# Texas Medical Center Mobility Study <br> September 2014 

## Prepared for City of Houston

Partner<br>Texas Medical Center



Consultant Team


Texas Medical Center

## PARSONS BRINCKERHOFF

Traffic Engineers, Inc.

# Texas Medical Center Mobility Study 

## FINAL REPORT

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City of Houston
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## TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... 1
1.0 INTRODUCTION ..... 7
1.1 Study Area ..... 7
1.2 Study Process ..... 9
1.3 Goals, Objectives, and Guiding Principles ..... 11
1.4 Stakeholder and Public Involvement ..... 11
2.0 BACKGROUND INFORMATION ..... 13
2.1 Campus Description ..... 13
2.2 Existing Traffic Volumes ..... 13
2.3 Traffic Level of Service ..... 15
2.4 Crash Experience ..... 19
2.5 Transit ..... 22
2.5.1 Metro Bus ..... 22
2.5.2 Metro LRT ..... 22
2.5.3 Ft. Bend Express ..... 22
2.5.4 TMC Shuttles ..... 24
2.5.5 Transit Use ..... 25
2.5.6 Operating Performance ..... 28
2.12 Parking ..... 29
2.12.1 Main Campus ..... 29
2.12.2 Mid Campus ..... 30
2.12.3 South Campus ..... 30
2.12.4 Rice University Campus ..... 30
2.12.5 Leland Anderson Campus ..... 30
2.13 Pedestrian and Bicycle Facilities ..... 33
2.13.1 Pedestrian Facilities ..... 33
2.13.2 Bicycle Facilities ..... 33
2.14 Travel Demand Management ..... 36
2.14.1 Overall Strategies ..... 36
2.14.2 Carpool/Vanpool and Transit Programs ..... 36
2.14.3 Staggered Work Hours ..... 36
2.14.4 Mixed-use High-Density Residential Development ..... 37
3.0 LAND USE AND GROWTH PROJECTIONS ..... 38
4.0 FUTURE YEAR CONDITIONS ANALYSES ..... 44
4.1 Street Network Analysis ..... 44
4.1.1 No-Build Conditions ..... 44
4.1.2 Build Conditions - Short and Mid-term Improvements ..... 49
4.1.3 Build Conditions - Long-term Improvements ..... 60
4.2 Transit ..... 73
4.2.1 METRO Bus ..... 73
4.2.2 Ft. Bend County Commuter Route ..... 81
4.2.3 Private TMC Shuttles ..... 81
4.2.4 Light Rail Transit ..... 81
4.2.5 US 90A/Southwest Rail Project ..... 98
4.2.6 Other Connections ..... 98
4.3 Parking Facilities ..... 98
4.3.1 Existing Parking Garage Operations ..... 99
4.3.2 Future Parking Demand /Supply ..... 99
4.3.3 ITS Parking Solutions ..... 99
4.3.4 Bicycle Parking ..... 102
4.4 Pedestrian/Bicyclist Facilities ..... 102
4.4.1 Needs Assessment ..... 103
4.4.2 Pedestrians ..... 103
4.4.3 Bicyclists ..... 108
5.0 MULTIMODAL CORRIDORS ..... 114
5.1 Recommended Multimodal Roadway Classification ..... 114
5.2 Corridor Sheets ..... 119
5.2.1 Holcombe Boulevard ..... 120
5.2.2 Old Spanish Trail ..... 121
5.2.3 Braeswood Boulevard/MacGregor Way ..... 122
5.2.4 Cambridge Street. ..... 123
5.2.5 Almeda Road ..... 125
5.2.6 Bertner Avenue ..... 126
5.2.7 Pressler Drive ..... 127
5.2.8 University Boulevard and Dryden Street ..... 128
5.2.9 Fannin Street ..... 129
5.2.10 Main Street ..... 131
6.0 CONCLUSION ..... 132
6.1 Roadway Short-term and Mid-term List of Improvements ..... 133
6.2 Roadway Long-term List of Improvements ..... 137
6.3 Parking List of Improvements ..... 139
6.4 Pedestrian and Bicycle List of Improvements ..... 139
6.5 Transit Bus and Rail Corridor Improvements ..... 151
6.6 Travel Demand Management Improvements ..... 153
APPENDIX - A: CONCEPT DEVELOPMENT OPTIONS
APPENDIX - B: PUBLIC COMMENT SUMMARY
$\qquad$APPENDIX - C: SYNCHRO TRAFFIC ANALYSIS RESULTS SUMMARY
TABLES
Table 2.1 24-HOUR TRAFFIC COUNTS IN PRIMARY STUDY AREA ..... 15
Table 2.2 WEEKDAY PEAK HOUR INTERSECTION OPERATING AT LEVEL OF SERVICE E OR F - EXISTING CONDITIONS ..... 16
Table 2.3 CRASH DATA BY INTERSECTION FROM 2007 TO 2011 ..... 20
TABLE 2.4 GEOGRAPHIC DISTRIBUTION OF TMC STUDY AREA ..... 25
TABLE 2.5 CURRENT TRANSIT PASSENGERS BOARDING AND ALIGHTING ..... 26
Table 2.6 TEN MOST-USED TMC BUS STOPS - AVERAGES IN FY2011 ..... 27
Table 2.7 OPERATING PERFORMANCE OF BUS SYSTEMS THAT SERVE THE TMC AREA ..... 28
Table 2.8 OPERATING PERFORMANCE OF THE METRO LIGHT RAIL RED LINE ..... 29
Table 3.1 H-GAC Model Data for TMC Study Area Traffic Analysis Zones ..... 38
Table 3.2 Projected Growth for TMC Study Area Traffic Analysis Zones ..... 39
TABLE 3.3 PROJECTED GROWTH FOR TMC STUDY AREA ROADWAY SECTIONS ..... 40
Table 4.1 LEVEL OF SERVICE (LOS) CRITERIA FOR INTERSECTIONS ..... 44
Table 4.22035 NO-BUILD CONDITIONS LEVEL OF SERVICE ..... 45
TABLE 4.3 LOS COMPARISON EXISTING CONDITIONS VS. SHORT-TERM IMPROVEMENTS50
Table 4.42035 OPERATIONS: NO-BUILD VS. UNIVERSITY/DRYDENONE-WAY PAIR ..... 52
Table 4.5 YEAR 2020 - NO-BUILD CONDITIONS VS. MID-TERM IMPROVEMENTS ..... 55
Table 4.62035 Volumes: No-Build vs. Holcombe Transportation Terminal ..... 61
Table 4.72035 Volumes: No-Build vs. Almeda Transportation Terminal ..... 62
Table 4.82035 OPERATIONS: NO-BUILD VS. HOLCOMBE OVERPASS OPTION. ..... 65
Table 4.92035 OPERATIONS : NO-BUILD vs. OLD SPANISH TRAIL OVERPASS OPTION ..... 66
Table 4.102035 OPERATIONS: NO-BUILD VS. HOLCOMBE BOULEVARD EXPRESS LANE GRADE SEPARATION ..... 69
Table 4.112035 OPERATIONS: NO-BUILD VS. OLD SPANISH TRAIL EXPRESS LANE GRADE SEPARATION ..... 70
Table 4.12 CHARACTERISTICS FOR REIMAGINED NETWORK IN TMC STUDY AREA ..... 80
TABLE 4.13 OVERALL LRT EVALUATION CRITERIA WEIGHTS ..... 95
TABLE 4.14 LRT EVALUATION CRITERIA SCORES ..... 95
Table 4.15 GENERAL TRAFFIC TRAVEL TIME ON FANNIN IMPACT (CAMBRIDGE TO PRESSLER STS.) ..... 97
TABLE 4.16 WEEKDAY PEAK HOUR LOS/DELAY WITH TWO-WAY LRT ON MAIN STREET ..... 97
Table 4.17 WEEKDAY PEAK HOUR LOS/DELAY WITH TWO-WAY LRT ON MAIN STREET PAIR98
TABLE 4.18 Summary of Parking Spaces Required by New Development in TMC ..... 100
TABLE 4.19 EXISTING BICYCLE RACK LOCATIONS ..... 102
Table 4.20 TMC Pedestrian Counts ..... 106
TABLE 5.1 RECOMMENDED MULTIMODAL ROADWAY CLASSIFICATION FOR TMC STUDY AREA117
TABLE 6.1 RECOMMENDED ROADWAY SHORT-TERM AND MID-TERM LIST OF IMPROVEMENTS ..... 133
Table 6.2 RECOMMENDED ROADWAY LONG-TERM LIST OF IMPROVEMENTS ..... 137
TABLE 6.3 RECOMMENDED SIDEWALK AND SHARED-USE PATH IMPROVEMENTS ..... 142
Table 6.4 RECOMMENDED INTERSECTION ACCESSIBILITY IMPROVEMENTS ..... 147
Table 6.5 RECOMMENDED ON-STREET BICYCLE FACILITY IMPROVEMENTS ..... 148
Table 6.6 RECOMMENDED NEW SKYWALK IMPROVEMENTS ..... 150
Table 6.7 RECOMMENDED METRO BUS SERVICE MPROVEMENTS ..... 152
Table 6.8 RECOMMENDED ENHANCED TDM STRATEGIES FOR TMC ..... 154
FIGURES
Figure 1.1 STUDY AREA ..... 8
FIGURE 1.2 CITY OF HOUSTON MOBILITY PLANNING PROCESS ..... 10
Figure 2.1 TMC CAMPUSES ..... 14
Figure 2.2 WEEKDAY AM PEAK HOUR LEVEL OF SERVICE AT STUDY INTERSECTIONS ..... 17
FIGURE 2.3 WEEKDAY PM PEAK HOUR LEVEL OF SERVICE AT STUDY INTERSECTIONS ..... 18
FIGURE 2.4 NUMBER OF CRASHES AT STUDY INTERSECTIONS FROM 2007 TO 2011 ..... 21
FIGURE 2.5 EXISTING TRANSIT ROUTES MAP - GENERAL STUDY AREA ..... 23
FIGURE 2.6 MD ANDERSON SHUTTLE ROUTES ..... 24
Figure 2.7 METRO RED LINE STATIONS WEEKDAY ON AND OFF PASSENGERS ..... 27
FIGURE 2.8 EXISTING TMC PARKING CAPACITY ..... 31
FIGURE 2.9 EXISTING TMC PARKING OCCUPANCY ..... 32
FIGURE 2.10 EXISTING PEDESTRIAN FACILITIES ..... 34
FIGURE 2.11 EXISTING BICYCLE FACILITIES ..... 35
FIGURE 3.1 PROJECT FUTURE GROWTH IN YEAR 2035 IN TMC AREA ..... 41
FIGURE 3.2 EXISTING AVERAGE DAILY TRAFFIC ..... 42
FIGURE 3.3 FUTURE YEAR 2035 PROJECTED AVERAGE DAILY TRAFFIC ..... 43
Figure 4.12035 NO-BUILD LEVEL OF SERVICE - WEEKDAY AM PEAK HOUR ..... 47
FIGURE 4.22035 NO-BUILD LEVEL OF SERVICE - WEEKDAY PM PEAK HOUR ..... 48
FIGURE 4.3 SHORT-TERM IMPROVEMENT LOCATIONS AND LOS WITH IMPROVEMENTS ..... 51
Figure 4.4 Texas medical center area mobility study ..... 53
FIGURE 4.5 MID-TERM IMPROVEMENT LOCATIONS AND LOS WITH IMPROVEMENTS ..... 56
FIGURE 4.6 POTENTIAL PRESSLER STREET EXTENSION CONCEPT THAT NEEDS FURTHER REVIEW ..... 57
FIGURE 4.7 FUTURE RECOMMENDED CAMPUS CONNECTIONS ..... 59
FIGURE 4.8 OPTION 1A HOLCOMBE BOULEVARD TRANSPORTATION TERMINAL ..... 63
FIGURE 4.9 OPTION 1B ALMEDA ROAD TRANSPORTATION TERMINAL ..... 64
FIGURE 4.10 OPTION 2A GRADE SEPARATION AT HOLCOMBE INTERSECTIONS ..... 67
FIGURE 4.11 OPTION 2B GRADE SEPARATION AT OST INTERSECTIONS ..... 68
FIGURE 4.12 OPTION 3A HOLCOMBE BOULEVARD GRADE SEPARATED EXPRESS LANES71 FIGURE 4.13 OPTION 3B OLD SPANISH TRAIL GRADE SEPARATED EXPRESS LANES ..... 72
FIGURE 4.14 DRAFT METRO REIMAGINED NETWORK ..... 77
FIGURE 4.15 DRAFT METRO FREQUENT NETWORK ..... 78
Figure 4.16 EXISTING FANNIN STREET CROSS SECTION WITH TWO-WAY LRT IN MEDIAN ..... 82
Figure 4.17 CONCEPTS FOR LRT RELOCATION AND TMC PEOPLE MOVER ROUTE ..... 83
FIGURE 4.18 FANNIN STREET CROSS SECTION WITH LRT ON WEST SIDE OF STREET (LOOKING SOUTHWEST) ..... 84
FIGURE 4.19 TRANSIT/PEDESTRIAN MALL CROSS SECTION ON FANNIN ..... 85
FIGURE 4.20 FANNIN STREET CROSS SECTION WITH ONE-WAY LRT COUPLET WITH MAIN (LOOKING SOUTHWEST). ..... 85
FIGURE 4.21 MAIN STREET CROSS SECTION WITH TWO-WAY LRT. ..... 86
Figure 4.22 SUBWAY LRT CROSS SECTION ON FANNIN STREET ..... 87
Figure 4.23 ELEVATED LRT CROSS SECTION ON FANNIN STREET. ..... 87
FIGURE 4.24 ESTIMATED LRT RUNNING TIMES AND DISTANCES FOR TMC ALTERNATIVES89
Figure 4.25 RANGE IN CAPITAL COSTS FOR LRT RELOCATION/PEOPLE MOVER ALTERNATIVES91
FIGURE 4.26 WEEKDAY USER TIME SAVINGS OR LOST WITH LRT RELOCATION/PEOPLE MOVER ALTERNATIVES ..... 92
FIGURE 4.27 ANNUALIZED COST AND USER BENEFITS FOR LRT RELOCATION/PEOPLE MOVER ALTERNATIVES ..... 93
Figure 4.28 BENEFIT/COST RATIO OF LRT RELOCATION/PEOPLE MOVER ALTERNATIVES. ..... 94
FIGURE 4.29 OVERALL LRT ALTERNATIVES COMPARISON ..... 96
FIGURE 4.30 TMC PARKING FACILITIES. ..... 101
Figure 4.31 PEDESTRIAN CONFLICTS ..... 104
Figure 4.32 SKYWALK PLAN ..... 105
Figure 4.33 EXISTING CONDITION OF SIDEWALKS AND SHARED-USE PATHS ..... 107
Figure 4.34 EXISTING CITY OF HOUSTON BICYCLE PLAN ..... 110
Figure 4.35 RECOMMENDED SIDEWALK AND SHARED-USE PATH Improvements ..... 112
Figure 4.36 RECOMMENDED TMC BICYCLE PLAN ..... 113
Figure 5.1 REVISED CITY STREET FUNCTIONAL CLASSIFICATION SYSTEM ..... 114
Figure 5.2 TYPICAL SECTION FOR HOLCOMBE BOULEVARD ..... 120
Figure 5.3 TYPICAL SECTION FOR OLD SPANISH TRAIL ..... 121
Figure 5.4 TYPICAL SECTION FOR BRAESWOOD BOULEVARD/MACGREGOR WAY ..... 122
Figure 5.5 TYPICAL SECTIONS FOR CAMBRIDGESTREET ..... 124
Figure 5.6 TYPICAL SECTIONS FOR ALMEDA ROAD ..... 125
Figure 5.7 TYPICAL SECTIONS FOR BERTNER AVENUE ..... 126
Figure 5.8 TYPICAL SECTIONS FOR PRESSLER DRIVE ..... 127
Figure 5.9 TYPICAL SECTIONS FOR UNIVERSITY BOULEVARD AND DRYDEN STREET ..... 128
Figure 5.10 TYPICAL SECTIONS FOR FANNIN STREET ..... 130
Figure 5.11 TYPICAL SECTIONS FOR MAIN STREET ..... 131
Figure 6.1 RECOMMENDED LOCAL CAMPUS CIRCULATION IMPROVEMENTS ..... 136
Figure 6.2 RECOMMENDED SIDEWALK AND SHARED-USE PATH IMPROVEMENTS ..... 140
Figure 6.3 RECOMMENDED TMC BICYCLE PLAN ..... 141

## EXECUTIVE SUMMARY

The City of Houston and the Texas Medical Center (TMC) developed a transportation plan for the TMC campus and surrounding area through the Texas Medical Center Mobility Study. The TMC Mobility Study's objective is to develop a comprehensive list of multi-modal transportation improvements for the study area.

A Steering Committee was formed to provide direction to the TMC Mobility Study. Members of the Steering Committee included representatives from the following organizations:

- City of Houston
- Harris County
- Houston Galveston Area Council (H-GAC)
- MD Anderson Campus
- METRO
- Rice University
- Texas Children's Hospital
- Texas Department of Transportation (TxDOT)
- Texas Medical Center Corporation
- The Methodist Hospital System

As part of the data collection task, traffic, transit, parking, employment, building usage, pedestrian and bicycle facility information was collected from TMC and member institutions, City of Houston, TxDOT, METRO and H-GAC. This data was the basis for conducting needs assessment and alternatives evaluation for future conditions.

An important part of this study was stakeholder input. Individual interviews and group meetings were held with all stakeholders identified for this study. An interview questionnaire was prepared that helped the study team gather information on transportation priorities, problem areas and needs of the stakeholders. A public meeting was also conducted to seek feedback from employees, residents, visitors and students regarding the TMC area facilities. Their input was summarized in a matrix format, Stakeholder Interview Summary.

Based on these interviews, the following were identified as the top priorities in TMC area by the stakeholders:

- Improve parking access and availability
- Improve road network mobility
- Reduce vehicular congestion
- Improve multimodal safety
- Improve pedestrian connectivity

The study methodology was developed as per the City of Houston Mobility Planning (CMP) Process. The Integration with CMP Process report documents how the TMC Mobility Study was integrated into the City of Houston Mobility Planning Process. Existing transportation, land use, socio-economic and environmental conditions in the study area were documented in an initial Background Conditions Report
(summarized in Chapter 2). Due to the unique multimodal components along Fannin Street, detailed Red Line LRT and traffic operational analysis was documented in a Fannin Street Corridor Analysis Memo (summarized in Chapter 4).

Based on the existing conditions analysis and needs assessment, an initial list of improvement concepts was developed for roadway, transit, parking, pedestrian and bicyclist facilities. A fatal flaw analysis was performed to screen the initial list with guidance and input from steering committee members and stakeholders. These improvement concepts combined with future growth and future traffic conditions were assessed before assembling a final list of improvement concepts.

This report documents the future year conditions analyses and identified list of improvement concepts for roadway, transit, parking, pedestrian and bicyclist facilities (Chapter 4). An updated Roadway Functional Classification is also recommended based on multimodal classification as per the Complete Streets policy (Chapter 5). A final public meeting was conducted to present the final list of improvement concepts. Corridor wide improvements are summarized in specific corridor sheets in Chapter 5.

The final list of improvement concepts is documented in Chapter 6 with detailed location, project detail, benefits and order of magnitude cost estimates presented below by mode. A summary of the improvement concepts is presented below. However, several of these concepts require further analysis and assessment for prioritization, design feasibility, traffic circulation and access impacts.

## Roadway Short-term and Mid-term Improvements

Short-term improvements are those that are proposed to be implemented within the next ten years and mid-term improvements in the next 15 years. The total cost to implement all the listed improvements is approximately $\$ 24$ million. These cost estimates do not include right-of-way acquisition costs. The analysis is included in Section 4.1.2

- Local Circulation Improvements
- Parking ITS Solutions
- Intersection Improvements
o Cambridge at East Drive
o Cambridge at Braeswood
o 288 Northbound Frontage Road at Old Spanish Trail
o 288 Northbound Frontage Road at Holcombe
o Main at Cambridge
o Fannin at Pressler
o Almeda at Old Spanish Trail
o Cambridge at Holcombe
o Holcombe at Main
o Holcombe at Almeda
o Old Spanish Trail at Fannin
o Old Spanish Trail at Bertner
o Old Spanish Trail at Cambridge
- Corridor Signal Timing Optimization


## Roadway Long-term Improvement Concepts

Future visions for corridors within the study area provided in Section 5.2. Below are long-term conceptual options that were evaluated by the study. These are independent alternative options. The capital cost to implement each alternative is listed in 2014 dollars and is an approximate value. These cost estimates do not include right-of-way acquisition costs. More details on these stand alone concepts are included in Section 4.1.3.

- Transportation Terminal (with remote parking, bus and shuttle services) on Holcombe Boulevard - \$ 30 M
- Grade-separation at Major Intersections on Holcombe Boulevard - \$ 85 M
- Grade Separated Express Lanes on Holcombe Boulevard - \$ 120 M
- Grade-separation at Major Intersections on Old Spanish Trail - \$ 85 M
- Grade Separated Express Lanes on Old Spanish Trail- \$ 105 M
- Transportation Terminal on Almeda Road - \$ 15 M
o With Almeda Road Direct Connector to Transportation Terminal- \$ 30 M


## Parking Improvement Concepts

The Texas Medical Center area has several parking garages and many more anticipated to be developed along with the proposed developments. Without the implementation of way finding signs and incorporated ITS solutions, the available spaces in parking garages may go unnoticed. The analysis is included in Section 4.3. The following list of improvements is proposed.

- Transportation Terminal /Remote Parking Options
o Almeda vicinity
o Holcombe Vicinity
- Parking Facilities Management
o Incorporate ITS Solutions
o Electronic Parking Guidance Signs
o Display Space Availability
o Improved Customer Information Through Enhanced Mobile Application
- Alternative Parking Payment Solutions
o Parking Mobile Application
o EZTag for Payment
o Payment through third party vendor


## Pedestrian and Shared-Use Infrastructure Improvement Concepts

New sidewalks and those that require replacement to fill gaps in the sidewalks and shared-use paths along the following streets are identified as pedestrian improvement concepts. The analysis is included in Section 4.4. Approximate cost estimates suggest that the total cost to implement all these improvements would be $\$ 4.2$ million. But potential right-of-way acquisition costs are not included. Roadways where these improvements would be implemented include:

- S. MacGregor Way
- Brays Bayou
- Cambridge
- N MacGregor
- Almeda
- Bertner
- Fannin
- Greenbriar
- Holcombe
- Braeswood
- University
- Rice
- Bates
- Wyndale
- Swanson
- Hepburn
- Lamar Fleming to Herman Park Drive


## Intersection Accessibility Improvement Concepts

Intersections where curb ramp improvements and some redesign of intersections due to pedestrian and bicyclist accessibility are listed below. Approximate cost estimates suggest that the total cost to implement all the improvements except the two probable major redesign intersection locations would be $\$ 36,000$. But potential right-of-way acquisition costs are not included.

- Holcombe at Fannin
- Fannin at Old Main
- Holcombe at Main
- Cambridge at MacGregor
- Dryden at Travis
- Dryden at Lanier
- Greenbriar at Sunset
- Holcombe at Ringness
- Fannin at Knight - redesign of intersection - separate study is needed
- Fannin at Greenbriar - redesign of intersection - separate study is needed


## On-street Bicycle Facilities

Streets along which on-street bicycle facilities are proposed are listed below. Approximate cost estimates suggest that the total cost to implement all the improvements would be $\$ 4.1$ million. These costs do not include right-of-way acquisition costs.

- East-Bertner-Moursund
- Knight-West-Bertner
- Kent-Alumni-path-Freeman-Bertner
- McClendon-Travis
- Stockton
- N Stadium-S Braeswood
- Pressler
- Dryden


## Skywalks

Two new pedestrian skywalks were identified to provide improved and safer access from garages as listed below.

- Braeswood Garage to MD Anderson - $\$ 3$ million
- TMC Transit Center to MD Anderson - $\$ 2$ million


## Light Rail Transit Assessed List of Concepts

A thorough analysis was conducted to assess the potential for Red Line LRT improvements through the TMC, including the following alternatives for potential relocation:

- LRT moved to the west side of Fannin
- Conversion of Main and Fannin to a one-way pair with split at-grade LRT
- LRT relocated to Main Street
- LRT realigned in subway on Fannin
- LRT realigned on elevated structure on Fannin
- LRT relocated via Cambridge, MacGregor, and Braeswood
- LRT relocated via Cambridge, MacGregor, and Holcombe

More details and thorough analyses is included in Section 4.2. Based on the evaluation of the different LRT relocation and people mover alternatives, and roadway analysis undertaken from Fannin Street, no major improvements to LRT operations or realignment is proposed because of the high cost of any of the alternatives considered. LRT operations would be improved with some reduction in vehicular conflicts with the following lower cost roadway improvements along Fannin:

- Develop a one-way couplet for University Boulevard (westbound) and Dryden Road (eastbound) between Fannin and Main Streets. This option would require further analysis and assessment of traffic circulation and access impacts.
- Remove traffic signals on Fannin at John Freeman Drive and Bellows Street
- Improved signal timing optimization
- Develop Transit/Pedestrian Mall on Fannin. This option would require a detailed assessment.

Alternatives for a potential automated people mover system within the TMC Main Campus to improve local accessibility were also evaluated. The people mover concept may require a separate evaluation with new development concepts in TMC area.

## Bus Transit Improvement Concepts

- Re-align route 34 and improve headways
- Re-route peak-direction route 292 service
- Extend route 402 into the TMC main campus or to VA Medical Center
- Retain the $26 / 27$ route as it is; modify route 426 to include service to VA Medical Center
- Campus shuttles for connections to new remote parking/transportation facility

In conclusion, the next steps after the TMC Mobility Study was submitted are -

- Evaluate parking improvement concepts for implementation
- Transit-related recommendations will be forwarded to Metro for consideration
- Trail-related recommendations will be forwarded to the City of Houston Parks and Recreation Department
- Sidewalk gaps will be evaluated under the City of Houston's Safe Sidewalk Program
- Intersection and roadway-related recommendations will be prioritized in accordance with the CIP process
- Economic development strategies to be developed with TMC/City of Houston and Harris County TIRZ 24


### 1.0 INTRODUCTION

The Texas Medical Center is the largest medical center in the world with 92,500 employees located close to downtown Houston. The City of Houston and the Texas Medical Center (TMC) decided to prepare an updated transportation plan for the TMC campus and surrounding area through the Texas Medical Center Mobility Study. This Mobility Study results in identifying improvement concepts for all modes of travel. The proposed improvements would improve accessibility, address traffic congestion, and better serve future development in the TMC area. The study represents an update of the TMC Transportation Master Plan in 2002, and will provide guidance on the identification of projects and prioritization of projects to enhance mobility in the TMC area in the future. The study consisted of collecting and assessing data from major intersections, parking facilities, transit routes, and current/ proposed developments for the purpose of addressing long-term mobility needs. Funding for the study was provided from an earmarked Federal Transit Administration (FTA) grant, with TMC and the City of Houston providing the local match. The area in and around TMC includes numerous interests whose involvement in the study process is critical. These interests were addressed in a series of Steering Committee meetings and Stakeholder meetings, as well as two general public meetings. While overall improvements were considered for a general area in the vicinity of TMC, the majority of analysis was focused on TMC and its immediate surroundings.

A Steering Committee was formed to provide direction to the TMC Mobility Study. Members of the Steering Committee include representatives from the following organizations:

- City of Houston
- Harris County
- Houston Galveston Area Council (H-GAC)
- MD Anderson Campus
- METRO
- Rice University
- Texas Children's Hospital
- Texas Department of Transportation (TxDOT)
- Texas Medical Center Corporation
- The Methodist Hospital System


### 1.1 Study Area

The project's general study area is bound by Alabama Street (north), Scott Street (east), Sam Houston Tollway (south), and Buffalo Speedway (west). Within the general study area is a primary study area, bounded by Hermann Drive/ Sunset Boulevard (north), Almeda Road (east), Holly Hall Street (south), and Greenbriar Drive (west). The TMC study area falls within the Greater Southeast Management District in the City of Houston. There are four Super Neighborhoods within the primary study area: Medical Center, Astrodome Area, University Place and Museum Park. Figure 1.1 shows a map of the overall study area.


FIGURE 1.1 STUDY AREA

### 1.2 Study Process

The TMC Mobility Study's objective was to develop a comprehensive list of multi-modal transportation improvements for the TMC campus and surrounding area. As part of the data collection task, traffic, transit, parking, employment, building usage, pedestrian and bicycle facilities information was collected from the TMC and member institutions, City of Houston, TxDOT, METRO and H-GAC. This data was the basis for conducting needs assessment and alternatives evaluation for future conditions.

Stakeholder interviews, an initial public meeting, two stakeholder group meetings and a final public meeting were conducted to provide study information and solicit inputs from the stakeholders. Their input was summarized in a matrix format, Stakeholder Interview Summary.

The study methodology was developed as per the City of Houston Mobility Planning (CMP) Process and is shown in Figure 1.2. The CMP Objectives report documents how the TMC Mobility Study was integrated into the City of Houston Mobility Planning Process. Existing transportation, land use, socioeconomic and environmental conditions in the study area were documented in an initial Background Conditions Report. Due to the unique multimodal components along Fannin Street, detailed Red Line LRT and traffic operational analysis was documented in a Fannin Street Corridor Analysis Memo.

Based on the needs assessment and existing conditions analysis, an initial list of improvement concepts was developed for roadway, transit, parking, pedestrian and bicyclist facilities. A fatal flaw analysis was performed to screen the initial list with guidance and input from steering committee members and stakeholders. These improvement concepts combined with future growth and future traffic conditions were assessed before finalizing a list of transportation improvement concepts.

This report documents the future year conditions analyses and identified list of improvement concepts for roadway, transit, parking, pedestrian and bicyclist facilities. An updated Roadway Functional Classification is also recommended based on multimodal classification as per the City of Houston Complete Streets policy. A final public meeting was conducted to present the final list of improvements.


FIGURE 1.2
CITY OF HOUSTON MOBILITY PLANNING PROCESS
(From City Mobility Planning - Phase 1: Executive Summary - 2009)

### 1.3 Goals, Objectives, and Guiding Principles

A set of 19 objectives were identified through a CMP Technical Working Group to guide the CMP process. These include:

1. Increased access to transit facilities
2. Increased access to pedestrian facilities
3. Increased access to bicycle facilities
4. Improve connectivity to the system
5. Accommodate the movement of freight
6. Cost efficiency
7. Minimize travel times
8. Reliable commutes
9. Reduce increase in congestion
10. Minimize conflict points
11. Provide a safe and secure environment for pedestrians and bicyclists
12. Neighborhood traffic
13. Air quality conformity
14. Ability to maintain infrastructure
15. Maintain a system that is energy efficient
16. Improve corridor aesthetics
17. Expand pedestrian amenities
18. Streets that are pedestrian scale
19. Facilitate all modes of travel

These objectives were used in the CMP process to help identify and prioritize projects and monitor progress in meeting the improved mobility goal within the City of Houston.

Based on stakeholder interviews and public input, the following five objectives were the top priority for the TMC Mobility Study:

1. Improve parking access and availability
2. Improve road network mobility
3. Reduce vehicular congestion
4. Improve multimodal safety
5. Improve pedestrian connectivity

Consistent with the CMP objectives, a set of specific TMC Mobility Plan objectives and a set of associated criteria and performance measures were identified for use in developing and evaluating mobility improvement options and final strategies for the TMC area. These are documented in detail in the Integration with City Mobility Planning Objectives memo.

### 1.4 Stakeholder and Public Involvement

An important part of this study was stakeholder input. Several of the steering committee members were also identified as stakeholders for conducting individual interviews. A stakeholder group was formed that included pertinent management districts, neighborhood associations, super neighborhoods, civic clubs, Hermann Park, Museum District, Reliant Stadium and representatives from Council Districts.

Individual interviews with sixteen stakeholders and two group meetings were held with all stakeholders identified for this study. An interview questionnaire was prepared that helped the study team gather information on priorities, problem areas and needs of the stakeholders. A public meeting was also conducted to seek feedback from employees, residents, visitors and students regarding the TMC area facilities. Their input was summarized in a matrix format and thus helped the study team to organize comments by mode, by problem and by location. All the public input comments received throughout the study are summarized in the TMC Study Public Comments Memo.

