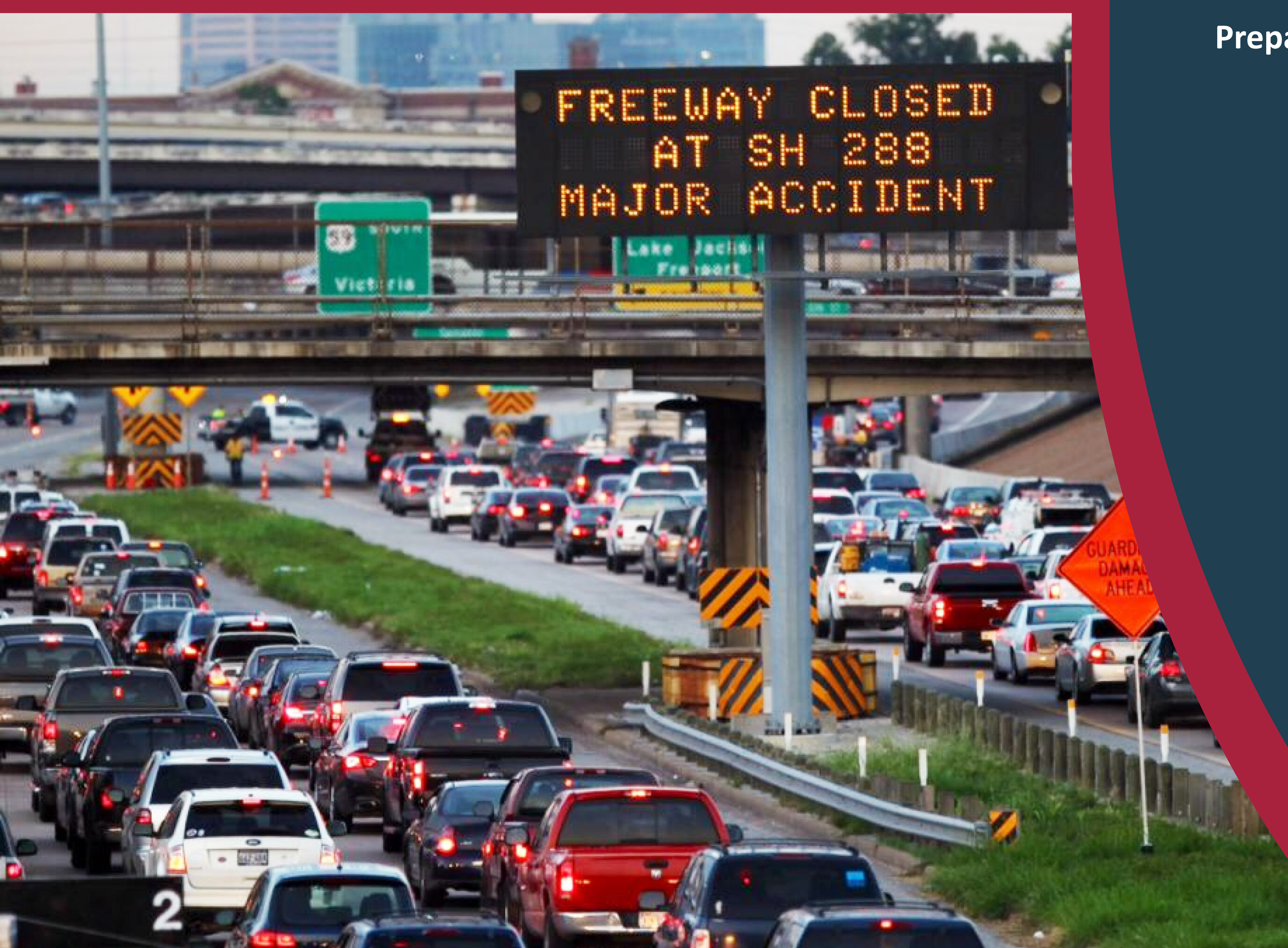

my SOUTHWEST FREEWAY

US 59 / IH-69 Rider 42 Corridor

Congestion Mitigation Study

Final Report
December 2015

Prepared for:

Houston-Galveston Area Council

In Partnership with:

Texas Department of Transportation, Houston District
City of Houston
Metropolitan Transit Authority of Harris County
Harris County Infrastructure Department

Prepared by:

ALLIANCE TRANSPORTATION GROUP

In Partnership with:

Brown & Gay Engineers, Inc.
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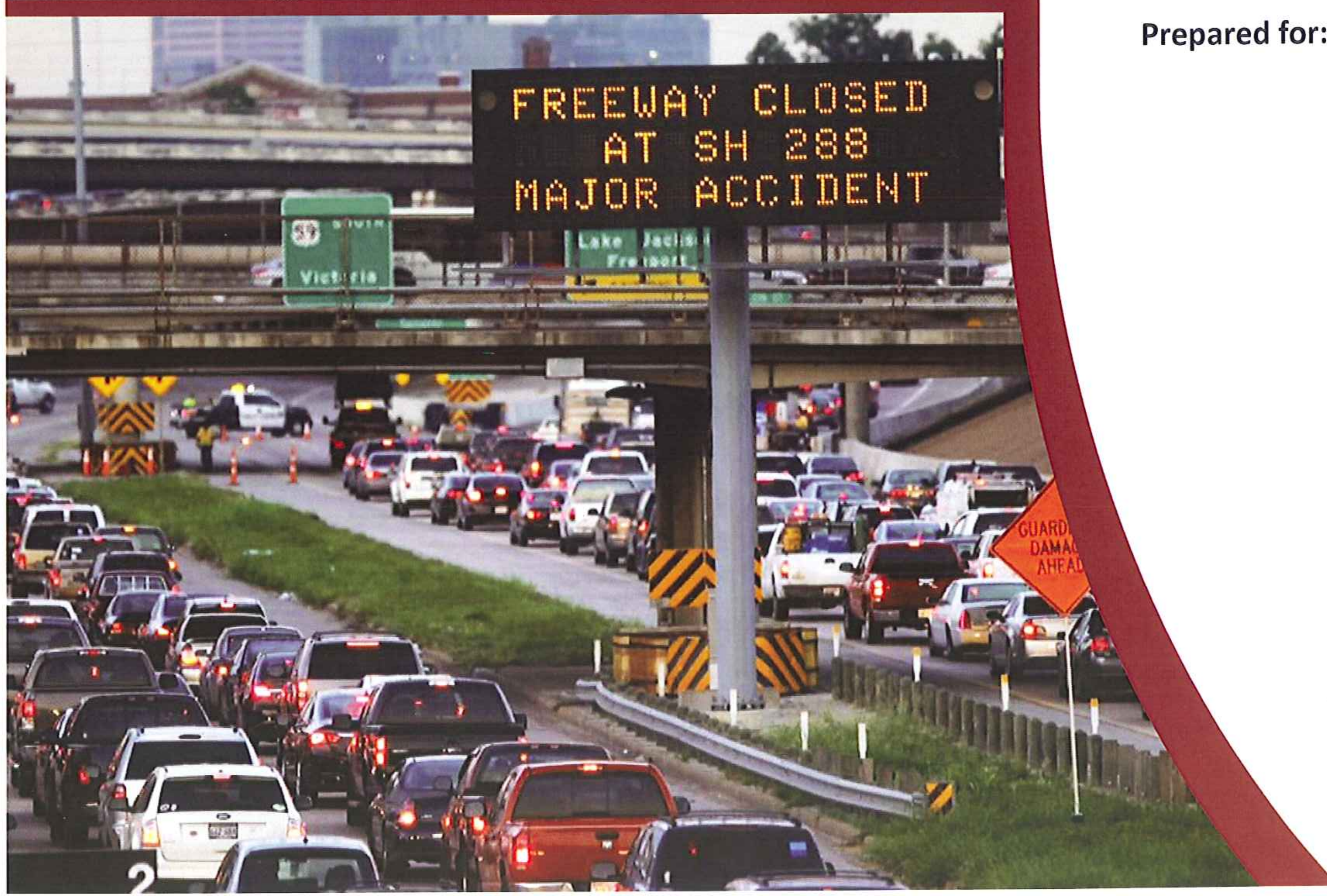

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Rider 42 Project Background

In May 2011, the 82nd Texas Legislature recognized the significant economic impact of congestion in major metropolitan areas and set aside $300 million of Proposition 12 bond proceeds to acquire right-of-way (ROW), conduct feasibility studies, project planning, and outsourced engineering work for the most congested roads in the four most congested regions in the state, Houston, Austin, Dallas-Fort Worth, and San Antonio. This allocation of funds is known as "Rider 42" after the number of the directive attached to the regular appropriations bill.

Rider 42 also requires that the Texas A&M Transportation Institute (TTI) serve as facilitator and coordinator to help the Texas Department of Transportation (TxDOT) and local agencies with two things:

- Advance those projects that can do the most to improve mobility and strengthen local economies in the most congested regions – Houston, Dallas-Fort Worth, Austin, and San Antonio – through new construction and better traffic and demand management.
- Identify publicly acceptable options to pay for the State's most urgent congestion-relief projects.

In November 2013, the Houston-Galveston Area Council (H-GAC), in partnership with TxDOT, approved the use of state bond funds to comply with Rider 42 and study the causes of congestion along the US 59/IH-69 corridor between the Sam Houston Tollway and IH-45 downtown, as well as identify alternatives for mitigating deficiencies. This document summarizes the results of the study.

MY SOUTHWEST FREEWAY

Table of Contents

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Chapter 1: Introduction

Purpose of Study
Project Study Area

Purpose of Study

Congestion plagues most U.S. cities, Houston is no exception. In fact, Houston's US 59/IH-69 (Southwest Freeway) corridor ranks high in congestion severity among cities across the U.S. According to TxDOT's 2014 list of 100 Congested Roadways in Texas, US 59 (between IH-610 and SH 288) is the third most congested corridor in the state.[1]

The purpose of this study is to provide low-cost strategies that relieve congestion, improve safety, and yield more reliable travel times on the Southwest Freeway.

1 Texas Department of Transportation-2014 Top 100 Congested Roadways in Texas, August 2014.

This study focuses on the section of US 59/IH-69 between the western limit of Beltway 8 and IH-45 in downtown Houston. The impact of congestion along the facility and the problems this study addresses are summarized by the following:

- The total annual cost of congestion within the study area is more than $215 million;
- The same trip can take 20 minutes during off-peak hours and over 40 minutes during peak hours;
- Due to unreliability of travel conditions along the corridor, travelers must plan for the same 20-minute trip to take between 2-3 hours if they want to make sure they reach their destination on time;
- The population in the Houston region is expected to grow by 1.2 million over the next decade;[2] and
- The Southwest Freeway cannot be expanded any further without acquiring significant ROW, which would be cost prohibitive.

Traffic congestion is often associated with economic prosperity. However, long-term sustained traffic congestion of the type seen on the US 59/IH-69 corridor in Houston could eventually dampen and even eliminate the region's future growth potential. Maintaining the economic viability of this corridor will require improvements of every type found in the transportation profession's tool box. A major focus of the study is to develop short and long-term strategies that are realistic and effective.

2 Houston-Galveston Area Council 2040 Regional Growth Forecast, 2014 Q2.

Project Study Area

US 59/IH-69 extends border-to-border from Mexico to Canada and is recognized as a major trade route (NAFTA Corridor Highway System) with local, regional, and national significance. The study area for this project extends between IH-45 in downtown Houston west to Beltway 8 (Sam Houston Tollway), a distance of approximately 14 miles. The limits of this project are illustrated in **Figure 1.1**. Locally, the facility is referred to as the Southwest Freeway.

Major interchanges along the corridor include the Sam Houston Tollway, Westpark Toll Road, IH-610, SH 288, and IH-45. Travel demand on the facility is significant due to the trips generated by several major employment centers adjacent to the corridor, including downtown Houston, the Houston Medical Center, Museum District, Rice University, Greenway Plaza, the Uptown Houston/Galleria area, and Sharpstown.

Figure 1.1: US 59/IH-69 Corridor Study Limits

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Chapter 2: Methodology

Establish Measures of Performance
Review of Previous Studies and Existing Data
Identification of Toolbox
Identification of Issues
Public Engagement and Participation Meeting #1
Refinement of Issues
Analysis of Existing Conditions
Development of Preferred Strategies
Public Engagement and Participation Meeting #2
Finalization of Recommendations

The methodology for the US 59/IH-69 Rider 42 Congestion Mitigation Study addresses congestion issues and develops context-sensitive, community-supported solutions. The methodology was developed in coordination with H-GAC and was approved by the Steering Committee prior to implementation. **Figure 2.1** shows the Project Summary of Engineering and Public Engagement items. The baseline year for traffic conditions is 2011. It was selected because the current H-GAC travel demand model uses a base year of 2011 and the availability of TranStar traffic data for the same year.

The study methodology followed these steps:

1. Establish Measures of Performance
2. Review of Previous Studies and Existing Data
3. Identification of Toolbox
4. Identification of Issues
5. Public Engagement and Participation Meeting 1
6. Refinement of Issues
7. Analysis of Existing Conditions
8. Development of Preferred Strategies
9. Public Engagement and Participation Meeting 2
10. Finalization of Strategies

Establish Performance Measures

Performance measures are used to evaluate the proposed strategies and allow the comparison of each strategy against the baseline. Several performance measures were considered for evaluating mitigation strategies, but three (3) key measures emerged as the most effective evaluation strategies.

Based on the study goals, corridor issues, and agency input, the key measures of performance used in evaluating mitigation strategies are: 1) reliability, 2) travel time, and 3) safety.

Reliability

Traffic congestion is traditionally presented in terms of averages, however, simple averages do not capture the true experience of the daily commuter. Trip travel times often vary greatly based on unexpected congestion, which are the instances that drivers remember. This study places particular emphasis on creating a more reliable freeway corridor.

Travel Time

Every driver pays attention to the overall travel time on a daily basis. One of the study goals is to improve travel time for all US 59/IH-69 users, whether it be for the daily commuter traveling from Fort Bend County to downtown, or a bus passenger traveling from the Galleria to Sugar Land.

Safety

The US 59/IH-69 freeway experiences a large number of accidents and includes one of the most dangerous interchanges in all of Texas, IH-610 West Loop at US 59/IH-69. In addition, the entrance and exit ramp spacing along the corridor, particularly inside IH-610, creates a stressful experience for local drivers. The Southwest Freeway was designed with standards that do not meet current desirable design practices. The goals of this study are to recommend solutions that will improve corridor safety.

Review of Previous Studies and Existing Data

Previous plans, studies, and data were gathered, reviewed, and compiled to create a picture of existing conditions for presentation to the public and to use as a baseline for further analysis. Additional research included, but was not limited to: an inventory of turning movement counts, traffic signal timings, crash data, lane geometry, general signage, closed circuit television (CCTV) locations, dynamic message sign (DMS) locations, ramp meter locations and timings, park and ride lot utilization, METRO bus routes and schedules, TranStar travel time data, Regional Incident Management System (RIMS) data, and bridge data.

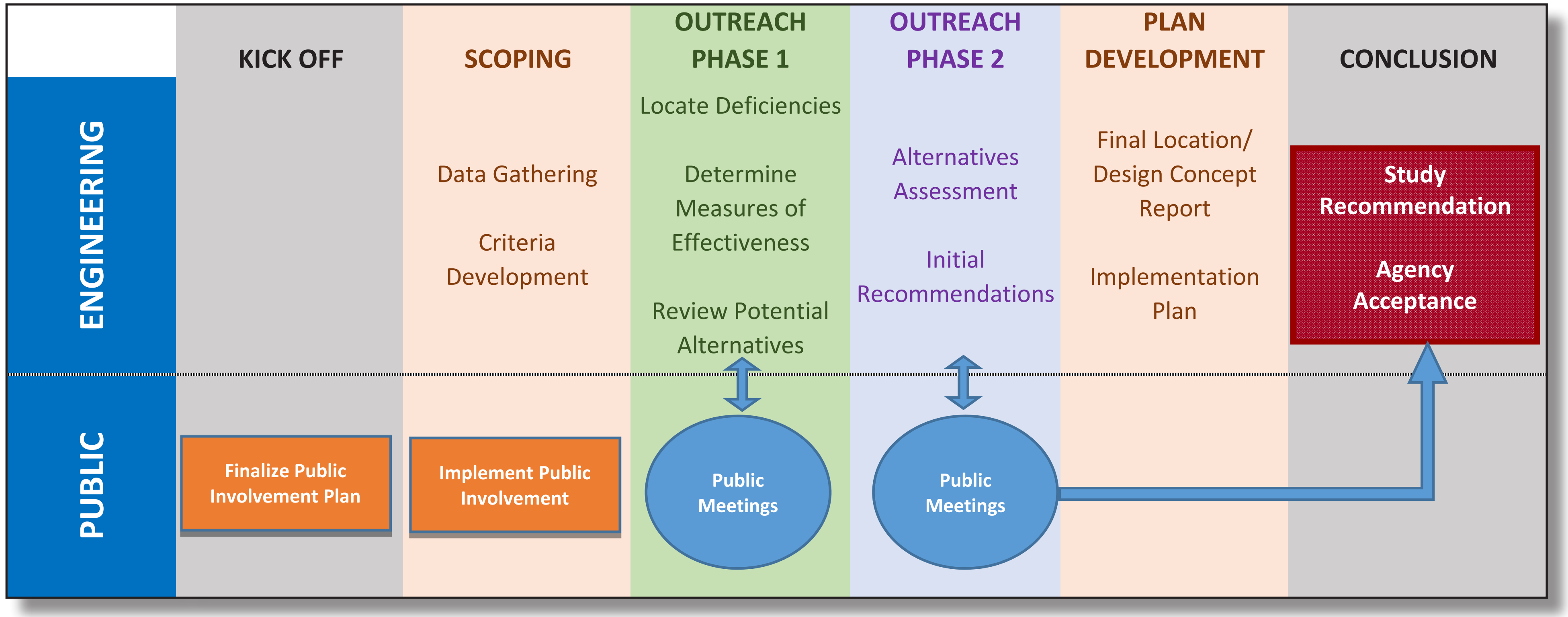
Identification of Toolbox

The US 59/IH-69 corridor is equipped with several ITS devices that are used by TranStar to manage traffic. There are 12 ramp meters, 5 DMS, 17 CCTV locations, multiple Bluetooth detectors, and fiber optic cable on US 59/IH-69 in the study area. This study considers existing devices as well as adding new devices and traffic management strategies that can be used to more efficiently operate the corridor during congestion.

Identification of Issues

A range of issues with the existing Southwest Freeway corridor were identified with existing data, agency input, study area investigation, and preliminary analysis. These issues were presented to the public for additional input. Southwest Freeway daily commuters provided over 80 comments related to traffic on the US 59/IH-69 corridor that affect them on a daily basis.

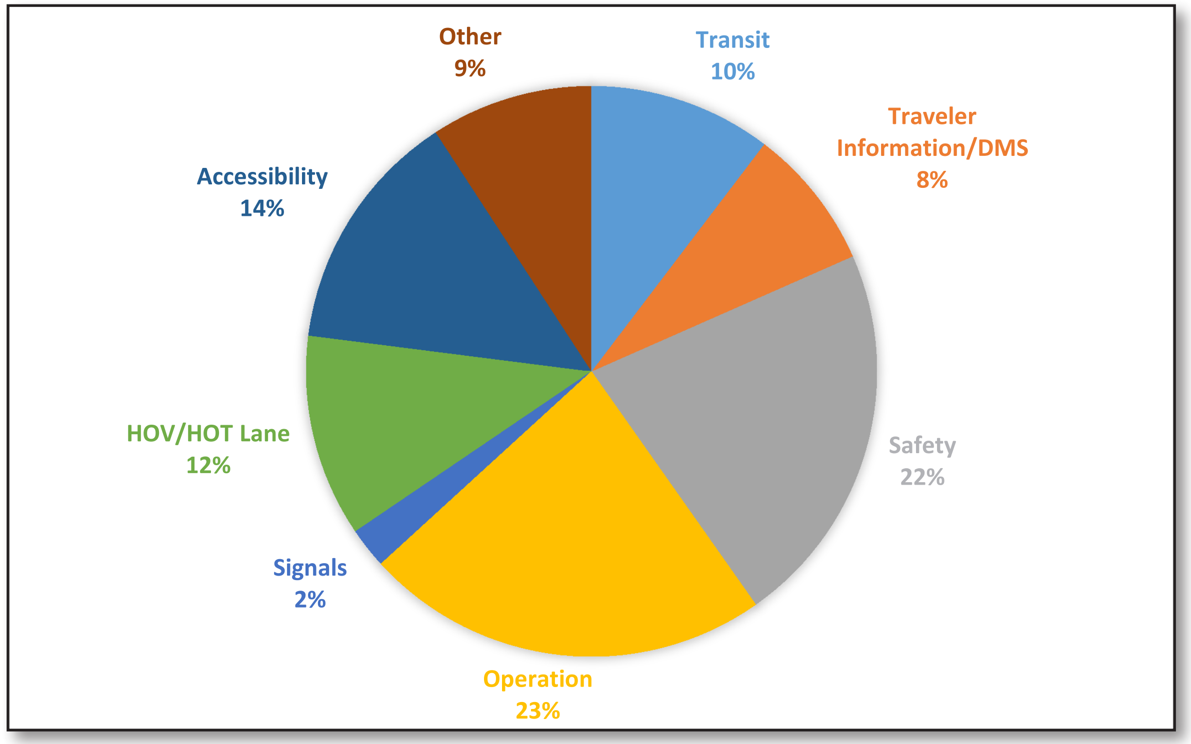
Figure 2.1: Project Summary - Engineering and Public Engagement



Public Engagement and Participation Meeting 1

Initial public engagement meetings were held on September 10, 2014 and were conducted in an open-house format which allowed participants to talk with the study team, view maps of the study area, and review information on the existing corridor (including speed profiles, crashes, and agency identified issues). Participants were encouraged to provide their input on corridor issues. **Figure 2.2** shows a summary of the major concerns expressed by the public during the meeting. Potential strategies were presented to help the public understand potential solutions.

