/SH 288 and US 59/I-45 interchanges.

Select-link assignments for AM peak periods were conducted for each select-link location to determine the distribution of traffic volumes from the selected location to all other locations in the model network. This provided the origin and destination of all traffic that is crossing this selected location. The percent of traffic at the select-link location represents 100 percent of the actual AM peak hour volume in the inbound peak direction, while other downstream/upstream locations represent percent of traffic coming from or going to the select-link location. Only the roadways that contributed five percent or more of the total traffic going to or coming from the select-link location were identified.

As discussed, all of the figures show the distribution of traffic from the select-link location to various roadways. Four of the figures, due to the location of the select-link itself, show the percentage of traffic that is going towards the select-link location.

Figures 1-13 through **1-26** illustrate existing origin-destination travel patterns in the study area for the 14 select-link locations.

FIGURE 1-12



Select Link Locations

LEGEND

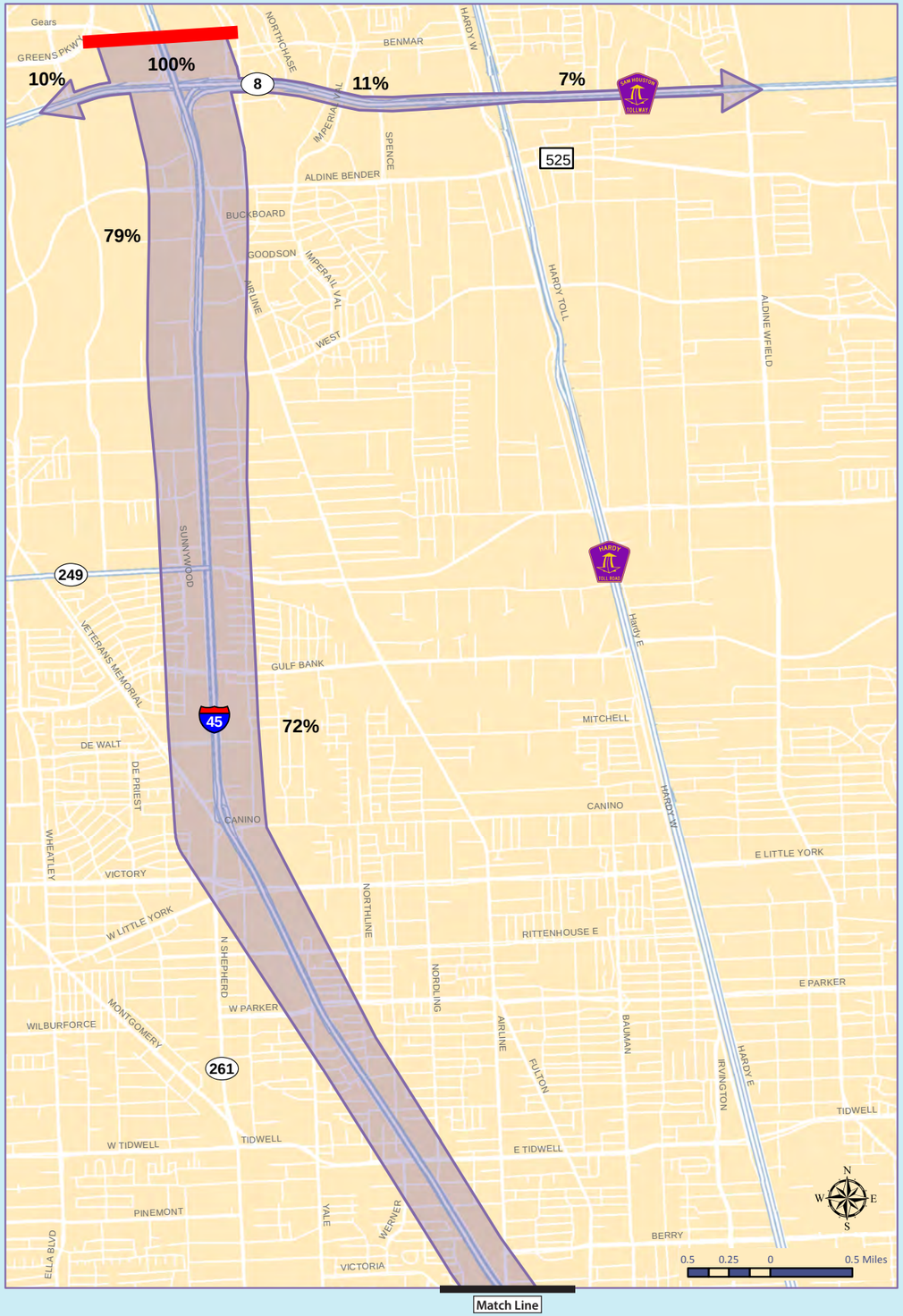
Select Link Locations

FIGURE 1-13

2011
Select Link - 1

IH 45
North of Sam Houston Tollway

Southbound Direction
DDHV = 10,900
Directional Design Hourly Volume

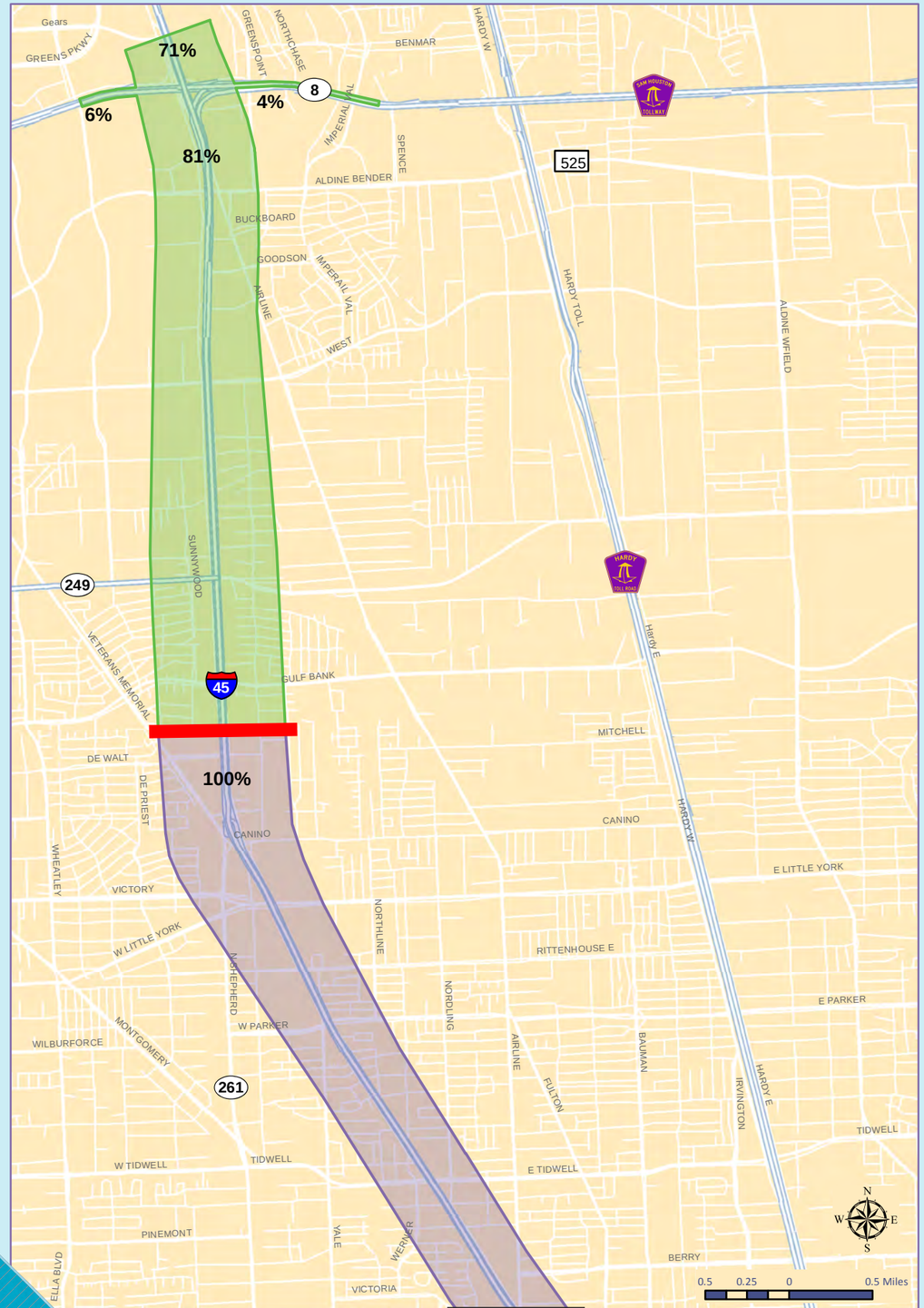


LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-14



2011
Select Link - 2

IH 45
North of
Shepherd Drive

Southbound Direction
DDHV = 9,200
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic TO Select Link Location*

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

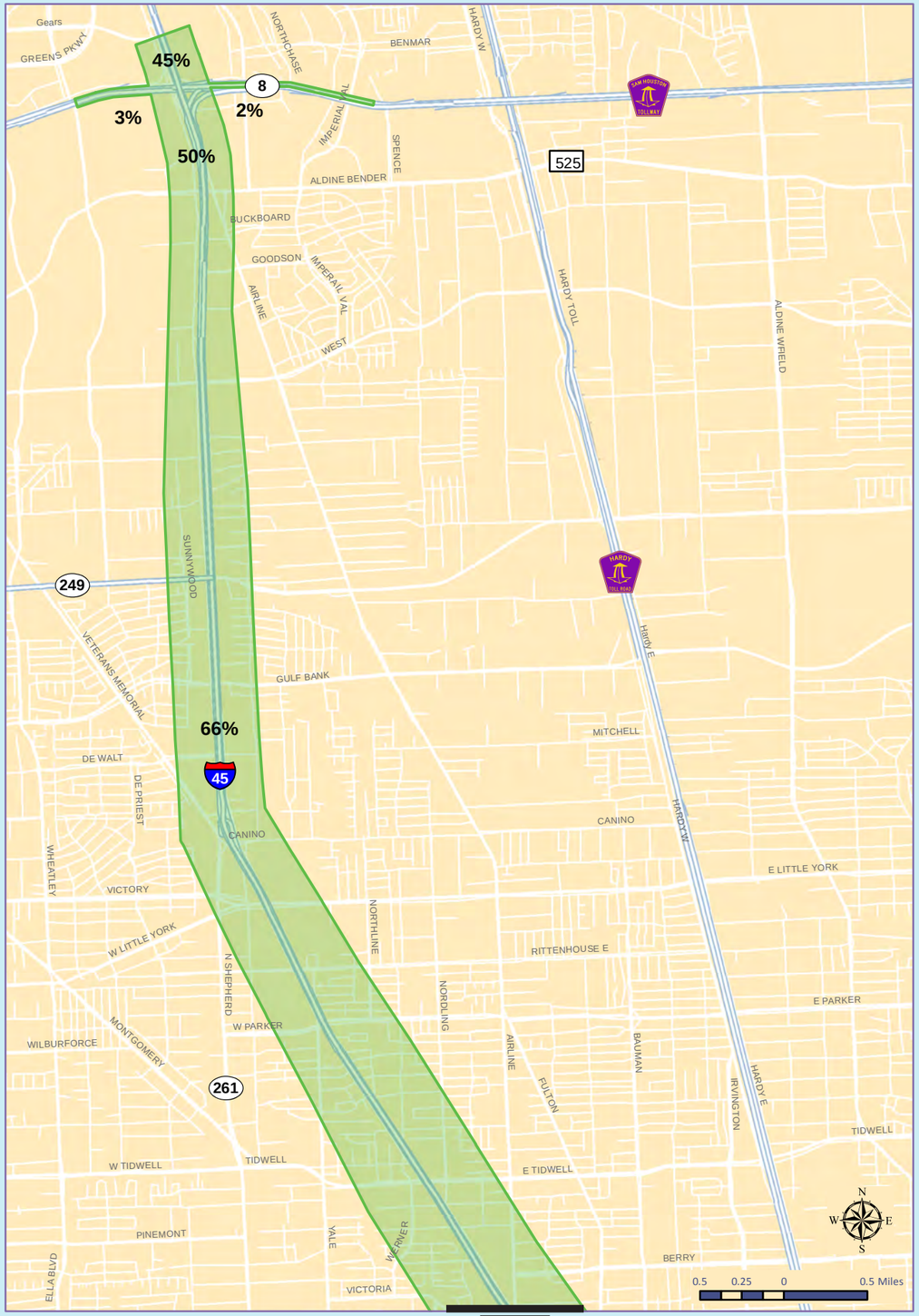
SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-15

2011
Select Link - 3

IH 45
North of
IH 610

Southbound Direction
DDHV = 9,900
Directional Design Hourly Volume



LEGEND

XX% = *Percent of Existing AM Peak Period Traffic TO Select Link Location*

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-16

2011
Select Link - 4

IH 45
North of
IH 10

Southbound Direction
DDHV = 8,400
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic TO Select Link Location*

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

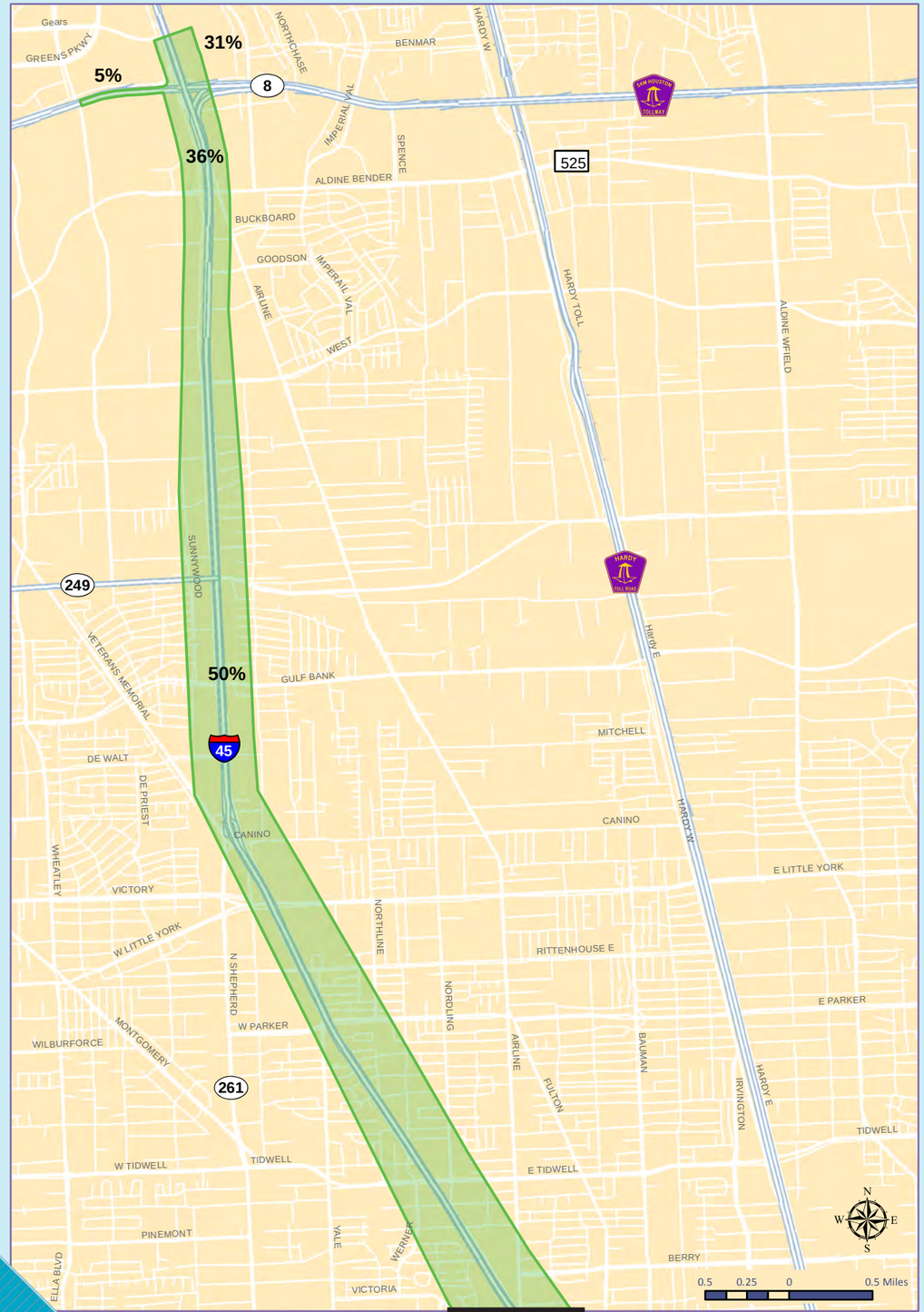


FIGURE 1-17

2011
Select Link - 5

IH 45
South of
US 59

Northbound Direction
DDHV = 7,400
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

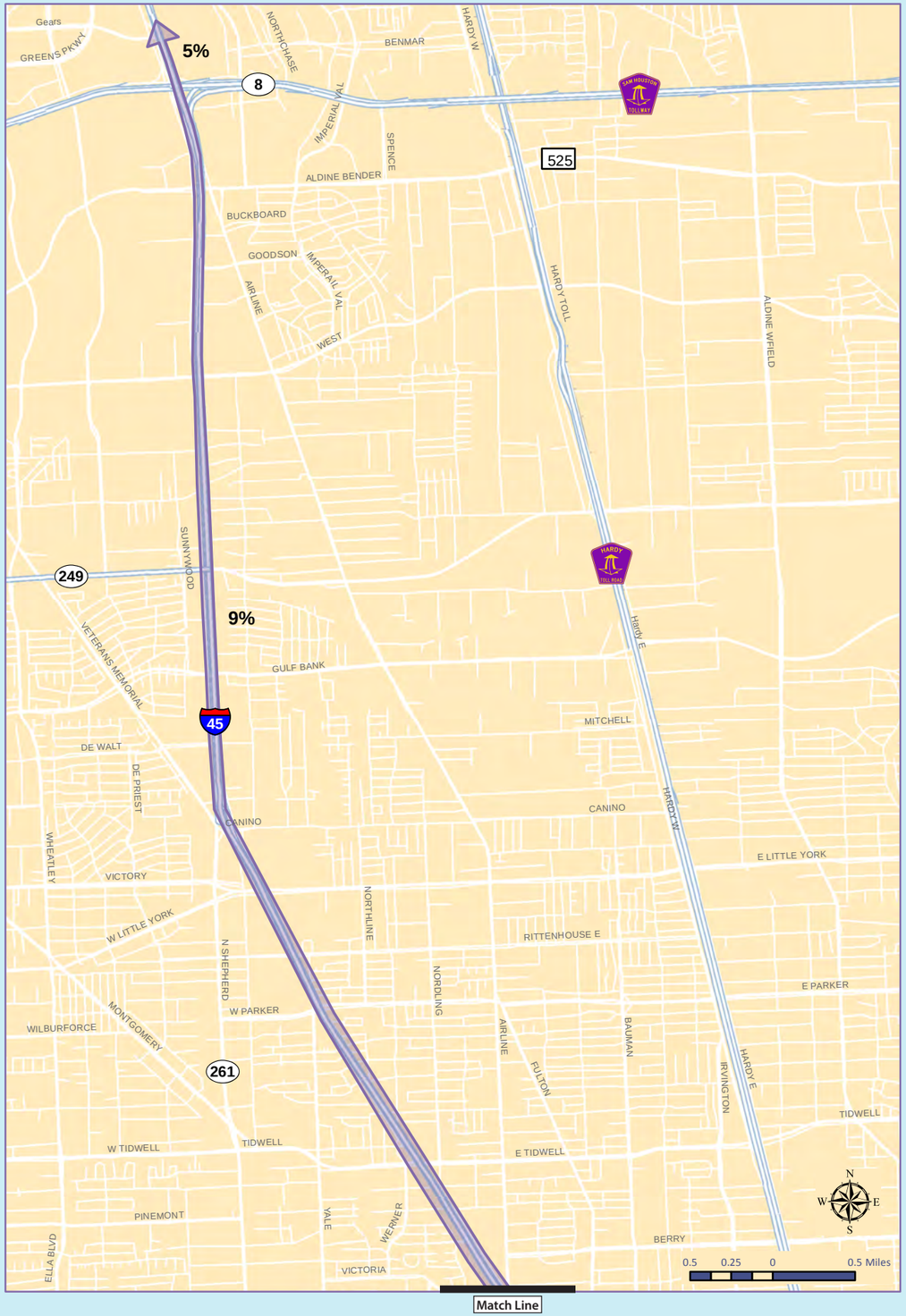
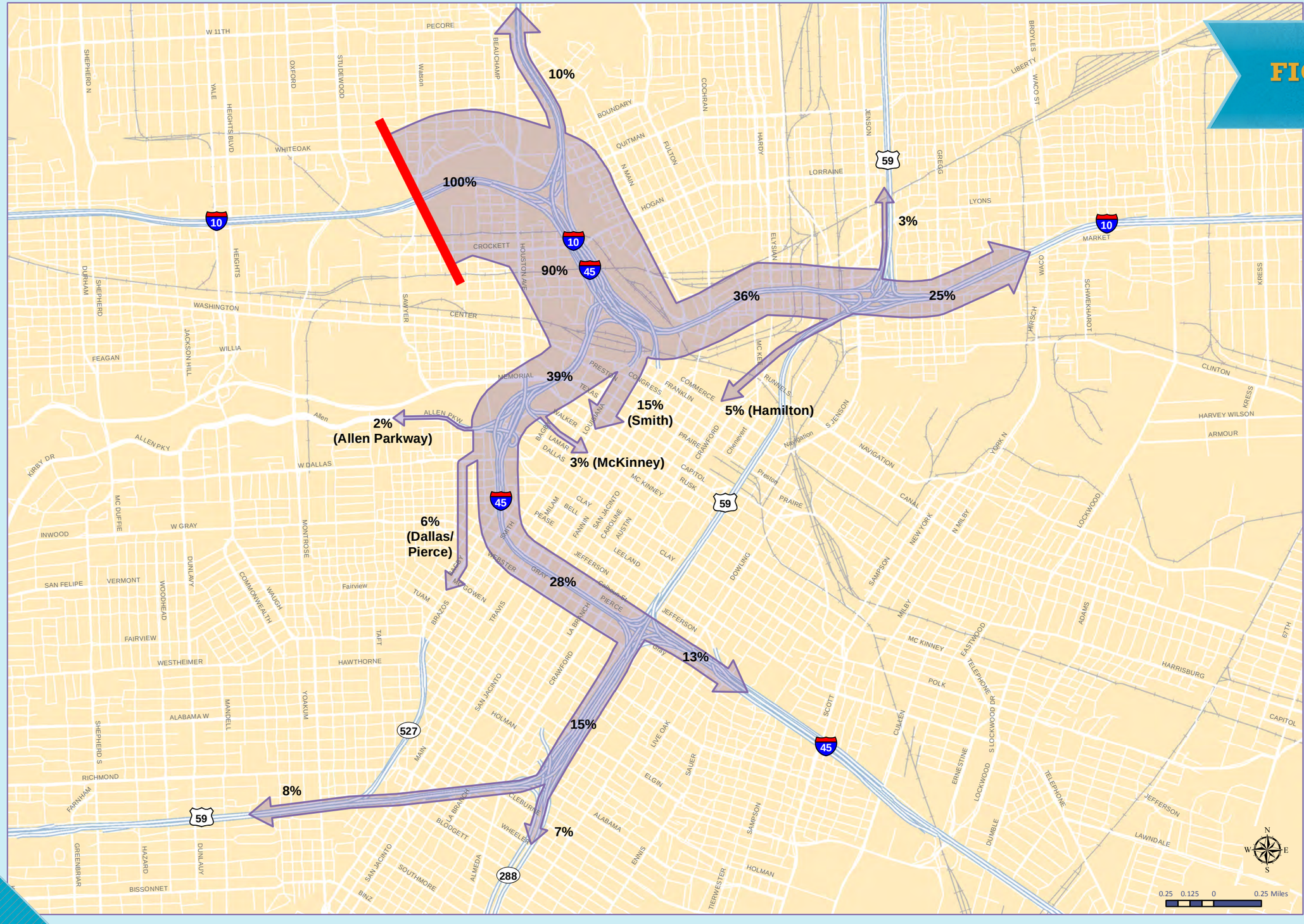


FIGURE 1-18

2011
Select Link - 6

IH 10
West of
IH 45

Eastbound Direction
DDHV = 9,600
Directional Design Hourly Volume



LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

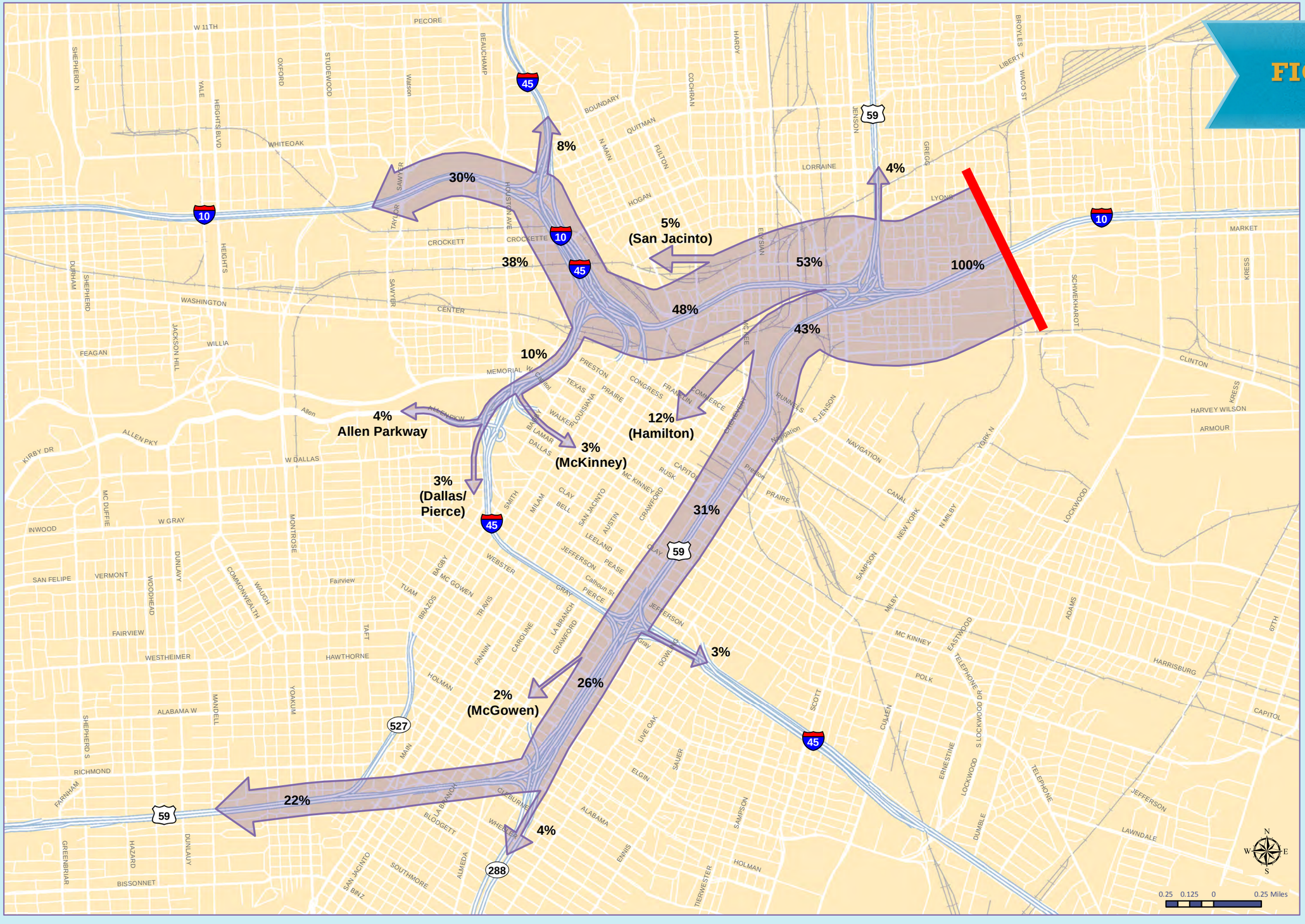
SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-19

2011
Select Link - 7

IH 10
East of
US 59

Westbound Direction
DDHV = 7,300
Directional Design Hourly Volume



LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

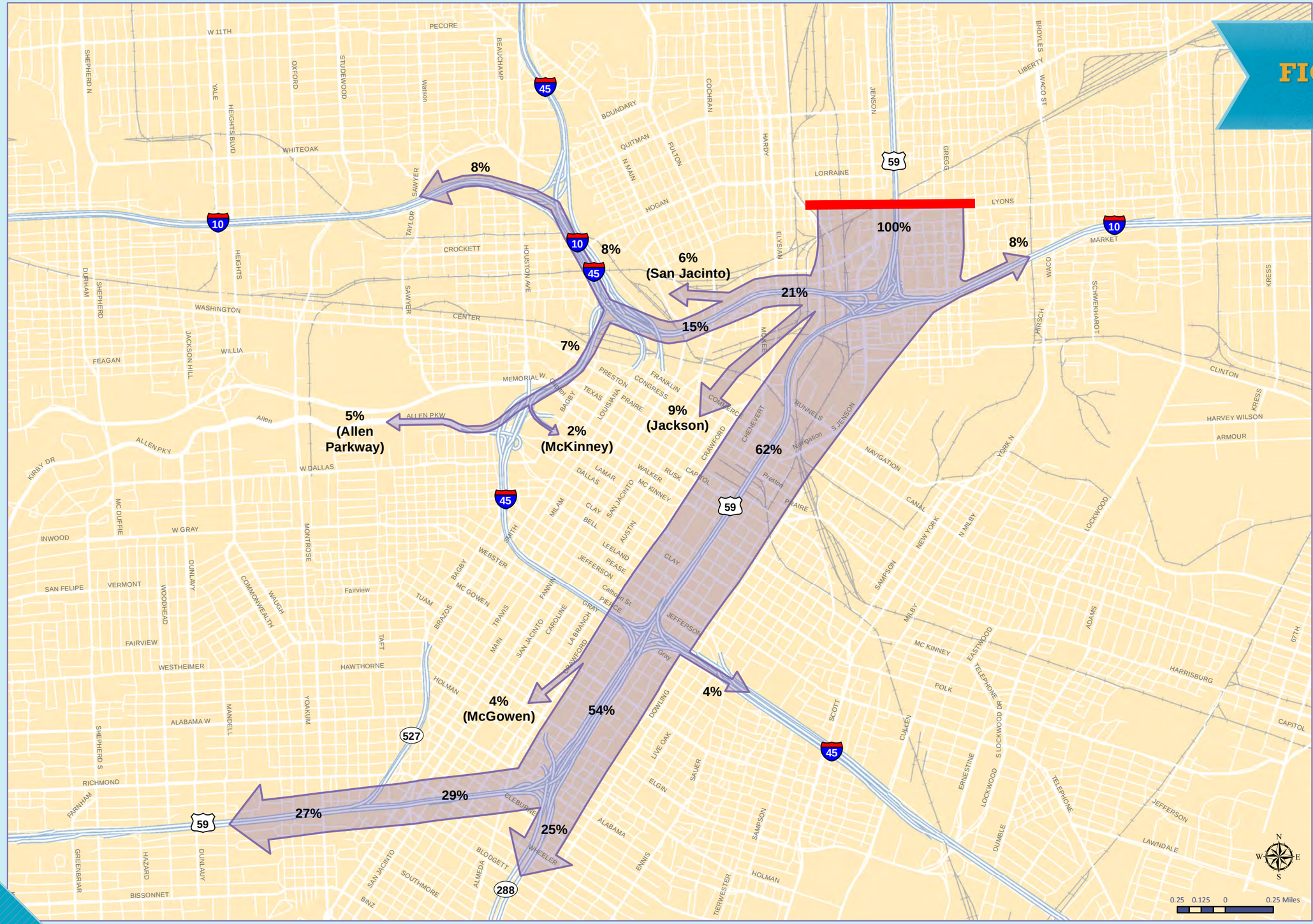
SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-20

2011
Select Link - 8

US 59
North of
IH 10

Southbound Direction
DDHV = 11,000
Directional Design Hourly Volume

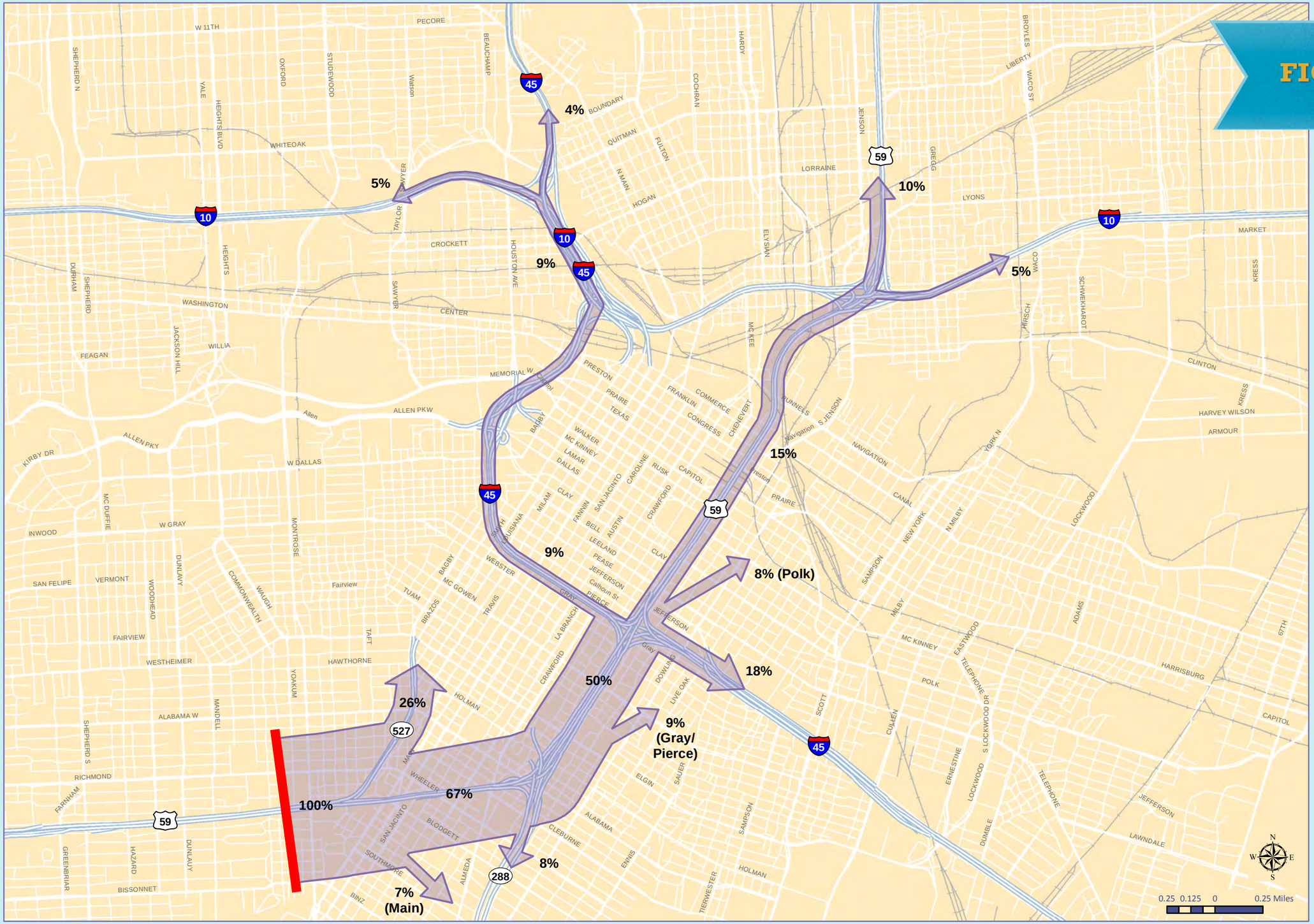


LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-21



2011 Select Link - 9

US 59 West of Spur 527

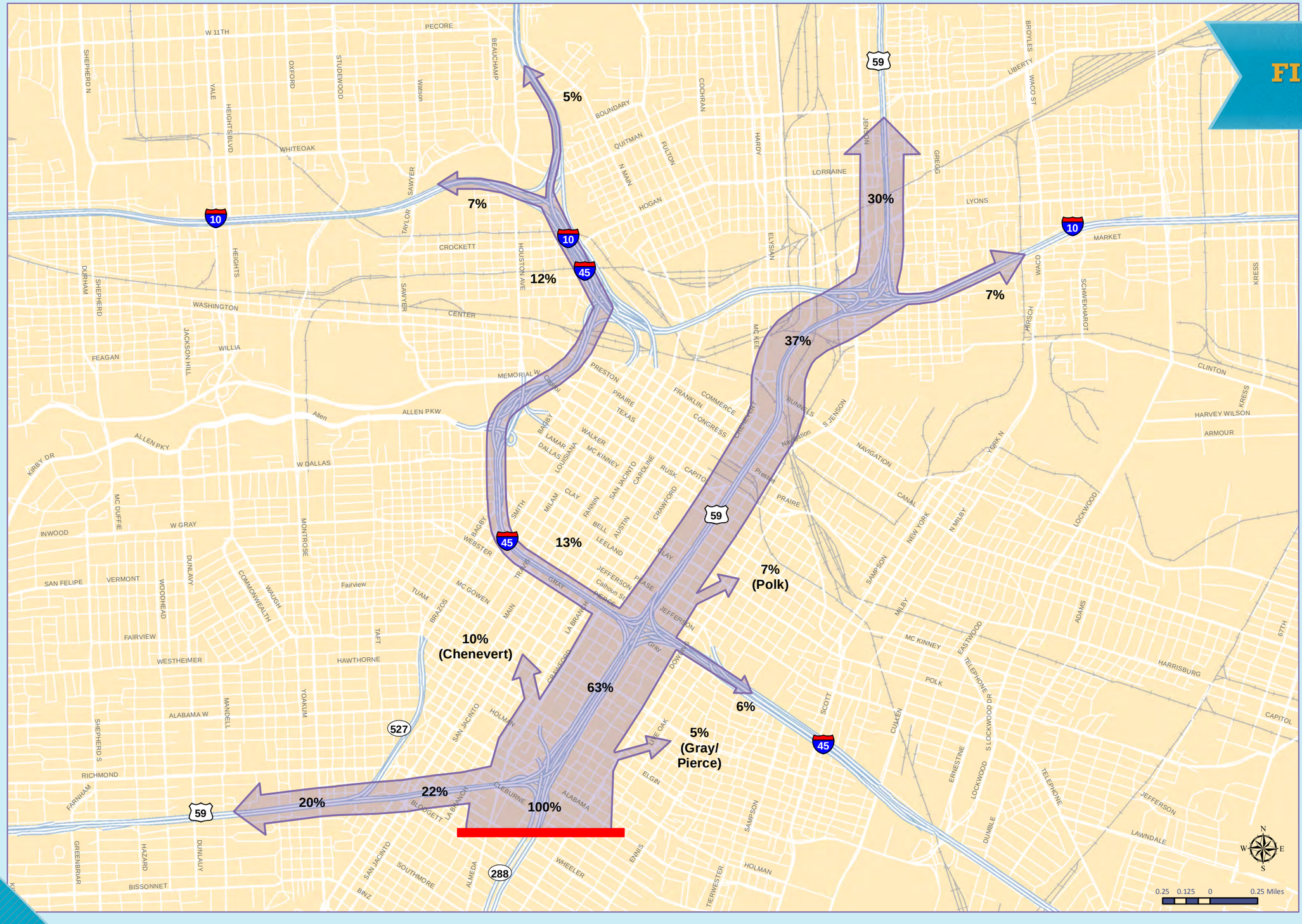
Eastbound Direction
DDHV = 12,900
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-22