The first stakeholder group meeting was held at the beginning of the study to provide background and scope of the study and gather feedback from the stakeholders on problem areas. This input was helpful for assessing area wide needs. The first public meeting was also held for needs assessment and to develop a vision for some of the improvement concepts. A second stakeholder group meeting and public meeting were held after the future year conditions analyses to discuss and provide information about improvement alternatives.

Steering Committee meetings were held every month or two months based on project milestones. The Steering Committee's guidance played a pivotal role in guiding the study team and forming the direction for the study.

### 2.0 BACKGROUND INFORMATION

This section includes a summary of the Background Information Report presented as a separate document. The purpose of this report was to document existing conditions and facilities for vehicular traffic, transit, pedestrians and bicyclists.

### 2.1 Campus Description

The TMC area comprises of the following five campuses as shown in Figure 2.1.

- Main Campus

Main Campus is the historic core of the Texas Medical Center. It extends from Main Street to MacGregor Way and Cambridge to Braeswood Boulevard. Main Campus is home to 72 institutions and buildings in the study area focusing on patient care, education, research, parking and administration. Emphasis for this campus is on direct connection to transit, well designed pedestrian environment and superior public spaces.

- Mid Campus

Mid Campus extends south of Braeswood Boulevard to Old Spanish Trail. In the recent years, development has extended west of Greenbriar Drive and east of Almeda Road. Mid Campus hosts large developments and buildings such as the Michael E.DeBakey Veterans Affairs Medical Center, the H.Markley Crosswell Campus, the John P. McGovern Campus, the South Extension and Smith Lands parking lots. Its focus includes patient care, research, retail, administration, office, housing and parking. In total, this campus comprises 375 acres, with 24 institutions and buildings.

- South Campus

South Campus extends south of Old Spanish Trail to El Paseo Street and between Fannin Street and Cambridge Street. The South Campus hosts 17 institutions and buildings including a premier world-class cancer research and treatment center, a dental school and mental health institute.

- Leland Anderson Campus

The Leland Anderson (LA) Campus hosts 5 institutions and buildings and is east of SH 288 and south of MacGregor Way. This campus is adjacent to a residential neighborhood with a high school for health professions and a child-care center. Its focus includes mental health; community based health care education, child-care services and parking.

- Rice University Campus

The Rice University Campus extends south of Sunset Boulevard to University Boulevard and from Rice Boulevard to Main Street. Rice University buildings, housing and libraries are at this campus.

### 2.2 Existing Traffic Volumes

The traffic data collection effort included Average Daily Traffic (ADT) volumes provided by the City of Houston and new vehicle turning movement counts obtained for the primary study area intersections during both weekday AM and PM peak periods. Existing roadway geometry and traffic control information was gathered through field review. Signal timing data was provided by the City of Houston; and crash data provided by the Houston-Galveston Area Council (H-GAC).


FIGURE 2.1
TMC CAMPUSES

The Year 2011 bi-directional 24-Hour traffic volumes on the roadways in the study area were obtained from the City of Houston GIMS maps; streets with the highest traffic volumes are listed in Table 2.1

TABLE 2.1
24-HOUR TRAFFIC COUNTS IN PRIMARY STUDY AREA

| Street | Location | ADT |
| :---: | :---: | :---: |
| Main St | North of Sunset Blvd | 34,469 |
| Main St | South of Sunset Blvd | 34,599 |
| Main St | South of University Blvd | 34,911 |
| Holcombe Blvd | West of Greenbriar Dr | 31,691 |
| Holcombe Blvd | East of Greenbriar Dr | 43,509 |
| Main St | South of Greenbriar Dr | 33,957 |
| Main St | South of Dryden | 34,911 |
| Holcombe Blvd | East of Bertner Ave | 31,265 |
| Fannin St | South of Braeswood Blvd | 25,238 |
| Fannin St | North of Holly Hall St | 30,004 |
| Fannin St | North of Old Spanish Trail | 25,238 |
| Kirby Dr | North of Old Spanish Trail | 25,769 |
| Old Spanish Trail | East of Kirby Dr | 25,094 |
| Holcombe Blvd | East of Cambridge St | 25,064 |

### 2.3 Traffic Level of Service

A traffic counting program was undertaken by the study team to obtain the existing weekday AM and PM peak hour traffic data at the analysis intersections. The pedestrian volumes at the study intersections were also collected. Traffic volumes for all study intersections were compared to determine the study area peak hours within the weekday peak periods. The overall peak hours determined from these counts are as follows:

- AM Peak Hour - 7:15 AM to 8:15 AM
- PM Peak Hour - 4:45 PM to 5:45 PM

Intersection Level of Service analyses were performed in accordance with the procedures set forth and recommended by the 2010 Highway Capacity Manual (HCM) Level of Service methodologies for evaluation of signalized and unsignalized intersections. The traffic analysis software SYNCHRO was used to evaluate the operations of the study intersections. Level of Service (LOS) is a quantitative stratification of a performance measure or measures that represent quality of service. A change of LOS indicates that roadway performance has transitioned from one given range of traveler-perceivable conditions to another range. LOS ' $A$ ' is considered as best, free-flow conditions and LOS ' $F$ ' is considered failing conditions. LOS ' $D$ ' is considered acceptable during the peak hours by the City of Houston.

As presented in Figure 2.2 and 2.3, some of the study intersections are presently operating at levels of service D or better. Intersections operating at level of service E or F are listed in Table 2.2.

TABLE 2.2
WEEKDAY PEAK HOUR INTERSECTION OPERATING AT LEVEL OF SERVICE E OR F - EXISTING CONDITIONS

| Intersection | AM |  |  |  | PM |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | LOS | Delay $(\mathrm{sec})$ | VIC <br> Ratio ${ }^{1}$ | VIC Movement | LOS | $\begin{aligned} & \text { Delay } \\ & \text { (sec) } \\ & \hline \end{aligned}$ | VIC <br> Ratio ${ }^{1}$ | VIC Movement |
| Main Campus |  |  |  |  |  |  |  |  |
| Fannin @ University | F* | 93.9* | 2.39* | EBL | E* | 63.4* | 1.99* | EBL |
| Fannin @ Holcombe | $\mathrm{F}^{*}$ | 151.9* | 4.53* | NBL/NBT | $\mathrm{F}^{*}$ | 135.7* | 3.21* | NBT/NBL |
| Main @ Cambridge | E | 62.0 | 1.04 | NBT/NBR | E | 73.5 | 1.09 | WBR |
| Main @ Holcombe | $\mathrm{F}^{*}$ | 313.0* | 2.31* | WBT/WBR | F* | 390.68* | 2.30* | WBT/WBR |
| Mid Campus |  |  |  |  |  |  |  |  |
| Almeda @ Holcombe | F | 80.8 | 1.69 | WBL | C | 24.2 | 1.34 | EBR |
| Almeda @ OST | E | 55.5 | 1.05 | WBR | F | 95.6 | 1.27 | EBR |
| Cambridge @ Holcombe | E | 68.6 | 1.18 | SBR | F | 144.1 | 1.27 | NBT |
| Cambridge @ Braeswood | E* | 60.8* | 1.46* | SBL | D* | 45.8* | 0.93* | SBL |
| Fannin @ OST | E | 65.0 | 1.12 | EBL | D | 51.6 | 0.97 | EBR |
| Leland Anderson Campus |  |  |  |  |  |  |  |  |
| SH 288 SBFR @ N. MacGregor | F* | 239.4* | 1.85* | SBR | C* | 23.5* | 0.82* | SBT |
| SH 288 NBFR @ Holcombe | F* | 454.6* | 2.77* | NBL | F* | 134.5* | 1.87* | NBT |
| SH 288 SBFR @ Holcombe | C* | 32.3* | 0.92* | WBT/WBL | F* | 103.3* | 1.23* | EBT/EBR |
| SH 288 NBFR @ OST | D* | 44.0* | 0.81* | NBT/NBL | E* | 66.5* | 1.18* | EBL |
| Volume to  <br> $*$ Capacity Ratio <br> HCM 2000 Used (HCM 2010 <br>  <br> $* *$$\quad$Unavailable) <br> Volumes <br> Unavailable |  |  |  |  |  |  |  |  |



FIGURE 2.2
WEEKDAY AM PEAK HOUR LEVEL OF SERVICE AT STUDY INTERSECTIONS


FIGURE 2.3
WEEKDAY PM PEAK HOUR LEVEL OF SERVICE AT STUDY INTERSECTIONS

### 2.4 Crash Experience

Crash data from 2007 to 2011 was obtained from the Houston Galveston Area Council (H-GAC) for the Texas Medical Center area. These data came from TxDOT's Crash Records Information System (CRIS). The data came from police reports from crashes where the crash resulted in a fatality, injury, or at least $\$ 1,000$ in property damage. These crashes represent traffic accidents with a fatality, an injury or property damage with one or more vehicles having to be towed.

Crash data was assembled for a set of streets located within the study area. The study area comprises a dense street network out of which 30 streets were chosen to query from, primarily based on having a significant amount of traffic, based on existing traffic patterns. It is estimated that approximately 95 percent of the crashes in the study area were captured.

Utilizing the crash data obtained from H-GAC, the crash rates for the study intersections were calculated. The computed crash rates for the study intersections for the year 2007-2011, range from 0.06 to 0.81 crashes per Million Entering Vehicles (MEV).

There are three intersections with more than 40 crashes from 2007-2011, including Old Spanish Trail at Almeda Road, Old Spanish Trail at Fannin Street, and Main Street at Sunset Boulevard. Additionally, there are three intersections with 30-39 crashes from 2007-2011, including Fannin Street at Dryden Road, Fannin Street at John Freeman Boulevard, and Holcombe Boulevard at Almeda Road. Table 2.3 presents the summary of crashes and crash rates in the vicinity of intersections in the primary study area. The number of crashes in the table includes all the crashes within the limits of the Texas Medical Center study area for the years 2007 to 2011. Figure 2.4 illustrates the magnitude of crashes at intersections in the primary study area.

TABLE 2.3
CRASH DATA BY INTERSECTION FROM 2007 TO 2011

| ID | INTERSECTION | NUMBER OF CRASHES | CRASH RATE |
| :---: | :---: | :---: | :---: |
| Main Campus |  |  | (MEV) |
| 1 | Fannin @ Cambridge | 28 | 0.50 |
| 2 | Fannin @ University | 11 | 0.26 |
| 3 | Fannin @ Ross Sterling | 11 | 0.30 |
| 4 | Fannin @ John Freeman | 30 | 0.59 |
| 5 | Fannin @ Dryden | 36 | 0.81 |
| 6 | Fannin @ Holcombe | 27 | 0.32 |
| 7 | Fannin @ Pressler | 28 | 0.57 |
| 8 | Holcombe @ Richard JV Johnson | 12 | 0.23 |
| 9 | Holcombe @ Bertner | 16 | 0.25 |
| 10 | Holcombe @ Elliot | 2 | 0.03 |
| 11 | Holcombe @ MD Anderson | 9 | 0.14 |
| 12 | Holcombe @ Braeswood | 28 | 0.47 |
| 13 | Bertner @ Pressler | 0 | 0.00 |
| 14 | Bertner @ Bates | 6 | 0.25 |
| 15 | Bertner @ Moursund | 3 | 0.15 |
| 16 | MD Anderson @ Bates | 0 | 0.00 |
| 17 | MD Anderson @ Moursund | 0 | 0.00 |
| 18 | Moursund @ Lamar Fleming | 2 | 0.10 |
| 19 | Moursund @ Braeswood | 7 | 0.15 |
| 20 | Main @ Cambridge | 13 | 0.16 |
| 21 | Main @ University | 22 | 0.28 |
| 22 | Main @ Holcombe | 20 | 0.13 |
| 23 | Main @ Pressler | 24 | 0.80 |
| Rice University Campus |  |  |  |
| 24 | Main @ Sunset | 41 |  |
| 25 | Fannin @ Sunset | 2 | 0.42 |
| Mid Campus |  |  |  |
| 26 | Almeda @ Holcombe | 30 | 0.35 |
| 27 | Almeda @ OST | 42 | 0.48 |
| 28 | Cambridge @ Holcombe | 14 | 0.22 |
| 29 | Cambridge @ Braeswood | 1 | 0.01 |
| 30 | Bertner @ OST | 0 | 0.00 |
| 31 | Fannin @ OST | 46 | 0.47 |
| South Campus |  |  |  |
| 32 | Cambridge @ South Campus Drive (East Road) | 0 | 0.00 |
| 33 | Knight @ South Campus Drive (West Road) | 1 | 0.06 |



FIGURE 2.4
NUMBER OF CRASHES AT STUDY INTERSECTIONS FROM 2007 TO 2011

### 2.5 Transit

Public transportation within the project study area consists primarily of services provided by the Metropolitan Transit Authority of Harris County (METRO), which operates bus and light rail routes serving the area, including the Texas Medical Center.

### 2.5.1 Metro Bus

Bus service within the larger study area consists mainly of routes that serve at least part of the Texas Medical Center area. Most routes that directly serve the TMC include a stop at the TMC Transit Center, which is located in the northwest quadrant of the intersection of Fannin Street and Pressler Street. Exceptions are METRO Route 1 Hospital and 11 Almeda/Nance. Route 1 serves the VA Medical Center area from the Main Street corridor to the north; its routing through the TMC is via Cambridge Street, which takes it to the east of the Transit Center. METRO Route 11 runs along Almeda Road and includes a stop serving the VA Medical Center. There are 17 bus routes using the TMC Transit Center; they include 11 local routes, four park \& ride routes (express routes that originate at Park \& Ride transit centers), and two enhanced-service limited-stop local routes, 402 Quickline Bellaire, and 426 Swiftline, which operate between the TMC Transit Center and the Southeast Transit Center.

### 2.5.2 Metro LRT

METRO's light rail Red Line, not to be confused with the TMC Red Shuttle (a bus route), is a $7.5-\mathrm{mile}$ line operating between the University of Houston Downtown campus just north of the Central Business District and the Fannin South terminal station south of $\mathrm{IH}-610$. Figure 2.5 depict all the METRO bus routes, rail routes and bus stops in the general study area and primary study area respectively. Trains operate every six minutes on weekdays from inception of service at 4:53 AM until 8:23 PM, every 12 minutes until 10:24 PM, and then every 18 minutes until the close of service. On weekends, trains operate every 12 minutes until 9:47 PM, and then every 18 minutes until the close of service. Service ends at 12:30 AM on Sunday, 12:48 AM Monday through Thursday, and at 2:59 AM on Friday and 2:40 AM on Saturday. Red Line ridership is discussed in Sections 2.5.5.

A vital feature of the Red Line is a station adjacent to the TMC Transit Center, which provides an important distribution function for bus passengers, for travel between the Transit Center and other Red Line stops in the vicinity including those along Fannin at Dryden Road, and between Ross Sterling Avenue and Cambridge Street. Another vital function performed by the Red Line is to link the TMC with the TMC Smith Lands remote parking facility.

### 2.5.3 Ft. Bend Express

Another route not making direct use of the TMC Transit Center is the Fort Bend Express, which is routed along a loop through the main TMC campus, including a stop near the Transit Center, and ending at the VA Medical Center. This service is operated by Fort Bend County, and links the Medical Center with three park \& ride locations along US 59 in Fort Bend County east of SH 6, including the Fort Bend County Fairgrounds in Rosenberg, the University of Houston Sugar Land campus, and the AMC Theatre First Colony, also in Sugar Land. The express service is predominantly one-way inbound during the morning and outbound in the afternoon, but provides limited reverse-commute service as well.


FIGURE 2.5
EXISTING TRANSIT ROUTES MAP - GENERAL STUDY AREA

### 2.5.4 TMC Shuttles

Texas Medical Center Transportation, a unit of the TMC, provides TMC Shuttle Service. This complimentary service for patients, visitors, and employees provides bus routes that interconnect TMC parking sites and the main campus institutions. There are two shuttle routes, which are operated by a contractor, Horizon Coach Lines. The TMC Red Shuttle, which operates from 6 AM to 6 PM, serves the Smith Lands remote parking facility and has five stops along its route through the TMC main campus. The TMC Blue Shuttle operates from 4:30 AM until midnight, along a figure-eight loop with 12 stops distributed through a broader area of the TMC main campus including two stops on Fannin Street in common with the TMC Red Shuttle.

MD Anderson Cancer Center also provides shuttle services for employees only. There are frequent shuttles operating on four routes for employees only namely Red, Black, Blue and Gray shuttle. Additionally, there is one patient shuttle. Figure 2.6 shows the MD Anderson bus shuttle routes.


FIGURE 2.6
MD ANDERSON SHUTTLE ROUTES

### 2.5.5 Transit Use

## Metro Transit Passenger O-D Survey

A system-wide transit passenger origin-destination (O-D) survey conducted from April through July 2011 provides a data source for information on transit use within the TMC study area. The survey encompassed certain non-METRO services including the Fort Bend Express TMC service, which is contained within the summary results given in this report. As extracted from the survey database, there were 64,900 weekday transit person trips (unlinked trips) to or from the General Study Area. Of these, 45,900 used bus as the dominant mode, 15,300 used light rail (the METRO Red Line) primarily, and 3,700 used TMC shuttle routes.

The geographic distribution of transit travel related to the TMC study areas has been broadly summarized by defining eight sectors (northwest, north central, northeast, etc.) encircling the General Study Area. Total year 2011 weekday transit person trips between each sector and the study areas are as shown in Table 2.4, which also indicates travel volumes within the General Study Area.

TABLE 2.4
GEOGRAPHIC DISTRIBUTION OF TMC STUDY AREA WEEKDAY TRANSIT PASSENGER TRIPS, YEAR 2011

| Geographic Sectors |  | TMC General Study Area |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Primary Study Area | Rest of the Study area | Total General Study area |
| TMC <br> Study <br> Area | Primary | 4,001 |  |  |
|  | Secondary | 4,460 | 2,568 |  |
|  | Sum | 8,461 | 2,568 | 11,029 |
|  | Northwest | 627 | 209 | 837 |
|  | North | 110 | 43 | 153 |
|  | Northeast | 1,118 | 425 | 1,543 |
|  | East | 2,359 | 2,074 | 4,433 |
|  | Southeast | 3,877 | 1,415 | 5,292 |
|  | South | 10,037 | 5,019 | 15,056 |
|  | Southwest | 10,750 | 5,611 | 16,361 |
|  | West | 6,725 | 3,443 | 10,168 |
| Totals |  | 44,065 | 20,808 | 64,873 |

Source: Extracted from METRO 2011 Transit Passenger O-D Survey File

## Transit Boardings and Alightings

Another indicator of the role played by transit within the study area is the number of passengers using bus stops and light rail stations. Total weekday stop and station activity is shown in Table 2.5. Most of the data are taken from METRO ride checks during July 2011, except for one of the TMC Shuttle routes, which was surveyed in April 2011. The light rail (Red Line) data are from September 2011. For the Fort Bend Express, September 2012 results are shown; this route, which began service in June 2010, has experienced rapid ridership growth, increasing from 166 passengers per day in September 2011 to the tabulated 388 passengers a year later.

TABLE 2.5
CURRENT TRANSIT PASSENGERS BOARDING AND ALIGHTING AT TMC PRIMARY STUDY AREA BUS STOPS AND LRT STATIONS

| Route | Entire Primary Study Area | TMC Transit Center |
| :--- | :---: | :---: |
| 1 Hospital | 2,070 | - |
| 2 Bellaire | 2,352 | 2,096 |
| 4 Beechnut | 1,747 | 1,633 |
| 8 South Main | 1,060 | 824 |
| 10 Willowbend | 717 | 710 |
| 14 Hiram Clarke | 1,601 | 1,401 |
| 26-27 Loop | 1,710 | 718 |
| 34 Montrose | 276 | 187 |
| 68 Brays Bayou | 2,071 | 1,191 |
| 73 Bellfort | 1,680 | 1,208 |
| 87 Sunnyside | 2,116 | - |
| 402 Bellaire Quickline | 421 | 421 |
| 426 TMC Swiftline | 251 | 251 |
| METRO Commuter Routes (170, 292, 297, 298) | 6,146 | 6,146 |
| Total, METRO Bus | $\mathbf{2 4 , 2 1 8}$ | $\mathbf{1 6 , 7 8 6}$ |
| METRO Rail | $\mathbf{1 7 , 2 2 7}$ | $\mathbf{7 , 7 0 5}$ |
| TMC Shuttle 320 | 7,884 | - |
| TMC Shuttle 321 | 1,990 | - |
| TMC Shuttle 322 | 2,298 | - |
| Total, Shuttles | $\mathbf{1 2 , 1 7 3}$ | - |
| Fort Bend TMC Express (September 2012) | $\mathbf{3 8 8}$ | - |
| Grand Total | $\mathbf{5 4 , 0 0 5}$ | $\mathbf{2 4 , 4 9 1}$ |

There are more than 900 bus stops within the Study Area. Of these, the TMC Transit Center and 119 onstreet bus stops are within the Primary Study Area. Recorded use of the bus stops varies widely, ranging from more than 11,000 weekday passengers boarding or alighting at the TMC Transit Center and nearly 1,900 at the busiest on-street bus stop, to two stops with no recorded weekday use. Table 2.6 identifies the ten most-used bus stops, on an annual basis. Note that the sequence would be slightly different if the stops were ranked on the basis of average weekday use.

TABLE 2.6
TEN MOST-USED TMC BUS STOPS - AVERAGES IN FY2011

| Bus Stop (Stop Number) | Board + Alight |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Weekdays | Saturdays | Sundays | Daysweighted sum |
| Bertner Avenue at Bates Street (9962) | 1,878 | 64 | 34 | 9,488 |
| Bertner Avenue at Moursund Street (9965) | 1,090 | 60 | 33 | 5,543 |
| William C. Harvin Blvd. at Old Spanish Trail (9391) | 1,063 | - | - | 5,315 |
| Lamar Fleming Avenue at MacGregor Way (63) | 976 | - | - | 4,880 |
| Ross Sterling Avenue at Fannin Street (11208) | 850 | 88 | 29 | 4,367 |
| Bertner Avenue at Bates Street (11552) | 800 | 81 | 40 | 4,121 |
| Veterans Memorial Hospital (11274-Northbound) | 725 | 185 | 113 | 3,923 |
| Veterans Memorial Hospital (11274-Southbound) | 569 | 184 | 124 | 3,153 |
| William C. Harvin Blvd. at Old Spanish Trail (9390) | 630 | - | - | 3,150 |
| William C. Harvin Blvd. at Braeswood Blvd. (9387) | 591 | - | - | 2,955 |

Source: Houston METRO 1109 Ridership Report

TMC Secondary Study Area accounts for about half of all passengers using light rail. The most-used station, Dryden, is in the TMC, and the three "TMC Destination" stations are in the top five Red Line stations as seen in Figure 2.7.


FIGURE 2.7
METRO RED LINE STATIONS WEEKDAY ON AND OFF PASSENGERS

### 2.5.6 Operating Performance

General operating characteristics of the transit systems that serve the TMC area are documented in Table 2.7 for bus services and Table 2.8 for METRO's light rail Red Line. The data for this purpose have been selected from the Federal Transit Administration FY 2011 National Transit Database. The TMC Shuttles have recently been changed to contracted service operated by Horizon Coach Lines; operating performance data is not currently available. The current two routes, TMC Red Shuttle and TMC Blue Shuttle, consolidate the service provided by three previous routes.

TABLE 2.7
OPERATING PERFORMANCE OF BUS SYSTEMS THAT SERVE THE TMC AREA

| OPERATIONS MEASURES (2011) | METRO <br> Directly- <br> Operated Bus | METRO <br> Contracted <br> Bus | Fort Bend <br> Transit |
| :--- | :---: | :---: | :---: |
| Boardings per Revenue Vehicle Hour | 23.5 | 22.4 | 6.9 |
| Passenger Miles per Revenue Vehicle Mile | 10.4 | 9.8 | 4.6 |
| Average Passenger Trip Length (miles) | 6.38 | 6.60 | 17.41 |
| Equivalent Weekdays, Revenue Vehicle Miles | 290.41 | 345.97 | 250.97 |
| Equivalent Weekdays, Revenue Vehicle Hours | 291.27 | 352.49 | 250.60 |
| Equivalent Weekdays, Boardings | 284.19 | 342.54 | 250.88 |
| Equivalent Weekdays, Passenger Miles | 272.73 | 311.85 | 251.02 |
| Revenue Vehicle Miles per Gallon Diesel | 3.28 | 3.50 | 3.92 |
| Average Miles per Hour, Revenue Service | 14.38 | 15.12 | 25.85 |
| O\&M Cost per Revenue Vehicle Hour | $\$ 123.508$ | $\$ 83.918$ | $\$ 77.145$ |
| O\&M Cost per Boarding | $\$ 5.246$ | $\$ 3.749$ | $\$ 11.241$ |
| O\&M Cost per Passenger Mile | $\$ 0.822$ | $\$ 0.568$ | $\$ 0.646$ |
| Average Fare per Boarding | $\$ 0.943$ | $\$ 0.828$ | $\$ 2.398$ |
| Average Fare per Passenger Mile | $\$ 0.148$ | $\$ 0.126$ | $\$ 0.138$ |
| Farebox Ratio | 0.180 | 0.221 | 0.213 |

Source: FY 2011 National Transit Database
These results are broadly typical of bus transit systems in the United States. METRO's higher cost effectiveness of contracted service, compared with that of directly operated service, also is typical.

The Fort Bend Transit data are for park \& ride express routes exclusively, and are affected by the characteristics of that type of service, which for the most part is limited to peak-period, peak-direction trips made on weekdays only. This requires more unproductive operation, such as deadhead (out-of-service) trips, compared with the local service that dominates METRO bus operations.

TABLE 2.8
OPERATING PERFORMANCE OF THE METRO LIGHT RAIL RED LINE

| OPERATIONS MEASURES (2011) | METRO Red <br> Line (LRT) |
| :--- | ---: |
| Boardings per Revenue Train Hour | 167.3 |
| Boardings per Revenue Rail Car Hour | 143.0 |
| Passenger Miles per Revenue Rail Car Mile | 27.4 |
| Average Passenger Trip Length (miles) | 2.33 |
| Equivalent Weekdays, Revenue Train Miles | 304.93 |
| Equivalent Weekdays, Revenue Train Hours | 312.71 |
| Equivalent Weekdays, Boardings | 299.79 |
| Equivalent Weekdays, Passenger Miles | 306.20 |
| Kwh per Rail Car Mile | 7.69 |
| Average Miles per Hour, Revenue Service | 11.84 |
| O\&M Cost per Revenue Train Hour | $\$ 275.715$ |
| O\&M Cost per Boarding | $\$ 1.648$ |
| O\&M Cost per Passenger Mile | $\$ 0.709$ |
| Average Fare per Boarding | $\$ 0.529$ |
| Average Fare per Passenger Mile | $\$ 0.227$ |
| Farebox Ratio | 0.321 |
| Sourei FY 211 Naion |  |

Source: FY 2011 National Transit Database

### 2.12 Parking

TMC operates one of the largest parking systems in the country with more than 160,000 visitors, patients, employees, students and volunteers coming to the TMC daily. As shown in Figure 2.8, there are 20 TMC garages and 23 surface parking lot facilities located throughout the study area that offer easily accessible and convenient parking to all Texas Medical Center institutions. There are also 50 private parking facilities conveniently located in the proximity of the member institution buildings. Rice University Campus parking facilities include two underground garages and 20 surface lots. Designated handicapped parking spaces are available in all locations.

### 2.12.1 Main Campus

There are 17 public garages and 15 public surface parking lots operated by the TMC located in the Main Campus area with a total of 16,351 parking spaces. Twenty-two private parking facilities operated by TMC member institutions from which eight are parking garages are located in the main campus area serving the adjacent member institution buildings with a total of 21,172 parking spaces.

The public surface parking lot facilities located towards the south west of the Main Campus area adjacent to Main Street and serving the Hornberger Conference Center and the Coleman College for Health Science buildings operate at or near capacity with a weekday peak utilization ranging from 81 percent to 93 percent. The public parking garage facilities located in the proximity of main buildings such as the UT Health Medical School, the St. Luke's Episcopal Hospital and the M.D Anderson Cancer Center operate at or near capacity with a weekday peak utilization ranging from 91 percent to 99 percent.

### 2.12.2 Mid Campus

There are three public garages and eight public surface parking lots operated by TMC located in the Mid Campus area with a total of 11,731 parking spaces. Ten private parking facilities operated by TMC member institutions from which two are parking garages are located in the Mid Campus area serving the adjacent member institution buildings.

The public surface parking facilities located in the proximity of the Texas Children's Hospital Meyer Building operate at or near capacity with a weekday peak utilization of 100 percent. Adjacent to these high utilization parking surface lots facilities, Garage 19 also exhibits a high weekday peak utilization of 76 percent. In general, the public parking facilities located to the west of the Mid Campus area have a high weekday peak utilization percent which indicates that there is a deficiency of available parking compared to the parking demand in the proximity to the Meyer Building.

### 2.12.3 South Campus

There are nine private parking facilities including one parking garage operated by TMC member institutions in the South Campus area serving the adjacent member institution buildings. The capacity of these private facilities varies from 19 to 1149 parking spaces. Utilization and parking fee information is currently not available for the majority of the private parking facilities in South Campus.

### 2.12.4 Rice University Campus

There are a total of 8,000 parking spaces divided between two underground garages and 20 surface parking. The parking facilities in the Rice Campus area operate at or near capacity the majority of the school year with a weekday peak utilization of 90 percent for the facilities located to the east and central area of campus and a weekday peak utilization of 60 percent for the facilities located to the west of Rice Campus University. The existing weekday utilization suggests that the available parking is insufficient with respect to the parking demand in this area.

### 2.12.5 Leland Anderson Campus

There are three public surface parking lots operated by Texas Medical Center located in the Leland Anderson Campus area with a total of 1,026 parking spaces. Two private surface parking facilities operated by TMC member institutions are located in the Leland Anderson campus area serving the adjacent member institution buildings. In general the public parking facilities located in the Leland Anderson campus area operates at a 56 percent weekday peak utilization which indicates that there is an adequate balance of available parking compared to the parking demand in the area.

Figure 2.9 summarizes parking utilization for each campus and shows the percentage occupancy in all the parking garages where available.


FIGURE 2.8
EXISTING TMC PARKING CAPACITY

FIGURE 2.9
EXISTING TMC PARKING OCCUPANCY

### 2.13 Pedestrian and Bicycle Facilities

The Regional Bikeway Plan was prepared by H-GAC in 2010. This Plan identifies TMC as the employment center with highest number of bicyclists in the region. According to the 2000 census, walking and biking trips to and from the TMC campus represented $0.9 \%$ and $0.8 \%$ respectively of all work trips. The TMC has the highest concentration of bicyclist trips within a census tract in the region (even greater than Downtown Houston), and the third highest concentration of walking trips in the region (after downtown and the University of Texas Medical Branch in Galveston). The number of commuter bicyclists for 2010 census is not precisely known. The H-GAC Plan summary indicated based on observations that over 1,000 bicyclists now commute to the TMC on a daily basis.

### 2.13.1 Pedestrian Facilities

The sidewalks located within the Texas Medical Center (TMC) study area are generally contiguous with little to no gaps; the width of the crosswalks was observed to be 4 feet or less along most public streets. The sidewalks provide convenient access to open spaces and institutions throughout the TMC. Crosswalks are generally located at each signalized intersection within the study area. Pedestrian signals are located at all the signalized intersections in the study area and were observed to be operating in good condition.

Figure 2.10 shows the location of sidewalks, skybridges and crosswalk locations within the Main Campus.

### 2.13.2 Bicycle Facilities

Bicycle access within the TMC study area is provided along several major roads and local routes that travel through the TMC campuses. The bicycle network includes a range of designated bicycle facilities. Some facilities are exclusively bicycle lanes while others are designed to accommodate multiple modes of transportation, including automobile and driving. Based on a review of GIS data provided by the City of Houston, the bicycle facilities include multi-use trails, on-street bike lanes, signed routes, shared lanes, and greenway trails. The city currently boasts nearly 722 miles of bicycle facilities. Figure 2.11 illustrates the location of the existing bicycle facilities.

Houston B-cycle is a "bike sharing" program that works as an additional transportation alternative for people living and visiting Houston. At its core, a public bike sharing system is intended to be used for short trips in and around downtown Houston and surrounding urban areas. Current expansion plans for Houston's B-Cycle bike share system call for 29 new stations. Some buildings in the TMC have bike racks for storage predominantly in the Main and Mid Campus areas.


FIGURE 2.10
EXISTING PEDESTRIAN FACILITIES


FIGURE 2.11
EXISTING BICYCLE FACILITIES

### 2.14 Travel Demand Management

The Texas Medical Center Corporation offers commuting solutions as part of its traffic demand management strategy to provide short-term congestion relief for local commuters.