Figure 2.2: Public Meeting 1 Comment Topic Summary



Refinement of Issues

Based on specific comments from the public, stakeholders, and the Steering Committee, the list of proposed strategies was refined for the corridor. Travel option strategies were eliminated from the potential strategy list, as a comprehensive set of travel option solutions was already implemented within the corridor. Various issues raised by the public were added to the consideration of evaluation strategies.

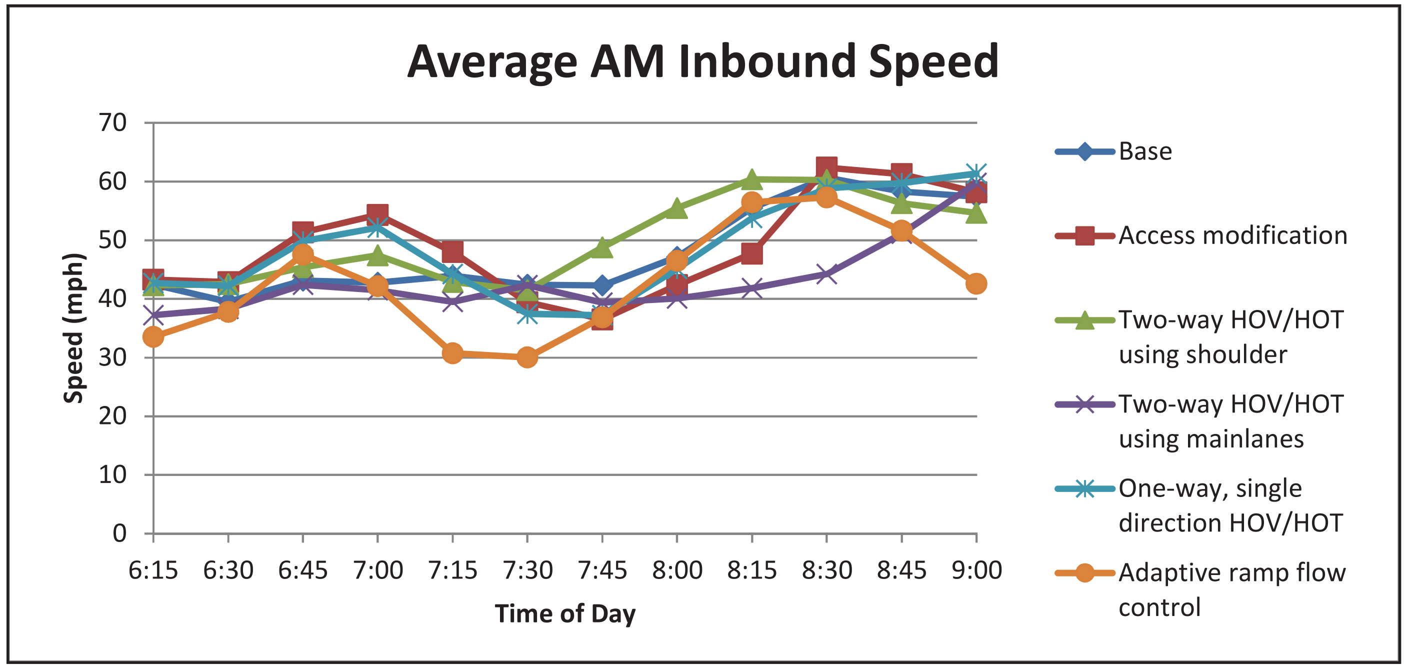
Analysis of Existing Conditions

Dynamic Traffic Assignment Modeling

DynusT is a dynamic traffic simulation and assignment software designed to address emerging issues in transportation planning and traffic operations. With DynusT, an estimate of system-wide traffic flow dynamic patterns can be evaluated. This model is able to replicate vehicular traffic flows resulting from individual drivers seeking the best routes to their destinations as traffic responds to changing network demand/supply conditions. The model was calibrated based on available existing data.

This tool was used initially to assess the impacts of preferred traffic management strategies. The results of this initial assessment were then evaluated by the microsimulation tool, Vissim, to examine the strategies at a finer level of detail. **Figure 2.3** shows a sample of the results from DynusT model runs that are shown in **Appendix C**.

Figure 2.3: Sample of DynusT Output Data



Development of Preferred Strategies

Modeling

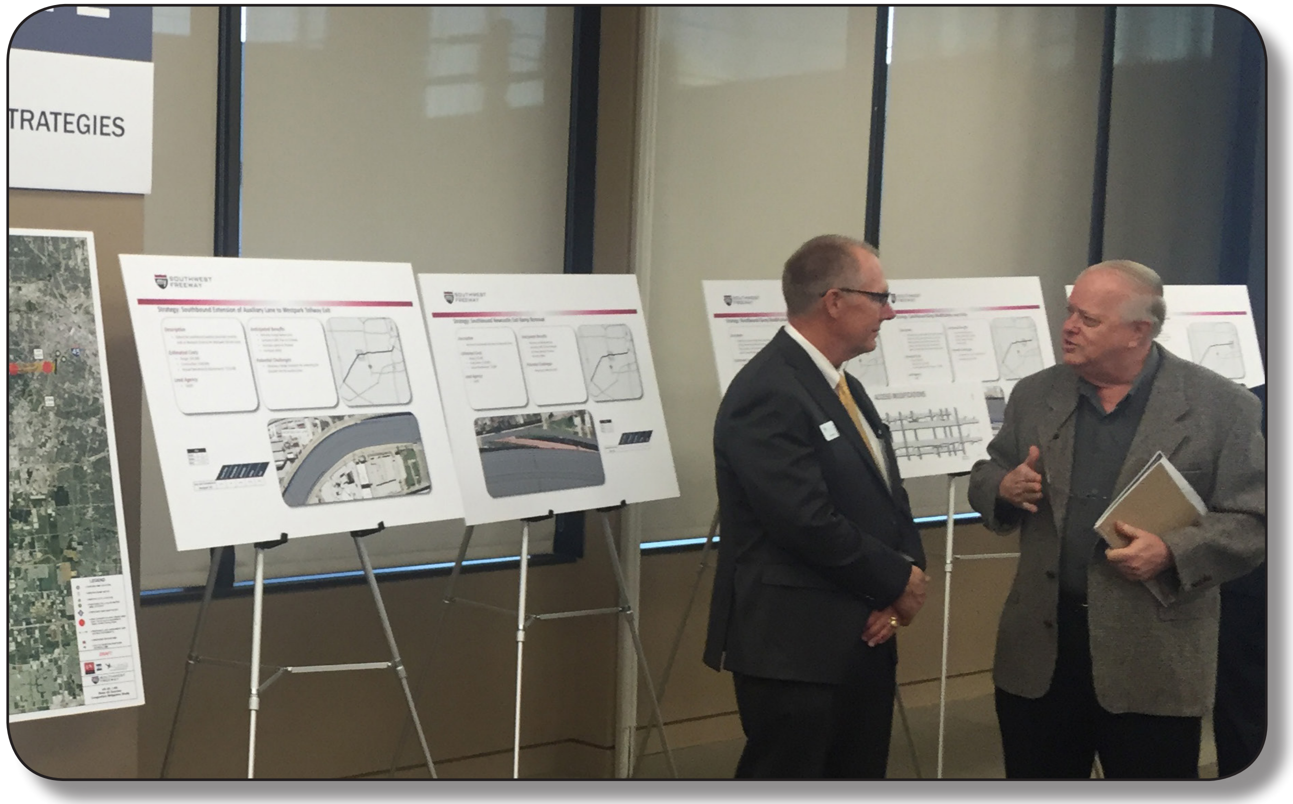
DynusT and Vissim, introduced on the previous page, were used to compare strategy implementation with the existing condition. The strategies that showed improvement in performance measures were retained, while those that did not show improvement in corridor performance were removed from consideration.

Case Studies

Previous studies from throughout the country were used to estimate the potential impacts of the proposed congestion mitigation strategies. These studies assessed real results after implementation and indicate the level of improvement that could be expected from a particular strategy. These case studies include the I-10 toll lanes in Houston, I-5 Active Traffic Managment in Washington, and I-80 Active Traffic Management in California, in additon to others throughout the U.S.

Benefit/Cost Analysis

A preliminary set of estimated construction, design, operations and maintenance costs associated with each alternative were created. The overall benefit in terms of delay savings, crash reduction, and managed lane use was estimated with DynusT and Vissim results. The benefits and costs were evaluated to determine priority of strategy implementation.



Public Engagement and Participation Meeting 2

The final public engagement meeting was held on November 12th, 2015. The meeting was conducted in an open-house format which allowed participants to talk with the study team, as well as view the recommended strategies. Recommended strategies were presented using fact sheets to help the public understand the types of solutions having the most impact.

A virtual layout of the public meeting was available on the project website for those who were unable to attend the meeting. All materials presented during the actual meeting were available online (www.mysouthwestfreeway.com).

Finalization of Recommendations

Using a combination of modeling, public engagement meetings, case studies, and benefit/cost analyses, a final set of alternatives were selected and a prioritized list was developed.

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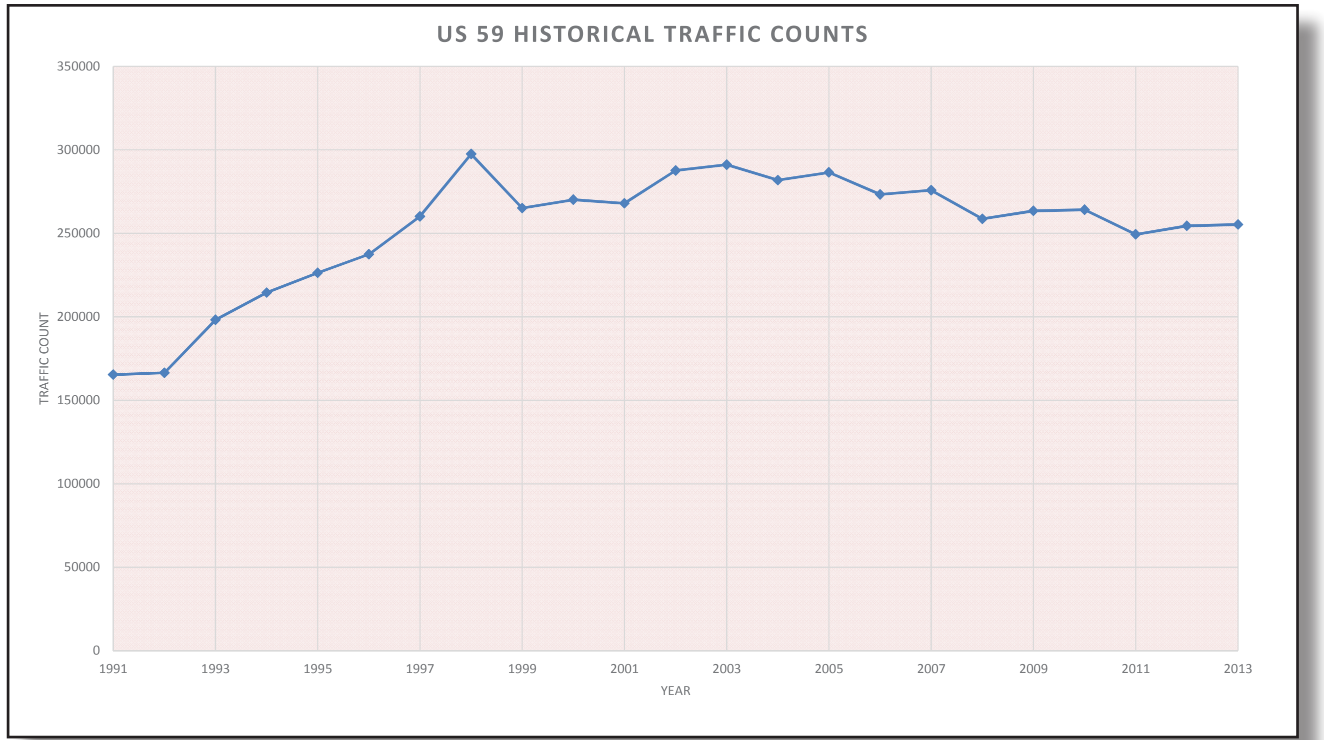
Chapter 3: Existing Conditions

Regional Connectivity
Planned Projects
Traffic Data
Crash Data
Roadway Characteristics
Traffic Operations
Transit

The base year of study is 2011. The corridor is fully developed and no substantive growth in traffic volumes is expected, assuming no changes are made to the network. Traffic counts from 1991 to 2013 confirmed that average annual daily traffic has leveled off over the past ten years. **Figure 3.1** shows the historical traffic counts along the US 59/IH-69 corridor.

Figure 3.1: US 59/IH-69 Historical Daily Traffic Counts

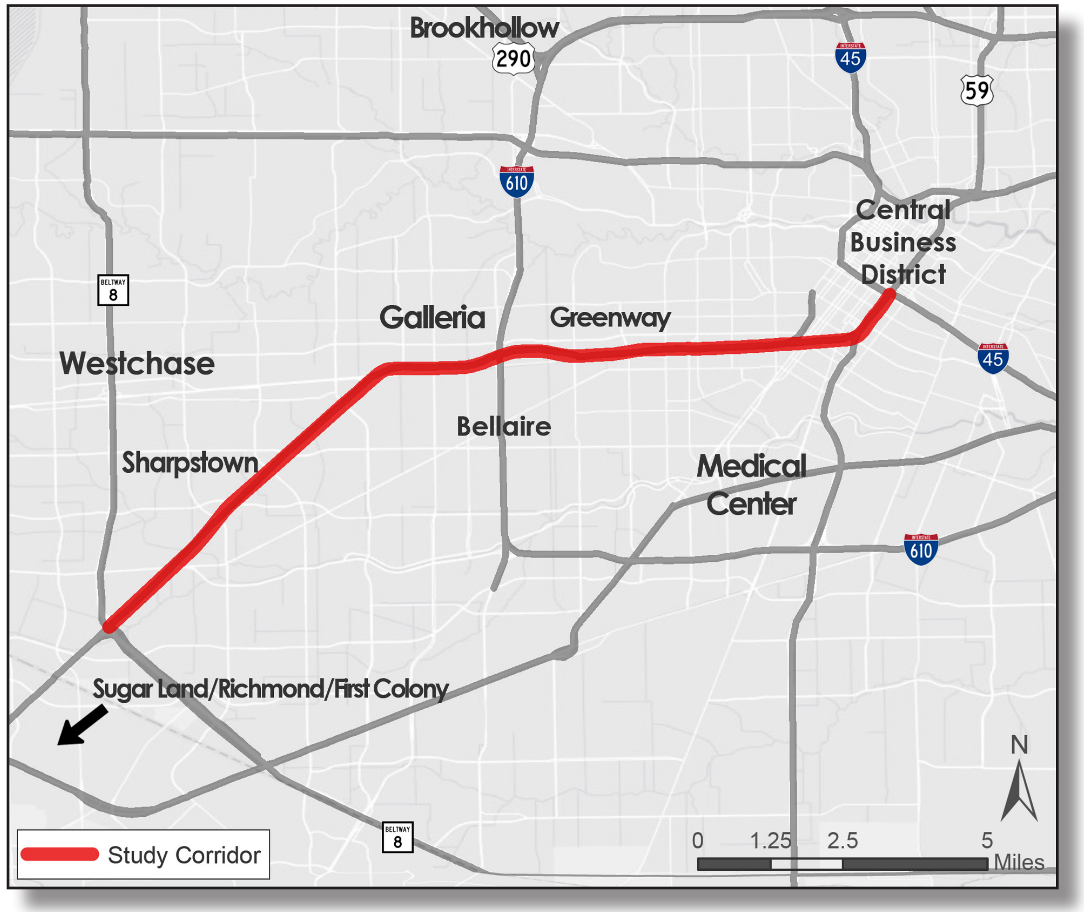


Various improvements are being planned along the corridor including significant changes to the IH-610 interchange and Chimney Rock exit. These were included in the base model for both DynusT and Vissim and are discussed in the, "Planned Projects" section of this report on the next page.

Regional Connectivity

Southwest Freeway is the main artery from the southwest Houston-Galveston Area to downtown Houston. Connectivity is vital to the major employment centers/trip generators adjacent to the corridor, including downtown Houston, the Houston Medical Center, Museum District, Rice University, Greenway Plaza, the Uptown Houston/Galleria area, and Sharpstown. **Figure 3.2** shows the extent of activity centers adjacent to the US 59/IH-69 corridor.

Figure 3.2: Major Activity Centers along US 59/IH-69 Corridor



Travelers going to major activity areas rely on the corridor for their daily commute. The economic success of these areas is dependant on reliable travel in the corridor. Any recurring or non-recurring congestion can have a substantial impact on the area economy.

When non-recurring congestion does occur, the availablity of alternate routes to these employment centers becomes vital to network efficiency. Alternative routes to the Southwest Freeway include: US 90-A, Bissonett Street, Bellaire Boulevard, Westpark Drive/Westpark Tollway, and Richmond Avenue.

Planned Projects

TxDOT has identified nine (9) near-term (planned letting by 2018) and long-term programmed projects within the corridor in the Transportation Improvement Plan (TIP).

Near-term programmed projects (funded by federal, state, and local dollars):

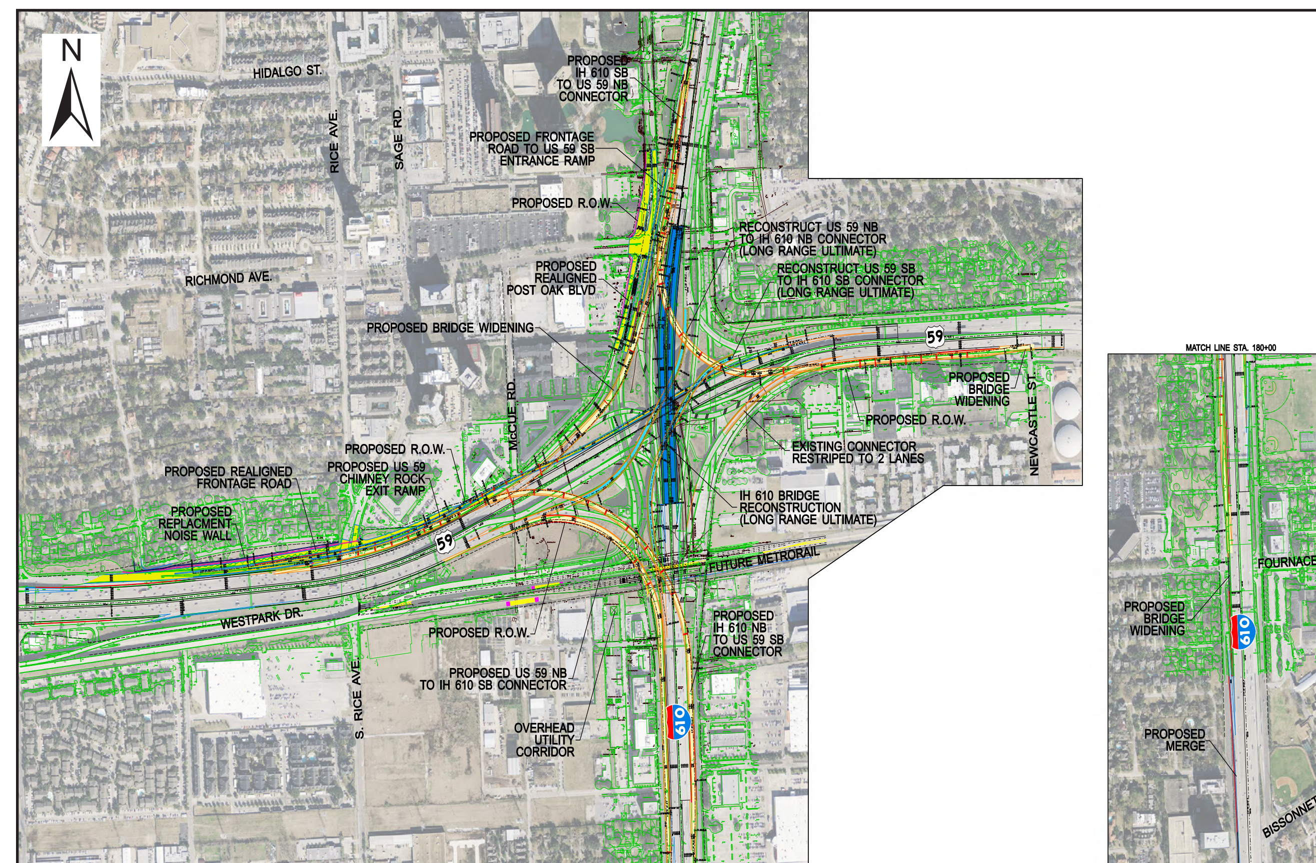
- IH-610 and US 59/IH-69 interchange reconstruction, ROW, and utilities (estimated letting in FY 2017). It includes proposed direct connectors and IH-610 mainlane bridge construction. Illustrated in **Figure 3.3**.
- Uptown/METRO dedicated bus lanes on Post Oak Boulevard (estimated letting in FY 2017). The project is expected to be part of the IH-610 and US 59/I-69 interchange project and include a proposed T-Ramp to the Bellaire/Uptown Transit Center.