2011
Select Link - 10

SH 288
South of
US 59

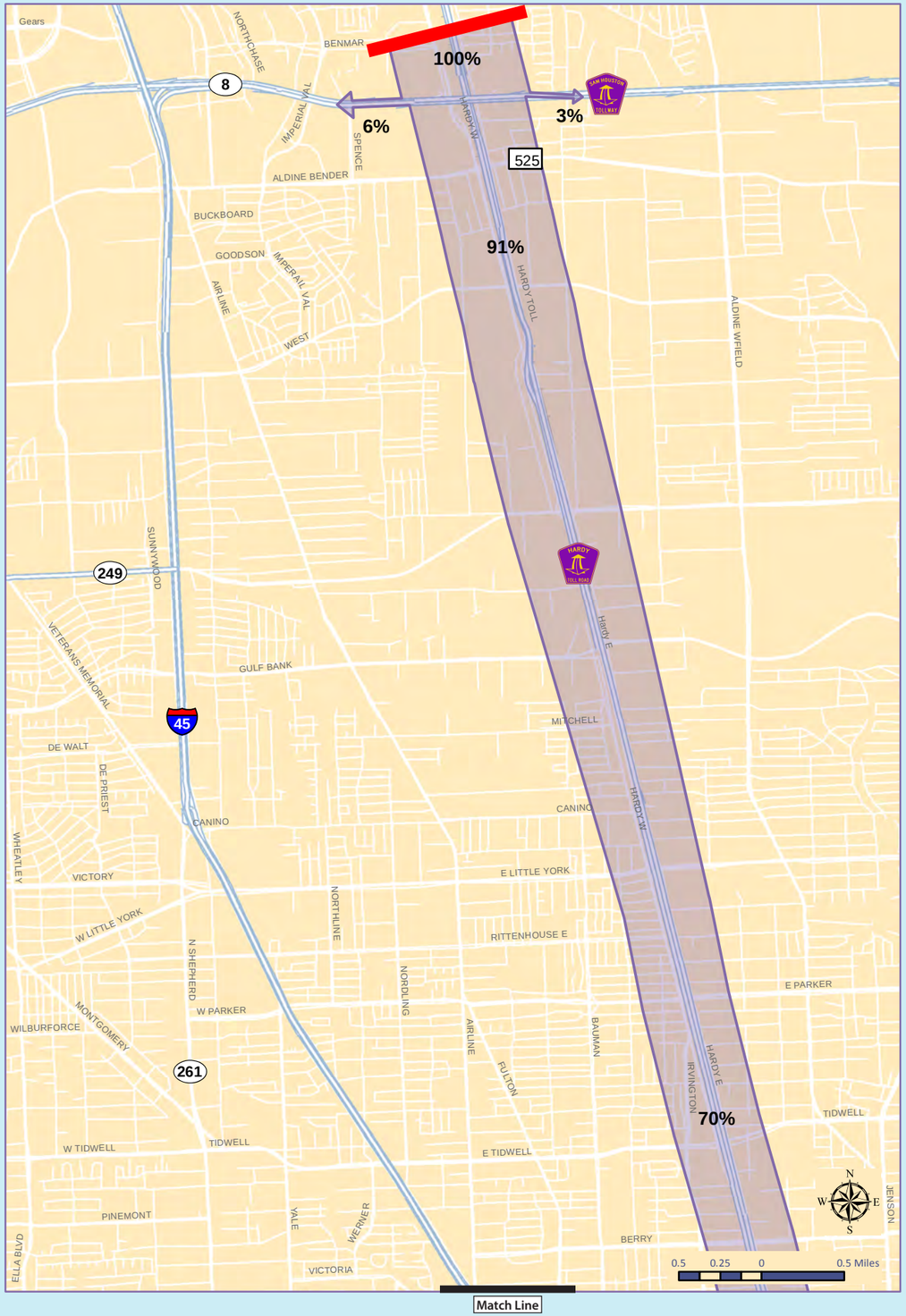
Northbound Direction
DDHV = 7,700
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-23



2011
Select Link - 11

Hardy Toll Road North of Beltway 8

Southbound Direction
DDHV = 3,000
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 1-24

2011
Select Link - 12

Hardy Toll Road North of IH 610

Southbound Direction
DDHV = 5,900
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic TO Select Link Location*

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

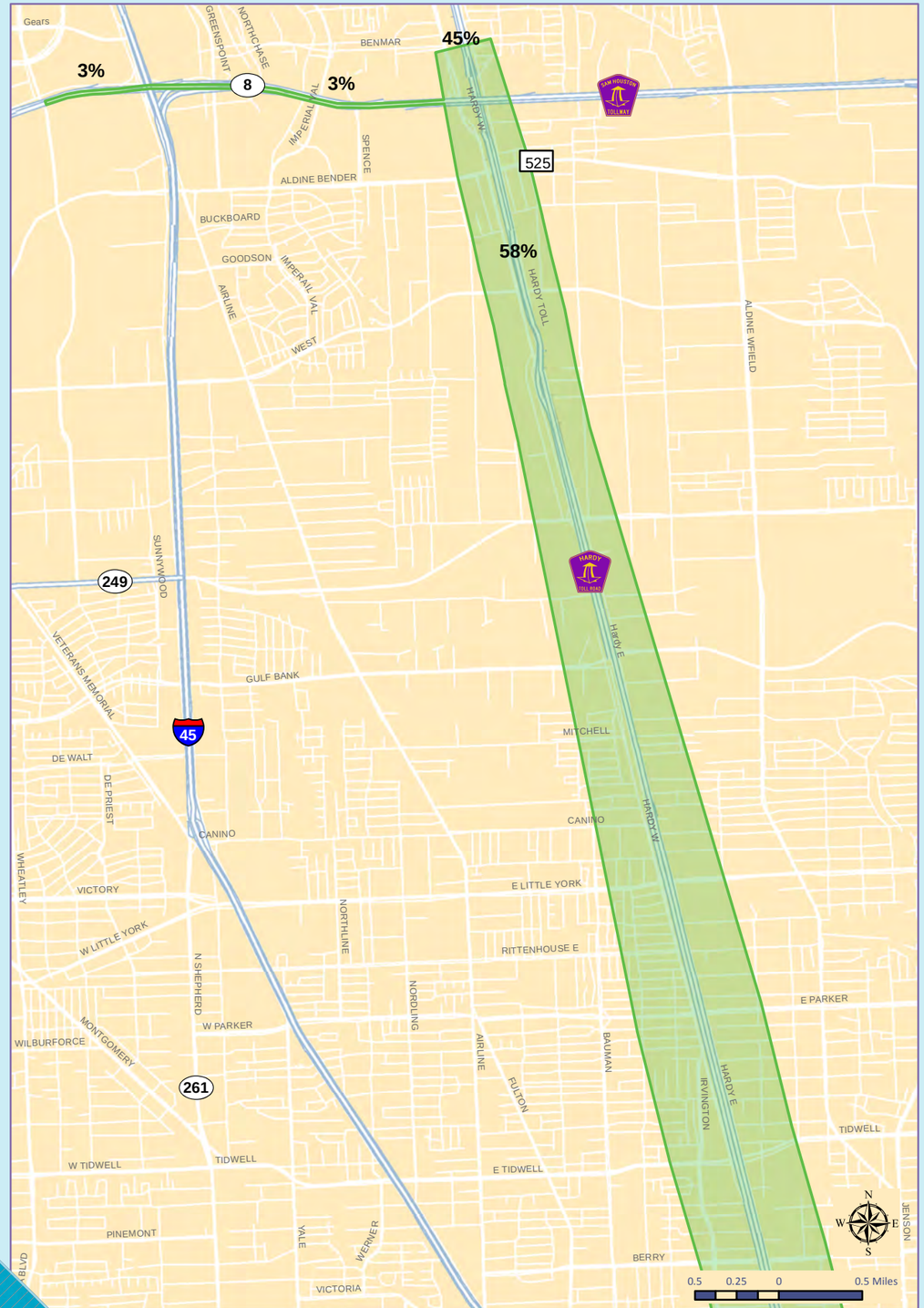


FIGURE 1-25

2011
Select Link - 13

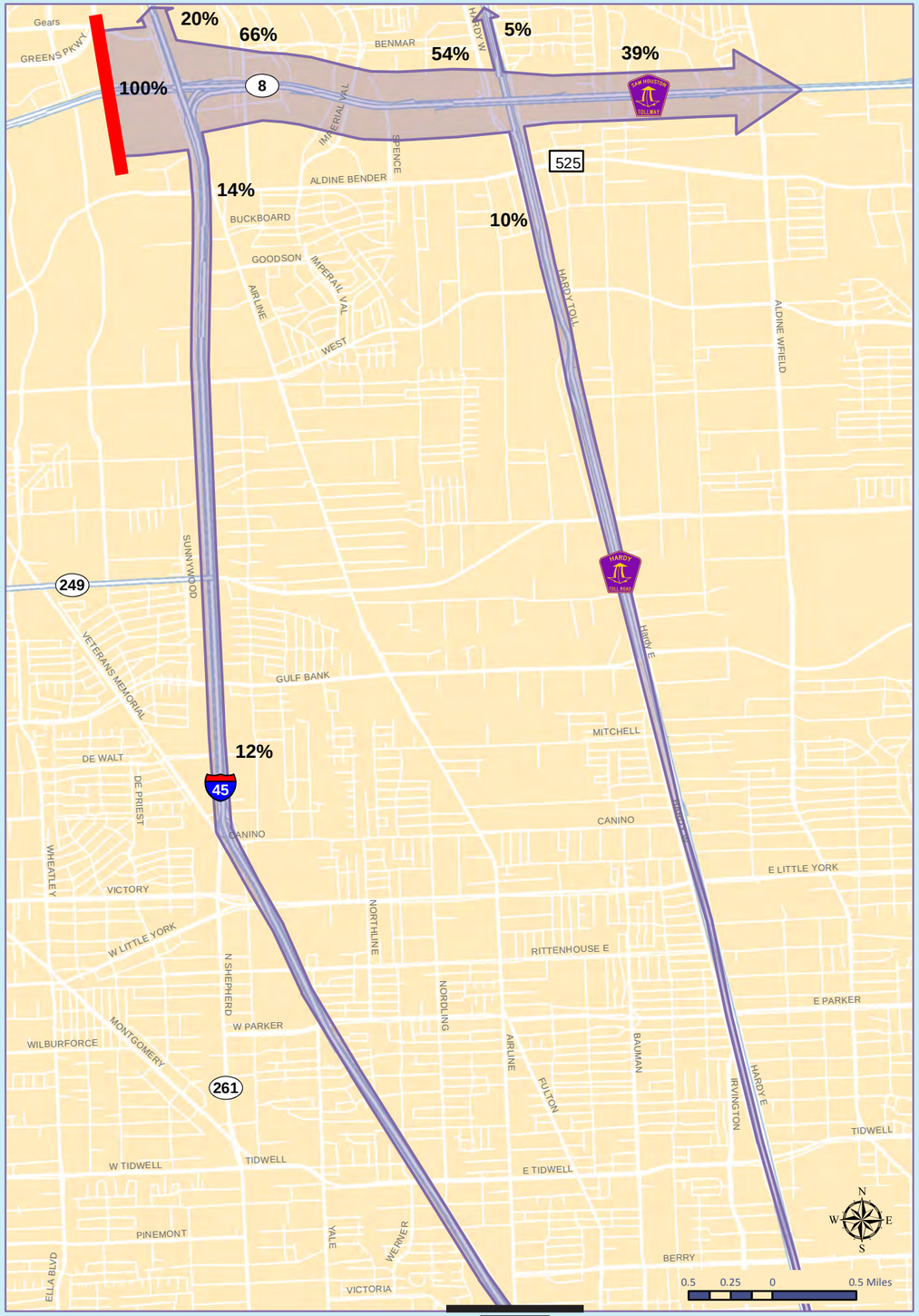
Sam Houston Tollway West of IH 45

Eastbound Direction
DDHV = 8,200
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model



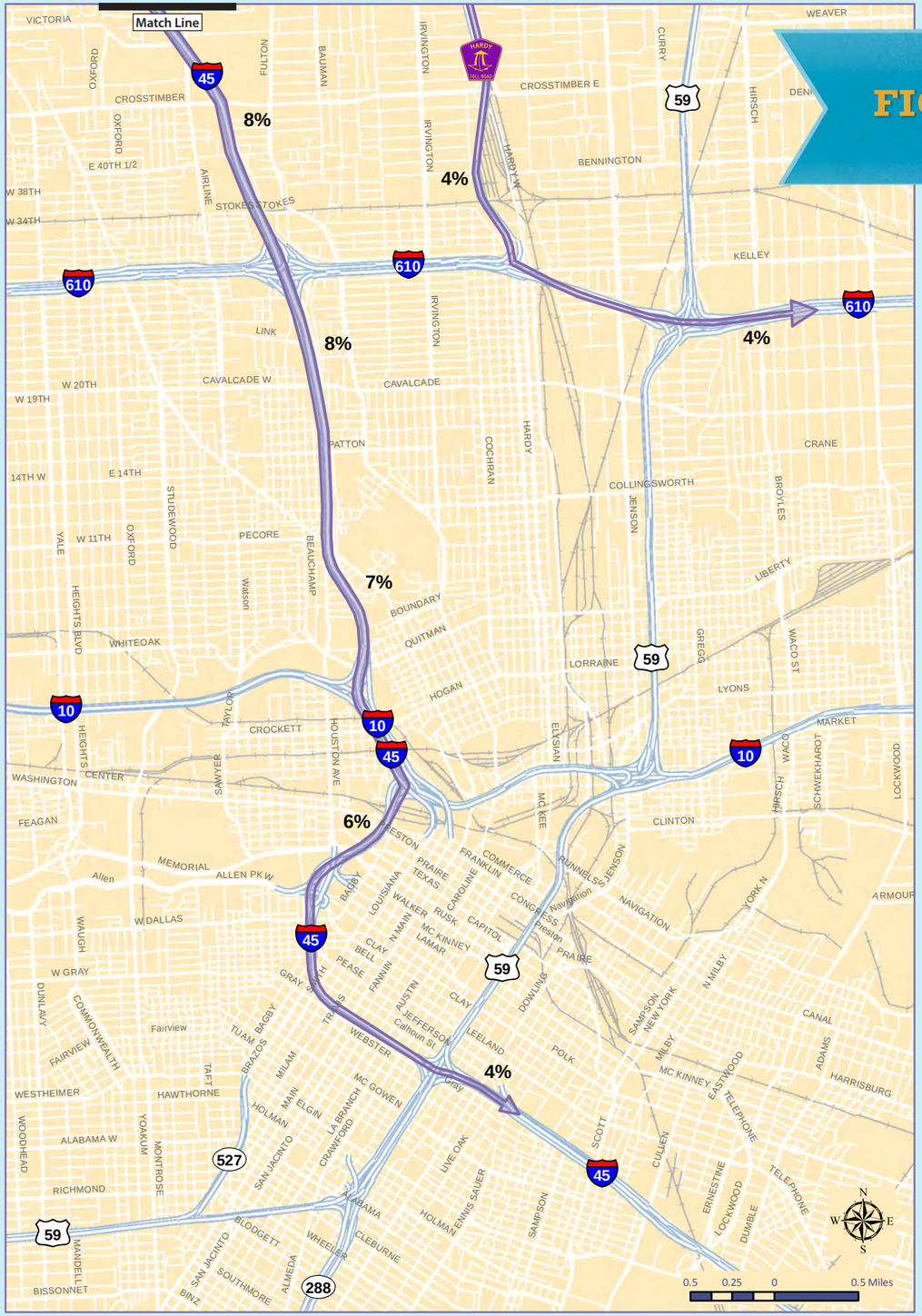


FIGURE 1-26

2011
Select Link - 14

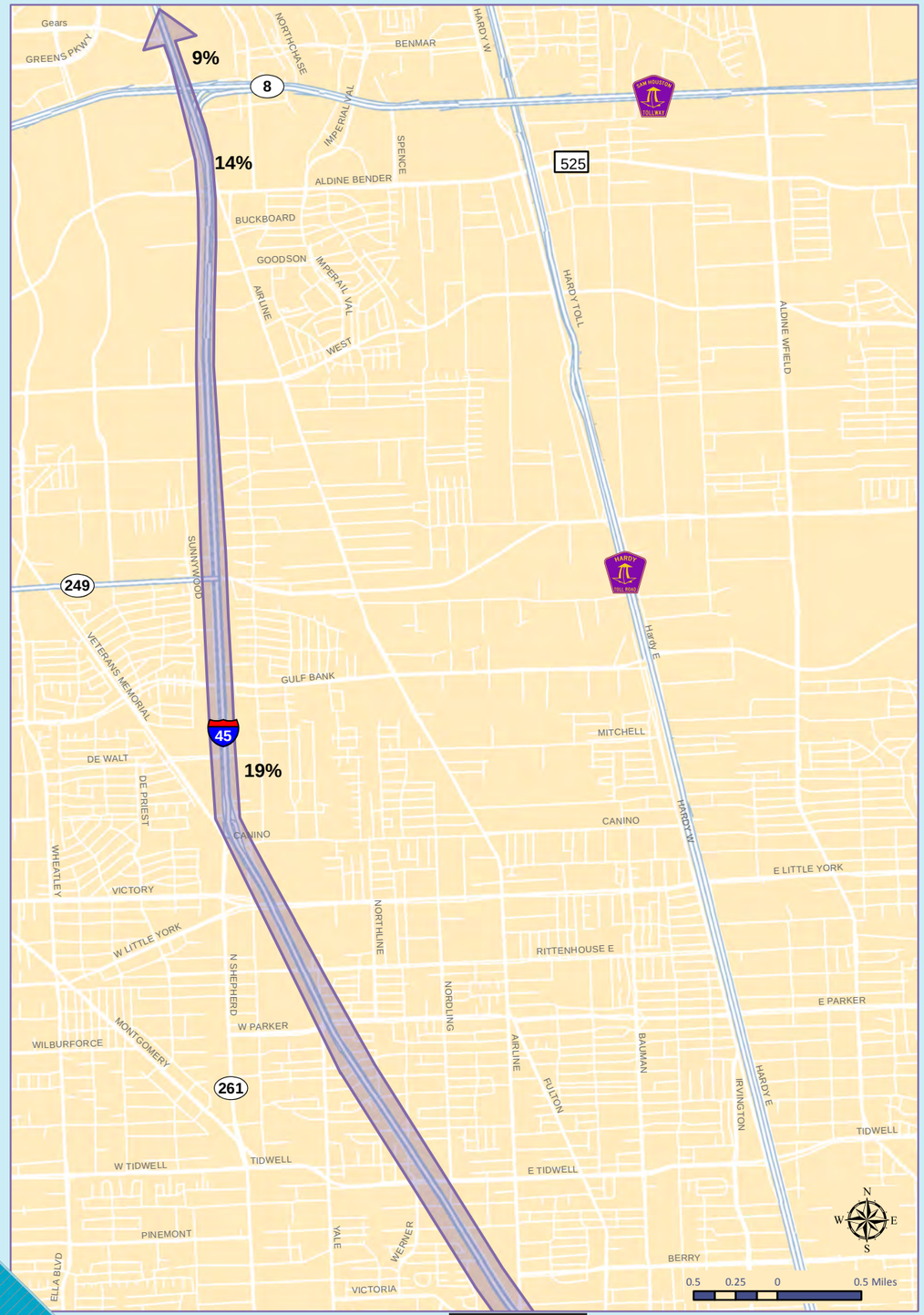
IH 610
West of
IH 45

Eastbound Direction
DDHV = 8,600
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Existing AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model



The distribution of traffic from the select-link locations to various roadways is summarized below. Please refer to **Figures 1-13** through **1-26** for detailed distribution from each select-link location. The following section provides a summary of existing travel patterns, during morning peak period, along different roadways in the study area:

I-45 Corridor

- Traffic from north of Sam Houston Tollway/Beltway 8
  - 19% to I-610
  - 5% to I-10
  - 6% to I-45 S (south of US 59)
  - 4% to US 59 S/SH 288
  - 9% to Downtown/Midtown areas
  - 21% to other destinations inside I-610 loop
- Traffic from north of Shepherd Drive
  - 25% to I-610
  - 12% to I-10
  - 8% to I-45 S (south of US 59)
  - 6% to US 59 S/SH 288
  - 13% to Downtown/Midtown areas
  - 29% to other destinations inside I-610 loop
- Traffic from north of I-610
  - 43% to I-610
  - 8% to I-10
  - 19% to I-45 S (south of US 59)
  - 15% to US 59 S/SH 288
  - 5% to Downtown/Midtown areas
  - 31% to other destinations inside I-610 loop
- Traffic from north of I-10
  - 23% to I-10
  - 24% to I-45 S (south of US 59)
  - 14% to US 59 S/SH 288
  - 18% to Downtown/Midtown areas
  - 35% to other destinations inside I-610 loop
- Along I-45, between the Sam Houston Tollway/Beltway 8 and I-610, there is significant volume of traffic exiting or entering the freeway using the surface street system. This interaction of traffic between the freeway and arterials through the entrance/exit ramps causes operational issues resulting into reduced travel speeds.

Hardy Toll Road Corridor

- Traffic from north of Beltway 8
  - 9% to Beltway 8
  - 38% to I-610
  - 29% to other destinations inside I-610 loop
  - 18% to US 59 S/SH 288
  - 4% to Downtown/Midtown areas
- Traffic from north of I-610
  - 60% to I-610
  - 36% to other destinations inside I-610 loop
  - 18% to US 59 S/SH 288
  - 6% to Downtown/Midtown areas
- Approximately half of the traffic traveling southbound on Hardy Toll Road north of I-610 is attracted from the arterial street system between Beltway 8 and Crosstimbers Street.

Downtown Loop System (I-45/I-10/US 59)

- I-10 eastbound traffic, from west of I-45
  - 29% to Downtown/Midtown areas
  - 25% continue on I-10 to east of US 59
  - 15% to US 59 S/SH 288
  - 13% to I-45 S (south of US 59)
  - 10% to I-45 N (north of I-10)
- I-10 westbound traffic, from east of US 59
  - 30% continue on I-10 to west of I-45
  - 24% to Downtown/Midtown areas
  - 8% to I-45 N (north of I-10)
  - 3% to I-45 S (south of US 59)
  - 26% to US 59 S/SH 288
- US 59 southbound traffic, from north of I-10
  - 27% continue on to US 59 S (west of Spur 527)
  - 25% to SH 288
  - 18% to Downtown/Midtown areas
  - 16% to I-10
  - 4% to I-45 S (south of US 59)

- US 59 northbound, from west of Spur 527
  - 34% to Downtown/Midtown areas
  - 26% to Spur 527
  - 18% to I-45 S (south of US 59)
  - 10% continue on to US 59 N (north of I-10)
  - 10% to I-10
  - 8% to SH 288
- SH 288 northbound, from south of US 59
  - 30% to US 59 N (north of I-10)
  - 20% to US 59 S (west of Spur 527)
  - 18% to Downtown/Midtown areas
  - 14% to I-10
  - 6% to I-45 S (south of US 59)
  - 5% to I-45 N (north of I-10)

A pie-chart showing distribution of traffic from each of the select-link locations to various destination zones is provided in the **Appendix** of this report.

Traffic Characteristics

For each of the 14 select-link locations a variety of traffic characteristics, including traffic volumes, historic growth rate, number of lanes, K and D factors, V/C ratio and major destinations, were evaluated and presented in the Appendix of this report. A summary of these traffic characteristics is provided in the following section:

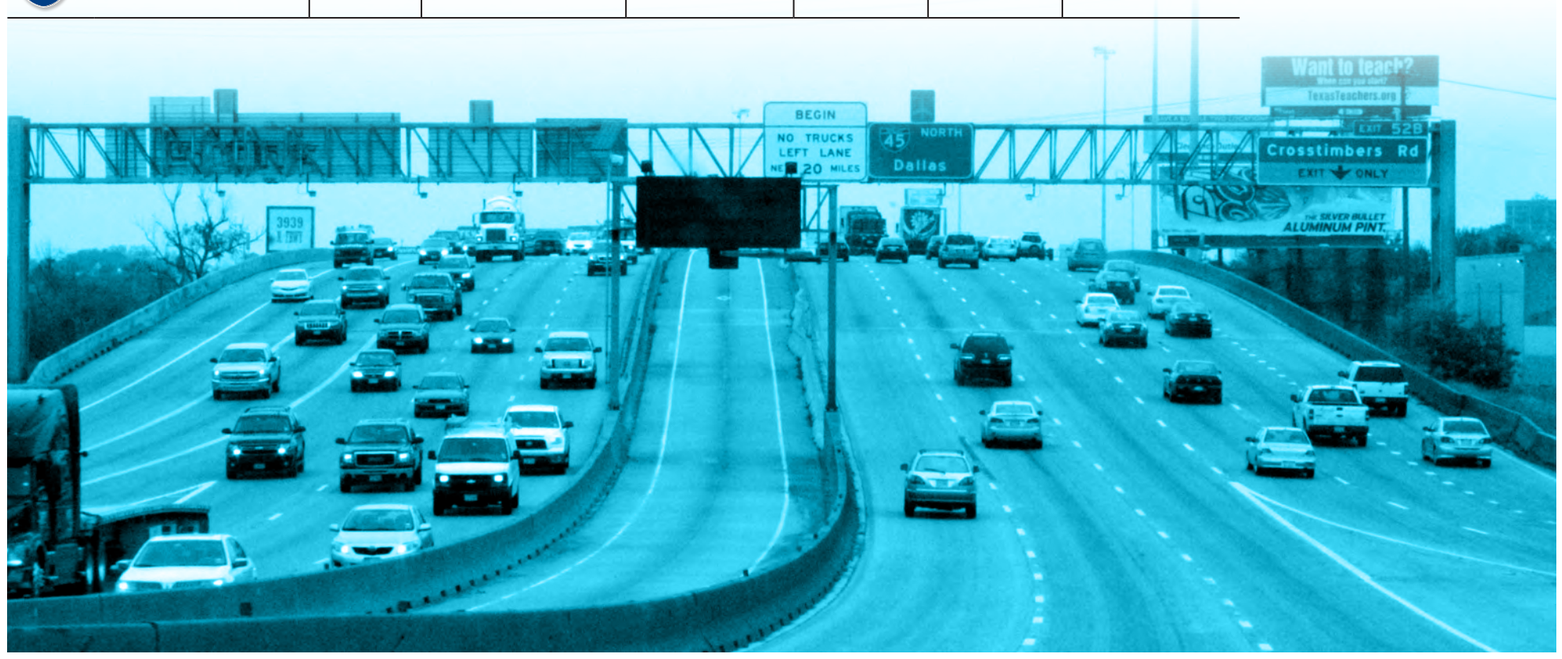
- **Existing Lane Configuration** – presented as a typical configuration at each select-link location showing number of main line lanes, HOV lanes, and frontage road lanes by direction.
- **Historic Traffic Growth** – presented as a graph showing daily traffic volumes from 2000 to 2010 and the corresponding compound annual growth rate.
- **Other Traffic Characteristics** – presented in a table format summarizing traffic volumes (main line/HOV/frontage road), peak hour and directional distribution factors, average speed and level of service.
- **Major Destinations** – presented as a pie chart illustrating distribution of traffic from each select-link location to major destinations in the Houston region. This is discussed in detail in the following section of this report.

A summary of existing traffic characteristics including Average Daily Traffic (ADT) volumes and Design Hourly Volumes (DHV) at the select link locations is provided in **Table 1-5**.

Table 1-5

Summary of Existing Traffic Characteristics by Select Link Location

STUDY CORRIDOR	SELECT LINK NO.	LOCATION	AVERAGE DAILY TRAFFIC (ADT) VOLUME 2011	K-FACTOR	D-FACTOR	DIRECTIONAL DESIGN HOURLY VOLUME (DDHV) 2011
I-45	1	North of BW 8	227,300	8.0%	60%	10,900
	2	North of Shepherd	213,000	8.2%	53%	9,200
	3	North of I-610	229,500	8.0%	54%	9,900
	4	North of I-10	211,700	6.7%	59%	8,400
	5	South of US 59	187,200	7.6%	53%	7,500
I-10	6	West of I-45	210,000	8.3%	55%	9,600
	7	East of US 59	161,500	7.5%	60%	7,300
US 59	8	North of I-10	210,400	8.2%	64%	11,000
	9	West of Spur 527	307,600	8.2%	51%	12,900
SH 288	10	South of US 59	193,000	7.5%	53%	7,700
Hardy Toll Road	11	North of BW 8	42,000	12.0%	70%	3,100
	12	North of I-610	61,000	12.0%	80%	5,900
Sam Houston Tollway	13	West of I-45	198,000	7.5%	55%	8,200
I-610	14	West of I-45	195,000	8.3%	53%	8,600



Major Traffic Destinations

Travel patterns are related to the available roadway infrastructure and land use activities in the region. For this study purpose, the Houston region was divided into six destination zones to analyze distribution of traffic volumes from selected locations along the study corridors to these major destinations. Select-link modeling technique using the regional travel demand model was utilized to determine the origin and destination of traffic patterns with respect to these major destination areas. The six major destination zones identified within the Houston area are listed below and also illustrated in **Figure 1-27**. In addition to these six regional zones, three major destination areas within the region including the Galleria, Midtown, and Texas Medical Center are also shown in this figure.

1. **Downtown Houston –**
   within I-45, I-10 and US 59
2. **I-610 Loop –**
   within I-610 loop (excluding Downtown)
3. **Northeast –**
   outside I-610 loop and between I-45 N and I-10 E
4. **Northwest –**
   outside I-610 loop and between I-45 N and I-10 W
5. **Southeast –**
   outside I-610 loop and between SH 288 and I-10 E
6. **Southwest –**
   outside I-610 loop and between SH 288 and I-10 W

DOWNTOWN HOUSTON

The Downtown Houston or the Central Business District is located east and north of I-45, south of I-10, and west of US 59 S. The Houston Downtown Management District has facilitated many of the public and private projects that have transformed Downtown over the last decade. According to The District, revitalization effort began in 1995 and continues today and in the future in an attempt to improve quality of life.

As of 2013, approximately 149,000 people worked in the Downtown area and around 2,000 people resided there. Two universities are located in Downtown – University of Houston Downtown Campus (with approximately 14,000 students) and the South Texas College of Law (with approximately 1,200 students).

MIDTOWN

Midtown is a district located south of the Houston Downtown roughly skirting west of SH 288, north of US 59, and east of Bagby Street. Based on 2013 H-GAC demographic data approximately 12,000 people worked in Midtown and is home to around 5,300 people. Houston Community College System's central campus is located in Midtown and is close to University of Houston (UH), the University of Houston–Downtown (UHD), Texas Southern University, Rice University, and University of St. Thomas.

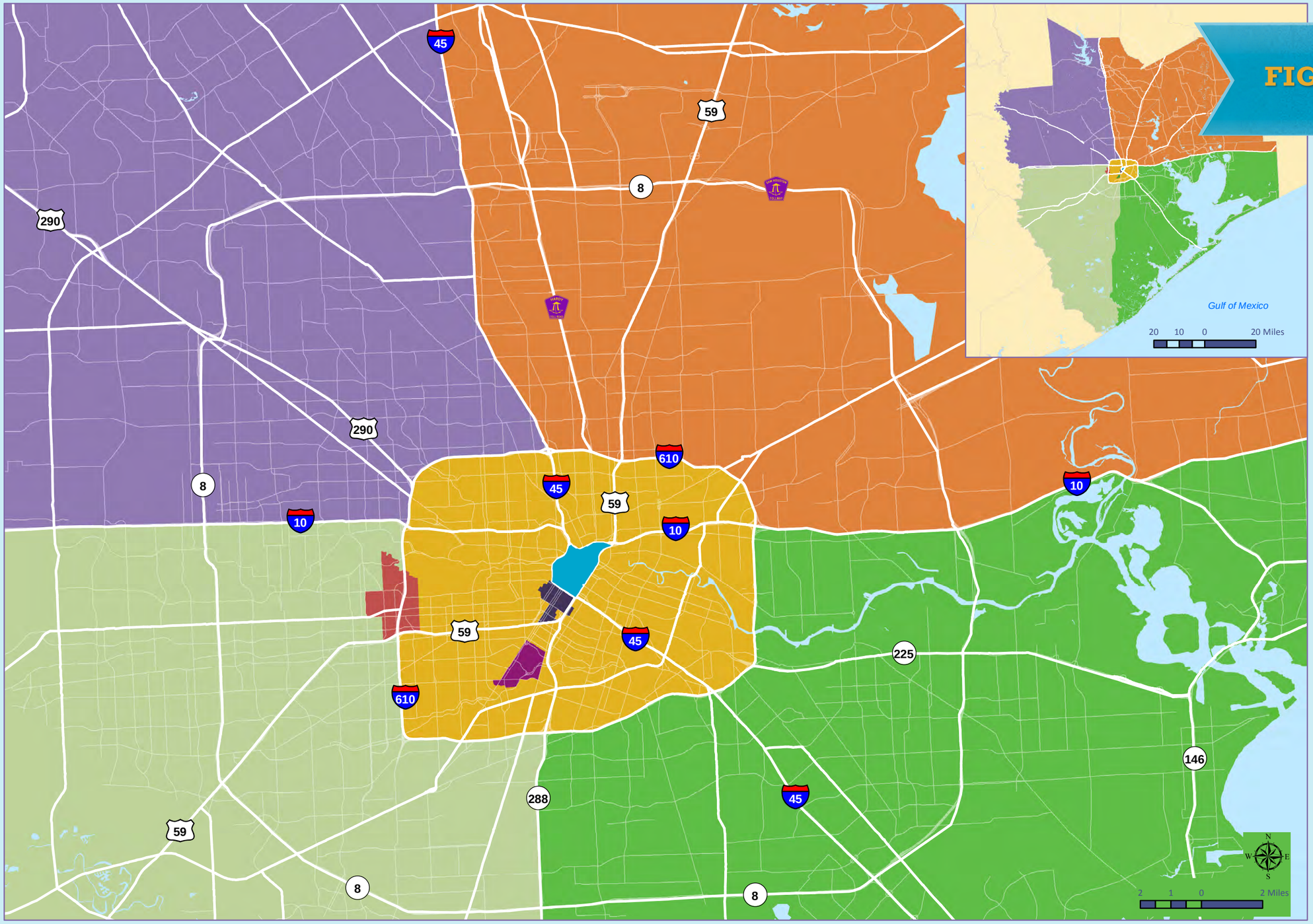
TEXAS MEDICAL CENTER (TMC)

TMC is a major medical facility located on the southwest side within the I-610 loop. It is the world's largest medical complex which opened in 1945. There are 42 independent institutions that are located on the medical center property. As of 2014, the TMC has approximately 7.2 million visitors per year and has 106,000 employees. It is the eighth-largest business district in the country with 1,345 acres.

GALLERIA

The Galleria is mixed-use urban district located on the west side of Downtown Houston just north of US 59 S along the I-610 North Loop. It has become the primary shopping and tourist destination in Houston with over 26 million annual visitors. It is Texas' largest shopping center and the fourth largest nationally, with 2.4 million square feet of space. The Galleria Mall is comprised of many stores, restaurants, and hotels, and is the fourth largest mall in the nation.

FIGURE 1-27



Major Destination Zones

LEGEND

- *Downtown*
- *Galleria*
- *IH 610 Loop*
- *Texas Medical Center*
- *Midtown*
- *Northeast*
- *Northwest*
- *Southeast*
- *Southwest*

SOURCE:
Houston-Galveston Area Council (H-GAC), 2011

Summary of Existing Transportation Conditions

The following section provides an overview of travel patterns, lane configurations, travel demand, level-of-service, and traffic characteristics in the study area.

I-45

Approximately six to 23 percent of the traffic on I-45 traveling inbound to Downtown Houston during morning peak period, from north of Sam Houston Tollway/Beltway 8 to north of I-10, is destined to locations within Downtown and Midtown areas, around 19 to 43 percent exits onto I-610, around five to 23 percent disperses onto I-10; and, nearly 10 to 38 percent travels through the Downtown area to I-45 /US 59/ SH 288.