The Commute Solutions Program was developed by the Houston-Galveston Area Council's (H-GAC's) as part of its Regional Commute Alternatives Program. The purpose of the Commute Solutions Program is to provide a "one-stop" alternative transportation resource in the Houston-Galveston area for both commuters and businesses.

### 2.14.1 Overall Strategies

The Texas Medical Center Corporation provides incentives to employees who participate in the different travel demand management programs available. The purpose of this strategy is to reduce Single Vehicle Occupancy (SVO) commuting, traffic volume and parking demand as well as help reduce emissions to the environment. The following commuting solutions have been implemented:

- Employees using METRO bus or vanpool services receive a benefit of $\$ 40$ pre-taxed once a month
- Employees who carpool receive a benefit of $\$ 40$ taxable income once a month
- Flexible work schedules
- Employees with a TMC parking contract received a benefit of $\$ 30$ pre-taxed once a month

There are other travel demand strategies that have been implemented as part of the travel demand management strategies in the Texas Medical Center, and include:

- Ride Match Program to connect employees and help finding alternative commuting options.
- Transportation fairs where employees can learn about commuting options.


### 2.14.2 Carpool/Vanpool and Transit Programs

Carpool/vanpool programs have been implemented by many of the TMC member institutions as an incentive to employees to help reduce SOV commuting. The carpool/vanpool programs provide monthly assistance that varies from $\$ 70$ to $\$ 230$ to those employees vanpooling; some member institutions also offer pre-tax vanpool paycheck deductions. Transit users are also eligible for receiving monthly assistance that varies from $\$ 70$ to $\$ 150$ per month.

### 2.14.3 Staggered Work Hours

Flexible work hour programs have been implemented as part of other travel demand management strategies by the TMC member institutions to reduce trips and hence traffic volume and parking demand at the different campuses.

Member Institutions such as Baylor College of Medicine, MD Anderson Cancer Center and Memorial Hermann have joined the H-GAC Regional Telework Program; this program replaces travel to, from and for work with telecommunications technologies that allow employees working from home and still have access to the employer network and communication systems.

### 2.14.4 Mixed-use High-Density Residential Development

Additional mixed-use high-density residential developments are already underway or being planned within walking/biking distance of the TMC. However, there is also over 2,000 acres of vacant land that is within 5 miles of the TMC that is part of TIRZ 24 and provides a residential infill development opportunity. TIRZ 24 is a partnership between the City and County with Harris County's participation.

### 3.0 LAND USE AND GROWTH PROJECTIONS

Information about future year development and growth trends was obtained from TMC and member institutions, City of Houston and H-GAC. New buildings, redevelopments, platting applications etc. were obtained along with land use type and size of the buildings. This data suggests that there would be a few new hospital buildings but a majority of the new development would consist of medical office and medical research land use.

The H-GAC regional travel demand model was used to develop a TMC model scenario. Several TAZs in the primary study area were subdivided according to the campus plans. Existing and future year 2035 TAZ population and employment data was verified and updated where necessary. Existing and future year 2035 model street networks were also refined to include more collector streets and to update access points for each zone. The future year street network included the following improvements:

- IH 610 eastbound frontage road connector at Cambridge Street
- SH 288 managed lanes and direct connector to Holcombe Boulevard
- Almeda Road widening to six lanes from IH 610 to N. MacGregor Way

These model data adjustments resulted in increasing accuracy of the travel demand forecasts for the study area. No other transit mode adjustments were made to the regional model. The transit mode share in both the existing and future models was $4.7 \%$ and $5.2 \%$ respectively of the total regional trips.

Table 3.1 shows a summary of the revised model data as input into the H-GAC regional model for the study area TAZs. Table 3.2 shows a summary of growth projected for the study area.

TABLE 3.1
H-GAC MODEL DATA FOR TMC STUDY AREA TRAFFIC ANALYSIS ZONES

| Demographic I Land Use Type | Existing (2012) Conditions <br> Primary <br> Study <br> General <br> Study |  |  | Total | Future (2035) Conditions <br> Preary <br> Study <br> Area |  |  | General <br> Study <br> Area | Total |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 25,804 | 122,595 | 148,399 | 29,439 | 164,414 | 193,853 |  |  |  |
|  | 12,718 | 48,694 | 61,412 | 15,550 | 76,353 | 91,903 |  |  |  |
| School Student Enrollment | 16,067 | 17,761 | 33,828 | 25,268 | 17,761 | 43,029 |  |  |  |
| College and University Enrollment | 2,599 | 0 | 2,599 | 2,599 | 0 | 2,599 |  |  |  |
| Retail Employment | 4,699 | 24,964 | 29,663 | 6,553 | 34,941 | 41,495 |  |  |  |
| Office Employment | 6,793 | 24,655 | 31,448 | 8,431 | 34,098 | 42,529 |  |  |  |
| Industrial Employment | 3,964 | 8,758 | 12,722 | 4,024 | 13,248 | 17,272 |  |  |  |
| Medical Research/Office Employment | 25,475 | 9,061 | 34,536 | 65,908 | 22,303 | 88,211 |  |  |  |
| Medical Hospital Employment | 35,256 | 1,986 | 37,242 | 39,624 | 3,006 | 42,630 |  |  |  |
| School Employment | 682 | 1,605 | 2,287 | 932 | 2,272 | 3,205 |  |  |  |
| College and University Employment | 23,660 | 2,498 | 26,158 | 36,745 | 3,217 | 39,962 |  |  |  |
| Government Office Employment | 4,261 | 1,893 | 6,154 | 4,513 | 2,597 | 7,111 |  |  |  |
| Total Employment | 104,790 | 75,420 | 180,210 | 166,731 | 115,683 | 282,414 |  |  |  |

TABLE 3.2
PROJECTED GROWTH FOR TMC STUDY AREA TRAFFIC ANALYSIS ZONES

|  | Growth over 23 years |  |  |
| :--- | :---: | :---: | :---: |
| Demographic $\boldsymbol{I}$ Land Use Type | Primary | $\begin{array}{c}\text { General }\end{array}$ | Total |
| Study Area | Study Area |  |  |$]$

In the combined total study area, population is assumed to increase by $31 \%$ and employment is assumed to increase by $56 \%$ by future year 2035.

Table 3.3 and Figure 3.1 show the existing Average Daily Traffic (ADT) and projected growth in future year 2035 on several roadways in the primary study area. Holcombe Boulevard and Old Spanish Trail show a high travel demand in the future emphasizing the need for capacity increase for east-west travel in the study area. Future growth along Main Street and Fannin Street is around 14,000 to 15,000 vehicles. Increased remote parking, transit and shuttle services were not reviewed through the regional travel demand model. Figures 3.2 and 3.3 show the existing (ADT) and future year 2035 projected ADT. The growth calculated from model forecasts was used for various alternative analyses before arriving at final list of improvement concepts.

TABLE 3.3
PROJECTED GROWTH FOR TMC STUDY AREA ROADWAY SECTIONS

| Roadway Section | Existing <br> ADT <br> Volume | Future <br> Year <br> $\mathbf{2 0 3 5}$ <br> Growth | $\mathbf{2 0 3 5}$ <br> Volume | Annual <br> Growth <br> Rate |
| :--- | :---: | :---: | :---: | :---: |
| Rice Blvd - from Greenbriar Dr to Sunset Blvd | 13,000 | 300 | 13,300 | 0.10 |
| Shepherd Dr- from Bissonet St to Rice Blvd | 11,600 | 2,400 | 14,000 | 0.82 |
| Main Street- from Sunset Blvd to Hermann | 34,500 | 8,300 | 42,800 | 0.94 |
| Main Street- from University Blvd to Sunset Blvd | 34,600 | 15,100 | 49,700 | 1.59 |
| Main Street- from Greenbriar Dr to University Blvd | 34,900 | 8,900 | 43,800 | 0.99 |
| Hermann Dr- from Main St to Almeda Rd | 4,800 | 3,900 | 8,700 | 2.62 |
| Fannin Street- from Holly Hall to Hermann | 25,200 | 13,900 | 39,100 | 1.93 |
| Braeswood Blvd / MacGregor Way- from Greenbriar Dr to Almeda Rd | 20,000 | 14,500 | 34,500 | 2.40 |
| Braeswood Blvd South Section- from Greenbriar Dr to Fannin St | 20,000 | 14,500 | 34,500 | 2.40 |
| Greenbriar Dr- from Holly Hall to Holcombe Blvd | 9,000 | 7,000 | 16,000 | 2.53 |
| Greenbriar Dr- from Holcombe Blvd to Rice Blvd | 15,100 | 3,400 | 18,500 | 0.89 |
| Bertner Ave- from Holcombe Blvd to Old Spanish Trail | 10,000 | 5,500 | 15,500 | 1.92 |
| Holly Hall- from Fannin St to Almeda Rd | 13,600 | 5,000 | 18,600 | 1.37 |
| Cambridge St- from Holly Hall to Main St | 7,400 | 14,800 | 22,200 | 4.89 |
| Cambridge St- from IH 610 Frontage Rd to Holly Hall | 7,400 | 14,800 | 22,200 | 4.89 |
| Almeda Rd - from Holly Hall to N MacGregor | 21,200 | 12,600 | 33,800 | 2.05 |
| Almeda Rd - from N MacGregor to Hermann | 21,200 | 12,600 | 33,800 | 2.05 |
| Holcombe Blvd - from Greenbriar Dr to Main St | 38,000 | 15,300 | 53,300 | 1.48 |
| Holcombe Blvd - from Main St to Bertner Ave | 38,000 | 15,300 | 53,300 | 1.48 |
| Holcombe Blvd - from Bertner Ave to Almeda Rd | 31,300 | 12,100 | 43,400 | 1.43 |
| Old Spanish Trail - from Greenbriar Dr to Almeda Rd | 28,400 | 27,000 | 55,400 | 2.95 |
| University Blvd Two-way- from Main St to Fannin St | 34,600 | 15,100 | 49700 | 1.59 |



FIGURE 3.1
PROJECT FUTURE GROWTH IN YEAR 2035 IN TMC AREA


FIGURE 3.2 EXISTING AVERAGE DAILY TRAFFIC


FIGURE 3.3
FUTURE YEAR 2035 PROJECTED AVERAGE DAILY TRAFFIC

### 4.0 FUTURE YEAR CONDITIONS ANALYSES

### 4.1 Street Network Analysis

Intersection Level of Service (LOS) analyses were performed in accordance with the procedures set forth and recommended by the 2010Highway Capacity Manual (HCM) Level of Service methodologies for evaluation of signalized and unsignalized intersections. The traffic analysis software SYNCHRO was used to evaluate the operations of the study intersections. The LOS criteria for signalized and unsignalized intersections are presented below in Table 4.1. The LOS is based on delay expressed in seconds per vehicle.

Level of Service (LOS) is a quantitative stratification of a performance measure or measures that represent quality of service. The Highway Capacity Manual (HCM) defines six levels of service, ranging from $A$ to $F$ based on a quantitative value of performance measures. LOS A represents the best operating conditions during analysis periods and LOS F represents worst conditions. A change of LOS indicates that roadway performance has transitioned from one given range of traveler-perceivable conditions to another range.

Delay is defined as additional travel time experienced by a driver beyond that required to travel at the desired speed, and is measured in seconds.

Volume to Capacity Ratio (v/c) is defined as the ratio of flow rate to capacity for a roadway segment.
LOS ' A ' is considered as best, free-flow conditions and LOS ' F ' is considered failing conditions. LOS ' D ' is considered acceptable during the peak hours according to City of Houston standards.

TABLE 4.1
LEVEL OF SERVICE (LOS) CRITERIA FOR INTERSECTIONS

| LOS | Signalized Intersection | Unsignalized Intersections |
| :---: | :---: | :---: |
|  | Delay (sec/veh) | Delay (sec/veh) |
| A | $0-10$ | $0-10$ |
| B | $>10-20$ | $>10-15$ |
| C | $>20-35$ | $>15-25$ |
| D | $>35-55$ | $>25-35$ |
| E | $>55-80$ | $>35-50$ |
| F | $>80$ | $>50$ |

The base Synchro model network was developed using the field collected data, which includes intersection lane configuration, traffic control and speed limits on streets in the study area. The peak hour traffic volumes, pedestrian volumes and peak hour factors, were entered as input.

The model network was then calibrated based on the observations made during the field visit. Variables such as bus blockages etc. for the study intersections were adjusted in order to represent the field conditions.

### 4.1.1 No-Build Conditions

Existing traffic volumes at the study intersections were projected to 2035 based on the growth factors developed by utilizing the $2035 \mathrm{H}-\mathrm{GAC}$ model as presented in Section 3.0.

The 2035 No Build Conditions AM and PM peak hour levels of service for the analysis intersections are summarized in Table 4.2, while detailed level of service analysis are included in the Appendix of this report. As presented in Table 4.2, some of the study intersections are presently operating at levels of service D or better. Some intersections are operating at level of service E or F. Figures 4.1 and 4.2 show the operational LOS as indicated by Synchro analysis at study intersections.

The analysis indicates that with the future year projected traffic volumes, several intersections in the study area fail to operate acceptably. Most of the intersections along Fannin Street, Holcombe Boulevard, Almeda Road and Main Street are operating at LOS E or F. Capacity constraints were observed on all major thoroughfares. In order to accommodate growth due to both population and employment growth, certain roadway improvements are necessary. These are discussed in the next few sections.

TABLE 4.2
2035 NO-BUILD CONDITIONS LEVEL OF SERVICE

| Intersection |  | AM |  | PM |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOS | Delay* | LOS | Delay* |
| Main Campus |  |  |  |  |  |
| 1 | Fannin @ Cambridge | F | 441.3 | F | 101.5 |
| 2 | Fannin @ University | D | 38.5 | C | 30.2 |
| 3 | Fannin @ Ross Sterling | B | 15.7 | C | 31.3 |
| 4 | Fannin @ John Freeman | E | 65 | F | 116.9 |
| 5 | Fannin @ Dryden | C | 32.2 | D | 43.9 |
| 6 | Fannin @ Holcombe | F | 408.6 | F | 352.4 |
| 7 | Fannin @ Pressler | F | 207.2 | F | 83.8 |
| 8 | Holcombe @ Elliot | F | 142.1 | E | 628.9 |
| 9 | Holcombe @ MD Anderson | E | 58.9 | E | 61.8 |
| 10 | Holcombe @ Braeswood | D | 48.8 | D | 50.6 |
| 11 | Bertner @ Pressler | C | N/A | F | 75.8 |
| 12 | Bertner @ Bates | F | 68.9 | F | 72 |
| 13 | Bertner @ Moursund | E | 36.1 | E | 37 |
| 14 | MD Anderson @ Bates | F | 63.5 | F | 63.5 |
| 15 | MD Anderson @ Moursund | B | 10.8 | F | 62.7 |
| 16 | Moursund @ Lamar Flemming | B | 10.4 | B | 10.4 |
| 17 | Moursund @ Braeswood | D | 44.3 | C | 25 |
| 18 | Main @ Cambridge | F | 147.5 | F | 193.5 |
| 19 | Main @ University | E | 55.8 | E | 73.8 |
| 20 | Main @ Holcombe | F | 496.6 | F | 705.5 |
| 21 | Main @ Pressler | N/A | N/A | N/A | N/A |
| Rice Campus |  |  |  |  |  |
| 22 | Main @ Sunset | D | 39.2 | D | 47.7 |
| 23 | Fannin @ Sunset | D | 41.4 | D | 44 |

*Delay is in seconds/vehicle

TABLE 4.2 (Cont.)
2035 NO-BUILD CONDITIONS LEVEL OF SERVICE

| Intersection |  | AM |  | PM |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | LOS | Delay | LOS | Delay |
| Mid Campus |  |  |  |  |  |
| 24 | Almeda @ Holcombe | F | 202.3 | C | 25.5 |
| 25 | Almeda @ OST | F | 268 | F | 405.2 |
| 26 | Cambridge @ Holcombe | F | 1901.7 | F | 2339.0 |
| 27 | Cambridge @ Braeswood | F | 319.3 | F | 189.4 |
| 28 | Bertner @ OST | F | 290.2 | F | 1122.8 |
| 29 | Fannin @ OST | F | 346.6 | F | 324.7 |
| South Campus |  |  |  |  |  |
| 30 | Cambridge @ South Campus Drive. (East Road) | E | N/A | N/A | 24499.8 |
| 31 | Knight @ South Campus Drive (West Road) | A | 0.5 | N/A | 4.4 |
| Leland Anderson Campus |  |  |  |  |  |
| 32 | SH 288 NBFR @ N. MacGregor | B | 19.1 | D | 40 |
|  | SH 288 SBFR @ N. MacGregor | A | 7.2 | D | 54.9 |
| 33 | SH 288 NBFR @ S. MacGregor | B | 19.6 | B | 16.4 |
|  | SH 288 SBFR @ S. MacGregor | B | 19.4 | D | 35.5 |
| 34 | SH 288 NBFR @ Holcombe | F | 1019.4 | F | 129.8 |
|  | SH 288 SBFR @ Holcombe | D | 48.5 | E | 67.2 |
| 35 | SH 288 NBFR @ OST | D | 53.6 | F | 111.2 |
|  | SH 288 SBFR @ OST | F | 135.6 | F | 145.6 |

*Delay is in seconds/vehicle


FIGURE 4.1
2035 NO-BUILD LEVEL OF SERVICE - WEEKDAY AM PEAK HOUR


FIGURE 4.2
2035 NO-BUILD LEVEL OF SERVICE - WEEKDAY PM PEAK HOUR

### 4.1.2 Build Conditions - Short and Mid-term Improvements

Future year No-build conditions analysis identified some deficiencies with respect to capacity and operations of the street network. Some short-term (within next 10 years), mid-term (in next 10-15 years) and long-term (in 25 years) improvements are needed to accommodate the future growth of traffic volumes. Improvement concepts were evaluated using the procedure outlined in the Integration with CMP memo.

The following section provides the details of the traffic analysis conducted for the study area intersections and roadways in the Texas Medical Center Area with the Short and Mid-term Improvements.

## Short-term Improvements

The intersections operating at level of service E or F in existing conditions are identified as candidates for implementing short-term improvements. The following six intersections are the locations where shortterm improvements are identified. The details of the improvements provided at each of the intersections are presented below:

## Holcombe at Main

- Install right-turn bay in the southbound direction
- Install right-turn bay in the westbound direction
- Add additional left-turn bay in the eastbound direction
- Add additional left-turn bay in the westbound direction
- Reconfigure the northbound lanes to one left and thru shared lane and one exclusive northbound right turn-lane
- Additional right-of-Way is anticipated to accommodate the above improvements


## Holcombe at Almeda

- Add additional left-turn bay in the westbound direction
- Modify signal timing for Holcombe Boulevard (approaches to provide lead-lag phasing for left turns)
- Additional right-of-Way is anticipated to accommodate the above improvements


## Fannin at Pressler

- Add additional left-turn bay in the eastbound direction
- Add additional left-turn bay in the westbound direction
- Signal Timing Improvements for Light Rail Transit Coordination
- Additional Right-of-Way is anticipated to accommodate the above improvements


## Almeda at Old Spanish Trail

- Install right-turn bay in the eastbound direction
- Add additional left-turn bay in the northbound direction
- Note: Improvements not required if Almeda Road is widened to 6 lanes per City of Houston Capital Improvement Program (CIP)


## SH 288 Northbound Frontage Road at Old Spanish Trail

- Add additional left-turn bay in the northbound direction


## SH 288 Northbound Frontage Road at Holcombe

- Add additional left-turn bay in the northbound direction
- Change existing thru/left shared lane to thru only

The additional turning lanes may increase the pedestrian crossing distance at intersections. However, the overall width of crossing would still be reasonable and refuge islands may be provided where feasible. The signal timing for the intersections where improvements would be implemented will need to be updated using the pedestrian crossing times calculated based on the new geometry of the intersection.

Texas Department of Transportation is currently undertaking a project for constructing direct connectors from SH 288 managed lanes to Holcombe Boulevard. If that project is completed, SH 288 northbound frontage road improvements at Holcombe Boulevard and Old Spanish Trail are not required. The locations where the short-term improvements are recommended are presented in Figure 4.3

## Corridor Signal Timing Optimization

In order to improve the efficiency of the traffic operations at the study intersections following the implementation of improvement measures traffic signal timing should be optimized. By optimizing the signal timing the intersection capacity and as a result roadway capacity will be efficiently utilized.

The AM and PM peak hour levels of service of the intersections with short-term improvements are summarized in Table 4.3, while detailed level of service analyses are included in Appendix of this report. As presented in Table 4.3, all the intersections which are currently operating at LOS E or F under existing conditions would be operating at acceptable levels of service $D$ or better after the implementation of recommended short-term improvements.

TABLE 4.3
LOS COMPARISON EXISTING CONDITIONS VS. SHORT-TERM IMPROVEMENTS

| Intersection | Existing Conditions |  |  | With Short-term Improvements |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  | PM | AM |  | PM |  |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| Fannin @ Pressler | F | 207.2 | F | 83.8 | C | 28.8 | C | 25.6 |
| Main @ Holcombe | F | 496.6 | F | 705.5 | D | 54.8 | D | 52.0 |
| Almeda @ Holcombe | F | 202.3 | C | 25.5 | C | 29.8 | D | 53.4 |
| Almeda @ OST | F | 268 | F | 405.2 | C | 33.4 | D | 42.5 |
| SH 288 @ Holcombe | F | 1019 | F | 129.8 | C | 34.4 | C | 32.7 |
| SH 288 NBFR @ OST | D | 53.6 | F | 111.2 | D | 41.6 | D | 35.6 |

*Delay is in seconds/vehicle


FIGURE 4.3

## One-Way Pair Option

One of the options developed as part of short-term improvements was to convert University Drive and Dryden Street to a one-way pair between Fannin Street and Main Street. University Boulevard will operate as a one-way street in the westbound direction and Dryden will operate as a one-way street in the eastbound direction, as seen in Figure 4.4. In order to ensure progressive traffic flow along Main Street following the conversion of University Boulevard and Dryden Road, signal timing for the intersections along Main Street between Holcombe Boulevard and Sunset Boulevard may be optimized, as required.

The AM and PM peak hour levels of service for the intersections directly impacted by the implementation of the one-way couplet are summarized in Table 4.4. As presented in Table 4.4, the LOS at all the intersections would improve following the implementation of the one-way couplet.

TABLE 4.4
2035 OPERATIONS: NO-BUILD VS. UNIVERSITYIDRYDENONE-WAY PAIR

| Intersection | $\begin{array}{c}\text { 2035 Volumes - No Build } \\ \text { Conditions }\end{array}$ |  |  |  | 2035 University/Dryden One-Way |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |$]$

*Delay is in seconds/vehicle


FIGURE 4.4
TEXAS MEDICAL CENTER AREA MOBILITY STUDY

Traffic Analysis - Mid-term Improvements
Intersections that will operate at level of service E or F in five to seven years from the current conditions are identified as candidates for implementing mid-term improvements. The following nine intersections are the locations where mid-term improvements are recommended to be implemented.

The details of the improvements provided at each of the intersections are presented below:
Main at Cambridge

- Add right-turn bay in the northbound direction
- Additional Right-of-Way is anticipated with potential impacts to Trees


## Cambridge at East Road

- Install traffic signal when warranted
- Add left-turn bay in the northbound direction
- Add U-turn bay in the southbound direction
- Add second right-turn bay in the eastbound direction


## Old Spanish Trail at Fannin

- Add exclusive right-turn bays in all directions (northbound, southbound, eastbound, and westbound)


## Old Spanish Trail at Bertner

- Add additional left-turn bay in the southbound direction, making a dual left-turn
- Add additional left-turn bay in the eastbound direction, making a dual left-turn
- Add two right-turn bays in the southbound direction, making a dual right-turn
- Add right-turn bay in the westbound direction


## Old Spanish Trail at Cambridge

- Add additional left-turn bay in the westbound direction
- Add additional left-turn bay in the eastbound direction
- Add additional right-turn bay in the eastbound direction
- Add additional right-turn bay in the westbound direction


## Old Spanish Trail at Almeda

- Add additional left-turn bay in the westbound direction, making a dual left-turn
- Add right-turn bay in the southbound direction
- Add right-turn bay in the northbound direction


## Cambridge at Holcombe

- Add left-turn bay in the westbound direction
- Add left-turn bay in the eastbound direction
- Add right-turn bay in the eastbound direction


## Cambridge at Braeswood

- Add additional westbound right turn bay, making a dual free right-turn


## Almeda at Holcombe

- Add additional left-turn bay in the northbound direction, making a dual left-turn
- Add two left-turn bays in the eastbound direction, making a dual left-turn
- Add right-turn bay in the eastbound direction

The AM and PM peak hour levels of service of the intersections with mid-term improvements are summarized in Table 4.5, while detailed level of service analyses are included in The Appendix section of this report. As presented in Table 4.5, all the intersections which are currently operating at LOS E or F under Year 2020 traffic conditions would be operating at acceptable levels of service D or better after the implementation of recommended mid-term improvements. The locations where the mid-term improvements are recommended are listed below and presented in Figure 4.5.

- Main Street at Cambridge Street
- Almeda Road at Holcombe Boulevard
- Almeda Road at Old Spanish Trail
- Cambridge Street at Holcombe Boulevard
- Cambridge Street at Braeswood Boulevard
- Bertner Avenue at Old Spanish Trail
- Fannin Street at Old Spanish Trail
- Cambridge Street at South Campus Drive (East Road)

TABLE 4.5
YEAR 2020 - NO-BUILD CONDITIONS VS. MID-TERM IMPROVEMENTS

| Intersection | No-Build Conditions |  |  | With Mid-term Improvements |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  | PM |  | AM |  | Play |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| Main @ Cambridge | E | 60.4 | F | 97.0 | D | 42.7 | D | 42.6 |
| Almeda @ Holcombe | D | 51.6 | F | 107.6 | D | 51.7 | D | 39.0 |
| Almeda @ OST | D | 50.2 | E | 76.2 | D | 36.3 | D | 44.8 |
| Cambridge @ Holcombe | D | 46.8 | E | 57.3 | D | 45.8 | D | 35.9 |
| Cambridge @ Braeswood | D | 53.8 | E | 58.0 | D | 39.2 | D | 47.9 |
| Bertner @ OST | E | 70.4 | F | 189.5 | D | 42.5 | D | 53.3 |
| Fannin @ OST | F | 84.6 | F | 101.6 | D | 52.6 | D | 47.4 |
| Cambridge @ South Campus <br> Drive (East Road) | F | 638.7 | F | 403.7 | C | 23.1 | D | 39.6 |

*Delay is in seconds/vehicle
During the second public meeting conducted to present future year conditions analyses findings, comments were received regarding future extension of Pressler Street to cross Brays Bayou and intersect with West Road to the south. A separate study is needed to explore the feasibility of constructing a bridge to link Pressler Street and the TMC Mid Campus between the Baylor Hospital Property and TMC Remote parking (West Road) that would essentially extend Pressler to Old Spanish Trail.


FIGURE 4.5
MID-TERM IMPROVEMENT LOCATIONS AND LOS WITH IMPROVEMENTS


FIGURE 4.6 POTENTIAL PRESSLER STREET EXTENSION CONCEPT THAT NEEDS FURTHER REVIEW

## Campus Connections

The recommendations for campus connections were gathered from the plans developed as part of previous studies conducted in the Texas Medical Center Area. As part of this study, the recommended campus connections were reviewed for feasibility. The recommended campus connections are presented in the Figure. X below.

Following the review of South and Mid Campus development plans, aerial images of the locations and conducting field visits it has been identified that some of the connections are not feasible due to the presence of physical barrier such as an existing building or in some cases proposed buildings. Such locations are identified in Red in the Figure X.X. Other connections appeared to be feasible and are identified in Green. Also, it has been observed that some connections are recommended to facilitate efficient ingress and egress of trips generated by the proposed developments.


FIGURE 4.7
FUTURE RECOMMENDED CAMPUS CONNECTIONS

### 4.1.3 Build Conditions - Long-term Improvements

It is projected that most of the intersections along the major roadways in the TMC study area would operate at unacceptable levels of service in the Year 2035. The short-term and mid-term improvements recommended will not be able to meet the traffic demand. Such a scenario calls for analysis of transportation infrastructure at the corridor level rather than localized intersection analysis. Therefore, the major east-west directional roadways, Holcombe Boulevard and Old Spanish Trail, and major northsouth roadway, Almeda Road, were analyzed.

## Alternative Concepts Development

## Holcombe Boulevard and Old Spanish Trail

In order to meet the traffic demand in 2035, the capacity of Holcombe Boulevard and Old Spanish Trail needs to be increased. It is estimated that these two major roadways may need five lanes in each direction. In addition, some intersection approaches may require new or additional exclusive right and/or left turn-lanes. With this increase in capacity along the roadways, improvements at the intersections would help relieve the anticipated congestion.

However, the widening of Holcombe Boulevard and Old Spanish Trail would require major acquisition of right-of-way. A desktop review of the aerial maps of the corridors indicated that some TMC buildings may be impacted. Therefore, alternative improvement options have been evaluated and are presented in the following sections.

## Almeda Road

Almeda Road is a major thoroughfare in north-south direction. As per the City of Houston's Capital Improvement Plan, this street is planned to be widened to six lanes from Old Spanish Trail to N. MacGregor Way in Year 2015. The right-of-way along Almeda Road between IH 610 and N. MacGregor Way is 150-160 feet with a wide median/drainage ditch separating northbound and southbound lanes.

Traffic analysis was conducted by modeling four lanes in each direction along Almeda Road for the Year 2035 from IH 610 to N. MacGregor Way. This option assumes that direct connectors would be provided to Almeda Road from IH 610. This improvement would require a storm sewer line to replace the median /ditch, which would be covered by the new lanes.

The projected average daily traffic for year 2035 suggests that six-lane section on Almeda would operate reasonably during most times of the day. During the AM and PM peak hours, intersections along Almeda Road which currently operate at LOS E or F under Year 2035 traffic conditions would operate at acceptable levels of service D or better with the six lane option. But the intersection of Almeda at Holcombe would be operating at LOS E. This indicates that additional improvements such as grade separation of Old Spanish Trail or Holcombe would be required at Almeda Road.

## Option 1 - New Transportation Terminal

For Option 1, new transportation terminal locations were studied. The overall TMC area was examined and two locations were identified as strategic locations for a transportation terminal. These two locations are directly off of major roadways feeding into the TMC in order to capture vehicles before entering the primary TMC area.

## Holcombe Boulevard Transportation Terminal

The alternative of providing a new transportation terminal on Holcombe Boulevard at SH 288, which is the primary gateway to the TMC, was analyzed as part of this study. The transportation terminal can
provide direct access from the proposed SH 288 Direct Connectors. This will enable the traffic oriented toward the TMC to park their vehicles at the terminal. A scheduled shuttle service would have to be provided to transport travelers to their destinations within the TMC. This facility could be used primarily by employees of the TMC who arrive during AM peak hour and depart during the PM peak period, thus relieving the traffic on the east-west roadways, Holcombe Boulevard and Old Spanish Trail. It is anticipated that with such a terminal, there would be a $25 \%$ reduction in auto trips to the TMC along both Holcombe Boulevard and Old Spanish Trail. Traffic analysis at study intersections was conducted using the $25 \%$ reduction in trips. Table 4.6 shows the LOS results during peak hour in comparison to future year 2035 No-build conditions.

This facility can be designed to provide an ultimate capacity of 2,000 spaces, but with the flexibility of phased development. The potential location of this terminal is illustrated in Figure 4.6.

