

# Mobility Investment Priorities Project

## Long-Term Central Texas IH 35 Improvement Scenarios

August 2013





# **Establishing Mobility Investment Priorities**

**Under TxDOT Rider 42:**

**Long-Term Central Texas  
IH 35 Improvement Scenarios**

**Prepared for  
Texas Transportation Commission  
And  
83<sup>rd</sup> Texas Legislature**

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**Mobility Investment Priorities Project  
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## TABLE OF CONTENTS

<b>Executive Summary</b>	<b>1</b>
<b>Introduction</b>	<b>11</b>
On-Going IH 35 Improvement Initiatives	11
Need for Long-Term IH 35 Analysis	11
Study Approach	11
MIP Working Group and Technical Subcommittee Involvement	12
Organization of Report	12
<b>Scenario Analysis</b>	<b>13</b>
Scenarios: Origin and Summary List	13
Technical Task Approach: Multi-Resolution Modeling	15
General Technical Assumptions Applicable to All Scenarios	18
Scenario 0: Base Case	21
Scenario 1: HOV Lanes	27
Scenario 2: Express Lanes	30
Scenario 3: System-Wide Dynamic Pricing	34
Scenario 4: My35 Conversion Plus	39
Scenario 5: My35 Swap	43
Scenario 6: Capacity Addition through Core	46
Scenario 7: Downtown Austin Alternative	50
Summary of Comparative Findings	55
<b>Key Findings</b>	<b>59</b>
Key Finding: The Problem is Huge	59
Key Finding: The Problem is Central Texas Travelers	60
Key Finding: A Managed Lane Provides an Option to Severe Congestion— But with Only One Lane, It Is a Limited Option	60
Key Finding: Long-Term Solution Must Include More than Added Capacity	60
What Does This Mean?	61
<b>What Would It Take?</b>	<b>63</b>
Why Is IH 35 Future Congestion So Extreme?	63
Hybrid Strategy Definition	64
Scenario 2c: “What Would It Take?”	65
What Hybrid Scenario Findings Mean for IH 35	69

<b>Supplemental Analyses</b>	<b>71</b>
Introduction	71
Through Traffic and Through Truck Routing	71
Scenario 2b: Express Lanes with No Free HOV	76
Scenario 6 Expanded: Capacity Addition through Core	80
Scenario 2d: Technology Strategy	85
Summary of Supplemental Analyses	90
<b>Next Steps</b>	<b>93</b>
What Next?	93
Technical Findings & Challenges	95
Concluding Comments	96



## LIST OF EXHIBITS

Exhibit ES-1 Study Level Context.....	1
Exhibit ES-2 Initial Scenarios Examined .....	3
Exhibit ES-3 “Heat” Diagram Summary of Base Case Congestion (2035) .....	5
Exhibit ES-4 Heat Diagram Summary “What Would It Take?” .....	8
Exhibit 1 Where Are We with This Study? Pre-Conceptual Level .....	12
Exhibit 2 Scenarios Examined .....	14
Exhibit 3 Capacity Concept in Traditional Regional Model Assignment .....	15
Exhibit 4 Operational Capacity under DTA .....	16
Exhibit 5 Queuing Concept – Vehicles Back-up on Other Streets.....	16
Exhibit 6 Congestion-Responsive Tolling: Light Congestion Toll Example .....	17
Exhibit 7 Congestion-Responsive Tolling: Moderate Congestion Toll Example.....	18
Exhibit 8 Scenario 0 Tolling Assumptions .....	21
Exhibit 9 2035 CAMPO Metropolitan Transportation Plan, Regional Roadway System .....	22
Exhibit 10 2035 CAMPO Metropolitan Transportation Plan, Regional Public Transportation System .....	23
Exhibit 11 Scenario 0 Performance Measures: Base Case .....	24
Exhibit 12 Scenario 0 Heat Diagrams .....	26
Exhibit 13 Scenario 1 Tolling Assumptions .....	27
Exhibit 14 Scenario 1 Performance Measures .....	28
Exhibit 15 Scenario 1 Heat Diagram Comparison .....	29
Exhibit 16 Scenario 2 Tolling Assumptions .....	30
Exhibit 17 Scenario 2 Performance Measures .....	31
Exhibit 18 Scenario 2 Heat Diagram Comparison .....	33
Exhibit 19 Scenario 3 Tolling Assumptions .....	34
Exhibit 20 Scenario 3 Performance Measures .....	35
Exhibit 21 Scenario 3 Heat Diagram Comparison .....	38
Exhibit 22 Scenario 4 Tolling Assumptions .....	39
Exhibit 23 Scenario 4 Performance Measures .....	40
Exhibit 24 Scenario 4 Heat Diagram Comparison .....	41
Exhibit 25 Scenario 5 Tolling Assumptions .....	43
Exhibit 26 Scenario 5 Performance Measures .....	44
Exhibit 27 Scenario 5 Heat Diagram Comparison .....	45
Exhibit 28 Scenario 6 Tolling Assumptions .....	46
Exhibit 29 Scenario 6 Performance Measures .....	47
Exhibit 30 Scenario 6 Heat Diagram Comparison .....	48
Exhibit 31 Scenario 7 Tolling Assumptions .....	50
Exhibit 32 Scenario 7 Performance Measures .....	52
Exhibit 33 Scenario 7 Heat Diagram Comparison .....	53
Exhibit 34 Person-Hours Traveled, Scenarios 0-7 .....	55
Exhibit 35 Person-Hours Traveled, Scenarios 0-7, Internal Trips Only .....	56

Exhibit 36 Person-Hours Traveled, Scenarios 0-7, External Trips Only.....	56
Exhibit 37 IH 35 Travel Time (min), Scenarios 0 through 7.....	57
Exhibit 38 IH 35 Travel Time (min), Scenarios 0 to 7: Morning Inbound in 2035 .....	58
Exhibit 39 IH 35 Travel Time (min), Scenarios 0 to 7: Evening Outbound in 2035 .....	58
Exhibit 40 Scenario 0 Base Case Heat Diagram.....	59
Exhibit 41 Total Hourly Auto-vehicle Trips for CAMPO Region (2015, 2035) .....	63
Exhibit 42 Scenario 2c Tolling Assumptions.....	65
Exhibit 43 Total Hourly Auto-Vehicle Trips for CAMPO Region, Scenario 2c: “What Would It Take?” .....	66
Exhibit 44 Scenario 2c Performance Measures .....	67
Exhibit 45 Scenario 2c Heat Diagram Comparison to Scenario 0 .....	68
Exhibit 46 Scenario 2c Heat Diagram Comparison to Scenario 2 .....	69
Exhibit 47 Definitions of Local and Through Trips for Traditional Travel Survey and Travel Model .....	72
Exhibit 48 Comparison of Truck Flows between Base Case and Scenario 5 .....	73
Exhibit 49 Through Truck Flows Using SH 130 by Scenario .....	74
Exhibit 50 Through Truck Flows Using SH 130 - Comparison to Scenario 0 .....	74
Exhibit 51 Scenario 2b Tolling Assumptions .....	76
Exhibit 52 Scenario 2b Performance Measures.....	78
Exhibit 53 Scenario 2b Heat Diagram Comparison .....	79
Exhibit 54 Scenario 6 Expanded Tolling Assumptions.....	80
Exhibit 55 Scenario 6 Expanded Performance Measures .....	82
Exhibit 56 Scenario 6 Expanded Heat Diagram Comparison to Scenario 0 .....	83
Exhibit 57 Scenario 6 Expanded Heat Diagram Comparison to Scenario 6 Original.....	84
Exhibit 58 Scenario 2d Tolling Assumptions .....	85
Exhibit 59 Technology Strategy: Daily Average Travel Time for Smartrek Users .....	87
Exhibit 60 Technology Strategy: Daily Average Travel Time for Non-Smartrek Users .....	87
Exhibit 61 Technology Strategy: Total Daily Travel Time Savings for All Drivers.....	87
Exhibit 62 Scenario 2d Heat Diagram Comparison to Scenario 0 .....	88
Exhibit 63 Scenario 2d Heat Diagram Comparison to Scenario 2 .....	89
Exhibit 64 Daily Region-Wide Person-hours of Travel, Supplemental Analyses (2035) .....	90
Exhibit 65 Daily Region-Wide Person-hours of Travel, Tabular, Supplemental Analyses (2035) .....	91



## EXECUTIVE SUMMARY

This summary presents an overview of the purpose, findings, and recommendations resulting from a computer modeling effort to examine potential long-term solutions for IH 35 through Central Texas.

### Context

The City of Austin is among the fastest-growing cities in the U.S., with surrounding counties keeping a similar pace. Travel times from downtown Austin to Round Rock, where many commuters live, range from 45 to 60 minutes during the average afternoon rush hour. And yet, there is no agreement on what should be done to solve the travel time problem. The long-range transportation plan for the Austin Metropolitan Area, the 2035 CAMPO Metropolitan Transportation Plan (2035 CAMPO), shows no large-scale construction improvement strategies for IH 35 through Central Texas. On-going IH 35 initiatives by the Texas Department of Transportation (TxDOT) and the City of Austin are focused upon short- and mid-term improvement strategies that address existing and near-term congestion with potential high-return strategies (<http://www.mobility35.org/>). At the same time, decision-makers have expressed a need for examination of long-term solutions for IH 35, considering, for example, concepts which had been discussed under previous studies but not fully explored.