Long-term planned projects:

- North Houston Highway Improvement Project (NHHIP) - IH-45S interchange reconfiguration, including the construction of entrance and exit ramps, as well as the replacement of the existing US 59/IH-69 northbound and southbound direct connectors (estimated letting after 2020, unfunded). The added capacity near Spur 527, as part of the NHHIP project, is illustrated in **Figure 3.4**.
- Richmond Avenue at IH-610 widening to 8 lanes with utility improvements sponsored by Uptown Houston (estimated completed in 2022, not funded).

These projects were included in the analysis models used to evaluate, assess, and compare various mitigation strategies.

Figure 3.3: US 59 at IH-610 Proposed Improvements

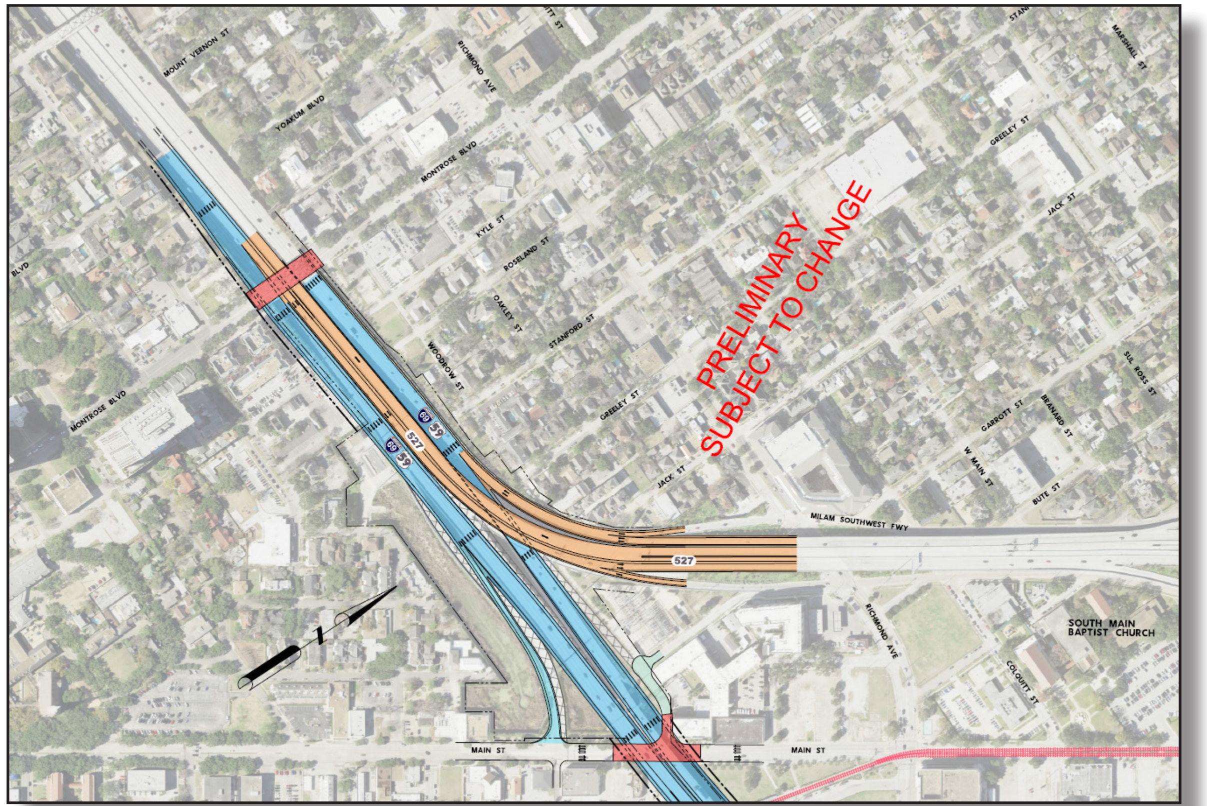


In addition to TxDOT projects, various agencies in the Houston Area have planned projects that will impact the Southwest corridor, including:

- City of Houston Intelligent Tranportation System (ITS) upgrades (estimated completion 2016). The City of Houston is implementing an ITS system that will add CCTV, DMS, and signal optimization to many intersections in the downtown area. Various intersections along the US 59/IH-69 corridor will be equipped with the upgraded technology.
- METRO Transit System Reimagining (implemented August 2015). METRO altered the bus routes through the Houston area to better serve the community.

A Quick Clearance program is also under development by H-GAC that will decrease incident response and clearance time for collisions and stalled vehicles. In May 2015, H-GAC requested $8 million in federal funds including $1.6 million in Transporation Development Credits (TDC) for initial funding.

Figure 3.4: IH-45 Project - Proposed Improvements along US 59 at Spur 527



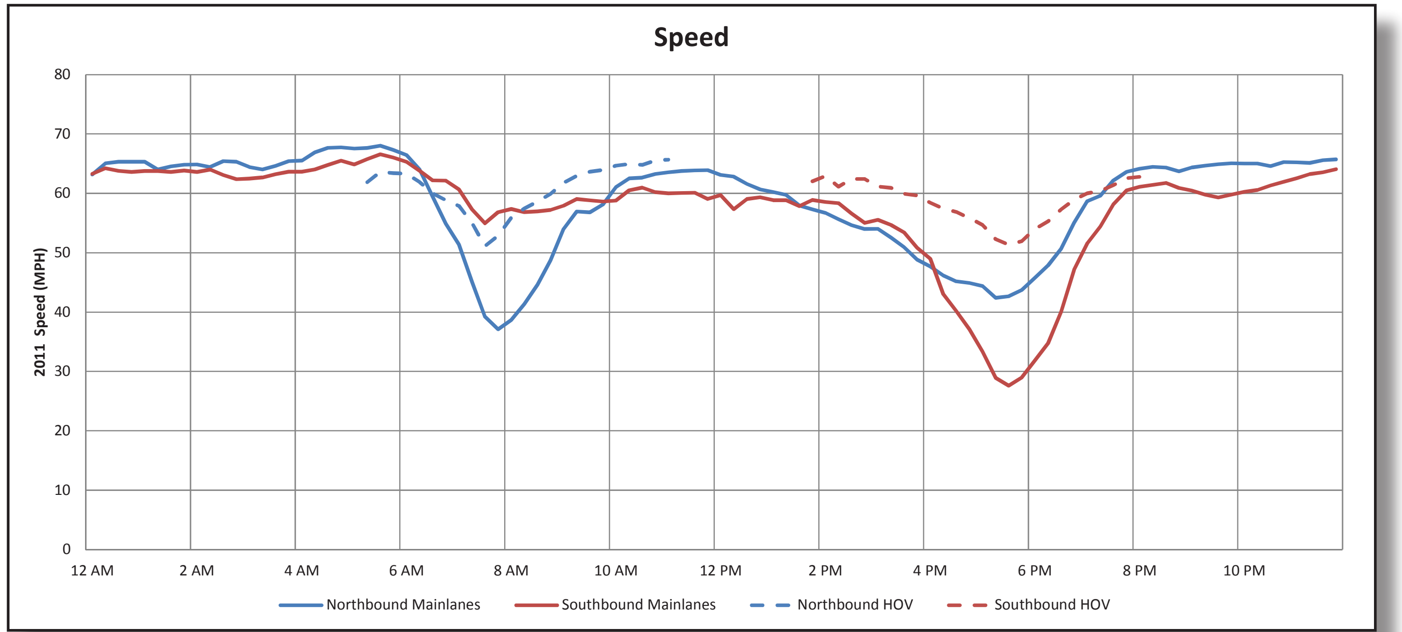
Traffic Data

Roadway characteristics and historical traffic data are used to identify problem areas along the corridor. For example, the magnitude and location of crash data may suggest a specific problem related to traffic entering and exiting the mainlanes. In analyzing this information, we can determine the cause of the problem and evaluate potential solutions, including ramp closures or ramp modifications.

Travel Time/Speeds

Travel times for the different segments along the US 59/IH-69 corridor are based on speed charts from the Houston TranStar website (www.houstontranstar.org) for the period between 2009 and 2013. Most speeds decreased, which indicates congestion is increasing as well. However, certain segments along the corridor have experienced a slight increase in speeds. Speed graphs were generated using 2011 Houston TranStar traffic data. **Figure 3.5** shows the average speed changes occuring during the day.

Figure 3.5: Corridor Average Speed



Reliability

Planning Time Index (PTI) is a reliability measure that compares the 95th percentile peak period travel time to the free-flow travel.[1] For example, a PTI value of 9.54 (US 59/IH-69 from IH-610 to SH 288) indicates that for a typical 20 minute trip in light traffic, more than 3 hours should be planned in order to arrive on time during a worst-case commute. The most significant impact on PTI is non-recurring congestion (incidents) that do not occur on a regular time-of-day basis. A summary of PTI along the corridor is reflected in **Table 3.1**.

Table 3.1: US 59/IH-69 Corridor Planning Time Index

Segment	Planning Time Index
Beltway 8 to IH-610	6.69
IH-610 to SH 288	9.54
SH 288 to IH-10	10.73

The ability to identify, verify, dispatch, and clear incidents quickly is important to the reliability of the corridor. Over 1,200 incidents were reported annually along the corridor between 2010 and 2013. The average time to clear an incident is about 30 minutes. **Figures 3.6 and 3.7** show a sample of speed variation on different days of the week, occuring downtown and west of IH-610.[2] **Figure 3.6** illustrates that in the downtown area, there is variation throughout the day with reduction of speed in both of the peak hours. **Figure 3.7** illustrates how traffic west of the IH-610 interchange is impacted southbound (outbound) in the PM peak, which is indicative of commuter traffic, as well as the variation that occurs on different days of the week.

Figure 3.6: Sample Daily Variation - Downtown Area

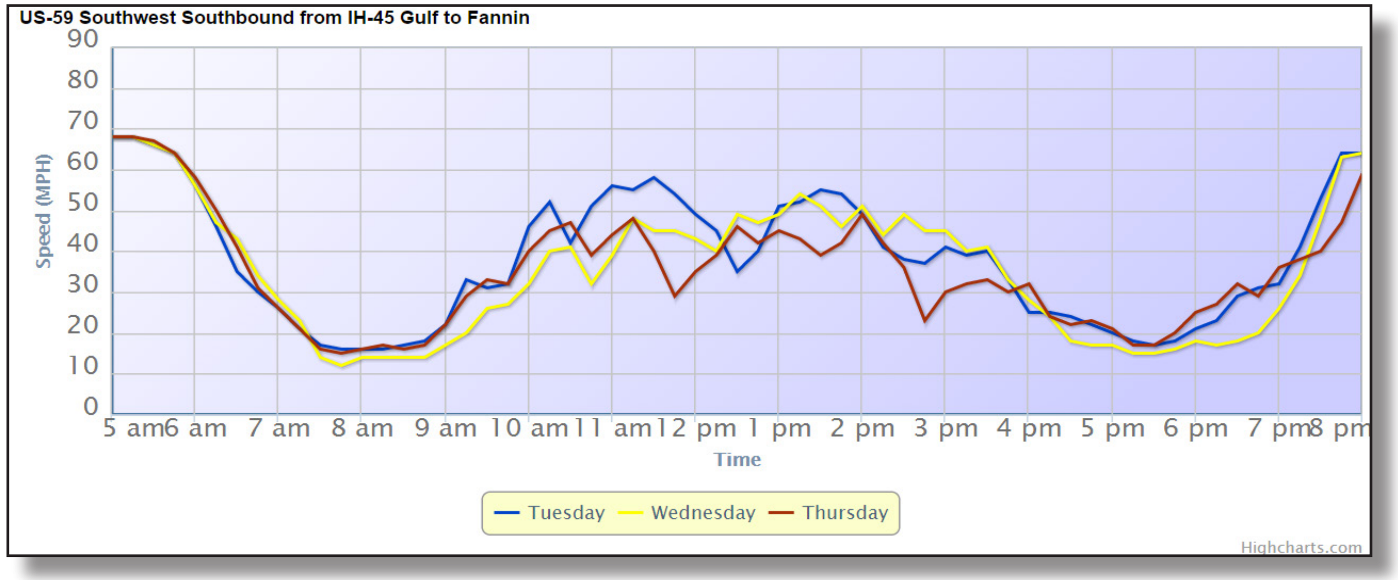
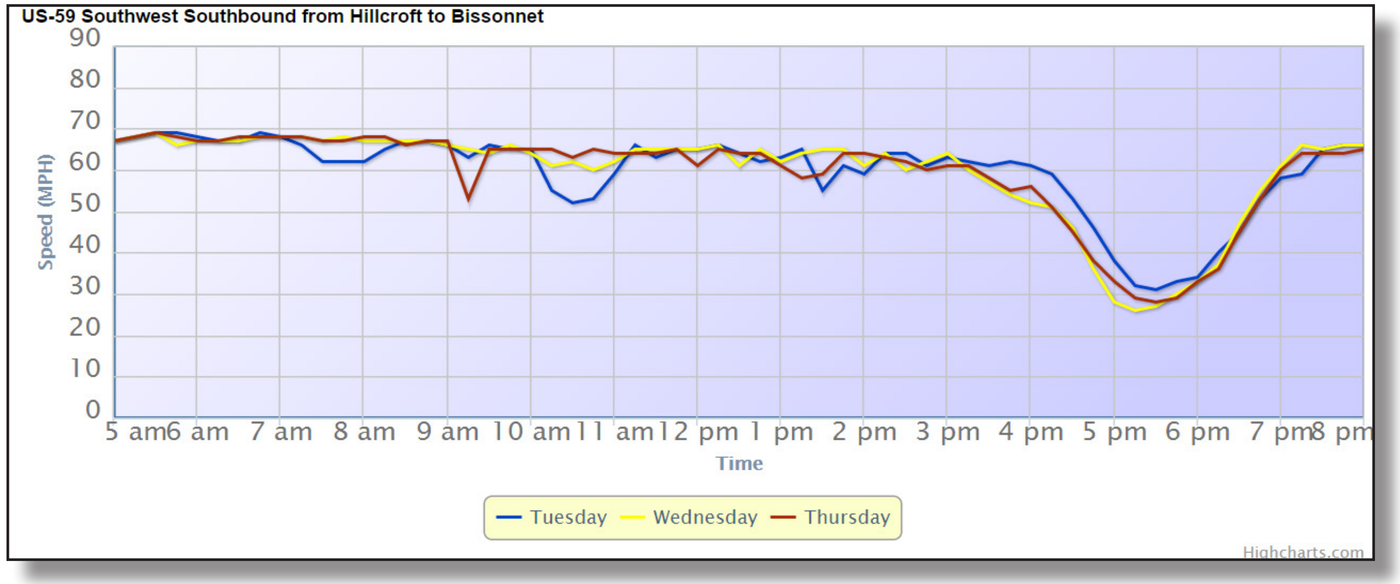


Figure 3.7: Sample Daily Variation - West of IH-610



1 TxDOT 2014 Most Congested Roadways in Texas

2 Houston TranStar 2014 http://www.houstontranstar.org/about_transtar/

Crash Data

The Regional Incident Managment System (RIMS) data for 2010 to 2013 was obtained, detailing the number of incidents, average clearance time, type of incident, incident conditions, and top incident locations.[1] Also available is an incident clearance report card for 2014 and data statistics from the quick incident clearance program. **Figure 3.8** shows the high incident locations along the corridor. The location with the most incidents is IH-610, which is also one of nine locations with more than 200 incidents. **Figure 3.9** shows the highest major and fatal collision locations. The IH-610 interchange was the location of the most major collisions and also has the highest rate for fatal collisions in the corridor.

Figure 3.8: High Incident Locations

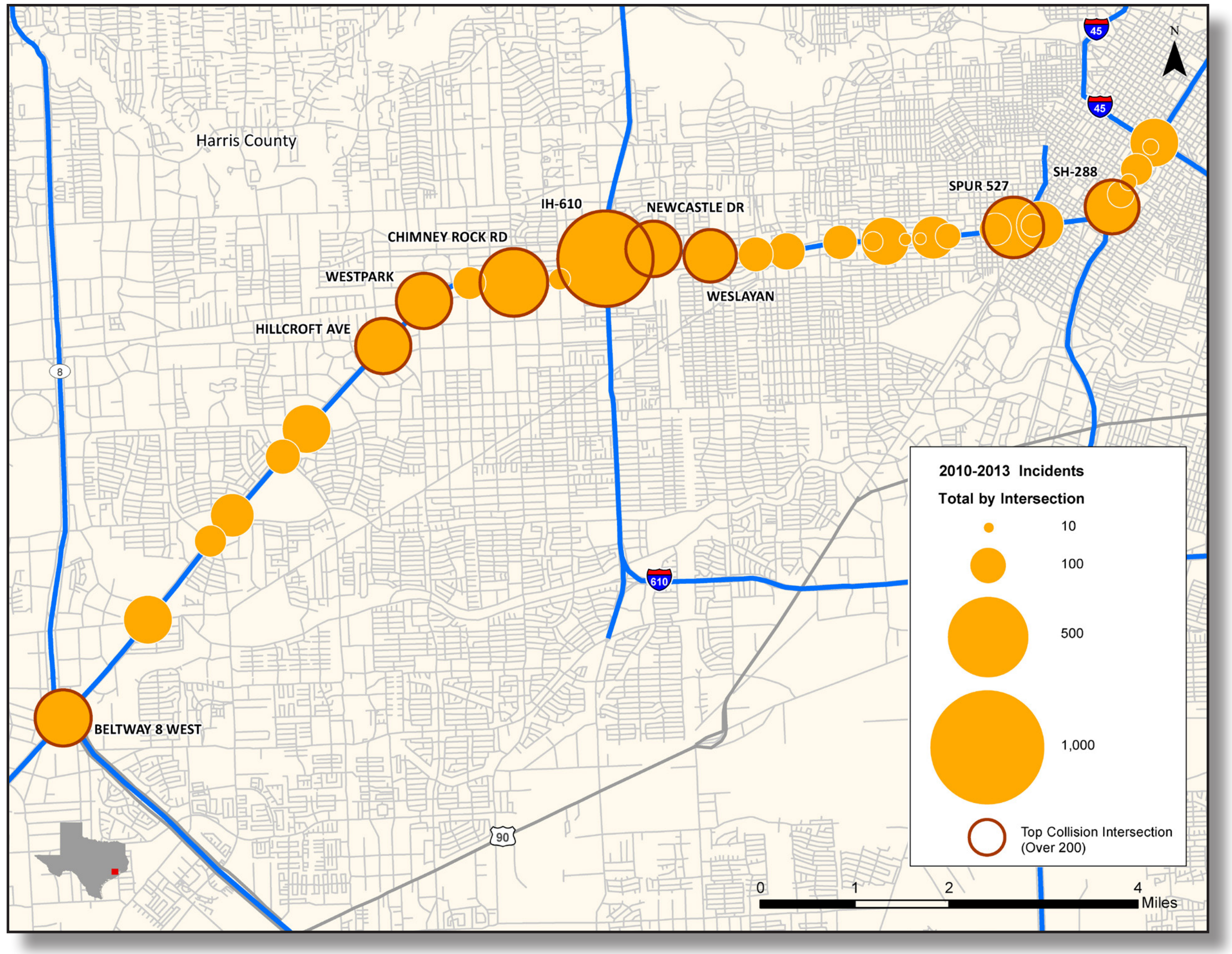
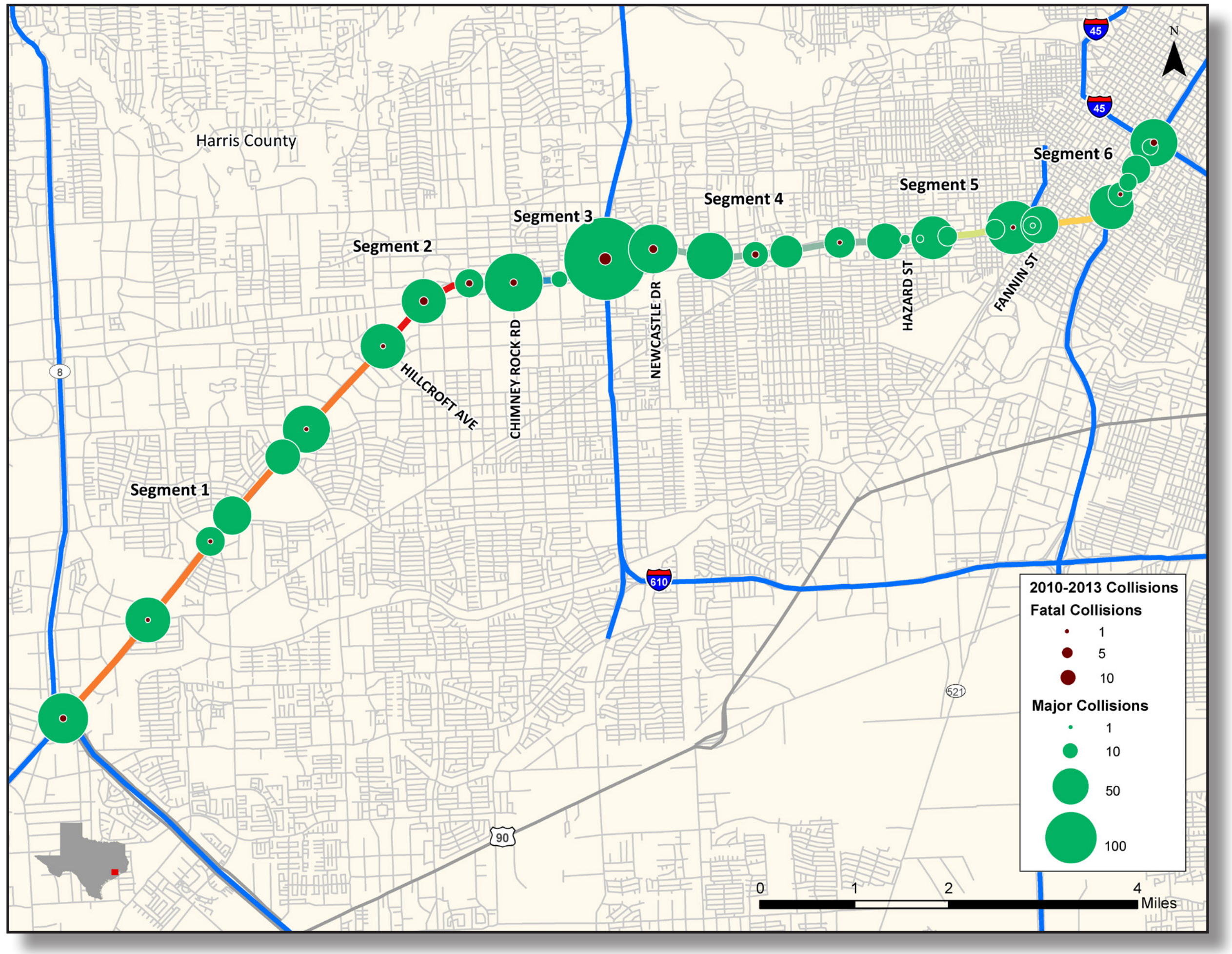