Hardy Toll Road

Approximately six percent of the traffic on Hardy Toll Road traveling inbound during morning peak period, between north of Sam Houston Tollway/ Beltway 8 and north of I-610, is destined to locations within Downtown/ Midtown areas, a significant portion 38 to 60 percent exits onto I-610; and, around 21 to 24 percent travels through the Downtown area before dispersing onto I-45 S /US 59 S/ SH 288.

I-10

Approximately 23 percent of the traffic on I-10 traveling inbound during morning peak period, between west of I-45 and east of US 59, is destined to locations within Downtown/Midtown areas, around eight to ten percent exits onto I-45 N, and approximately 28-29 percent travels through the Downtown loop onto I-45 S/US 59 S/SH 288.

US 59

Nearly 60 percent of the morning peak period traffic on US 59 traveling inbound from north of I-10 continue onto US 59 through the Downtown/ Midtown area dispersing onto I-45 S/US 59 S/SH 288, approximately 13 percent is destined to locations within Downtown/Midtown areas, and around 16 percent exits and continues onto I-10.

For inbound traffic on US 59 coming from west of Spur 527, only 15 percent travels the Downtown loop to US 59 N and I-10 E, a large portion around 26 percent is destined to locations within Downtown/Midtown areas, and around four and 18 percent travels onto I-45 north of I-10 and I-45 south of US 59 respectively.

SH 288

Of the total AM peak period traffic traveling northbound on SH 288 from south of US 59, approximately half takes US 59 to north of I-10 and west of Spur 527, 13 percent travels to destinations within Downtown Houston and Midtown areas, 14 percent travels to I-10 to west of I-45 and east of US 59, and about 11 percent travels to I-45 to north of I-10 and south of US 59.

Beltway 8

Of all AM peak eastbound traffic on Sam Houston Tollway, from west of I-45, nearly 40 percent continues on Beltway 8, east of Hardy Toll Road, approximately 14 percent travels southbound on the I-45 corridor, and only about five percent continues through the Downtown area.

I-610

Of all the traffic traveling eastbound on I-610 from west of I-45, in the AM peak period, nearly 46 percent utilizes I-45, with approximately 10 percent traveling through the Downtown area along I-45/US 59/SH 288, and over 30 percent continuing on I-610 traveling east of US 59.

Lane Configuration

This study mainly focuses on the I-45 and Hardy Toll Road corridors between Sam Houston Tollway/ Beltway 8 and I-10 and the Downtown loop consisting of I-45/I-10/US 59 segments. I-45 has four general purpose lanes in each direction plus one-lane reversible HOV lanes in the middle. Hardy Toll Road has three toll lanes in each direction. Around the Downtown loop, there are four to five general purpose lanes in each direction with no HOV lane, and three lanes in each direction on I-45 between Allen Parkway and US 59, known as the Pierce Elevated section. Other roadways in the study area include Sam Houston Tollway/Beltway 8, I-610, SH 288 and Spur 527 with travel lanes ranging from two to five in each direction.

Travel Demand and Level-of-Service

Average daily traffic volumes on I-45 range from as high as 306,000, south of I-10, to 163,000 in the Downtown area. I-45 experiences significant congestion during peak hours with level-of-service (LOS) unacceptable at E/F. Hardy Toll Road experiences daily traffic volume between 68,000 and 42,000 with operating conditions generally acceptable with LOS at D.

Other facilities in the study area experiences high traffic volumes, with travel demand on I-10 ranging from 141,000 to 210,000 vehicles per day (vpd) and operating at LOS E. US 59 currently operates at an unacceptable LOS F with daily traffic volume between 210,000 and 307,600 vpd. Beltway 8 experiences travel demand ranging from 177,000 to 198,000 vpd operating at LOS F, and I-610 currently operates at LOS D or F with traffic volume between 170,000 and 195,000. As stated previously, unless transportation improvements are implemented, congestion will continue to increase in the future.

Traffic Characteristics

The percentage of traffic occuring in the peak hours along I-45 ranges from a high of nine percent north of Sam Houston Tollway/Beltway 8 to a low of six percent near I-10 reflecting the outer-suburban to urban/CBD traffic characteristics. The distribution of traffic in the peak hours along I-45 ranges from 60/40 in the north to a fairly even split of 53/47 in the Downtown area. Hardy Toll Road shows a very high peak hour percent of 15 to 20%.

Chapter 2
VISSIM Traffic Modeling

A micro-simulation model using the VISSIM software was developed to evaluate the existing and future traffic operating conditions along the Downtown loop consisting of I-45/I-10 US 59 segments and US 59 from I-45 to Spur 527. The roadway network included in the model is illustrated in **Figure 2-1**. VISSIM is a time step and behavior-based simulation tool developed to model urban traffic and public transit operations. The inputs for the VISSIM model include detailed traffic volume data, vehicle speed profiles, vehicle types/characteristics, traffic compositions, lane geometries, routing decisions, and signal timing information. The VISSIM model was developed for both AM and PM peak period conditions and will be utilized to evaluate the operational impacts associated with the transportation improvements that will be developed and analyzed as part of the North Houston Highway Improvement Project.

The following sections describe in detail the various inputs, assumptions, and parameters considered in the development of this VISSIM model.

Data Sources

The following data was obtained and utilized in the VISSIM model development:

- Aerial imagery (2010) from H-GAC was utilized in building the detailed model network.
- Traffic signal timing plans were obtained from Houston TranStar for the study area intersections.
- Detailed traffic counts were conducted by C J Hensch and Associates (CJH) in September 2011 along freeway lanes, ramps, and direct connectors within the modeling area. These counts included 50 intersection turning movement counts, 124 24-hour counts, and five 12-hour manual classification counts.
- The field traffic counts were supplemented and verified with available daily traffic volume count information obtained from TxDOT.
- 2011 three-month speed data was obtained from Houston TranStar and was supplemented with travel time runs conducted in the field in September 2011.
- License plate video survey was conducted by CJ Hensch in October 2011 between I-45/US 59 and SH 288/US 59 interchanges to determine peak hour travel patterns between these roadways. This information served as a valuable input to the VISSIM model to accurately reflect realistic traffic patterns in the modeling area.
- The license plate information was supplemented by origin-destination information obtained from the H-GAC travel demand model.

Model Inputs

VISSIM is a microscopic, behavior based simulation model that enables a very realistic replication of real-life driver behavior. As such, to simulate real-life traffic conditions, the model requires very detailed data inputs. This section describes the various inputs that were utilized to develop the VISSIM model for this study.

Vehicle Speed Profiles

The desired speed for a vehicle type at any location in the model network is defined as a distribution rather than a fixed value in order to reflect the stochastic nature of traffic realistically. For any vehicle type, the speed distribution is an important parameter that has a significant influence on roadway capacity and achievable travel speeds. Posted speed limits were used as a basis to generate speed distributions. Also, different stochastic speed profiles are defined for different vehicle types. For example, for passenger cars a posted speed limit of 60 miles per hour (mph) was defined as a distribution with a minimum value of 50 mph and a maximum value of 75 mph with the 85th percentile value equal to the posted speed limit of 60 mph. For heavy vehicles such as trucks and transit buses, a distribution with a range of 50 mph to 70 mph was used with the 85th percentile value equal to the posted speed limit of 60 mph.

In addition to defining the speed profiles of vehicles based on the speed limits, a few other speed distribution profiles were also modeled in the VISSIM network. These profiles account for the speed changes arising out of geometric conditions, such as turning lanes at intersections and curves in freeway segments.

FIGURE 2-1

VISSIM Model Network Coverage

LEGEND

VISSIM Network

Vehicle Types/Characteristics

For the purpose of modeling the network in VISSIM, vehicles observed in the study area were broadly classified into three types – passenger cars, heavy vehicles, and buses. VISSIM default characteristics for each vehicle type, such as vehicle dimensions, occupancy, and acceleration/deceleration profiles were not modified.

Traffic Composition

The traffic counts conducted by CJH were utilized in determining the percentage of different vehicle types on the study area roadways. During the AM peak period, it was estimated that the I-45 and I-10 freeway main lanes and frontage roads carry an average of 2.1% heavy vehicles in either direction. Hardy Toll Road carries approximately 3.4% heavy vehicles and I-45 HOV lane carries an estimated 4.6% buses. Similarly, during the PM peak hour it was estimated that I-45 and I-10 freeway main lanes and frontage roads carry an average of 2% heavy vehicles in either direction, Hardy Toll Road carries approximately 4.5% heavy vehicles, and I-45 HOV lane carries an estimated 5% buses.

In VISSIM, traffic composition on a roadway can be defined only at the entry points into the network. So in order to replicate the observed traffic composition on different roadways in the VISSIM model, routing decisions were created in the model for different vehicle types. For example, only passenger cars and buses are allowed to operate on the HOV lanes. A routing decision which prohibits heavy vehicles from entering the HOV lane was created for the HOV entrance ramps.

Roadway Network

The model study area consists of a complicated roadway network with direct connectors, entrance and exit ramps, frontage roads, freeway main lanes, reversible HOV lanes, and toll roads. Several field trips were conducted to document the roadway geometric and operational details such as speed limits, number of lanes, acceleration and deceleration lanes, "chicken" merges, and location of entrance and exit ramps. Aerial imagery obtained from H-GAC was utilized in developing the existing model roadway network.

Traffic Volumes

CJH conducted peak hour intersection turning movement counts and 24-hour counts in the study area. This information was utilized in developing traffic volumes inputs in the VISSIM model. Freeway main lane and ramp volumes were adjusted where necessary to account for variations from counts conducted on different days to develop a balanced traffic count profile along the entire model network. The VISSIM model network includes only the freeway segments shown in Figure 2-1 including key intersections where the Downtown freeway system interacts with the street system. The model does not include Downtown streets or HOV lanes.

Intersection Traffic Control

VISSIM has the capability to model any type of intersection, either signalized or stop-sign controlled. As mentioned previously, AM and PM peak hour traffic signal timings for study area intersections were obtained from Houston TranStar. Various priority rules were also defined at these intersections to allow for maneuvers such as right turn on red, left-turn yield, etc. Speed profiles for such turning maneuvers were also defined in order to better represent real world conditions.

Simulation Parameters

The AM and PM VISSIM models were simulated for a total of 5,400 seconds including 1,800 seconds of network seeding (loading) time for each time period. All the simulation runs were carried out at a simulation resolution of five time steps per simulation second. Simulation resolution is the number of times a vehicle's position is calculated within one simulated second (range 1 to 10). With a higher simulation resolution, vehicles move more smoothly in the network. The simulation speed was set to the maximum possible speed – it does not affect the simulation results and is determined by the size of the network simulated as well as the computer hardware.

Model Calibration and Validation

Calibration is a necessary process to ensure that traffic conditions in the real world are sufficiently replicated by the simulation model. VISSIM is a complex mathematical model with several parameters that can be adjusted to match driver behavior in the real world. Model parameters in VISSIM can be classified as following:

- Lane changing parameters
- Car following parameters
- Vehicle parameters

Car following and lane change parameters directly affect driving behavior for vehicles in the model. Vehicle parameters describe attributes associated with each vehicle type modeled such as vehicle dimensions, occupancy, and acceleration and deceleration profiles. Some of the parameters affect the model performance on a global scale while others have a local effect.

The model calibration process involved adjusting and fine-tuning the following model parameters:

Lane Changing Parameter

Lane change distance parameter was reasonable. This parameter defines the distance at which vehicles will begin to attempt to change lanes in order to be on the correct route to their destination. The default freeway lane change parameters did not produce lane changing behavior similar to what was observed in the field primarily because most drivers in the study area during the peak hour are commuters. Although there is a random variation in the perceived distance to an exit, there is no data to accurately estimate this average distance. Therefore, lane change parameters on the freeway segments were modified until a realistic animation was observed.

Car Following Parameter

The next stage of parameter calibration involved adjustments to the car following parameters in VISSIM. There are 10 car following (CC0- CC9) parameters in VISSIM. Default values for these CC-parameters were used as a starting point and were modified to better reflect actual conditions. For example, peak hour commuters tend to accept smaller gaps when changing lanes, especially with high volume weaving. Using field observations, this driver behavior was replicated for target segments on the freeway corridor by reducing the CC1 parameter and the absolute value of CC4 and CC5 parameters and by increasing the deceleration thresholds for lane changing vehicles. Reducing CC1 parameter results in smaller car following distances, while lower absolute values of CC4 and CC5 result in tighter coupling of vehicles in VISSIM. Increasing the deceleration thresholds makes drivers more aggressive during lane changes, as is typically the real world case during the peak hour.

"Waiting Time Before Diffusion" Parameter

This parameter is very effective for removing gridlocks in the model, caused sometimes by cars that stop and are unable to make a lane change maneuver due to unacceptable gaps. In the real world, other drivers typically allow such a driver to make the maneuver. The "waiting time before diffusion" parameter essentially allows vehicles to wait for a preset "waiting time" at a distance, known as emergency stop distance, and then force a gap in order to stay on their route.

Other Vehicle Parameters

In addition to the driving and lane change parameters, some vehicle parameters such as vehicle dimensions, occupancy, and acceleration and deceleration profiles can also be changed. However, during the calibration of this model, these parameters were not modified and the default values were used instead.

After the calibration process was completed, the model was run multiple times and inspected visually to ensure expected operation. Analysis output from the VISSIM model was obtained after running the model for one hour representing the peak hour. Three types of output data can be analyzed to determine the level of calibration – vehicular throughput, average traffic speed, and average travel time along freeway sections.

Vehicular Throughput

Throughput represents the total number of vehicles passing through a roadway cross-section over a specific period of time. Data collection points were defined and configured in VISSIM to collect traffic volume data at various points in the model network. Throughput at these locations, for AM and PM peak hours, was compiled and compared to input traffic volumes. **Table 2-1** shows actual traffic and simulated model volumes along the freeway lanes, and the percentage difference for the various points in the network. **Table 2-2** shows the information for direct connectors in the model. As seen modeled volumes are within less than five percent of input volumes on freeway main lanes and within less than ten percent on the ramps and direct connectors.

Table 2-1

Summary of Data Collection Sections
Vehicular Throughput – Freeway Main Lanes

	DATA COLLECTION LOCATION	AM PEAK PERIOD			PM PEAK PERIOD		
		SIMULATED MODEL VOLUME	ACTUAL VOLUME	% DIFFERENCE	SIMULATED MODEL VOLUME	ACTUAL VOLUME	% DIFFERENCE
NORTHBOUND/WESTBOUND	I-45 north of Beltway	6917	6730	+2.78%	8285	8330	-0.54%
	I-45 north of I-610	7837	7450	+5.19%	7366	7260	+1.46%
	I-45 north of I-10	5812	5830	-0.31%	6916	7060	-2.04%
	I-45 at Allen Pkwy	6465	6720	-3.79%	8794	8760	+0.39%
	I-10 Westbound west of I-45	7967	8290	-3.90%	7323	7380	-0.77%
	I-10 Westbound at Main St.	5645	5760	-2.00%	3700	3790	-2.37%
	I-10 Westbound east of US 59	6297	6320	-0.36%	5011	5020	-0.18%
	US 59 south of I-10	5318	5310	+0.15%	6606	6760	-2.28%
	Hardy Toll Rd north of I-610	1534	1550	-1.03%	3499	3490	+0.26%
	Hardy Toll Rd at Toll Plaza	1090	1100	-0.91%	2597	2590	+0.27%
SOUTHBOUND/EASTBOUND	I-45 north of Beltway	9492	9970	-4.79%	5976	6000	-0.40%
	I-45 north of I-610	8455	8730	-3.15%	6747	6920	-2.50%
	I-45 north of I-10	8032	8110	-0.96%	5740	5830	-1.54%
	I-45 at Allen Pkwy	7041	7130	-1.25%	6050	6260	-3.35%
	I-10 Eastbound west of I-45	6943	6960	-0.24%	6735	6780	-0.66%
	I-10 Eastbound at Main St.	4571	4630	-1.27%	5042	5050	-0.16%
	I-10 Eastbound east of US 59	4666	4820	-3.20%	5635	5780	-2.51%
	US 59 south of I-10	6485	6490	-0.08%	6217	6310	-1.47%
	Hardy Toll Rd north of I-610	4497	4400	+2.20%	2063	2120	-2.69%
	Hardy Toll Rd at Toll Plaza	4080	4110	-0.73%	1189	1170	+1.62%

Table 2-2

Summary of Data Collection Sections
Vehicular Throughput – Direct Connectors

	AM PEAK PERIOD			PM PEAK PERIOD		
	SIMULATED VOLUME	ACTUAL VOLUME	% DIFFERENCE	SIMULATED VOLUME	ACTUAL VOLUME	% DIFFERENCE
I-45 SB to Beltway 8 (EB and WB)	2312	2490	-7.15%	1682	1720	-2.21%
I-45 NB to Beltway 8 (EB and WB)	1901	1900	+0.05%	1910	1920	-0.52%
I-45 SB to I-610 (NB and SB)	3754	3850	-2.49%	3175	3220	-1.40%
I-45 NB to I-610 (NB and SB)	1929	1920	+0.47%	2299	2430	-5.39%
I-45 SB to I-10 WB	1351	1390	-2.81%	689	700	-1.57%

Traffic Speed and Travel Time

Travel speed is the average speed of all vehicles passing through a section over a specific period of time and travel time is the average time taken by vehicles to traverse a specific portion of a roadway. Houston TranStar provides historical traffic speed and travel time information along major Houston area freeways. This data was used to further calibrate the VISSIM model to existing traffic conditions.

Chapter 3
Future Transportation Conditions

This chapter provides a discussion of future transportation conditions including planned transportation projects, demographic projections, 2035 travel demand, level of service, and future traffic characteristics and travel patterns along the study corridors.

Planned Transportation Projects

Planned transportation projects are financially committed projects identified in H-GAC *2035 Regional Transportation Plan (RTP) Update*. Projects located within the study area are listed in **Table 3-1** and illustrated in **Figure 3-1**. The projects identified in this table are primarily added capacity improvement projects, including existing roadway widening and new roadway construction projects. These RTP projects are broadly categorized into three timeframes as shown below:

- **Transportation Improvement Program (TIP) – 2013 - 2016**

  The projects included under TIP are authorized and scheduled to be implemented within the next one to four years. The projects listed in the TIP are the only `fully funded' roadway projects within the RTP.

- **Short-Range Projects (SHORT) – 2017 - 2020**

  Short-Range projects are those under development for implementation within five to 10 years. This timeframe is the beginning of the project implementation process.

- **Long-Range Projects (LONG) – 2021 - 2035**

  Project identified as long-range will require additional planning to understand the project's purpose, need, and scope. The timeframe for implementation may be 11 to 25 years in the future.

A major planned improvement that will impact the traffic patterns and mobility in the study area is the extension of Hardy Toll Road from I-610 to I-10. This extension will have two lanes in each direction and one mainlane tolling station. The Tollway will have an entrance into Downtown and a two-lane direct connector to US 59.

The Burnett Transit Center within the study area was opened in December, 2013. This intermodal facility was built as part of the METRO North/Red Line Extension and is located in the Union Pacific Railroad Hardy Yard approximately half mile north of the University of Houston light rail station on North Main Street. It is located at the intersection of North Main Street and Burnett Street and is an elevated facility which connects vertically with six bus lines below. It has a kiss-and-ride area and it is expected to connect future commuter rail and Amtrak as well.

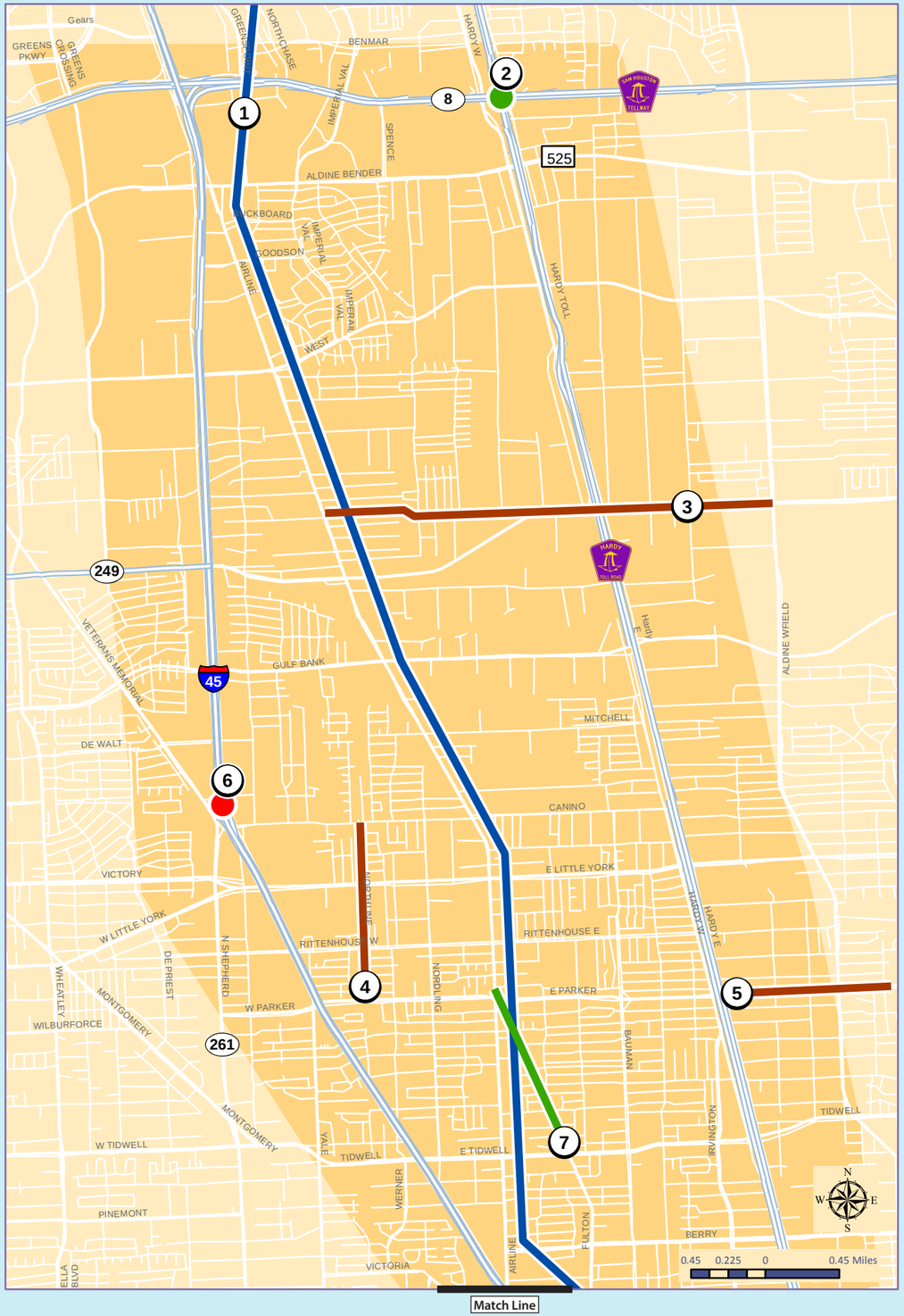
Table 3-1

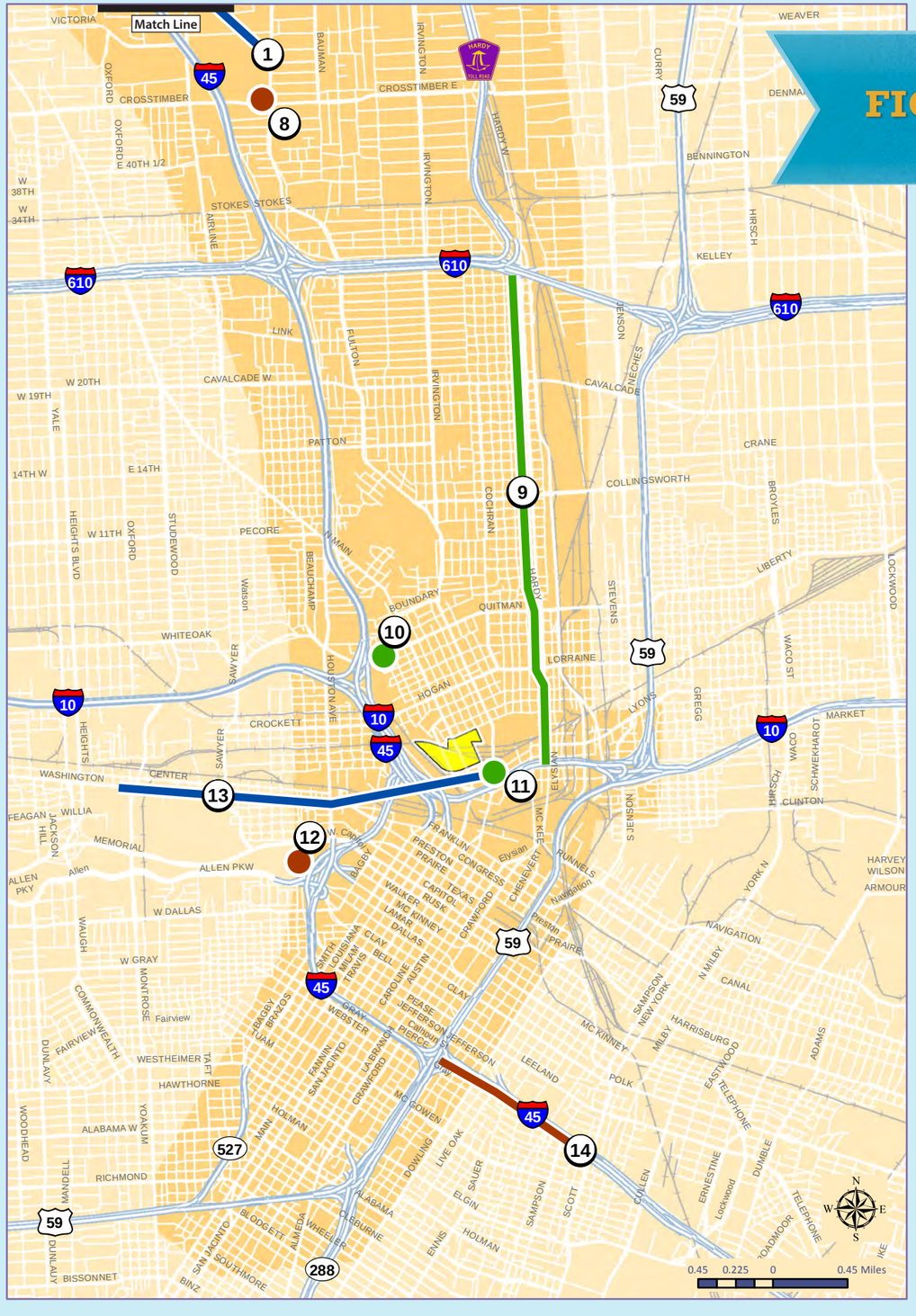
Existing and Proposed Projects - H-GAC 2035 Regional Transportation Plan Update - 'Phase III' Conformity

MAP ID NUMBER	PROJECT ID	HIGHWAY/PROJECT	PROJECT LIMITS	PROJECT DESCRIPTION	LEAD AGENCY	STATUS	YEAR
1	15247	North LRT	Northline Commons to IAH	Light Rail	METRO	Long	2023
2	16076	Hardy Toll Road @ BW8	–	Construct EB-SB and NB-WB direct connectors	HCTRA	Short	2019
3	10097	Aldine Mail Route Road	Airline Drive to Aldine Westfield Road	Construct 4-lane concrete blvd section	Harris County	TIP	2014
4	10023	Northline Drive	Cannino E to Parker E	Construct 4-lane concrete street	City of Houston	TIP	2015
5	5040	Parker Road	Hardy Toll Road to US 59	Construct 4-lane divided concrete highway	City of Houston	TIP	2013
6	16038	I-45 @ N. Shepherd	–	Construct NB and SB direct connectors	TxDOT	Let	2013
7	10024	Fulton Street	Tidwell E to Parker E	Widen to 4-lane concrete divided road	City of Houston	Short	2017
8	15544	Northline Transit Center	Northline Transit Center	–	METRO	TIP	2014
9	15208	Hardy Toll Road	I-610 to US 59	Construct 4-lane toll road	HCTRA	Short	2018
10	13616	Bayou Drive	Burnet Road Ext to Quitman Road	Construct pavement for underground utilities for transit center	City of Houston	Short	2020
11	13615	Burnett Street	Chestnut Street to Maury Street	Construction of street	City of Houston	Short	2020
12	15436	I-45 S	Allen Parkway to Jefferson Avenue	Reconfigure existing SB Allen Parkway SB entrance ramp	TxDOT	TIP	2014
13	11473	Inner Katy Corridor Guided Rapid Transit	–	–	METRO	Long	2025
14	15574	I-45 S NB	US 59 to SP 5	Replace US 59 SB and NB direct connectors	TxDOT	TIP	2015

FIGURE 3-1

Planned / Committed Transportation and Transit Improvements





LEGEND

1 *Map ID*

Project Status:

- *Let*
- *TIP*
- *Short Range*
- *Long Range*

Transit Improvements:

- *Proposed Intermodal Terminal*

Source: *H-GAC 2035 Regional Transportation Plan Update, 2013*

Future Socioeconomic Data

Socioeconomic data includes population and employment data which is primarily responsible for generating demand for travel in the region. This section discusses trends in population and employment growth between 2011 and 2035 for Houston Downtown, study area, Harris County, and the H-GAC region. The population and employment data for base year (2011) and future year (2035) was obtained from H-GAC's regional travel demand model. Year 2035 demographic forecasts were prepared by H-GAC using UrbanSim, a modeling tool used to study interactions between land use and the transportation network. H-GAC is responsible for developing and updating the population and employment projections for the Houston Transportation Management Area. The demographic data is one of the key inputs to the regional travel demand model and forecasting of this data, at traffic analysis zone level, is required to support agency's efforts in maintaining the model.

Table 3-2 summarizes the socioeconomic data for 2011 and 2035 along with compounded annual growth rate (CAGR) between them. The table shows future growth trends in population and employment for Houston Downtown, study area, Harris County, and the H-GAC region.

Table 3-2

Household Population and Employment (2011 and 2035)

COUNTY/STUDY AREA	POPULATION			EMPLOYMENT		
	2011	2035	CAGR	2011	2035	CAGR
Downtown	3,200	6,000	2.7%	159,000	166,400	0.2%
I-45 Study Area	198,800	242,800	0.8%	273,000	350,300	1.0%
Harris County	4,094,400	5,781,800	1.5%	2,303,200	3,146,500	1.3%
H-GAC Region	5,825,200	8,683,800	1.7%	2,865,800	4,069,400	1.5%

Source: Houston-Galveston Area Council, 2011

As seen in Table 3-2, the population and employment within the eight-county H-GAC region is expected to grow at 1.7 percent and 1.5 percent per year respectively, i.e. adding approximately three million people to reach a population of more than 8.5 million by 2035. Harris County, where the corridor study area is located, also shows a growth in population and employment of about one and a half percent per year between 2011 and 2035.

Compared to the region, the I-45 study area shows a relatively lower growth rate per year of one percent or less. This is mainly because of limited developable land within the study area compared to the region. However, Houston Downtown shows significantly higher growth in population and only a slight growth in employment by 2035. This trend is due to decentralization of employment activities in the region in future, current, and planned revitalization efforts in the Downtown area to add more residential/mixed-use development.

Future No-Build Scenario

This chapter primarily focuses on the assessment of future transportation conditions within the study area based on a no-build scenario. The no-build scenario includes existing conditions plus future planned/committed transportation investments in the region, discussed in the previous section. The no-build scenario considers existing conditions along the study corridors and serves as a future baseline to compare alternative transportation improvement actions along the I-45/Hardy corridors including the Houston Downtown loop system which will be studied as part of the North Houston Highway Improvement Project.

Future 2035 Travel Demand

Travel demand model forecasting technique was utilized to estimate the future travel demand based on the projected population and employment growth in the Houston area. H-GAC's 2035 regional travel demand model was utilized to understand the future growth in traffic volumes between 2011 and 2035 at various locations along the study corridors. The model includes the 2035 financially committed transportation network and adopted regional socioeconomic forecasts. **Table 3-3** summarizes the compounded annual growth rate (CAGR) in modeled traffic volumes along the sections of the study corridors.

Figure 3-2 presents the 2035 average daily traffic (ADT) volumes in the study area. These volumes were forecasted based on the existing 2011 traffic volumes and the growth rates obtained from the regional travel demand model.

The travel demand along the I-45 study corridor between Beltway 8 and Houston Downtown is projected to increase by around one percent annually, with the highest increase of 1.4 percent between Beltway 8 and Shepherd Drive and the lowest increase of around half a percent between I-610 and I-10.

Table 3-3

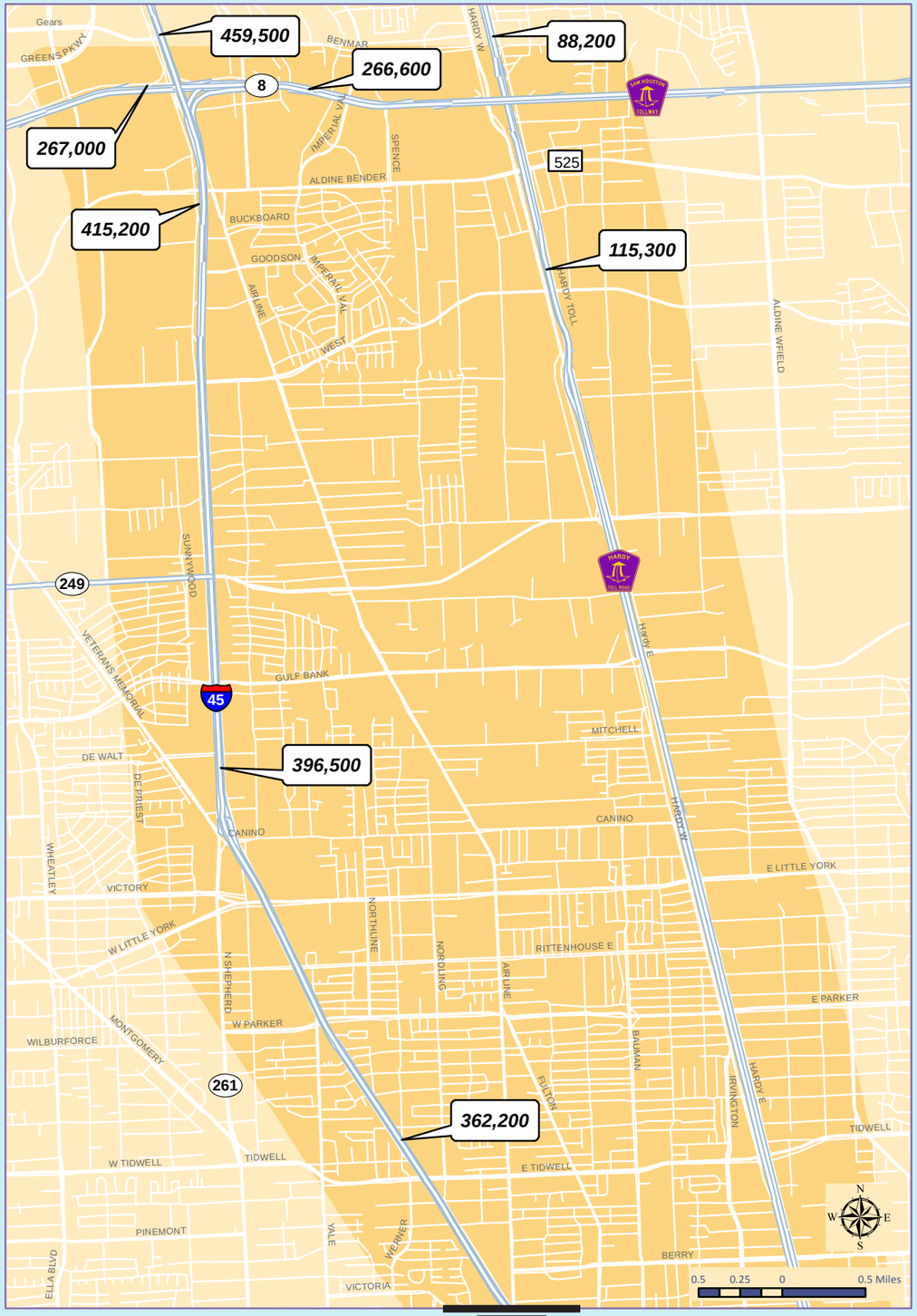
Projected Annual Traffic Growth (2011 to 2035)

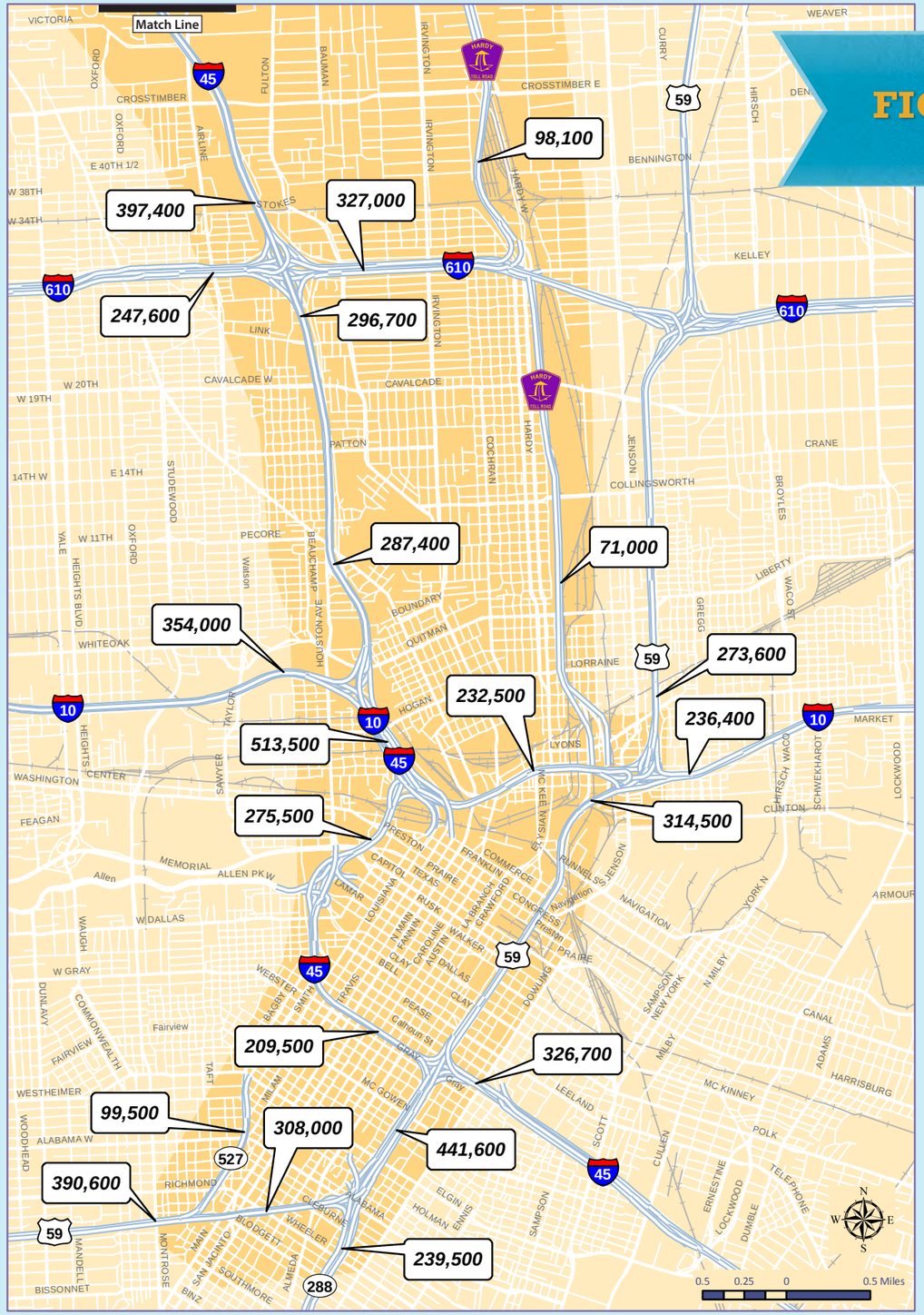
STUDY CORRIDORS	SEGMENTS	COMPOUNDED ANNUAL GROWTH RATE (CAGR)
I-45	BW 8 – Shepherd Dr	1.4%
	Shepherd Dr – I-610	1.0%
	I-610 – I-10	0.6%
	I-10 – Allen Parkway	1.3%
	Allen Parkway – US 59	1.1%
Hardy Toll Road	Beltway 8 – I-610	2.0%
US 59	I-10 – I-45	1.5%
	I-45 – Spur 527	1.0%
I-10	I-45 – US 59	2.3%
Sam Houston Tollway	I-45 – Hardy Toll Road	1.5%
I-610	I-45 – Hardy Toll Road	1.2%
SH 288	South of US 59	1.0%

Sources: 2010 Highway Capacity Manual, 2035 H-GAC's Regional Travel Demand Model

FIGURE 3-2

Future 2035 No-Build Average Daily Traffic Volumes





LEGEND

X,XXX = *Average Daily Traffic Volumes*

NOTE:
Traffic volumes include mainlanes and frontage road volumes. Does not include HOV lane volume.