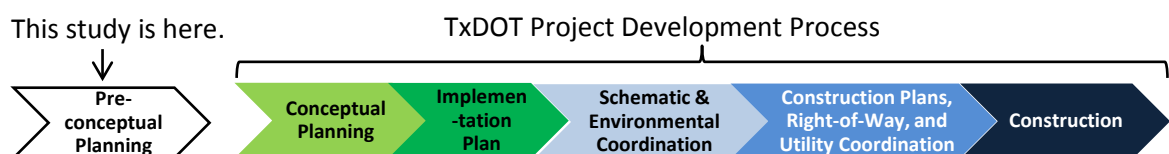


*IH 35 looking northbound, 2012*

The Mobility Investment Priorities project offers an opportunity to perform this initial examination. As referenced in the [Mobility Investment Priorities \(MIP\) First Year Report](#), the most congested metropolitan highways in Texas are becoming even more crowded, resulting in lost time and wasted fuel topping \$10 billion per year. Not only is congestion high, but traffic problems are also increasing faster in Texas than in similar U.S. areas: the areas of Houston, Dallas-Fort Worth, San Antonio, and Austin rank in the 15 fastest-growing congested urban areas in the country. Congested corridors cause problems for the movement of goods and services to areas throughout Texas. This study applies advanced traffic modeling techniques to assess long-term congestion reduction strategies for IH 35 through Central Texas.

The MIP modeling analysis is conducted at what is called a pre-conceptual level (Exhibit ES-1).

#### Exhibit ES-1 Study Level Context



This modeling effort provides an opportunity for Central Texas stakeholders to explore roadway design scenarios unbounded by the consideration of today's financial constraints or federal restrictions on conversion of existing travel lanes to toll lanes. This exercise enables stakeholders to determine if any of the scenarios have benefits that are substantial enough to warrant the additional effort and investment necessary to further pursue a large-scale commitment for the complex IH 35 corridor, or even to seek an exception to the federal restrictions mentioned above. In short, this effort is a first step in addressing the question:

### ***What is the long-term solution for IH 35 congestion through the Austin Metropolitan Area?***

This study provides a framework for preliminary screening of long-term, large-scale options. The modeling analysis is intended to complement and support existing planning and development efforts underway in the region, and is **not a replacement for current local efforts**.

### **Common Perceptions about IH 35 through Central Texas**

The study team uncovered findings directly pertinent to beliefs common to many residents in Central Texas:

- Through traffic causes most of the congestion problems along IH 35 in Central Texas.
- Truck traffic along IH 35 is a major problem that can be addressed by diverting trucks to SH 130, a parallel route east of IH 35.
- Central Texas can build enough road and transit system capacity to eliminate IH 35 congestion.

Researching these perceptions was not a specific task of the research effort, although the analysis does provide insight into these common assumptions and offers insight into the underlying causes of the mobility challenges awaiting future Central Texans.

### **Study Approach**

As a pre-conceptual analysis, this study was oriented toward two broad tasks:

- 1) **Scenario Analysis:** examination of a base case and seven improvement scenarios.
- 2) **Supplemental Analysis:** addressing questions which arose as part of the initial scenario analysis.

Exhibit ES-2 summarizes the initial scenarios considered.

### Exhibit ES-2 Initial Scenarios Examined

Scenario <b>0</b>	<b>Base Case</b>	The 2035 CAMPO plan—adopted roads and transit network. Scenario 0 includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South, which is consistent with the current CAMPO-adopted plan.
Scenario <b>1</b>	<b>HOV Lanes</b>	One express lane added to IH 35 in each direction, HOV 3+ and bus transit access only, configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South.
Scenario <b>2</b>	<b>Express Lanes</b>	Same as Scenario 1, but also allow HOV2 and SOV vehicles paying an auto toll rate and truck vehicles paying a truck toll rate. Congestion on these lanes is “managed” by allowing the toll rate to vary dynamically throughout the day in order to maintain vehicle flow.
Scenario <b>3</b>	<b>System-Wide Dynamic Pricing</b>	Same as Scenario 2, but allow toll rates to vary dynamically for IH 35 and other north-to-south tolled facilities in the CAMPO 2035—adopted plan system, specifically SH 130, SH 45 Southeast, US 183 South tolled mainlanes, and tolled express lanes along Loop 1 (MoPac).
Scenario <b>4</b>	<b>My35 Conversion Plus</b>	Based on a concept derived by local stakeholders as part of the My35 statewide study. Includes one express lane added to IH 35 in each direction (configuration and access according to the current City of Austin study between 51st Street and William Cannon) plus conversion of one existing IH 35 general purpose lane between SH 45 North and SH 45 South to an express lane.* The express lanes are tolled dynamically; HOV3+ and bus transit ride for free. Remove tolls from SH 130/SH 45 Southeast completely and move the Interstate designation to SH 130/SH 45 Southeast.
Scenario <b>5</b>	<b>My35 Swap</b>	Explores a concept derived by local stakeholders as part of the My35 statewide study. No added capacity. Toll all existing IH 35 mainlanes dynamically during morning and afternoon peak periods (6-9 am and 4-7 pm);* HOV3+ and bus transit ride for free. Remove tolls from SH 130/SH 45 Southeast completely and move the Interstate designation to SH 130/SH 45 Southeast.
Scenario <b>6</b>	<b>Capacity Addition through Core</b>	Explores a concept frequently discussed as an ultimate need to address future congestion. Concept was examined as three additional express lanes in each direction, depressed or tunneled, and dynamically tolled; HOV3+ and bus transit ride for free.
Scenario <b>7</b>	<b>Downtown Austin Alternative</b>	Same as Scenario 2, but with downtown Austin configuration providing alternative cross-street access and separation of through traffic and downtown traffic.

SOV = Single-Occupancy Vehicle; HOV2 = High-Occupancy Vehicle, 2 persons; HOV3+ = High-Occupancy Vehicle, 3 or more persons

\* Note that federal law currently prohibits the conversion of existing general purpose lanes on an Interstate facility to tolled lanes. This study explores such a scenario only to see if any benefits merit exploring an exception.

Scenario 0 is the base case against which the remaining scenarios were compared. This base case is the 2035 CAMPO–adopted road and transit network, which includes no additional capacity along IH 35 between SH 45 North and SH 45 South. Scenarios 1, 2, and 3 build upon Scenario 0 and each other in sequence, exploring different operational approaches to adding one express lane in each direction. Scenarios 4, 5, and 6 explore concepts discussed in previous stakeholder involvement activities. Scenario 7 is based upon Scenario 2, but with an alternative downtown Austin configuration based upon recent local input.

A key assumption for the initial scenario analysis is that transit vehicles and passenger cars with three or more occupants (HOV3+) may use any express lane on IH 35 without paying a toll, but two-person vehicles (HOV2), single-occupancy vehicles (SOV), and trucks pay a toll. Variations on this assumption were explored under a follow-up examination.

An additional important assumption concerns the transit system. The research team determined that the transit system as coded in the 2035 CAMPO model network represents an aggressive representation of current transit plans for Central Texas, but is still within realistic bounds of what is being planned. Therefore, according to this model representation, Central Texas users in 2035 will have many more transit opportunities than they do currently, and therefore the transit mode is well represented in the model being used for this exercise.

The research team applied the CAMPO regional travel model together with DynusT, a traffic analysis software offering several advantages relevant for this study, including the capability to:

- Perform dynamic traffic assignment (DTA) that models a more detailed level of roadway operations than a typical regional travel model, including traffic back-up as a result of extreme congestion.
- Examine the entire CAMPO regional study area (Travis, Bastrop, Caldwell, Hays, and Williamson County), instead of merely the IH 35 corridor. This showed the diversion of traffic to other roadways or attraction of traffic from other roadways in response to IH 35 improvements.
- Model driver behavior and choices in congested conditions closer to reality than typical regional travel models do.
- Model driver choices made with regard to dynamic tolling in response to congestion to maximize system efficiency.

At the same time that DynusT offers the above advantages, the application of a DTA software in a regional context and at this stage of pre-conceptual study is a research application of this approach. That is, while this and other studies are showing DTA as a very useful tool, the technology has been only recently developed, and further research in coming years will standardize DTA practice. In that context, caveats apply, as documented in this report.