Figure 3.9: Major and Fatal Collisions



1 Houston TranStar "Rimstats"-2014 http://www.houstontranstar.org/about_transtar/

Crashes have been further classified by type of crash and by type of injury associated with the crash.[1] **Figure 3.10** shows the crashes by type, with 49% being rear-end and 24% being sideswipe, which can both be attributed to traffic congestion. **Figure 3.11** shows the injury by type, with 73% of crashes having no one injured.

Figure 3.10: Crashes by Type

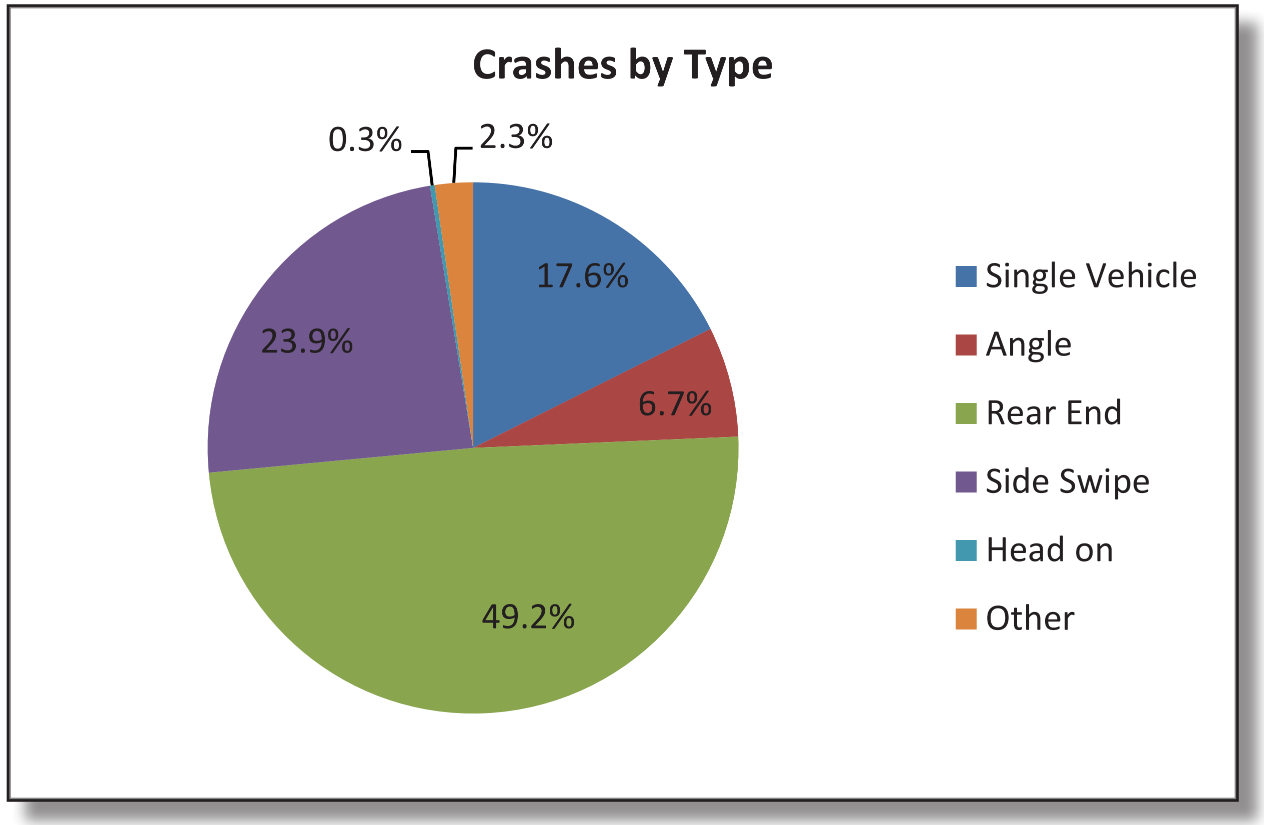
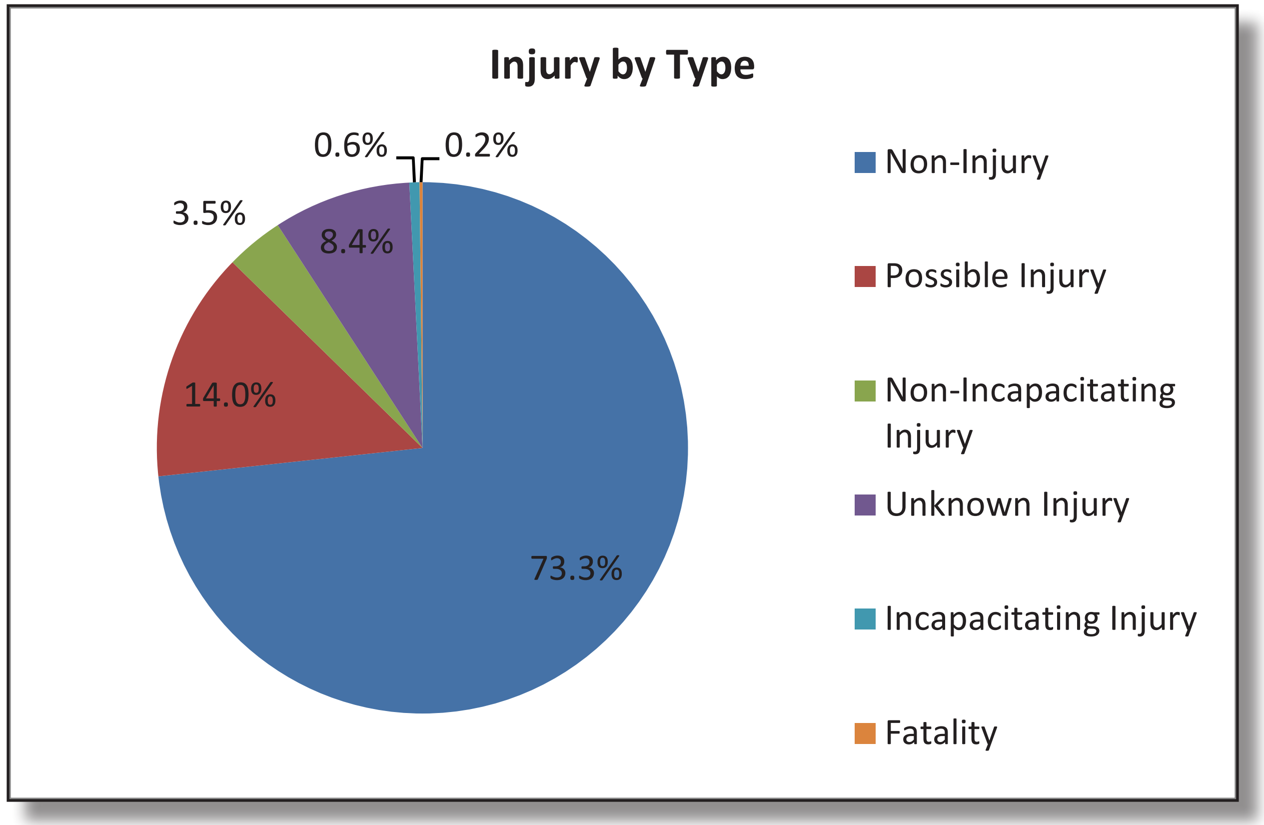


Figure 3.11: Crash Injuries by Type



1 TxDOT Crash Records Information System (CRIS) 2010-2013

Roadway Characteristics

Roadway characteristics include the physical aspects of the roadway, including ramp location, spacing, and configuration; roadway geometry, including horizontal and vertical curves; managed lanes, including high-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes; interchanges; and direct connectors. This information is useful in combination with traffic operations data to assess how the physical aspects of the roadway are impacting congestion along the corridor.

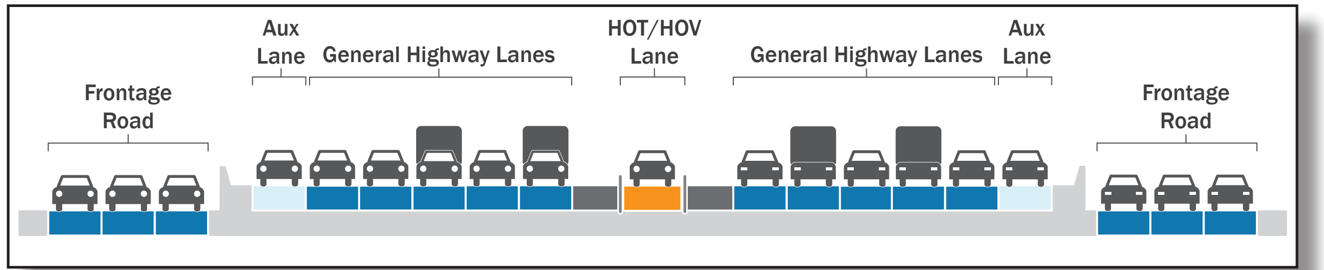
The Southwest Freeway is under the jurisdiction of multiple agencies, including TxDOT, METRO, and the City of Houston. The primary operation and maintenance responsibilities are summarized in **Table 3.2**.

Table 3.2: Operations and Maintenance Responsibilities

Agency	Operations and Maintenance Responsibilities
TxDOT	Frontage Roads, Ramps, Mainlanes
METRO	HOV/HOT Lanes, Park-and-Ride Facilities, Transit Centers
City of Houston	Arterial Street Intersections and Frontage Road Traffic Signals

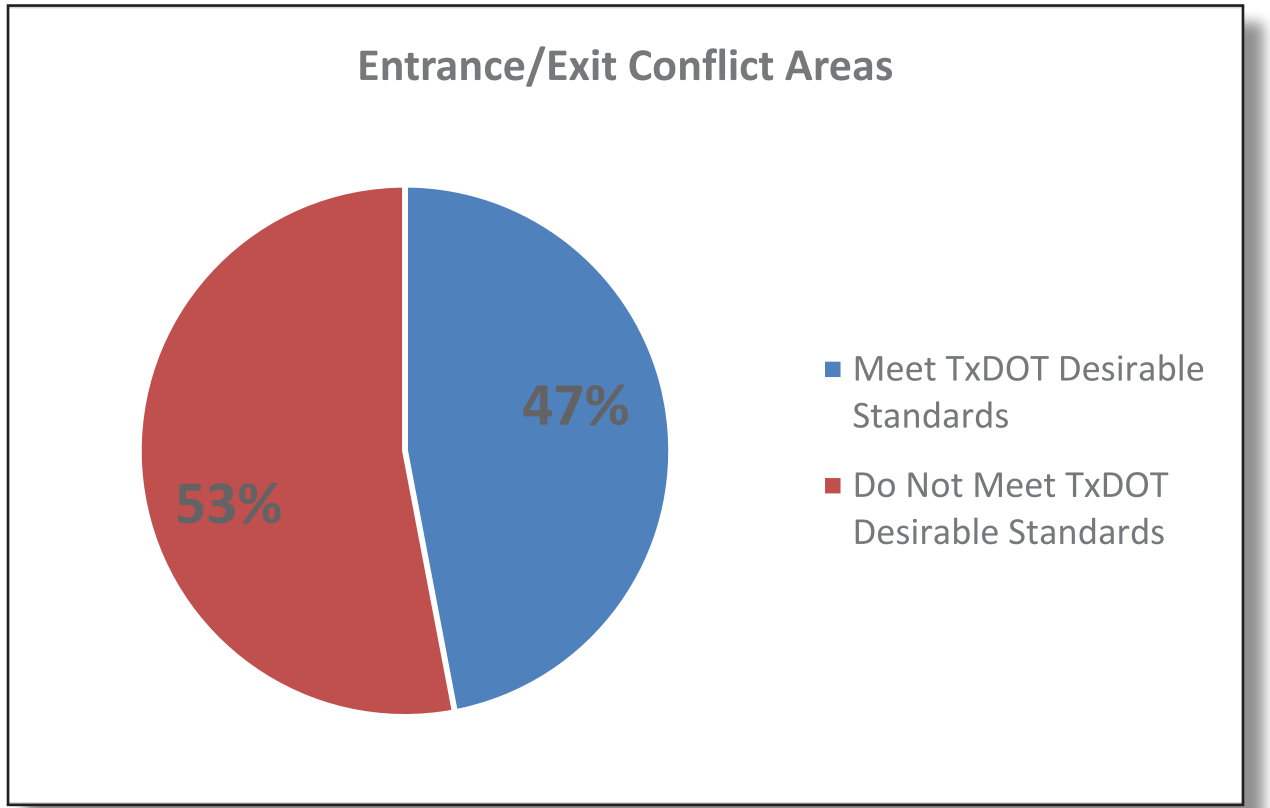
The Southwest Freeway consists of 8 to 14 general purpose lanes, with the typical section having 8 lanes and a single reversible HOV/HOT lane. The number of lanes on the frontage roads range from 2 to 3 lanes in each direction. **Figure 3.12** shows the mainlane and frontage road cross section near Buffalo Speedway.

Figure 3.12 US 59/IH-69 Cross Section near Buffalo Speedway



To improve operations and reduce crashes, TxDOT recommends a distance of 1,500 feet between the end of an entrance ramp and start of an exit ramp with an auxiliary lane and 2,000 feet between ramps without an auxiliary lane.[1] Several entrance and exit ramps along the corridor do not meet TxDOT's desirable weave area standards. **Figure 3.13** shows the percentage of weave conflict areas that do not meet this desirable length.

Figure 3.13: Entrance and Exit Ramp Conflict Area Rating



1 Roadway Design Manual, Texas Department of Transportation, Revised October 2014

Intelligent Transportation System (ITS) Infrastructure

One of the key mitigation strategies evaluated is traffic management. One of the key components of a traffic management system are field devices (i.e. communications, closed-circuit television, dynamic message signs, and advanced traffic signal controllers) used to communicate with and control traffic.

Traffic management is one part of a broader ITS system. The existence of this infrastructure is a significant asset and supports the implementation of an integrated traffic management system.

The Houston region (including the Southwest Freeway) has an extensive deployment of ITS infrastructure. The hub for the monitoring and operation is Houston TranStar, the multi-agency regional transportation and emergency response center. Freeway, tollway, and managed lane operations are all monitored from Houston TranStar using the ITS infrastructure. Other agencies that are involved in monitoring the corridor include: TxDOT, METRO, Harris County, City of Houston, Uptown Houston, the Houston Police Department, and the Houston Fire Department.

The arterial street system is continuously being upgraded by the City of Houston to allow increased communications and traffic management capabilities. Several intersections along the corridor have wireless communication capabilities and advanced traffic signal controllers. The transit system has extensive ITS capabilities. ITS infrastructure along the corridor includes:

- Communications (Fiber, Wireless, and Hardwire)
- Closed-Circuit Television (CCTV – 22 locations)
- Automatic Vehicle Identification (AVI)
- Dynamic Message Signs (DMS – 7 locations)
- Highway Advisory Radio (HAR)
- Freeway Ramp Meters (12 locations)
- Regional Computerized Traffic Signal System (RCTSS)
- Roadway Weather Information System (RWIS)
- Automated Traveler Information System (ATIS)
- Regional Incident Management System (RIMS)
- Regional Integrated Traffic Management System (RITMS)

HOV/HOT Lane

The High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) lane along US 59/IH-69 operates from south of Beltway 8 to Spur 527. This lane is open to transit, HOV, and single-occupancy vehicles (SOV). It is a single reversible lane that varies in width from about 14 feet to 33 feet. Access to the HOV/HOT lane is via slip ramps or T-ramps from the park and ride and transit center facilities located along the corridor and also at Edloe Street, IH-610, and Smith Street access points.[1] **Figure 3.14** shows the park and ride and transit center locations along the corridor.

Figure 3.14: METRO Park and Ride and Transit Center Locations

Operation of managed lane facilities is performed by various agencies. METRO is responsible for the reversible HOT lane located within the METRO jurisdiction (Airport to Dunlavy). The City of Sugar Land and Fort Bend County operate the HOV diamond lanes outside this study area. TxDOT has recently transitioned operational and capital/maintenance responsibilities (except for structural maintnance) for the HOT lane to METRO, including signing, barrier realignment, and debris removal.

METRO sets operation rules with TxDOT concurrence. METRO changes hours when Single Occupancy Vehicles (SOV) can use the region's lanes and updates toll rates. The standard hours of operation are weekdays from 5 to 11 a.m. and 1 to 8 p.m. for the inbound and outbound directions, respectively. METRO has also implemented a pilot program that extends the outbound direction hours of operation on weekdays and adds operation in the inbound direction on weekends. HOVs carrying two plus people are not charged a toll, however, SOVs are charged a fee based on the time of day the facility is used. The toll charge ranges from $1.00 per vehicle when the lanes open to $6.50 per vehicle during peak driving times of morning and evening.