TABLE 4.6
2035 VOLUMES: NO-BUILD VS. HOLCOMBE TRANSPORTATION TERMINAL

| Intersection | No Build Conditions |  |  | Transportation Terminal |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| Fannin @ Holcombe | F | 408.6 | F | 352.4 | D | 51.7 | D | 53.5 |
| MD Anderson @ Holcombe | E | 58.9 | F | 61.8 | A | 7.5 | B | 10.4 |
| Holcombe @ Braeswood | D | 48.8 | D | 50.6 | D | 46.6 | D | 41.9 |
| Main @ Holcombe | F | 496.6 | F | 705.5 | D | 51.8 | D | 54.3 |
| Almeda @ Holcombe | F | 202.3 | C | 25.5 | D | 39.5 | D | 43.7 |
| Cambridge @ Holcombe | F | 1901.7 | F | 2339.0 | D | 46.5 | E | 69.2 |
| SH 288 NBFR @ Holcombe | F | 1019.4 | F | 129.8 | D | 42.4 | D | 54.6 |
| SH 288 SBFR @ Holcombe | D | 48.5 | F | 67.2 | C | 33.5 | D | 48.8 |
| Almeda @ OST | F | 268 | F | 405.2 | D | 47.3 | D | 49.9 |
| Bertner @ OST | F | 290.2 | F | 1122.8 | D | 46.2 | E | 59.5 |
| Fannin @ OST | F | 346.6 | F | 324.7 | D | 51.0 | E | 65.1 |
| SH 288 NBFR @ OST | D | 53.6 | F | 111.2 | C | 25.2 | D | 53.9 |
| SH 288 SBFR @ OST | F | 135.6 | F | 145.6 | C | 33.5 | D | 52.9 |

*Delay is in seconds/vehicle

## Almeda Road Transportation Terminal

Providing a transportation terminal on Almeda Road, near the intersection of IH 610, which is the primary gateway to TMC traffic arriving from southwest region, was another alternative analyzed as part of this study. The transportation terminal could provide access via the Direct Connector from IH 610. This would enable the traffic destined to the TMC to park their vehicles at the terminal without interfering with Almeda Road traffic. Even at this location, a scheduled service would have to be provided to transport travelers to their destinations within TMC. This facility could be used primarily by employees of the TMC who arrive during AM peak hour and depart during the PM peak period, thus relieving the traffic along the northsouth roadways, Almeda Road and Cambridge Street. It is anticipated that there would be a $25 \%$ reduction in the trips to the TMC along Almeda Road. Traffic analysis at study intersections was conducted using the $25 \%$ reduction in trips. Table 4.7 shows the LOS results during peak hour in comparison to future year 2035 No-build conditions.

It is proposed that this facility be designed to provide an ultimate capacity of 1,000 spaces, but with the flexibility of phased development. The potential location of this terminal is illustrated in Figure 4.7.

TABLE 4.7
2035 VOLUMES: NO-BUILD VS. ALMEDA TRANSPORTATION TERMINAL

| Intersection | No Build Conditions |  |  |  | Transportation Terminal |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| Almeda at Holcombe | F | 496.6 | F | 705.5 | D | 42.6 | C | 28.8 |
| Almeda at OST | F | 268 | F | 405.2 | D | 45.8 | D | 39.5 |

*Delay is in seconds/vehicle



## Option 2 - Grade Separation at Select Intersections

## Holcombe Boulevard

The traffic operations at the intersections along Holcombe will be significantly impacted by the regional traffic growth, as well as the proposed improvements within TMC. One strategy to address the anticipated congestion along Holcombe Boulevard is to grade separate the through lanes at select major intersections along Holcombe.

The AM and PM peak hour levels of service of the intersections for this option are summarized in Table 4.8, while detailed level of service analyses are included in the Appendix section of this report. As presented in Table 4.8, all intersections which currently operate at LOS E or F under Year 2035 traffic conditions would be operating at acceptable levels of service D or better after the implementation of grade separated express lanes. As seen in Figure 4.8, the existing six-lane street would remain, but at intersections, 4 lanes would be grade separated and four lanes would connect to cross-streets.

TABLE 4.8
2035 OPERATIONS: NO-BUILD VS. HOLCOMBE OVERPASS OPTION

| Intersection | No Build Conditions |  | Overpass Option |  |
| :---: | :---: | :---: | :---: | :---: |
|  | PM |  | PM |  |
|  | LOS | Delay | LOS | Delay |
| Fannin @ Holcombe | F | 352.4 | D | 54.8 |
| Bertner @ Holcombe | E | 61.8 | D | 44.1 |
| Braeswood @ Holcombe | D | 50.6 | D | 53.8 |
| Main @ Holcombe | F | 705.5 | D | 53.1 |
| Almeda @ Holcombe | C | 25.5 | D | 44.3 |
| Cambridge @ Holcombe | F | 2339.0 | D | 27.2 |

## Old Spanish Trail

The traffic operations at the intersections along Old Spanish Trail will be significantly impacted by the regional traffic growth, as well as the proposed improvements within TMC. One strategy to address the anticipated congestion along Old Spanish Trail would be to grade separate the through lanes at select major intersections along Old Spanish Trail. As seen in Figure 4.9, the existing six-lane street would remain, but at intersections, 4 lanes would be grade separated and four lanes would connect to crossstreets.

The AM and PM peak hour levels of service of the intersections for this option are summarized in Table 4.9, while detailed level of service analyses are included in the Appendix section. As presented in Table 4.9, all intersections which currently operate at LOS E or F under Year 2035 traffic conditions would operate at acceptable levels of service $D$ or better after the implementation of grade separated express lanes.

TABLE 4.9
2035 OPERATIONS: NO-BUILD VS. OLD SPANISH TRAIL OVERPASS OPTION

| Intersection | No Build Conditions |  | Overpass Option |  |
| :---: | :---: | :---: | :---: | :---: |
|  | PM |  | PM |  |
|  | LOS | Delay | LOS | Delay |
| Almeda at Old Spanish Trail | F | 405.2 | D | 37.5 |
| Bertner at Old Spanish Trail | F | 1122.8 | D | 49.3 |
| Fannin at Old Spanish Trail | F | 324.7 | D | 51.4 |

*Delay is in seconds/vehicle



The grade separation of through lanes at select intersections also would have operational benefits such as improvement of level of service at the intersections along both Holcombe Boulevard and Old Spanish Trail, reduction in travel time, and increase in the capacity of these corridors. The improved traffic operations would result in the reduction of the vehicle emissions and has a positive impact on the environment and quality of life on the residents and employees of TMC.

The option of grade separation of through lanes at select intersections along Holcombe Boulevard and Old Spanish Trail also has drawbacks such as short weaving distances for vehicles entering and exiting from through lanes. Also, the eastbound and westbound left-turn movements at the intersections of Holcombe at Richard JV Johnson and MD Anderson Drive might have to be eliminated to accommodate this improvement.

### 4.1.4.1 Option 3 - Grade Separated Express Lanes

## Holcombe Boulevard

There are residential and commercial developments on the west side of Texas Medical Center Study Area which generate and attract significant traffic. Based on the current traffic patterns, it is estimated that approximately $35 \%$ of the traffic on Holcombe is destined to non-TMC areas. Separating this through traffic from the TMC traffic would improve traffic operations at the intersections along Holcombe.

The AM and PM peak hour levels of service of the intersections for this option are summarized in Table 4.10, while detailed level of service analyses are included in the Appendix section. As presented in Table 4.10, all the intersections which are currently operating at LOS E or F under Year 2035 traffic conditions would be operating at acceptable levels of service $D$ or better after the implementation of grade separated express lanes. This improvement along Holcombe Boulevard is illustrated in Figure 4.9.

During the second public meeting conducted to present future year conditions analyses findings, comments were received from residents along Holcombe Boulevard between Almeda and Cambridge. The residents request was, as part of the Holcombe Elevated expressway option, consider shifting the elevated section south of the existing Holcombe Boulevard alignment to reduce impacts to the residential buildings in that section.

TABLE 4.10
2035 OPERATIONS: NO-BUILD VS. HOLCOMBE BOULEVARD EXPRESS LANE GRADE SEPARATION

| Intersection | No Build Conditions |  |  |  | Express Lane Option |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |  |
| Fannin @ Holcombe | F | 408.6 | F | 352.4 | D | 43.5 | D | 44.6 |  |
| MD Anderson @ Holcombe | E | 58.9 | E | 61.8 | A | 7.9 | B | 11.9 |  |
| Holcombe @ Braeswood | D | 48.8 | D | 50.6 | D | 50.3 | D | 44.7 |  |
| Main @ Holcombe | F | 496.6 | F | 705.5 | D | 51.2 | D | 54.5 |  |
| Almeda @ Holcombe | F | 202.3 | C | 25.5 | D | 40.4 | D | 51.0 |  |
| Cambridge @ Holcombe | F | 1901.7 | F | 2339.0 | D | 44.5 | D | 52.5 |  |
| SH 288 NBFR @ Holcombe | F | 1019.4 | F | 129.8 | D | 42.4 | D | 54.6 |  |
| SH 288 SBFR @ Holcombe | D | 48.5 | E | 67.2 | C | 33.5 | D | 48.8 |  |

*Delay is in seconds/vehicle

## Old Spanish Trail

There are residential and commercial developments on the west side of Texas Medical Center Study Area which generate and attract significant traffic. Based on the current traffic patterns it has been estimated that significant portion ( $35 \%-40 \%$ ) of the traffic on Old Spanish Trail is destined to non-TMC areas. Separating this through traffic from the TMC traffic would improve traffic operations at the intersections along Old Spanish Trail.

The AM and PM peak hour levels of service of the intersections for this option are summarized in Table 4.11, while detailed level of service analyses are included in the Appendix section. As presented in Table 4.11, all the intersections which are currently operating at LOS E or F under Year 2035 traffic conditions would be operating at acceptable level of service D or better after the implementation of grade separated express lanes. This improvement along Old Spanish Trail is illustrated in Figure 4.10.

TABLE 4.11
2035 OPERATIONS: NO-BUILD VS. OLD SPANISH TRAIL EXPRESS LANE GRADE SEPARATION

| Intersection | No Build Conditions |  |  |  | Express Lane Option |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| Almeda @ OST | F | 268 | F | 405.2 | D | 36.0 | D | 50.1 |
| Bertner @ OST | F | 290.2 | F | 1122.8 | D | 46.2 | D | 49.5 |
| Fannin @ OST | F | 346.6 | F | 324.7 | D | 42.7 | D | 50.1 |
| SH 288 NBFR @ OST | D | 53.6 | F | 111.2 | C | 25.2 | D | 53.9 |
| SH 288 SBFR @ OST | F | 135.6 | F | 145.6 | C | 33.5 | D | 52.9 |

*Delay is in seconds/vehicle
The implementation of grade separated express lanes has operational benefits, such as improvement of level of service at the intersections along both Holcombe Boulevard and Old Spanish Trail, reduction in travel time, and increase in the capacity of these corridors. Also, the express lanes facilitate the separation of non-TMC traffic. The improved traffic operations would result in the reduction of vehicle emissions and has a positive impact on the environment and quality of life on the residents and employees of TMC.

However, the grade separated express lanes have drawbacks such as impacts on the pedestrian skywalks along Holcombe Boulevard and higher cost of implementation. Also, the express lanes could be considered as a physical barrier.

## Summary of Option 2 and Option 3

In order for Holcombe Boulevard and Old Spanish Trail to operate at acceptable levels of service in the future, both streets must be altered to either Option 2 or Option 3. Therefore, there are four possible outcomes, as follows:

- Holcombe Boulevard Grade Separated Intersections + OST Grade Separated at Intersections
- Holcombe Boulevard Grade Separated Express Lanes + OST Grade Separated Express Lanes
- Holcombe Boulevard Grade Separated Intersections + OST Grade Separated Express Lanes
- Holcombe Boulevard Grade Separated Express Lanes + OST Grade Separated at Intersections




### 4.2 Transit

### 4.2.1 METRO Bus

## Context

At the time of preparing this report, METRO was conducting a study to "re-imagine" bus services. That process may result in substantial re-design of routes, including those serving the TMC. To the extent this occurs, the recommendations described below for route modifications may require revision. It is possible, however, that they will remain relevant and applicable.

Using passenger boardings per revenue hour as the productivity measure, five routes (counting routes 26 and 27 as a single route) were selected as the least productive and therefore most in need of improvement. The routes include two limited-stop services, 402 and 426; one express route, 292; the 26/27 counter-clockwise and clockwise loops; and a local route, 34. Compared with the 22.3 boardings per hour average for all bus routes serving the TMC, the lowest five have the following productivity (passenger boardings per revenue hour):

$$
\begin{array}{ll}
26 \text { Outer Loop - } 27 \text { Inner Loop } & 20.7 \\
402 \text { Quickline Bellaire } & 20.0 \\
34 \text { Montrose Crosstown } & 14.9 \\
292 \text { West Bellfort/Westwood/TMC Transit Center } & 13.1 \\
426 \text { Swiftline } & 11.0
\end{array}
$$

## Evaluation

Based upon inspection of their routing, hours of service, headways, and ride count data, the following evaluation of METRO bus route modifications serving the TMC and potential route and service modifications is presented.

Route 34 Montrose: This route has relatively infrequent service, ranging generally between 25 or 30 minutes to 45 minutes. The scheduled round trip time is approximately 90 minutes, excluding layover. Map examination of the route suggests that it might be worthwhile to revise the routing to avoid the diversion of the route to Heights Boulevard and Waugh Street, instead using Studewood, Studemont, and Montrose (a continuous north-south routing) throughout. This would shorten the route length by about 1.2 miles in each direction and eliminate two right turns and two left turns. This could reduce the route running time by five to eight minutes in each direction, giving a round trip time of about 75 minutes. With little effect on the number of buses assigned, the running time improvement could allow peak-period headways to be reduced from 25-30 minutes to 20 minutes, and off-peak service to have 30 -minute headways.

From a review of the ride check information from this route, the stops along Heights and Waugh have a significant proportion of the route's boardings and alightings, but the stops where these occur support an assumption that many of them are transfers between route 34 and other services, such as routes 3,18 , 36,50 , and 85 . All of these except Route 85 should support equally-convenient transferring if route 34 follows the more direct north-south routing. Although it is not certain whether the existing Heights-Waugh routing or the more direct routing would attract more walk-access trips, there are in fact significant residential locations that would be served by the direct alignment, especially with the improved headways available because of the reduced round trip time.

Route 292 West Bellfort Express: This route provides peak-period peak-direction only service. It has the second-lowest productivity (13.1 boardings per revenue hour) of those identified for this analysis. One possible reason for this low utilization is the indirectness of its alignment, which follows US 59 from southwest of the TMC to a point due north of the TMC and then "back tracks" south to the TMC Transit Center. Although this allows it to provide stops within the Medical Center Main Campus, it may unduly limit the attractiveness of travel to the TMC Transit Center, where there are multiple opportunities for further trip distribution.

Examination of the 2011 O-D survey indicates that about 56 percent of the destinations of passengers currently using this route would find entry to the TMC via the Transit Center more convenient than the approach from the north. Another 15 percent would be at least as well served by this re-orientation. On that basis, and considering the fact that US 59 is chronically congested during peak periods in the peak direction of travel, it is suggested that route 292 AM Peak trips be re-routed from US 59 via BellaireHolcombe to the TMC Transit Center, and then follow the present afternoon-peak routing through the TMC and northward on Main Street. Buses returning to the West Bellfort Park \& Ride for another revenue trip would enter US 59 at Spur 527, as they currently do during the afternoon peak period. During the PM Peak, revenue service would begin at Main Street and Bissonnet, follow the present AM Peak routing to the TMC, and then continue via Holcombe - Bellaire to US 59.

It is likely that this re-routing would incur about the same running time as is currently required, and might actually shorten non-revenue return-trip times. Most passengers would be better-served, by reaching their TMC destinations more quickly. One might also consider adding limited stops along Bellaire and Holcombe, increasing the potential passenger market served by Route 292. Another way of accomplishing that function would be to include only a single stop on Bellaire, at the Bellaire Transit Center.

Route 402 Quickline Bellaire: The effectiveness of this route might be strengthened by extending service beyond its present TMC TC terminus, either farther into the Medical Center main campus or to the VA Medical Center. This could yield higher ridership without excessive increase in revenue service hours. An increase in the current six buses required to operate the service to seven buses would accommodate the expanded direct coverage of the route. Another option would be to combine the 402 and 426 routes, with possible savings in layover and recovery time and with even further augmentation of coverage.

Routes $26 / 27$ and the 426 Swiftline: The concept of the route-pair $26 / 27$ is attractive because it enables no-transfer connectivity of a series of well-located Metro transit centers forming a loop around central Houston. Its disadvantage is that it operates uniform headways ( 20 minutes during peak periods and 30 minutes during the midday period) over the entire length, while passenger loadings vary considerably. Improved productivity might result from breaking the loop route into two or more segments with different headways, but almost certainly with some loss in ridership.

Route 426, recently introduced as a peak-only limited-stop service, operates between the TMC Transit Center and the Southeast Transit Center. The route, which provides 15 -minute headways, duplicates part of the $26 / 27$ routing but omits the $26 / 27$ diversion to the VA Medical Center and has only three intermediate stops between the two transit centers. Most route 426 riders were diverted from routes 26 and 27, and benefit from closer headways and shorter running times between the two transit centers (18 minutes, compared with approximately 30 minutes via 26/27).

Options that might improve the productivity of route 426 include:

- Coordinate headways and timetables with 26/27
- Reduce service frequency
- Extend coverage beyond the TMC TC or the SE TC, or both
- Modify the routing to include service to the VA Medical Center
- Augment hours of service by including midday operation

Coordinate headways: Adopting the 20-minute headways of route $26 / 27$ would reduce the number of bus trips but would not reduce the number of vehicles in service. Passenger time savings provided by diversion of some trips from $26 / 27$ to 426 would be more uniform and predictable, possibly increasing the use of the 426 route.

Reduce service frequency (and the number of buses in operation): The only reasonably-attractive option would be to adopt 20 -minute headways, coordinated with $26 / 27$ at only one of the 426 termini. There would be some loss of ridership and a reduction from three to two buses in service; productivity might be improved.

Extension of route 426 beyond one or both of its present termini: Examination of 26/27 passenger on/off patterns indicates that extension to the northwest of the TMC TC would have to be too far to be beneficial. To the northeast of the SE TC, extension to the Magnolia Transit Center could augment ridership significantly (at the expense of $26 / 27$ ridership), but would increase one-way running time by about 15 to 20 minutes, requiring five to six buses in service, compared with the current schedule's three buses. It is unlikely that a proportional gain in ridership would be achieved.

Modification of route 426 to include service to the VA Medical Center: This would add about five to seven minutes to the current 18-minute one-way running time, and one bus to the three-vehicle current operation. Serving the VA hospital would augment the 426 passenger market, by diverting more riders from the 26/27 route. The gain in riders would more than offset the loss in riders affected by the longer overall running time, and might improve route productivity. A variant would be to lengthen headways from 15 to 20 minutes, allowing the same three-bus service as at present; this might improve productivity with no increase in operating cost or the bus fleet requirement. As discussed regarding route 402, merging the 402 and 426 , including the diversion to serve the VA Medical Center, could improve operating efficiency as well as attract additional riders.

Include midday operation: Review of the 2011 transit passenger origin-destination survey indicates that the 26/27 peak-period (6-9 AM and 3-6 PM) ridership was 29 percent of total weekday ridership, while midday ( $9 \mathrm{AM}-3 \mathrm{PM}$ ) ridership was 62 percent of the total for the weekday - more than twice as many passengers per hour. Although the midday ridership is not as strongly concentrated along the TMC - SE TC portion of the 26.27 service area, it seems virtually certain that midday service on route 426 could attract significantly more riders per revenue service hour than are attained by the current peak-only service. Despite doubling the revenue service hours compared with peak-only service, this option should improve Route 426 productivity, and require no augmentation of the bus fleet.

## Transit Re-Imagined Plan

The Transit System Reimagining Project represents a transformative opportunity for METRO. The project takes a fresh look at the regional bus network to develop a 5 -Year Transit Service Plan that reimagines the transit network to better meet the needs of the Houston region utilizing METRO's existing financial resources and redeploying those resources to meet the goals for the plan. The plan also defines a framework to manage future growth in the network as revenues grow, based on items such as the 2012 voter-approved referendum on the sales tax revenues that are the primary source of funding for METRO. Figure 4.12 shows the reimagined network for the TMC study area.

The purpose of the Frequent Network is to generate high ridership by providing service for typically high density, walkable areas where the street network allows transit routes to use efficient, relatively straight paths and where the pedestrian network does not present barriers to access for people near to transit. Figure 4.13 shows the frequent network for the general study area. Routes in the

Frequent Network are characterized by:

- 15 minute or better midday and peak frequencies for at least 15 hours each day, with at least three additional hours of evening/late night service at 20 or 30 minute headways
- 18+ hour total span every day, including weekends

Where the routes are similar to existing services, effort was made to maintain frequency and span of service where existing ridership supports those levels of service.

Table 4.12 summarizes the service characteristics for the reimagined routes in the TMC study area and provides comparison to the existing METRO routes that provide service along the same route or part of the proposed re-imagined route. While some aspects of the reimagined routes are similar to the existing services, features of the existing system were maintained only if they were believed the best approach. The Draft Reimagined Network Plan introduces a new route numbering pattern that was developed to make the network structure clearer and more legible for existing and prospective riders alike.

Route 2 Brays Bayou: This route is proposed to operate between Lee Clinic and Eastwood TC similar to the existing route 68 Brays Bayou Crosstown. Route 2 is part of the proposed frequent network between TMC TC and Eastwood TC with proposed midday headway of 15 minutes. The whole route would be operating with peak headway of 12 minutes and a span of service of 18 hours.
Route 4 Beechnut: This route is proposed to operate between Mission Bend park-n-ride and TMC TC similar to existing route 4 Beechnut. The proposed route 4 is part of the frequent network with a midday frequency of 15 minutes. The operations during peak hours would be kept the same headway of 10 minutes as the existing route 4 but the span of service is proposed to be extended from 19 hours to 20 hours.

Route 5 Bellaire: This route is proposed to operate along Bellaire Boulevard similar to existing route 2 Bellaire. The proposed route 5 is part of the frequent network with midday headway of 15 minutes. The proposed changes to the service frequency identify operations with peak headway of 10 minutes and a span of service of 20 hours.

Route 5Q Bellaire Quickline: This route is proposed to operate weekdays only similar to the existing route 402 Quickline Bellaire. Route 5Q is part of the proposed frequent network with midday frequency of 15 minutes. Operations during peak hours identify 10 minutes headway and a span of service of 15 hours.

Route 10 Kirby Dallas Polk: This route is proposed to operate between TMC TC and Eastwood TC similar to existing route 18 Kirby but extending to the east with Eastwood TC as terminus to the east. The proposed route 10 is part of the frequent network with a midday frequency of 15 minutes. The proposed peak headway for route 10 would be 20 minutes with a span of service of 19 hours.

Route 50 Shepherd: This route is proposed to operate from N Shepherd park-n-ride to TMC TC similar to a segment in which existing route 26 and existing route 27 operate along Greenbriar. The proposed route 50 is part of the frequent network with midday headway of 15 minutes, peak headway of 15 minutes and a span of service of 18 hours.


FIGURE 4.14
DRAFT METRO REIMAGINED NETWORK


FIGURE 4.15 DRAFT METRO FREQUENT NETWORK

Route 53 Almeda N Main: This route is proposed to operate from Hiram Clarke TC to Fannin South similar to existing route 11 Almeda/Nance with peak headway of 30 minutes and span of service of 14 hours. The route is also proposed to operate from Fannin South to Garden Oaks with a service frequency of 15 minutes during peak and a span of service of 18 hours.

Route 54 Airline Montrose: This route is proposed to operate from Greenspoint TC to TMC TC on a segment similar to existing route 34 Monrose Crosstown but extending to Greenpoint. Route 54 is part of the proposed frequent network with midday headway of 15 minutes, peak headway of 12 minutes and a span of service of 19 hours.

Route 66 OST Wayside: This route is proposed to operate from FW/DH TC to TMC TC similar to a segment in which existing route 26 and existing route 27 operate. The proposed route 66 would operate with peak headway of 20 minutes and a span of service of 14 hours.

Route 71 Cambridge: This route is proposed to operate from El Camino to TMC TC with peak headway of 10 minutes and a span of service of 18 hours; operations from Southeast TC to El Camino are proposed to be provided with peak headway of 30 minutes and a span of service 14 hours.

Route 72 Yellowstone Reed: This route is proposed to operate from Fannin South TC to TMC TC with peak headway of 30 minutes and a span of service of 14 hours.

Route 73 Southmore Park Place: This route is proposed to operate from Allen Genoa to Wheeler TC similar to a portion of existing route 5 Kashmere Gardens/Southmore. The service frequency is proposed to be 30 minutes during peak with a span of service of 14 hours.

Route 80 Westridge: This route is proposed to operate between Bellfort to TMC TC with peak headway of 10 minutes and a span of service of 14 hours. There are no existing routes that currently serve this corridor.

Route 81 Willowbend: This route is proposed to operate between Fondren to TMC TC similar to existing route 10 Willowbend. The proposed frequency of service would be 30 minutes during peak with a span of service of 14 hours.

TABLE 4.12
CHARACTERISTICS FOR REIMAGINED NETWORK IN TMC STUDY AREA

| Reimagined Route | Existing Route | Peak <br> Headway- <br> Reimagined (min) | Peak <br> Headway Existing (min) | Span - <br> Reimagined (hours) | Span Existing (hours) | Transit Center/ Park-n-Ride Connections - Reimagined | Transit Center/ Park-n-Ride Connections - Existing | Frequent Network Reimagined | Notes - Reimagined |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 West Bellfort | 8 South Main | 15 | 20 | 19 | 19 | W Bellfort P-n-R, Fannin South TC | W Bellfort P-n-R, TMC TC, Wheeler Station |  |  |
| 2 Brays Bayou | 68 Brays Bayou Crosstown | 12 | 15 | 18 | 16 | West Loop TC, TMC TC, Eastwood TC | TMC TC, West Loop P-n-R, Eastwood TC | TMC to Eastwood |  |
| 3 Bissonnet | 65 Bissonnet | 10 | 15 | 20 | 19 | Bellaire TC, Wheeler TC | Bellaire TC, Wheeler Station | Synott to Wheeler |  |
| 4 Beechnut | 4 Beechnut | 10 | 10 | 20 | 19 | Mission Bend P-n-R, TMC TC | TMC TC | Mission Bend to TMC |  |
| 5 Bellaire | 2 Bellaire | 10 | 15 | 20 | 19 | Mission Bend P-n-R, Bellaire TC, TMC TC | Bellaire TC, Mission Bend P-nR, TMC TC | Mission Bend to TMC |  |
| 5Q Bellaire Quickline | 402 Quickline Bellaire | 10 | 15 | 15 | 12 | Bellaire TC, TMC TC | Bellaire TC, TMC TC | Bellaire \& Ranchester to TMC |  |
| 6 Gulfton Holman | 9 North Main/Gulfton Ltd | 15 | 25 | 18 | 16 | Eastwood TC | Heights TC |  |  |
| 7 Richmond | 25 Richmond | 10 | 10 | 20 | 19 | Mission Bend P-n-R, Wheeler TC, Eastwood TC | Mission Bend P-n-R, Wheeler Station | Westchase to Eastwood | Mission Bend to Westchase: Peak Headway 20 min , Span 18 hours |
| 10 Kirby Dallas Polk | 18 Kirby | 20 | 30 | 19 | 15 | Eastwood TC, TMC TC | Fannin South P-n-R | TMC to Eastwood |  |
| 50 Sheperd | 26/27 Outer Loop/Inner Loop Crosstown | 10 | 20 | 18 | 14 | N Sheperd P-n-R, TMC TC | Fifth Ward/Denver Harbor TC, Heights TC, Magnolia TC, Southeast TC, TMC TC | N Sheperd to TMC |  |
| 53 Almeda N Main | 11 Almeda/Nance | 15 | 25 | 18 | 16 | Downtown TC, Fannin South P-n-R, Hiram Clarke TC | Downtown TC, Fifth <br> Ward/Denver Harbor TC, Hiram Clarke TC |  | Hiram Clarke TC to Fannin: Peak Headway 30 min , Span 14 hours |
| 54 Airline Montrose | 34 Montrose Crosstown | 12 | 25 | 19 | 12 | Greenspoint TC, Northline TC/HCC, TMC TC | Heights TC | Greenspoint to TMC |  |
| 60 Kelley Scott | $52 \mathrm{Hirsch} / \mathrm{Scott}$ | 10 | 10 | 20 | 19 | Kashmere TC, Downtown TC, <br> Southeast TC, Hiram Clarke TC | Downtown TC, Kashmere TC, Mesa TC, Southeast TC | Airport to Kashmere | Hiram Clarke TC to Airport: Peak Headway 30 min , Span 14 hours |
| 66 OST Wayside | 26/27 Outer Loop/Inner Loop Crosstown | 20 | 20 | 14 | 14 | Fifth Ward/Denver Harbor TC, Magnolia Park TC, Palm Center TC, TMC TC | Fifth Ward/Denver Harbor TC, Heights TC, Magnolia TC, Southeast TC, TMC TC |  |  |
| 70 Bellfort | 73 Bellfort Crosstown | 12 | 10 | 19 | 17 | Hobby Airport TC, Fannin South TC | Hobby Airport TC, TMC TC | Hobby Airport to Fannin South |  |
| 71 Cambridge | 87 Sunnyside/TMC | 10 | 20 | 18 | 17 | TMC TC, Southeast TC | Southeast TC, TMC TC |  | Southeast TC to El Camino: Peak Headway 30 min , Span 14 hours |
| 72 Yellowstone Reed | 88 Sunnyside/TMC | 30 | 20 | 14 | 17 | Palm Center TC, TMC TC, Fannin South TC | Southeast TC, TMC TC |  |  |
| 73 Southmore Park Place | 5 Kashmere Gardens/Southmore | 30 | 15 | 14 | 18 | Fannin South TC, Palm Center TC, Southeast TC, Wheeler TC | Gulfgate TC, Southeast TC |  |  |
| 80 Westridge | N/A | 10 | N/A | 14 | N/A | TMC TC | N/A |  |  |
| 81 Willowbend | 10 Willowbend | 30 | 20 | 14 | 19 | TMC TC | TMC TC |  |  |

### 4.2.2 Ft. Bend County Commuter Route

Fort Bend Express is the commuter bus service operated by Ft. Bend County. One of the three routes operates between Highway 34 and the University of Houston county campus to the TMC area. There are 11 trips in the weekday AM and PM peak periods, and one mid-day trip. The AM service currently operates from 4:40 to 9:34 AM, and the PM service from 3:20 to 8:34 PM. There are seven route stops in the TMC area:

- Main/Cambridge
- Main/University
- HCC/Pressler
- Pressler Garage
- Bertner/Bates
- MD Anderson/Bertner
- John Freeman


### 4.2.3 Private TMC Shuttles

### 4.2.4 Light Rail Transit

An analysis of potential improvements to LRT operations in the Fannin Street corridor through the TMC area was conducted. The analysis reviewed existing traffic operations and safety issues along the corridor. Then both higher cost light rail transit (LRT) realignment options were identified and evaluated, followed by an assessment of lower cost roadway and signal modifications to improve conditions. The study area encompassed the TMC Central Campus area, from Hermann Park north of Cambridge Street on the north to south of Braeswood Boulevard on the south, and between Main Street on the west and Cambridge, McGregor Way and Braeswood on the east. The analysis was summarized in a separate technical memo, Fannin Street Corridor Analysis, August 2014. A summary of the assessment is presented below.

## Existing Conditions

The METRO Red Line occupies effectively three lanes on Fannin Street (two lanes for the tracks, and one lane between the tracks for stations). This LRT configuration, shown in cross-section in Figure 4.14, requires study because of the following issues:

- Chronic traffic congestion on Fannin Street
- Undesirably narrow station platforms and related inadequate pedestrian space
- Conflicts among LRT trains, general traffic and pedestrians


FIGURE 4.16
EXISTING FANNIN STREET CROSS SECTION WITH TWO-WAY LRT IN MEDIAN

Because of the narrow street cross section, separate side platforms at two stations (south of Cambridge Street and at Dryden Road) are provided currently (serving northbound and southbound trains). These platforms have a narrow width of 10 feet total, and less effective width because of various station furnishings on the platform. Also the restriction of vehicular traffic to only two lanes in each direction has forced the use of the trackway at most of the signalized intersections as a left turn-lane for traffic. This introduces a source of driver confusion and increases exposure to collisions.

## LRT Relocation Alternatives

As a result, a series of LRT relocation alternatives were evaluated, for consideration as methods to mitigate these problems. They include the following:

1) LRT moved to the west side of Fannin
2) Develop Transit Mall on Fannin
3) Conversion of Main and Fannin to a one-way pair with split at-grade LRT
4) LRT relocated to Main Street
5) LRT realigned in subway on Fannin
6) LRT realigned on elevated structure on Fannin
7) LRT relocated via Cambridge, MacGregor, and Braeswood
8) LRT relocated via Cambridge, MacGregor, and Holcombe

The alternatives are shown in Figure 4.15.