## **Key Findings**

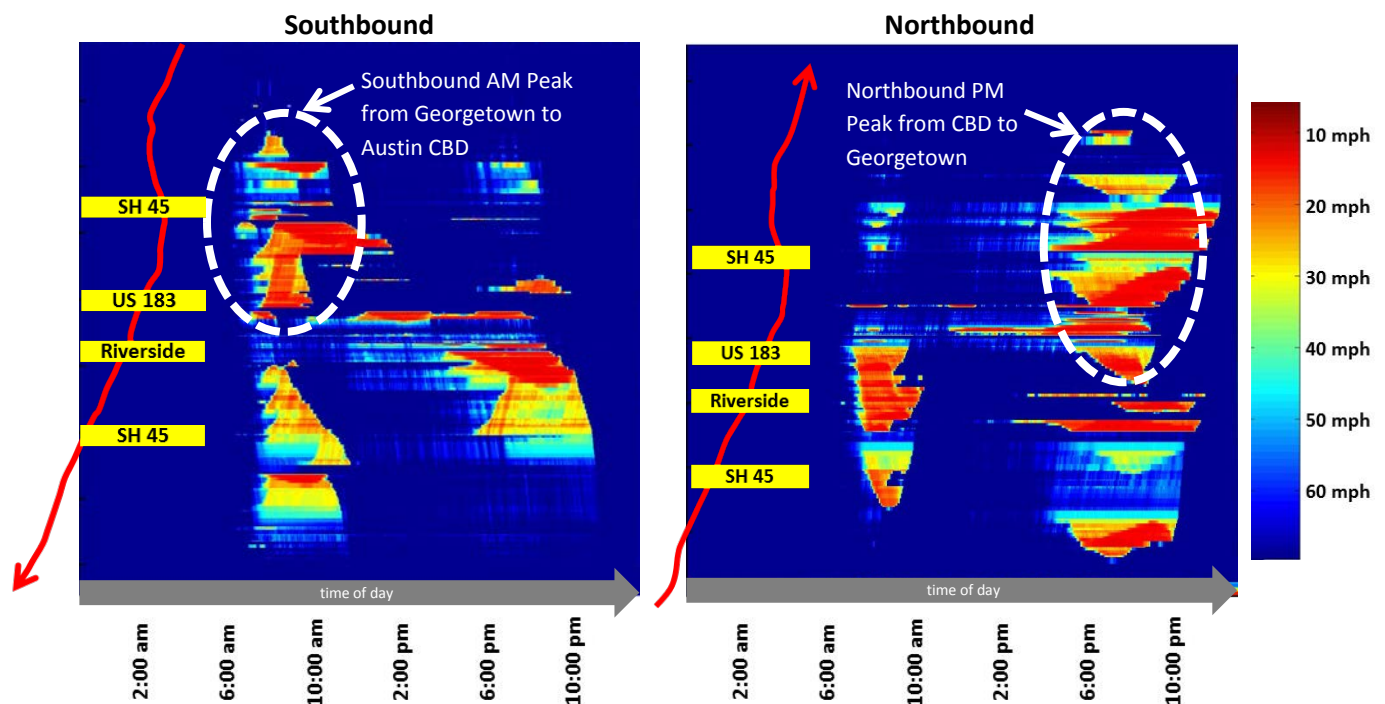
This study applied dynamic traffic assignment and dynamic tolling analysis to examine various long-term scenarios with potential to address growing congestion on the critical IH 35 corridor through

Central Texas. The findings were illuminating: if residential and employment growth each continue on their current pace through 2035, Central Texas faces a grim future of extreme traffic congestion on IH 35.

### Key Finding: The Problem is Huge

The most dramatic finding is that IH 35 congestion will be severe even if a substantial amount of roadway capacity (typically as lanes) is added. This finding is best illustrated using a “heat” diagram such as depicted for the current CAMPO-adopted plan in Exhibit ES-3. The scale provided to the right of the diagram shows colors that represent freeway speeds: dark blue is speeds 60 mph and above, with yellow, orange, and red representing worsening conditions, down to 10 mph and below. The left side represents southbound IH 35 travel speeds in the general purpose lanes, from the northern Williamson County line to the southern Hays County line. The diagram on the right represents the same for northbound traffic. The entire day is shown in each, as indicated by the time of day shown along the bottom—moving from midnight on the left to noon in the middle and 11:59 pm on the right.

**Exhibit ES-3 “Heat” Diagram Summary of Base Case Congestion (2035)**



Unfortunately, due to the number of trips anticipated for the region and IH 35 in the year 2035, the heat diagrams for the seven improvement scenarios showed only minor changes from this base case (no IH 35 construction improvements) scenario. Other performance measures, including point-to-point travel times for typical commuters, also showed very little change among the initial scenarios examined. Basically, traffic “swamps” the IH 35 corridor and the Austin region in 2035. In addition, peak-period congestion is so severe that it extends into off-peak periods, for example as late as 10 pm as shown in Exhibit ES-3.



**Key Finding: The Problem is Central Texas Travelers**

The research team identified an apparent contradiction between a common perception voiced in Central Texas regarding the cause of IH 35 congestion and reality: that is, Central Texans have a much greater impact than through travelers. The magnitude of commuter and other local traffic using IH 35 is substantial and increasing due to local projected population and employment growth. Based on the best available data, local traffic represents approximately 86% of traffic on IH 35 through Austin. Thus, through traffic (the traffic that many think should be bypassing Austin) is not the primary cause of Central Texas IH 35 congestion problems. Commuters or other trips with an origin or destination in the Austin area are the major factor influencing IH 35 congestion, not through travelers.

Attempts to re-route truck traffic from IH 35 to SH 130 will have limited impact on IH 35 congestion for two reasons. First, much of the truck traffic has an origin or destination or both near the corridor, making IH 35 a desirable or necessary route. Second, the analysis indicates that truck trips that are traveling through the Austin metropolitan area without stopping generally find the path afforded by IH 35 to be most efficient to allow them to meet their delivery schedule. The effect of congestion on business planning and development (for example, the need for additional manufacturing plants, distribution centers, trucks or staffing to serve customers and suppliers) was not part of this study.

**Key Finding: The Long-Term Solution Likely Cannot Be Capacity-Addition Alone**

This modeling research demonstrates that Central Texas cannot simply “build its way out of congestion” on IH 35. Of the build-alone options tested, the only one found to have a substantial congestion-reducing effect was Scenario 6, which assumes the addition of six tolled express lanes (three each direction) between SH 45 North and SH 45 South and eight intermediate access points. Although no cost estimate was developed, Scenario 6 will be costly to build and likely to have community and environmental concerns.

Nonetheless, the over-arching and positive message of this examination is that Central Texas does have options to address IH 35 congestion—using a combined “everything including the kitchen sink” approach. Any substantial improvement must come from adding capacity together with operating the system efficiently, new development patterns, and travel behavior changes. Examination of the initial set of scenarios demonstrates that, as capacity is added to IH 35, Central Texas drivers move from other severely congested streets and roads to IH 35, in essence “re-filling” the highway. Therefore, additional capacity provides little relief to peak-hour IH 35 general purpose lane congestion. And, because population and jobs are projected to grow so much in the corridor, any open road space created by new lanes is quickly filled by new trips. As the regional performance measures demonstrate, adding capacity to IH 35 improves system-wide measures because these additional trips are better served on IH 35. Additional capacity for buses, carpoolers, or toll-payers provides users a mobility option that is not present under the base scenario. However, the travel experience along IH 35 general purpose lanes does not substantially improve as a result of any of the scenarios that only add roadway capacity.

**What Does This Mean?**

The MIP Working Group concluded that the arrangement of land uses and transportation capacity that was modeled, which was based on the 2035 CAMPO plan, is unlikely to occur. That is, the levels of congestion the model predicts for IH 35 and the Central Texas region—as seen in a 3-hour commute



between Round Rock and downtown Austin in 2035—will be unacceptable for local residents and businesses and is not likely to occur. This means that behavior changes would probably occur: jobs and homes would likely relocate to shorten commute times, travelers would avoid making peak-period trips, and severe congestion would likely dampen the area’s population and employment growth. Therefore, with impacts to quality of life and economic health predicted to be this substantial, there may be sufficient motivation to approach IH 35 congestion solutions differently.

## **What Would It Take? A Hybrid Strategy**

Considering the findings from the initial scenario analysis, the logical question is “if a lot of capacity by itself will not solve the problem, what will?” Key to formulating a solution is understanding the underlying issues causing the levels of congestion in the 2035 model. Three primary factors are in play:

- Population and employment growth anticipated for 2035 are substantial. How can these be accommodated?
- The standard analysis approach assumes that people will exhibit the same travel behaviors in the future as they do today. How reasonable is it to assume that Central Texans will change their patterns to avoid severe congestion? And by how much?
- A hybrid approach involving capacity increases and demand pattern changes will almost certainly be required. The demand appears too large for any single congestion strategy.

To address these issues, the hybrid approach assumed the following aggressive strategies:

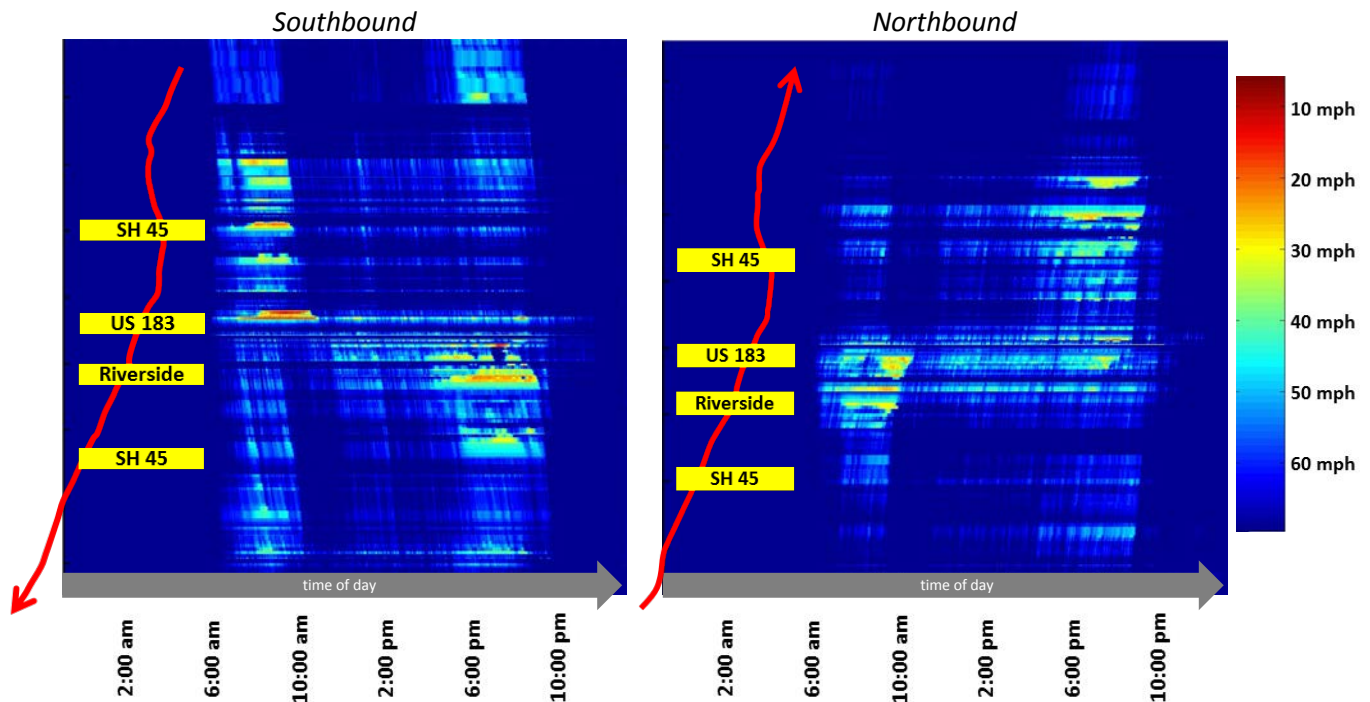
- Adding and managing capacity similar to Scenario 2.
- Shifting 40% of region-wide work commuter trips to work-at-home jobs.
- Reducing university commuter trips by 30% region-wide, assuming, for instance, technology options replace the in-class experience.
- Reducing retail shopping trips by 10% region-wide, for example being replaced by online shopping.
- Shifting trips to off-peak periods.
- Increasing HOV, transit, and non-motorized usage each by 25%, decreasing auto vehicle usage.