1 Metropolitan Transit Authority of Harris County 2014 http://www.ridemetro.org/

Traffic Operations

Traffic Incident Management and Response

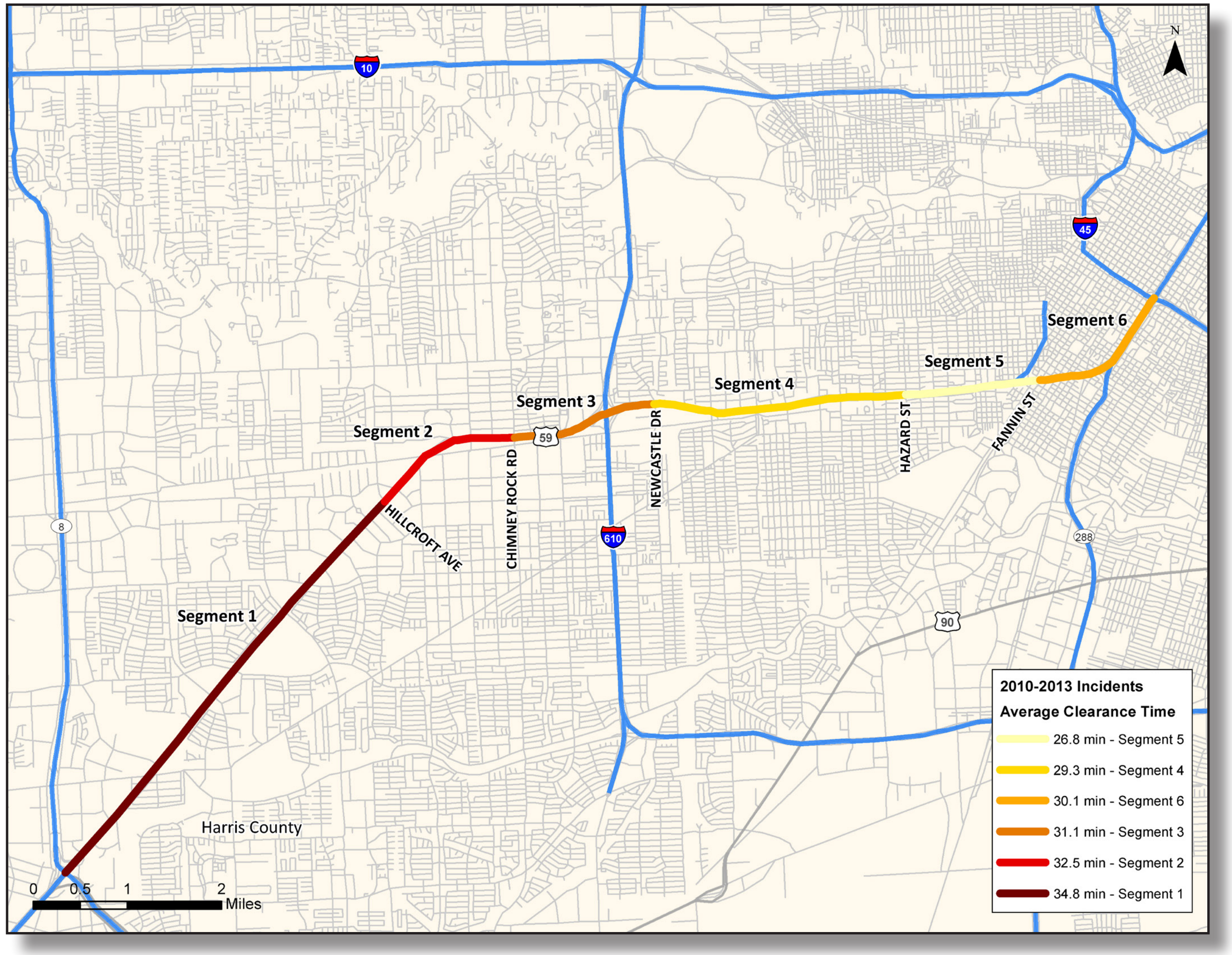
According to the FHWA, about half of congestion is caused by non-recurring congestion -- temporary disruptions that take away part of the roadway from use.[1] Non-recurring congestion is a major issue along the US 59/IH-69 corridor. Local companies provide services to clear incidents, led by the quick towing and Moving Ahead for Progress (MAP) programs. As previously mentioned, H-GAC is leading efforts to implement a regional incident clearance program that will be sustainable and annually funded, using regional resources. These programs help improve safety and restore mobility when incidents occur.

The Houston TranStar partnership has developed an incident response manual that provides guidance for the region. The relationship between police, fire, emergency medical services (EMS), tow companies, traffic management, and emergency management staff is critical during major incidents, special events, and evacuation. **Figure 3.15** shows the average incident clearance time along the corridor. Segment 1, located the furthest from the city center, has the highest response time (34.8 minutes), while Segment 5 has the lowest (26.8 minutes.)

Frontage Road and Arterial Operations

Frontage road and arterials are operated with coordination between TxDOT and the City of Houston. TxDOT is responsible for frontage road maintenance, while the City of Houston operates signal timing and arterials. The enhancement to arterial ITS is expected to be completed in the near future, which will benefit the frontage road and arterials. Currently, traffic signal coordination on arterial north/south streets are given higher priority than frontage road traffic signal coordination.

Figure 3.15: Average Incident Clearance Time



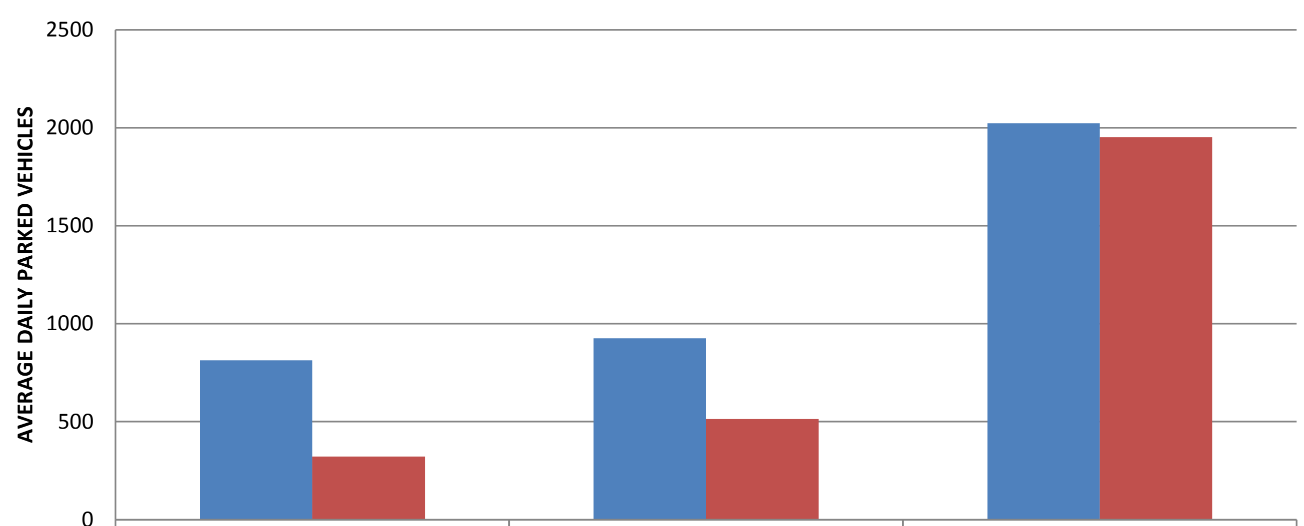
1 FHWA 2014 http://ops.fhwa.dot.gov/program_areas/reduce-non-cong.htm

Transit

The Metropolitan Transit Authority of Harris County (METRO) serves the Houston-Galveston area with bus, light rail, bus rapid transit (BRT), and paratransit operation. Several bus and BRT routes operate along the Southwest Freeway and rely on park and ride locations adjacent to the Southwest Freeway that tie into the HOV/HOT lane. The park and ride locations access the HOV/HOT lane using T-Ramps placed at various points on the Southwest Freeway. These ramps provide direct, efficient access for METRO and HOV uses. **Figure 3.16** illustrates the current lot utilization for the park and ride locations along the Southwest Freeway corridor.

In August 2015, METRO launched a brand new bus network developed under their METRO System (Re)Imagining to better serve the citizens of the Houston-Galveston area. The new bus network was considered in this study.

Figure 3.16: Park and Ride Lot Utilization - March 2014



	Westwood PNR	Hillcroft TC PNR	W Bellfort PNR
Capacity	813	926	2024
Usage	322	514	1953

SOURCE: TEXAS A&M TRANSPORTATION INSTITUTE

Chapter 4: Mitigation Strategies

Traffic Management
Travel Options
Active Traffic Management
System Modification and Added Capacity

Factors contributing to congestion along the Southwest Freeway are not uncommon to large metropolitan areas experiencing significant growth. They can be addressed and evaluated using various strategies that fall into these distinct categories:[1]

- Traffic Management
- Travel Options
- Active Traffic Management
- Access Modification & Added Capacity

Over the next several years, vehicles will be equipped with smart vehicle technology, including sensors and wireless technologies. This new technology will involve vehicle-to-vehicle and vehicle-to-infrastructure communication and will improve safety and driver decisions. For example, Visible Lighting Communications (VLC) can be used to control auto/traffic signaling and communication between vehicles to improve safety and will change the approach toward conventional signal timing, traffic analysis, and roadway design criteria.[2] The implementation and adoption of future policy changes will depend on vehicle fleet penetration and political rule-making. The strategies considered in this study that have a longer timeline will likely be influenced by these emerging technologies.

Traffic Management

Aggressive Incident Clearance

Incident clearance is the duration of time from when an incident is reported to when it is cleared from the roadway. Aggressive incident clearance aims at creating an operational system to clear incidents efficiently and safely.

1 Texas A&M Transportation Institute, Mobility Investment Priorities, 2014 http://mobility.tamu.edu/mip/strategies.php

2 Intech, Smart Vehicles, Technologies and Main Applications in Vehicular Ad hoc Networks, Vegni A. et al, 2013, http://dx.doi.org/10.5772/55492

Dynamic Merge Control

Dynamic merge control regulates or closes lanes near high-volume merge areas. Lane assignments are regulated using Dynamic Message Signs (DMS) at these freeway junction areas. Dynamic merge control can also be used to alert drivers of work zone or incident lane changes. Strategies that complement dynamic merge control include: variable speed limits, temporary shoulder use, and queue warning.

Dynamic Rerouting

Dynamic rerouting is an operational system that presents drivers comparable alternative routes when the normal route is severely congested. Alternative route information is usually shown with dynamic message signs. The dynamic message signs can simply state the alternative route or compare travel times.

Queue Warning

Queue warning deploys real-time warning displays along a roadway to alert drivers of downstream queues or slowdowns. The aim of queue warnings is to reduce rear-end crashes and improve safety. A strategy that complements queue warning is variable speed limits/advisory speeds.

Ramp Flow Control

Ramp flow control uses traffic signals at entrance ramps to regulate the flow of vehicles entering a freeway. The cycle length of the signal can be adjusted to create the desired volume entering the freeway at that location during congested periods. Ramp meters also create better spacing between merging vehicles. Adaptive ramp control is based on upstream and downstream traffic volumes and signal control is changed based on the real-time traffic conditions.

Signal Operations & Management

Signal operations and management monitors arterial traffic conditions and queuing at intersections to dynamically adjust signal timings based on daily conditions. For the US 59/IH-69 corridor, intersections along the frontage road are of particular importance in order to lower delay and offer an alternate route choice.

Temporary Shoulder Use

Temporary shoulder use, also known as hard shoulder running, is a dynamic measure designed to adapt roadway capacity to high traffic volumes on a temporary basis. By allowing vehicles (either all vehicles or only transit vehicles) to use the shoulder with reduced speed limits, it is possible to serve a higher number of vehicles and reduce congestion during peak periods and during incidents. Strategies that complement temporary shoulder use include: variable speed limits/advisory speeds and queue warning.[3]

Traveler Information Systems

Traveler information systems provide real-time information and alerts to motorists via technology. The traditional information dissemination platforms were radio and TV traffic reports, which are now being supplemented by websites, email, phone applications, 511 phone systems, and dynamic traffic signs. Traveler information systems manage demand by distributing route choice, mode choice, and trip assignment.

Variable Pricing

In variable pricing, low occupancy vehicles are charged a toll to use HOT lanes, while HOV, public transit buses, and emergency vehicles are allowed to use lanes free of charge. The toll rate fluctuates based on the level of congestion.

Variable Speed Limits/Advisory Speeds

Variable speed limits are enacted by signs that can be changed to alert drivers when traffic congestion is imminent. Sensors along the roadway detect when congestion or weather conditions exceed specified thresholds and automatically reduce the speed limit (in 5 mph increments) to slow traffic and postpone the onset of congestion. The system's goal is to slow traffic uniformly in a way that allows smooth traffic flow and avoids stop-and-go conditions. Depending upon the objectives set for the system, speed limits can be regulatory or advisory. Strategies that complement variable speed limits include: temporary shoulder use and queue warning.[4]

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3 http://mobility.tamu.edu/mip/strategies.php.

4 http://mobility.tamu.edu/mip/strategies.php.

According to FHWA, variable speed limits are, "speed limits that change based on road, traffic, and weather conditions."[5] Variable speed limits can improve safety by reducing crashes in highly congested or low visibility areas. Variable speed limits are used to achieve speed harmonization, an even distribution of speeds among vehicles.

Travel Options

Bicycle & Pedestrian Facilities

According to FHWA, bicycle facilities include "a new or improved lane, path, or shoulder for use by bicyclists and a traffic control device, shelter, or parking facility for bicycles."[6] Pedestrian facilities include people traveling by foot or by wheelchair.

Carpooling

Carpooling is defined by FHWA as, "an arrangement where two or more people share the use and cost of privately owned automobiles in traveling to and from pre-arranged destinations together."[7]

Express Bus Service

Express bus service is a public transit bus route intended to run at a faster service speed than a normal bus service between the same two destination points.

Flexible work hours

Flexible work hours allow employees at workplaces to adjust the time that they enter and leave the office. In transportation, flexible work hours distribute automobiles to non-peak hours.

Park and Ride Lots

According to TTI, park and ride lots are "specialized parking lots typically located on the suburban fringe of urbanized areas" that offer commuters "fixed routes, express bus, BRT, and/or rail."[8]

5 http://safety.fhwa.dot.gov/speedmgt/vslimits/

6 http://www.fhwa.dot.gov/environment/bicycle_pedestrian/overview/bp-broch.cfm

7 http://www.fhwa.dot.gov/planning/glossary/glossary_listing.cfm?sort=definition

8 http://mobility.tamu.edu/mip/strategies.php

Telecommuting

Telecommuting is the process of working at home with the use of internet, email, and telephone.

Transportation Management Associations

Transportation Management Associations (TMAs) are member-controlled organizations that provide transportation services in a particular area, for a particular land use. They often consist of area businesses with local government support.

Active Traffic Management

FHWA defines Active Traffic Management as, "the ability to dynamically manage recurrent and non-recurrent congestion, based on prevailing and predicted traffic conditions."[9] The goal is to increase throughput and speed with the use of new technology, integrated systems, and operational strategies. This strategy may utilize many of the previously mentioned strategies including: ramp flow control, dynamic rerouting, dynamic merge control, queue warning, temporary shoulder use, traveler information, and variable speed limits.

Access Modification and Added Capacity

Access Management

Access management is a set of strategies and techniques used to control access to highways and major arterials.

HOV/HOT Lanes

High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) lanes are lanes on a freeway that may include toll rates that fluctuate dynamically with the change in congestion on the general purpose lanes. Low occupancy vehicles are charged a dynamically changing toll, while HOV, public transit, and emergency vehicles access the lanes free of charge.

Auxiliary/Acceleration/Deceleration Lanes and Added Capacity

Auxiliary, acceleration, and deceleration lanes provide a lane to speed up or slow down for entering and exiting traffic. The length of auxiliary, acceleration, and deceleration lanes has a substantial affect through speed and safety.

Intersection Improvements

Intersection improvements include any improvements to unsignalized or signalized intersections. This includes signal timing adjustments, geometric improvements, and dynamic signal management.

Ramp Configurations

Ramp configurations are the geometric layout and spacing among entrance and exit ramps. The spacing of these ramps has a large impact on the speed and safety of the facility, as this influences when and where to make lane changes, and if there is a merging or weaving condition with other vehicles.

9 http://ops.fhwa.dot.gov/atdm/approaches/atm.htm

Chapter 5: Evaluation of Strategies

Modeling
Case Studies
Safety

Strategies were assessed using multiple sources of information. These included modeling, previous case studies (including HOT/HOV Lanes, Active Traffic Managment, and Safety), and benefit/cost analysis. The initial strategy toolbox was produced from a large set of strategies, reduced to those that applied to the corridor, and then further reduced to a set of recommended strategies through analysis and evaluation. This refinement is represented graphically in **Figure 5.1** on page 31.

Pages 32 through 41 summarize the preferred strategies evaluated. Using these analysis tools the inital list of strategies was refined to a preferred list of strategies and finally to a recomended list of strategies.

Modeling

A Dynamic Traffic Assignment model was developed to compare mitigation strategies. The model, DynusT, provided summary statistics on a segment by segment basis. Using the DynusT model volume output, Vissim was used to simulate traffic behavior on a lane basis. To supplement both of the model outputs, various data was evaluated, including: existing implementation locations (including before and after studies), safety, cost, and feasibility of construction.

Case Studies

HOV/HOT Lanes

Table 5.1 illustrates examples of HOV/HOT lanes that are implemented in the U.S.[1] Some are fixed toll, while others are tolled dynamically based on congestion. These case studies were used in addition to the dynamic traffic assignment modeling to evaluate different types of HOV/HOT lane tolling strategies.

Table 5.1: HOV/HOT Lane Examples

Urban Area	Highway Covered	Toll Type	Toll Range ($/collection point)
Houston, TX	I-10	Fixed Toll Rates	$0.40 - $3.20
Orange County, CA	State Route 91	Fixed Toll Rates	$1.30 - $8.95
San Diego, CA	I-15	Dynamic Pricing	$0.50 - $8.00
Miami, FL	I-95	Dynamic Pricing	$0.25 - $8.00
Minneapolis, MN	I-394	Dynamic Pricing	$1.00 - $8.00

1 http://mobility.tamu.edu/mip/strategies.php, https://www.hctra.org/katymanagedlanes, http://www.mnpass.org/

Active Traffic Management

Active Traffic Managment (ATM) has not been implemented in very many areas of the U.S. However, several countries in Europe have used ATM for years and reap the benefits. ATM strategies have been shown to increase overall capacity by up to 22 percent, throughput by up to 7 percent, and reduce crashes and secondary incidents by up to 30 percent and 50 percent, respectively. With ATM implementation, the onset of traffic congestion is delayed and trip times are more reliable.[2]

ATM has recently been implemented in various U.S. locations. T**able 5.2** describes some of these domestic projects. These case studies show how ATM is starting to be implemented effectively in the US and supplements the limitations of the modeling software in modeling these complex concepts.

Table 5.2: Active Traffic Management Case Studies

Location	Description	Source
US 75 Corridor in Dallas	Integrated Corridor Management (ICM) study as part of an ICM initiative. It consisted of freeway, arterial, bus and rail alternatives. About 25 miles and included 15 miles of HOV, 34 miles of tollways, and areas surrounding freeway.	RITA (ITS, gov), and 2008 Concept of Op-erations (USDOT)
I-15 Corridor in San Diego	ICM strategies on 21-mile segment of I-15 corridor, including 8-mile managed lanes facility. The corridor currently oper-ates with two reversible HOV/HOT lanes.	AMS for I-15 Corridor (Cambridge/USDOT)
I-80 Corridor in Alameda, CA	ICM project in Alameda and Contra Costa Counties, 20.5-mile segment of I-80, which includes incident management by use of VMS, lane assignment DMS, and information display boards. Adaptive ramp metering and arterial improvements are also included.	I-80 ICM Operations and Management Plan (DKS Associates)
I-5/I-90/SR 520 in Washington State	Active Traffic and Demand Management was implemented in 2010 to reduce collisions and improve incident operations. Sign bridges that display variable speed and queue warning are displayed along approximately 25 miles of roadway.	WSDOT

2 http://mobility.tamu.edu/mip/strategies.php.