LRT Moved to West Side of Fannin - This alternative would move the LRT to the west side of Fannin (see Figure 4.16), improving access to the many vehicular access points, which are mainly along the east side of Fannin. The re-design would seek to improve LRT station platform widths as well as removal of the left-turn barrier formed by the present alignment and inhibiting southbound vehicles seeking to enter access roadways along the east side of Fannin Street. Ideally, this option would include measures to divert traffic away from Fannin, making use of Main Street and Cambridge-MacGregorBraeswood and other streets to bypass the TMC or as alternate means of vehicular access to TMC parking and drop-off pick-up sites. Both LRT and traffic might benefit in this alternative if Main and Fannin were made a one-way pair, with Fannin Street used for northbound vehicles only. This configuration provides four traffic lanes, as in the present design, and wider station platforms, although with some encroachment on the sidewalk along the west side of Fannin. Between stations, the width taken by station platforms becomes available for an added traffic lane and a wide sidewalk. The added traffic lane accommodates various turning lane arrangements. Aside from the narrow sidewalk at stations, this configuration has the disadvantage of restricting access to the entire length of Fannin Street's west side.


FIGURE 4.18
FANNIN STREET CROSS SECTION WITH LRT ON WEST SIDE OF STREET (LOOKING SOUTHWEST)

Fannin Street Transit/Pedestrian Mall: This alternative would be to reduce the through-carrying capacity of Fannin Street for motor vehicles by providing only one traffic lane in each direction, still maintaining the LRT in the median. This would allow more space for pedestrian circulation along the street. The cross section shown in Figure 4.17, with widened 24 -foot sidewalks on both sides of the street, is one potential concept for the reallocation of street space under the transit/pedestrian mall concept. Another concept could include widening the LRT platforms to 12-15 feet, and still provide widened sidewalks on both sides closer to 20 feet. Signage would be required to indicate the reduced roadway would be for "Local Traffic" only, for access to parking garage accesses and for emergency and delivery vehicles.


FIGURE 4.19

## TRANSIT/PEDESTRIAN MALL CROSS SECTION ON FANNIN

Fannin/Main One-Way Pair with Split At-Grade LRT: The improvement of traffic flow on Fannin Street would be achieved by giving vehicular traffic one of the lanes now occupied by LRT, and by operation of both Fannin and Main streets as a one-way pair (see Figure 4.18 for revised cross section on Fannin).
Access to the LRT stations would be less convenient as a result of the split operation, but traffic flow might be enhanced significantly, subject to adequate provision for crossing and u-turn movements between the two streets. The LRT stations could be built to a higher standard, with greater width than is now provided. Access to the TMC Transit Center at the intersection of Fannin and Pressler would be inconvenient for the southbound LRT service on Main Street.


FIGURE 4.20
FANNIN STREET CROSS SECTION WITH ONE-WAY LRT COUPLET WITH MAIN (LOOKING SOUTHWEST)

LRT Relocated to Main Street: This alternative would relocate LRT entirely to Main Street, where pedestrian activity and traffic turning movements are less intensive (see Figure 4.19 for revised Main Street cross section). The realignment would begin north of Cambridge Street and continue south on Main Street to Greenbriar, then following Greenbriar to merge into the existing LRT alignment north of the Smith Lands Station. TMC Transit Center access would be inconvenient for both southbound and northbound LRT service. Like for the existing Fannin Street LRT operation, left turns from Main at signalized intersections would have to be made from the trackway area.


FIGURE 4.21
MAIN STREET CROSS SECTION WITH TWO-WAY LRT

LRT Vertical Realignment Options on Fannin: As an option to maintaining an at-grade alignment for LRT along Fannin, there are vertical realignment options that would provide a transition from the current at-grade alignment to a subway or elevated alignment at a location sufficiently far north of Cambridge Street to pass above or underneath that street. As a subway, the alignment would be shallow at the Smith Lands Station, but otherwise deep, allowing provision of a mezzanine level above each TMC station, with underground passage to entrances on both sides of the street (see Figure 4.20 for cross section view at a station). These passageways also would allow pedestrians to cross underneath the street, and could accommodate direct entry to TMC buildings on both sides of the street; to the extent this may be desirable. The depth of the guideway tunnel also would be sufficient to pass underneath the existing Holcombe underpass and Brays Bayou immediately to the south. At each end of the subway, the track profile would rise sufficiently above ground level to minimize the risk of flooding during episodes of heavy rain. On-street pedestrian entrances also would be raised above sidewalk level, for the same reason. The elevated alignment alternative would be designed to interface with and hopefully minimize disruption of or requirements to reconstruct the pedestrian bridges that cross Fannin Street. A pedestrian mezzanine level could be integrated with existing and new pedestrian bridges and might also include a longitudinal pedestrian-way, providing further sheltered distribution of passengers to and from their TMC destinations (see Figure 4.21 for station cross section). The design would seek to minimize the adverse effects of support columns, which can obstruct sight lines and also occupy otherwise-useful right of way.


FIGURE 4.22
SUBWAY LRT CROSS SECTION ON FANNIN STREET


Easterly LRT At-Grade Options: Two other alternative total relocations were considered, again with the objective of maximizing the potential for Fannin Street to carry vehicular traffic and accommodate traffic access to TMC parking or passenger drop-off and pickup locations. Both alternatives would re-route LRT to the east around the TMC main campus, turning from Fannin Street to Cambridge Street and then south onto MacGregor. In one alternative, the alignment would continue to Braeswood, then following Braeswood to rejoin the present LRT alignment where it turns onto Braeswood just west of Fannin. In the other alternative, the alignment would turn to the west from MacGregor onto Holcombe, returning to Fannin just north of the TMC Transit Center Station. This alternative has geometric and right of way challenges in accommodating the curve from Holcombe to Fannin.

## People Mover

There is no viable alignment better than Fannin Street with respect either to the directness of the LRT route or the convenience Fannin Street stations can provide for access to TMC destinations. Even so, there are access deficiencies for LRT passengers; the stations are not near all of the TMC's activity centers. Aside from the LRT access issues; there are intra-TMC travel needs that entail long walking distances or the use of shuttle buses within the area. An option that has been considered from time to time would be to design and build a people mover to address these needs. A suitable technology might be an automated guideway transit (AGT) system, such as those commonly used for interconnection of airport terminal buildings and less commonly found as activity center distribution systems. In comparison with LRT, AGT systems typically fit within a smaller clearance envelope, can negotiate tighter curves and steeper grades, and may be integrated more easily with existing structures.

The all-elevated alignment for a people mover considered in this study (see Figure 4.15) would begin with a passenger interchange station adjoining an LRT station near or on Cambridge Street (at Main Street, at Fannin Street, or on Cambridge east of Fannin), turn into the TMC campus between Memorial Hermann and Ben Taub hospitals, cross above existing buildings, and then make its way on elevated structure along or near East Cullen Street and Bertner Avenue, crossing Holcombe. The alignment would turn west from Bertner onto Pressler Street, south onto Fannin, and then east onto Braeswood, where a terminal station and small maintenance facility could be located near Bertner. The southern portion of the route could vary, ending at Pressler and Fannin in the case of LRT alternatives that retain the existing TMC Transit Center LRT station, extending westward along Pressler Street to Main Street to meet a Main Street LRT alignment, or continuing to the Braeswood-Bertner terminal station to provide passenger interchange with the Cambridge-Braeswood LRT alternative. Six to eight stations are envisioned.

## Alternatives Evaluation

For the eight LRT relocation alternatives, the following concept-level analyses were undertaken:

- Estimation of LRT train running times through the TMC area
- Estimation of "rough order of magnitude" (ROM) capital costs
- Estimation of operating and maintenance (O\&M) costs
- Calculation of TMC main campus access times
o For current Red Line passenger trips to/from TMC locations
o For current TMC main campus employment
- Recognition of right of way and environmental issues

Analysis of the people mover alternative is limited primarily to its potential value to LRT passengers under each of the seven LRT route alternatives. Analyses for this purpose mirror those of the LRT route alternatives. Study of the potential time-saving benefit of a people mover found that it would produce only small benefits as a supplement to the existing light rail route, even without considering the benefits already provided by TMC shuttle bus routes. The people mover would be of significant benefit for LRT alignments in other streets, and especially as a supplement to the Cambridge-Braeswood LRT alternative.

The evaluation of LRT re-routing alternatives considered numerous factors including travel times as they affect transit operations and transit passengers, traffic level of service, traffic delay, traffic access, needs for parking access modifications, traffic and pedestrian safety, TMC accessibility generally, LRT station capacity, right of way availability, environmental effects, constructability, and capital cost.

Some of these factors are addressed in the following sections:

## Light Rail Passenger Travel Time and TMC Accessibility

Figure 4-22 shows the estimated running time for the different LRT relocation alternatives. LRT travel time would be best if the alignment remains on Fannin Street, but placed on aerial structure or in subway through the TMC area. Train running time would be more reliable (predictable) and would save an estimated 3.6 minutes in each direction, reducing vehicle fleet requirements by one train (two light rail vehicles).

The shorter travel time through the TMC area would benefit passengers traveling through the TMC, and, subject to the design of pedestrian access to the aerial or subway stations, would also provide time savings to passengers traveling to or from TMC locations. LRT travel time for an alignment re-routed via Main Street would be about the same as the current route, but with adverse effects on passengers using the TMC stations. Travel time would be slightly longer for an alignment along Cambridge and Braeswood (estimated to add only 18 seconds), and significantly longer for an alignment following Cambridge and Holcombe ( 2.7 minutes longer). Both of the Cambridge alignments would be significantly worse for access to TMC trip origins and destinations.


FIGURE 4.24
ESTIMATED LRT RUNNING TIMES AND DISTANCES FOR TMC ALTERNATIVES

## LRT Station Capacity

The design of the narrow existing LRT stations, located between the northbound and southbound tracks, was a compromise intended to leave as much street width as possible for vehicular traffic. This was mitigated to a degree by providing separate station platforms for northbound and southbound trains, but even so, the result is unsatisfactory for passengers, whose access is severely restricted by necessary station furniture such as fare vending equipment. The holding space for passengers leaving trains and waiting for a traffic signal to cross traffic lanes between the station and curbside is also inadequate. The joint use of the northbound trackway by trains and left-turning vehicles at Cambridge Street is another problematic effort to accommodate both LRT and vehicular traffic.

A re-design of the LRT line on Fannin Street would seek to provide more station platform and station access space, while still providing for traffic movement and local TMC access. One approach would be to shift the tracks to the west side of the street, close together, and provide conventional side-platform stations. A controlling feature of the alignment would be to leave adequate sidewalk space adjacent to stations serving southbound trains. Station platforms must be approximately 13 inches above track level, which is about six to eight inches higher than the sidewalks. Consequently sidewalks and station platforms cannot occupy shared space. This sidewalk restriction at stations would extend for approximately 250 feet, but between stations, the sidewalk could be wider than normal. This configuration also would allow a traffic lane to be added between stations. The added lane could be used for southbound traffic right turns, or to allow the southbound lanes to be shifted to the west, permitting provision of a southbound left turn-lane.

One might also consider a more extreme re-configuration of Fannin Street, coupled with maximum diversion of traffic from Fannin. Some traffic could gain access to the TMC via Main, Cambridge, and Holcombe, and the effort would be made to divert all through traffic via a counter-clockwise loop using streets that form the TMC main campus perimeter. An optimal configuration satisfying LRT requirements and best accommodating vehicular traffic would require detailed study beyond the scope of this project.

## Right of Way Requirements

Re-routing LRT would introduce various right of way requirements. Shifting one or two tracks to Main Street would most likely be accomplished just south of the Hermann Park/Rice University station, where Fannin and Main are very close to one another. The space between the streets is park land, and its use for LRT tracks would have to be negotiated. Farther south of Holcombe, the turn from Main to Greenbriar would require acquisition of land to allow a curve of about 400-foot radius.

Re-routing LRT via Cambridge Street and MacGregor Way requires LRT curves across existing park land, affecting mature oak trees, at the Fannin-Cambridge and Cambridge-MacGregor intersections. The alternative that turns from MacGregor to Holcombe would be accomplished by aligning the track offstreet to the south of MacGregor, to provide for the curve westward into Holcombe. The curve from Holcombe westbound to Fannin southbound would cross private right of way, with the alignment complicated by the need to enter Fannin Street where the slope from the Fannin underpass of Holcombe reaches surface level.

## Environmental Effects

There are potential adverse noise and vibration effects associated with the LRT re-alignment alternatives, including during construction as well as during subsequent operation. LRT structures, particularly the aerial alternative on Fannin Street, introduce visual intrusion that may be objectionable and require design attention. Flooding hazards actually may be lessened by the aerial and subway alternatives, by avoiding the Holcombe underpass traversed by the present LRT route. Subway stations will require
design attention to avoid the risk of introducing flooding from building basement levels that may be subject to flooding during periods of severe rainfall.

## Constructability

Because of limited street rights of way, the presence of underground utilities, and intensive urban activity levels, the re-alignment alternatives introduce constructability issues that would require resolution. These issues are likely to be most severe for alignments that remain on Fannin Street (re-building at surface level, and subway or aerial construction). Alignments in Main Street and Holcombe Boulevard are likely to pose the second highest level of constructability issues.

## Costs and Benefits

Using very approximate quantities and generic unit costs for guideway transit and street construction, "rough order of magnitude" (ROM) estimates of capital cost have been prepared for the LRT and People Mover alternatives described above, in existing dollars (see Figure 4-23). Estimates of annual operating and maintenance (O\&M) costs in existing dollars also have been prepared, using recent Houston METRO Red Line cost experience for light rail, and Miami (Florida) Metromover cost experience for the people mover alternatives.

Understandably, the subway alternative is the most expensive, followed by aerial LRT, then the Fannin/Main split routing, then the alternatives that re-route both tracks, and finally, the least expensive is to re-configure LRT on Fannin Street.


FIGURE 4.25
RANGE IN CAPITAL COSTS FOR LRT RELOCATION/PEOPLE MOVER ALTERNATIVES

As a means of demonstrating possible comparative justification of these alternatives, the capital costs have been converted to equivalent annualized cost, considering the discounted life span cost of major capital cost elements. These costs have been added together with the annual O\&M cost estimates, and the existing O\&M cost subtracted, to give the net annual cost of each improvement alternative.

Potential user benefits of the alternatives have been estimated for existing users of the METRO Red Line, treating travel between LRT stations and ultimate passenger origins or destinations within the TMC Main Campus as walk trips. This approach disregards the fact that some LRT passengers use shuttle buses for access to less convenient TMC destinations. In the case of the People Mover alternatives, the link between LRT stations and TMC origin/destination locations was assumed to use the People Mover if its use would save time, compared with walking time. There are also potential LRT passenger benefits or dis-benefits to those traveling through the affected length of the Red Line.

The alternatives also have the intention of improving traffic conditions, so there are possible time savings to those traveling to, from, or through the TMC via motor vehicle (see Figure 4.24). Approximate notional values were selected for time saved by users of the daily 30,000 vehicles on Fannin (also as a proxy for traffic effects on other streets having traffic conditions affected by the guideway transit alternatives). The benefit to motor vehicle users would be greatest in the case of the Fannin Street subway LRT alternative, somewhat less for the Fannin Street aerial LRT alternative, less still for the alternatives routed to the east of the main campus, and with the least benefit in the case of the surface-transit Main Street and Fannin Street alternatives.


FIGURE 4.26

## WEEKDAY USER TIME SAVINGS OR LOST WITH LRT RELOCATION/PEOPLE MOVER ALTERNATIVES

As will be seen, most of the alternatives result in lost time for LRT passengers. This demonstrates that Fannin Street is well-placed for transit service to the TMC, and that finding is reinforced by the fact that only small further savings would result from providing a connecting people mover routed more within the center of the TMC main campus.

The estimated annual costs and benefits of the alternatives are presented in Figure 4.25. The analysis indicates that none of the alternatives would have benefits exceeding their cost. It should be recognized, however, that there are unquantified user benefits (safety improvements and life-saving reduction in delay to emergency vehicles, for example), and non-user benefits such as reduced flooding risk and a less cluttered visual environment. Considering only the quantified benefits, the benefit/cost ratios of the alternatives are shown and ranked in Figure 4.26.


FIGURE 4.27
ANNUALIZED COST AND USER BENEFITS FOR LRT RELOCATION/PEOPLE MOVER ALTERNATIVES

| Benefit/Cost Ratio - \% |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  | LRT on Cambridge-Braeswood <br> LRT on Cambridge-Holcombe <br> Fannin Street Transit-Pedestrian Mall <br> Existing LRT |
|  |  |  |  |  |  |  |  |  |
|  |  |  | $\square$ |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  | $]$ |  |  |  |  | Fannin St. Transit-Pedestrian Mall with People... Existing LRT with People Mover |
|  |  |  | $\square$ |  |  |  |  |  |
|  |  |  |  |  |  |  |  | LRT on Cambridge-Holcombe with People Mover Surface LRT on Main Street |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | LRT on Cambridge-Braeswood with People Mover |
|  |  |  |  |  |  |  |  | LRT split, on Fannin and Main with People Mover |
|  |  |  |  |  |  |  |  | Surface LRT on Main Street with People Mover |
|  |  |  |  |  |  |  |  | LRT split, on Fannin and Main |
|  |  |  |  |  |  |  |  | Surface LRT re-built on Fannin with People Mover |
|  |  |  |  |  |  |  |  | Subway LRT on Fannin with People Mover <br> Aerial LRT on Fannin with People Mover |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | Subway LRT on Fannin |
|  |  |  |  |  |  |  |  | Surface LRT re-built on Fannin |
|  |  |  |  |  |  |  |  | Aerial LRT on Fannin |

FIGURE 4.28
BENEFIT/COST RATIO OF LRT RELOCATION/PEOPLE MOVER ALTERNATIVES

## Overall

Nine criteria were evaluated to provide a total evaluation of the different LRT relocation alternatives. Each criteria was assigned a \% by the study team based on an assumed importance or weight from a total of $100 \%$ (see Table 4.13). Each criteria for each alternative was rated on a scale of 1 (lowest) to 5 (highest). Unweighed scores were then tabulated, followed by a tabulation of weighed scores applying the individual criteria \% identified (see Table 4.14). A graphical representation of the weighed scores is shown in Figure 4.27.

The analysis revealed that the lower cost options - transformation of Fannin into a transit/pedestrian mall and the existing configuration scored the highest. The lowest scores were associated with the LRT relocation alternatives to the east to the Cambridge/MacGregor corridors, primarily because of their poor accessibility and impact on ridership. The grade separated alternatives on Fannin scored lower because of their high cost.

TABLE 4.13
OVERALL LRT EVALUATION CRITERIA WEIGHTS

| IMPORTANCE WEIGHTING (Assumed by Study Team) |  |
| :---: | :---: |
| LRT Through Passenger Travel Time | $2 \%$ |
| LRT TMC Ridership Access | $10 \%$ |
| Traffic Operations | $13 \%$ |
| Safety | $20 \%$ |
| Right-of-Way Required | $5 \%$ |
| Environmental Effects | $5 \%$ |
| Constructability | $10 \%$ |
| Capital Cost | $30 \%$ |
| O\&M Cost | $5 \%$ |
| WEIGHTED SCORE (highest is best) | $100 \%$ |

TABLE 4.14
LRT EVALUATION CRITERIA SCORES

|  |  | Existing | Rebuilt on Fannin | Fannin <br> Transit/ Pedestrian Mall | Split, <br> Fannin and Main | Main <br> Street | Fannin <br> Subway | Fannin <br> Aerial | CambridgeBraeswood | CambridgeHolcombe |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| LRT Through Passenger Travel |  |  |  |  |  |  |  |  |  |  |
| Time |  | 2 | 3 | 4 | 3 | 3 | 5 | 5 | 2 | 1 |
| LRT TMC Ridership Access |  | 5 | 5 | 5 | 4 | 3 | 4 | 4 | 1 | 2 |
| Traffic Operations |  | 1 | 2 | 3 | 3 | 4 | 5 | 4 | 4 | 4 |
| Safety |  | 1 | 2 | 3 | 2 | 2 | 5 | 4 | 3 | 2 |
| Right-of-Way Required |  | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 2 | 1 |
| Environmental Effects |  | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 2 |
| Constructability |  | 5 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 |
| Capital Cost |  | 5 | 4 | 4 | 3 | 3 | 1 | 2 | 3 | 3 |
| O\&M Cost |  | 5 | 5 | 5 | 5 | 5 | 3 | 3 | 5 | 4 |
| UNWEIGHTED TOTALS: |  | 32 | 32 | 35 | 30 | 30 | 33 | 33 | 26 | 22 |
| IMPORTANCE WEIGHTING (judgment-based percent of all criteria) |  |  |  |  |  |  |  |  |  |  |
| LRT Through Passenger Travel |  |  |  |  |  |  |  |  |  |  |
| Time | 2\% | 0.04 | 0.06 | 0.08 | 0.06 | 0.06 | 0.10 | 0.10 | 0.04 | 0.02 |
| LRT TMC Ridership Access | 10\% | 0.50 | 0.50 | 0.50 | 0.40 | 0.30 | 0.40 | 0.40 | 0.10 | 0.20 |
| Traffic Operations | 13\% | 0.13 | 0.26 | 0.39 | 0.39 | 0.52 | 0.65 | 0.52 | 0.52 | 0.52 |
| Safety | 20\% | 0.20 | 0.40 | 0.60 | 0.40 | 0.40 | 1.00 | 0.80 | 0.60 | 0.40 |
| Right-of-Way Required | 5\% | 0.25 | 0.25 | 0.25 | 0.20 | 0.20 | 0.25 | 0.25 | 0.10 | 0.05 |
| Environmental Effects | 5\% | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.20 | 0.20 | 0.15 | 0.10 |
| Constructability | 10\% | 0.50 | 0.30 | 0.30 | 0.30 | 0.30 | 0.10 | 0.20 | 0.30 | 0.30 |
| Capital Cost | 30\% | 1.50 | 1.20 | 1.20 | 0.90 | 0.90 | 0.30 | 0.60 | 0.90 | 0.90 |
| O\&M Cost | 5\% | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.15 | 0.15 | 0.25 | 0.20 |
| WEIGHTED SCORE (highest is best) | 100\% | 3.52 | 3.37 | 3.72 | 3.05 | 3.08 | 3.15 | 3.22 | 2.96 | 2.69 |



FIGURE 4.29
OVERALL LRT ALTERNATIVES COMPARISON

## General Traffic Impacts of LRT vs. No LRT on Fannin

## With LRT vs. without LRT on Fannin Street

General traffic operations on Fannin Street operation with and without the LRT was evaluated by comparing the travel times of the vehicles traveling through from Cambridge to Pressler Streets, using the VISSIM model. In the scenario where LRT is present along Fannin (in its existing configuration), the intersection operation is impacted due to the signal priority given to the LRT vehicle.

Based on VISSIM model runs, the travel times of the vehicles would be reduced along Fannin if LRT was eliminated from the Fannin Corridor. Table 4.15 presents the comparison of the vehicular travel times with LRT and without LRT on Fannin Street with the same general traffic volume. General traffic volumes would be reduced on average by about $16 \%$ northbound and $11 \%$ southbound.

TABLE 4.15
GENERAL TRAFFIC TRAVEL TIME ON FANNIN IMPACT (CAMBRIDGE TO PRESSLER STS.)

|  | Northbound |  |  |  | Southbound |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | With LRT | W/O <br> LRT | \% Change | W/BRT | W/OBRT | \% Change |  |
| Avg. Of 5 <br> model runs | 644.7 | 325.2 | $-15.7 \%$ | 363.9 | 323.9 | $-11 \%$ |  |

## LRT moved from Fannin to Main Street

The operation of intersections along Fannin Street and Main Street for the scenario where LRT is moved to Main Street was evaluated using the Synchro model.

Two alternatives were analyzed:

1. One-Way LRT Pair on Fannin and Main
2. Two Way LRT on Main Street

The analysis was conducted assuming a reduction of $20 \%$ through traffic volume from Main when the LRT is moved to Main. For each alternative, two scenarios were analyzed:

- Changing only the lane configuration and keeping the volumes same as existing
- Changing lane configurations as well as traffic volumes based on assumptions provided earlier.

The number of lanes on Main Street was reduced from existing six lanes to four lanes with left turn bays not shared with the LRT track.

The results of the analysis as shown in Tables 4.16 and 4.17 indicated that the LOS/Delay at Main Street intersections at Cambridge and University worsened in both One-way pair and Two-way pair alternatives in both scenarios. Also, it has been observed that LOS/Delay at the Fannin Street intersections at Cambridge and University significantly got worse in the Two-Way Pair alternative when volumes from Main were shifted to Fannin.

TABLE 4.16
WEEKDAY PEAK HOUR LOSIDELAY WITH TWO-WAY LRT ON MAIN STREET

| Intersection | No-Build |  |  |  | Two-Way LRT on Main |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | Lane Configuration Updated |  |  |  | Lane Configuration \& Volumes Updated |  |  |  |
|  | AM |  | PM |  | AM |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| Main @ University | D | 36.3 | D | 45.5 | E | 62.7 | F | 107.7 | D | 45.4 | E | 61.6 |
| Main @ Cambridge | F | 83.3 | F | 87.3 | F | 180.9 | F | 186.4 | F | 115.9 | F | 118.7 |
| Fannin @ University | D | 22.6 | C | 23.0 | C | 22.3 | C | 22.9 | C | 22.3 | D | 47.8 |
| Fannin @ Cambridge | D | 37.6 | D | 39.6 | D | 37.2 | D | 38.9 | E | 55.2 | F | 85.4 |

TABLE 4.17
WEEKDAY PEAK HOUR LOSIDELAY WITH TWO-WAY LRT ON MAIN STREET PAIR

| Intersection | No-Build |  |  |  | One-Way LRT Pair Los |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | Lane Configuration$\qquad$ |  |  |  |  <br> Volumes Updated |  |  |  |
|  | AM |  | PM |  | AM |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| Main @ University | D | 36.3 | D | 45.5 | E | 61.4 | D | 48 | D | 44.3 | D | 45.8 |
| Main @ Cambridge | F | 83.3 | F | 87.3 | F | 160.5 | F | 183.9 | F | 109.4 | F | 114.8 |
| Fannin @ University | D | 22.6 | C | 23.0 | C | 22.2 | C | 22.6 | C | 21.1 | C | 29.2 |
| Fannin @ Cambridge | D | 37.6 | D | 39.6 | D | 36.8 | C | 33.8 | D | 40.2 | D | 37.7 |

*Delay is in seconds/vehicle

## Conclusions

The evaluation conducted suggests that none of the LRT relocation alternatives would appear to be costeffective, with or without the people mover, given their high capital cost. This led to the consideration of a set of lower cost modifications to the roadway and signal system in the TMC Central Campus area to improve traffic operations and safety, described in Section 4.1. The Transit/Pedestrian Mall option can also be considered as reducing vehicular conflicts option and can be combined with the traffic improvement concepts.

### 4.2.5 US 90A/Southwest Rail Project

A proposed nine-mile commuter rail corridor from Missouri City to the end of the Red LRT line at Fannin South station has been proposed with initial analysis conducted. The service would operate along US 90A and the parallel Union Pacific Railroad. The intent would be to provide premium, direct rail service from the southwest portion of the Houston region with the TMC area.

The METRO Board of Directors in September 2012 placed the corridor project on hold to reassess investment priorities in the region.

### 4.2.6 Other Connections

During the second public meeting conducted to present future year conditions analyses findings, comments were received for METRO to consider light rail connections to both Intercontinental and Hobby Airports. If METRO can implement these connections, it would enhance the ability of travelers to reach the major activity centers in the area. The public comment also emphasizes that as an interim step, airport express bus service should be expanded to major activity centers including major hotels and in the Galleria/Greenway Plaza area, downtown and the Texas Medical Center.

### 4.3 Parking Facilities

Texas Medical Center currently has almost 27,000 parking spaces located in 43 parking areas. These are primarily off-street parking lots and garages. The future parking demand was developed based on developments that are expected to be complete by 2035. Rather than applying one standard parking rate factor to all future development, rates for various development types were calculated. The calculated parking rates were developed based on industry standards and existing parking occupancy
rates for similar development types within the TMC. Based on the use of future development and type of individuals requiring parking (staff, residential, student, patient, or visitor), the rate of spaces per 1,000 Gross Square Feet (GSF) was determined.

### 4.3.1 Existing Parking Garage Operations

A field visit was conducted in order to make observations of parking garage entrances and exits along Main Street and Fannin Street in the TMC. Most parking facilities have access on both Main Street and Fannin Street. The Houston Methodist Hospital Smith Tower has a drop-off/valet curbside area with two lanes that were both full, causing backup onto the southbound lanes of Fannin Street. The O'Quinn Medical Tower of St. Luke's Hospital has a valet/patient drop-off entrance on Fannin Street that was causing back-ups onto Fannin. The southbound right lane of Fannin Street was backed up past Dryden Road due to the delay of vehicles entering the O'Quinn Medical Tower. There is one entrance lane into the facility that then becomes two lanes for valet and drop-off; however, both lanes filled with vehicles before the valet could move the vehicles or patients were dropped off. In addition to improved efficiency of valet and drop-off locations, a wayfinding plan would also help visitors to identify the location of parking facilities in TMC.

### 4.3.2 Future Parking Demand /Supply

As presented in Section 3.0, several medical research facilities, medical office buildings, educational institutions, residential developments, and hotels are proposed to be developed in the TMC Area. The majority of new development is anticipated to occur in Mid Campus and South Campus, therefore the bulk of the future parking facilities are shown in these two campuses as well. It is anticipated that approximately 28 million square feet of new development will occur in the TMC area by the Year 2035.

It is essential that adequate parking be provided for the proposed new developments. Based on discussions with the TMC staff and review of the Mid and South Campus Plan Report, the future parking demand was estimated. It is estimated that approximately 50,000 parking spaces will be required by the year 2035. Table 4.18 presents the developments by Traffic Analysis Zone (TAZ), the approximate size of the development, and the required parking.

### 4.3.3 ITS Parking Solutions

The TMC staff indicated the need for improving traffic operations at the entrances of parking garages as traffic is spilling back onto the street at some parking garage entrances. Also, the TMC does not have existing way finding signs for specific hospital destinations and specific parking garages. The addition of way finding signage will improve the navigability of the TMC as a whole, therefore decreasing traffic caused by slow drivers or drivers unfamiliar with the TMC area. In addition to way finding, the signage should include Intelligent Transportation Systems (ITS) for displaying information on available parking spaces and how to reach the location of available parking spaces.

The implementation of the following parking solutions is recommended to improve parking operations:

- Electronic Parking Guidance Signs
- Display Space Availability
- Improved Mobile Applications
- Payment using Mobile Application
- EZ Tag as a mode of Payment
- Payment through $3^{\text {rd }}$ party vendor

The TMC area has several parking garages and many more anticipated to be developed along with the proposed developments. Without the implementation of way finding signs and incorporated ITS solutions, the available spaces in parking garages may go unnoticed.

The TMC Parking mobile application has been developed and currently provides parking information, traffic conditions, shuttle information, and information on pre-paid Smart Chips. Using this app, TMC patrons can identify parking closest to their current location, the parking facility closest to the facility they are going to visit, and a general parking map. However, this app does not provide real-time space availability. The implementation of additional features such as space availability, entry and exit locations, and price and payment information would improve the users' parking experience.

TABLE 4.18
Summary of Parking Spaces Required by New Development in TMC

| Sub-TAZ ID (New TMC ID) | New Development Type | 1,000 Square Feet | Parking Spaces Required |
| :---: | :---: | :---: | :---: |
| 745 | Condominiums | 400.00 | 720 |
| 749 | Memorial Hermann Duplicate Tower | 300.00 | 540 |
| 757 | McNair Specialty Clinic \& Hospital | 1,200.00 | 2,160 |
| 757 | Potential Campus Development | 1,550.00 | 2,790 |
| 837 | Owned by Methodist | 1,700.00 | 3,060 |
| 838 | Potential Campus Development | 3,750.00 | 6,750 |
| 1164 | TCH Professional Building | 500.00 | 900 |
| 1164 | Long-Term Development | 400.00 | 720 |
| 1166 | Debakey High School | 166 | 299 |
| 1168 | Future Medical Office Complex | 640.00 | 1,152 |
| 74601 | Temporary Outpatient Building | 40.00 | 72 |
| 74601 | Research/Outpatient Center | 500.00 | 900 |
| 75002 | UH - College of Pharmacy | 800.00 | 1,440 |
| 75301 | Zayad Building | 600.00 | 1,080 |
| 75302 | Research Building | 250.00 | 450 |
| 75302 | Surgical Suites | 20.00 | 36 |
| 75602 | Potential Campus Development | 200.00 | 360 |
| 75801 | Potential Campus Development | 1,600.0 | 2,880 |
| 75802 | Potential Campus Development | 5,900.0 | 10,620 |
| 84302 | Potential Campus Development | 1,600.00 | 2,880 |
| 84302 | Research/Education | 1,500.00 | 2,700 |
| 84303 | Potential Campus Development | 800.0 | 1,440 |
| 84304 | Potential Campus Development | 1,600.0 | 2,880 |
| 84305 | Potential Campus Development | 2,000.0 | 3,600 |
| TOTAL 50,429 |  |  |  |



FIGURE 4.30

### 4.3.4 Bicycle Parking

Bicycle parking is an essential element in bicycle programs. Providing secure bicycle parking is one of the key ingredients to encourage biking.