As shown in the resulting heat diagram (Exhibit ES-4), the hybrid strategy demonstrates that IH 35 traffic congestion can be substantially addressed by those significant changes: the red areas representing the lowest speeds have essentially disappeared, and the remaining red areas appear to represent localized bottlenecks which could be addressed individually through operational improvements. And yet, the changes to travel behavior necessary to effect such an improvement are significant.

Additional scenario aspects are detailed in the full report: different express lane tolling policies for HOV2+ and HOV3+ and a technology-based strategy facilitated by personal mobile devices.

### Exhibit ES-4 Heat Diagram Summary “What Would It Take?”

24-Hour, IH 35 between North Williamson County Line and South Hays County Line on General Purpose Lanes



### Additional Finding: Interim Improvement Is Helpful

Of particular note, Scenarios 2 and 7 most closely represent current local planning efforts toward an interim, short-term improvement—adding one lane for some yet-to-be-determined purpose in each direction to IH 35 within the existing right-of-way. Scenario 2 (which was modeled as one express lane in each direction) relieves some future congestion versus the base scenario and performed the best overall among the initial scenarios. For example, the two scenarios reduced person-miles traveled by 5% for the region overall, a substantial positive impact translating into roughly \$1 billion in travel time cost savings annually.

Further study of any express lane configuration should consider issues related to maximizing facility efficiency, including:

- The concept’s potential for non-traditional funding of construction and maintenance.
- Social and environmental considerations.
- The number and design of access points; the study scenarios generally assumed open access to express lanes. However, if Central Texans are moving on and off the corridor to meet travel needs within the study area, the express lane may become congested if access is too frequent or too cheap.
- A tolling strategy that recognizes the study findings concerning the huge volume of potential users. It is likely that express bus transit will be the only reasonable toll-free users; any other

toll-free usage, for example by carpools, is likely to compromise the operational efficiency of the express lane facility.

The issue of tolling strategy was further examined as part of this study, as Scenario 2b. For this scenario, the Working Group directed the technical team to examine the impact of all HOV vehicles paying a toll except bus transit. For this scenario, region-wide system measures demonstrate only slightly less benefit relative to Scenario 0: 4% reduction in vehicle-hours traveled (VHT) or person-hours traveled (PHT) versus 5% for the original Scenario 2. With regard to point-to-point travel time, Scenario 2b delivers reasonable improvements for all movements on the general purpose lanes, except for a slight increase for IH 35 northbound during the evening peak period. Additional detailed analysis is recommended to determine which designs, operating practices, and tolling policies can maximize the efficiency of any IH 35 express lane facility while considering the benefits and costs to the region as a whole.

## Next Steps

The Mobility Investment Priorities project formally concludes in August 2013. This summary and the technical report represent the conclusion of the technical study of long-term scenarios for IH 35 through Central Texas. The conversation will continue, considering:

- Implications of this study's findings for on-going implementation efforts.
- Long-term IH 35 planning recommendations.

An additional recommendation resulting from this examination is the need to further maximize the efficiency of the Central Texas system, including in particular:

- Maximizing the multimodal options available to Central Texans.
- Reviewing other primary travel corridors serving Central Texas including further development of US 183, LP 360, RM 620, as well as continued investigation of approaches to utilize SH 130.
- Examining other north-south arterial roadways such as Red River, North Lamar, Burnet Road, and Pleasant Valley to maximize efficiency for local travel, including multimodal access and coordinating traffic signals to provide more consistent green time to commuters.
- Continuing to address the most critical bottlenecks to system-wide efficiency.
- Exploring options for additional parallel capacity to IH 35, for example a potential US 183 South connection to SH 45 South.

These findings and recommendations are merely a starting point; the ideas proposed by the MIP Working Group require further discussion and exploration to determine the best mobility options for Central Texas.



## INTRODUCTION

This chapter presents an overview of the purpose and approach used to examine potential long-term solutions for IH 35 through Central Texas.

### On-Going IH 35 Improvement Initiatives

In the spring of 2012, when this modeling study began, local agencies including the City of Austin and the Texas Department of Transportation (TxDOT) Austin District were actively working on an interim improvement concept for IH 35, including a future transportation corridor for a variety of purposes within the existing right-of-way. Following initial findings from that study, TxDOT Austin District continued to work on that concept, maintaining the scope of analysis toward interim-term improvements with minimal need for freeway reconstruction.

### Need for Long-Term IH 35 Analysis

At the same time, local decision-makers expressed a need to examine the long-term options for IH 35, considering, for example, concepts which had been discussed in theory under previous studies, but not fully explored for their potential to address IH 35 long-term congestion. These included such concepts as switching tolls from SH 130 to IH 35 to encourage redistribution of travel by through trips, especially trucks, and the addition of substantial additional capacity to IH 35. The purpose of this modeling study, therefore, was to explore this question: “What is the long-term solution for IH 35 congestion through the Austin Metropolitan Area?”

In particular, this question would be explored at a pre-conceptual level of planning, enabling evaluation of concepts with potentially high impacts and necessitating complex sacrifices, to consider if any of the solutions offered sufficient benefits to justify further pursuit. This study is only a modeling exercise designed as a basis for conversations and further analysis; in particular, design feasibility, project cost, construction impacts, and community and environmental impacts are not considered.

The Mobility Investment Priorities (MIP) project offered an opportunity to perform this pre-conceptual-level examination. All of the products resulting from this larger effort of the MIP project are available on the Texas A&M Transportation Institute’s Mobility Investment Priorities website:

[mobility.tamu.edu/mip](http://mobility.tamu.edu/mip).

### Study Approach

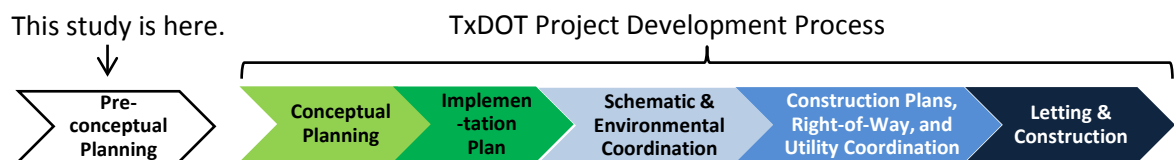
The MIP modeling analysis for IH 35 analyzes the “big picture” of travel patterns and congestion for IH 35—exploring scenarios that have been discussed by local stakeholders since the late 1990s but deemed infeasible for project-level study due to capital costs and other constraints. This modeling effort



*IH 35 looking northbound, 2012*

provides a starting point for local stakeholders in the Austin area to explore roadway design scenarios and determine if their benefits are substantial enough to make them a good long-term vision and investment for the public. The modeling analysis is intended to complement and support existing planning and development efforts underway in the region, and does not replace any such local efforts. The MIP modeling analysis is purposefully conducted at what is called a pre-conceptual level (Exhibit 1).

### Exhibit 1 Where Are We with This Study? Pre-Conceptual Level



Local stakeholders have placed a high priority on improving the mobility of persons and goods within and through the Austin metropolitan area along IH 35. The scenarios to be considered include a variety of strategies to improve mobility along IH 35 specifically. Therefore, the technical analysis approach also had to be capable of considering dynamic tolling, capacity-constraint, and queuing. The research team applied the 2035 CAMPO Metropolitan Transportation Plan (2035 CAMPO) regional travel model together with DynusT, a traffic analysis software capable of examining driver behavior under congested conditions and response to dynamic tolling options. The technical analysis approach is described in more detail in the next chapter.