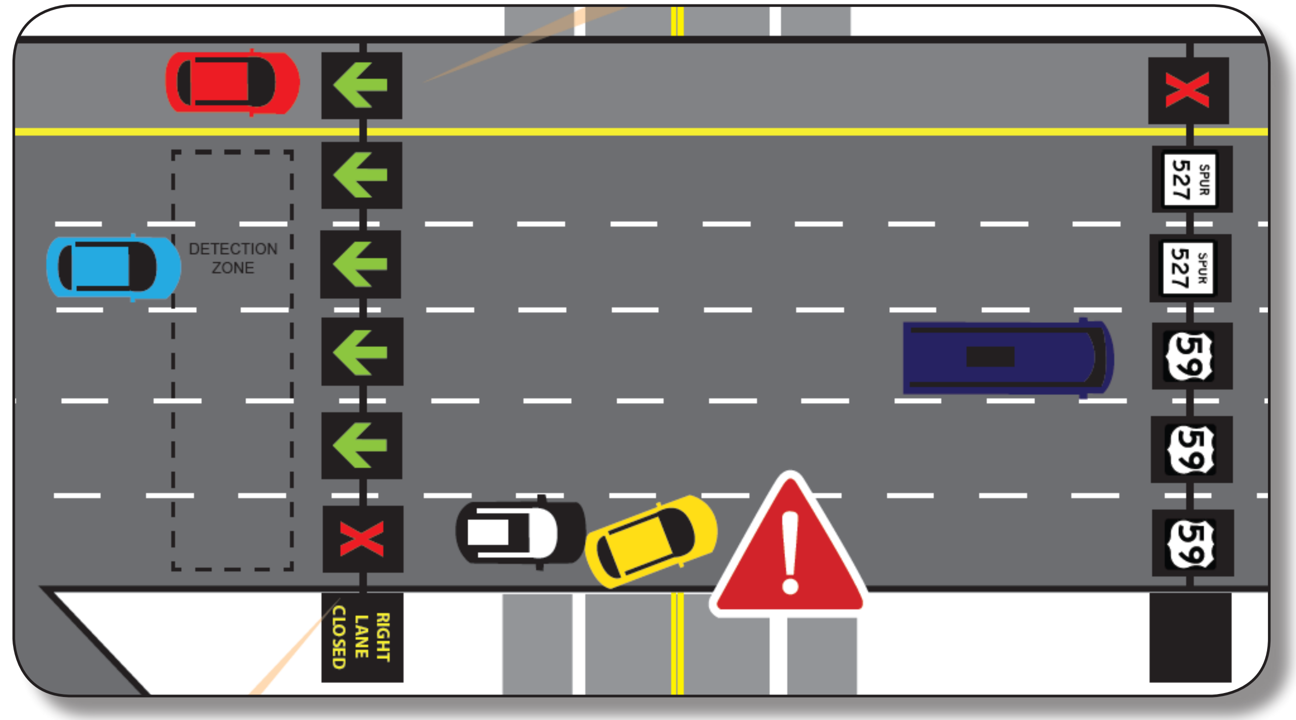
Safety

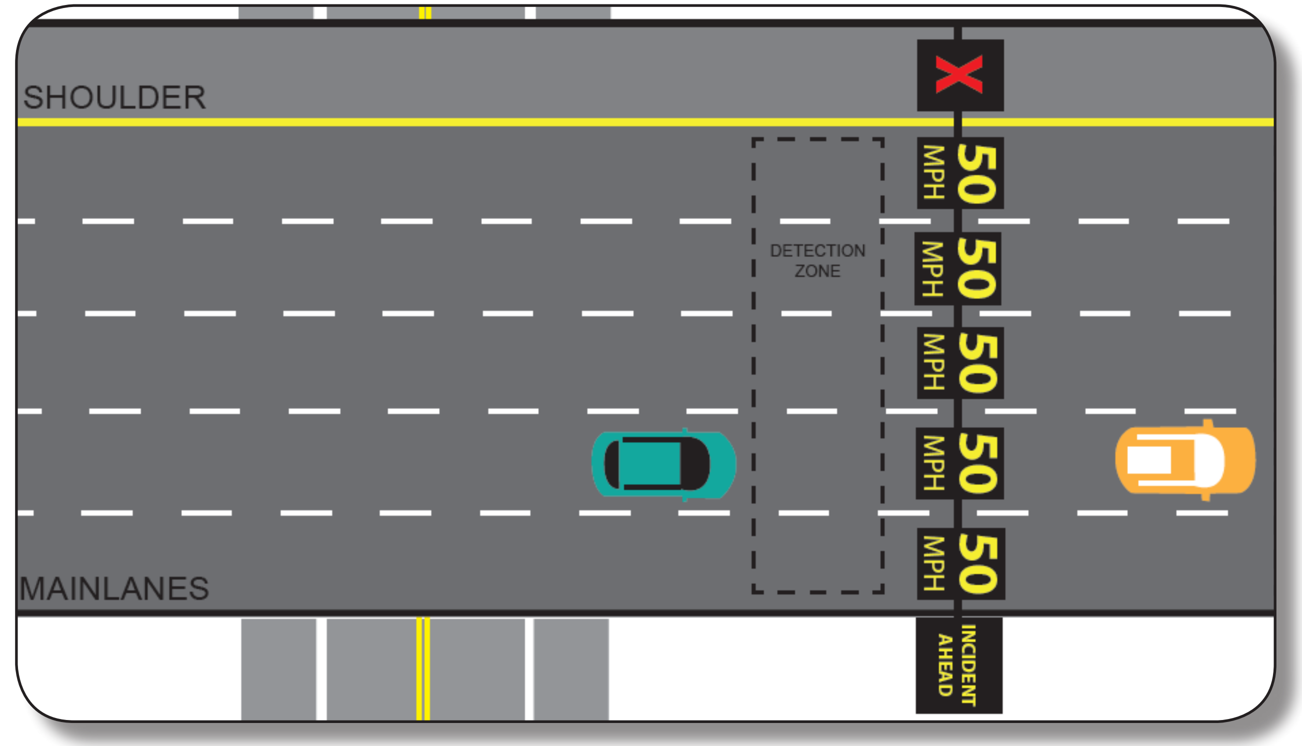
Changes to improve safety on a facility are more difficult to predict than other measures of effectiveness. One way to evaluate safety of an improvement is to look at the associated Crash Modification Factors (CMF) that have been developed using before and after studies.[3] The CMF is a ratio of crashes after an improvement divided by the crashes before the improvement. The Crash Reduction Factor (CRF) represents the percent reduction associated with each modification. **Table 5.3** lists some of the strategies and the estimated CMF and CRF that could be expected after implementation.

Table 5.3: Crash Modification Factors for US 59/IH-69 Strategies

Strategy	Safety Impact	Crash Modification Factor (CMF)	Crash Reduction Factor (CRF)
Access Modification	Increase distance between entrance and exit ramps	0.79 - 0.88	12 - 21%
Access Modification	Add Auxiliary Lane	0.96	4%
HOV/HOT Lane	Reduce Shoulder Width	0.45	55%
Active Traffic Management	Ramp Flow Control	0.64	36%
Active Traffic Management	Queue/Crash Warning DMS	0.56 - 0.84	16 - 44%

Safety improvements were applied to the Active Traffic Management benefit/cost analysis. Active Traffic Management, specifically speed harmonization and queue warning, were assumed to reduce property-damage only crashes by 20% and all other crashes by 15%.[4] The economic value of each incident is based on a 2012 National Safety Council Report, "Estimating the Costs of Unintentional Injuries".

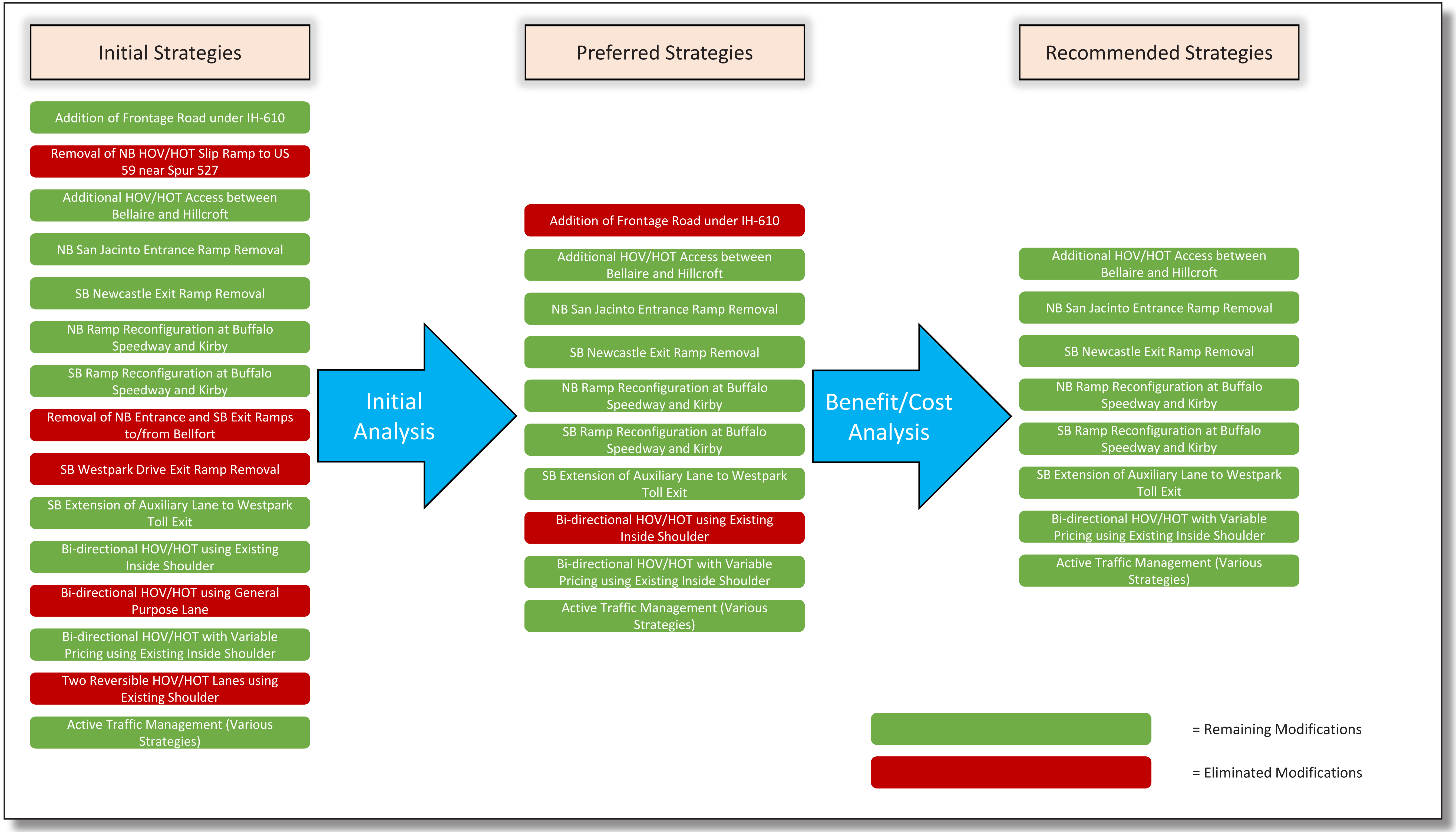




3 www.cmfclearinghouse.org

4 FHWA 2007: Active Traffic Management: The Next Step in Congestion Management

Figure 5.1: Strategy Refinement Process



Strategy: Frontage Road Extended through IH-610 Interchange

Description

- Extend US 59/IH-69 frontage roads under IH-610 between Sage Avenue and Newcastle Drive

Estimated Costs

- Design: $15,000,000
- Construction: $110,000,000
- Annual Operation & Maintenance: ~$130,000

Lead Agency

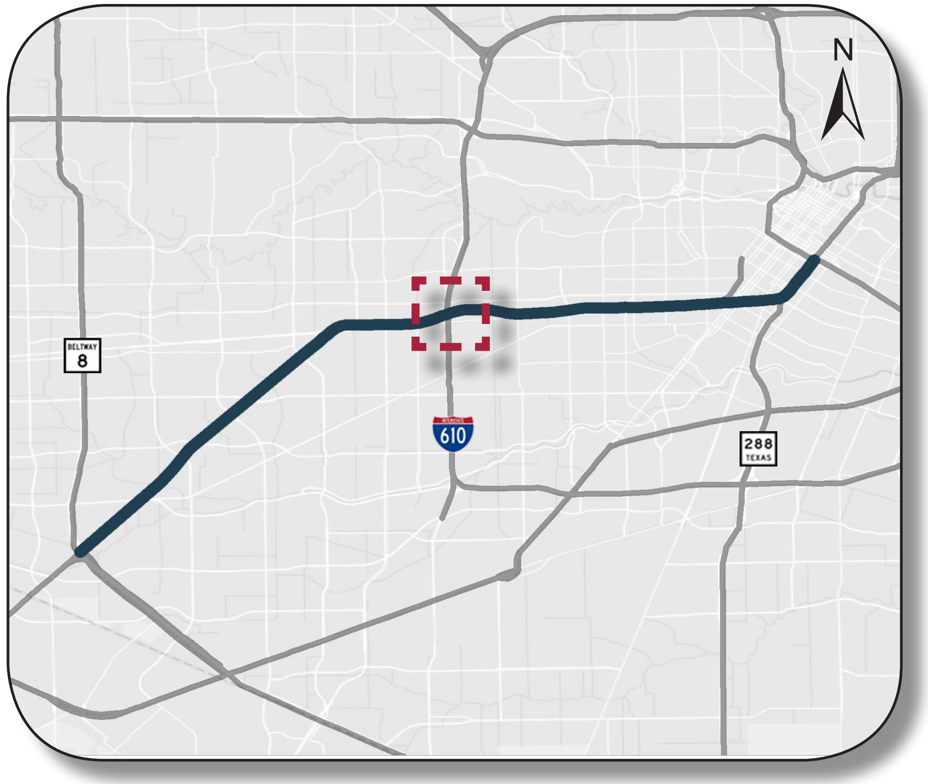
- TxDOT

Anticipated Benefits

- Provides direct congestion relief, increasing or creating new person-moving capacity
- New roads alleviate other nearby congested corridors by attracting drivers off those roads onto the new facility and improving access to surrounding areas

Potential Challenges

- Available funding
- Requires tunnel in northbound direction
- Southbound frontage road would have low design speed



Key	
Good	★
Better	★★
Best	★★★

	Travel Time	Throughput	Reliability	Safety	Cost
Frontage Road Extension	★★	★★	★★	★	★

Strategy: New HOV/HOT Access between Hillcroft Street and Bellaire Boulevard

Description

- Provide new HOV/HOT access between Hillcroft Street and Bellaire Boulevard

Estimated Costs

- Design: $105,000
- Construction: $460,000
- Annual Operations & Maintenance: ~$15,000

Lead Agency

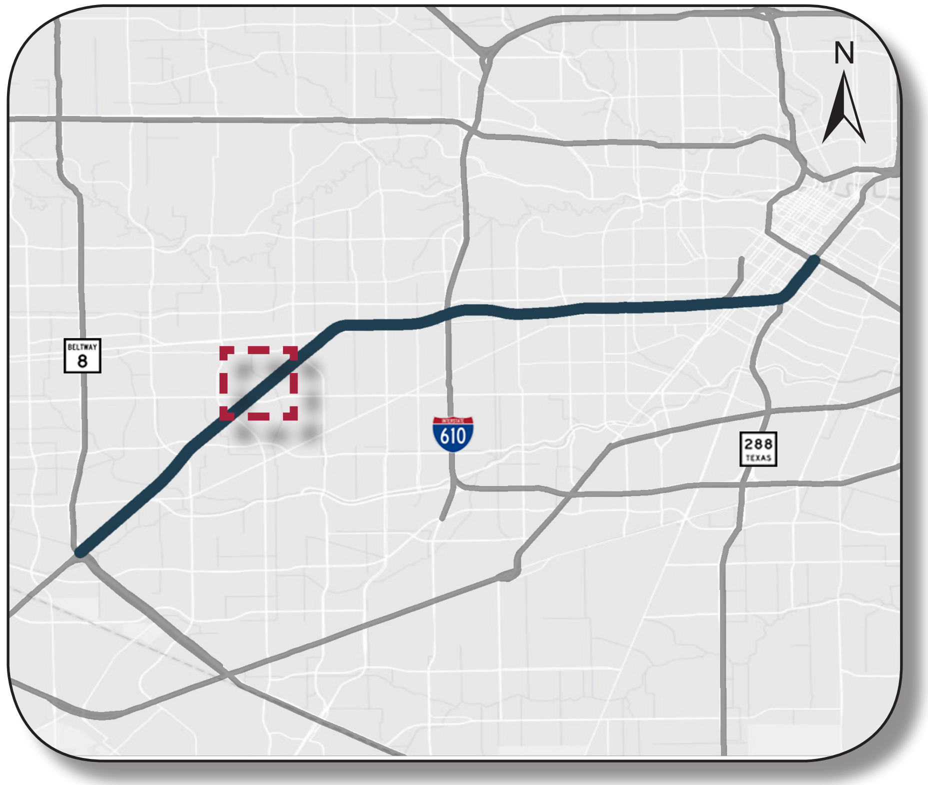
- TxDOT

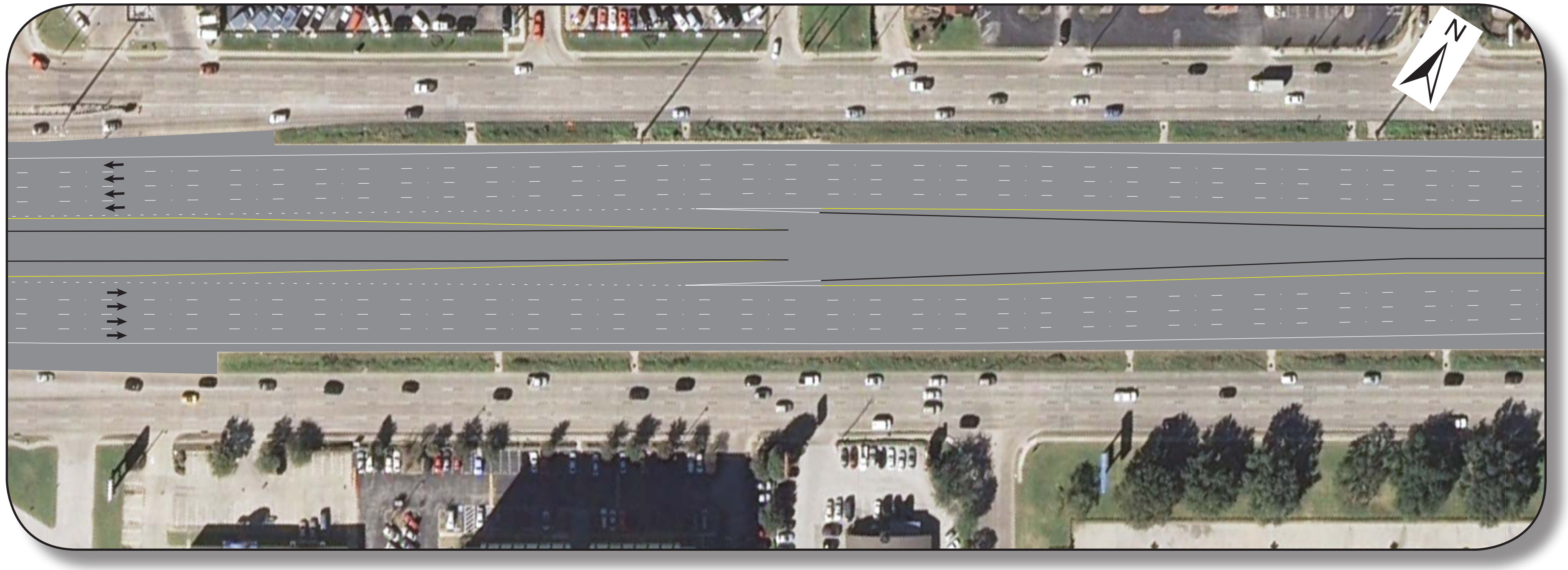
Anticipated Benefits

- Provides new access that is not from a park and ride facility

Potential Challenges

- New merge/weave area





Key	
Good	★
Better	★★
Best	★★★

	Travel Time	Throughput	Reliability	Safety	Cost
New HOV/HOT Access	★★	★★	★★	★	★★

Strategy: Northbound San Jacinto Entrance Ramp Removal

Description

- Removal of northbound entrance ramp from San Jacinto Street

Estimated Costs

- Design: $25,000
- Construction: $115,000
- Annual Operations & Maintenance: ~$5,000

Lead Agency

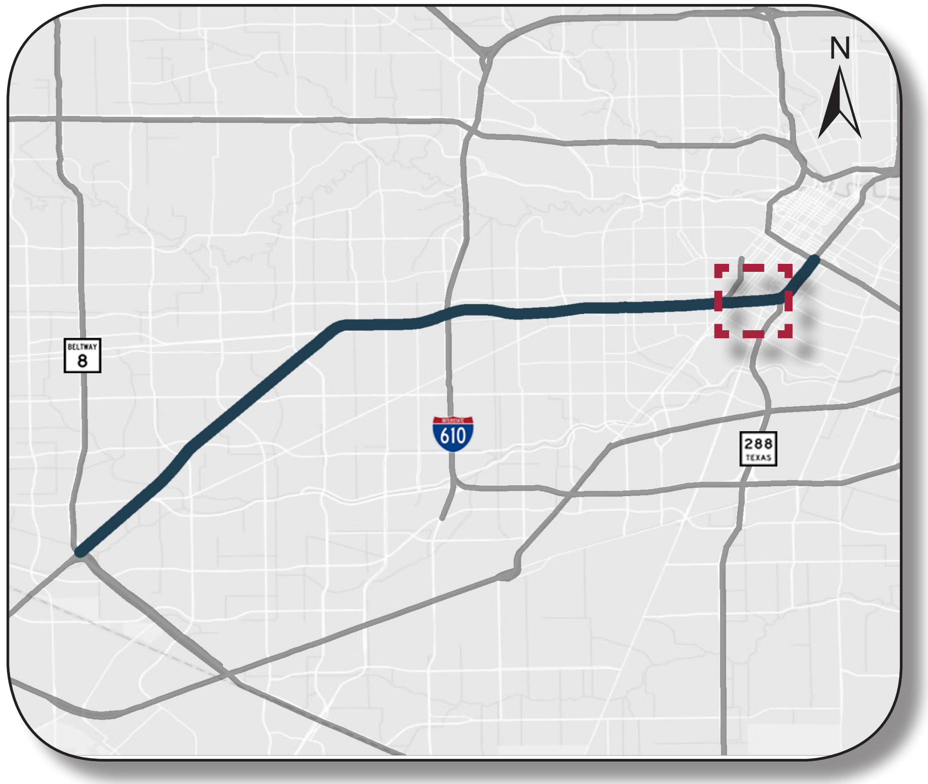
- TxDOT

Anticipated Benefits

- Removes merge/weave area
- Increases traffic flow on freeway
- Increases speed on freeway
- Increases safety