SOURCE:
Houston-Galveston Area Council (H-GAC) Regional Travel Demand Model; CDM Smith

Projected Level-of-Service

As discussed in Chapter 1, with the exception of Hardy Toll Road and part of I-610, all study corridors are currently experiencing congestion during peak traffic hours, operating at level-of-service at E or worse. Under the future 2035 conditions, with no capacity improvements and increased travel demand, the congestion along the study corridors will continue to worsen in the no-build scenario, with volume-to-capacity ratio far exceeding one. **Figure 3-3** illustrates the projected 2035 level-of-service along the study corridors.

Future Travel Patterns

Future travel patterns are directly related to the planned roadway network and travel demand in 2035. Understanding the future travel patterns and traffic characteristics is the primary purpose of this study and would aid in the development and evaluation of specific alternative improvements to serve future mobility needs along the study corridor. The regional travel demand model and select-link analysis technique were utilized to evaluate the future travel patterns at 14 locations (see Figure 1-12) along the study corridors. A detailed summary of traffic characteristics including projected daily traffic volumes, design hourly volumes, peak hour and directional distribution factors, and volume-to-capacity ratio is presented in **Table 3-4**.

Figures 3-4 through **3-17** illustrate future 2035 origin-destination travel patterns conducted using the select-link analysis at the 14 locations in the study area.

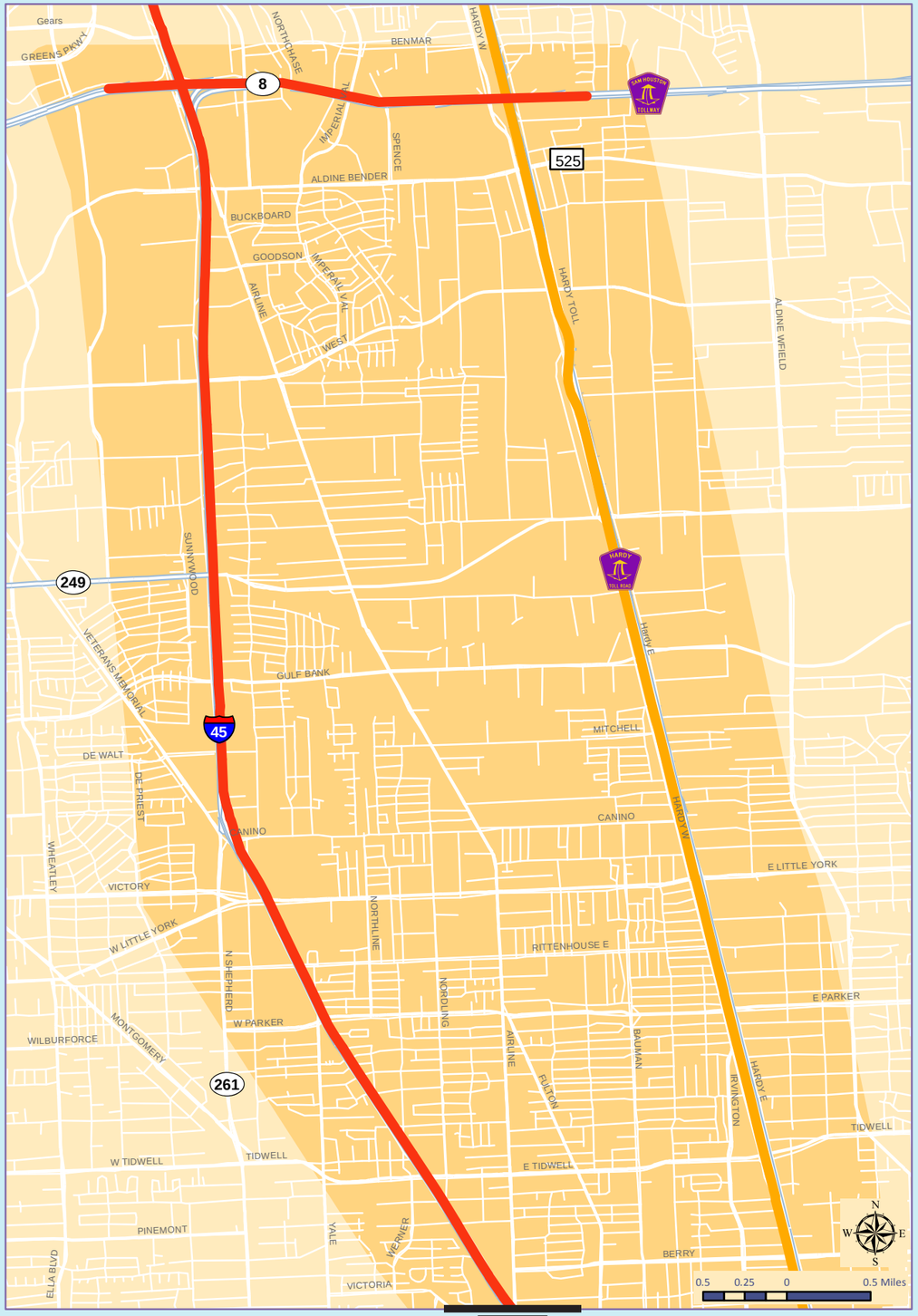
Table 3-4

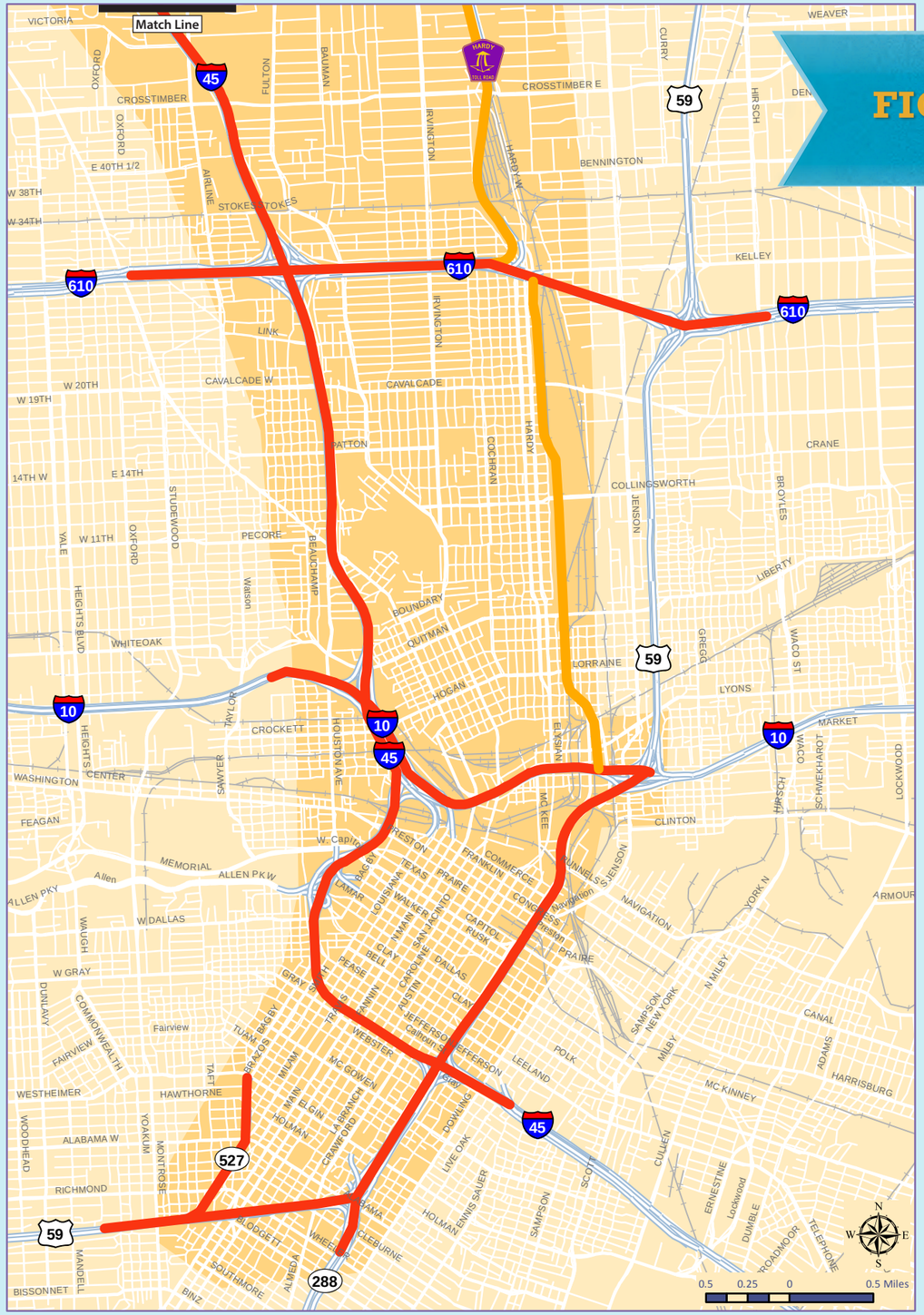
Summary of Traffic Characteristics by Location

STUDY CORRIDORS	SEGMENT	LANES	ADT	K-FACTOR	D-FACTOR	DDHV	V/C RATIO	LOS
I-45	BW 8 - Shepherd Dr	8	304,500	8.2%	53%	13,200	1.43	F
	Shepherd Dr - I-610	8	278,000	8.0%	54%	12,000	1.30	F
	I-610 - I-10	8	233,500	7.0%	59%	9,600	1.04	F
	I-10 - Allen Parkway	10	338,000	6.5%	58%	12,700	1.10	F
	Allen Parkway - US 59	6	209,500	7.1%	56%	8,300	1.20	F
Hardy Toll Road	Beltway 8 - I-610	6	106,500	10.0%	60%	6,400	0.93	E
	I-610 - I-10	4	71,000	10.0%	60%	4,300	0.93	E
US 59	I-10 - I-45	8	314,500	7.9%	58%	14,400	1.57	F
	I-45 - Spur 527	8	308,000	7.9%	55%	13,400	1.46	F
I-10	I-45 - US 59	8	232,500	8.3%	60%	11,600	1.26	F
Sam Houston Tollway	I-45 - Hardy Toll Road	8	227,000	8.4%	52%	9,900	1.08	F
I-610	I-45 - Hardy Toll Road	8	266,500	8.0%	56%	11,900	1.29	F
SH 288	South of US 59	8	239,500	7.5%	53%	9,500	1.03	F

Sources: 2010 Highway Capacity Manual, 2035 H-GAC's Regional Travel Demand Model
Note: ADT = Average Daily Volume; K-FACTOR = Peak Hour Factor; D FACTOR = Directional Distribution Factor; DDHV = Directional Design Hourly Volume; V/C RATIO = Volume-to-Capacity Ratio; LOS = Level-of-Service
Note: The daily traffic volumes shown in this table do not include the frontage road traffic.

FIGURE 3-3





Future Year 2035 No Build Condition Peak Hour Level-of-Service

LEGEND

Level-of-Service

- *A/B/C*
- *D*
- *E*
- *F*

Source: Houston Transtar, 2011; CDM Smith

FIGURE 3-4

2035
Select Link - 1

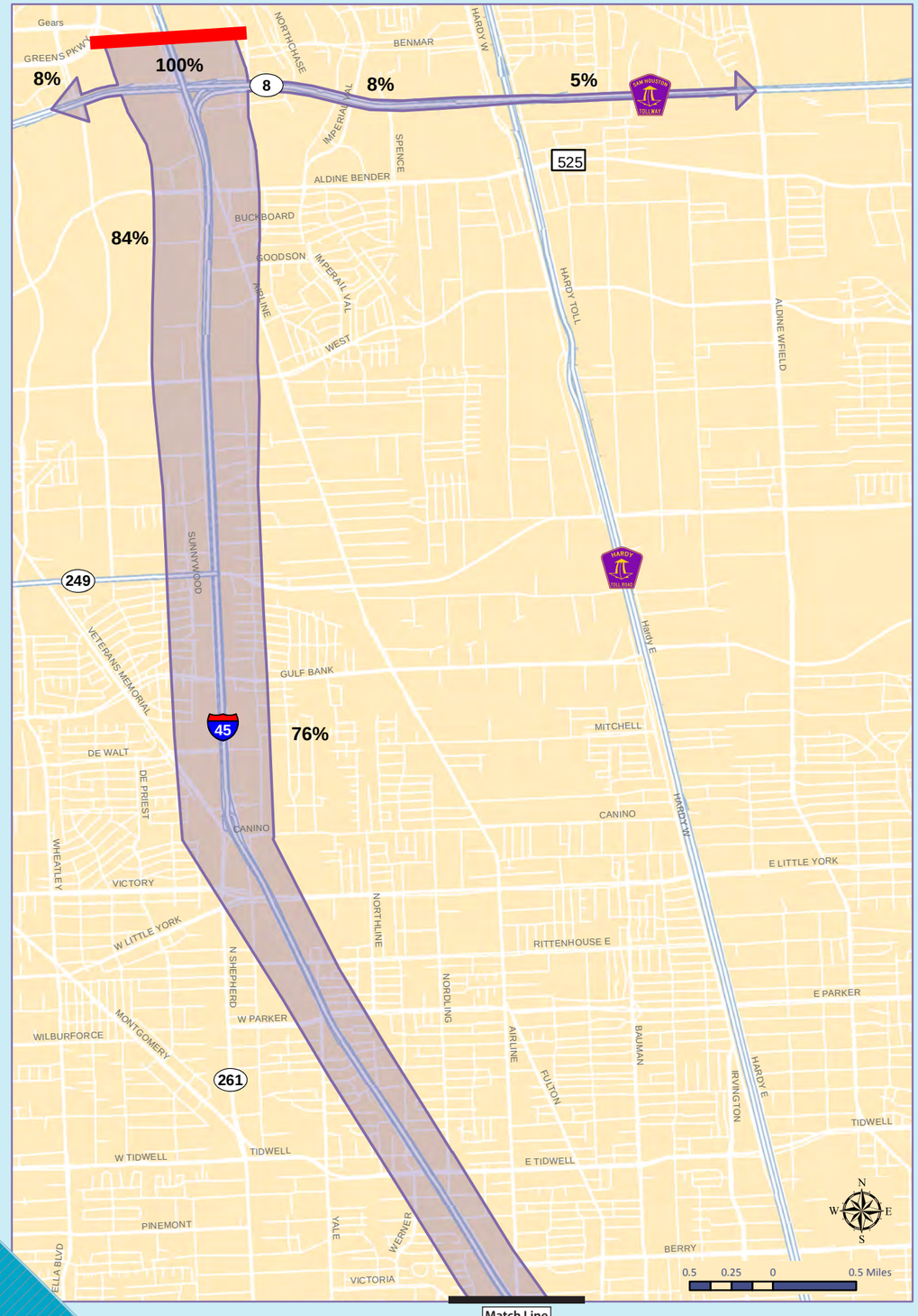
IH 45
North of Sam Houston Tollway

Southbound Direction
DDHV = 16,500
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model



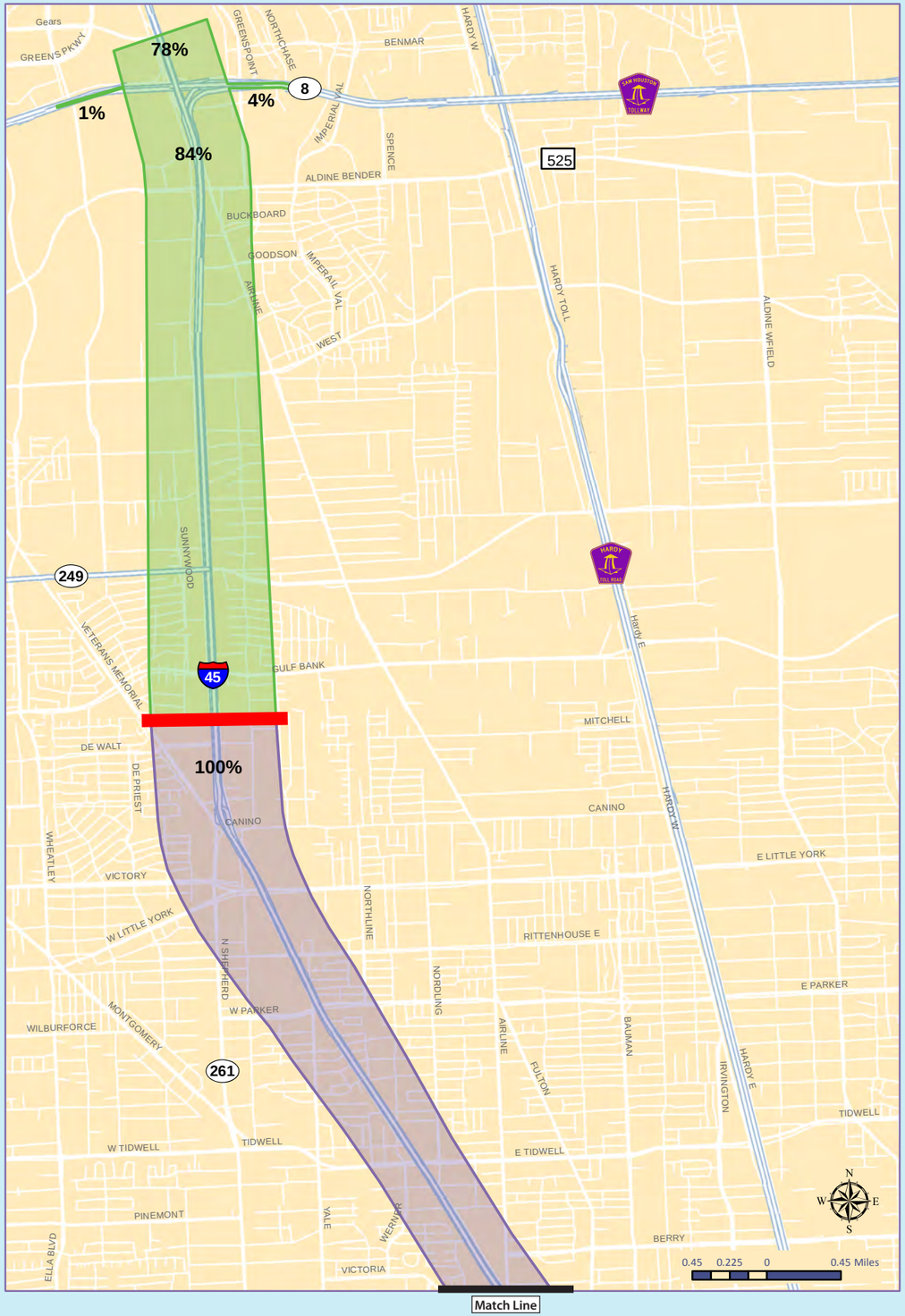


FIGURE 3-5

2035 Select Link - 2

IH 45 North of Shepherd Drive

Southbound Direction
DDHV = 12,800
Directional Design Hourly Volume

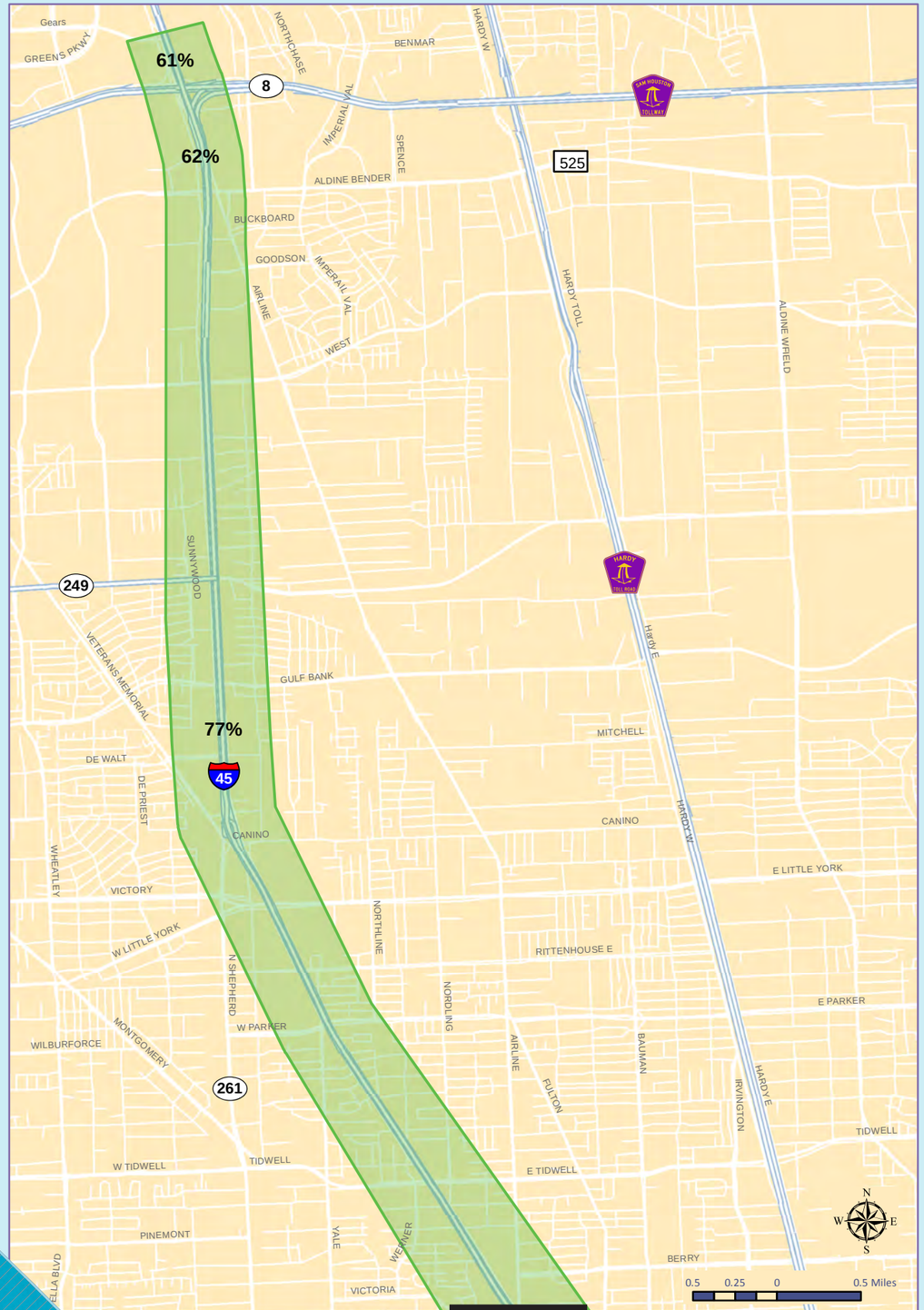
LEGEND

XX% = *Percent of Future AM Peak Period Traffic TO Select Link Location*

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-6



2035 Select Link - 3

IH 45 North of IH 610

Southbound Direction
DDHV = 12,300
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic TO Select Link Location*

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-7

2035 Select Link - 4

IH 45 North of IH 10

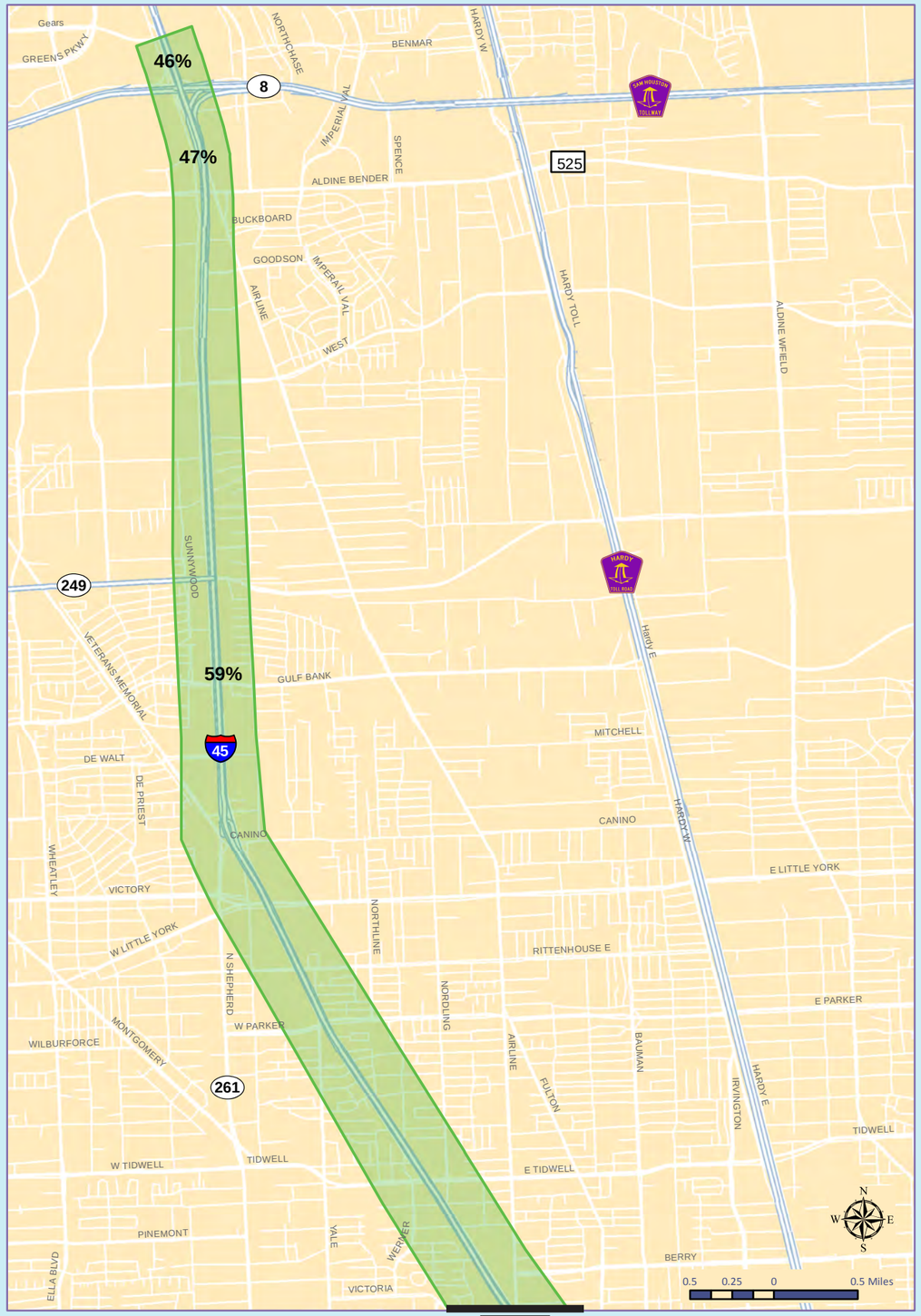
Southbound Direction
DDHV = 9,700
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic TO Select Link Location*

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model



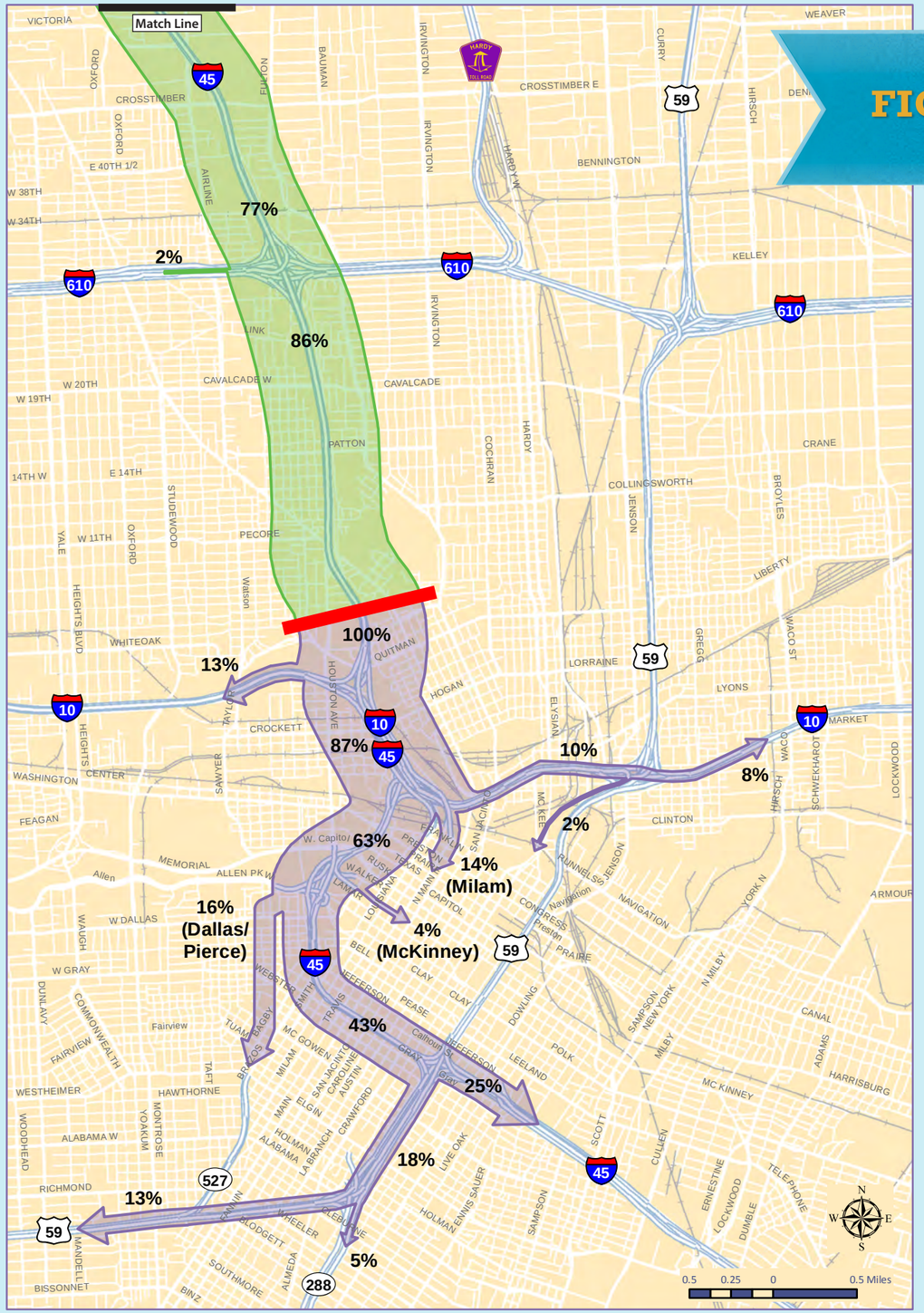


FIGURE 3-8

2035
Select Link - 5

IH 45
South of
US 59

Southbound Direction
DDHV = 10,500
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

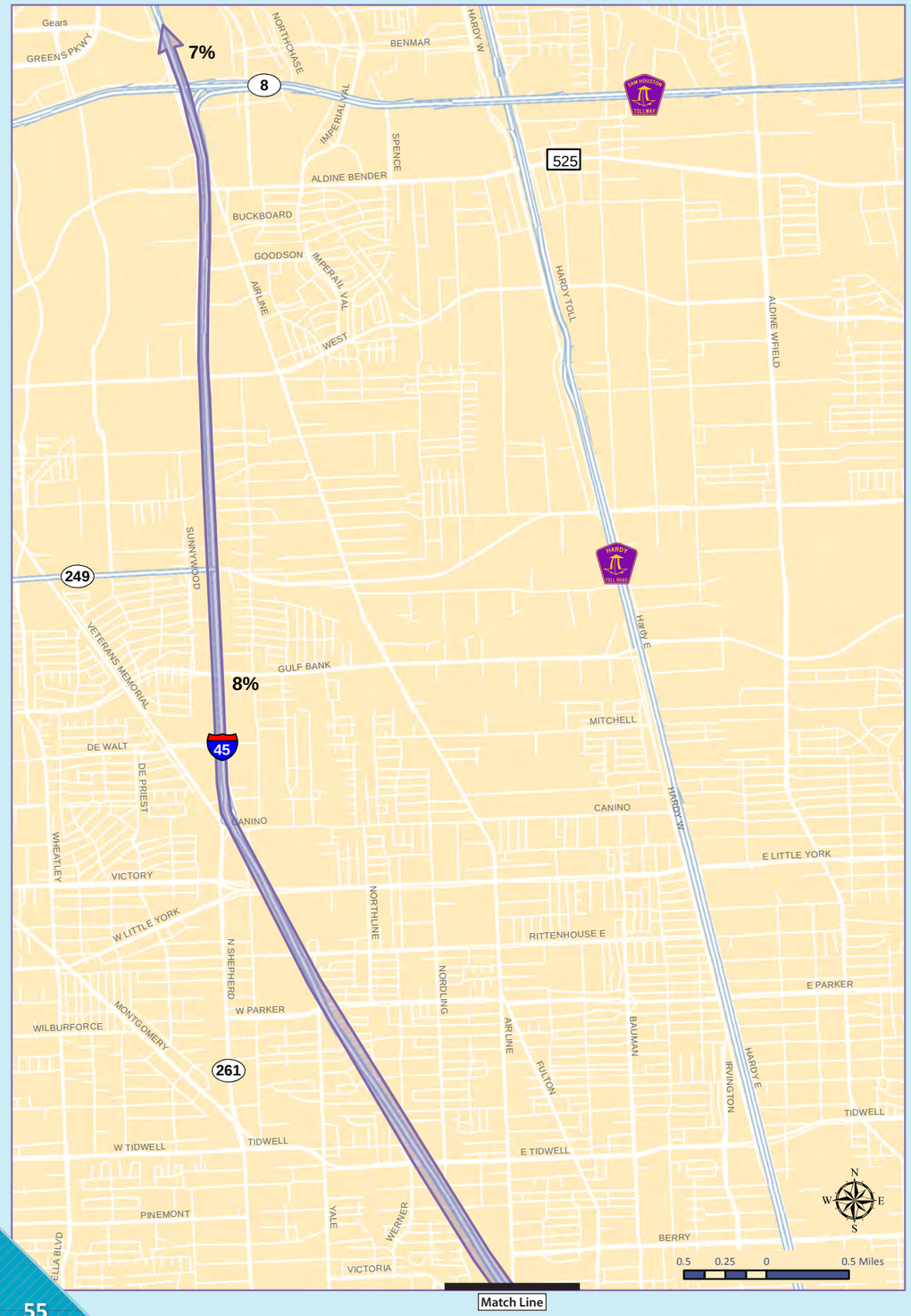
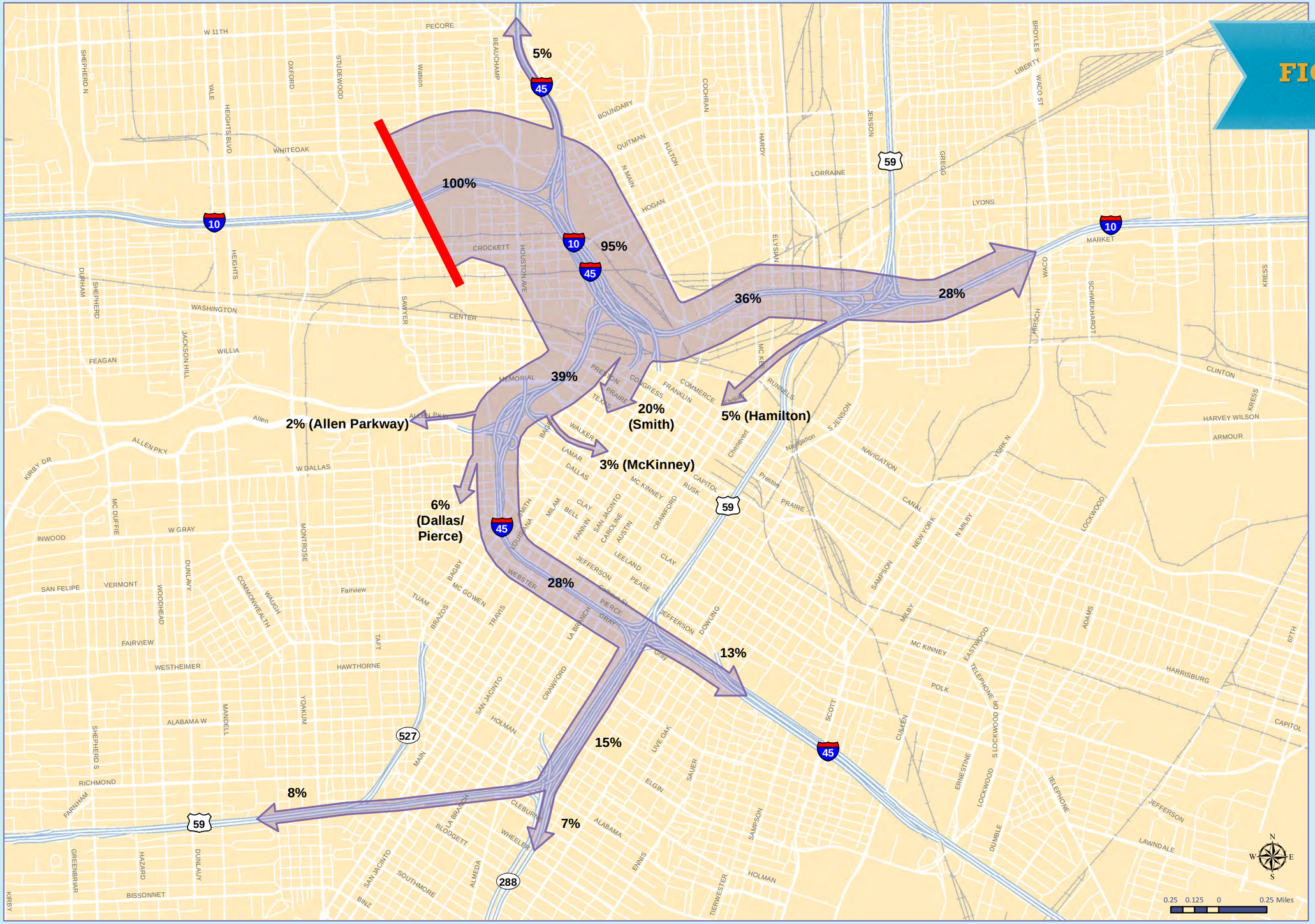