## MIP Working Group and Technical Subcommittee Involvement

During the course of this modeling effort, the research team regularly engaged the MIP Working Group and Technical Subcommittee to provide updates and seek input. Significant milestones include:

- December 14, 2012 – MIP Technical Subcommittee Meeting: preview and discussion of results for Scenarios 0 through 6.
- December 20, 2012 – MIP Working Group Meeting: presentation and discussion of results for Scenarios 0 through 6.
- March 7, 2013 – MIP Working Group Meeting: presentation and discussion of the What Would It Take? scenario and findings from other follow-up analyses.
- June 13, 2013 – MIP Technical Subcommittee Meeting: discussion of Scenario 7 characteristics.
- August 16, 2013 – MIP Working Group Meeting: concluding presentation and discussion of this draft modeling report, as well as Scenario 7 findings and next steps.

## Organization of Report

The remainder of this report is organized to describe the scenario analysis—the base case and seven improvement scenarios, key findings, a sensitivity analysis to identify what it might take to address congestion on IH 35, as well as supplemental analyses conducted in the course of this study. These supplemental analyses included: different treatments for HOV2+ and HOV3+ paying a toll on the express lanes, reconfiguration of Scenario 6 to provide more local access, and a technology-based strategy.



## SCENARIO ANALYSIS

This chapter summarizes the scenarios examined, describes the technical analysis approach and assumptions, and walks through the results by scenario. Key findings are reviewed in the following chapter.

### Scenarios: Origin and Summary List

This examination considers improvement scenarios oriented toward capacity additions and policy change scenarios. During the summer of 2012, when this modeling effort started, Texas A&M Transportation Institute (TTI) researchers developed these scenarios based on a variety of sources, including input from the MIP Technical Subcommittee:

- IH 35 Corridor Development Study recommendations (received June 6, 2012).
- Outreach activities for the IH 35 Corridor Development Study (summer 2012).
- IH 35 Major Investment Study (1998).
- My35 IH 35 Corridor Advisory Committee Plan (August 2011).

Exhibit 2 summarizes the scenarios considered. Scenario 0 is the base case against which the remaining scenarios were compared. This base case is the 2035 CAMPO-adopted road and transit network, which includes no additional capacity along IH 35 between SH 45 North and SH 45 South. Scenarios 1, 2, and 3 build upon Scenario 0 and each other in sequence, exploring different operational approaches to adding one express lane in each direction. Scenarios 4, 5, and 6 explore concepts discussed in previous stakeholder involvement activities and include a critical caveat: federal law currently prohibits the conversion of existing general purpose lanes on an Interstate facility to tolled lanes; this study explores such a scenario only to see if any benefits merit exploring an exception. Scenario 7 is based upon Scenario 2, but with an alternative downtown Austin configuration based upon recent local input.

A key assumption for the initial scenario analysis is that transit vehicles and passenger cars with three or more occupants (HOV3+) may use any express lane on IH 35 without paying a toll, but two-person vehicles (HOV2), single-occupancy vehicles (SOV), and trucks pay a toll. Variations on this assumption were explored under a follow-up examination.

An additional important assumption concerns the transit system. The research team investigated the transit system coded into the 2035 CAMPO model network and determined that the transit system as coded represents an aggressive representation of current transit plans for Central Texas, but is still within realistic bounds of what is being planned. Therefore, according to this model representation, Central Texas users in 2035 will have much more transit opportunities than they do currently, and therefore the transit mode is well represented in the model being used for this exercise.

## Exhibit 2 Scenarios Examined

Scenario 0	Base Case	The 2035 CAMPO plan—adopted roads and transit network: consistent with the current CAMPO-adopted plan, Scenario 0 includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.
Scenario 1	HOV Lanes	One express lane added to IH 35 in each direction, HOV 3+ and bus transit access only, configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South.
Scenario 2	Express Lanes	Same as Scenario 1, but also allow HOV2 and SOV vehicles paying an auto toll rate and truck vehicles paying a truck toll rate. Congestion on these lanes is “managed” by allowing the toll rate to vary dynamically throughout the day in order to maintain vehicle flow.
Scenario 3	System-Wide Dynamic Pricing	Same as Scenario 2, but allow toll rates to vary dynamically for IH 35 and other north-to-south tolled facilities in the 2035 CAMPO—adopted plan system, specifically SH 130, SH 45 Southeast, US 183 south tolled mainlanes, and tolled express lanes along Loop 1 (MoPac).
Scenario 4	My35 Conversion Plus	Based on a concept derived by local stakeholders as part of the My35 statewide study. Includes one express lane added to IH 35 in each direction (configuration and access according to the current City of Austin study between 51st Street and William Cannon) plus conversion of one existing IH 35 general purpose lane between SH 45 North and SH 45 South to an express lane.* Toll these express lanes dynamically; HOV3+ and bus transit ride for free. Remove tolls from SH 130/SH 45 Southeast completely and redesignate Interstate to SH 130/SH 45 Southeast.
Scenario 5	My 35 Swap	Explores a concept derived by local stakeholders as part of the My35 statewide study. No added capacity. Toll all existing IH 35 mainlanes dynamically during morning and afternoon peak periods (6-9 am and 4-7 pm);* HOV3+ and bus transit ride for free. Remove tolls from SH 130/SH 45 Southeast completely and redesignate Interstate to SH 130/SH 45 Southeast.
Scenario 6	Capacity Addition through Core	Explores a concept frequently discussed as an ultimate need to address future congestion. Concept was examined as three additional express lanes in each direction, depressed or tunneled, and dynamically tolled; HOV3+ and bus transit ride for free.
Scenario 7	Downtown Austin Alternative	Same as Scenario 2, but with downtown Austin configuration providing alternative cross-street access and channelization of through traffic versus downtown traffic.

SOV = Single-Occupancy Vehicle; HOV2 = High-Occupancy Vehicle, 2 persons; HOV3+ = High-Occupancy Vehicle, 3 or more persons

\* Note that federal law currently prohibits the conversion of existing general purpose lanes on an Interstate facility to tolled lanes. This study explores such a scenario only to see if any benefits merit exploring an exception.

## Technical Task Approach: Multi-Resolution Modeling

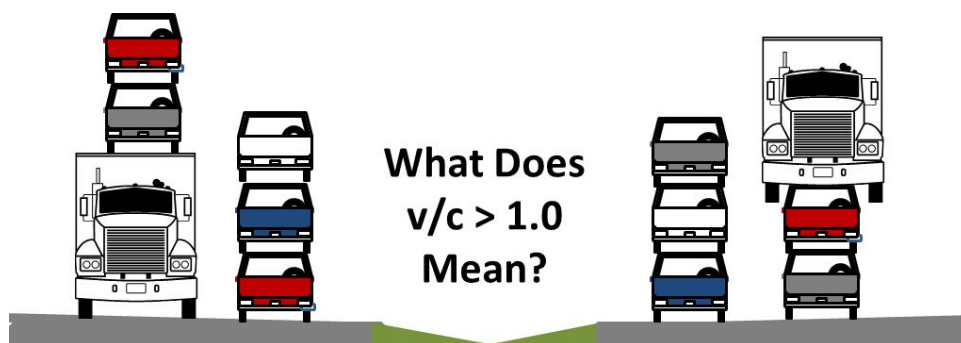
Local stakeholders place a high priority on improving the mobility of persons and goods within and through the Austin metropolitan area using IH 35, as is clear from the list of scenarios considered. A multi-resolution approach—one that considered both regional travel demand and operational strategies—was used to address corridor congestion.

The CAMPO area five-county travel forecasting model was used as a starting point to derive region-wide demand for IH 35; TTI's modeling team made adjustments for the purpose of this study. A base scenario, Scenario 0, was run in this travel forecasting model to generate projected trips for the following modes: single-occupant vehicles (SOV autos), high-occupant vehicles (HOV2 and HOV3+ autos), and trucks. Travel by other modes was generated, but not used in the dynamic traffic assignment (DTA) model.

In addition, TTI used a simulation-based meso-scopic DTA model, DynusT, to examine the entire five-county region. Such a model can explicitly consider operational constraints at the link level—a much greater level of detail than a typical region-wide model. It is typical for facilities as congested as IH 35 to be represented in a region-wide model as having traffic volumes much greater than is actually possible. This concept is depicted in Exhibit 3 and the volume-to-capacity ratio is often presented as representing the “demand” for a facility. In contrast, DTA analysis constrains facility capacity to operational capacity, as shown in Exhibit 4. As a result of representing operational capacity more closely to reality and also due to additional computational steps taken, DTA can also be used to examine queuing activity. Described in general terms and depicted in Exhibit 5, queuing occurs when a section of roadway is full or a signal fails to clear all the cars waiting at a light. Queuing refers to a line of vehicles waiting to enter that segment of roadway or go through a signal because there is more demand than capacity for the location.