Potential Challenges

- Rerouting of affected traffic



Key	
Good	★
Better	★★
Best	★★★

	Travel Time	Throughput	Reliability	Safety	Cost
San Jacinto Exit Ramp Removal	★★★	★★	★★	★★	★★★

Strategy: Southbound Newcastle Exit Ramp Removal

Description

- Removal of southbound exit ramp to Newcastle Drive

Estimated Costs

- Design: $35,000
- Construction: $150,000
- Annual Maintenance: ~$5,000

Lead Agency

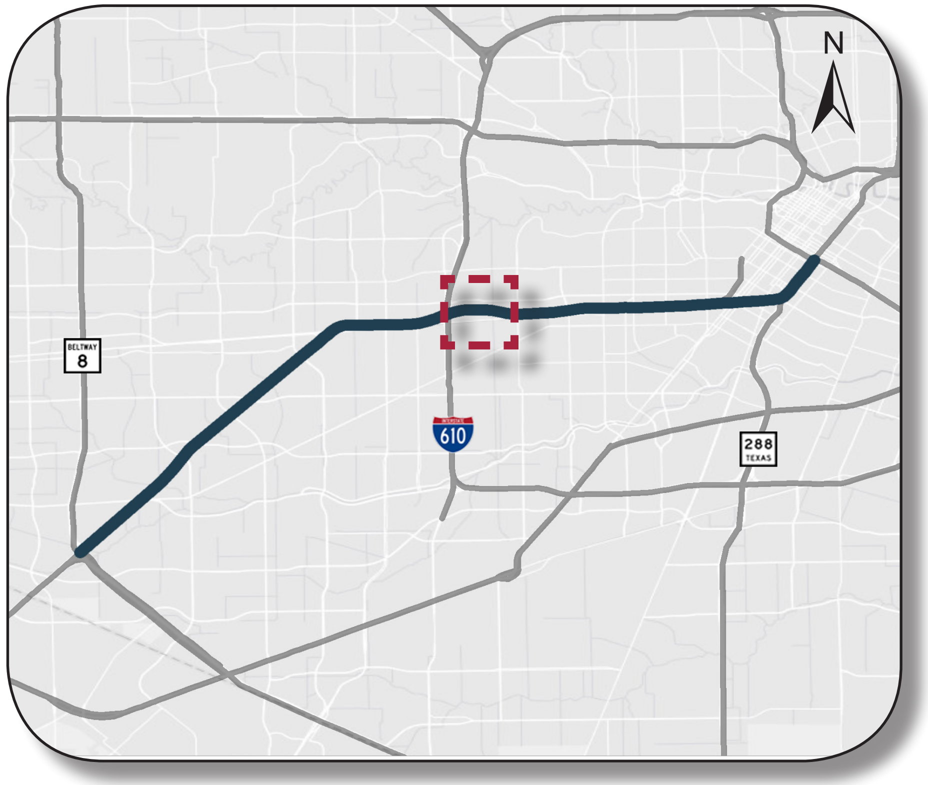
- TxDOT

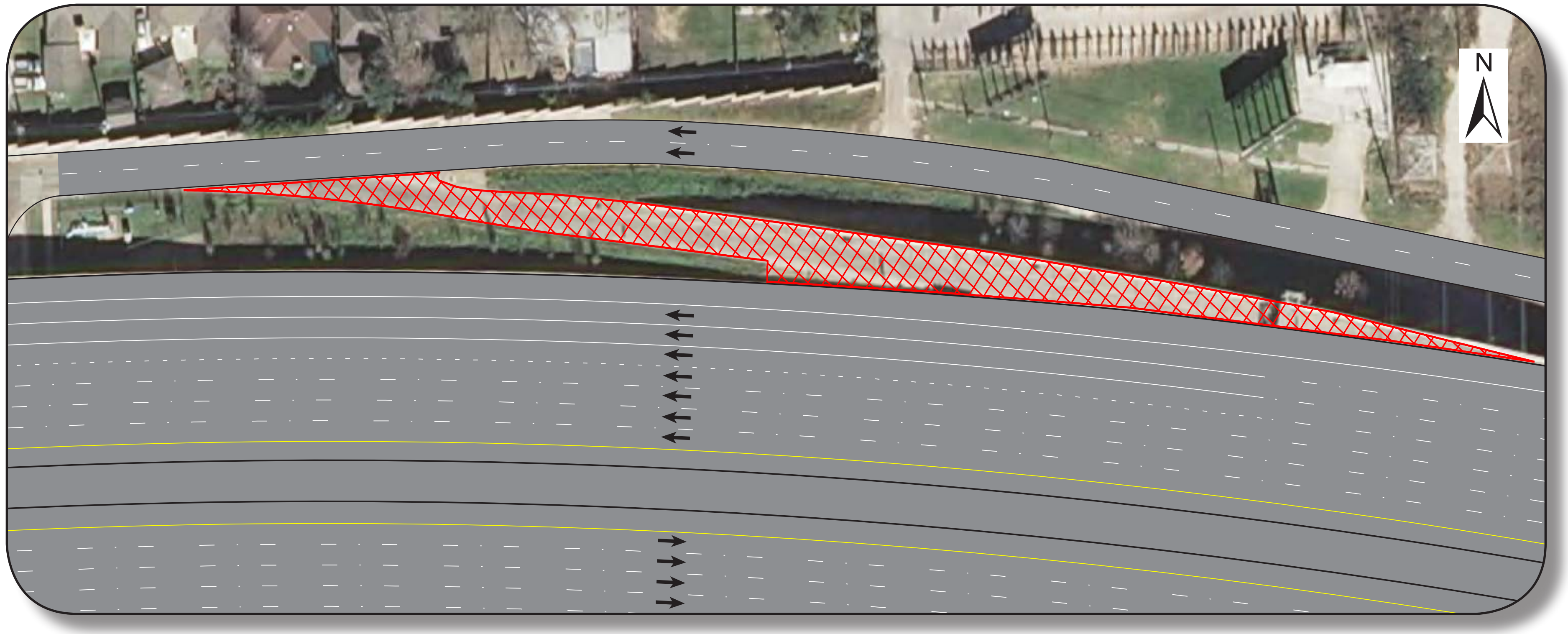
Anticipated Benefits

- Removes merge/weave area
- Increases traffic flow on freeway
- Increases speed on freeway
- Increases safety

Potential Challenges

- Rerouting of affected traffic





Key	
Good	★
Better	★★
Best	★★★

	Travel Time	Throughput	Reliability	Safety	Cost
Newcastle Exit Ramp Removal	★★★	★	★	★★	★★★

Strategy: Southbound Ramp Modifications near Kirby

Description

- Southbound ramp modifications from Kirby Drive to Buffalo Speedway removing the entrance ramp from Kirby Drive, creating a bypass at Buffalo, and extending an auxiliary lane from the southbound Greenbriar Drive entrance to the Edloe Street exit. (Multiple alternatives were evaluated)

Estimated Costs

- Design: $930,000
- Construction: $7,170,000
- Annual Operations & Maintenance: ~$30,000

Lead Agency

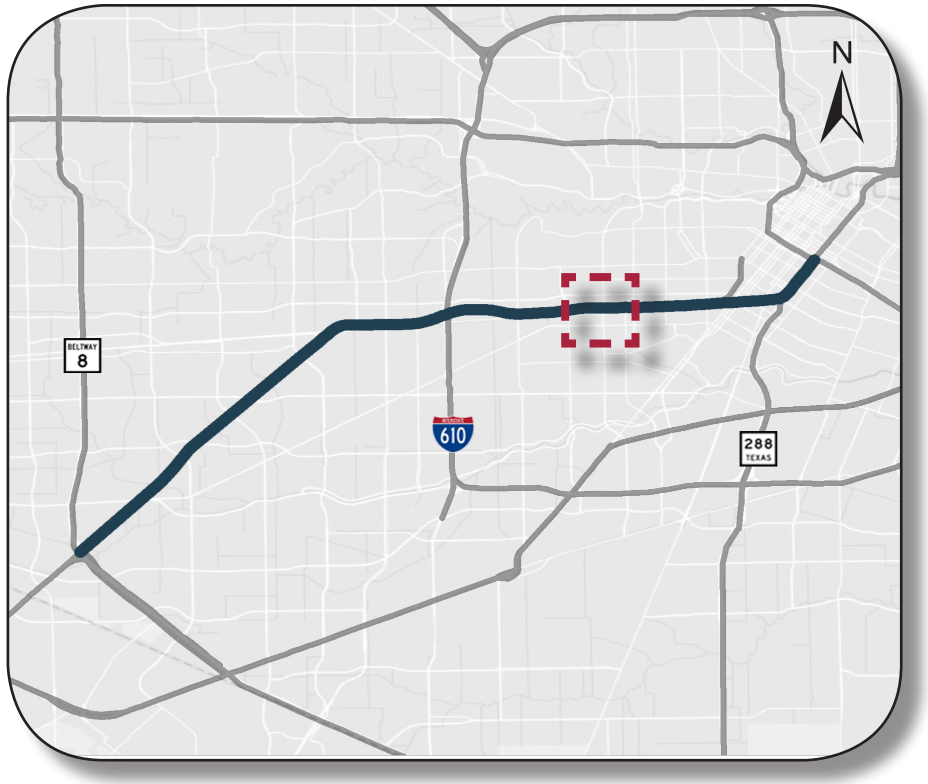
- TxDOT

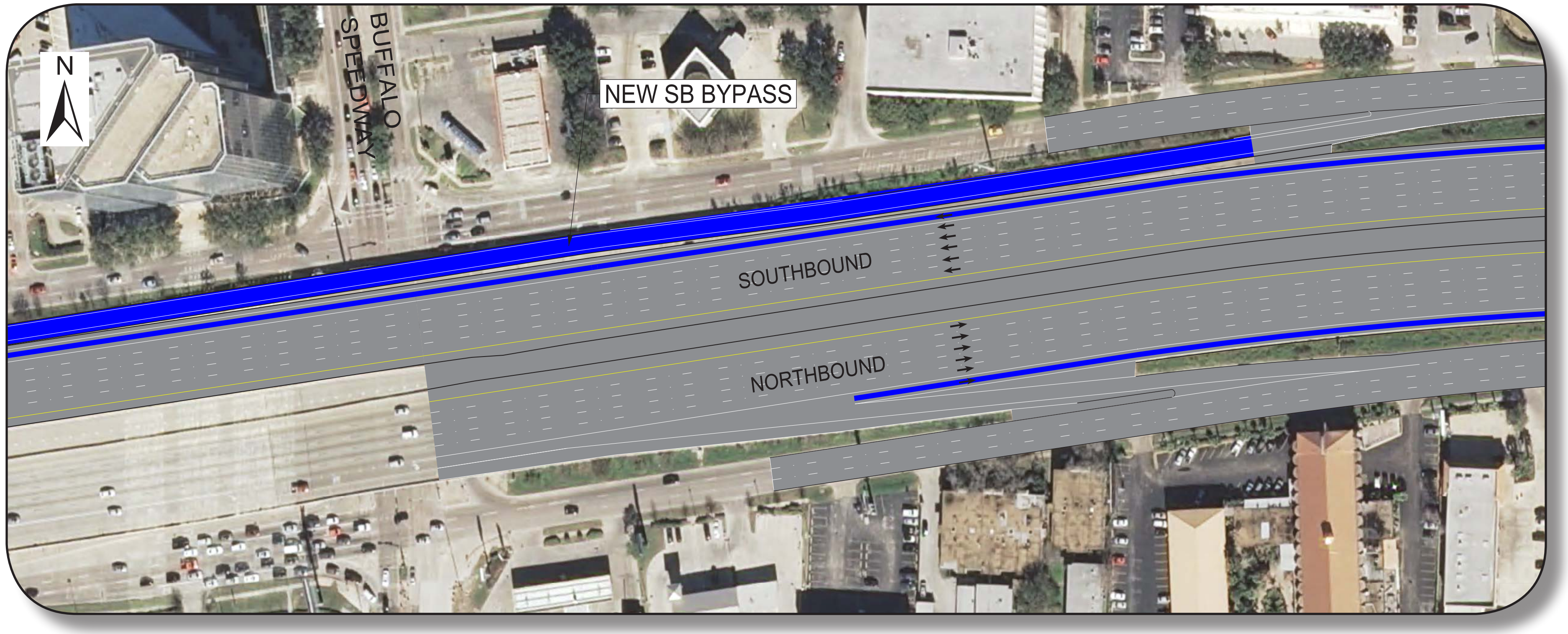
Anticipated Benefits

- Removes merge/weave area
- Increases traffic flow on freeway
- Increases speed on freeway
- Increases safety

Potential Challenges

- Rerouting of affected traffic





Key	
Good	★
Better	★★
Best	★★★

	Travel Time	Throughput	Reliability	Safety	Cost
Ramp Modifications near Kirby - SB	★★	★	★★	★★	★

Strategy: Northbound Ramp Modifications near Kirby

Description

- Northbound ramp modifications from Buffalo Speedway to Kirby Drive modifying the northbound entrance ramp from Buffalo and extending an auxiliary lane from the northbound Edloe Street entrance to the Greenbriar Drive exit. It removes the northbound entrance ramp from Kirby Drive. (Multiple alternatives were evaluated)

Estimated Costs

- Design: $860,000
- Construction: $6,600,000
- Annual Operations & Maintenance: ~$30,000

Lead Agency

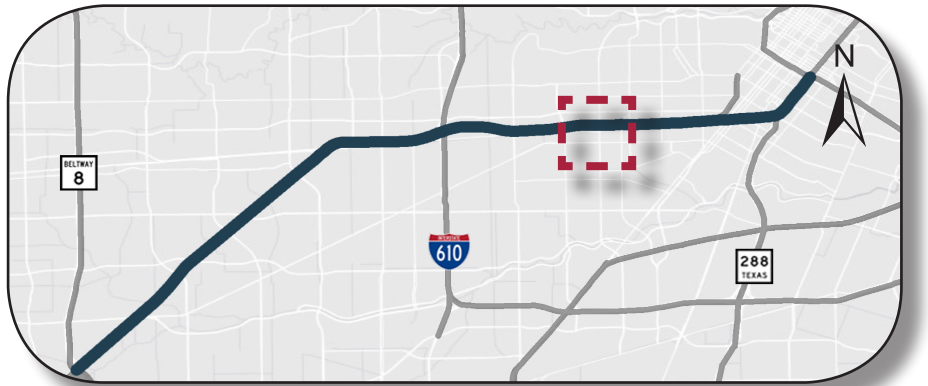
- TxDOT

Anticipated Benefits

- Removes merge/weave area
- Increases traffic flow on freeway
- Increases speed on freeway
- Increases safety

Potential Challenges

- Some alternatives impact METRO Route 283
- Rerouting of affected traffic



Key	
Good	★
Better	★★
Best	★★★

	Travel Time	Throughput	Reliability	Safety	Cost
Ramp Modifications near Kirby - NB	★★★	★★★	★★	★★	★

Strategy: Southbound Extension of Auxiliary Lane to Westpark Tollway Exit

Description

- Extend the southbound auxiliary lane that currently ends at Westpark Drive to the Westpark Toll exit ramp

Estimated Costs

- Design: $35,000
- Construction: $160,000
- Annual Operations & Maintenance: ~$15,000

Lead Agency

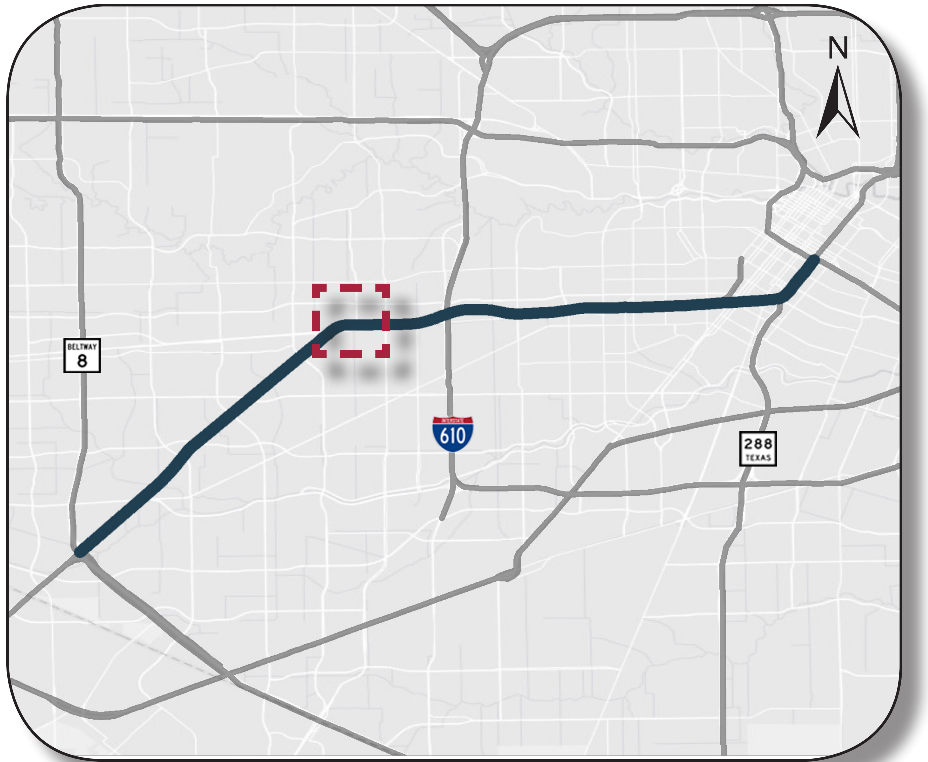
- TxDOT

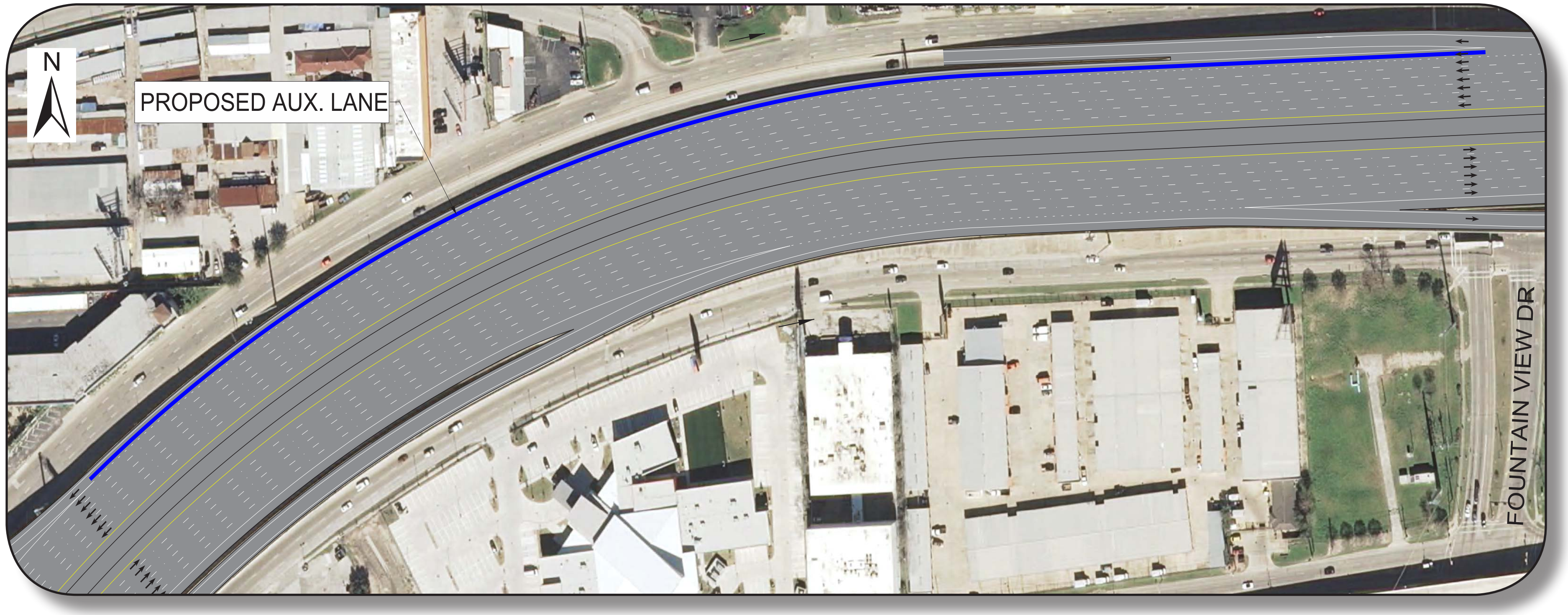
Anticipated Benefits

- Removes merge/weave area
- Increases traffic flow on freeway
- Increases speed on freeway
- Increases safety

Potential Challenges

- Obtaining a design exception for converting the shoulder into the auxiliary lane.