FIGURE 3-9

2035 Select Link - 6

IH 10 West of IH 45

Westbound Direction
DDHV = 16,200
Directional Design Hourly Volume

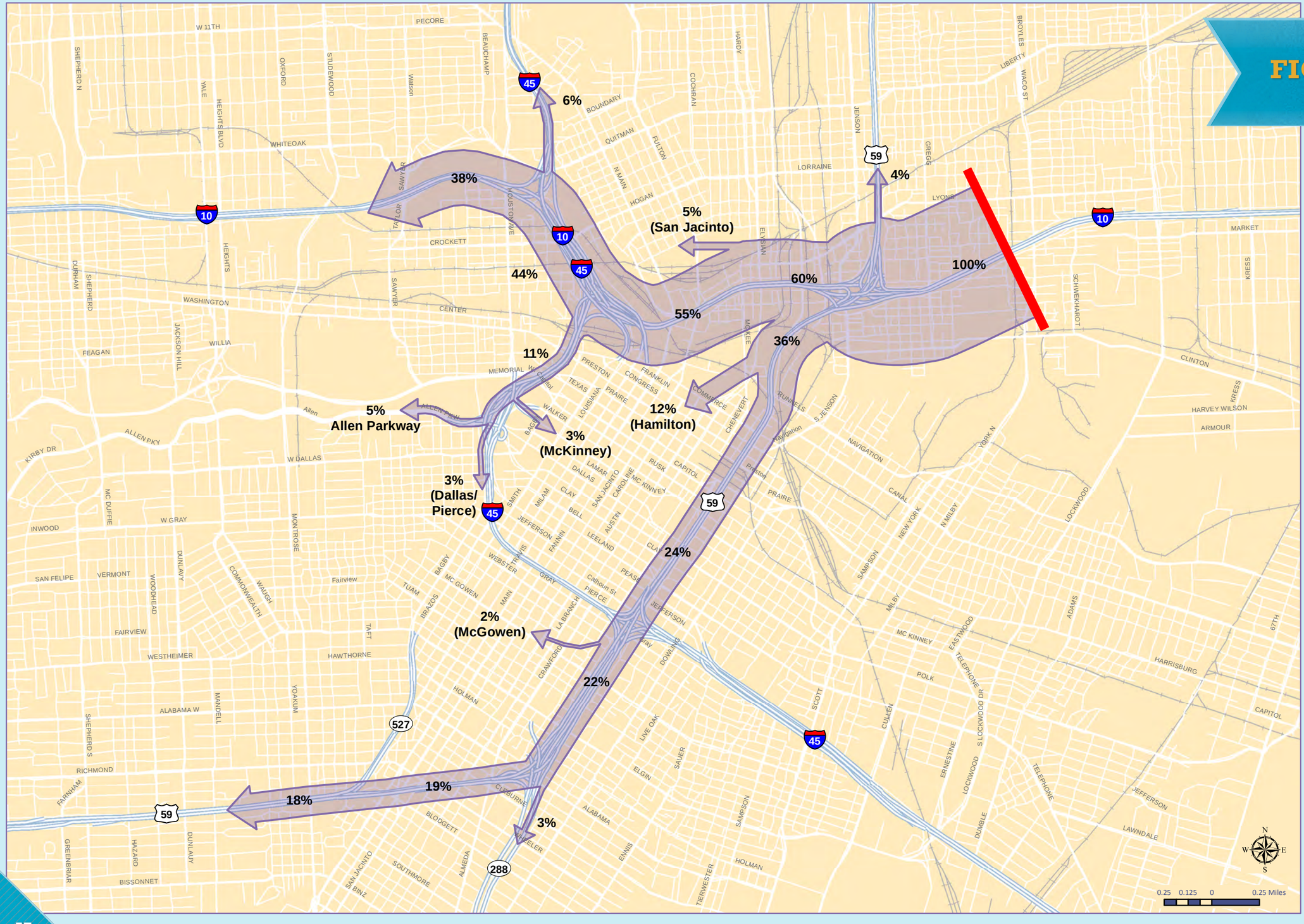


LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-10



2035 Select Link - 7

IH 10 East of US 59

Westbound Direction
DDHV = 10,600
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

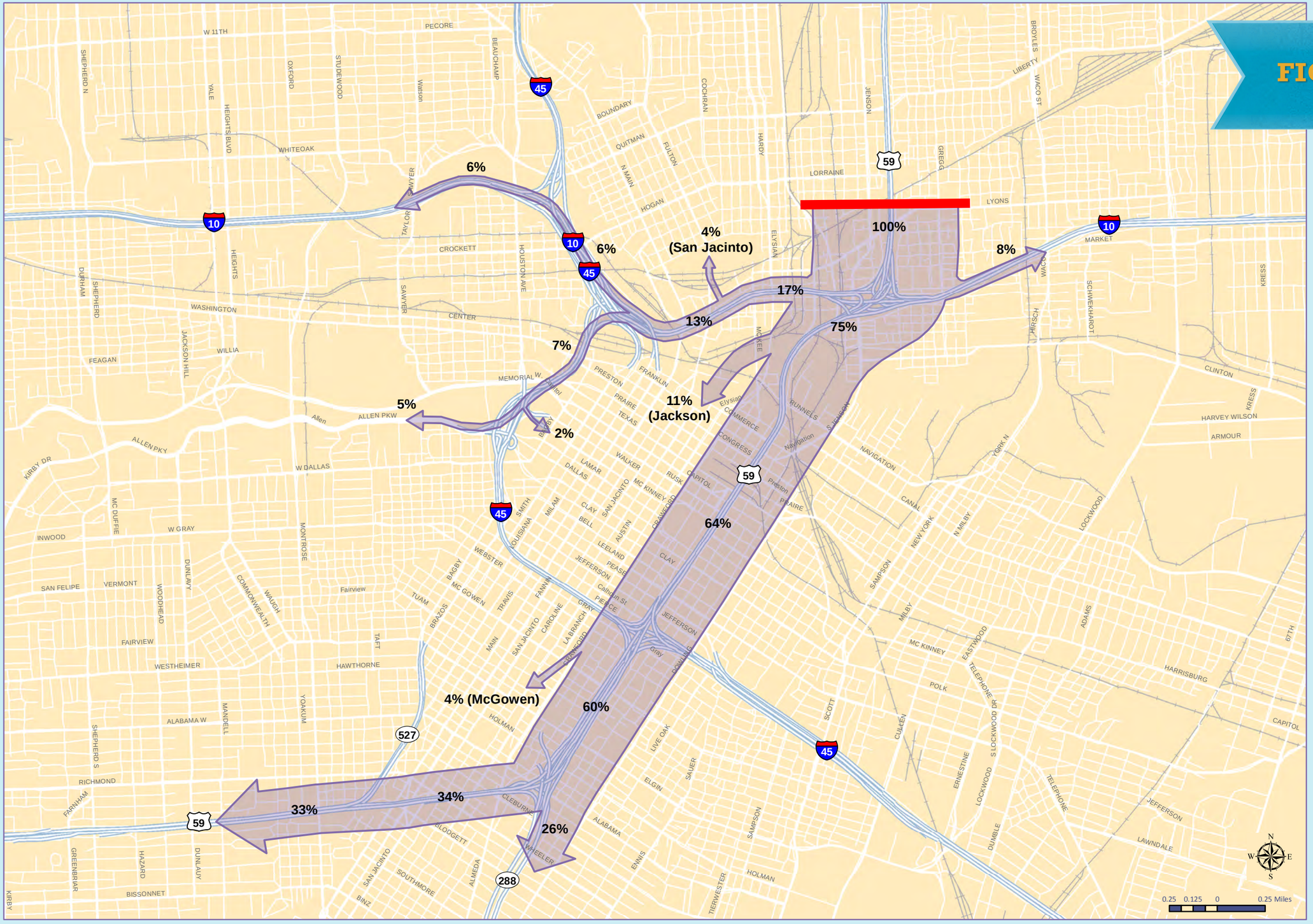
SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-11

2035 Select Link - 8

US 59 North of IH 10

Southbound Direction
DDHV = 14,400
Directional Design Hourly Volume



LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

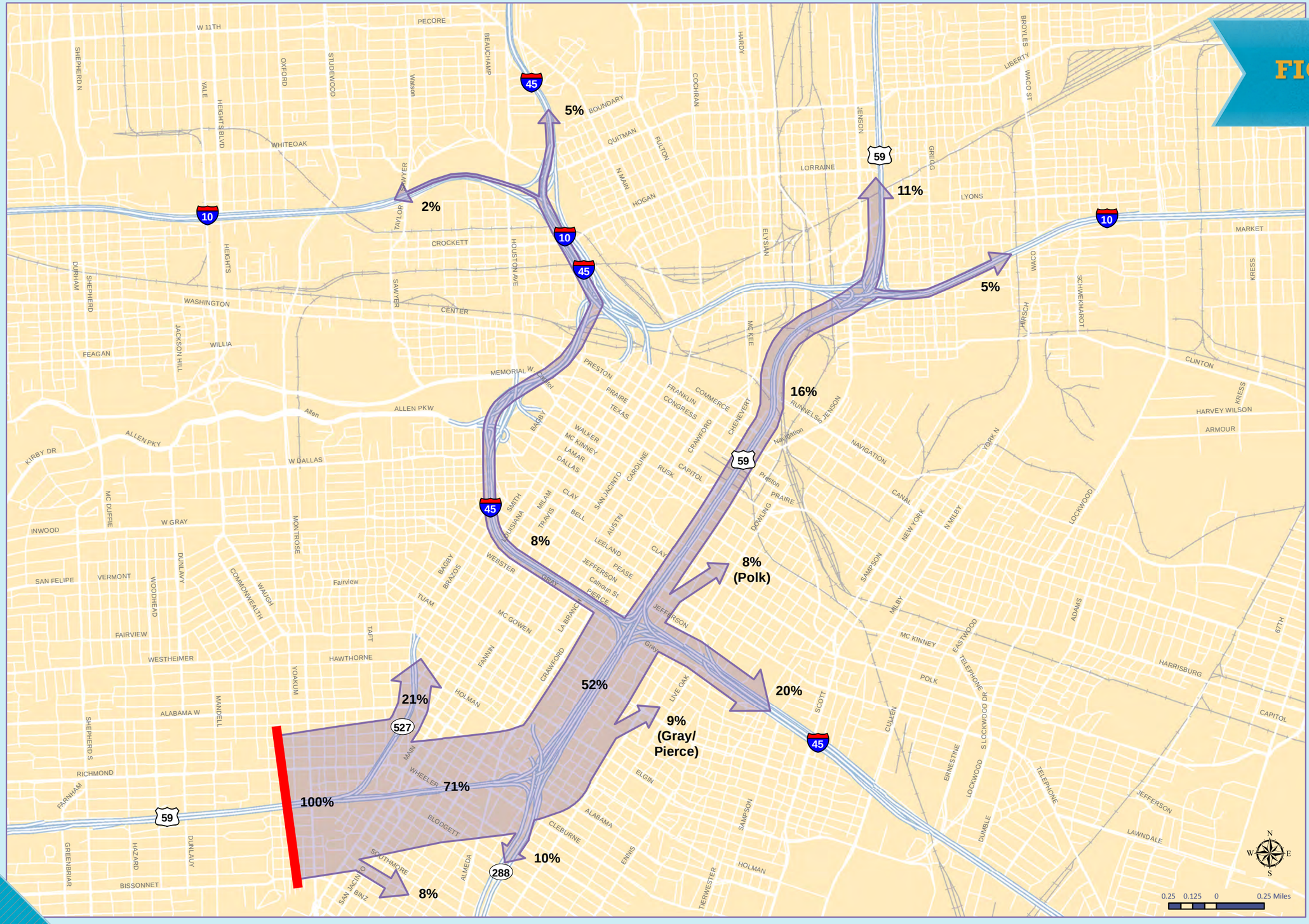
SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-12

2035 Select Link - 9

US 59 West of Spur 527

Eastbound Direction
DDHV = 16,300
Directional Design Hourly Volume



LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-13

2035 Select Link - 10

SH 288 South of US 59

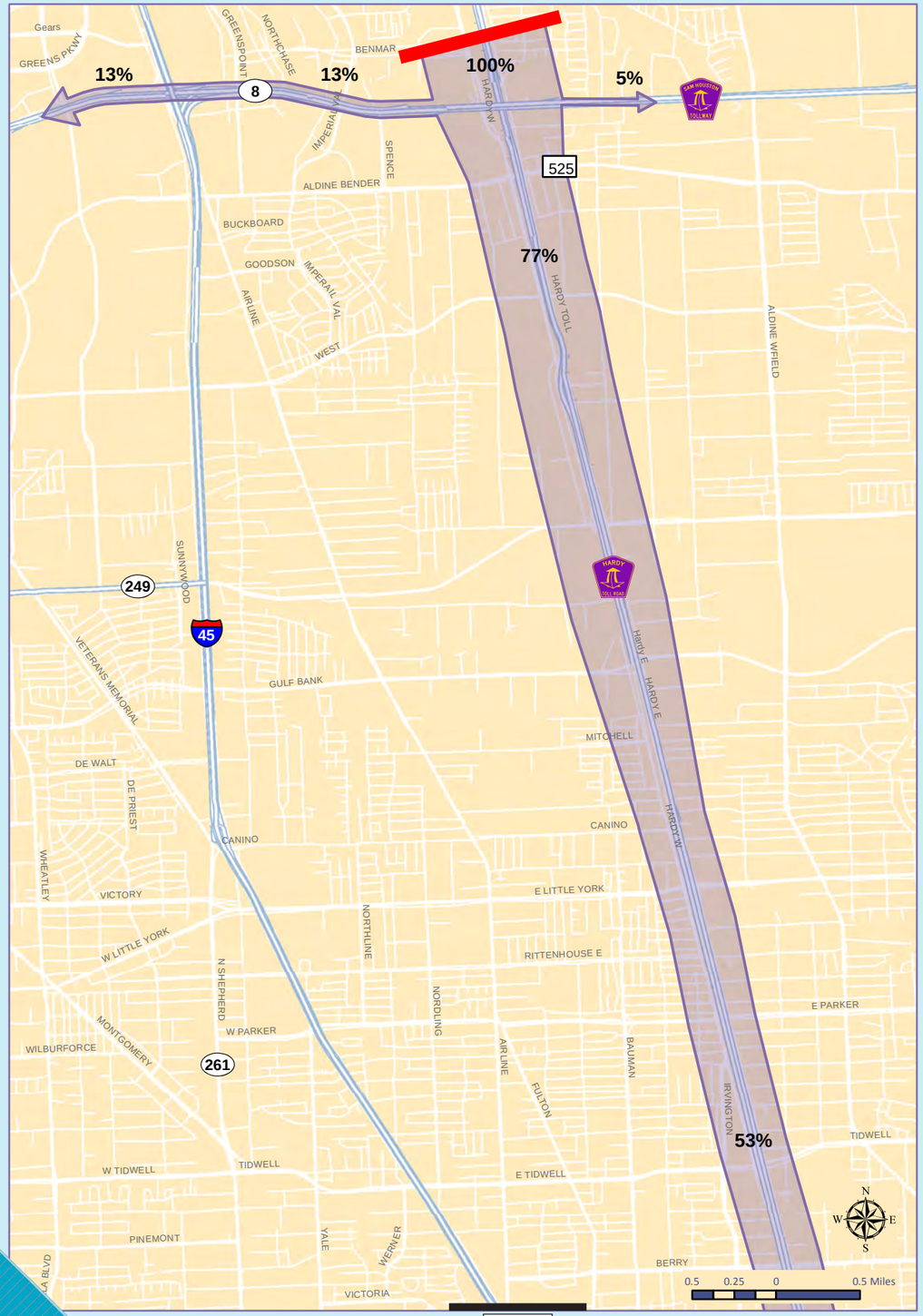
Northbound Direction
DDHV = 9,500
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-14



2035 Select Link - 11

Hardy Toll Road North of Beltway 8

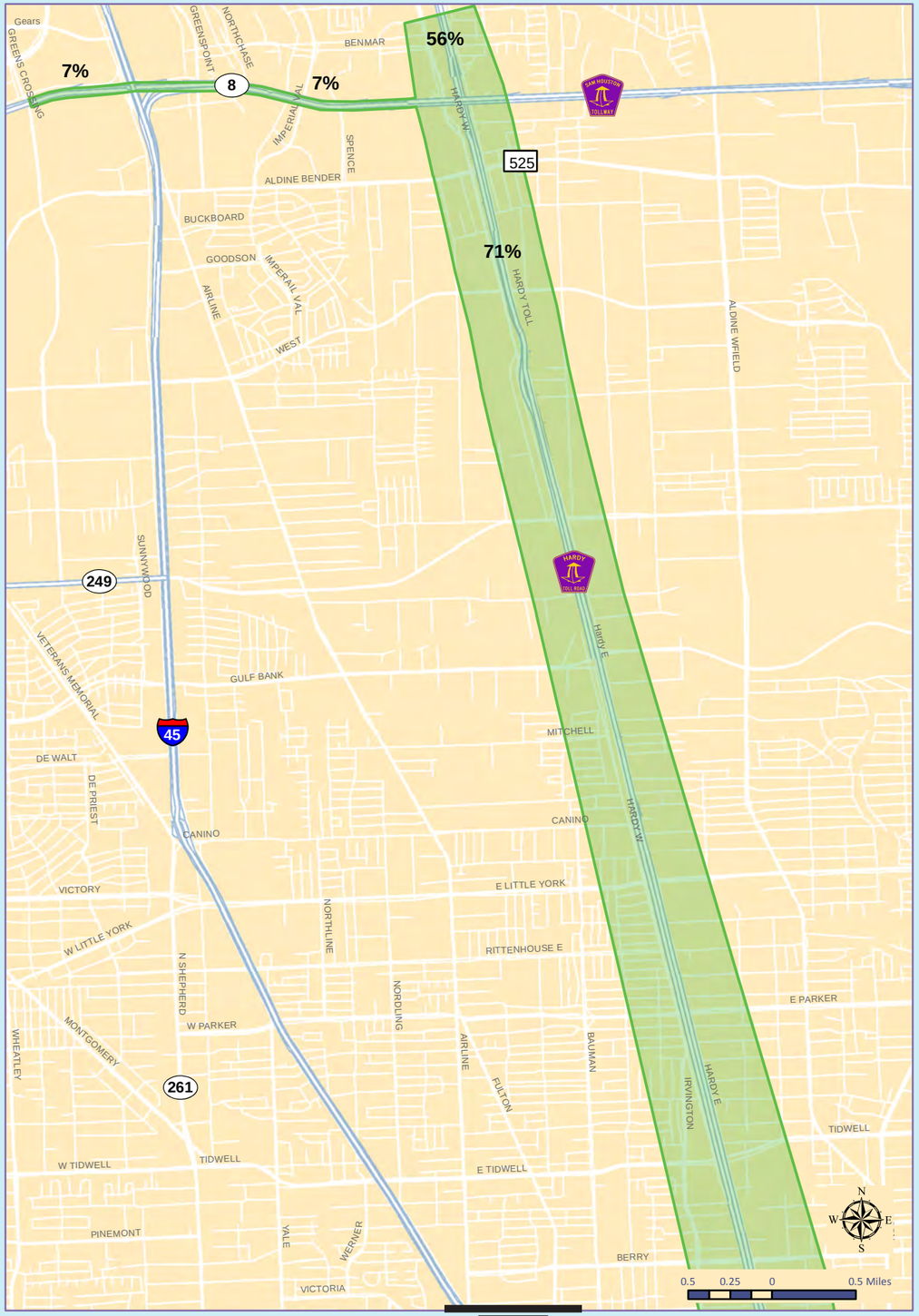
Southbound Direction
DDHV = 5,600
Directional Design Hourly Volume

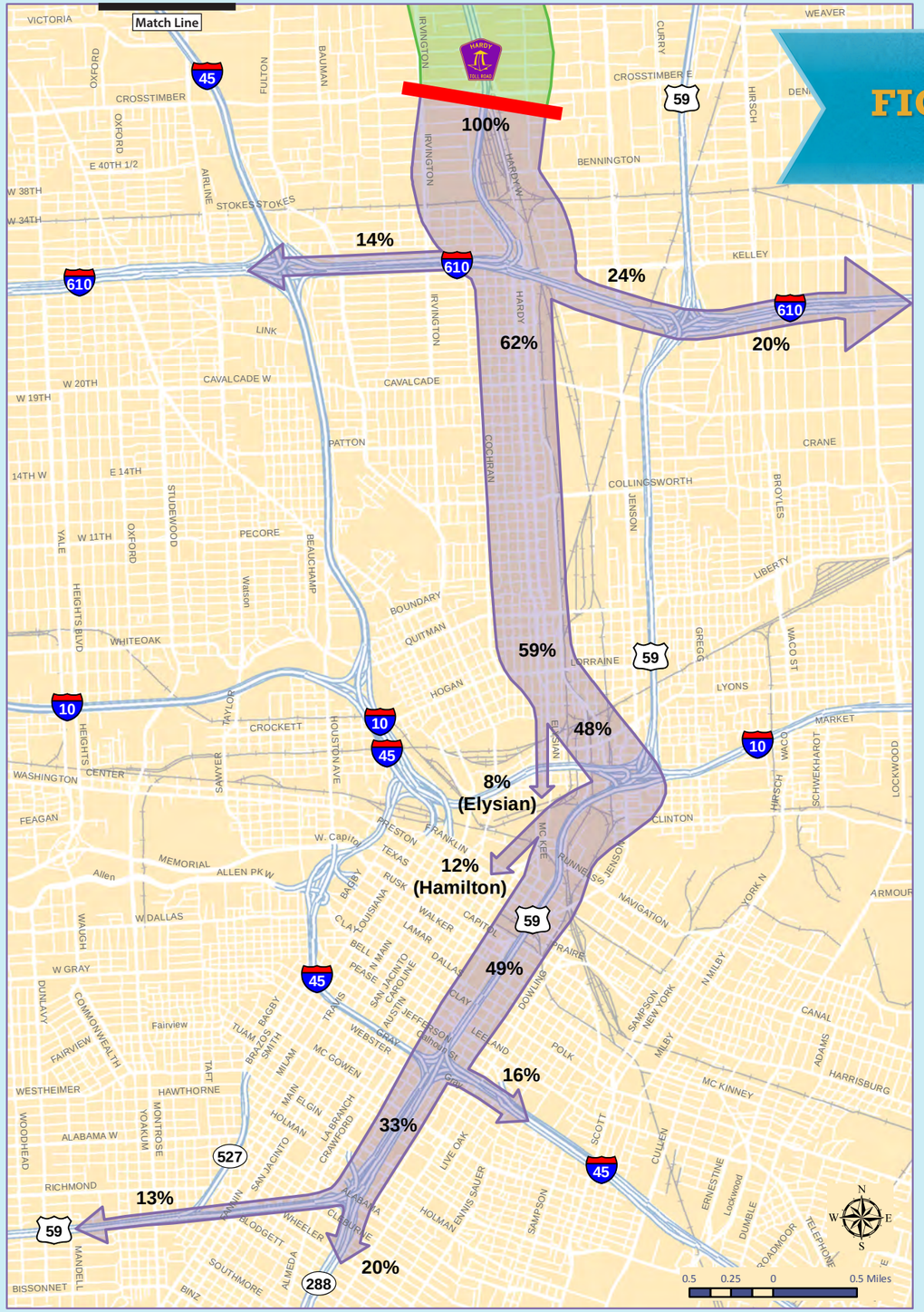
LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-15





2035 Select Link - 12

Hardy Toll Road North of IH 610

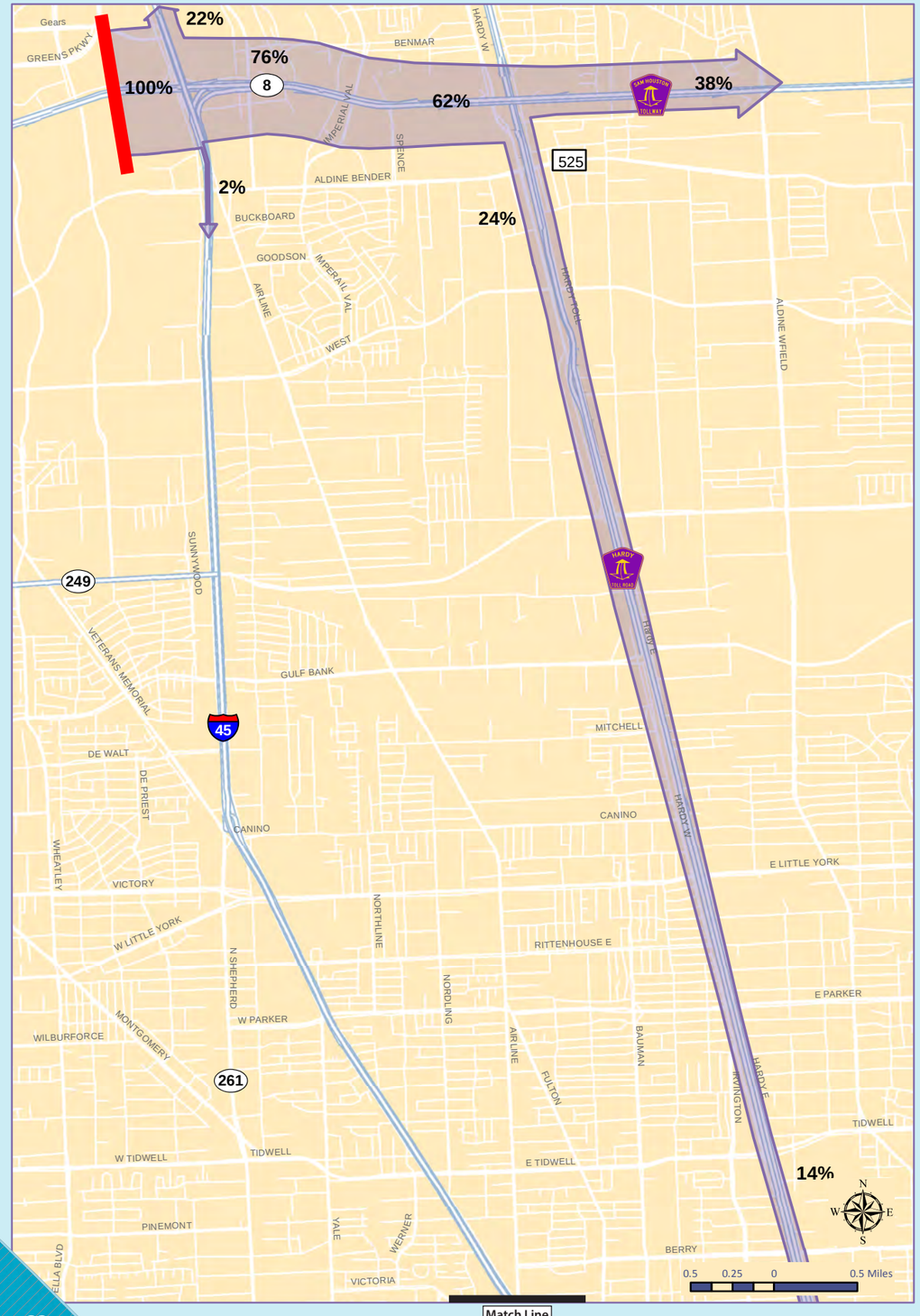
Southbound Direction
DDHV = 8,200
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic TO Select Link Location*

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model



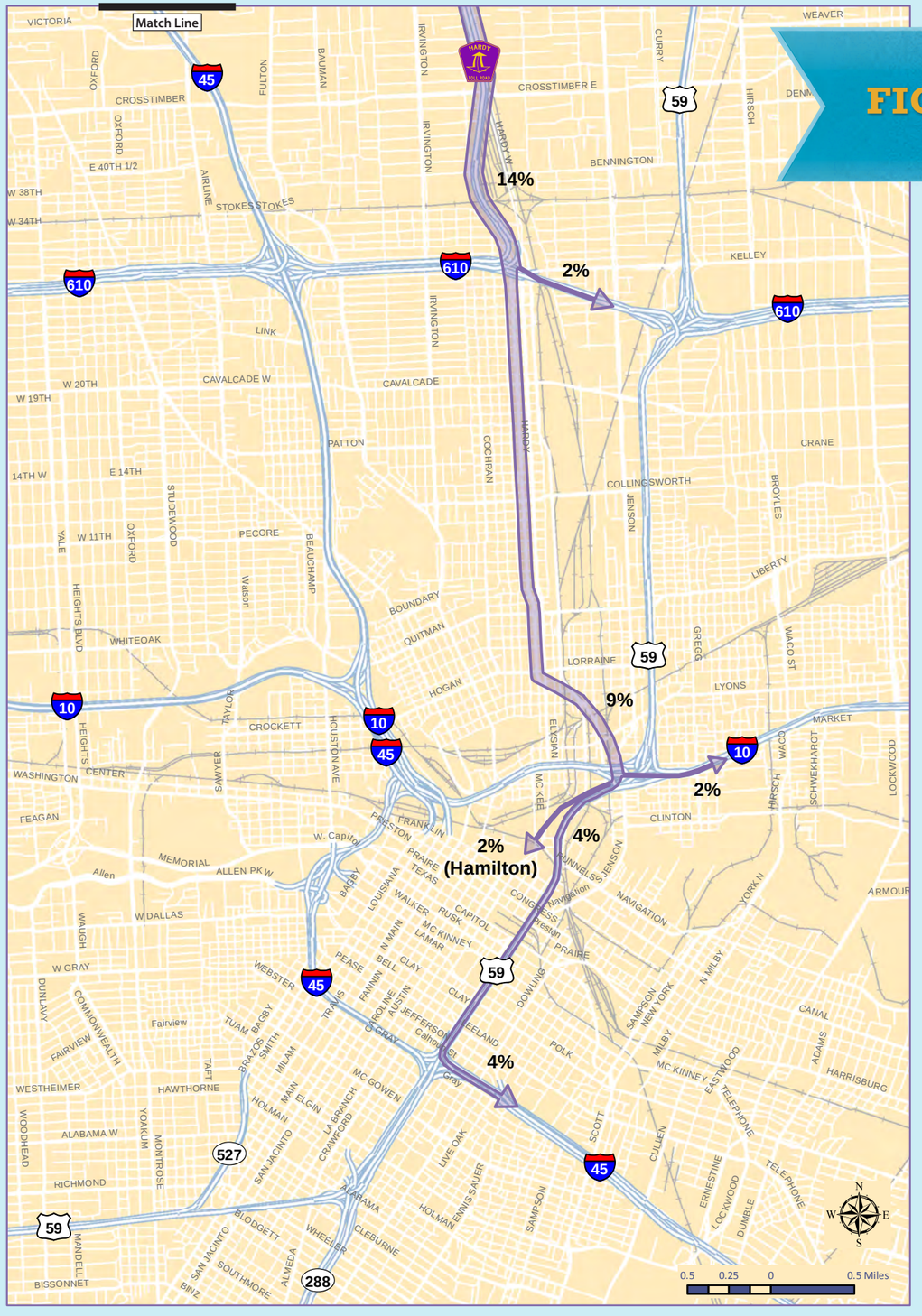


FIGURE 3-16

2035 Select Link - 13

Sam Houston Tollway West of IH 45

Southbound Direction
DDHV = 11,100
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model