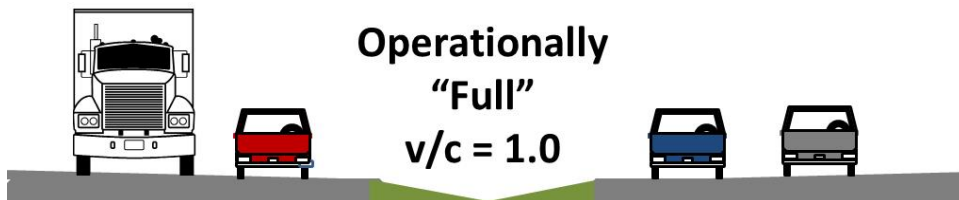
### Exhibit 3 Capacity Concept in Traditional Regional Model Assignment

*Traffic is allowed to stack*  
( $v/c$  = traffic volume-to-capacity)



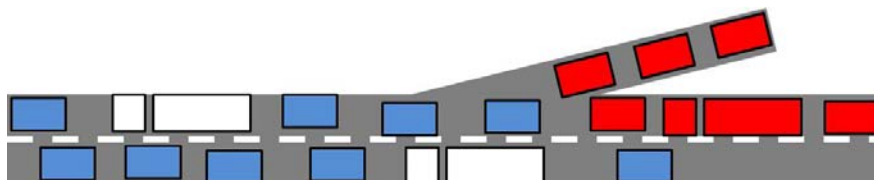
#### Exhibit 4 Operational Capacity under DTA

*Traffic is not allowed to exceed the maximum possible number of vehicles on each road section  
( $v/c$  = traffic volume-to-capacity)*



#### Exhibit 5 Queuing Concept – Vehicles Back-up on Other Streets

*The red cars are experiencing queuing because there is insufficient capacity after the merge to accommodate all of the vehicles.*



One benefit of the greater operational detail of DTA is that the influence of congestion and operational efficiency are better represented in their influence on drivers' route decisions. Specifically, in the DTA model, driver route choice behavior is influenced by various factors including congestion levels, user cost of roadways including tolls, and roadway traffic information. In addition to providing more operational detail, DTA can be used to generate a description of traffic at varying time periods, representing the ways that traffic changes on each roadway link both temporally and spatially. One specific analysis output is a graphic representation of these changes in a "heat diagram"—a color depiction of congestion levels with stop-and-go traffic represented by a red (very hot) color. Various heat diagrams are presented for the scenario findings.

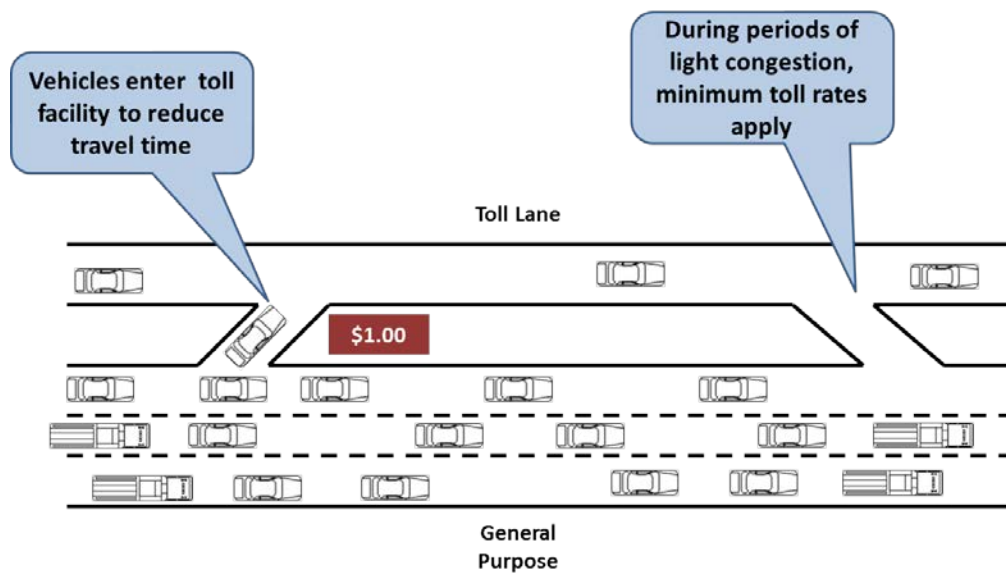
In addition to providing more operational detail, DynusT offers a unique advantage among similar analysis tools of being capable of examining dynamic tolling as an operational strategy. DynusT considers the level of congestion in the toll lanes when setting the toll, raising the toll as necessary to maintain the toll lane's desired operational speed and lowering the toll when the toll lane is being underutilized. The algorithm assumes that drivers have the tolling information when making these decisions. This dynamic tolling concept is depicted in Exhibit 6 and Exhibit 7.

Using DynusT, therefore, offered these capabilities to:

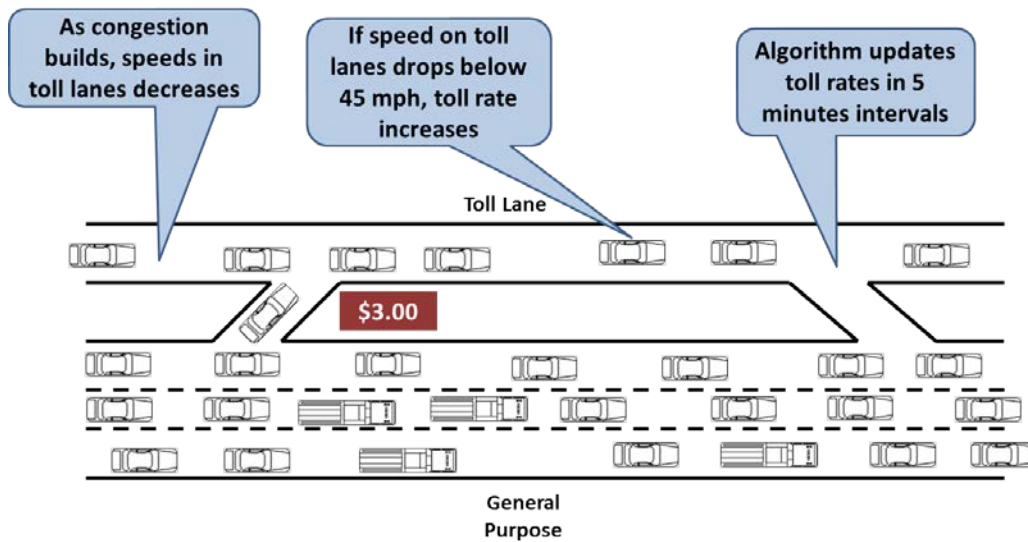
- Model and report analysis results for a more detailed level of roadway operations than a typical regional travel model, including traffic back-up as a result of extreme congestion.

- Examine the entire CAMPO regional study area (Travis, Bastrop, Caldwell, Hays, and Williamson County) instead of merely the IH 35 corridor, thus considering diversion of traffic to other roadways or attraction of traffic from other roadways in response to IH 35 improvements.
- Model driver behavior and choices in congested conditions closer to reality than typical regional travel models do.
- Model driver choices made with regard to dynamic tolling in response to congestion to maximize system efficiency.

**Exhibit 6 Congestion-Responsive Tolling: Light Congestion Toll Example**



### Exhibit 7 Congestion-Responsive Tolling: Moderate Congestion Toll Example



The application of the DTA software in a regional context and at this stage of pre-conceptual study, however, is a work in progress. That is, while this and other studies show DTA is a very useful tool, the technology has only been recently developed; research in coming years will standardize DTA practice. In that context, these caveats apply to this modeling effort:

- 1) Traffic conditions estimated using DTA are more realistic than using traditional modeling practices. There are, however, no standard techniques to integrate this level of realism into the travel demand modeling process to reflect changes in behavioral choices, such as travel mode.
- 2) The DTA model was not calibrated to observed speeds and is only an estimate of future 2035 conditions.
- 3) The DTA model did not use specific signal timings and could have various localized anomalies; these were not investigated in detail.
- 4) While absolute numbers are presented, this study used the relative change in speed and congestion to draw conclusions about the relative efficacy of each scenario compared to others.
- 5) The values shown for travel times and vehicle hours of travel should not be taken as specific predictions, but are only shown for relative comparison purposes.

### General Technical Assumptions Applicable to All Scenarios

The following technical assumptions apply to all of the analysis scenarios, unless explicitly noted. More information on the effect of these assumptions is presented in subsequent sections.

- All scenarios are examined for year 2035.
- The CAMPO area five-county travel forecasting model was used as a starting point for the base scenario, Scenario 0. The CAMPO model internal feedback mechanism was activated and adjustments were made according to CAMPO staff direction regarding how tolls are applied by the model under the traffic assignment stage.



*What this means:* All roadway, rail, bus transit, and other projects assumed to be in place for the CAMPO 2035 Metropolitan Transportation Plan (MTP) are included in this analysis. In addition, all travel demand model assumptions follow CAMPO travel model assumptions. Because of the model adjustments made for the purpose of this study, model results should not be compared to model runs performed by CAMPO for the CAMPO 2035 MTP. As a reminder, for Scenario 0, the base case, no capacity additions are included along IH 35 because none are included in the 2035 CAMPO plan.

- The trip table is “fixed” for the initial scenarios analysis. The trip table generated in Scenario 0 is being used for the remaining scenarios.

*What this means:* Auto and truck demand is assumed to be constant, irrespective of additional capacity or operational improvement resulting from proposed improvements. Origin and destination points are fixed, as are modal choices, but auto and truck trips can change routes.

*Why this approach was taken:* Attempts to apply the CAMPO model to assess changes in job, home, shopping, health care, and other destinations, as well as changes in mode choice, under each scenario within the study schedule were unsuccessful within the time frame of this study; the decision to use a constant trip table as input is not unprecedented for dynamic traffic analysis approaches.

- The application used to perform the simulation-based meso-scopic-level DTA is DynusT.

*What this means:* Results from this study are unique to this study’s purpose and are generally not comparable to model output from the CAMPO regional model.

- Traffic signals were coded on all major arterials.

*What this means:* The 2035 CAMPO plan model network does not include signal information, therefore the study team had to code in general representations of signal timing across the five-county network and signal timings were adjusted as needed to best accommodate year 2035 traffic flows.

- Assignment is modeled in 1-minute intervals for the 24-hour period.

*What this means:* The 24-hour trip table resulting from the CAMPO regional model was disaggregated into hourly trip tables based upon diurnal factors by trip purpose provided by CAMPO staff.