Although bicycle lockers and other in-building parking methods can be used, bicycle racks are prevalent in the TMC. The bicycle rack locations listed in Table 4.19 provide valuable insight into the existing demand and destinations within the TMC.

TABLE 4.19
EXISTING BICYCLE RACK LOCATIONS

| Member Institution | Physical Address | Rack Location |
| :---: | :---: | :---: |
| G-1 | 6519 Fannin St. | Just inside garage entry on level 1 |
| G-2 (Parking Office) | 1151 Holcombe Blvd. | Across from ATM and on sidewalk |
| G-2 (0-Lot) | 1151 Holcombe Blvd. | Just inside lot entry and at NW corner |
| G-4 | 1406 Cambridge Blvd. | Just inside South Entry to the left on |
| G-6 | 1329 Moursund St. | Just inside of entry, near main exit |
| G-7 | 1120 John Freeman Blvd. | Just inside entry on level B-1 |
| G-10 | 6700 M.D. Anderson Blvd. | NW Contract exit near stairwell |
| G-14 | 1919 South Braeswood | Just inside entry on the ground level |
| G-17 | 1653 South Braeswood | Just inside west entry; sidewalk |
| G-21 (TCH Woman's Pavilion) | 6651 Main St. | Outside of Main St. exit on sidewalk |
| AM Lot (Texas A\&M Health Inst.) | 2121 West Holcombe | Near rear of lot on sidewalk |
| Ben Taub Hospital | 1504 Taub Loop | Outside of E.R. dock on the sidewalk |
| BioScience Research Collaborative | 6500 Main St. | Front of building along the sidewalk |
| A-Lot (U.T. Medical School) | 6440 Fannin St. | Rear of A-lot near U.T. Medical School |
| D-Lot (One Baylor Plaza) | 6450 E. Cullen | Near rear corner of lot on the sidewalk |
| E-Lot (One Baylor Plaza) | 6450 E. Cullen | Just outside of the exit on the sidewalk |
| Favrot Tower Apartments | 6540 Bellows Lane | Front of building near the sidewalk |
| Feigin Center | 1102 Bates St. | Near front entrance on sidewalk |
| Houston Community College | 1900 Pressler | Near front entrance on sidewalk |
| Jesse Jones Medical Library | 1133 John Freeman | Front of building along the sidewalk |
| Jewish Institute of Med. Research | 1200 Moursund | Near Moursund and E. Cullen inter. |
| J-Lot (U.T. Dental Branch) | 6516 M.D. Anderson Blvd. | Rear of J-Lot near sidewalk |
| Methodist Neurosensory Center | 6501 Fannin St. | Breezeway between Meth. and G-7 |
| Metro Transit Center | 7000 Fannin | Along sidewalk near H.C.C. campus |
| Mitchell/U.T. School of Bio Science | 6767 Bertner | Along sidewalk in front of bus stop |
| Texas Child. Hosp. Clinical Care Ctr. | 6701 Bates St. | Near valet entrance on sidewalk |
| Texas Child. Hosp. NRI Building | 1250 Moursund | Along sidewalk in front of building |
| Texas Child. Hosp. West Tower | 6621 Fannin St. | Along sidewalk in front of E.R. entrance |
| Texas Heart Institute | 6700 Bertner | Bertner Side of building at top of stairs |
| Univ. of Texas School of Nursing | 6901 Bertner | Along sidewalk near front of building |
| Univ. of Texas Pressler Garage | 1155 Herman Pressler | Just inside of entry on level 1 |
| Univ. of Texas School of Public Health | 1200 Herman Pressler | Along sidewalk near front of lot |

### 4.4 Pedestrian/Bicyclist Facilities

Historically trips to, from, and within the TMC have been served by a primarily auto oriented system on 18 miles of public/private roadways with large internal and external parking garages. Going forward these trips will be accommodated by a more balanced system - a system that connects transit, skywalks, sidewalks, and bicycle infrastructure; and accommodates autos, delivery vehicles, and emergency vehicles. A balanced system will require significant tradeoffs.

Medical studies indicate that engaging in physical activity for 30 minutes or more a day can prevent or help treat conditions such as diabetes, breast and colon cancer, depression, dementia, anxiety,
osteoporosis, cardiovascular disease, obesity, and high blood pressure. Clearly, a world class pedestrian and bicycle infrastructure serving TMC is aligned with TMC's goals in the delivery of health care.

### 4.4.1 Needs Assessment

A needs assessment was carried out to assess and understand the gap between existing conditions and required/future condition of the bicycle and pedestrian facilities in the TMC study area. The key objectives of the bicycle /pedestrian facilities are discussed below.

## Skywalks, Sidewalks, and Shared-Use Paths

- Connect high-pedestrian traffic facility to center of TMC Main Campus
- Closes critical gap in network
- Enables improved routes and connections
- Upgrades connections that are already possible but not ideal
- Completes sidewalks along all thoroughfares and collectors
- Upgrades sidewalks along thoroughfares and collectors to be easily passable (especially by handicapped)
- Connects existing sidewalks, previously recommended


## Intersection Accessibility

- Makes pedestrian facilities along all thoroughfares, collectors, and streets accessible


## Bicycle Projects

- Improves access to heart of Main Campus
- Improves access to other parts of Primary Study Area


### 4.4.2 Pedestrians

The success of all modes of travel depends on good connections from the trip origin to the trip destination. And all trips, no matter the mode, include pedestrian trips.

There are at least 372,000 person trips per day traveling to and from TMC (not including intra-campus trips during the course of the day). Of course some of these pedestrian trips are very short (drop offs and valet parking), but many are not. Pedestrians must walk from parking garages, transit stops, shuttle stops, and in some cases from home. A great pedestrian environment is essential for the TMC.

For visitors and staff, walking is an extremely important form of transportation within the TMC. Walking is also essential for pedestrians traveling between buildings in the TMC and the value of walking is well known.

Planning studies have shown that people are more likely to walk if they perceive the pedestrian environment to be safe, comfortable, and convenient (pedestrian friendly). The same can be said for cycling. Build the proper infrastructure and the people will come.

Currently, skywalks, sidewalks and some shared-use trails serve pedestrians in the TMC.
Figure 4.12 illustrates the conflict points between pedestrians and vehicles/bicycles at an unsignalized intersection and a signalized intersection. There are 16 pedestrian conflict points at a typical unsignalized intersection and 4 conflict points at a signalized intersection that has protected left turn phases.


FIGURE 4.31
PEDESTRIAN CONFLICTS

Minimizing these intersection conflicts can improve the pedestrian environment. In order to improve intersection safety, road widening and other improvement projects should consider installing pedestrian refuge islands wherever necessary.

The on-campus intersection of Bertner at Bates has significant pedestrian activity and it is controlled by a 4 -way stop. The segment of Fannin between Cambridge and Bellows has significant pedestrian activity and the intersections where pedestrians cross are controlled by signals.

Although Fannin accommodates pedestrian crossings with traffic signals, pedestrian congestion is prevalent and there are surges due to boarding and alighting at the light rail stops. Parking garages and drop off zone destinations within the campus, while convenient for autos, are the source of considerable pedestrian/vehicle conflicts at the street level.

Internal parking garages are not consistent with a walkable campus at the street level.

## Skywalks

A system of skywalks has been developed and is planned for the core. A long-range plan for the skywalk system was developed by Skidmore, Owings \& Merrill in 2005.

The skywalk plan is shown in Figure 4.13. Although this plan has not been followed precisely, it has been followed conceptually and remains a viable plan for the future.

Two elements from the Skidmore Skywalk plan are recommended as a high priority.
The first is the connection to the transit center on Fannin (marked in Figure 4.13 as Connectivity). This is an essential connectivity issue required to integrate the transit center into the skywalk system. This connection is awaiting the construction of a building. If this building is not planned soon, the connection should be constructed prior to the building.

The second recommendation is the connection to the parking garage on Braeswood (marked in Figure 4.13 as Safety). This is a safety issue due to a large amount of jaywalking from the garage across Braeswood.


FIGURE 4.32
SKYWALK PLAN

## Sidewalks

In general, the TMC street level sidewalk surfaces are in good physical shape. There are a few missing gaps that should be filled in and some repairs and replacements should be completed. Existing sidewalk and shared-use path physical conditions are illustrated in Figure 4.14.

Although the street level sidewalks are in generally good physical shape, other elements of design are missing or inconsistent.

Providing good design elements that define and provide a sense of identity will encourage use of sidewalks. The sidewalk design should consider:

- Street furniture such as benches, trash cans, kiosks, bicycle racks, and newspaper containers, pedestrian-scale lighting, landscaping such as street tree canopies, landscape strips, and other greening elements
- Street crossing elements such as raised crosswalks, pedestrian refuge islands within medians, bump outs, etc.
- Transit shelters
- Decorative crosswalks and crosswalk signals/count down timers

Comfortable walking spaces are a key component of the design. The decision to walk outdoors is very much dependent on the microclimate of the pedestrian environment, particularly in Houston. A canopy
along sidewalks is essential. A tree canopy that does not inhibit or directly influence the airflow will improve thermal comfort at pedestrian level. Better ventilation occurs in areas where building heights vary. Moreover, the height to width ratio affects the quantity of solar energy obtained by street surfaces (facades, roofs and ground). Shade and good airflow are essential.

To better identify the needs and demand for the pedestrian realm, intersection pedestrian counts are listed in Table 4.20. Table 4.20 only includes intersections where the pedestrian counts exceed 100 for the weekday AM and PM peak period in total.

TABLE 4.20
TMC PEDESTRIAN COUNTS

| Intersection | AM | PM | Total |
| :--- | ---: | ---: | ---: |
| Fannin St. at Dryden Rd. | 1248 | 1575 | 2823 |
| Fannin St. at Ross Sterling Ave. | 1165 | 859 | 2024 |
| Fannin St. at Holcombe Blvd. | 715 | 702 | 1417 |
| Bertner Ave. at Bates St. | 640 | 699 | 1339 |
| Fannin St. at Pressler St. | 556 | 766 | 1322 |
| Fannin St. at University Blvd. | 573 | 435 | 1008 |
| Fannin St. at Cambridge St. | 728 | 227 | 955 |
| Main St. at Cambridge St. | 288 | 658 | 946 |
| Bertner Ave. at Pressler St. | 357 | 334 | 691 |
| Fannin St. at John Freeman Blvd. | 211 | 268 | 479 |
| Fannin St. at Holly Hall St. | 221 | 206 | 427 |
| Fannin St. at Sunset Blvd. | 103 | 160 | 263 |
| Cambridge St. at S Campus Dr. | 107 | 63 | 170 |
| Fannin St. at Old Spanish Trail | 73 | 71 | 144 |
| Almeda Rd. at Old Spanish Trail | 54 | 66 | 120 |
| Bertner Ave. at Old Spanish Trail | 51 | 64 | 115 |



FIGURE 4.33
EXISTING CONDITION OF SIDEWALKS AND SHARED-USE PATHS

## Bertner at Bates

As mentioned above, the on-campus intersection of Bertner at Bates has significant pedestrian activity and it is controlled by a 4-way stop (16 pedestrian conflicts); and the segment of Fannin between Cambridge and Bellows has significant pedestrian activity and the intersections where pedestrians cross are controlled by signals.

Although Fannin accommodates pedestrian crossings with traffic signals, pedestrian congestion is prevalent and there are surges due to boarding and alighting at the light rail stops.

There are near side transit stops on Bertner at the intersection of Bertner at Bates. Metro and the TMC Shuttles make these stops. These transit stops serve six Metro routes and two TMC Shuttle routes. There are also several institutional shuttles that pass through the intersection, but do not necessarily use these stops.

The total weekday peak period pedestrian count in the Bertner at Bates intersection ranked $4^{\text {th }}$ highest for intersections counted in the study area, higher than many intersections on Fannin.

Signalization of this intersection would appear to be a solution; however the intersection is too close to the existing signal for Bertner at Holcombe.

Another alternative would be to close the median on Bertner and only allow right turns into and out of Bates on the east and the west side of the intersection. This would result in a significant reduction in vehicle/pedestrian conflicts, but would redistribute traffic and could increase conflicts at other locations on campus. Further, as will be seen below, a bicycle lane is recommended for Bertner in this area and that will be another important consideration for this intersection.

## Fannin between Cambridge and Bellows

The pedestrian issues on Fannin between Cambridge and Bellows will be addressed directly by decisions made for improvements in the transit section of this document.

The best alternative for the pedestrians on Fannin between Cambridge and Bellows is the mall alternative. This alternative allows for good connectivity between the modes.

If the mall were not chosen to be implemented, it is recommended that the existing north and south leftturn lanes on Fannin between Cambridge and Bellows be removed. Left turns and u-turns would be prohibited and the resulting savings in traffic signal interval timing would be reallocated to pedestrian intervals.

Figure 4.14 illustrates the existing conditions of sidewalks and shared-use paths.
Figure 4.16 illustrates recommended improvements related to sidewalks, shared-use paths, and intersection accessibility.

### 4.4.3 Bicyclists

Some institutions in the TMC, like the University of Texas Medical Center and Baylor College of Medicine, provide in campus housing facilities up to one mile from their facilities, for students and persons affiliated with the facility. These facilities include in campus dormitories and apartments. Some of the popular off-campus housing neighborhoods serving TMC are Montrose, Galleria, Bellaire, Binz, Reliant, Heights, and Braeswood. Serving these home based work trips is important and will require consideration of facilities within the TMC and beyond.

Existing bicycle accommodations in the TMC area are less than adequate. A viable bicycle infrastructure in TMC will require a commitment of significant funds. Connecting cyclists to residential areas and to transit by dedicated facilities will be required. Grade separated facilities (underpasses/overpasses) will be required in some locations in order to provide good connectivity.

Bicycle accommodations vary significantly from virtually no infrastructure such as signed bicycle routes and signed shared roadways with occasional sharrow pavement markings to shared-use paths.

Houston has recently started a bicycle share program through the BCycle platform. The closest BCycle station to the TMC is located within Herman Park near the Houston Zoo. There are extensive plans to expand the BCycle system and the TMC would be an ideal location due to the high density of employment. High quality bicycle infrastructure would assist in supporting an expanded bicycle share program within the TMC area.

## Signed Bicycle Route

Public streets, unless prohibited by law, are shared by bicycles and other vehicles. Low volume streets, such as neighborhood streets, can provide a relatively safe and comfortable bicycling route. On major streets, wide outside lanes are often used to provide more space for bicyclists. Share the road signs, bicycle route signs and shared-lane pavement marking (sharrows) can also be used to provide a reminder to motorists of the use of the facility by bicyclists. Although these signs and markings are guidance or advisory, their purpose is basically to warn drivers of possible bicycle use. The Texas Manual of Uniform Traffic Control Devices (TMUTCD) provides guidance about shared lanes and the placement of shared-lane markings.

## Bicycle Lanes

Bicycle lanes are designated by a white stripe, a bicycle symbol, and signs setting aside a portion of street for bicycle use. Bicycle lanes range for four to six feet in width; however it is useful to provide buffers for additional operating space and lateral separation from moving and parked vehicles and to reduce the risk of "dooring" from parked vehicles. Green colored pavement or a pavement marking material is desirable to distinguish bicycle lanes from motor vehicle lanes. See TMUTCD and NACTO Urban Bikeway Design Guide for further information.

Cycle tracks are a high quality bicycle lane design. Cycle tracks are separated bicycle facilities that run alongside a roadway but are separated from other traffic by a physical barrier, such as pylons, parked cars, bollards, landscaped buffers, raised pavement markers, or curbs. A cycle track is for bicycle use only and is also separated from a sidewalk. Cycle tracks can be one-way or two-way and either raised or at street-level. Cyclists feel more comfortable being physically separated from other traffic and cycle tracks provide a reliable facility that is not subject to being blocked by parked or queued vehicles. Cycle tracks may also include grade separations over/under congested or unsafe traffic areas including freeways, major streets and intersections.

In this report, the term "bicycle lane" means a high quality design that provides a safe, reliable, separated facility for bicycles.

## Shared-Use Paths

Not to be confused with a shared lane, a shared-use path is a physically separated facility for pedestrians and bicyclists. Shared-use paths provide off-road facilities that are used for recreational trips and
commuting trips. These paths are often found along bayous, abandoned railroad right of way, and within parks and open space areas, and soon within utility corridors.

Shared-use paths attract bicyclists of varying skill levels, including older adults and young children. A path, even if designed as a bicycle facility, will attract runners, strolling pedestrians, in-line skaters, etc. The transportation profession must pay particular attention to planning and design of these facilities for safe and effective day-to-day use.

Most cyclists will prefer bicycle lanes over the long-term for most riding due to the conflicts with slower and sometimes erratic movements by path users. Ultimately, shared-use paths with high usage will need some method of separating the modes.

The City of Houston existing bicycle plan in the area surrounding TMC is illustrated in Figure 4.15.


FIGURE 4.34
EXISTING CITY OF HOUSTON BICYCLE PLAN

## Bicycle Parking

An effective bicycle parking program should include the following strategies:

- Provide well-located secure bicycle parking in the TMC area.
- Install bicycle parking at transit stops and in parking garages.
- Encourage the installation of high-security bicycle parking at existing worksites, schools, and high-density residential developments.
- Encourage existing businesses to provide bicycle parking for their customers.
- Require ample bicycle parking as part of new developments, particularly commercial, public, and high-density residential developments.
- Make these requirements part of the process of securing a building permit and TMC's review of planned internal development.

This bicycle plan was developed to address commuter needs and intra campus needs as appropriate with connections to transit, Herman Park, and the Brays Bayou trails. The recommended bicycle plan for TMC is illustrated in Figure 4.17.

The TMC's continued growth will depend on good, reliable transportation for employees and patients that live away from the campus, but growth will be inhibited if sufficient transit capacity is not available and if additional on campus and near campus high density residential development does not occur. Higher density development is coming on line as developers move to fill this need. Bicycle and pedestrian infrastructure will need to be developed to support this development.

Externally and internally there is considerable competition for street space between the travel modes serving TMC. In most cases it will not be possible to provide wider sidewalks, bicycle lanes, rail lines, bus/HOV lanes, and at the same time add more vehicle lanes. Therefore, priorities will have to be set to achieve a better balance between the modes.

- New roads, widening existing roads, grade separations, etc. are likely not affordable, or socially/environmentally acceptable.
- Significant additional growth at TMC will require dense residential growth within walking/cycling distance of the jobs and great transit service.
- Additional mixed-use high-density residential developments are already underway or being planned within walking/biking distance of the TMC.
- The basic transit infrastructure is in place and increased ridership will be required in the future which will put even greater emphasis on pedestrian improvements.
- Pedestrian and bicycle infrastructure will require more attention, greater planning, and a greater share of the transportation funding in the future.


FIGURE 4.35
RECOMMENDED SIDEWALK AND SHARED-USE PATH IMPROVEMENTS


FIGURE 4.36
RECOMMENDED TMC BICYCLE PLAN

### 5.0 MULTIMODAL CORRIDORS

### 5.1 Recommended Multimodal Roadway Classification

Associated with the City of Houston Mobility Planning Process is a revised street functional classification system. This system allows for the design of streets to change through areas that are urban or suburban, regardless of land use type. Figure 5.1 illustrates the new multimodal classification system as it relates to the previous conventional street classification system applied by the City. The street system in the Primary study area was reclassified based on the new system, and provided guidance for the integration of multimodal improvements on certain roadways. The City of Houston's Major Thoroughfare Plan (MTFP) Street Hierarchy Table was used to gather information on existing conditions. Table 5.1 shows the proposed multimodal classification within the TMC study area for existing conditions as well as with future improvement concepts.


FIGURE 5.1 REVISED CITY STREET FUNCTIONAL CLASSIFICATION SYSTEM

Specific guidelines for each functional classification, as defined in the 2009 document, City Mobility Planning - Phase 1: Executive Summary, are as follows:

## Boulevards

Urban Boulevards are walkable, divided thoroughfares in urban environments designed to carry both through and local traffic, bicyclists, pedestrians and other modes where appropriate. Urban Boulevards may also be high ridership transit corridors. Urban Boulevards are routes for primary goods movement, emergency response, and they utilize access management techniques. The pedestrian and context realms of Urban Boulevards are oriented towards the pedestrian and building frontages. Most often the buildings are close to the street with wide sidewalks and tree wells forming space where pedestrians feel comfortable and safe. The building height to street ratio often exceeds a 3:1 ratio. This ratio creates a
comfort level for pedestrians crossing wide thoroughfares. In certain contexts portions of an Urban Boulevard may be undivided.

Suburban Boulevards are divided thoroughfares in suburban environments. They are designed to carry some local but primarily through and regional traffic. They may also be local and high frequency transit corridors. Suburban Boulevards serve as routes for goods movement, emergency response and utilize access management techniques. Suburban Boulevards typically serve separated single land uses such as residential subdivisions, shopping centers, industrial areas, and business parks. They may also serve as regional connections to and between activity centers. Suburban Boulevards in certain residential contexts and through activity centers may be designed to accommodate on-street bicycle facilities and pedestrian crossings. The pedestrian realm is distinguished by a landscape buffer separating the street from the sidewalk. Trees are located outside of the sidewalk area.

Transit Streets-Boulevards / Avenues, much like the Urban Boulevard, are very walkable, divided thoroughfares in urban environments. They are designed to carry local traffic, pedestrians, and bicyclists. Transit Boulevards are designed to provide space in the median for transit facilities. However in some instances transit facility may not be within a dedicated lane. Additionally, these streets are designed to provide the pedestrian with more walkable space. The buildings are often close to the street with wide sidewalks and tree wells. The wide sidewalks and tree wells provide a feeling of safety and comfort for pedestrians.

Industrial Boulevard/Avenues are thoroughfares \& collector streets for effective local and regional movement of goods. Streets with an industrial designation are designed to connect heavy vehicles to and from major highways and industrial areas. These streets have wider travel lanes with large turning radii to accommodate truck movements. The pedestrian realm is distinguished by a landscape buffer separating the street from the sidewalk. In certain contexts an Industrial Boulevard may be undivided with a center turn lane.

## Avenues

Urban Avenues are walkable, undivided urban thoroughfares or collectors. They are generally shorter than Urban Boulevards and give access to adjacent land. Urban Avenues may also serve as pedestrian and bicycle routes and serve local transit routes. Urban Avenues do not exceed four-lanes. Goods movement is typically limited to local routes and deliveries. Urban Avenues may serve commercial or mixed-use and often provide on-street parking. Most often the buildings are close to the street with wide sidewalks and tree wells forming space where pedestrians feel comfortable and safe. In certain contexts portions of an Urban Avenue may be divided.

Suburban Avenues are walkable, suburban thoroughfares or collector, generally shorter in length than Suburban Boulevards, serving access to adjacent land. Suburban Avenues serve as primary bicycle and pedestrian routes and may serve local transit routes. Goods movement is typically limited to local routes and deliveries. Some Suburban Avenues feature a raised landscaped median. Suburban Avenues may serve neighborhood institutional, commercial or mixed-use sectors. They may also provide curb parking in certain contexts. The pedestrian realm is distinguished by a landscape buffer separating the street from the sidewalk. Trees are located outside of the sidewalk area.

## Streets

Urban Streets are walkable, collector streets in urban areas primarily serving adjacent property. Urban Streets are designed to connect neighborhoods with commercial and other districts, and connect local streets to thoroughfares. These Urban Streets may serve as the main street of commercial or mixed-use sectors and emphasize on-street parking. Most often the buildings are close to the street with wide
sidewalks and tree wells forming space where pedestrians feel comfortable and safe. Goods movements are restricted to local deliveries only.

Suburban Streets are walkable, collector streets in suburban areas primarily serving abutting property. A Suburban Street is designed to connect neighborhoods with commercial and other districts, and local streets to thoroughfares. Suburban Streets may serve as the main street for commercial or mixed-use sectors and emphasize curb parking. The context realm is defined by a landscape buffer of trees with a separated sidewalk. Goods movements are often restricted to local deliveries only.

One-Way Couplets are pairs of one-way thoroughfares or collector that function as a single highercapacity street in urban environments. One-way Couplets are usually separated by one city block, allowing travel in opposite directions. They provide access to active higher-density commercial and mixed-use areas such as Downtown and regional centers. They may also lower-density residential or mixed use areas and often provide on-street parking. Most often the buildings are close to the street with wide sidewalks and tree wells forming space where pedestrians feel comfortable and safe. One-way Couplets are designed to carry both through and local traffic, bicyclists and pedestrians. They may also serve as local or high frequency transit corridors. They serve as routes for goods movement, emergency response, and may utilize access management techniques. One-way Couplets are designed to have a higher transportation capacity than an equivalent two-way street. Both parallel and angled parking are appropriate for these streets.

## TABLE 5.1

| Street Name | From | To | Existing MTFP Code | Proposed MTFP Code | Median Type | Speed | Proposed Right-ofway (feet) | No. of Lanes | Existing <br> ADT <br> Volume | $\begin{gathered} \hline 2035 \\ \text { ADT } \\ \text { Volume } \end{gathered}$ | Proposed Functional Class | Proposed Multimodal Classification | Bike Facility | Parking | Transit | Ped Realm |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Rice Boulevard | Greenbriar Dr | Sunset Blvd | C-2-70 | C-2-70 | Undivided | 30 | 70 | 2 | 13,000 | 13,300 | Major Collector | Urban Street | x* |  |  | x |
| Shepherd Dr | Bissonet St | Rice Blvd | C-2-60 | C-3-60 | Undivided | 30 | 60 | 3 | 11,600 | 14,000 | Major Collector | Couplet |  |  |  | x |
| Main St | Sunset Blvd | Hermann | P-6-110 | P-6-110 | Median | 35 | 110 | 6 | 34,500 | 42,800 | Principal Thoroughfare | Urban Boulevard |  |  |  | x |
| Main St | University Blvd | Sunset Blvd | P-6-110 | P-6-120 | Median | 35 | 120 | 6 | 34,600 | 49,700 | Principal Thoroughfare | Urban Boulevard |  |  |  | x |
| Main St | Greenbriar Dr | University Blvd | P-6-120 | P-6-120 | Median | 35 | 120 | 6 | 34,900 | 43,800 | Principal Thoroughfare | Urban Boulevard | x |  |  | x |
| Hermann Dr | Main St | Almeda Rd | C-2-80 | T-4-80 | Undivided | 30 | 80 | 2 | 4,800 | 8,700 | Major Collector | Urban Street |  | x |  | x |
| Fannin Street | Hermann | Cambridge | P-6-100 | TCS-4-100 | Median | 35-40 | 100 | 6 | 25,200 | 39,100 | Major Thoroughfare | Transit Street |  |  | x-LRT | x |
| Fannin Street | Cambridge | Braeswood | P-6-100 | TCS-4-100 | Median | 35-40 | 100 | 6 | 25,200 | 39,100 | Major Thoroughfare | Transit Street |  |  | x-LRT |  |
| Fannin Street | Braeswood | Greenbriar | P-6-100 | T-4-100 | Median | 35-40 | 100 | 6 | 25,200 | 39,100 | Major <br> Thoroughfare | Urban Boulevard |  |  |  |  |
| Fannin Street | Greenbriar | IH 610 | P-6-100 | TCS-4-100 | Median | 35-40 | 100 | 6 | 25,200 | 39,100 | Major Thoroughfare | Transit Avenue |  |  | x-LRT |  |
| Braeswood Blvd / MacGregor Way | Fannin St | Almeda Rd | T-6-100 | T-6-100 | Median | 30 | 100 | 5-6 | 20,000 | 34,500 | Major <br> Thoroughfare | Urban Boulevard | x |  |  | x |
| Braeswood Blvd South Section | Greenbriar Dr | Fannin St |  | T-4-100 | Median | 30 | 100 | 4 | 20,000 | 34,500 | Major Thoroughfare | Transit Boulevard |  |  | x-LRT |  |
| Greenbriar Dr | Fannin | Braeswood | T-4-110 | T-4-110 | CTL/ Median | 30 | 80-110 | 4 | 9,000 | 16,000 | Major Thoroughfare | Transit Boulevard |  |  | x-LRT | x |
| Greenbriar Dr | Braeswood | Main | T-4-110 | T-4-110 | CTL/ Median | 30 | 80-110 | 4 | 9,000 | 16,000 | $\begin{gathered} \text { Major } \\ \text { Thoroughfare } \\ \hline \end{gathered}$ | Urban Avenue |  |  |  |  |
| Greenbriar Dr | Main | Rice Blvd | T-2-60 | T-2-60 | CTL | 30 | 60 | 4 | 15,100 | 18,500 | Major Thoroughfare | Urban Avenue |  |  |  | x |
| Greenbriar Dr | Rice Blvd | Sunset Blvd | T-2-50 | T-3-60 | Undivided | 30 | 60 | 2 |  |  | Major <br> Thoroughfare | Couplet |  |  |  |  |
| Bertner Ave | Holcombe Blvd | Old Spanish Trail | C-4-80 | C-4-80 | Median | 35 | 80 | 4 | 10,000 | 15,500 | Major Collector | Urban Avenue | x |  |  | x |
| Pressler St | Fannin St | $\begin{gathered} \text { Braeswood } \\ \text { Blvd } \end{gathered}$ | N/A | C-4-80 | Median | 20 | 80 | 4 | N/A | N/A | Collector | Urban Street | x |  |  | x |
| Pressler St | Main St | Fannin St |  | C-4-80 | Undivided | 30 | 80 | 4 | N/A | N/A | Collector | Urban Street | $x$ |  |  |  |
| FY On-Street Bike Facility Pressler | Fannin St | $\begin{gathered} \text { Braeswood } \\ \text { Blvd } \\ \hline \end{gathered}$ | N/A | C-4-80 | Median | 30 | 80 | 4 | N/A | N/A | Collector | Urban Avenue | x |  |  | x |
| Holly Hall | Fannin St | Almeda Rd | C-4-150 | C-4-150 | Undivided | 30 | 150 | 4 | 13,600 | 18,600 | Major Collector | Urban Avenue | x |  |  | x |
| MD Anderson Blvd (Private) | Holcombe Blvd | Moursund St | N/A | C-4-80 | Undivided | 20 | 80 | 4 | N/A | N/A | Collector | Urban Avenue |  |  |  | x |
| Cambridge St - Existing - 4 In | Holly Hall | Main St | Varies | C-4-120 | Median/ CTL | 30 | Varies | 4 | 7,400 | 22,200 | $\begin{gathered} \text { Major } \\ \text { Collector } \end{gathered}$ | Urban Avenue | x |  |  | x |
| Cambridge St - Existing - 4 In | IH 610 Frontage Rd | Holly Hall | C-4-100 | C-4-100 | Median/ Undivided | 30 | 100 | 4 | 7,400 | 22,200 | Major Collector | Urban Avenue | x |  |  | x |
| Almeda Rd - Existing - 4 Ln | Holly Hall | N MacGregor | P-6-150 | P-6-150 | Median | 40 | 150-160 | 4-6 | 21,200 | 33,800 | Principal | Urban | x |  |  | x |


| Street Name | From | To | Existing MTFP Code | Proposed MTFP Code | Median Type | Speed | Proposed Right-ofway (feet) | No. of Lanes | Existing ADT Volume | $\begin{gathered} 2035 \\ \text { ADT } \\ \text { Volume } \end{gathered}$ | Proposed Functional Class | Proposed Multimodal Classification | Bike Facility | Parking | Transit | Ped Realm |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  | Thoroughfare | Boulevard |  |  |  |  |
| Almeda Rd | N MacGregor | Hermann | T-4-80 | T-4-80 | CTL | 40 | 80 | 4 | 21,200 | 33,800 | Thoroughfare | Urban Avenue | x |  |  | x |
| FY Option 1 Almeda Rd Transportation Terminal/Remote Parking | Holly Hall | N MacGregor |  | P-6-150 | Median | 40 | 150-160 | 6 | 21,200 | 25,350 | Principal Thoroughfare | Transit Boulevard | x |  | x-LRT | x |
| FY Option 2 Almeda Rd-6 In | Holly Hall | N MacGregor |  | P-6-150 | Median | 40 | 150-160 | 6 | 21,200 | 33,800 | Principal Thoroughfare | Urban Boulevard | x |  |  | x |
| Holcombe Blvd - Existing - 6 In | Greenbriar Dr | Main St | P-6-115 | P-6-120 | Median | 30 | 120 | 6 | 38,000 | 53,300 | Principal Thoroughfare | Transit Boulevard |  |  |  | x |
| Holcombe Blvd - Existing - 6 In | Main St | Bertner Ave | P-6-110 | P-6-120 | Median | 30 | 120 | 6 | 38,000 | 53,300 | Principal Thoroughfare | Transit Boulevard |  |  |  | x |
| Holcombe Blvd - Existing - 6 In | Bertner Ave | Almeda Rd | P-6-80 | P-6-120 | Median/ Undivided | 30 | 120 | 6 | 31,300 | 43,400 | Principal Thoroughfare | Transit Boulevard |  |  |  | x |
| FY Option 1 Holcombe Blvd Transportation Terminal/Remote Parking | Main St | Almeda Rd |  | P-6-120 | Median/ Undivided | 30 | 120 | 6 | 38000 | 39,975 | Principal Thoroughfare | Transit Boulevard |  |  |  | x |
| FY Option 2 Holcombe Blvd - Grade Separated Intersections | Main St | Almeda Rd |  | P-6-130 | Median/ Undivided | 30 | 130 | 6 | 38000 | 53,300 | Principal Thoroughfare | Transit Boulevard |  |  |  | x |
| FY Option 3 Holcombe Blvd - Elevated Expressway | Main St <br> At ground Arterial | Almeda Rd |  | P-6-120 | Median/ Undivided | 30 | 120 | 6 | 38000 | 38,000 | Principal Thoroughfare | Urban Boulevard |  |  |  | x |
|  | Elevated Expressway |  |  | P-4-110 | Median | 45 | 110-115 | 4 | N/A | 40,700 | Principal Thoroughfare | Expressway |  |  |  |  |
| Old Spanish Trail - Existing - 6 In | Greenbriar Dr | Almeda Rd | P-6-100 | P-6-120 | Median / CTL | 35 | 120 | 6 | 28,400 | 55,400 | Principal Thoroughfare | Urban Boulevard |  |  |  | x |
| FY Option 1 Old Spanish Trail - Grade Separated Intersections | Main St | Almeda Rd |  | P-6-130 | Median/ CTL | 35 | 130 | 6 | 28,400 | 55,400 | Principal Thoroughfare | Urban Boulevard |  |  |  | x |
| FY Option 2 Old Spanish Trail Elevated Expressway | Main St <br> At ground Arterial | Almeda Rd |  | P-6-120 | Median/ Undivided | 35 | 120 | 6 | 28400 | 35,000 | Principal Thoroughfare | Urban Boulevard |  |  |  | x |
|  | Elevated Expressway |  |  | P-4-110 | Median | 45 | 110-115 | 4 | N/A | 40,700 | Principal Thoroughfare | Expressway |  |  |  |  |
| University Blvd | Kirby Dr | Main St | C-2-70 | T-2-70 | Undivided |  | 70 | 2 | 34,600 | 49700 | Thoroughfare | Urban Street |  |  |  | $x$ |
| University Blvd - Existing - Two-way | Main St | Fannin St | C-2-70 | T-4-70 | Undivided |  | 70 | 4 | 34,600 | 49700 | Thoroughfare | Urban Boulevard |  |  |  | x |
| FY Option University Blvd - One-way Westbound | Main St | Fannin St |  | C-4-70 | Undivided |  | 70 | 4 | 34,600 | 49700 | Thoroughfare | Couplet |  |  |  | x |
| Dryden Road | Greenbriar Dr | Main St | N/A | L-2-60 | Undivided | 30 | 60 | 2 | N/A | N/A | Local Street | Urban Street |  |  |  | x |
| Dryden Road - Existing - Two-way | Main St | Fannin St | N/A | C-4-80 | Undivided | 30 | 80 | 4 | N/A | N/A | Collector | Urban Avenue |  |  |  | x |
| FY Option Dryden Road - One-way Eastbound | Main St | Fannin St | N/A | C-4-80 | Undivided | 30 | 80 | 4 | N/A | N/A | Collector | Couplet |  |  |  | x |
| Future Year (FY) Proposed Roadway Improvement Concept as part of TMC Mobility Study 2014 |  |  |  |  |  | CTL - Center Turn-lane; |  |  |  | RoW - Right of Way; |  |  | x - Partially along the corridor |  |  |  |