FIGURE 3-17

2035 Select Link - 14

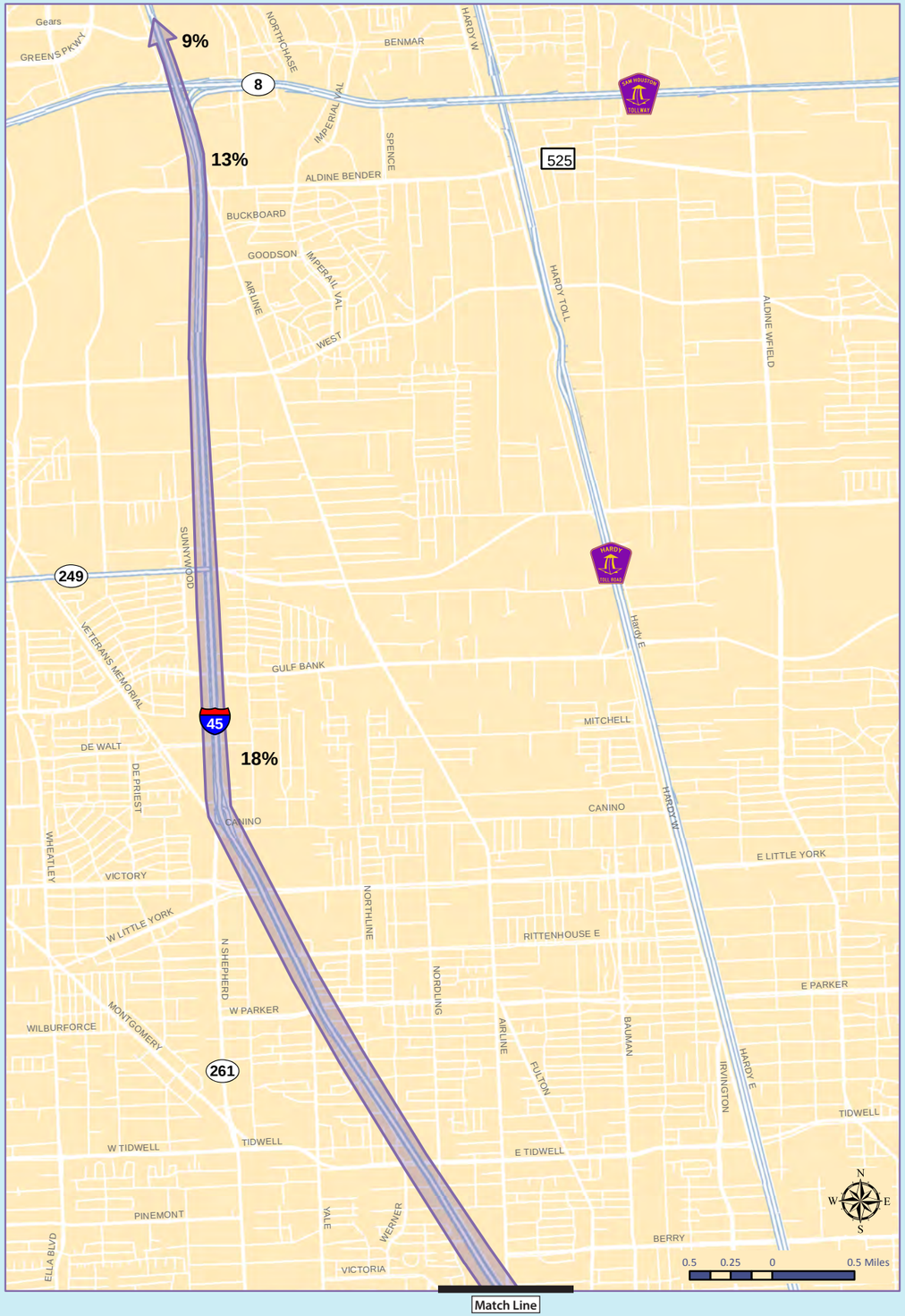
IH 610 West of IH 45

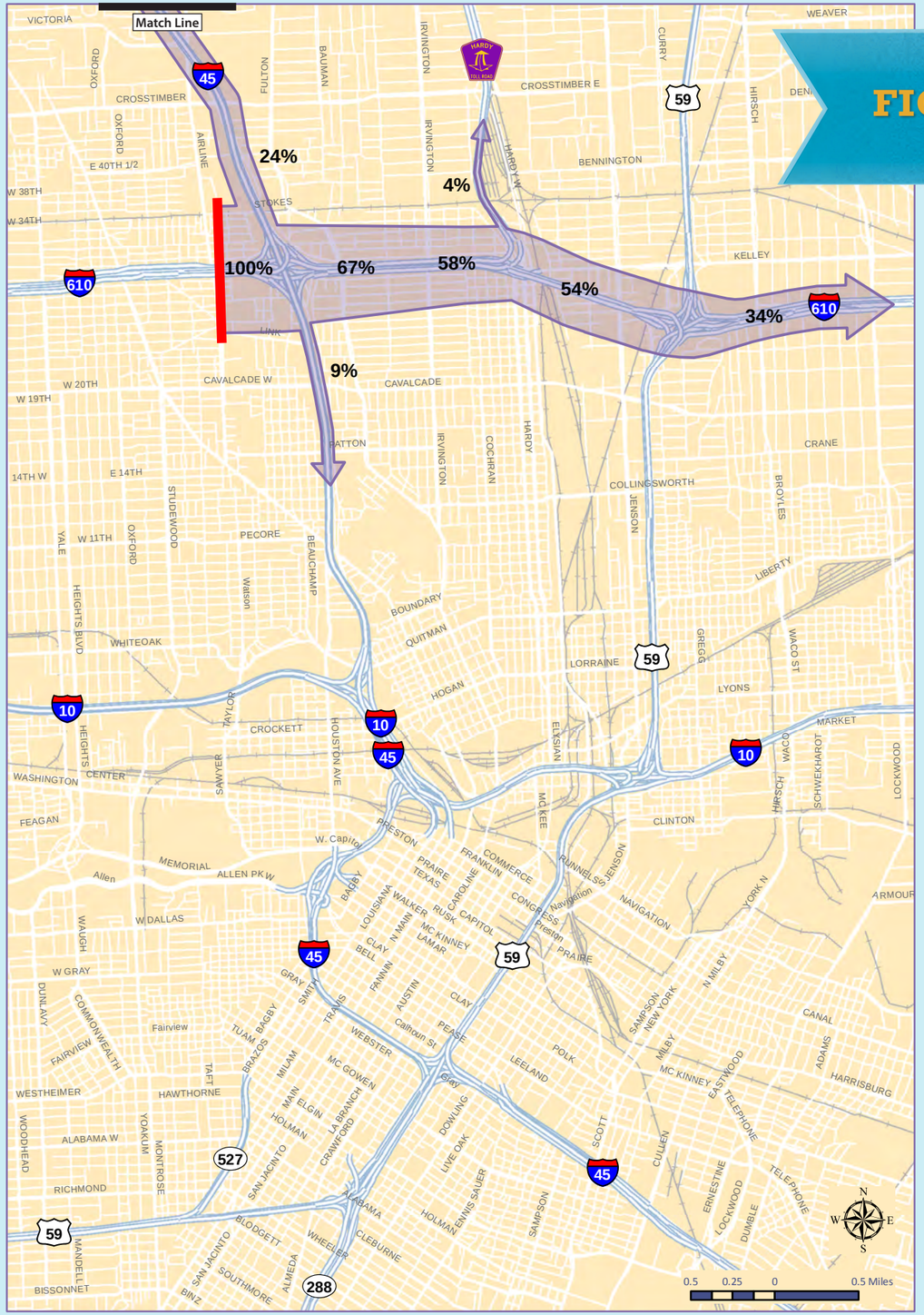
Eastbound Direction
DDHV = 10,900
Directional Design Hourly Volume

LEGEND

XX% = *Percent of Future AM Peak Period Traffic FROM Select Link Location*

SOURCE:
CDM Smith, H-GAC Year 2035 Regional Travel Demand Model





Summary of Future Travel Patterns

Some key travel patterns based on the select link analysis conducted at 14 locations are summarized in this section. The following information represents the peak direction of travel in the AM peak hour (i.e. inbound towards Downtown Houston):

I-45 Corridor

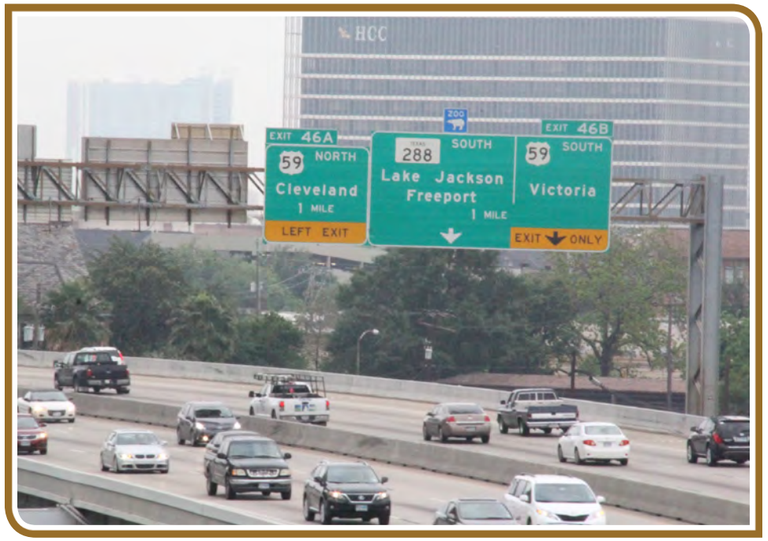
- Traffic from north of Sam Houston Tollway/Beltway 8
  - 15% to I-610
  - 6% to I-10
  - 7% to I-45 S (south of US 59)
  - 5% to US 59 S/SH 288
  - 11% to Downtown/Midtown areas
  - 25% to other destinations inside I-610 loop
- Traffic from north of Shepherd Drive
  - 21% to I-610
  - 12% to I-10
  - 9% to I-45 S (south of US 59)
  - 5% to US 59 S/SH 288
  - 13% to Downtown/Midtown areas
  - 31% to other destinations inside I-610 loop
- Traffic from north of I-610
  - 48% to I-610
  - 8% to I-10
  - 18% to I-45 S (south of US 59)
  - 12% to US 59 S/SH 288
  - 6% to Downtown/Midtown areas
  - 31% to other destinations inside I-610 loop
- Traffic from north of I-10
  - 21% to I-10
  - 25% to I-45 S (south of US 59)
  - 18% to US 59 S/SH 288
  - 28% to Downtown/Midtown areas
  - 35% to other destinations inside I-610 loop
- Compared to existing, 2035 show no significant change in travel patterns, with the exception of I-45 which shows a reduction in percentage of traffic diverting to I-610 coming from north of Shepherd and the percentage of traffic destined to Downtown/Midtown areas increased for traffic traveling between I-610 and I-10 section.

Hardy Toll Road Corridor

- Traffic from north of Beltway 8
  - 18% to BW 8
  - 19% to I-610
  - 25% to other destinations inside I-610 loop
  - 15% to US 59 S/SH 288
  - 12% to Downtown/Midtown areas
- Traffic from north of I-610
  - 38% to I-610
  - 34% to other destinations inside I-610 loop
  - 33% to US 59 S/SH 288
  - 22% to Downtown/Midtown areas
- Hardy Toll Road shows the most changes in future travel patterns with traffic from north of I-610 diverting to I-610 decreasing from 60 to 38 percent and traffic into Downtown/Midtown areas increasing from 6 to 22 percent. This is mainly contributed due to the extension of Hardy Toll Road into Downtown south of I-610.

Downtown Freeway Loop System

- I-10 eastbound traffic, from west of I-45
  - 34% to Downtown/Midtown areas
  - 28% continue on I-10 to east of US 59
  - 15% to US 59 S/SH 288
  - 13% to I-45 S (south of US 59)
  - 5% to I-45 N (north of I-10)
- I-10 westbound traffic, from east of US 59
  - 38% continue on I-10 to west of I-45
  - 24% to Downtown/Midtown areas
  - 22% to US 59 S/SH 288
  - 6% to I-45 N (north of I-10)



- US 59 southbound traffic, from north of I-10
  - 33% continue on to US 59 S (west of Spur 527)
  - 26% to SH 288
  - 19% to Downtown/Midtown areas
  - 14% to I-10
- US 59 northbound, from west of Spur 527
  - 40% to Downtown/Midtown areas
  - 21% to Spur 527
  - 20% to I-45 S (south of US 59)
  - 11% continue on to US 59 N (north of I-10)
  - 7% to I-10
  - 10% to SH 288
- SH 288 northbound, from south of US 59
  - 28% to US 59 N (north of I-10)
  - 20% to US 59 S (west of Spur 527)
  - 24% to Downtown/Midtown areas
  - 9% to I-10
  - 4% to I-45 S (south of US 59)
  - 5% to I-45 N (north of I-10)

A pie-chart showing distribution of traffic from each of the select-link locations to various destination zones is provided in the Appendix of this report.

Summary of Future Traffic Conditions

Travel Demand and Traffic Operations: By 2035, I-45 is projected to carry traffic volumes ranging from 209,500 vpd in Downtown to 415,200 vpd south of BW 8; I-10 is projected to carry 232,500 vpd west of US 59 to 354,000 vpd west of I-45; and US 59 is projected to carry traffic volumes in the range of 273,600 vpd north of I-10 to 390,600 vpd west of Spur 527. Hardy Toll Road is projected to carry 115,300 vpd south of BW 8 and 71,000 vpd along the future Hardy connector south of I-10. As seen in Figure 3-3, all the study area roadways including I-45, I-10, US 59, I-610, Sam Houston Tollway, and Hardy Toll Road are projected to experience significant congestion, operating at LOS F.

Traffic Destinations: Based on the travel demand model results the distribution of traffic to major destinations within the study area was estimated. Along I-45, percentage of total traffic destined to Downtown, Midtown, and Texas Medical Center ranges from ten percent and 27 percent between BW 8 and I-10. Both I-10 and US 59 segments in the study area, carry 21 to 28 percent of traffic destined to locations within Downtown, Midtown, and Texas Medical Center. SH 288, south of US 59 and Hardy Toll Road, north of I-610 carry traffic in the range of 13 and 16 percent that is destined to Downtown/Midtown areas. Around 23 to 40 percent of traffic on I-45/I-10/US 59 study area segments is destined to other locations within the I-610 loop.

Travel Patterns: Compared to existing 2011 traffic conditions, the future travel patterns show a similar percentage of traffic along I-45 accessing the ramp system along the Downtown Loop. Traffic coming from I-45 north of Sam Houston Tollway/Beltway 8, accounts for seven percent, from north of Shepherd Drive eight percent, from north of I-610 four percent, and from north of I-10 20 percent. With the future Hardy connector from south of I-610 to US 59 interchange, the percentage of Hardy Toll Road traffic from north of I-610 accessing the Downtown Loop ramp system jumped from five percent in 2011 to 20 percent in 2035. This indicates that with a projected increased daily traffic volumes in 2035 and higher share of traffic accessing the Downtown Loop ramp system due to the Hardy Toll Road extension, improved accessibility to Downtown and surrounding areas in future would be important.

Traffic Characteristics: The future 2035 traffic characteristics included the K-factor (percentage of daily traffic occurring in the peak hour) and D-factor (directional split of peak hour traffic) and were derived from the existing traffic count data. The K-factor for most roadway segments in the study area varied between seven and eight percent and the D-factor ranged from 51 to 55 percent which indicate that these corridors serve a mix of more than just commuter type trip purposes. For Hardy Toll Road, based on the model estimates, the future year K-factor was assumed at ten percent (compared to 12 percent today) and the D-factor was assumed at 65 percent compared to 80 percent in 2011. As the travel demand increases in future, it is expected that the heavy directional flow of traffic along Hardy Toll Road during the peak hours would taper off.

A summary of future 2035 traffic characteristics including Average Daily Traffic (ADT) volumes and Directional Design Hourly Volumes (DDHV) at the select link locations is provided in **Table 3-5**.

Table 3-5

Summary of Future 2035 Traffic Characteristics by Select Link Location

STUDY CORRIDOR	SELECT LINK NO.	LOCATION	"AVERAGE DAILY TRAFFIC (ADT) VOLUME 2035"	K-FACTOR	D-FACTOR	DIRECTIONAL DESIGN HOURLY VOLUME (DDHV) 2035
I-45	1	North of BW 8	344,600	8.0%	60%	16,500
	2	North of Shepherd	297,400	8.2%	53%	12,800
	3	North of I-610	284,600	8.0%	54%	12,300
	4	North of I-10	244,300	6.7%	59%	9,700
	5	South of US 59	261,300	7.6%	53%	10,500
I-10	6	West of I-45	354,000	8.3%	55%	16,200
	7	East of US 59	236,400	7.5%	60%	10,600
US 59	8	North of I-10	273,600	8.2%	64%	14,400
	9	West of Spur 527	390,600	8.2%	51%	16,300
SH 288	10	South of US 59	239,500	7.5%	53%	9,500
Hardy Toll Road	11	North of BW 8	88,200	12.0%	70%	5,600
	12	North of I-610	98,100	12.0%	70%	8,200
Sam Houston Tollway	13	West of I-45	267,000	7.5%	55%	11,100
I-610	14	West of I-45	247,600	8.3%	53%	10,900

Note: The daily traffic volumes shown in this table do not include the frontage road traffic.

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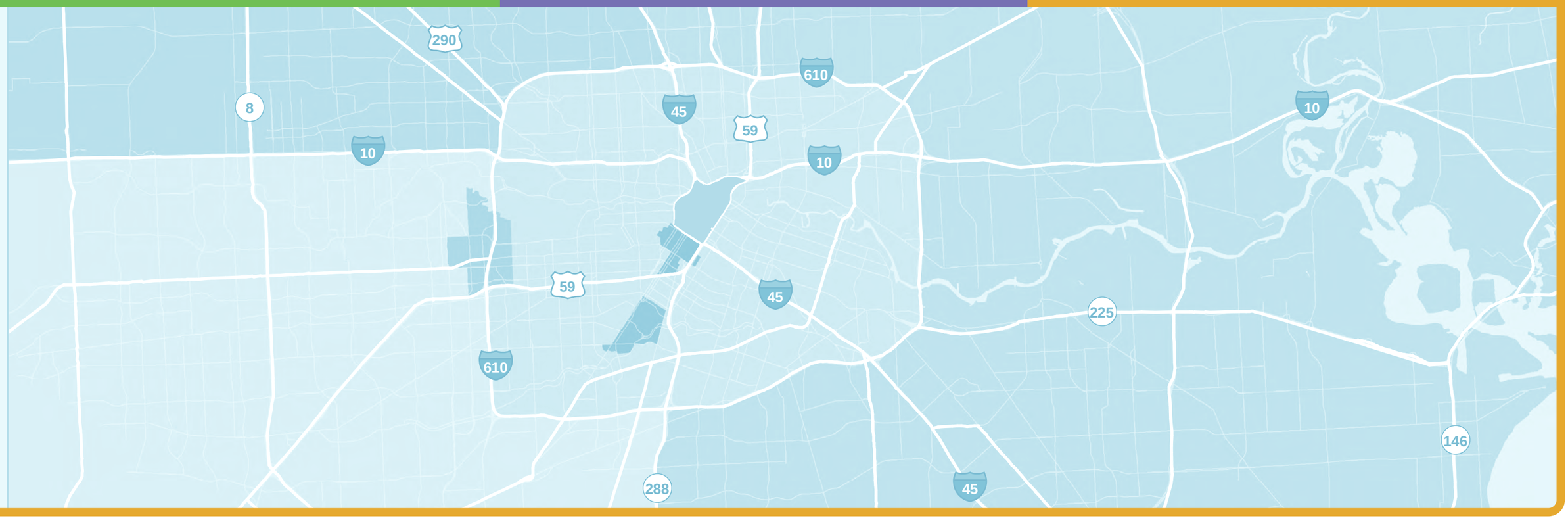
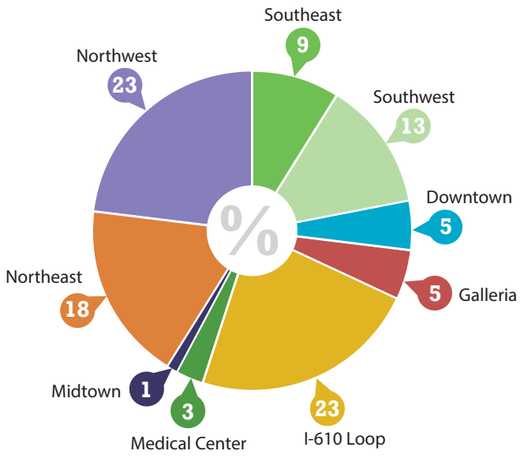
Appendix

EXISTING (2011) AND FUTURE (2035) TRAFFIC CHARACTERISTICS



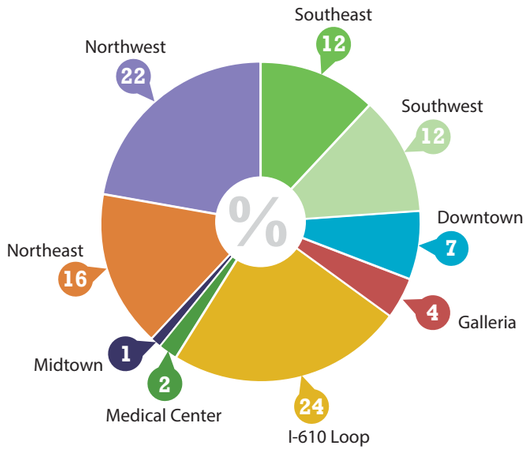
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



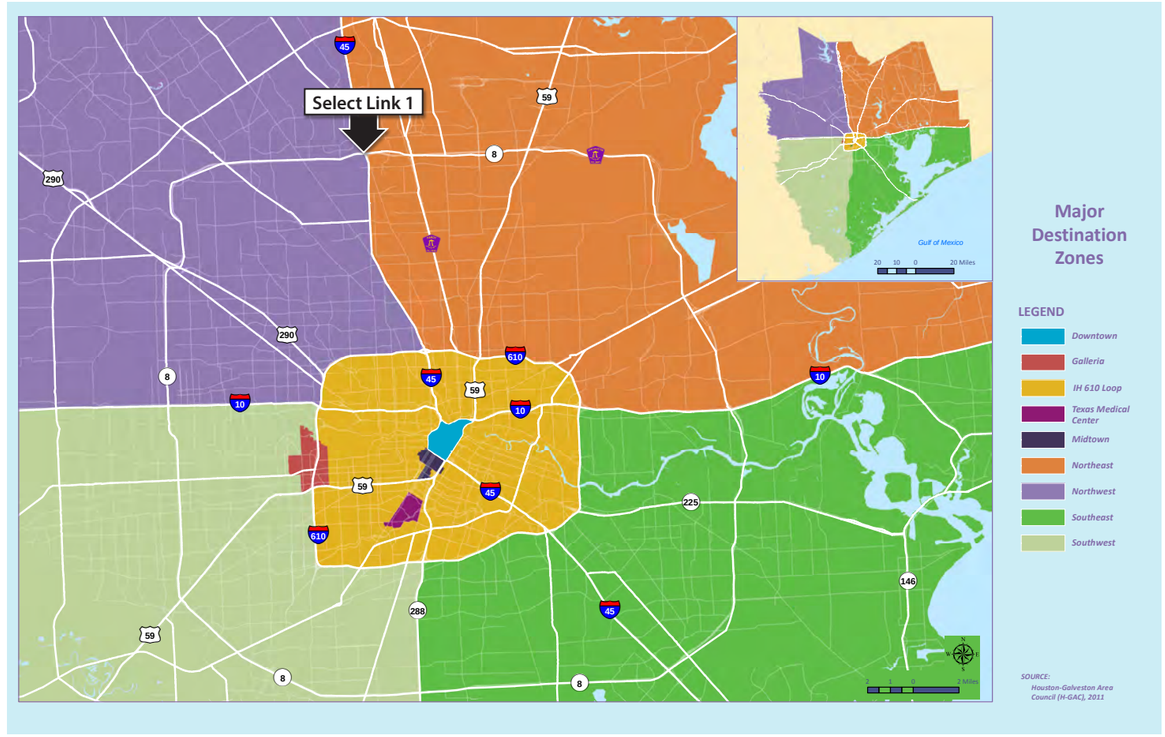
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



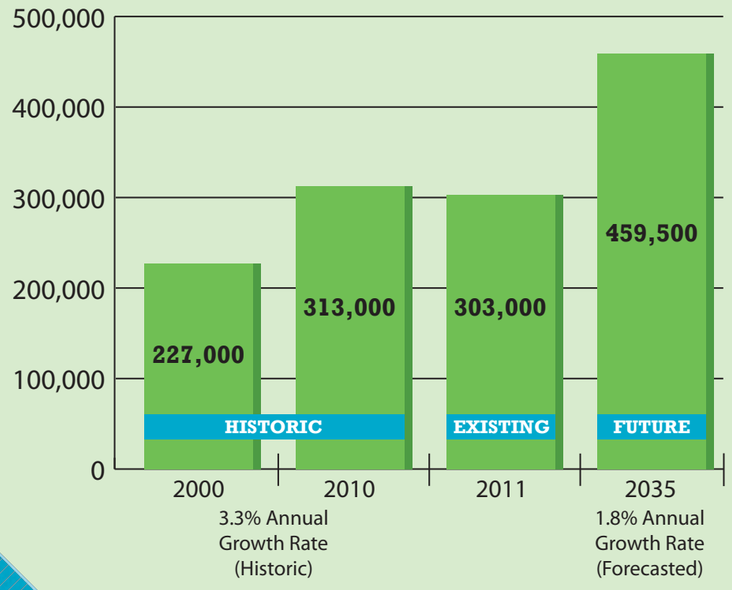
SELECT LINK 1

I-45, North of BW 8



Daily Traffic Volume Trends

Average Daily Traffic Volumes

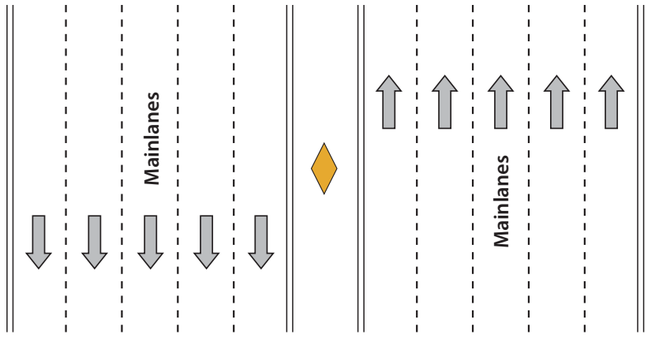


Note: ADT includes frontage road volumes.

Existing and Future Traffic Characteristics

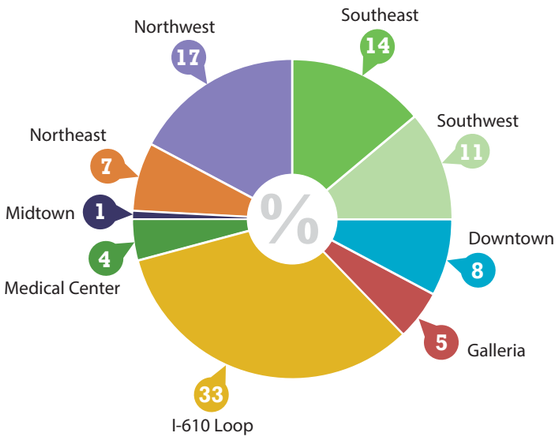
PEAK HOUR PERIOD	DAILY VOLUME*	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	227,300	8%	60%	10,900	SB
PM		7%	59%	9,400	NB
2035 Future Traffic Characteristics					
AM	344,600	8%	60%	16,500	SB
PM		7%	59%	14,200	NB

Existing Lane Configuration



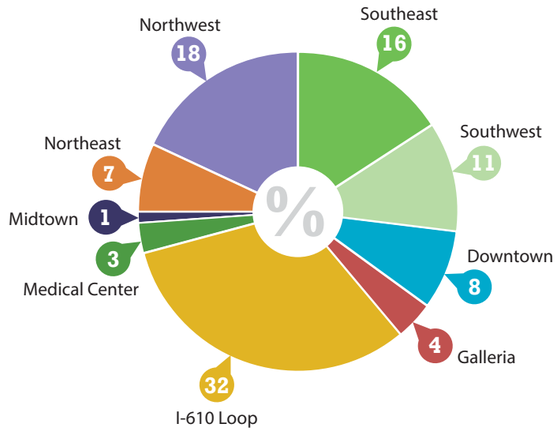
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



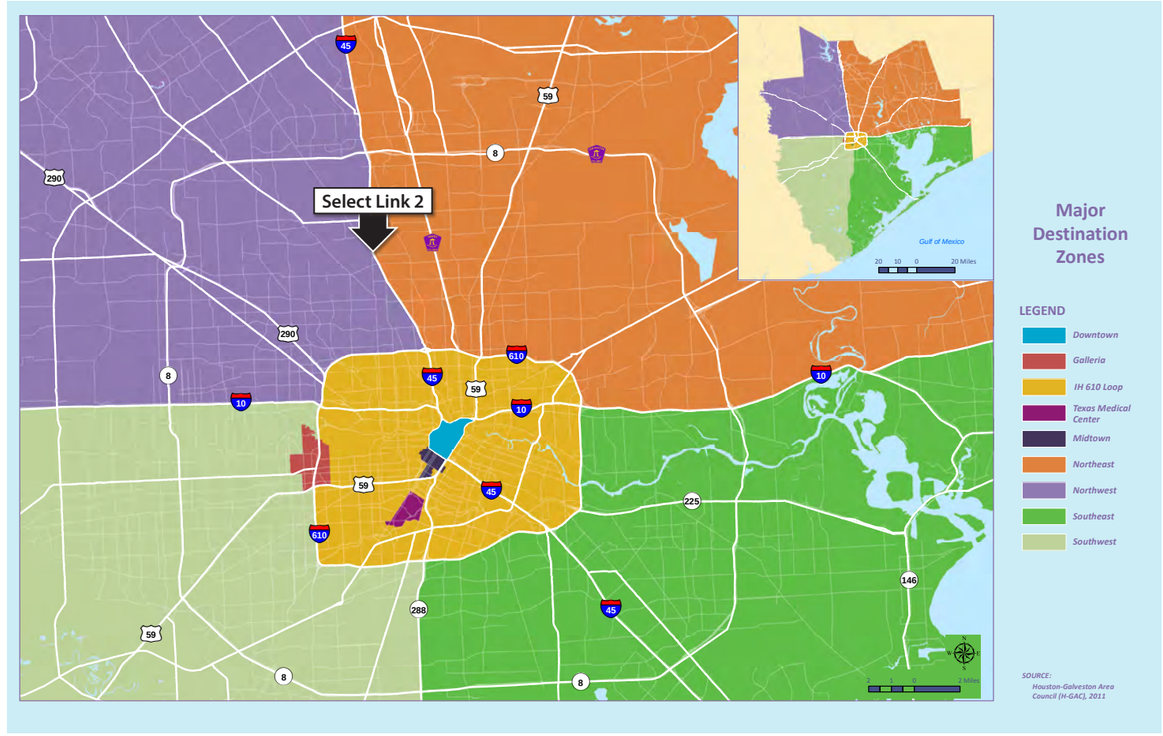
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



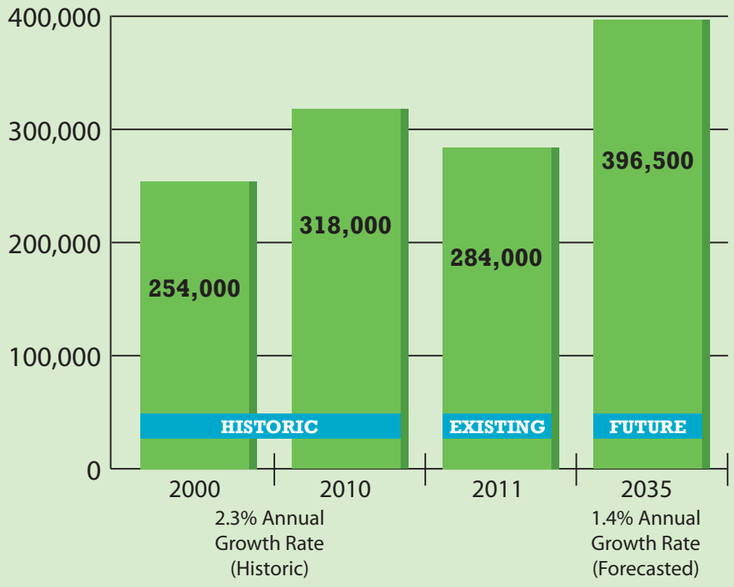
SELECT LINK 2

I-45, North of Shepherd Drive



Daily Traffic Volume Trends

Average Daily Traffic Volumes

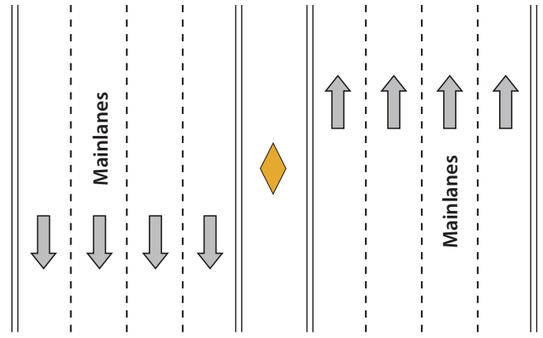


Note: ADT includes frontage road volumes.

Existing and Future Traffic Characteristics

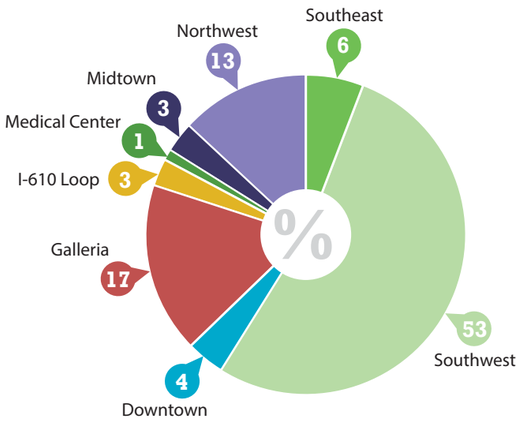
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	213,000	8%	53%	9,200	SB
PM		7%	53%	8,100	NB
2035 Future Traffic Characteristics					
AM	297,400	8%	53%	12,800	SB
PM		7%	53%	11,300	NB

Existing Lane Configuration



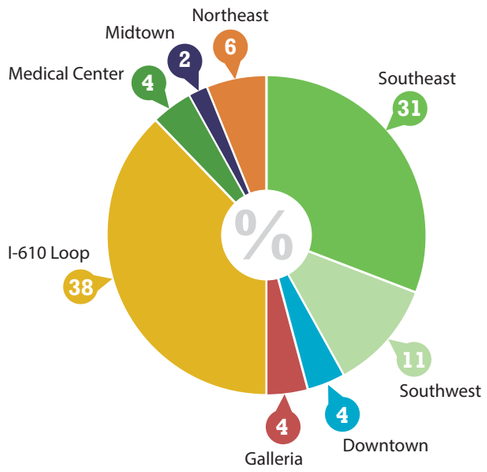
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



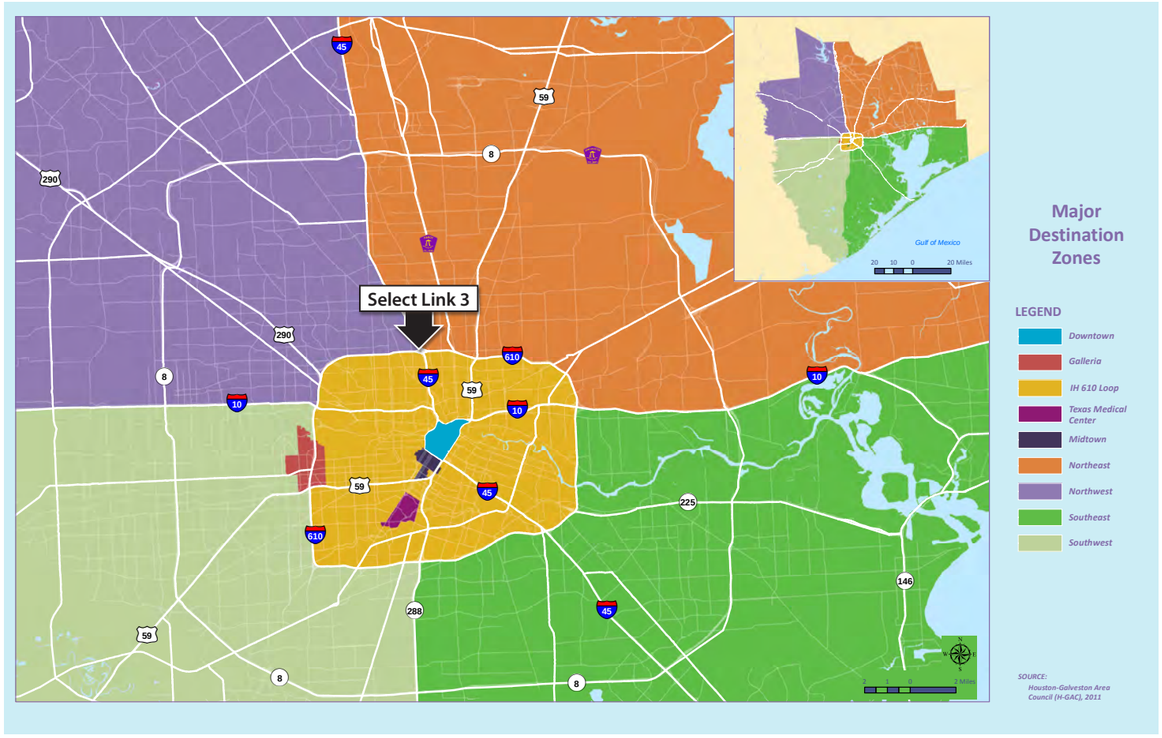
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



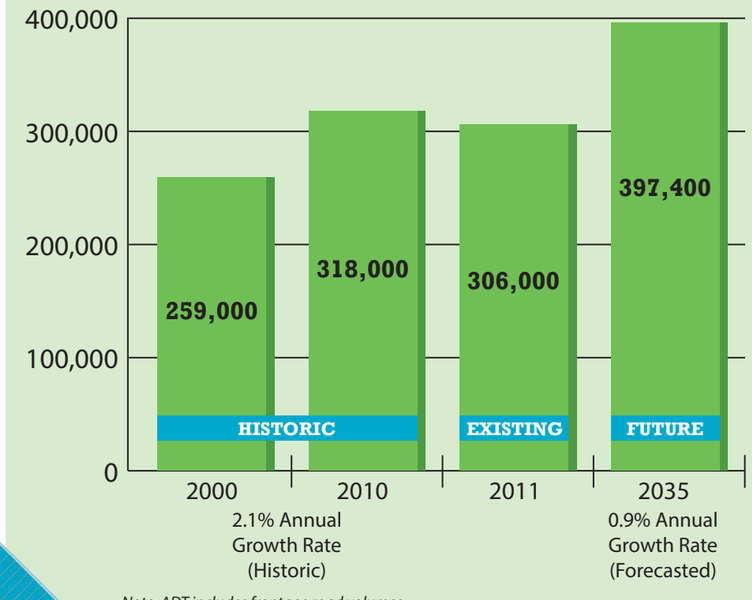
SELECT LINK 3

I-45, North of I-610



Daily Traffic Volume Trends

Average Daily Traffic Volumes

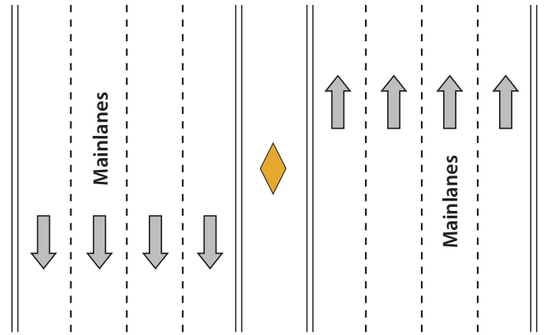


Note: ADT includes frontage road volumes.