- Peak-spreading was not analyzed.

*What this means:* There is a tendency of travelers to shift the time of travel to a less-congested or lower-cost time period; the current analysis approach does not have that technical capacity.

- For static tolling operation, toll rates were selected by the model based upon the toll values coded into the CAMPO model.

*What this means:* Static tolls are consistent with CAMPO plan model assumptions.

- For dynamic tolling operation, toll rates were selected by the model to ensure the managed lanes operated above 50 mph.

*What this means:* The tolls are unrealistically high for an actual lane operation. They indicate the enormous demand in the corridor.

- Based upon the level of congestion anticipated for 2035, the research team conducted informal interviews of local agency contacts and ascertained that there is a high likelihood of sections of Loop 1 (MoPac), US 183 North, and US 183 South managed lane facilities being operated with dynamic tolls by 2035. Hence, these facilities are assumed to be dynamically tolled in Scenario 0 and all subsequent scenarios.

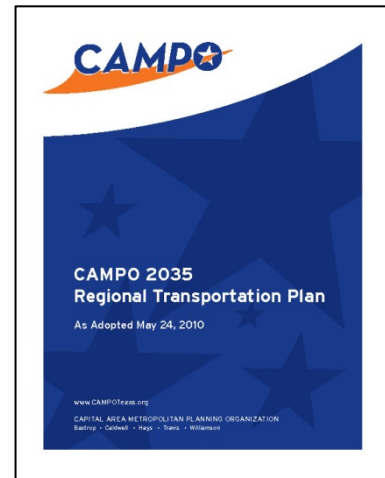
No analysis has been conducted to confirm or question the design feasibility of specific scenarios, total cost, impacts to travelers during construction, or other community or environmental impacts.

## Scenario 0: Base Case

### Description

The 2035 CAMPO-adopted plan roads and transit network was used as the basis for Scenario 0. It includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

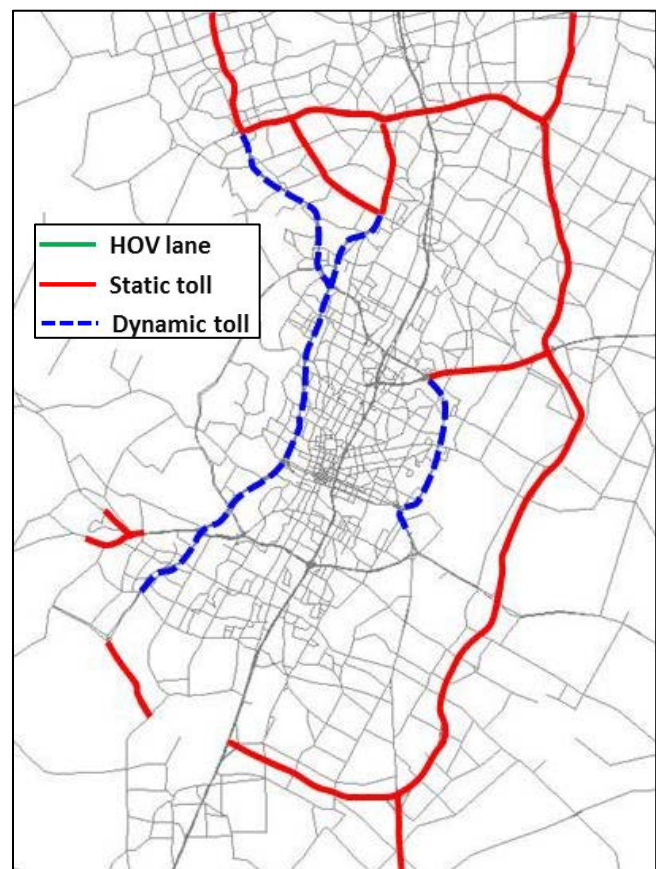
An overview of the tolling assumptions is depicted in Exhibit 8. The Scenario 0 model includes all of the 2035 CAMPO-adopted plan roads and transit network assumptions, as summarized in Exhibit 9 and Exhibit 10, as well as rail, bicycle, and pedestrian facilities assumptions to the extent they were originally represented in the CAMPO model.



### Assumptions

- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Any HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- Based upon the level of congestion anticipated for 2035, the research team conducted informal interviews of local agency contacts and ascertained that there is a high likelihood of sections of Loop 1 (MoPac), US 183 North, and US 183 South managed lane facilities being operated with dynamic tolls by 2035. Hence, these facilities are assumed to be dynamically tolled in all scenarios.

**Exhibit 8 Scenario 0 Tolling Assumptions**



**Exhibit 9 2035 CAMPO Metropolitan Transportation Plan, Regional Roadway System**

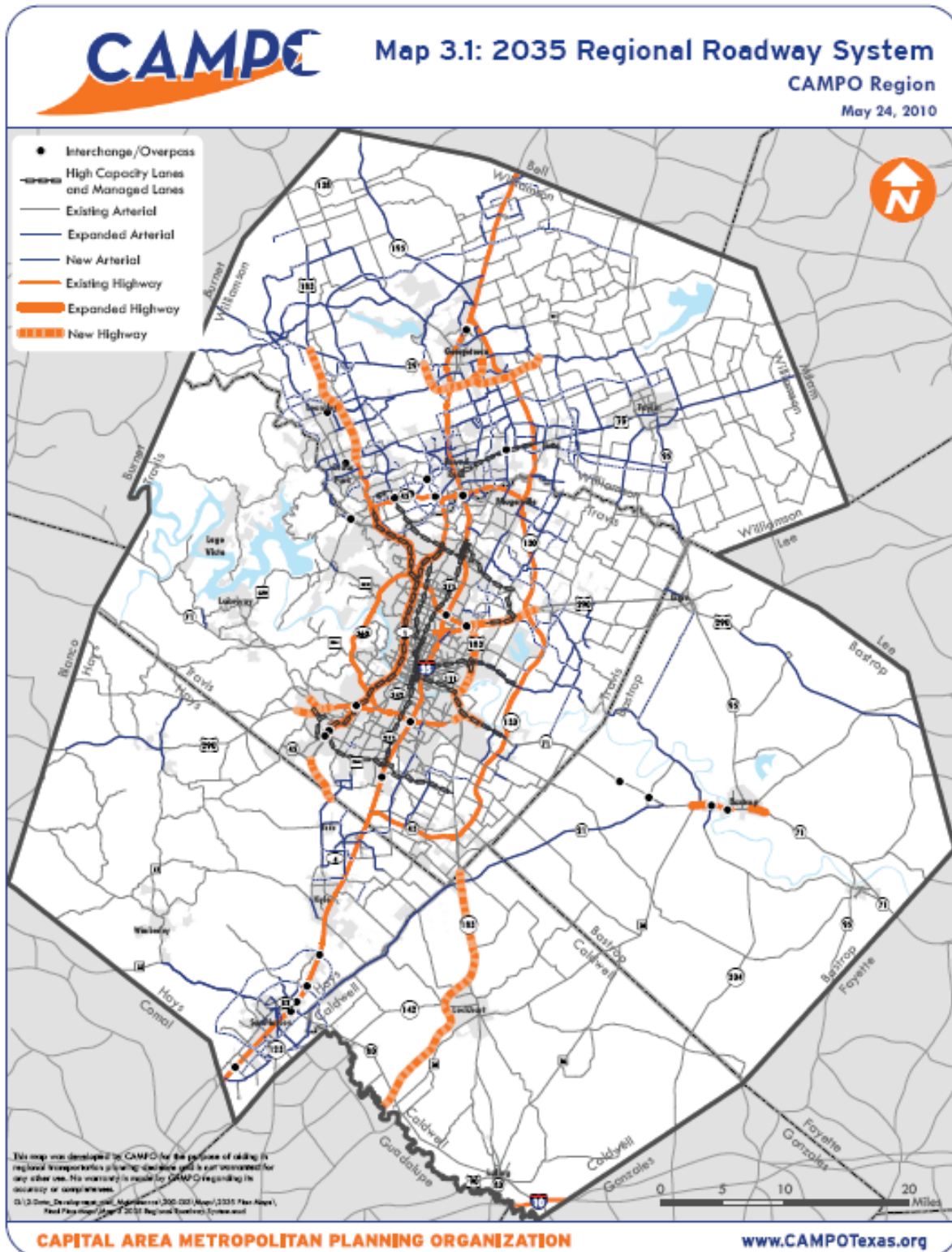
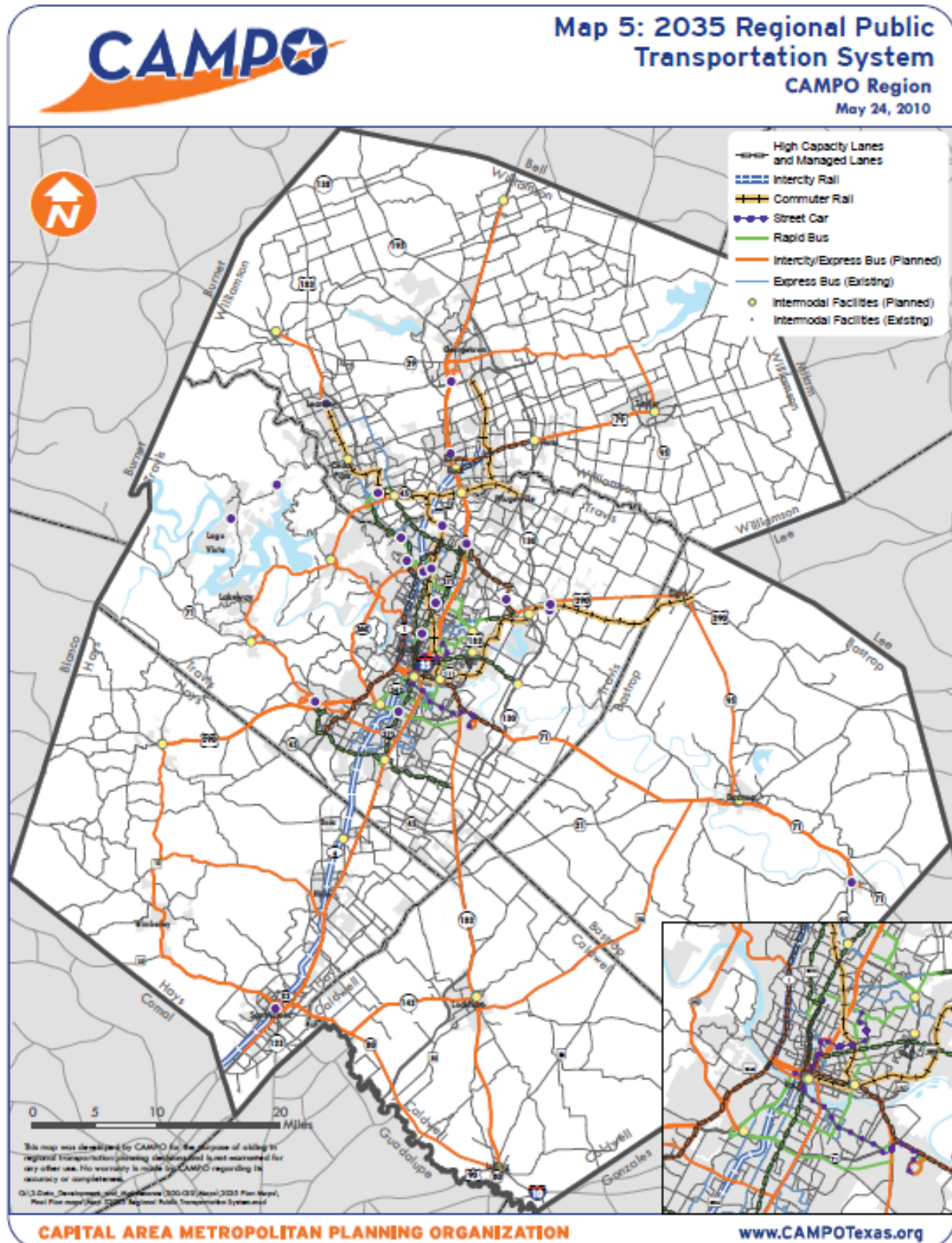