### 5.2 Corridor Sheets

The proposed improvements in the TMC area through this study help City of Houston to achieve the Complete Streets vision by constructing single projects or a group of projects over time. The multimodal improvements proposed consider all users of the road. The following sections include corridor sheets that bring together the vision for each corridor by combining short-term, mid-term, long-term, pedestrian and bicycle and transit improvements. The proposed multimodal roadway classification was based on the future vision for each of these corridors. The roadway typical section exhibits included at the end of each corridor sheet show the future corridor vision in detail. The modes shown on each sheet are as follows:

Modes Legend

| $\bigcirc$ | METRO Bus Route | - | Vehicles |
| :---: | :---: | :---: | :---: |
| - | Remote Parking Facilities | dos | Bicycles |
| $\hat{\lambda}$ | Pedestrians | E- | Light Rail Transit |

### 5.2.1 Holcombe Boulevard

Limits: Main Street to Almeda Road
Modes:日P(

## Existing Conditions

Holcombe Boulevard is an east-west major thoroughfare that bisects the TMC. It runs from just east of SH 288 where it connects to Old Spanish Trail west through the TMC to Edloe Street where it becomes Bellaire Boulevard In the study area, Holcombe Boulevard is three lanes in each direction with left turnlanes at the intersections and a landscaped median. The posted speed limit on Holcombe Boulevard in the study area is 30 mph .

## Issues and Needs

Holcombe carries a large amount of traffic, which ranges approximately from 25,000 to 33,000 daily. The eastbound traffic is heavy during AM peak hour and westbound traffic was high and experiencing high delays during PM peak hour. In terms of intersection LOS, The intersections of Fannin at Holcombe, Holcombe at Richard JV Johnson, Holcombe at Almeda Road, and Holcombe at Main Street were all observed to be operating at LOS F during both AM and PM peak hours.

## Future Vision

Short-term improvements will include adding left-turn bays, reconfiguring lanes, and optimizing signal timings for those intersections operating at LOS E or F. There are also intersection accessibility improvements such as adding curb ramps at Holcombe at Fannin and Holcombe at Main. After the implementation of improvements above, those intersections will operate at levels of service D or better. Mid-term improvements, which include adding left-turn bays, will be implemented on the intersection of Almeda at Holcombe. LOS at that intersection will be brought to $D$. For the long term improvements, conceptual options analyzed were widening roadway, elevated expressway, grade separation at selected intersections, and a new transportation terminal. Analysis details are included in Appendix A. Given the context of the study area as a high density urban activity center and input from stakeholders and general public, the corridor is envisioned to retain its current urban boulevard characters with high frequency transit. To accommodate the projected mobility needs, improvements such as corridor access management and grade separation at certain intersections may be needed. Further assessment and design consideration will be required to develop specific improvement options that fit the area context and serve multimodal needs along the corridor.


FIGURE 5.2
TYPICAL SECTION FOR HOLCOMBE BOULEVARD

### 5.2.2 Old Spanish Trail

Limits: Main Street to Almeda Road
Modes:


## Existing Conditions

Old Spanish Trail is an east-west principal thoroughfare that traverses south of TMC area. It runs from Main Street in the west to Scott St in the east. In the study area, Old Spanish Trail has three lanes in each direction with medians in the center. The posted speed limit in the study area is 35 mph .

## Issues and Needs

The intersection of Almeda Road at Old Spanish Trail is operating at LOS E during AM peak hour and LOS F during PM peak hour. The northbound approach and westbound left turn volumes are high during AM peak hour. During PM peak, eastbound approach has heavy traffic volume and the left turning vehicles at all four approaches were experiencing delays. SH 288 NB Frontage Road at Old Spanish Trail also experiences LOS F at PM peak hour. In addition, Fannin at Old Spanish Trail was observed to be operating at LOS E during AM peak hour. The traffic along Old Spanish Trail in both eastbound and westbound direction was heavy. Also, the left turning movements in all directions were experiencing high delays.

## Future Vision

In order to improve traffic operations at intersections along Old Spanish Trail, short-term improvements include adding turn-lanes or shared lanes at intersections of Almeda at Old Spanish Trail and SH 288 Northbound Frontage Road at Old Spanish Trail. Corridor signal timing will also be optimized. After these improvements are implemented, above mentioned intersections will be able to operate at LOS D or better. The mid-term improvements related to Old Spanish Trail include adding turn-lane at the intersections of Old Spanish Trail at Fannin, Old Spanish Trail at Bertner, Old Spanish Trail at Almeda, and Old Spanish Trail at Cambridge. Accordingly, LOS at these intersections will be changed from E/F to D or Better. For the long term improvements, conceptual options analyzed were widening roadway, elevated expressway and grade separation at selected intersections. Analysis details are included in Appendix A. To accommodate the projected mobility needs, improvements such as corridor access management and grade separation at certain intersections may be needed. Further assessment and design consideration will be required to develop specific improvement options that fit the area context and serve multimodal needs along the corridor.


FIGURE 5.3
TYPICAL SECTION FOR OLD SPANISH TRAIL

### 5.2.3 Braeswood Boulevard/MacGregor Way

Limits: Greenbriar Drive to Fannin Street
Modes


是
0

## Existing Conditions

Braeswood Boulevard/MacGregor Way is a north-south major thoroughfare that runs from Calhoun Road to the east all the way to Bissonnet Street in the west. North of Holcombe Boulevard, it is known as MacGregor Way, and south of Holcombe Boulevard, it is known as Braeswood Boulevard. In the study area, Braeswood Boulevard has three lanes in each direction separated by a median. Left turn bays are provided at major signalized intersections. The posted speed limit on Braeswood Boulevard/MacGregor Way in the study area is 30 mph .

## Issues and Needs

The intersection of SH 288 southbound frontage road at N . Macgregor Way is operating at LOS F during AM peak hour. The southbound right-turn movement has very high volume during AM peak hour. Cambridge at Braeswood intersection is operating at LOS E during AM peak hour. High delay was observed for the southbound left turn movement. Additionally, Cambridge at Macgregor pedestrian crossing was observed to have discontinuous sidewalks. South of Macgregor, Cambridge has sidewalks as well as pedestrian ramps; however, after the crosswalk and pedestrian ramps, there are no pedestrian facilities connecting to the existing sidewalk on the southwest corner of the intersection.

## Future Vision

Proposed mid-term improvement for this corridor will be adding additional westbound right turn bay and making a dual free right-turn at the intersection of Cambridge at Braeswood. After implementing this improvement, Cambridge at Braeswood which is currently operating at LOS E or F would be operating at acceptable levels of service D or better. Other improvements include filling bike route gap along S MacGregor Way, filling sidewalk gap closure and replacing sidewalks in poor condition along N MacGregor and S Braeswood. These steps will provide better bicycle and walk access along this corridor. Curb ramp will be added to the intersection of Cambridge at MacGregor which will make west side of Cambridge an accessible route. Furthermore, a new skybridge is recommended which connect Braeswood garage to MD Anderson skybridge network at Rotary House to discourage mid-block crossings on Braeswood.


FIGURE 5.4
TYPICAL SECTION FOR BRAESWOOD BOULEVARD/MACGREGOR WAY

### 5.2.4 Cambridge Street

Limits: IH 610 to Main Street
Modes:


04


## Existing Conditions

Cambridge Street is a north-south major collector that bisects the TMC. Cambridge Street has two lanes in each direction. It begins at IH 610 South Loop West, continues through the Medical Center and terminates at Main Street. Cambridge Street has a posted speed limit of 30 mph .

## Issues and Needs

Main at Cambridge was observed to be operating at LOS E during both AM and PM peak hours. During the AM peak north and southbound traffic was heavy and in the PM peak hour southbound and westbound left turning movements were heavy. For Holcombe at Cambridge, it was observed to be operating at LOS E during both AM and PM peak hours. During the AM peak hour eastbound left turn movement was heavy and is experiencing delays, and in the PM peak northbound approach was heavy. Cambridge at Braeswood intersection was operating at LOS E during AM peak hour. High delay was observed for the southbound left movement. On the other hand, Cambridge at Macgregor pedestrian crossing was observed to have discontinuous sidewalks. South of Macgregor, Cambridge has sidewalks as well as pedestrian ramps; however, after the crosswalk and pedestrian ramps, there are no pedestrian facilities connecting to the existing sidewalk on the southwest corner of the intersection

## Future Vision

Proposed midterm, roadway improvements include adding turn-lanes at intersections of Main at Cambridge, Cambridge at East Road, Cambridge at Old Spanish Trail, Cambridge at Holcombe, and Cambridge at Braeswood. After improvements, operating LOS for all these intersections will be improved to D or better. Additional improvements for bicycle, pedestrian infrastructures include filling sidewalk gap closure from N MacGregor to Hermann Park, and from El Paseo to Holly Hall. Curb ramps will be added to the intersection of Cambridge at MacGregor. Accessibility along Cambridge will be improved as a result.

| EXISTING CONDITIONS |  | FUTURE CONDITION |  |
| :---: | :---: | :---: | :---: |
| Existing Lanes | 4 | Future Lanes | 4 |
| Existing Counts Range | 7400 | Future Volume Range | 22200 |
| Right-of-way | $40 '-120$ | Proposed MMC | Urban Avenue |
| Median/CTL/Undivided | Median/CTL | Median/CTL/Undivided | Median/CTL |
| MTFP Designation | C-4-100 | MTFP Designation | C-4-100 |




FIGURE 5.5
TYPICAL SECTIONS FOR CAMBRIDGESTREET

### 5.2.5 Almeda Road

Limits: Hermann Drive to Holly Hall Street
Modes:日 P ( do ?

## Existing Conditions

Almeda Road is a north-south principal thoroughfare in the study area that runs along the east side of the TMC. It has two to three lanes in each direction throughout the study area. Almeda Road has a posted speed limit of 40 mph .

## Issues and Needs

Almeda Road at Old Spanish Trail intersection is operating at LOS E during AM peak hour and LOS F during PM peak hour. The northbound approach and westbound left turn volumes are high during AM peak hour. During PM peak, eastbound approach had heavy traffic volume and the left turning vehicles at all four approaches are experiencing delays. The intersection of Holcombe at Almeda Road is operating at LOS F during AM peak hour with eastbound approach experiencing delays. At intersection of Almeda at South Macgregor - the southbound left turn-lane storage length is not sufficient. Further, Almeda Road is planned to be expanded to six lanes throughout; however, bridges will remain four lanes which will definitely cause bottleneck back up issues at each of the intersections of Almeda at North and South Macgregor. Almeda at Holcombe and Almeda at Old Spanish Trail were observed to have poor traffic operations. Particularly, Almeda at Holcombe in the northbound direction appeared to operate above capacity, while other directions were operating smoothly.

## Future Vision

Proposed short-term improvements for intersection of Almeda and Holcombe include adding left-turn bay in the westbound direction and modifying signal timing for Holcombe Boulevard approaches. For intersection of Almeda at Old Spanish Trail, new turn bays are proposed. In the midterm, additional turn bays are proposed to the two intersections mentioned above. These improvements will bring LOS at the two intersections to D or better and reduce delays. Sidewalks in poor condition along this corridor from Holly Hall to 7205 Almeda and are proposed to be replaced. Sidewalks from Holcombe to Holly Hall will be replaced with shared-use path so as to connect existing Almeda and Holly Hall shared-use paths. The long-term improvements proposed for Almeda road include widening to 6 lanes from Old Spanish Trail to N MacGregor Way. Building a transportation terminal on Almeda Road north of IH 610 or along Holcombe Boulevard needs further assessment. These options will either increase the capacity of roadways or reduce traffic towards TMC area both of which will improve traffic operating conditions along Almeda road. This corridor is envisioned to be 6 lanes with potential grade separation at Holcombe.

| EXISTING CONDITIONS |  | FUTURE CONDITION 2 |  |
| :---: | :---: | :---: | :---: |
|  |  | Widening to 6 Lanes |  |
| Existing Lanes | 4 | Future Lanes | 6 |
| Existing Counts Range | 21200 | Future Volume Range | 33800 |
| Right-of-way | 150 '-160' | Proposed MMC | Urban Boulevard |
| Median/CTL/Undivided | Median | Median/CTL/Undivided | Median |
| MTFP Designation | P-6-150 | MTFP Designation | P-6-150 |



FIGURE 5.6
TYPICAL SECTIONS FOR ALMEDA ROAD

### 5.2.6 Bertner Avenue

Limits: West Road to Moursund Street
Modes:


## Existing Conditions

Bertner Avenue is a north-south local street that connects West Road to the south and E. Cullen Street to the north in the TMC. It has two lanes in each direction with a landscaped median in the study area. The posted speed limit on Bertner Avenue is 20 mph .

## Issues and Needs

Traffic flow on Bertner Avenue is operating at acceptable LOS. However, the on campus intersection of Bertner at Bates has significant pedestrian activity and it is controlled by a 4 way stop ( 16 pedestrian conflicts). Also, there are near side transit stops at that intersection. This situation leaves room for future improvement.

## Future Vision

In order to improve the operation at the intersection of Old Spanish Trail at Bertner, additional left-turn bay and two right-turn bays are recommended as midterm improvement. Moreover, new sidewalks will be installed along Bertner from OLD SPANISH TRAIL to 7007 Bertner where there are missing sidewalks. Shared-use path is proposed on west side between bayou and Pressler to connect bayou trails to Pressler shared lanes.

| EXISTING CONDITIONS |  | FUTURE CONDITION |  |
| :---: | :---: | :---: | :---: |
| Existing Lanes | 4 | Future Lanes | 4 |
| Existing Counts Range | 10000 | Future Volume Range | 15500 |
| Right-of-way | $80^{\prime}$ | Proposed MMC | Urban Avenue |
| Median/CTL/Undivided | Median | Median/CTL/Undivided | Median |
| MTFP Designation | C-40-80 | MTFP Designation | C-40-80 |



FIGURE 5.7
TYPICAL SECTIONS FOR BERTNER AVENUE

### 5.2.7 Pressler Drive

Limits: Holcombe Boulevard to Braeswood Boulevard
Modes:

## Existing Conditions

Pressler Street is an east-west local street that connects Holcombe Boulevard in the west to MacGregor Way in the east. It has two lanes in each direction with a landscaped median in the study area. The posted speed limit on Bertner Avenue is 30 mph .

## Issues and Needs

Overall traffic operation for this street is satisfactory even at the intersection of Fannin and Pressler where there is presence of the METRO transit center and heavy pedestrian activity. However, high delays were observed for the southbound left turn movement of the intersection due to the presence of the METRO Rail LRT station north of the intersection. It was observed that the southbound left turn phase is prohibited when the train is detected in either direction and is not released until the train leaves the station. In the scenario where northbound train checks in before the southbound train checks out of the station the delay for the southbound left turn movement extended up to five minutes.

## Future Vision

Short-term improvements proposed for Pressler include adding left-turn bay in the eastbound and westbound directions and optimizing signal timing for the light rail transit coordination. Shared lane is proposed from Fannin to Braeswood which will connect proposed bridge to skywalk and transit center. Due to increase in future traffic volumes on Pressler, it is proposed that the section between Fannin and Braeswood Boulevard be classified as Urban Avenue

| EXISTING CONDITIONS |  | FUTURE CONDITION |  |
| :---: | :---: | :---: | :---: |
| Existing Lanes | 4 | Future Lanes | 4 |
| Existing Counts Range | N/A | Future Volume Range | N/A |
| Right-of-way | 80 | Proposed MMC | Urban Street / Urban Avenue |
| Median/CTL/Undivided | Median | Median/CTL/Undivided | Median |
| MTFP Designation | N/A | MTFP Designation | C-4-80 |



### 5.2.8 University Boulevard and Dryden Street

Limits: Main Street to Fannin Street

Modes:


## Existing Conditions

University Boulevard is an east-west major collector road from Kirby Drive in the west to Fannin Street in the east. Dryden Road is an east-west local street from Greenbriar Drive to Fannin Street. Both University Boulevard and Dryden Road are two-way undivided roadway with one lane in each direction. The posted speed limit is 30 mph along the two roadways.

## Issues and Needs

Fannin at University was observed to be operating at LOS F in the AM peak hour and LOS E during PM peak hour. The northbound and southbound traffic is moderate. However, the westbound left turning traffic is experiencing high delays during AM peak hour and eastbound left turning traffic is heavy during PM peak hour. In addition, the intersection of Fannin at University experienced heavy delays during the AM peak hour. During peak hours, Dryden Street served as a cut-through street for commuting traffic causing noise and safety issues to nearby neighborhood.

## Future Vision

The proposed short-term improvement is to convert University Drive and Dryden Street to a one-way pair between Fannin Street and Main Street. University Boulevard will operate as a one-way street in the westbound direction and Dryden will operate as a one-way street in the eastbound direction. In order to ensure progressive traffic flow along Main Street following the conversion of University Boulevard and Dryden Road, signal timing for the intersections along Main Street between Holcombe Boulevard and Sunset Boulevard will be optimized, as required. After these implementations, intersections of Fannin at university, Fannin at Dryden, and University at Main will get improved significantly.

| EXISTING CONDITIONS | FUTURE CONDITION |  | EXISTING CONDITIONS |  | FUTURE CONDITION |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| University Boulevard |  | One-way Westbound |  | Dryden Road |  | One-way Eastbound |  |
| Existing Lanes | 2 | Future Lanes | 4 | Existing Lanes | 2 | Future Lanes | 4 |
| Existing Counts <br> Range | 34600 | Future Volume <br> Range | 49700 | Existing Counts <br> Range | N/A | Future Volume <br> Range | N/A |
| Right-of-way | $60^{\prime}-70^{\prime}$ | Proposed MMC | Couplet | Right-of-way | $60^{\prime}-80^{\prime}$ | Proposed MMC | Couplet |
| Median/CTL/Un <br> divided | Undivided | Median/CTL/Un <br> divided | Undivided | Median/CTL/Un <br> divided | Undivided | Median/CTL/Un <br> divided | Undivided |
| MTFP <br> Designation | C-2-70 | MTFP <br> Designation | C-4-70 | MTFP <br> Designation | N/A | MTFP <br> Designation | C-4-80 |



FIGURE 5.9
TYPICAL SECTIONS FOR UNIVERSITY BOULEVARD AND DRYDEN STREET

### 5.2.9 Fannin Street

Limits: Holly Hall to Hermann Drive
Modes:


OF $=$

## Existing Conditions

Fannin Street is a north-south major thoroughfare and a transit corridor that runs along the western edge of the TMC. Fannin Street begins south of IH 610 South Loop West and continues north through Downtown Houston and eventually merges with San Jacinto Street. South of Old Spanish Trail, Greenbriar Drive branches off of Fannin Street. In the study area, it has two lanes in each direction. The posted speed limit on Fannin Street is 3540 mph .

## Issues and Needs

Fannin at University was observed to be operating at LOS F in the AM peak hour and LOS E during PM peak hour. The westbound left turning traffic is experiencing high delays during AM peak hour and eastbound left turning traffic was observed to be heavy during PM peak hour. The intersection of Fannin at Holcombe was observed to be operating at LOS F during both AM and PM peak hours. The eastbound and westbound left turn volume was high and experiencing high delays. Meanwhile, the intersection of Fannin at Old Spanish Trail was observed to be operating at LOS E during AM peak hour. The traffic along Old Spanish Trail in both eastbound and westbound direction was heavy. Also, the left turning movements in all directions were experiencing high delays due to conflicting LRT movements. The he intersection of Fannin at University also experiences heavy delays during the AM peak hour. Furthermore, the field observations at the intersection of Fannin @ IH 610 Eastbound Frontage Road field indicated heavy traffic. Long queues were observed at eastbound IH 610 frontage road.

## Future Vision

Proposed short-term improvement for this corridor include adding left-turn bays and optimizing signal timing for Light Rail Transit coordination. Also conversion of University Boulevard and Dryden Street to on-way pair between Fannin Street and Main Street, and signal removal at John Freeman Drive and Bellows Drive to achieve efficient traffic signal timing utilization. The mid-term improvement include adding exclusive right-turn bays for the intersection of Old Spanish Trail at Fannin which will bring the intersection LOS to D. Long-term improvements on intersecting corridors like Holcombe and Old Spanish Trail will further improve the traffic conditions on Fannin Street. Other improvements include adding new shared-use lane along this street, replacing sidewalks in poor condition, adding curb ramps for intersections of Fannin at Old Main, Fannin at Holcombe, Fannin at Knight, and Fannin at Greenbriar.

| EXISTING CONDITIONS |  | FUTURE CONDITION |  |
| :---: | :---: | :---: | :---: |
| Existing Lanes | 6 | Future Lanes | 6 |
| Existing Counts Range | 25200 | Future Volume Range | 39100 |
| Right-of-way | $90^{\prime}-115^{\prime}$ | Proposed MMC | Transit Boulevard |
| Median/CTL/Undivided | Median | Median/CTL/Undivided | Median |
| MTFP Designation | P-6-100 | MTFP Designation | P-6-100 |



FIGURE 5.10
TYPICAL SECTIONS FOR FANNIN STREET

### 5.2.10 Main Street

Limits: Greenbriar Drive to Sunset Boulevard

Modes:


## Existing Conditions

Main Street is a north-south principal thoroughfare that runs along the western edge of the TMC. Main Street begins south of IH 610 South Loop, continues through Downtown Houston and crosses North Loop West. South of Kirby Drive, Old Spanish Trail branches off of Main Street. It has four lanes in each direction south of Old Spanish Trail and three lanes in each direction north of Old Spanish Trail. The posted speed limit on Main Street is 35 mph .

## Issues and Needs

Main at Cambridge was observed to be operating at LOS E during both AM and PM peak hours. During the AM peak northbound and southbound traffic was heavy and in the PM peak hour southbound and westbound left turning movements were heavy. During PM peak hour, northbound Main Street has heavy traffic flow which results in traffic spilling back into upstream intersections from Cambridge to Southgate.

## Future Vision

Proposed short-term improvements include adding right-turn and left-turn bays, reconfiguring lane configuration for intersection of Holcombe at Main. Mid-term improvement proposed is to add right-turn bay in the northbound direction for the intersection of Main at Cambridge. By the year of 2020, LOS for Main at Cambridge will be improved to D. After long-term improvements for other corridors are completed, LOS for Main at Holcombe will change from F to D .

| EXISTING CONDITIONS |  | FUTURE CONDITION |  |
| :---: | :---: | :---: | :---: |
| Existing Lanes | 6 | Future Lanes | 6 |
| Existing Counts Range | $34500-34900$ | Future Volume Range | $42800-49700$ |
| Right-of-way | $110 '-120$ | Proposed MMC | Urban Boulevard |
| Median/CTL/Undivided | Median | Median/CTL/Undivided | Median |
| MTFP Designation | P-6-110 | MTFP Designation | P-6-110 |



FIGURE 5.11
TYPICAL SECTIONS FOR MAIN STREET

### 6.0 CONCLUSION

The TMC Mobility Study's objectives broadly include developing a plan to improve accessibility, address traffic congestion, and better serve future development in the TMC area. This Study results in identifying improvement concepts for all modes of travel. The results of the analyses conducted as part of the Study led to the identification of improvement concepts and multimodal roadway classification that are listed in this section of the report. These improvements would go through project development process as per the City of Houston's CIP process. Several of the identified improvement concepts aim at addressing the goals for Complete Streets Policy. Future vision for each corridor is also documented in this section.

Based on City of Houston's input and public comments, the study team also identified a list of potential policy updates as follows:

- Develop standards for big block developments such that pedestrian and bicyclist mobility and roadway connectivity is not a hindrance. Such standards should include block widths, access points and speed limits.
- Modifications to the Houston Development Ordinances to require better drop off and valet standards for high traffic areas such as the TMC to mitigate traffic impacts on adjacent public streets and improve customer services for TMC
- Require infrastructure improvements such as bike and pedestrian improvements to be constructed as a part of the building permit approvals
- Partner with TIRZ 24/TMC to encourage infill housing development which could create an estimated 6,000 to 8,000 new residential homes ranging from townhomes to high density housing styles creating over $\$ 1.7 \mathrm{~B}$ in new real property values as well as increasing sales tax revenues for the City. TMC member institutions indicated support for close in housing to be available for all levels of staff.
- Work with the regional agencies such as METRO and H-GAC to plan and prioritize Bus Rapid Transit (BRT) corridors.
- Encourage, through economic incentives, the development of higher density housing to be located along highways/major thoroughfares, LRT and BRT corridors designed to handle the increased traffic

The next steps subsequent to the completion of this TMC Mobility Study will include:

- Transit-related recommendations will be forwarded to Metro for consideration
- Trail-related recommendations will be forwarded to the City of Houston Parks and Recreation Department
- Sidewalk gaps will be evaluated under the City of Houston Safe Sidewalk Program
- Intersection and roadway-related recommendations will be prioritized in accordance with the City of Houston CIP process
- Economic development strategies to be developed with TMC/City of Houston and Harris County TIRZ 24


### 6.1 Roadway Short-term and Mid-term List of Improvements

## TABLE 6.1

RECOMMENDED ROADWAY SHORT-TERM AND MID-TERM LIST OF IMPROVEMENTS

| Serial Number | Conceptual Improvement | Limits | Scope of Work | Timeline | Estimated Constr. Cost* | Right-ofWay Needed | Potential Funding Application |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Short/Mid/ Long | (Millions in 2014 Dollars) | (acres) |  |
| 1 | Local Circulation Improvements | University/Dryden between Main Street and Fannin Street | Convert University Street and Dryden Street to one-way pair between Main StS and Fannin Street Modify four(4) | Short | 1 | N/A | CoH/CMAQ |
| 2 | Parking ITS Solutions | TMC Study Area | Provide Parking Guidance Signs, Space Availability Signs at strategic locations. Develop Mobile App to assist TMC patrons. | Short | 5 | N/A | Private |
| 3 | Cambridge at East Drive Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersection as identified (NBL, SBU, Additional EBR).Conduct Traffic Signal Warrant Study and install traffic signal. | Short/Mid | 0.85 | 0 | CoH/CMAQ |
| 4 | Cambridge at Braeswood Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersections as identified (WBR Dual) | Short/Mid | 0.4 | 0 | CoH/CMAQ |
| 5 | 288 NBFR @ OST <br> Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersection as identified (NBL) | Short/Mid | 0.4 | 0 | CoH/CMAQ |


| Serial Number | Conceptual Improvement | Limits | Scope of Work | Timeline | Estimated Constr. Cost* | Right-of- <br> Way Needed | Potential Funding Application |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Short/Mid/ Long | (Millions in 2014 Dollars) | (acres) |  |
| 6 | 288 NBFR @ Holcombe Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersection as identified (NBL) | Short/Mid | 0.4 | 0 | CoH/CMAQ |
| 7 | Main @ Cambridge Intersection Improvements | Intersection approaches | Add exclusive Turn bay at intersection as identified (NBR) | Short/Mid | 0.6 | 0.08 | CoH/CMAQ |
| 8 | Fannin at Pressler Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersection as identified (EBL, WBL) \& Signal Timing Improvements (LRT) | Short/Mid | 1.2 | 0.19 | CoH/CMAQ |
| 9 | Almeda @ OST Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersections as identified (EBR, Additional NBL bay, Additional WBL, SBR, NBR) | Short/Mid | 2 | 0.17 | CoH/CMAQ |
| 10 | Cambridge at Holcombe Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersection as identified (WBL, EBL, EBR) | Short/Mid | 2.2 | 0.29 | CoH/CMAQ |
| 11 | Holcombe @ Main Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersection as identified(SBR, WBR, Additional bays EBL and WBL) | Short/Mid | 2 | 0.39 | CoH/CMAQ |


| Serial Number | Conceptual Improvement | Limits | Scope of Work | Timeline | Estimated Constr. Cost* | Right-ofWay Needed | Potential Funding Application |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Short/Mid/ Long | (Millions in 2014 Dollars) | (acres) |  |
| 12 | Holcombe @ Almeda Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersections as identified(WBL, Additional NBL, EBL Dual, EBR) | Short/Mid | 2.4 | 0.39 | CoH/CMAQ |
| 13 | OST at Fannin Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersections as identified (NBR, SBR, EBR, WBR) | Short/Mid | 0.8 | 0.39 | CoH/CMAQ |
| 14 | OST at Bertner Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersection as identified (Additional bays SBL, EBL Dual SBR, WBR) | Short/Mid | 2.6 | 0.48 | CoH/CMAQ |
| 15 | OST at Cambridge Intersection Improvements | Intersection approaches | Add exclusive Turn bays at intersection as identified | Short/Mid | 2.6 | 0.39 | CoH/CMAQ |
| 16 | Corridor Signal Timing Optimization | Intersection approaches | Optimize signal timing for major corridors such as Holcombe, OST, Almeda, Cambridge | Short/Mid | 0.3 | N/A | CoH/CMAQ |
| *Costs are estimated Construction Costs Only in 2014 Dollars. Costs shown do not include Right-of-way or Utilities Relocation Costs. |  |  |  |  |  |  |  |



FIGURE 6.1
RECOMMENDED LOCAL CAMPUS CIRCULATION IMPROVEMENTS

### 6.2 Roadway Long-term List of Improvements

TABLE 6.2
RECOMMENDED ROADWAY LONG-TERM LIST OF IMPROVEMENTS

| Serial Number | Conceptual Improvement | Limits | Scope of Work | Timeline | Estimated Constr. Cost* | Right-ofWay Needed | Potential Funding Application |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Short/Midl Long | (Millions in 2014 Dollars) | (acres) |  |
| 1 | Transportation Terminal on Holcombe Boulevard | At SH 288 | Construct a 2000 space parking garage along Holcombe Boulevard at SH 288. This facility may include retail space. | Long | 30 | 7 | CoH/CMAQ |
| 2 | Grade separation at Major Intersections on Holcombe Boulevard | SH 288 to East of Greenbriar | Grade separation at Almeda Road, Cambridge Street, Braeswood Boulevard, and Bertner Road and Main Street/Fannin Street. Overpasses/underpasses will have 4 lanes. | Long | 85 | 6.1 | STP |
| 3 | Grade Separated Express Lanes on Holcombe Boulevard | SH 288 to East of Greenbriar | Construct grade separated express lanes along Holcombe. The elevated structure will have 4 lanes. | Long | 120 | 3.6 | STP |
| 4 | Grade separation at Major Intersections on Old Spanish Trail | SH 288 to West of Greenbriar | Grade separation at Almeda Road., Cambridge Street, Braeswood Boulevard, and Bertner Road. Fannin Street overpasses/underpasses will have 4 lanes with a median | Long | 85 | 4.4 | STP |
| 5 | Grade Separated Express Lanes on Old Spanish Trail | SH 288 to West of Greenbriar | Construct grade separated express lanes along Holcombe. The elevated structure will have 4 lanes. | Long | 105 | 1.8 | STP |

*Costs are estimated Construction Costs Only in 2014 Dollars. Costs shown do not include Right-of-way or Utilities Relocation Costs.

| Serial Number | Conceptual Improvement | Limits | Scope of Work | Timeline | Estimated Constr. Cost* | Right-ofWay Needed | Potential Funding Application |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Short/Mid/ Long | $\begin{gathered} \text { (Millions in } \\ 2014 \\ \text { Dollars) } \end{gathered}$ | (acres) |  |
| 6 | Transportation Terminal on Almeda Road | At Holly Hall | Construct a 1000 space parking garage along Almeda Road. This facility may include retail space. | Long | 15 | 5 | CoH/CMAQ |
| 7 | Almeda Road Direct Connector to Transportation Terminal | IH 610 to Holly Hall/ Transportation Terminal | Construct a direct connector from IH 610 to the proposed Transportation Terminal. This will be a bi-directional connector with one lane in each direction. | Long | 30 | 0 | STP |

*Costs are estimated Construction Costs Only in 2014 Dollars. Costs shown do not include Right-of-way or Utilities Relocation Costs.