Existing and Future Traffic Characteristics

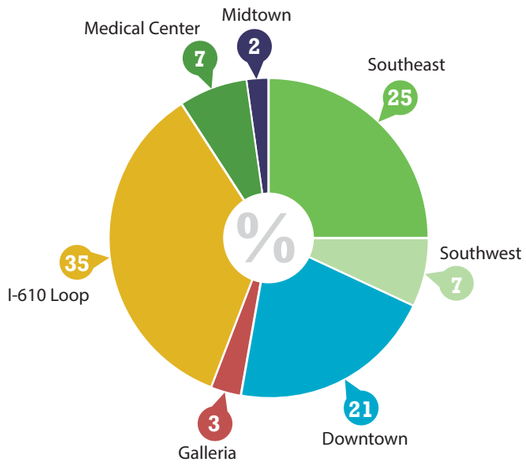
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	229,500	8%	54%	9,900	SB
PM		7%	54%	8,300	NB
2035 Future Traffic Characteristics					
AM	284,600	8%	54%	12,300	SB
PM		7%	54%	10,300	NB

Existing Lane Configuration



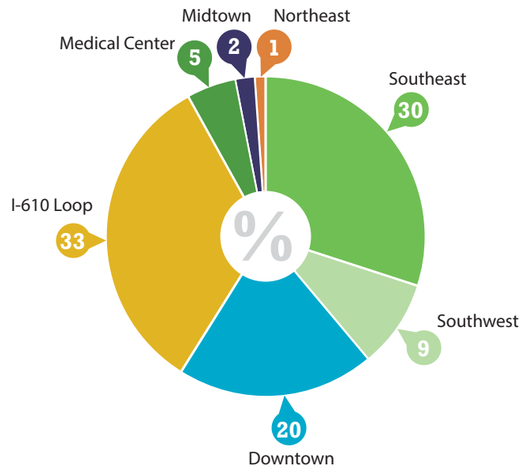
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



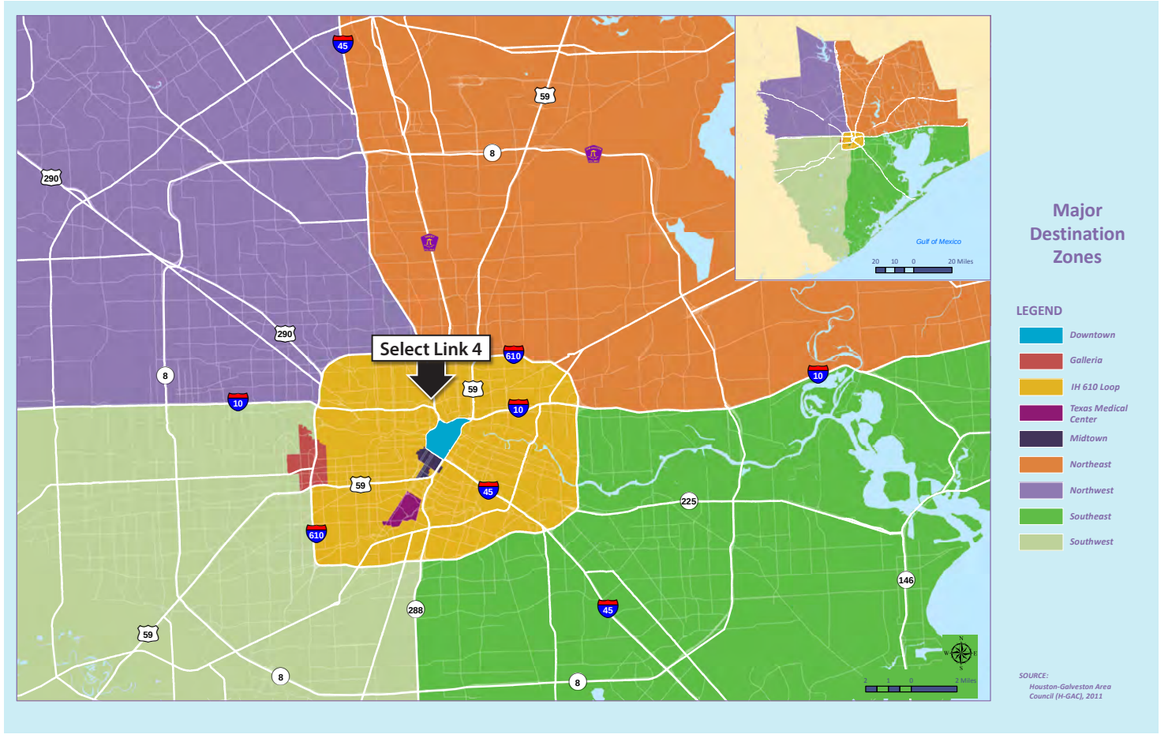
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



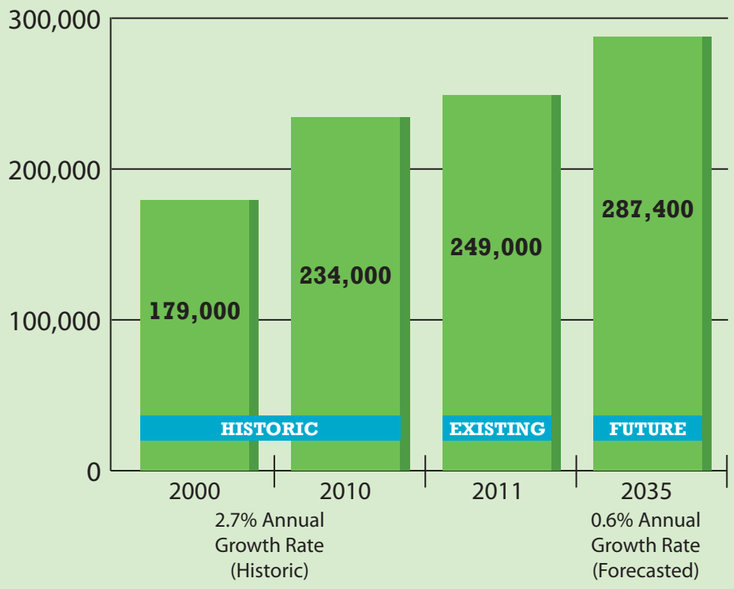
SELECT LINK 4

I-45, North of I-10



Daily Traffic Volume Trends

Average Daily Traffic Volumes

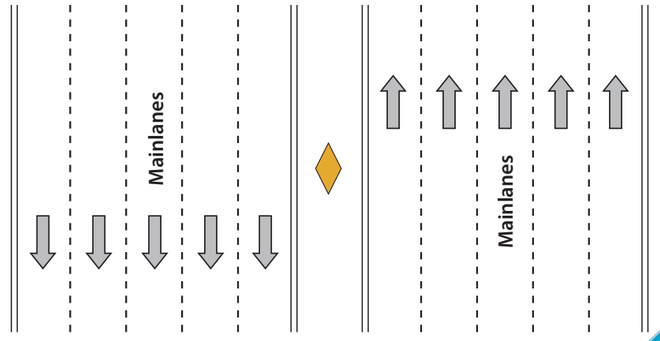


Note: ADT includes frontage road volumes.

Existing and Future Traffic Characteristics

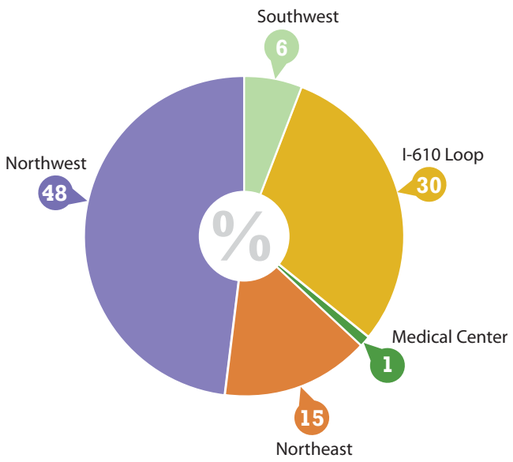
PEAK HOUR PERIOD	DAILY VOLUME*	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	211,700	7%	59%	8,400	SB
PM		7%	51%	7,600	NB
2035 Future Traffic Characteristics					
AM	244,300	7%	59%	9,700	SB
PM		7%	51%	8,700	NB

Existing Lane Configuration



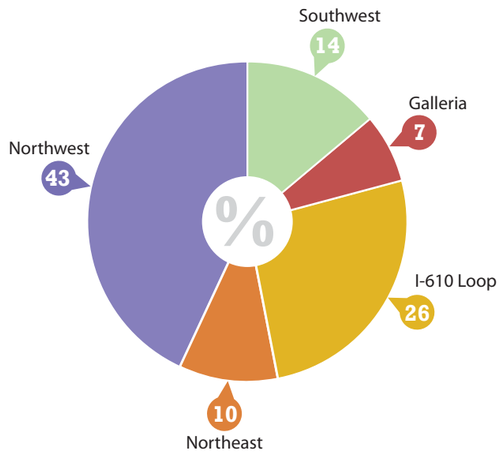
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



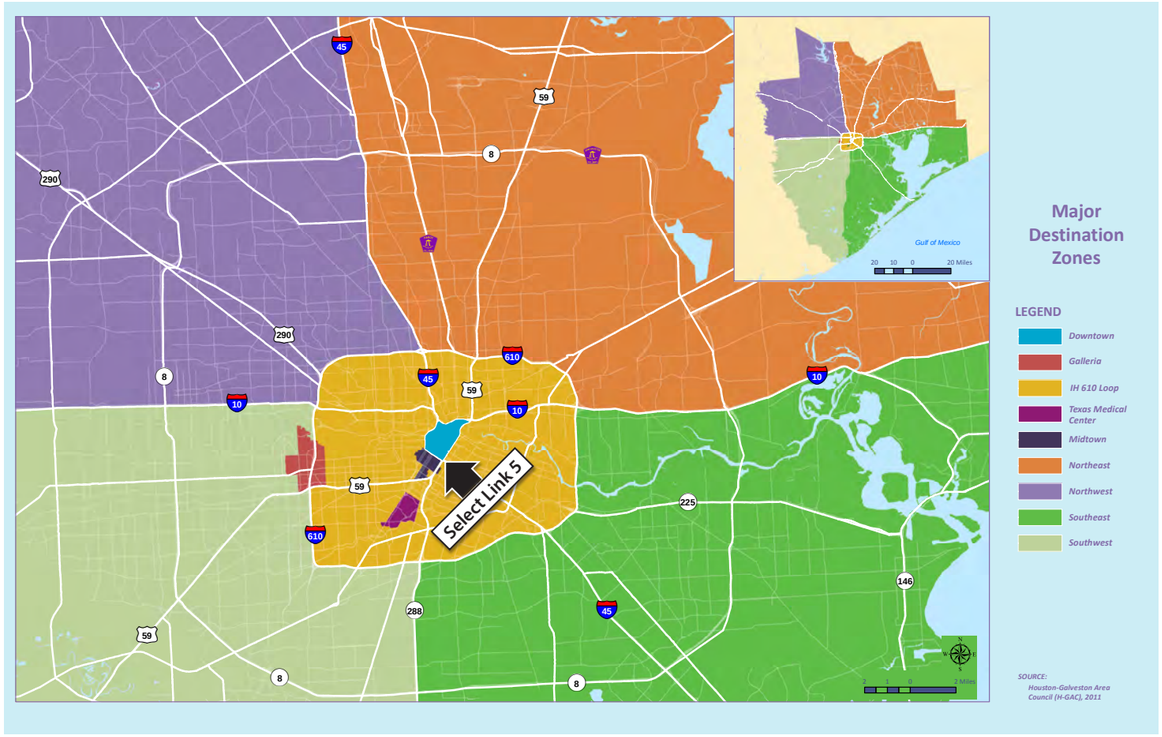
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



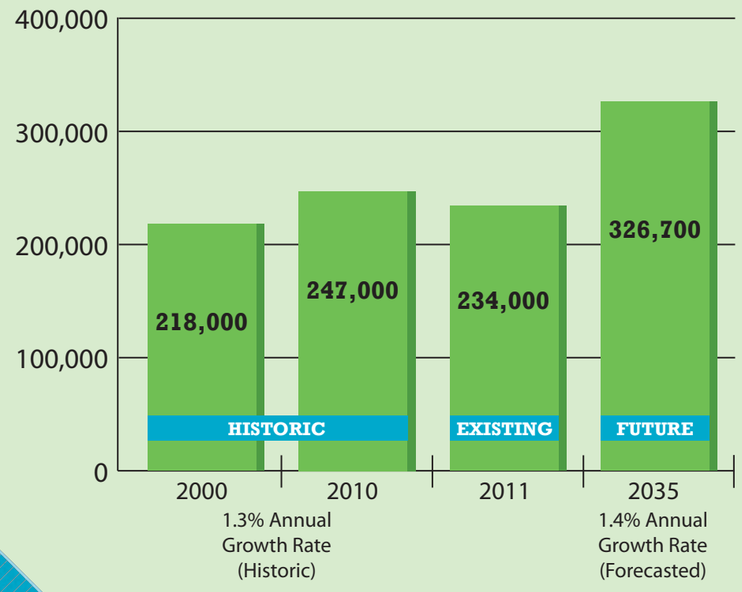
SELECT LINK 5

I-45, South of US 59



Daily Traffic Volume Trends

Average Daily Traffic Volumes

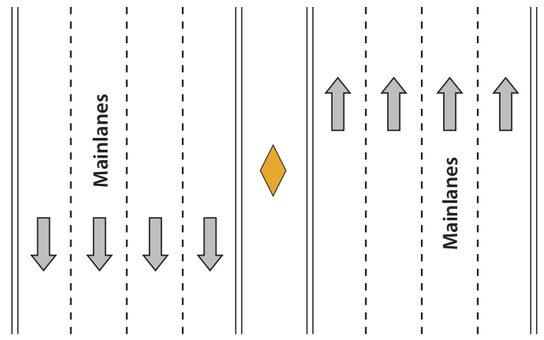


Note: ADT includes frontage road volumes.

Existing and Future Traffic Characteristics

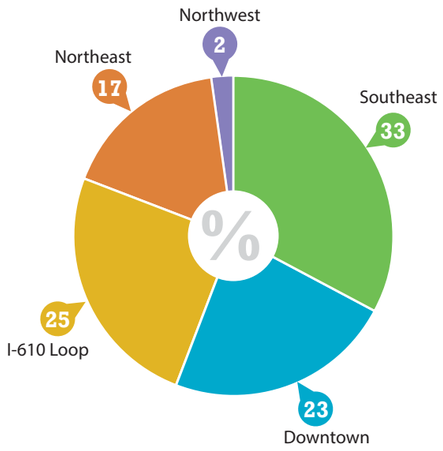
PEAK HOUR PERIOD	DAILY VOLUME*	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	187,200	8%	53%	7,500	SB
PM		6%	61%	6,600	SB
2035 Future Traffic Characteristics					
AM	261,300	8%	53%	10,500	SB
PM		6%	61%	9,200	SB

Existing Lane Configuration



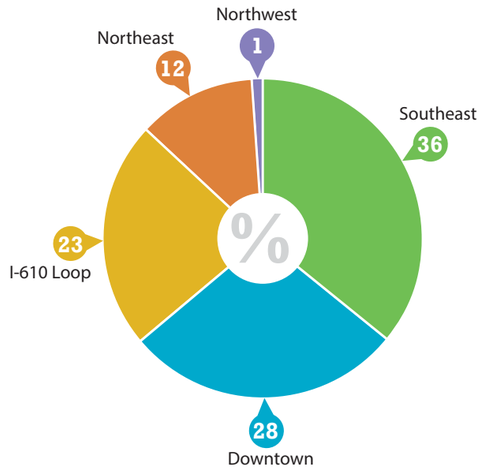
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



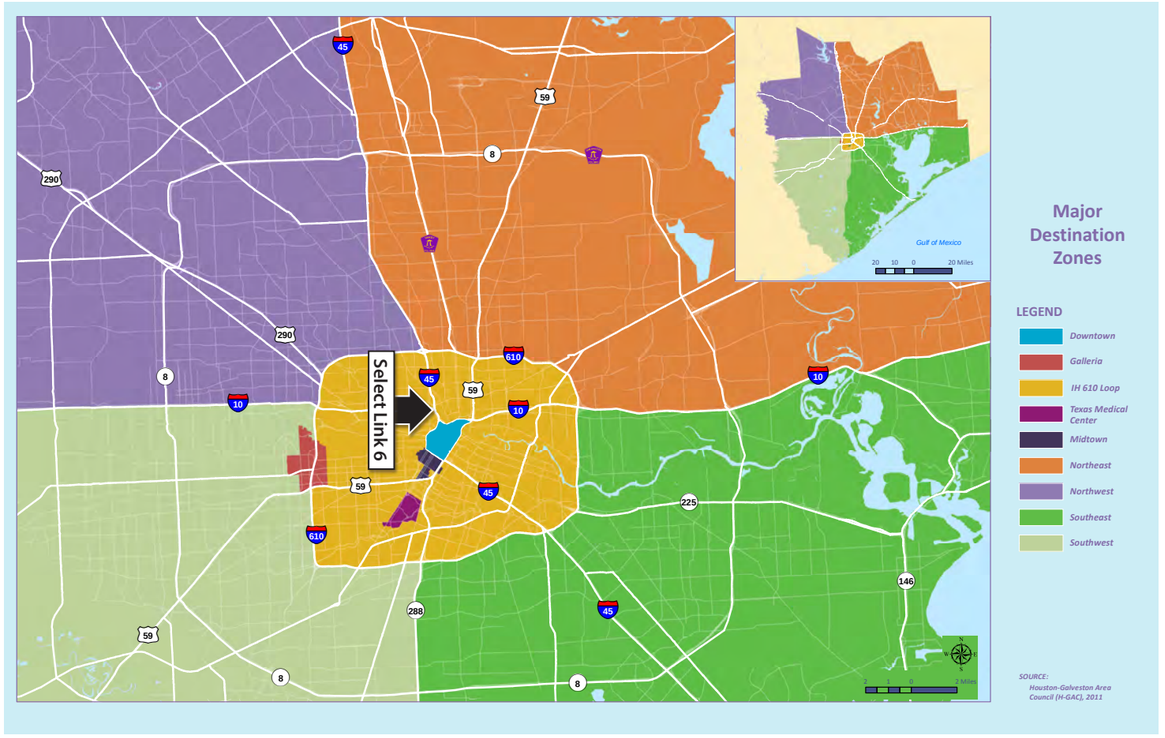
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



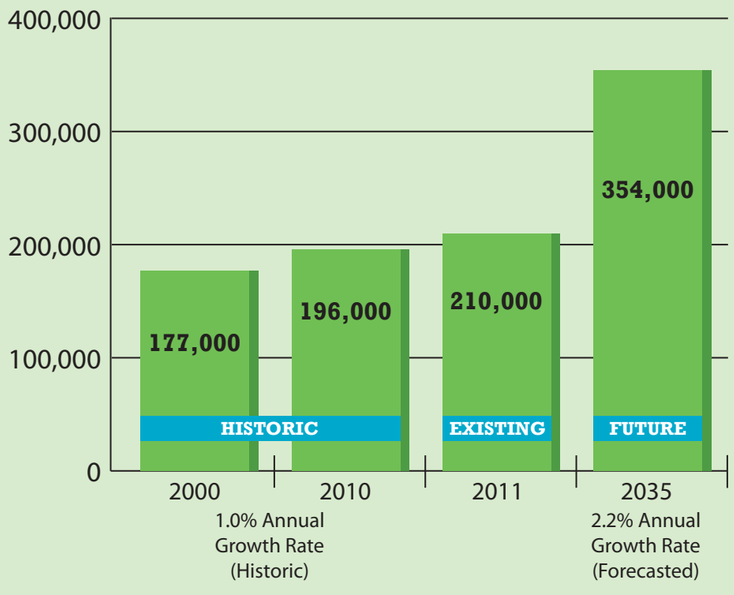
SELECT LINK 6

I-10, West of I-45



Daily Traffic Volume Trends

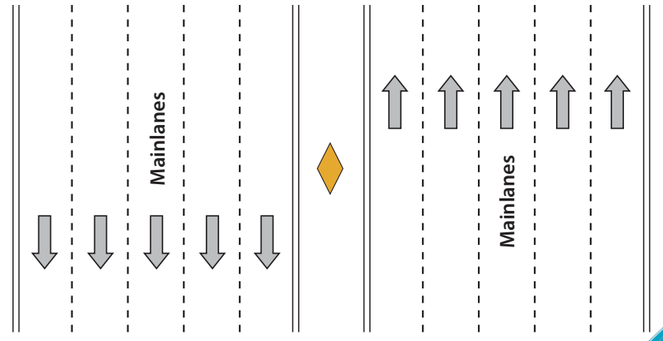
Average Daily Traffic Volumes



Existing and Future Traffic Characteristics

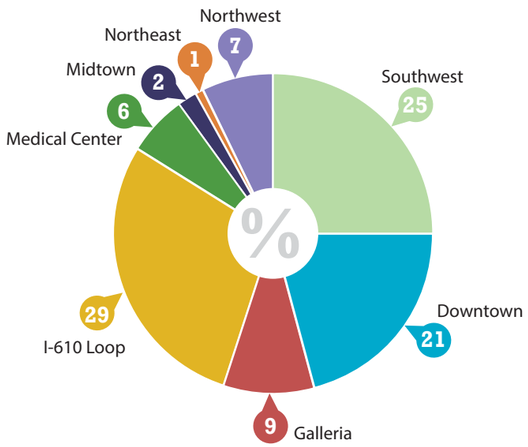
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	210,000	8%	56%	9,100	WB
PM		8%	55%	9,600	WB
2035 Future Traffic Characteristics					
AM	354,000	8%	56%	15,300	WB
PM		8%	55%	16,200	WB

Existing Lane Configuration



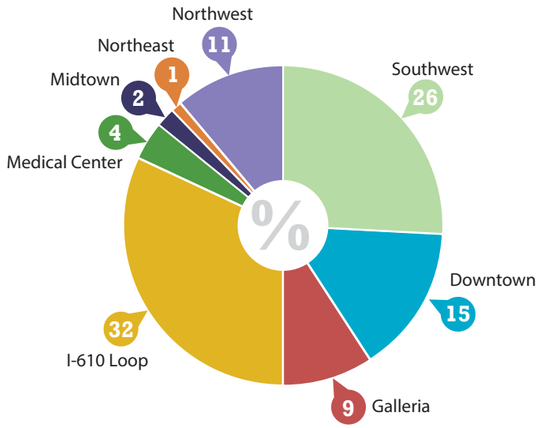
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



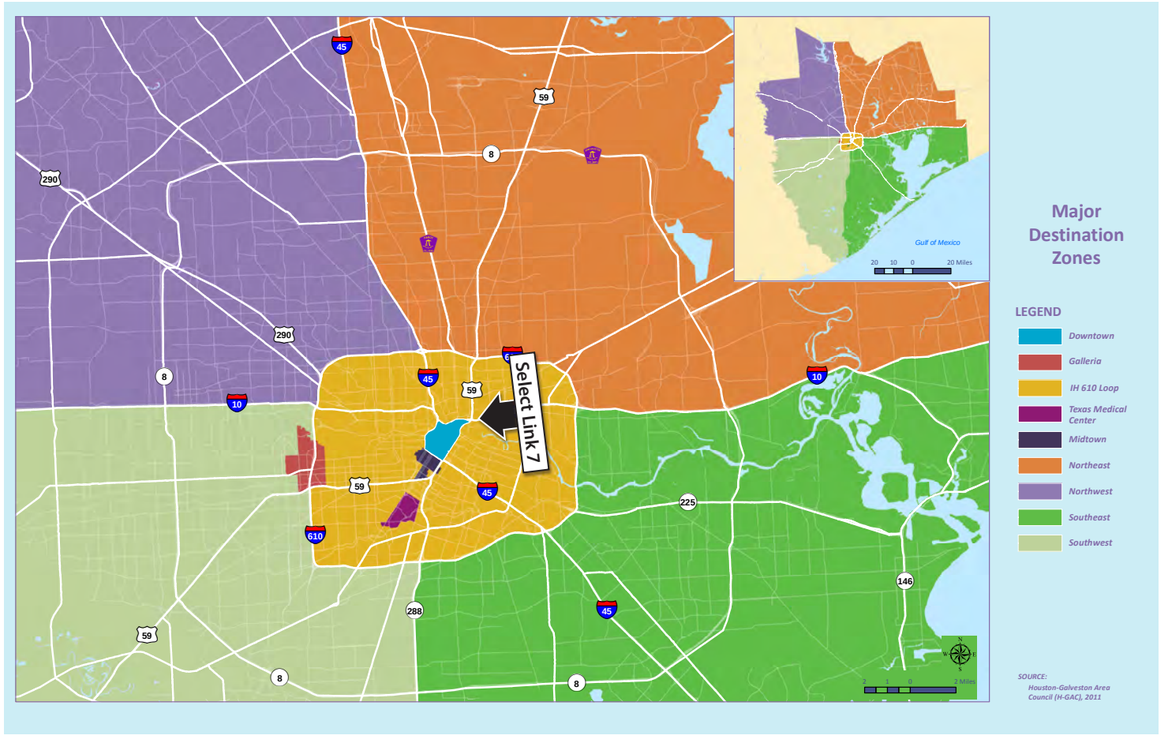
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



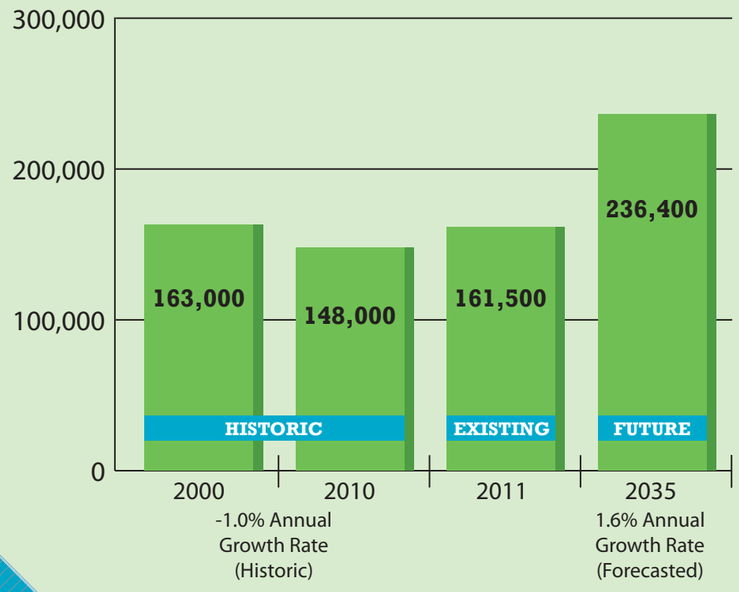
SELECT LINK 7

I-10, East of US 59



Daily Traffic Volume Trends

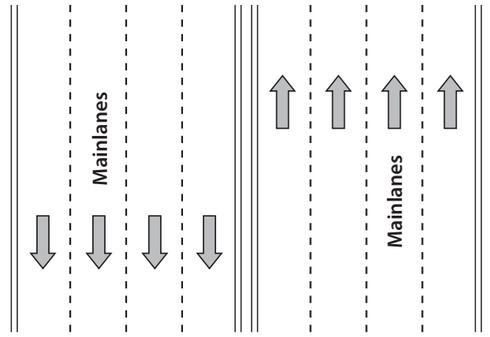
Average Daily Traffic Volumes



Existing and Future Traffic Characteristics

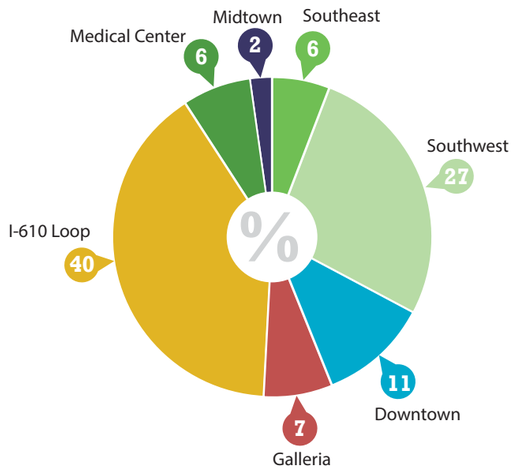
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	161,500	8%	60%	7,300	WB
PM		7%	60%	6,500	EB
2035 Future Traffic Characteristics					
AM	236,400	8%	60%	10,600	WB
PM		7%	60%	9,500	EB

Existing Lane Configuration



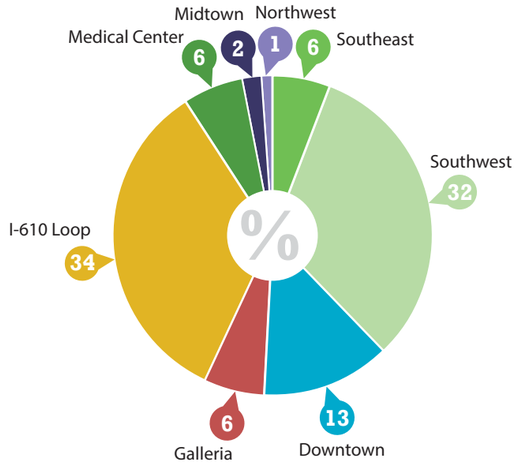
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



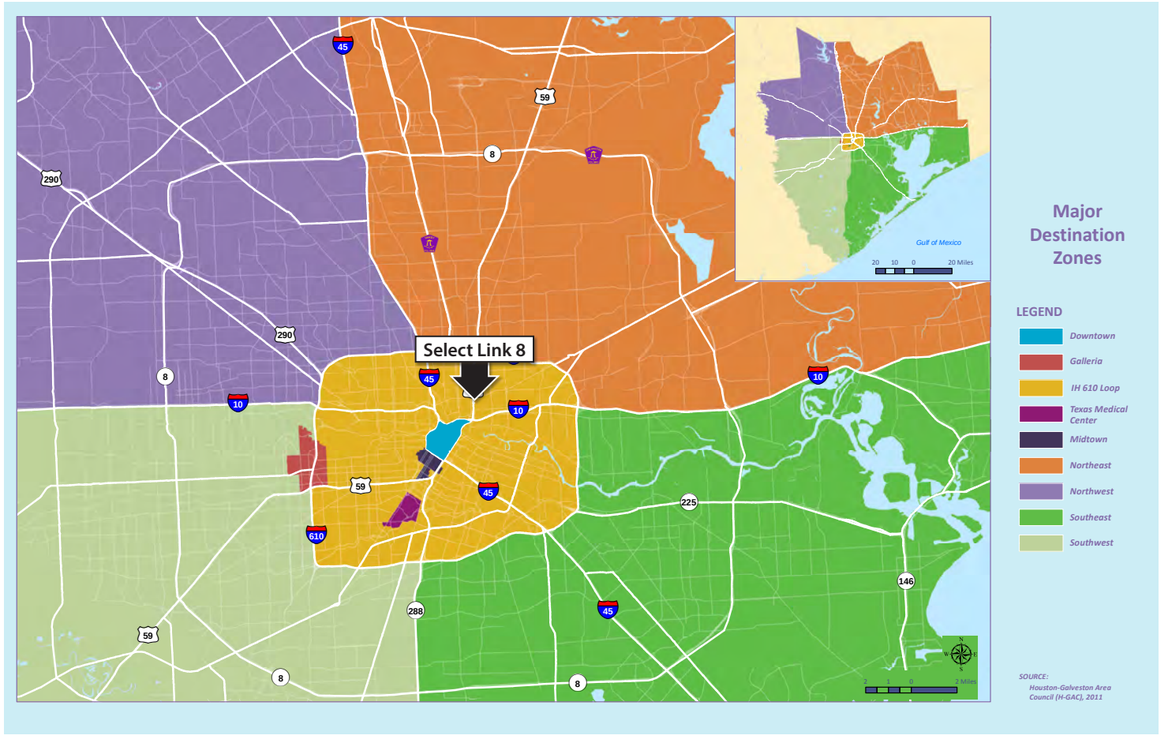
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



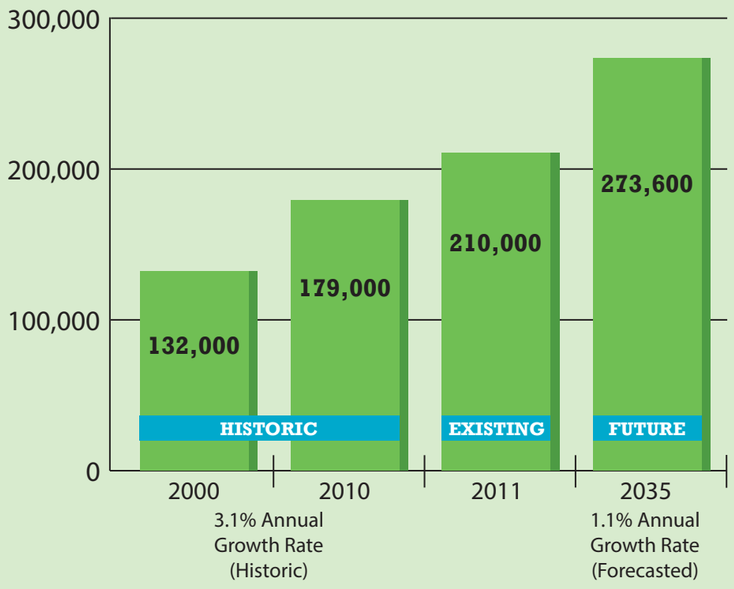
SELECT LINK 8

US 59, North of I-10



Daily Traffic Volume Trends

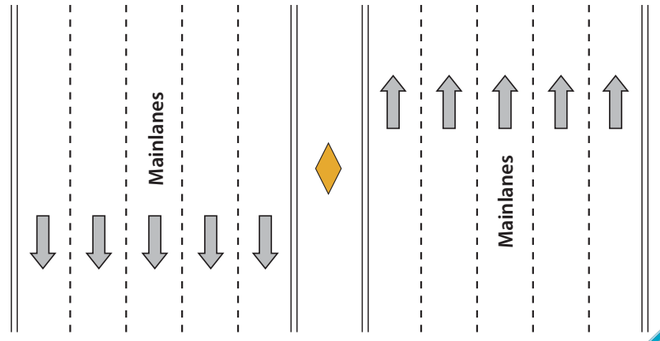
Average Daily Traffic Volumes



Existing and Future Traffic Characteristics

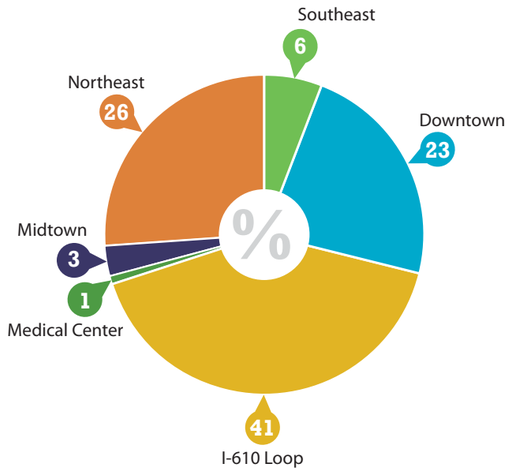
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	210,400	8%	64%	11,000	SB
PM		8%	65%	10,700	NB
2035 Future Traffic Characteristics					
AM	273,600	8%	64%	14,400	SB
PM		8%	65%	13,900	NB

Existing Lane Configuration



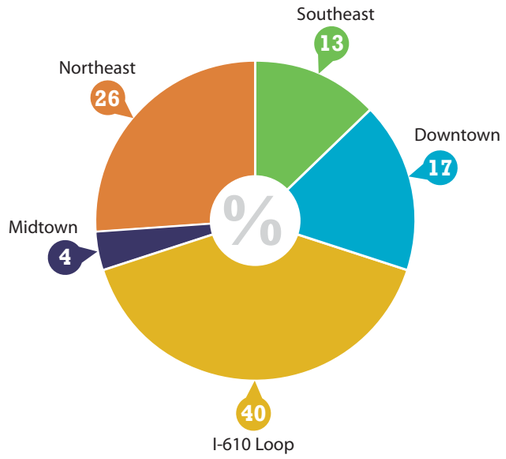
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



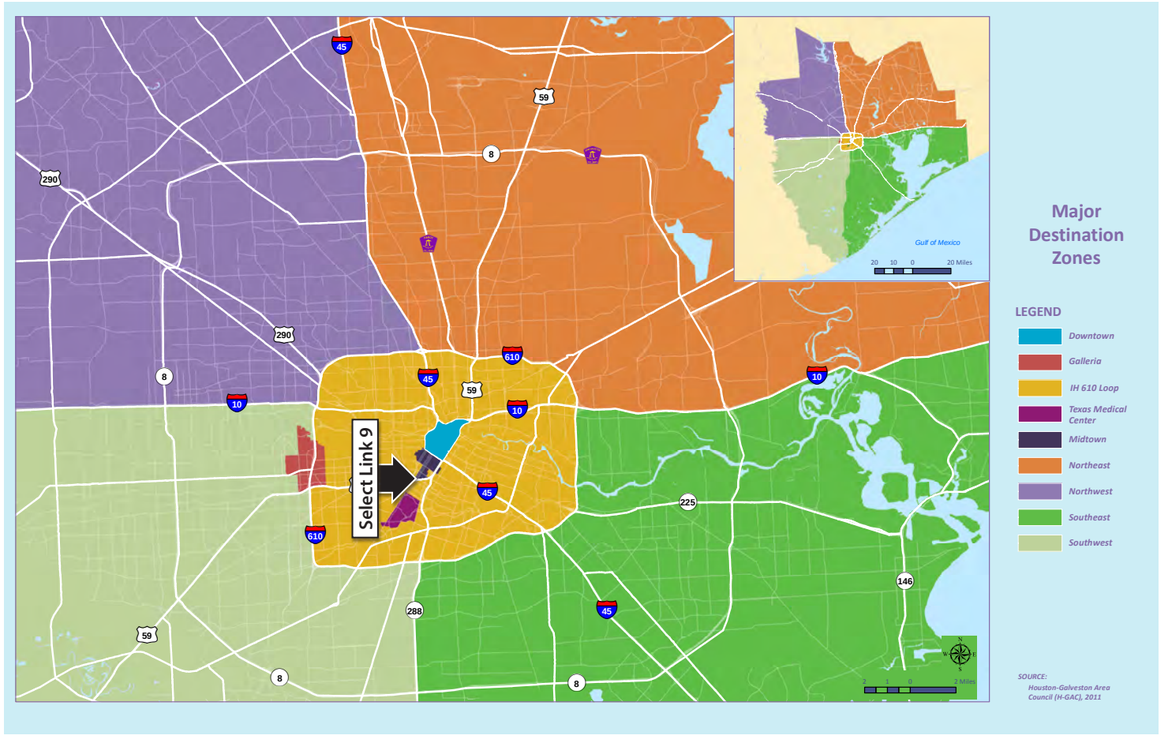
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