Key	
Good	★
Better	★★
Best	★★★

	Travel Time	Throughput	Reliability	Safety	Cost
Aux Lane Extended to Westpark Toll	★★	★	★★	★★	★★

Strategy: Bi-Directional HOV/HOT Lanes with Variable Pricing

Description

- Addition of a second HOT/HOV lane using available inside shoulders
- Additon of Variable Pricing

Estimated Costs

- Design: ~$20,000,000
- Construction: ~$200,000,000
- Annual Operations & Maintenance: ~$1,000,000

Lead Agency

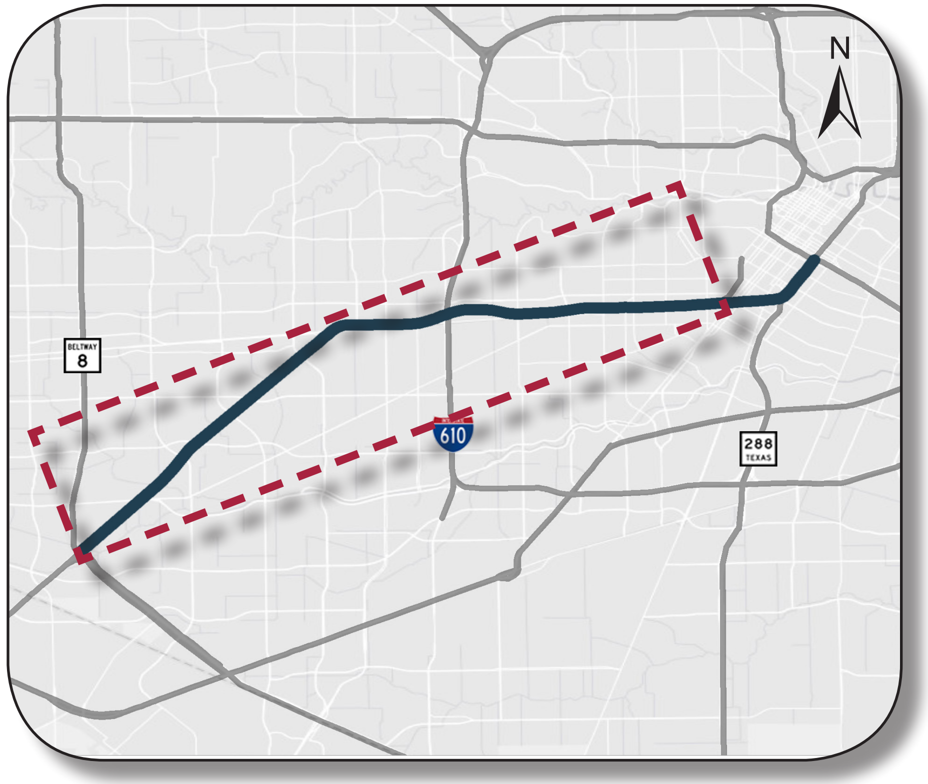
- METRO
- TxDOT

Anticipated Benefits

- Improves travel time relibility for transit or other eligible vehicles
- Increases speed and efficiency on main traffic lanes
- Improves safety by removing transit vehicles from main traffic flow
- Reduces congestion on tolled facilities by moving some traffic demand to alternate times and routes

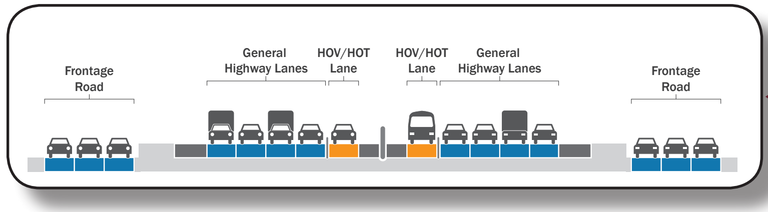
Potential Challenges

- Constructability
- Cost/Available Funding

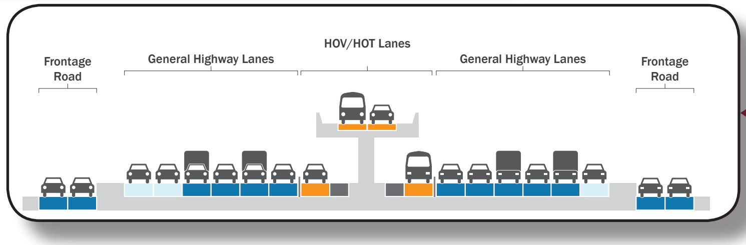


Key	
Good	★
Better	★★
Best	★★★

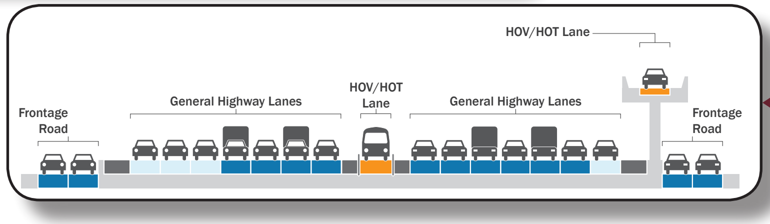
	Travel Time	Throughput	Reliability	Safety	Cost
Bi-directional HOV/HOT with Variable Pricing	★★	★★★	★★★	★	★



Typical



T-Ramp



IH-610 to Edloe

Strategy: Active Traffic Management

Dynamic Traffic Rerouting

Anticipated Benefits

- Reduces congestion by switching traffic to alternate routes
- Maximizes efficiency and capacity of the network by spreading traffic across the network
- Increases safety by decreasing the likelihood of secondary crashes

Potential Challenges

- Extensive sensor and sign infrastructure to ensure reliable alternate route information can be generated
- Available funding/cost

Dynamic Lane Assignments (Temporary Shoulder Use)

Anticipated Benefits

- Delays the onset of congestion by increasing capacity and improving trip reliability
- Increase in throughput by temporarily increasing capacity

Potential Challenges

- Available funding/cost
- Not used in many places in the U.S.
- Legislative change (temporary shoulder use)

Adaptive Ramp Flow Control (Ramp Metering with Detection)

Anticipated Benefits

- Increases speed and throughput on freeway by improving the flow of vehicles entering the freeway
- Decreases crash rates
- Relatively low cost to install and maintain

Potential Challenges

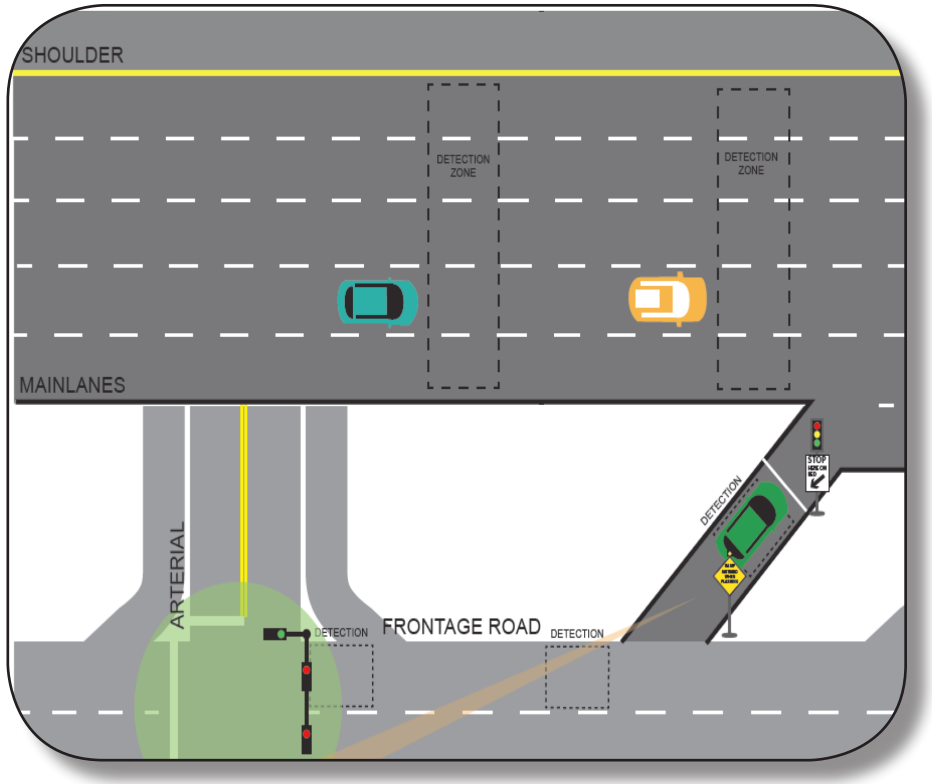
- Public acceptance

Estimated Costs

- Construction & Design: $35,000,000
- Annual Operations & Maintenance: ~$2,000,000

Lead Agency

- TranStar



Strategy: Active Traffic Management

Aggressive Incident Clearance

Anticipated Benefits

- Improves travel time reliability and decreases delay that accounts for ¼ of all congestion
- Increases response time through better coordination and information management
- Improves safety for emergency management personnel, those involved in the incident, and other drivers

Potential Challenges

- Available funding/cost

Traveler Information Systems

Anticipated Benefits

- Maximizes efficiency and capacity by providing current transportation system information to drivers
- Reduces impact of congestion
- Increases safety by alerting drivers of upcoming hazards

Potential Challenges

- Available funding/cost

Queue Warning

Anticipated Benefits

- Reduces primary and secondary crashes by alerting drivers of congested conditions
- Delays the onset of congestion, improving smooth and efficient traffic flow and trip reliability
- Provides environmental benefits through decreased emissions, noise, and fuel consumption

Potential Challenges

- Available funding/cost

Variable Speed Limit(Speed Harmonization)

Anticipated Benefits

- Improves safety by slowing vehicles approaching stop-and-go traffic
- Delays onset of congestion allowing traffic to flow smoothly and efficiently and improving trip reliability
- Provides environmental benefits through decreased emissions, noise, and fuel consumption

Potential Challenges

- New to the U.S. (successful in Europe)
- Public acceptance and understanding of the system
- Legislative change associated with particular strategies including temorary shoulder use and variable speed limits

Key	
Good	★
Better	★★
Best	★★★

	Travel Time	Throughput	Reliability	Safety	Cost
Active Traffic Management	★★★	★★★	★★★	★★★	★★★

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Chapter 6: Recommended Improvements

Active Traffic Management
Access Modifications
HOV/HOT Lanes
Prioritized List of Strategies

Final recommended improvements were determined based on benefit/cost analysis, agency feedback, and public involvment. Benefit/cost analysis was performed over a 20-year life cycle for the preferred strategies. The public benefit from time savings was calculated using Texas Transportation Institute (TTI) value of time, time of day adjustments, and an annualization factor. Annual growth for benefit calculations was based on estimated added operation capacity and the highest historical traffic counts.

Cost calculations were based on construction, design, operations, and maintenance. Using as-builts available from TxDOT and aerial imagery, the access modifications and additional capacity strategies were developed into conceptual engineering exhibits. Based on these concepts, cost estimates for plan development, construction, and operations and maintenance were developed. The benefit and cost calculations are provided in **Appendix D**.

Active Traffic Management

Active Traffic Management was evaluated using various strategies in DynusT. Dynamic rerouting, traveler information, and temporary shoulder use were modeled and showed significant improvement from the base conditions during recurring and non-recurring congestion. Based on case studies, the number of crashes is also expected to be reduced after implementation.

Benefit was calculated based on time savings and crash reduction. Cost was estimated based on infrastructure improvements, maintenance, and staffing to operate the additional infrastructure. The infrastructure includes:

- 5 full-color matrix DMS.
- 32 sign bridges with lane assignment DMS.
- 36 detour DMS along alternative routes and arterials.
- 12 adaptive ramp meters.

The 20-year timeline for the benefit/cost analysis was from 2018-2038. The 2018 date represents the target date of construction contingent on design and environmental requirements. **Table 6.1** shows the benefit/cost for the Active Traffic Management strategy.

Table 6.1: Active Traffic Management/Incident Management Benefit and Cost

Strategy	20-year Benefit ($2015)	20-year Cost ($2015)	Benefit/Cost
Active Traffic Management	$550,000,000	$72,000,000	7.6

The recommended Active Traffic Management incorporates several individual strategies into one traffic management plan. The strategies included in this Active Traffic Management Plan include:

- Traffic management during incidents.
- Dynamic rerouting and traveler information.
- Queue warning.
- Variable speed lImits/advisory speeds.
- Temporary shoulder use during incidents.
- Adaptive ramp flow control.
- Signal operation and management throughout the corridor.

The goal is to deploy new technology and implement new operational strategies to manage traffic during both recurring and non-recurring congestion, while improving safety along the corridor.

Access Modifications

Various access modifications are recommended to improve operations along the corridor. The existing ramp configuration has very short distances between entrance and exit ramps, which do not meet current desirable design standards. The access modifications aim at adjusting ramp locations to meet the current design standards, and in doing so, improve safety, reliability, and mobility throughout the corridor. The recommended access modifications include:

- Addition of an entrance/exit to the Southwest Freeway general purpose lanes between Hillcroft St. and Bellaire Blvd.
- Removal of the northbound entrance ramp from San Jacinto St.
- Removal of the southbound exit ramp to Newcastle Dr.
- Removal of the southbound entrance ramp from Kirby with the addition of a bypass over Buffalo Speedway.
- Consolidation of the two northbound entrance ramps upstream and downstream of Kirby Dr. to one entrance ramp bypassing Kirby Dr.
- Addition of a southbound auxiliary lane between exit ramp to Westpark Dr. and exit ramp to Westpark Tollway.

Each strategy showed benefit independently, as well as in combination with other proposed access modifications. The benefit was calculated for all proposed access modifications combined. It used a combination of Vissim and Synchro, an HCM intersection analysis tool, for time saving benefit and included frontage road intersection impacts. The cost for all proposed access modifications was developed using TxDOT bid items and expected maintenance of each modification.

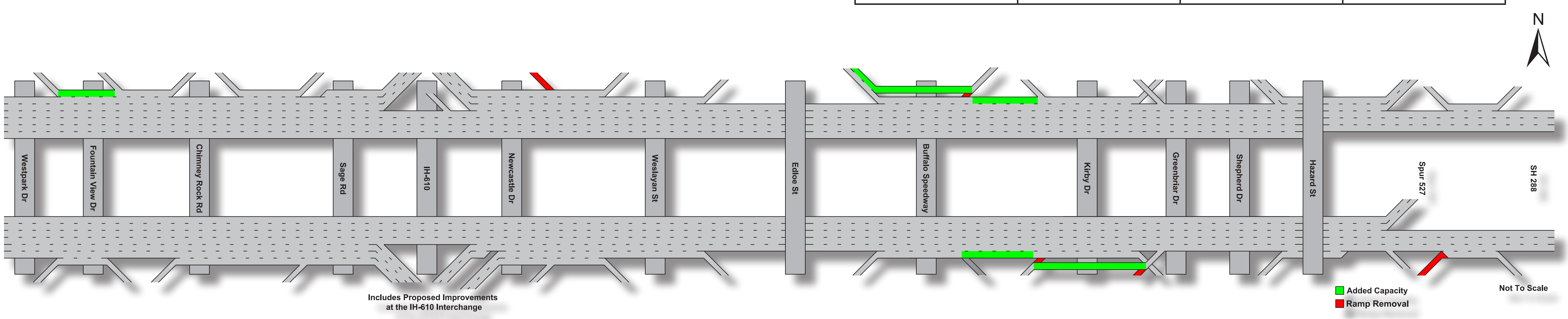
The 20-year timeline for the benefit/cost analysis was from 2021-2041. The 2021 date represents the target date of construction contingent on design and environmental requirements. **Table 6.2** shows the benefit/cost for the Access Modification strategies.

Access modifications provide significant operational improvement along the corridor.

The access modifications have historically been controversial due to the potential impact on adjacent businesses. Travelers will also be impacted due to change in normal travel routes. Public outreach and information would be necessary to further demonstrate the positive impacts associated with this strategy. A more detailed design analysis is required before implementation of these improvements can proceed.

Table 6.2: Access Modifications Benefit and Cost

Strategy	20-year Benefit ($2015)	20-year Cost ($2015)	Benefit/Cost
Access Modifications	$430,000,000	$19,000,000	23.1



HOV/HOT Lanes

The recommended managed lane strategy is to construct bi-directinal HOV/HOT lanes with variable pricing. Multiple managed lane strategies were analyzed relating to constructability, reliability, mobility, and cost. The HOV/HOT strategies eliminated from further consideration include bi-directional HOV/HOT without variable pricing and two reversible lanes in a single direction.

The 20-year timeline for the benefit/cost analysis was from 2025-2045. The 2025 date represents the target date of construction contingent on design and environment requirements. The HOV/HOT lanes strategy would also require further feasibility and design study before implementation. **Table 6.3** shows the benefit/cost for the HOV/HOT strategy.

Table 6.3: HOV/HOT Lanes Benefit and Cost

Strategy	20-year Benefit ($2015)	20-year Cost ($2015)	Benefit/Cost
HOV/HOT Lanes	$270,000,000	$240,000,000	1.1

The benefit includes time savings based on bi-directional movement, but does not reflect the benefit associated with travel time reliability. The strategy benefits travelers by providing a more reliable trip choice. It will also allow more effective transit planning and operations due to improved consistency in HOV/HOT operation. Transit ridership is expected to increase due to improved travel time. Finally, fewer maintenance and operation staff are required because there is no need to change direction of operation.

The majority of the cost is related to the elevated alignment required from the vicinity of IH-610 to Edloe St. There are design challenges at both interchanges that would need to be resolved. A schematic feasibility study must be conducted to determine the detailed design schematic for bi-directional managed lanes between IH 610 and Edloe St.

Prioritized List of Strategies

The three recommended strategies are prioritized based on expected construction year. The expected construction year was determined based on the next steps for each strategy.

Active Traffic Management – 2018

Active Traffic Management (ATM) can be implemented first because it can be constructed within the existing ROW and requires no additional pavement. This strategy has broad agency acceptance.

The ATM strategy will rely on new traffic operation plans that will be implemented at TranStar through the coordination of multiple agencies. These operational enhancements will require the agencies to update their current Concept of Operations (ConOps). The ConOps will identify the operational roles and responsibilities of agencies during specific case occurances (i.e., normal congestion, major incidents, and special events). The ConOps is necessary before system requirements and detailed design can begin. The ATM will be an integral part of the regional incident management plan. Possible funding sources include: Transportation Investment Generating Economic Recovery (TIGER) Grants, Motor Fuel Taxes, and State and Community Highway Safety Grants (Section 402).

Access Modifications – 2021

Access Modifications are the next priority. The strategies include ramp closures, re-striping, and additional pavement. Some individual strategies could be implemented contingent on public, business, and agency acceptance. This would include ramp closures and the added managed lane access points between Hillcroft St. and Bellaire Blvd. The bypasses at Buffalo Speedway and Kirby Dr. will require further detailed design analysis to determine details on how to retrofit this with existing infrastructure, including bridge structures. Possible funding sources include: Motor Fuel Taxes, Bonds, and the Highway Safety Improvements Program (HSIP).

TxDOT is expected to conduct a comprehensive planning and environmental study of the corridor beginning in 2016 and will include the recommended access modifications as part of the study.

HOV/HOT Lanes – 2025

The HOV/HOT lanes strategy is the final priority because it requires additional study. A schematic feasibility study must be conducted to address design issues for the managed lanes between IH-610 and Edloe St. The HOV/HOT lanes strategy will also require environmental study because it adds new pavement and elevated structure to the US 59/IH-69 corridor.

The next step for the HOV/HOT lanes strategy would be a detailed design feasibility study to determine lane location, access points, and start/end points. If it is determined that the proposed HOV/HOT lanes fit in the existing ROW, an environmental study would be performed to define the environmental impact along the corridor. TxDOT will include the recommended HOV/HOT lane improvements in the aforementioned planning and environmental study.

In addition to the three strategies stated above, investments in travel options should continue. These include strategies such as van pooling, carpooling, and additional express bus services.