### 6.3 Parking List of Improvements

- Transportation Terminal /Remote Parking Options
- Almeda vicinity
- Holcombe Vicinity
- Parking Facilities Management
- Incorporate ITS Solutions
- Electronic Parking Guidance Signs
- Display Space Availability
- Improved Mobile App
- Alternative Parking Payment Solutions
- Parking Mobile App
- EZTag for Payment
- Payment through third party vendor


### 6.4 Pedestrian and Bicycle List of Improvements

Figures 6.3 and 6.42 show the recommended sidewalks and shared-use paths and recommended bike plan respectively. Tables 6.3 through 6.6 show the proposed list of improvements with location, project details and order of magnitude costs. These costs do not include right-of-way acquisition costs.


FIGURE 6.2
RECOMMENDED SIDEWALK AND SHARED-USE PATH IMPROVEMENTS
The numbered labels refer to the project numbers identified in Tables 6.3 and 6.4


FIGURE 6.3

TABLE 6.3
RECOMMENDED SIDEWALK AND SHARED-USE PATH IMPROVEMENTS

| Pedestrian and Shared-Use Infrastructure |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/ Area | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 1 | S MacGregor Way Along bayou, west of Cambridge | Shared-use path gap closure | Primary <br> Study Area | - Approx. 462 linear feet <br> - 10 ft . width | \$71,818 | 1 | - Connects trail from west to Cambridge \& MacGregor intersection, Cambridge bicycle route |
| 2 | Brays Bayou <br> North side, west of Cambridge | Shared-use path gap closure | Primary <br> Study Area | - Approx. 100 linear feet <br> - 10 ft . width | \$15,965 | 1 | - Connects ramp from Cambridge underpass to upper trail to west <br> - Closes critical gap in trail <br> - Eliminates dirt/mud riding |
| 3 | S MacGregor Way Along Brays Bayou, east of Cambridge | Shared-use path gap closure | Primary Study Area | - Approx. 475 linear feet <br> - 10 ft . width | \$73,486 | 1 | - Connects trail from east to Cambridge \& MacGregor intersection, Cambridge bicycle route |
| 4 | Brays Bayou <br> North side, east of Cambridge | Shared-use path gap closure | Primary <br> Study Area | - Approx. 90 linear feet <br> - 10 ft . width | \$14,681 | 1 | - Connects ramp from Cambridge underpass to upper trail to east <br> - Eliminates dirt/mud riding |
| 5 | Brays Bayou <br> North side, under <br> Almeda | Shared-use path gap closure | Primary Study Area | - Approx. 334 linear feet <br> - 10 ft . width | \$52,259 | 1 | - Closes critical gap in trail <br> - Eliminates dirt/mud riding |
| 6 | Cambridge East side, N MacGregor to Hermann Park Jogging Trail | Sidewalk gap closure | Primary <br> Study Area | - Approx. 260 linear feet <br> - 8 ft . width <br> - 2 curb ramps | \$19,073 | 1 | - Closes critical gap in pedestrian network <br> - Creates accessible route between Cambridge/ Brays Bayou and TMC |
| 7 | N MacGregor North side, Almeda to Hermann Park Jogging Trail | Sidewalk gap closure | Primary <br> Study Area | - Approx. 510 linear feet <br> - 8 ft . width <br> - 4 curb ramps | \$37,536 | 1 | - Closes critical gap in pedestrian network <br> - Creates accessible route between Almeda and Hermann Park |
| 8 | Almeda East side, Holly Hall to 7205 Almeda | New and replacement sidewalk | Primary Study Area | - Approx. $3,155 \mathrm{ft}$. new sidewalk <br> - Approx. 315 ft . replaced sidewalk <br> - 6 ft width, 10 curb ramps | \$176,474 | 1 | - Adds sidewalk where missing along thoroughfare and transit route |


|  | trian and Shared-U | Infrastructure |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/ Area | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 9 | Bertner <br> East side, OST to 7007 Bertner | New sidewalk | Mid Campus | - Approx. 1,212 ft. new sidewalk <br> - 6 ft . width <br> - 2 curb ramps | \$58,538 | 1 | - Adds sidewalk where missing along major collector and important campus link |
| 10 | Fannin <br> West side, Sunset to Cambridge | New shareduse path | Primary <br> Study Area | - Approx. 1,985 ft. new sidewalk <br> - 10 ft . width <br> - 1 curb ramp | \$154,602 | 1 | - Provides paved, off-street connection between Sunset bicycle route to TMC Main Campus <br> - Replaces cinder path included in current Hermann Park plans |
| 11 | Greenbriar <br> East side, Rice to Bolsover | New sidewalk | Primary <br> Study Area | - Approx. 305 ft. new sidewalk <br> - 6 ft . width <br> - 2 curb ramps | \$17,236 | 1 | - Adds sidewalk where missing align major thoroughfare |
| 12 | Almeda <br> West side, Holcombe to Holly Hall | Replace sidewalk with <br> shared-use path | Mid <br> Campus, <br> Primary <br> Study Area | - 10 ft . width | \$652,756 | 2 | - Replaces sidewalk in fair to poor condition <br> - Connects existing Almeda and Holly Hall shared-use paths <br> - Provides bicycle access where roadway is not suitable |
| 13 | Holcombe <br> North side, Almeda to Grand | Sidewalk replacement | Mid Campus | - Approx. 1,295 ft. sidewalk replaced - 6 ft. width, 2 curb ramps replaced | \$50,405 | 2 | - Replaces sidewalk in poor condition <br> - May require relocation of streetlights at additional cost |
| 14 | Holcombe <br> South side, Ringness <br> to Almeda | Sidewalk spot replacement | Mid Campus | - Approx. 15 ft. <br> sidewalk replaced <br> - 4 ft . existing width | \$3,871 | 2 | - Replaces sidewalk segment in poor condition <br> - Restores accessibility in proximity to transit stops |
| 15 | Holcombe <br> North side, near Main and Fannin | Sidewalk spot replacement | Main Campus | - Two 50 -ft. sections replaced <br> - 6 ft. existing width | \$5,453 | 2 | - Low section prone to pooling water just west of Fannin <br> - Uneven section with excessive cross slope just west of Main <br> - Restores accessibility along major thoroughfare |


| Pedestrian and Shared-Use Infrastructure |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/ Area | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 16 | Greenbriar <br> Both sides, Main to $S$ <br> Braeswood | Sidewalk spot replacement | Primary <br> Study Area | - One missing section (north side) <br> - Two uneven sections (south side) <br> - 100 linear ft., 4 ft . existing width | \$4,898 | 2 | - Restores accessibility along major thoroughfare |
| 17 | S Braeswood North side, Fannin to Phoenix | Sidewalk replacement | Primary <br> Study Area | - Approx. 505 linear ft. replaced <br> - 6 ft. width | \$26,037 | 2 | - Replaces sidewalk in poor condition <br> - Brings sidewalk up to COH MTFP Transit Corridor standards |
| 18 | S Braeswood South side, Fannin to Phoenix | Sidewalk gap closure | Primary <br> Study Area | - Approx. 110 linear ft. added <br> - 4 ft . existing width | \$6,648 | 2 | - Closes gaps in sidewalk along transit corridor |
| 19 | S Braeswood <br> South side, Fannin to Bertner | Sidewalk replacement | Primary <br> Study Area | - Approx. 825 linear ft. replaced <br> - 6 ft . width <br> - 2 curb ramps <br> replaced | \$45,861 | 2 | - Replaces sidewalk in poor condition along major thoroughfare |
| 20 | Cambridge West side, El Paseo to Holly Hall | Sidewalk replacement | South Campus | - Approx. 1,300 linear <br> ft. replaced <br> - 6 ft . width <br> - 2 curb ramps <br> replaced | \$68,805 | 2 | - Replaces sidewalk in poor condition along major collector |
| 21 | Fannin <br> East side, Greenbriar to Knight | Sidewalk replacement | Primary <br> Study Area | - Approx. 1,200 linear <br> ft. replaced <br> - 6 ft . width <br> - 2 curb ramps <br> replaced | \$64,422 | 2 | - Replaces sidewalk in poor condition along major thoroughfare |
| 22 | University <br> South side, Travis to Lanier | Sidewalk replacement | Primary <br> Study Area | - Approx. 650 linear ft. replaced <br> - 6 ft . width <br> - 2 curb ramps replaced | \$36,580 | 2 | - Replaces sidewalk in poor condition along major collector |


| Pedestrian and Shared-Use Infrastructure |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/ Area | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 23 | Rice <br> North side between Cherokee \& Ashby | Sidewalk spot replacement | Primary Study Area | - Approx. 165 linear ft. replaced <br> - 4 ft . existing width <br> - 1 curb ramp replaced | \$7,661 | 2 | - Replaces sidewalk in poor condition along major collector <br> - Tree root encroachment may require alternative treatment to concrete |
| 24 | Brays Bayou North side between Fannin \& Bertner | Shared-use path connection | Primary Study Area | - Approx. 920 linear ft. <br> - 10 ft . width | \$139,992 | 2 | - Allows connections from lower trail to east side of Fannin, west side of Bertner |
| 25 | Brays Bayou <br> North side between Holcombe \& Cambridge | Shared-use path connection | Primary Study Area | - Approx. 700 ft . added <br> - 10 ft . width <br> - Includes bicycle /ped bridge | \$400,000 | 2 | - Allows continuous travel on the lower trail through the TMC |
| 26 | Brays Bayou South side, under Almeda | Shared-use path connection | Primary Study Area | - Approx. 700 linear feet <br> - 10 ft . width | \$105,495 | 2 | - Connects dead-ends of existing trail <br> - Avoids crossing two busy streets along south side trail |
| 27 | Fannin <br> East side, Brays <br> Bayou to TMC <br> Transit Center stair tower | Shared-use path connection | Primary Study Area | - Approx. 640 linear feet <br> - Add 4 ft . for 10 ft . total width | \$19,490 | 3 | - Connects Brays Bayou trail to TMC Transit Center |
| 28 | N Braeswood North side, Brays Bayou to Main | Shared-use path connection | General Study Area | - Approx. 250 linear feet <br> - 10 ft . width | \$22,062 | 3 | - Allows connection from Morningside bicycle route to Brays Bayou trails with only one street crossing |
| 29 | Bates <br> MD Anderson to MacGregor \& Moursund | Shared-use path connection | Main Campus | - Approx. 630 linear feet <br> - Replace sidewalk with 10 ft . path | \$108,784 | 3 | - Connection between parking garages allows traffic-separated connection from Brays Bayou trails to Bates |
| 30 | Wyndale <br> Both sides, Staffordshire to Cambridge | Sidewalk replacement/ addition | Mid Campus | - Approx. 1300 linear feet, 6 ft . width - Street under construction; subject to change | \$68,805 | 3 | - Provides access from residential area to major thoroughfare with bus stops |
| 31 | Swanson <br> Both sides, Fannin to Bertner | Sidewalk addition | Mid Campus | - Approx. 1300 linear feet, 6 ft . width | \$58,538 | 3 | - Provides access from developed area to major thoroughfare with bus stops |


| Pedestrian and Shared-Use Infrastructure |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/ Area | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 32 | Hepburn <br> Both sides, <br> Cambridge to Almeda | Sidewalk replacement/ addition | Primary Study Area | - Approx. 1050 linear feet, 6 ft . width | \$46,508 | 3 | - Provides access from residential area to major thoroughfare with bus stops |
| 33 | Braeswood East side, Wyndale to Pressler | Shared-use path and bridge | Main <br> Campus <br> Mid <br> Campus | - Approx. 1000 ft. incl. 300 ft bridge <br> - 10 ft . width | \$1,000,000 | 3 | - Provides alternative to inadequate sidewalks on Braeswood bridge along major bicycle /ped route |
| 34 | Brays Bayou South side between Cambridge and Bertner | Shared-use path | Mid Campus | - Approx. 3,700 ft. <br> - 10 ft . width | \$475,000 | 3 | - Connects south side trail to Wyndale and bridges at Braeswood and Bertner |
| 35 | Lamar Fleming to Herman Park Drive | Shared-use path | Primary Study Area | - Approx. 600 ft . <br> - 10 ft . width | N/A | 3 | - Connects study area to Houston Zoo and Herman Park |

TABLE 6.4
RECOMMENDED INTERSECTION ACCESSIBILITY IMPROVEMENTS

| Intersection Accessibility Improvements |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/A rea | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 1 | Holcombe at Fannin South side | Curb ramp addition | Main Campus | - Add 2 missing curb ramps between travel lanes of Fannin <br> - Design challenges due to location on bridge structure | \$6,000 | 1 | - Makes south side of Holcombe an accessible route |
| 2 | Fannin at Old Main West side | Curb ramp addition | Main Campus | - Add 2 missing curb ramps | \$3,000 | 1 | - Makes west side of Fannin an accessible route |
| 3 | Holcombe at Main South side | Curb ramp addition | Main Campus | - Add 2 missing curb ramps between travel lanes of Main <br> - Design challenges due to location on bridge structure | \$6,000 | 1 | - Makes south side of Holcombe an accessible route |
| 4 | Cambridge at MacGregor <br> Northwest corner | Curb ramp addition | Primary Study Area | - Add 2 missing curb ramps across right turn-lane | \$3,000 | 1 | - Makes west side of Cambridge an accessible route <br> - Northeast corner included in Infrastructure project 6 |
| 5 | Dryden at Travis West side | Curb ramp addition, stripe crosswalks | Primary Study Area | - Add curb ramps to 2 corners where missing | \$3,000 | 1 | - Makes Dryden an accessible route <br> - Two blocks from rail station, one block from bus stops |
| 6 | Dryden at Lanier Four corners | Curb ramp addition, stripe crosswalks | Primary Study Area | - Add curb ramps to 4 corners where missing | \$6,000 | 1 | - Makes Dryden an accessible route <br> - Three blocks from rail station, two blocks from bus stops |
| 7 | Greenbriar at Sunset Four corners | Curb ramp modifications | Primary Study Area | - Modify curb ramps for safety | \$6,000 | 1 | - Fixes ramps that could force users into traffic |


| Intersection Accessibility Improvements |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/A rea | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 8 | Holcombe at Ringness West Side | New curb ramps, crosswalk | Primary Study Area | - Add 4 curb ramps to allow crossing of west side of intersection <br> - Stripe crosswalk | \$3,000 | 1 | - Allows use of wide median as safe refuse so mobility-impaired users may cross in two phases |
| 9 | Fannin at Knight | Additional study required | South Campus | - Redesign of intersection, potentially in the form of a roundabout | not available | 1 | - Seven tenths of a mile between safe crossing locations of Fannin |
| 10 | Fannin at Greenbriar | Additional study required | Primary Study Area | - Redesign of intersection, potentially in the form of a roundabout | not available | 1 | - Seven tenths of a mile between safe crossing locations of Fannin <br> - Located along Transit Corridor |

TABLE 6.5
RECOMMENDED ON-STREET BICYCLE FACILITY IMPROVEMENTS

| On-Street Bicycle Facilities |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/A rea | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 1 | East-BertnerMoursund Cambridge to MacGregor | Bicycle lane | Mid <br> Campus <br> Main <br> Campus | - 1.8 mile route <br> - Signs and pavement markings, Cycle track, Grade separation at Holcombe/Bates | \$3,500,000 | 1 | - Provides direct bicycle connection from residential areas and Mid Campus to Main Campus |
| 2 | Knight-WestBertner Holly Hall to East | Shared lane | Mid Campus Primary Study Area | - 0.8 mile route <br> - Signs and pavement markings | \$12,857 | 1 | - Connects UT housing, residential areas to Bertner route to Main Campus |


| On-Street Bicycle Facilities |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | Campus/A rea | Project Detail | Cost Estimate | Priority | Goals/Benefits |
| 3 | Kent-Alumni-path- <br> Freeman-Bertner <br> Sunset to Moursund | Signed bicycle route | Primary <br> Study Area <br> Rice <br> University <br> Campus <br> Main <br> Campus | - 1.1 mile route <br> - Signs | \$5,046 | 1 | - Connects Sunset bicycle route, Rice to Main Campus |
| 4 | McClendon-Travis Morningside to Dryden | Signed bicycle route | Primary Study Area | - 0.8 mile route <br> - Signs and traffic control modifications | \$3,924 | 1 | - Connects Morningside bicycle lanes to Main Campus |
| 5 | Stockton University to McClendon | Signed bicycle route | Primary Study Area Rice University Campus | - 0.4 mile route <br> - Signs | \$1,682 | 2 | - Connects Rice Campus to proposed McClendon bicycle route |
| 6 | N Stadium - S Braeswood Reliant Park to bayou | Signed bicycle route | Primary Study Area | - 0.9 mile route <br> - Signs and intersection modifications | \$3,364 | 2 | - Connects Brays Bayou trails to Reliant Park |
| 7 | Pressler Holcombe to Braeswood | Bicycle lane | Main Campus | - 0.4 mile route <br> - Signs and pavement markings, cycle track | \$450,000 | 2 | - Connects proposed bridge to skywalk and transit center <br> - Includes connection to Montclair |
| 8 | Dryden/Driveway Main to Bertner | Bicycle lane | Main Campus | - 0.3 mile route <br> - Signs and pavement markings | \$50,000 | 2 | - Connects signed bicycle route along Dryden west of the study area to the Metro Red Line as well as the proposed bicycle lane along Bertner |

TABLE 6.6
RECOMMENDED NEW SKYWALK IMPROVEMENTS

|  | alks |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# | Project | Project Type | $\begin{gathered} \text { Campus/A } \\ \text { rea } \end{gathered}$ | Project Detail | Cost Estimate* | Priority | Goals/Benefits |
| 1 | Braeswood Garage To MD Anderson Safety | New Skywalk | Main Campus | - Connect garage to MD Anderson Skywalk network at Rotary House <br> - Approx. 520 linear ft. <br> - Open air or climate controlled | \$3,000,000* | 1 | - Discourages mid-block crossings of Braeswood |
| 2 | TMC Transit Center To MD Anderson Connectivity | New Skywalk | Main Campus | - Connect transit center to MD Anderson network at Duncan Building <br> - Approx. 300 linear ft. <br> - Covered, open air | \$2,000,000* | 1 | - Connects transit center into heart of TMC via existing climate-controlled walkways |
|  |  |  |  |  | * Order of magnitude only. Additional study required. |  |  |

### 6.5 Transit Bus and Rail Corridor Improvements

### 6.5.1 METRO Bus

Based on the METRO bus route evaluation conducted, the following METRO local bus service modifications in the TMC area are recommended (see Table 6.7).

Re-align route 34 and improve headways as noted in Section 4.4.1.

- Re-route peak-direction route 292 service via Bellaire - Holcombe between US 59 and the Medical Center, reversing its direction of travel north of the TMC TC. seven buses
- Extend route 402 into the TMC main campus or to the VA Medical Center; consider combining routes 402 and 426.
- Retain the $26 / 27$ routing as it is; modify route 426 to include service to the VA Medical Center. Budget permitting, add midday service on route 426. Consider combining route 426 peak-period service with route 402.
Pending the approval of the final METRO Re-Imagined Plan, further local bus and premium bus improvement in the TMC study area would be implemented over time, as indicated in Section 4.4.1.


### 6.5.2 Ft. Bend Transit Commuter Route

Improved service frequency during off-peak periods for the existing Ft. Bend Transit TMC commuter route is recommended, beyond the one noon time trip currently provided. This would provide more trip opportunities for TMC employees living in Ft. Bend County given varying shift schedules at the TMC. Added stops could be provided particularly in the South Campus area with added TMC development.

### 6.5.3 Private Shuttles

The current TMC and MD Anderson private shuttle system is proposed to be maintained and expanded associated with added remote parking facilities being developed in the South Campus area. The shuttles would continue to provide door-to-door service, with enhanced frequency and hours of operation pending available funds, as well as increased use of mobile applications for passenger information.

### 6.5.4 Light Rail Transit

Based on the evaluation of the different LRT relocation and people mover alternatives, and roadway analysis undertaken from Fannin Street, no major improvements to LRT operations or realignment is proposed because of the high cost of any of the alternatives considered. LRT operations would be improved with some reduction in vehicular conflicts with the following lower cost roadway improvements along Fannin:

- Develop a one-way couplet for University Boulevard (westbound) and Dryden Road (eastbound) between Fannin and Main Streets. This option would require further analysis and assessment of traffic circulation and access impacts.
- Remove traffic signals on Fannin at John Freeman Drive and Bellows Street
- Improved signal timing optimization
- Develop Transit/Pedestrian Mall on Fannin. This option would require a detailed assessment.
It is also recommended that enhanced shuttle bus service as identified in Section 6.4.2 be implemented. Investment in a people mover within the TMC needs to be further evaluated based on refined new development plans.

TABLE 6.7
RECOMMENDED METRO BUS SERVICE MPROVEMENTS

| Serial Number | Conceptual Improvement | Limits | Scope of Work | Timeline Short/Mid/Long | Potential Funding Application |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | Re-align route 34 and improve headways |  | Re-routing to avoid the diversion of the route to Heights Boulevard and Waugh Drive, instead using Studemont Street, and Montrose Boulevard. <br> Peak-period headways to be reduced from 25-30 minutes to 20 minutes. | Short-term | METRO |
| 2 | Re-route peakdirection route 292 service | US 59 to Medical Center | Route 292 AM Peak trips be re-routed from US 59 to Bellaire Boulevard Holcombe Boulevard Transit Center, and then follow the present afternoonpeak routing through TMC. <br> During PM Peak, revenue service would begin at Main Street and Bissonnet Street, follow the present AM Peak routing to the TMC, and then continue via Holcombe-Bellaire to US 59. | Short-term | METRO |
| 3 | Extend route 402 into the TMC main campus or to VA Medical Center | TMC TC terminus to TMC main campus or to VA Medical Center | The effectiveness of this route might be strengthened by extending service beyond its present TMC TC terminus, either farther into the Medical Center main campus or to the VA Medical Center. | Short-term | METRO |
| 4 | Retain the 26/27 route as it is; modify route 426 to include service to VA Medical Center |  | Modification of route 426 to include service to the VA Medical CenterS increasing passenger market. | Short-term | METRO |


| Serial <br> Number | Conceptual <br> Improvement | Limits | Scope of Work | Timeline <br> Short/Mid/Long | Potential <br> Funding <br> Application |
| :---: | :--- | :--- | :--- | :--- | :--- |
| 5 | Campus <br> shuttles for <br> connections to <br> new remote <br> parking <br> /Transportation <br> facility | N/A | New remote parking: privately <br> operated, shared management, Short-term <br> METRO | TMC |  |
| 6 | Commuter Rail <br> Corridors - US <br> $90 A$ | Needs a separate study | Long-term | METRO |  |

### 6.6 Travel Demand Management Improvements

The current TDM program in place at the TMC focuses on subsidies for bus passes and vanpools, the private shuttles operated by TMC and MD Anderson, and the ride match program which involves input from H-GAC. A broader set of TDM strategies are recommended, as indicated in Table 6.8.

Strategies are divided into three major categories: 1) Financial Incentives 2) Provision of Transportation Services and 3) Employer or Institutional Support Actions. Financial incentives would focus on added subsidies for vanpool drivers and even pedestrians, as well as free bike tune-ups and carpool parking spaces. Provision of enhanced transportation services would focus on introduction of a guaranteed ridehome for employees for unexpected events, provision for Flexcar within the TMC campus, and increased application of private shuttle service as discussed in Section 4. Employer or institutional (TMC) sponsored actions could include increased and improved bicycle and motorcycle parking, enhanced information on transit and rideshare opportunities (through the TMC and institutional websites), and added incentives for staggered work hours and telecommuting. Increased partnership between TMC and member institutions with H-GAC and its regional TDM program is also recommended with respect to enhancements in vanpool and carpool matching and dissemination of TDM information.

TABLE 6.8
RECOMMENDED ENHANCED TDM STRATEGIES FOR TMC

| TDM Strategy | Existing TMC Provisions | Potential Enhanced TDM Strategies |
| :---: | :---: | :---: |
| Financial Incentives | -Employees using METRO bus or vanpool receive pre-tax incentives -Subsidies for bus passes | Bicyclist receive an annual free on-site bicycle tune-up |
|  |  | Carpoolers receive free parking and/or preferred spaces |
|  |  | Commute bonuses for using alternate modes and increase rates for SOV parking |
|  |  | Additional Incentives for vanpool drivers, bookkeepers, and back-up drivers |
|  |  | Pedestrian subsidies |
| Provision of Transportation Services | Internal campus shuttle service provided by TMC and MD Anderson | Expanded inner campus free shuttle for patients and employees |
|  |  | Guaranteed-Ride-Home to all alternative commuters to ensure that they can get home in case of unexpected events |
|  |  | On-site flexcar: Low emission, fuel efficient vehicles available for an hourly rate that includes gas, insurance, and maintenance |
| Employer or Institutional Support Actions | -Ride Match Program to connect employees and help finding alternative commuting options <br> -Transportation fairs <br> -Flexible work hour programs | Sheltered and secure bicycle parking and free bike safety checkup |
|  |  | Enhanced transit and rideshare written and on-line information |
|  |  | Lockers and showers provided for bicycle riders |
|  |  | Bike repair station available |
|  |  | Offer umbrellas to pedestrians on an annual basis |
|  |  | Covered motorcycle parking and subsidies |
|  |  | Increased application of staggered work hours and telecommuting |

## APPENDIX - A: CONCEPT DEVELOPMENT OPTIONS

This appendix includes additional options that were analyzed for some study arterials.

## Almeda - Additional Options

| EXISTING CONDITIONS |  | FUTURE OPTION 1 |  | FUTURE OPTION 2 |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Transportation Terminal |  | Widening to 6 Lanes |  |  |
| Existing Lanes | 4 | Future Lanes | 6 | Future Lanes | 6 |
| Existing Counts <br> Range | 21200 | Future Volume Range | 33800 | Future Volume Range | 33800 |
| Right-of-way | $150 '-160 '$ | Proposed MMC | Transit Boulevard | Proposed MMC | Urban Boulevard |
| Median/CTL/Undivide <br> $d$ | Median | Median/CTL/Undivide <br> d | Median | Median/CTL/Undivide <br> $d$ | Median |
| MTFP Designation | P-6-150 | MTFP Designation | P-6-150 | MTFP Designation | P-6-150 |

Holcombe - Additional Options

| EXISTING CONDITIONS |  | FUTURE OPTION 1 <br> Transportation Terminal |  | FUTURE OPTION 2 <br> ade Separated Intersection |  | FUTURE OPTION 3 <br> Elevated Expressway |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |
| Existing Lanes | 6 | Future Lanes | 6 | Future Lanes | 6 | Future Lanes | 6 (Ground)+4 (Elevated) |
| Existing Counts Range | $\begin{gathered} 31300- \\ 38000 \end{gathered}$ | Future Volume Range | $\begin{gathered} 43400- \\ 53300 \end{gathered}$ | Future Volume Range | $\begin{gathered} 43400- \\ 53300 \end{gathered}$ | Future Volume Range | $\begin{gathered} 43400- \\ 53300 \end{gathered}$ |
| Right-of-way | 115' | Proposed MMC | Transit Boulevard | Proposed MMC | Transit Boulevard | Proposed MMC | Urban Boulevard |
| Median/CTL/Undivided | Median | Median/CTL/Undivided | Median | Median/CTL/Undivided | Median | Median/CTL/Undivided | Median |
| MTFP Designation | P-6-115 | MTFP Designation | P-6-120 | MTFP Designation | P-6-130 | MTFP Designation | P-6-120 |



Old Spanish Trail - Additional Options

| EXISTING CONDITIONS |  | FUTURE CONDITION 1 |  | FUTURE CONDITION 2 |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Grade Separated Intersection |  | Elevated Expressway |  |  |
| Existing Lanes | 6 | Future Lanes | 6 | Future Lanes | (Ground) + 4 <br> (Elevated) |
| Existing Counts <br> Range | 28400 | Future Volume Range | 55400 | Future Volume Range | 55400 |
| Right-of-way | 100 | Proposed MMC | Urban Boulevard | Proposed MMC | Urban Boulevard |
| Median/CTL/Undivide <br> d | Median | Median/CTL/Undivide <br> $d$ | Median | Median/CTL/Undivide <br> d | Median |
| MTFP Designation | P-6-100 | MTFP Designation | P-6-130 | MTFP Designation | P-6-110 |

## APPENDIX - B: PUBLIC COMMENT SUMMARY

This appendix includes the comments and ideas received from stakeholder groups, general public at public meetings and throughout the study process. A separate project email address and a comment form on the project website were maintained to receive public input. This section includes a summary of all the comments received.

## APPENDIX - C: SYNCHRO TRAFFIC ANALYSIS RESULTS SUMMARY