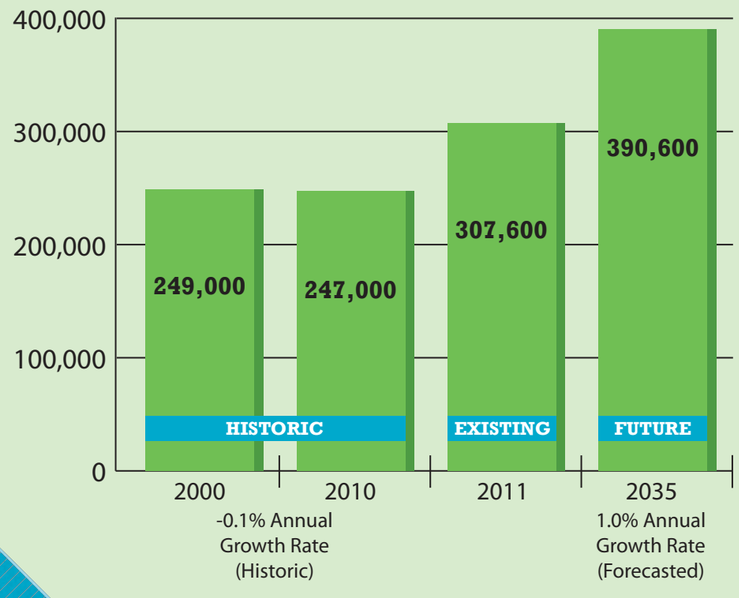
SELECT LINK 9

US 59, West of Spur 527



Daily Traffic Volume Trends

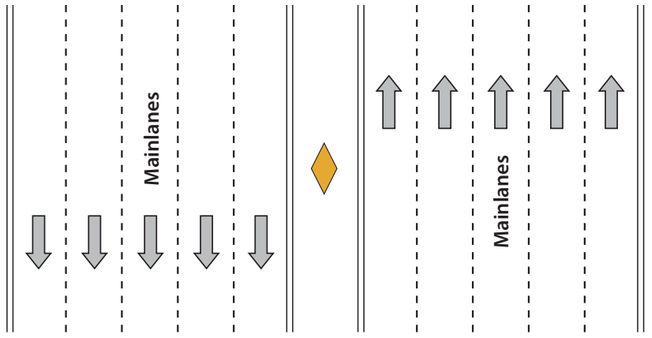
Average Daily Traffic Volumes



Existing and Future Traffic Characteristics

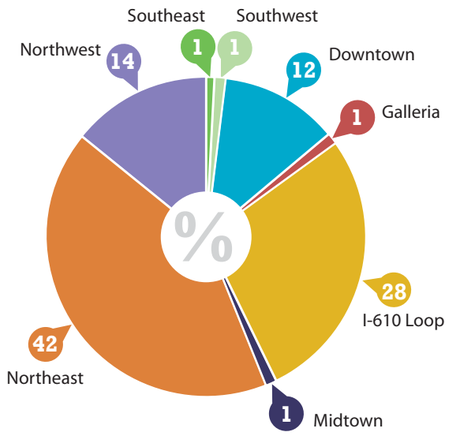
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	307,600	8%	51%	12,900	EB
PM		6%	51%	10,000	WB
2035 Future Traffic Characteristics					
AM	390,600	8%	51%	16,300	EB
PM		6%	51%	12,700	WB

Existing Lane Configuration



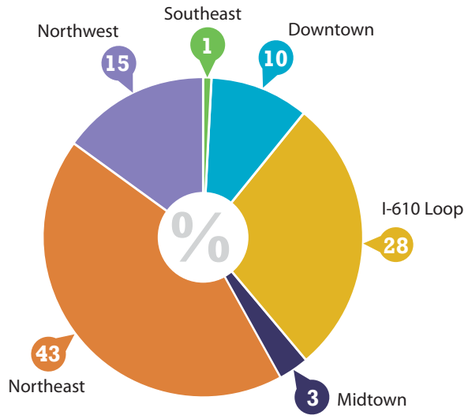
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



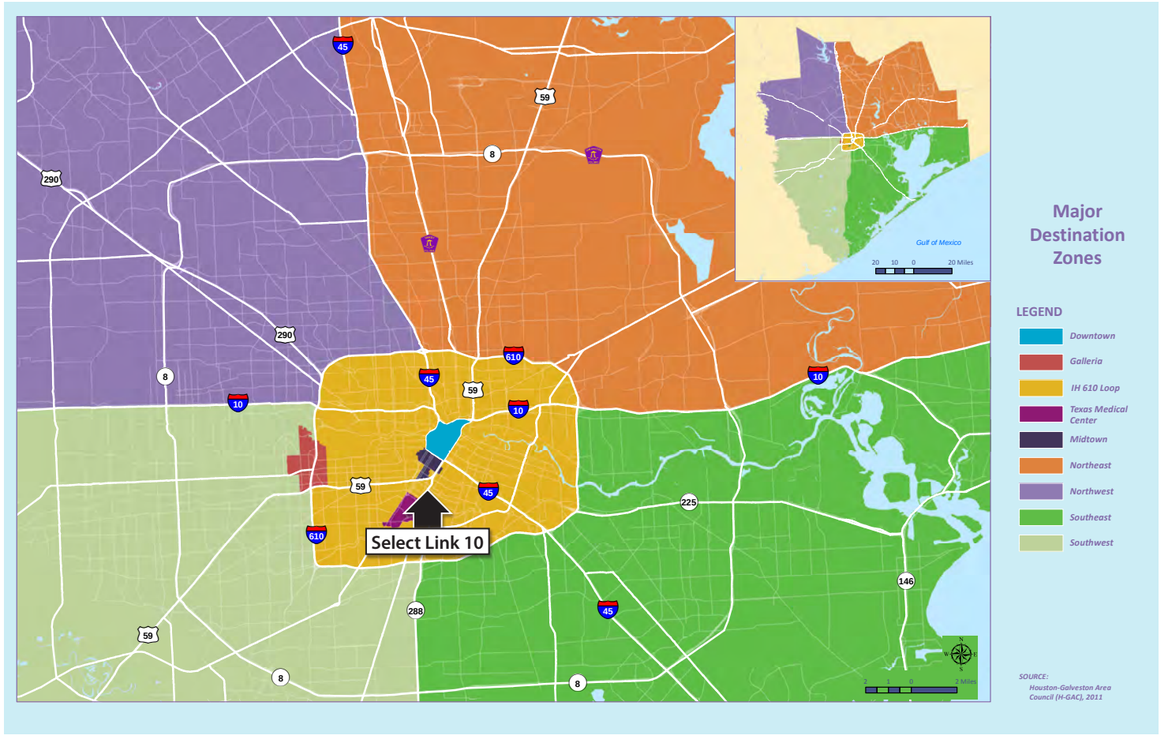
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



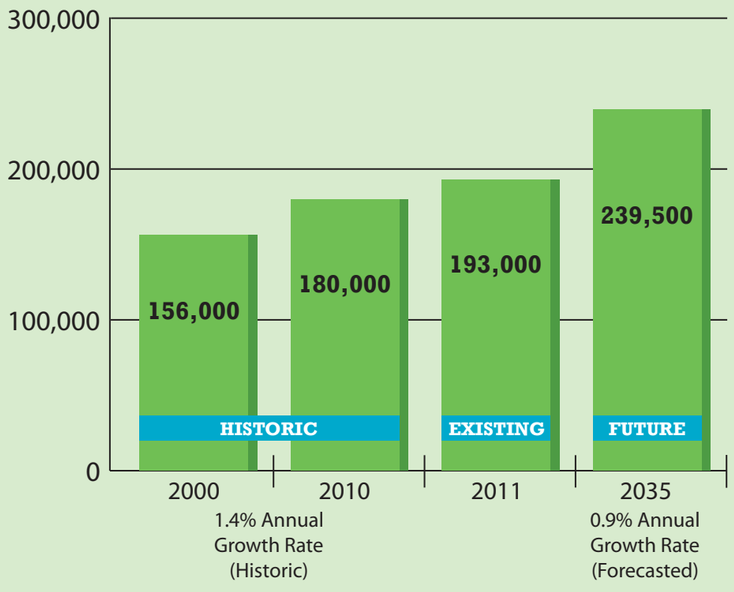
SELECT LINK 10

SH 288, South of US 59



Daily Traffic Volume Trends

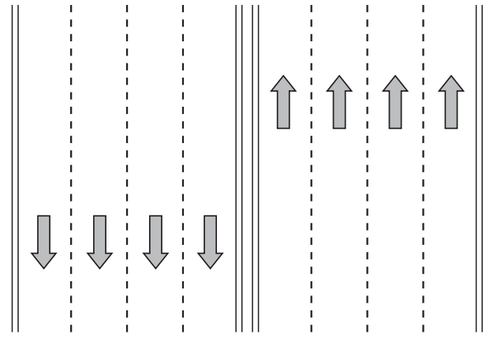
Average Daily Traffic Volumes



Existing and Future Traffic Characteristics

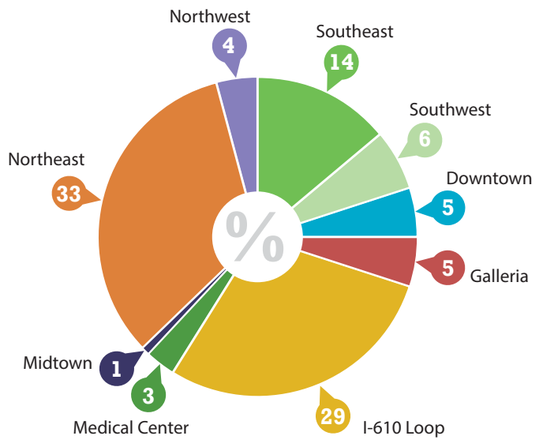
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	193,000	8%	51%	7,700	NB
PM		7%	54%	7,400	SB
2035 Future Traffic Characteristics					
AM	239,500	8%	51%	9,500	NB
PM		7%	54%	9,200	SB

Existing Lane Configuration



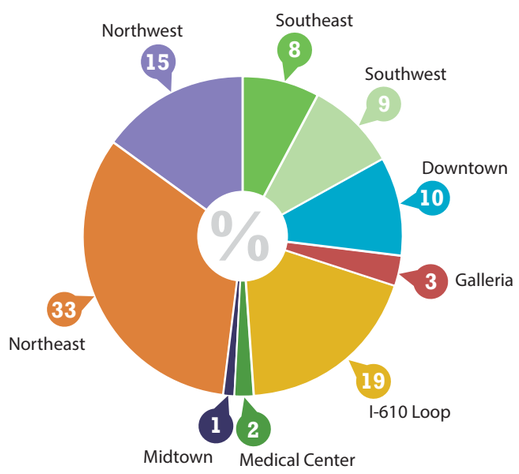
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



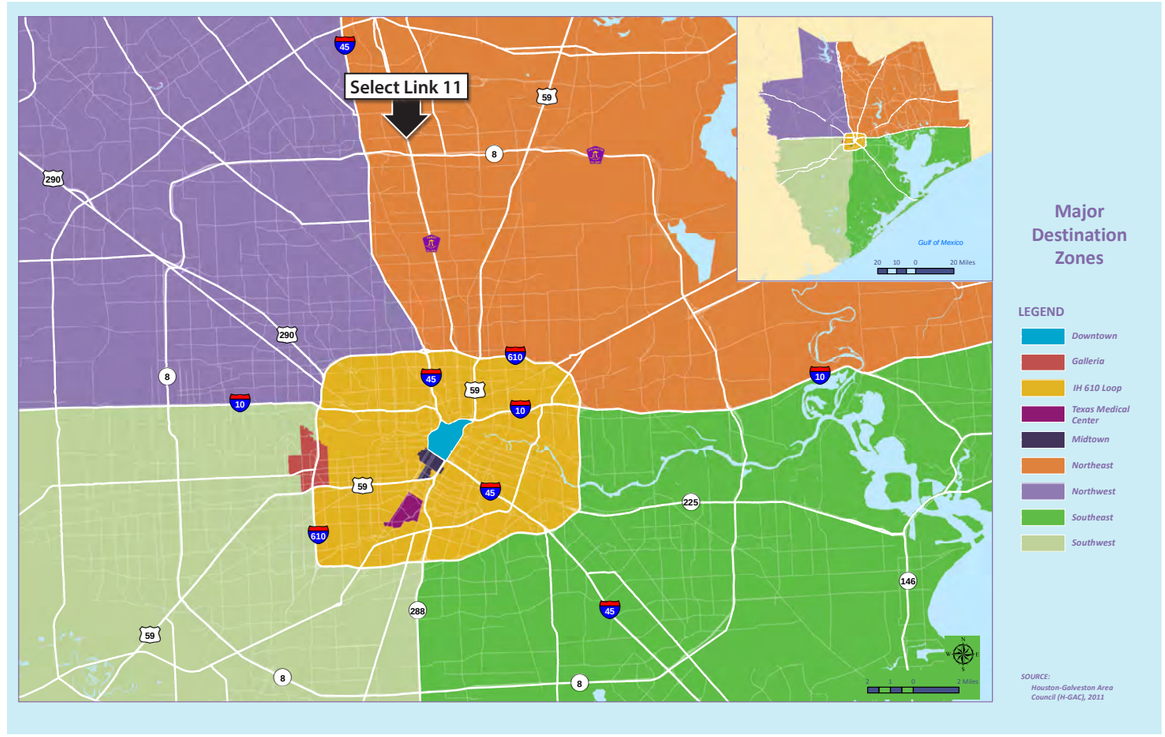
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



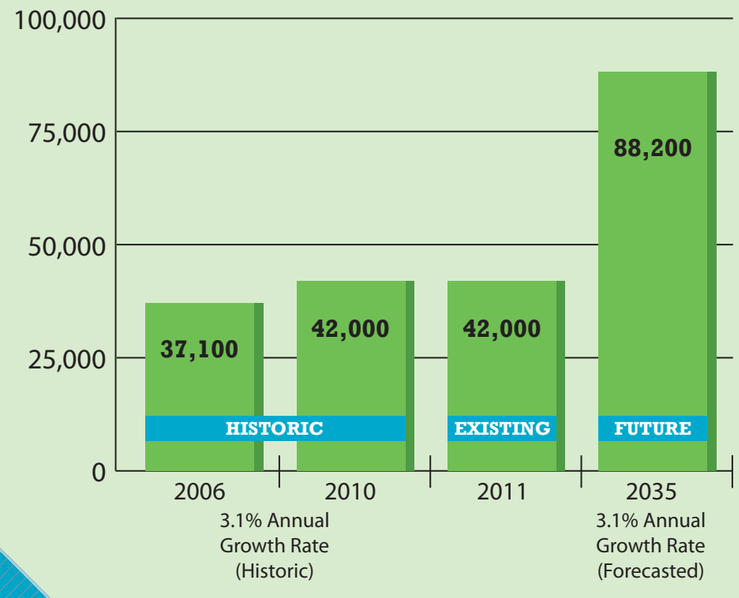
SELECT LINK 11

Hardy Toll Road, North of BW 8



Daily Traffic Volume Trends

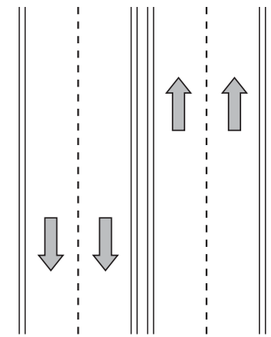
Average Daily Traffic Volumes



Existing and Future Traffic Characteristics

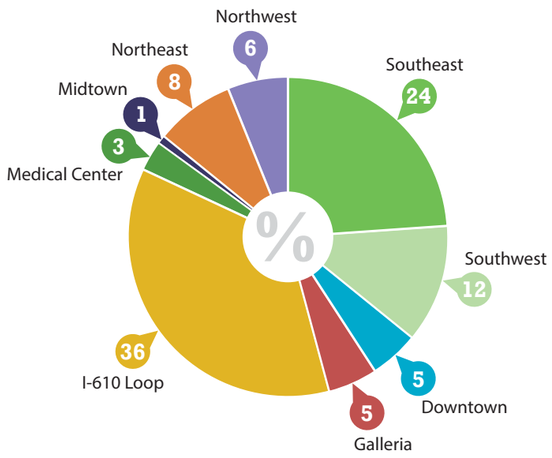
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	42,000	12%	80%	4,000	SB
PM		12%	70%	3,500	NB
2035 Future Traffic Characteristics					
AM	88,200	12%	75%	7,900	SB
PM		12%	65%	6,900	NB

Existing Lane Configuration



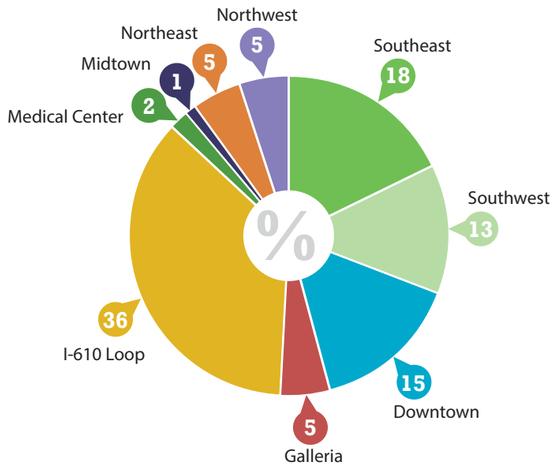
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



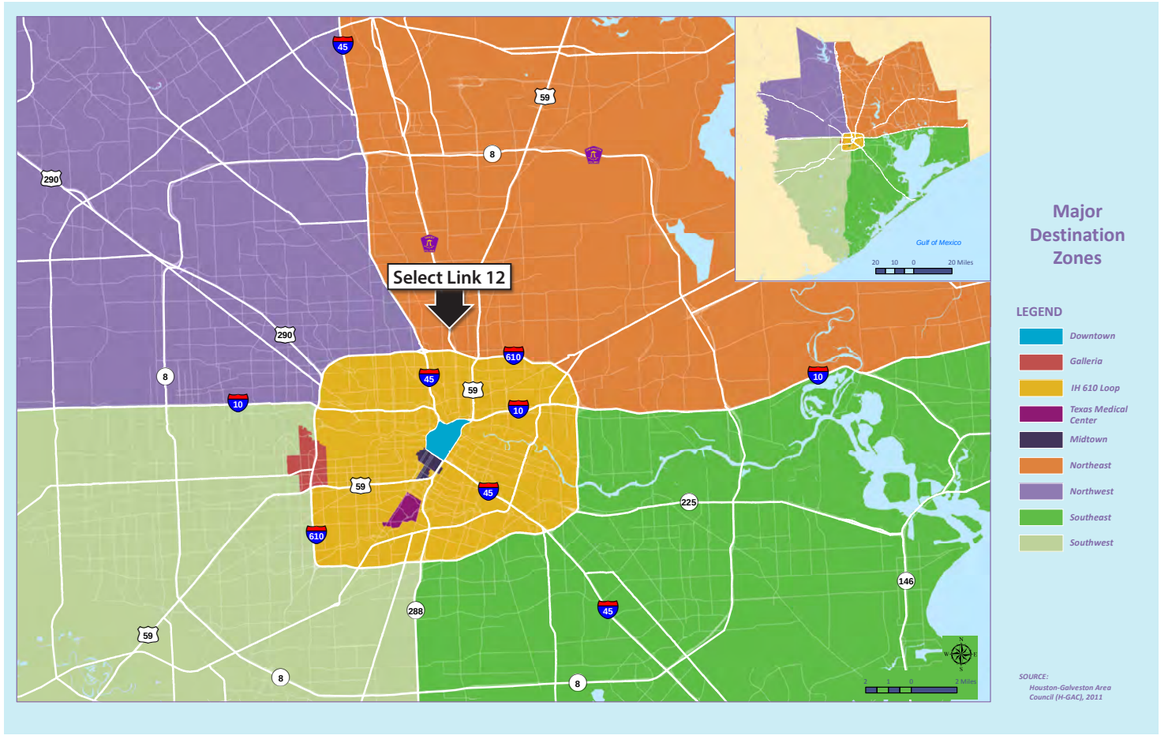
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



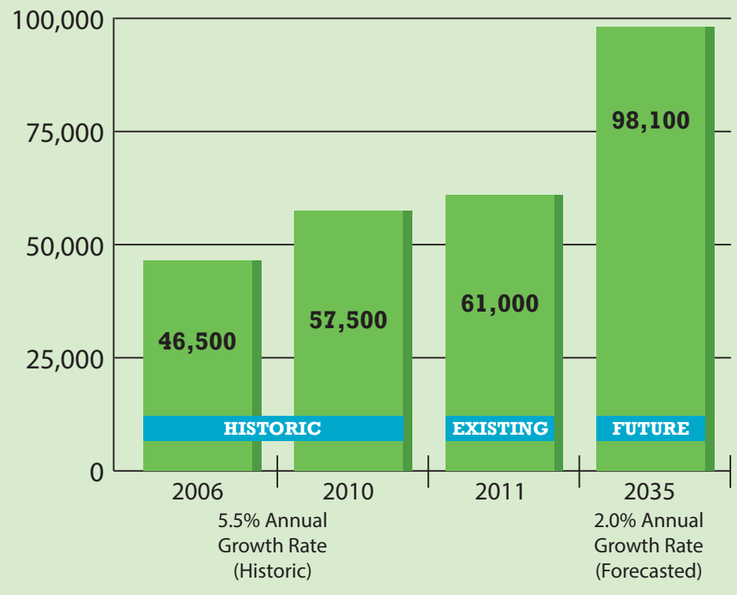
SELECT LINK 12

Hardy Toll Road, North of I-610



Daily Traffic Volume Trends

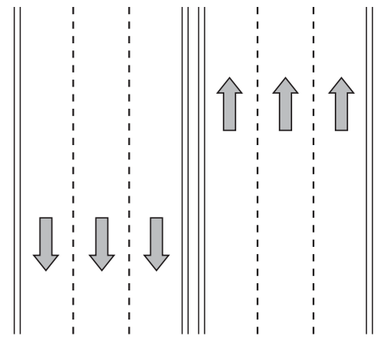
Average Daily Traffic Volumes



Existing and Future Traffic Characteristics

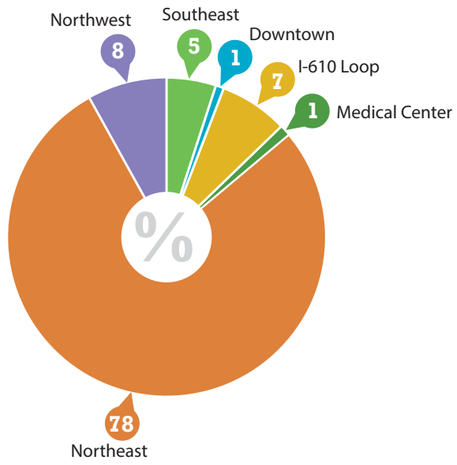
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	61,000	12%	70%	5,100	SB
PM		12%	60%	4,400	NB
2035 Future Traffic Characteristics					
AM	98,100	10%	60%	5,900	SB
PM		10%	60%	5,900	NB

Existing Lane Configuration



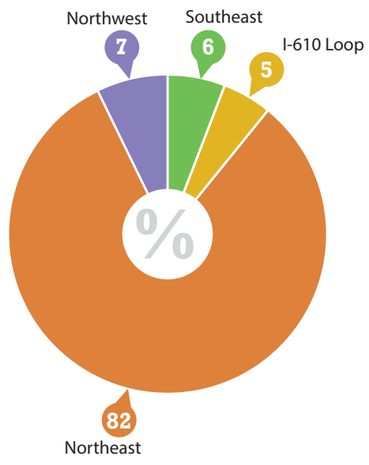
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



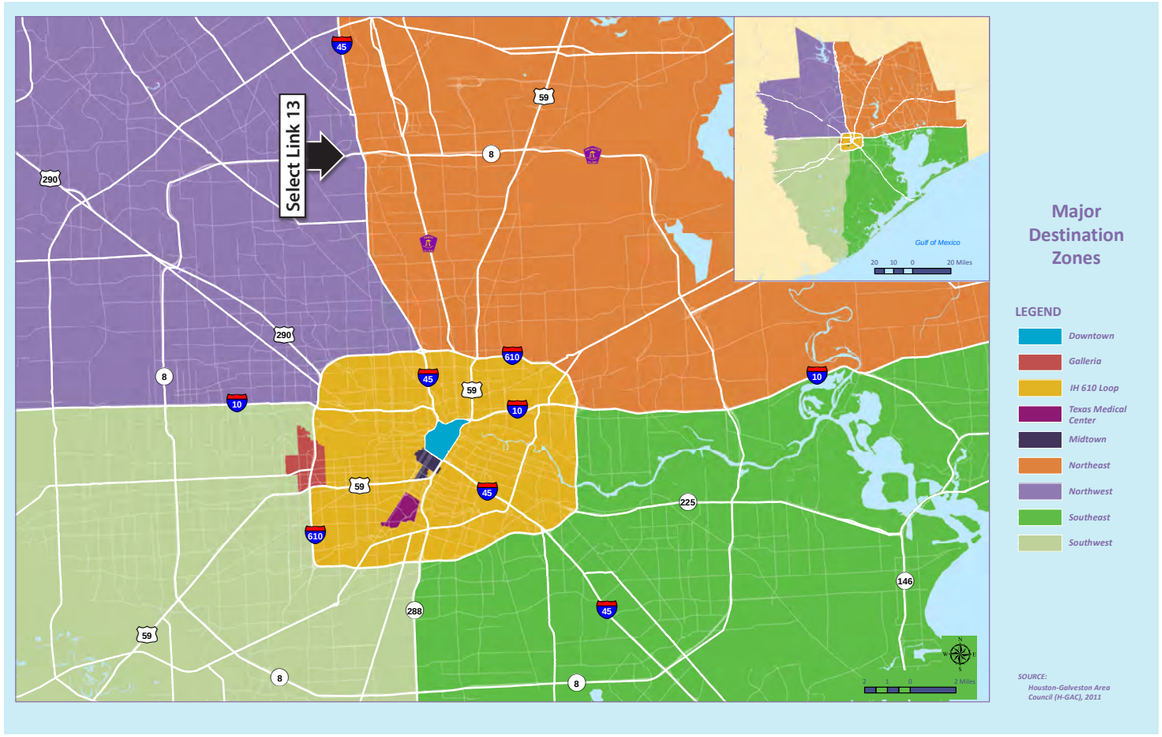
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



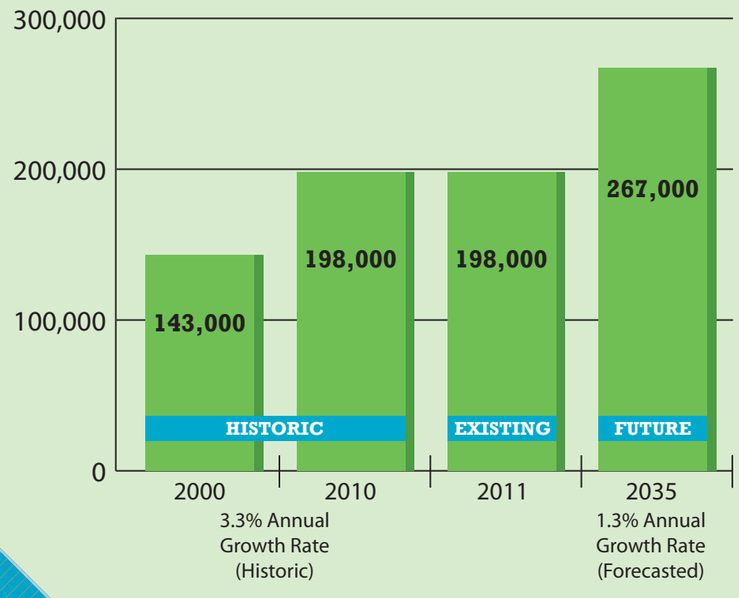
SELECT LINK 13

Sam Houston Tollway, West of I-45



Daily Traffic Volume Trends

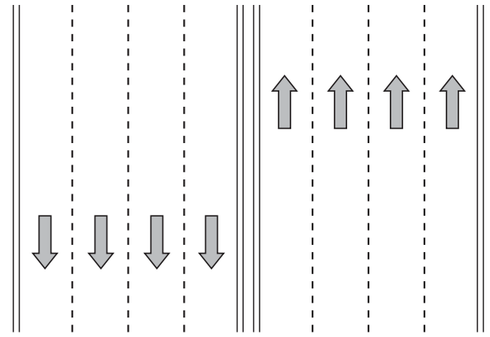
Average Daily Traffic Volumes



Existing and Future Traffic Characteristics

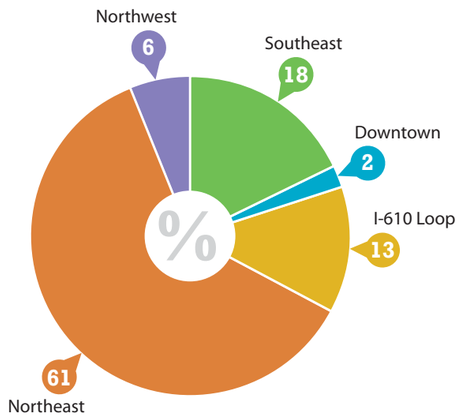
PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	198,000	8%	55%	8,200	EB
PM		6%	51%	6,500	EB
2035 Future Traffic Characteristics					
AM	267,000	8%	55%	11,000	EB
PM		6%	51%	8,700	EB

Existing Lane Configuration



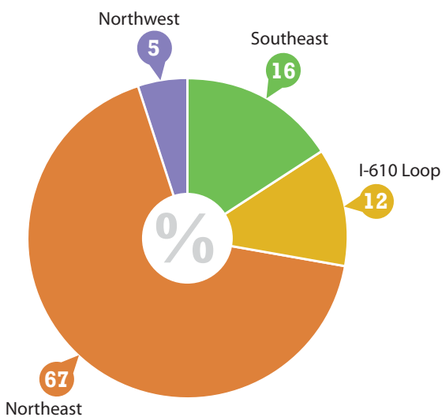
2011 Existing Traffic Distribution

(AM Peak, Inbound Direction)



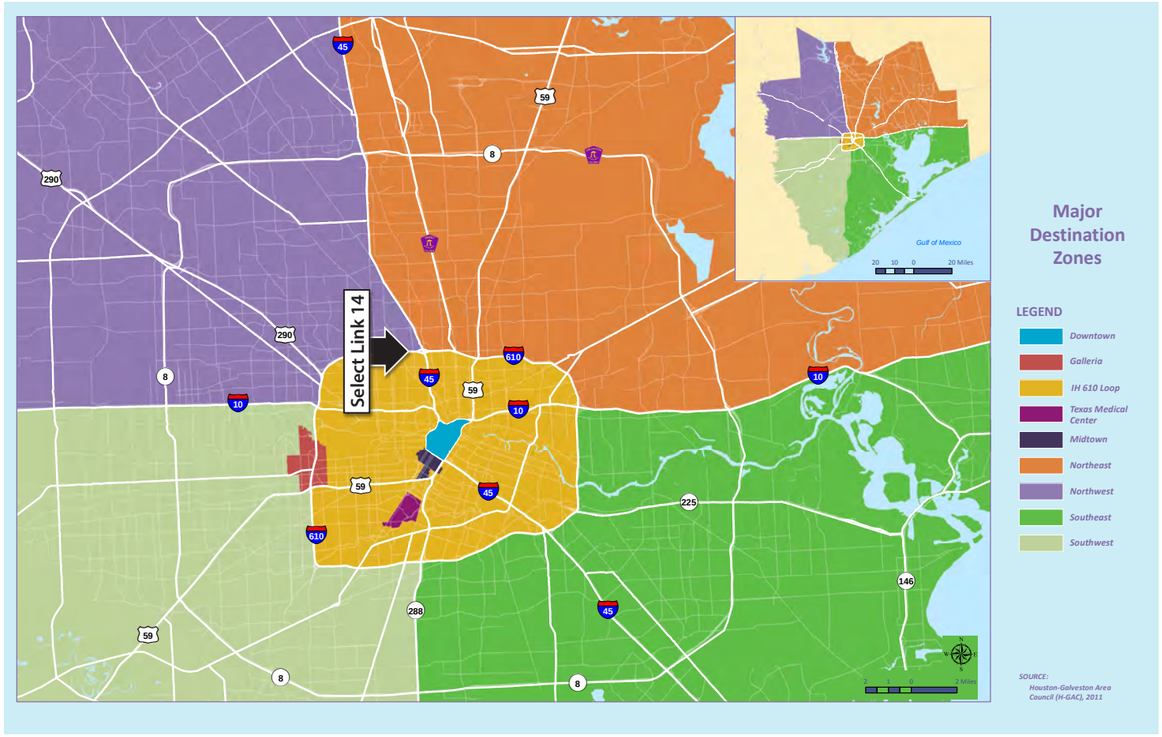
2035 Future Traffic Distribution

(AM Peak, Inbound Direction)



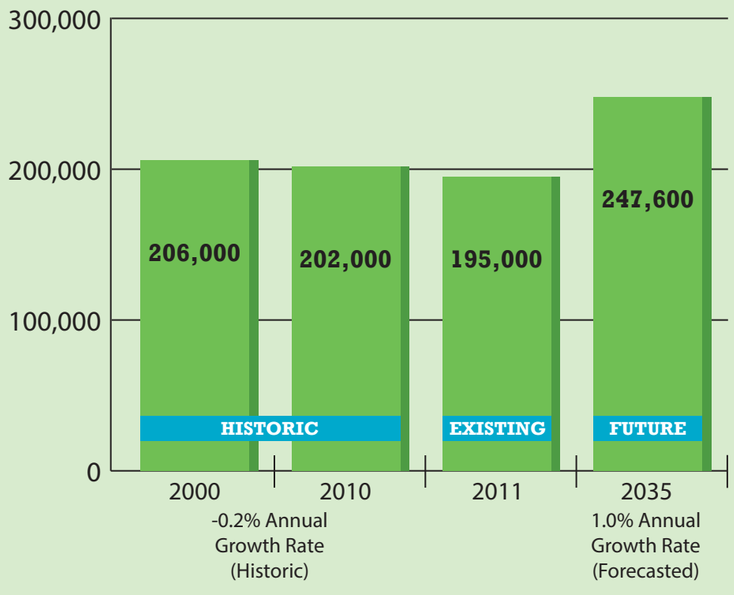
SELECT LINK 14

I-610, West of I-45



Daily Traffic Volume Trends

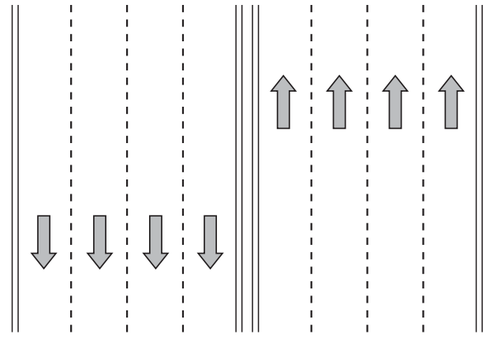
Average Daily Traffic Volumes

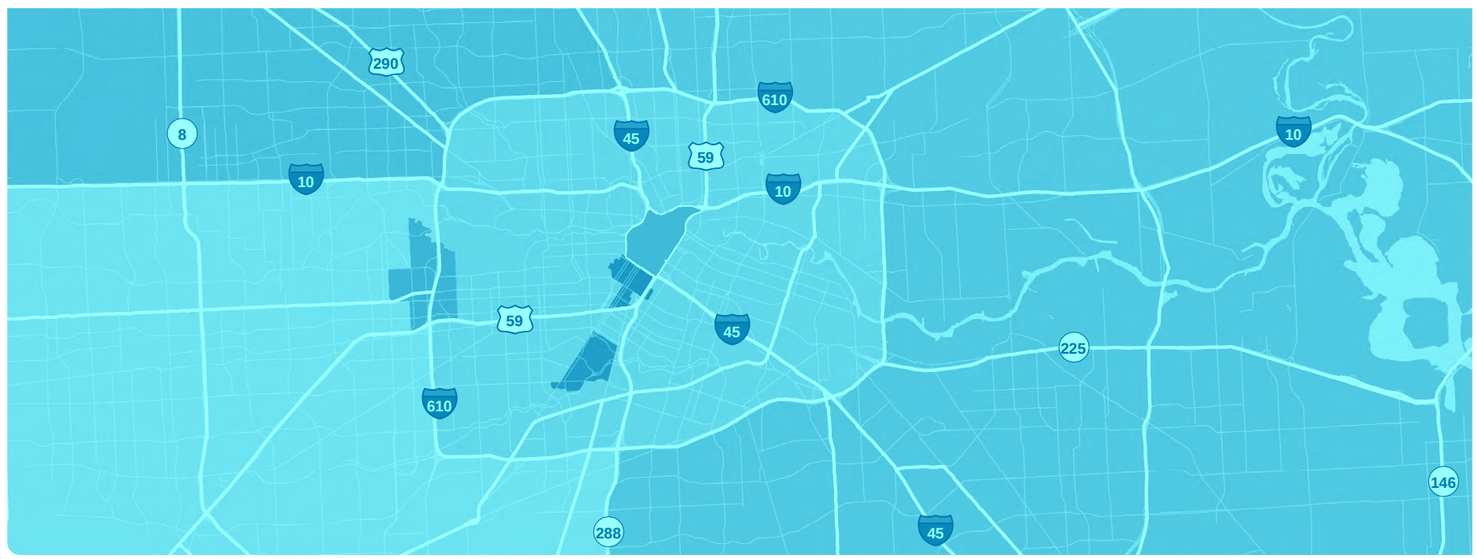


Existing and Future Traffic Characteristics

PEAK HOUR PERIOD	DAILY VOLUME	PEAK HOUR PERCENT	DIRECTIONAL DISTRIBUTION	PEAK HOUR VOLUME	PEAK DIRECTION OF TRAVEL
2011 Existing Traffic Characteristics					
AM	195,000	8%	53%	8,600	WB
PM		7%	51%	6,600	EB
2035 Future Traffic Characteristics					
AM	247,600	8%	53%	10,900	WB
PM		7%	51%	8,300	EB

Existing Lane Configuration

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