Exhibit 10 2035 CAMPO Metropolitan Transportation Plan, Regional Public Transportation System



## Technical Assessment

Some of the pertinent performance measures resulting from the dynamic traffic assignment analysis are provided in Exhibit 11. Daily vehicle-hours traveled (VHT) is a measure which aggregates all of the time spent by vehicle in personal and commercial vehicles over the course of an entire day. The total value includes all vehicles; the subsequent two rows separate out internal trips and external trips. By comparing the region-wide measures in this exhibit to the equivalent measures for the improvement scenarios, it is possible to assess the relative regional impact of each scenario.

Internal trips are those with either an origin or destination inside the five-county study area, which is interpreted in modeling analysis as a person living in or conducting their daily affairs or business inside the study area. External trips are those with both an origin and destination outside the five-county study area, which is interpreted to represent through traffic. As shown in Exhibit 11, the total amount of time for through (external) trips is much lower than that for internal trips. Generally, external trips are longer in distance than internal trips, so that this small number in comparison to internal trips in fact indicates that through trips represent a very small percentage of all of the travel occurring in the study area.

**Exhibit 11 Scenario 0 Performance Measures: Base Case**

Performance Measure	Scenario 0: Base	
Daily Vehicle-Hours Traveled (VHT) Region-Wide		
Total	3,705,800	
Trips with at least an origin or destination inside the study area	3,687,900	
Trips with both origin and destination outside the study area	17,900	
Daily Person-Hours Traveled (PHT) Region-Wide		
Total	3,879,300	
Trips with at least an origin or destination inside the study area	3,860,500	
Trips with both origin and destination outside the study area	18,800	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231
Using SH 130	177	117
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301
Using SH 130	217	315

In addition, Exhibit 11 also includes morning and evening point-to-point travel times for the facilities of greatest interest for this study. For perspective, according to 2011 data available to the research team, the average travel time experienced during morning or evening peak period, either northbound or southbound, is 104 minutes, or 1.7 hours, to cross the three counties of Williamson, Travis, and Hays using IH 35. As shown, the travel times projected for Scenario 0, the 2035 base case, are shockingly higher. For example, in the southbound direction, using the IH 35 general purpose lanes, a driver in 2035 starting at the southern Hays County line and driving north to the northern Williamson County line during the morning rush period can expect a trip to take 221 minutes, or over 3.6 hours. SH 130, unfortunately, offers no comparative advantage. These times are excessive and demonstrate the magnitude of the challenge for addressing IH 35 congestion in the long-term future.



Internal trips are those with either an origin or destination inside the five-county study area, which is interpreted in modeling analysis as a person living in or conducting daily affairs or business inside the study area. External trips are those with both an origin and destination outside the five-county study area, which is interpreted to represent through traffic. As shown in Exhibit 11, the total amount of time for through trips is much lower than that for internal trips. Generally, external trips are longer in distance than internal trips, so that this small number in comparison to internal trips in fact indicates that through trips represent a very small percentage of all of the travel occurring in the study area.

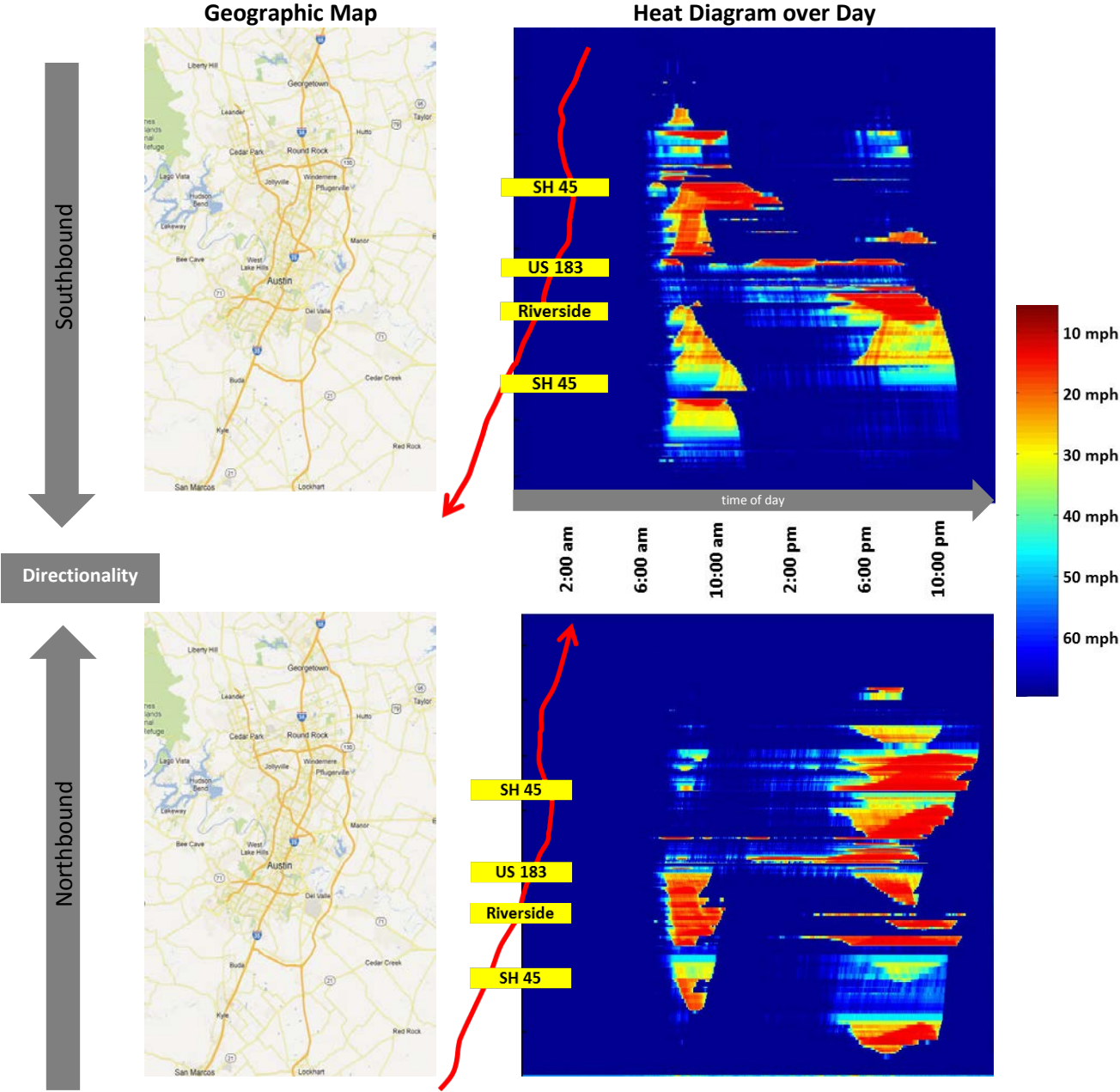
In addition to tabular data, the software DynusT enables a summary diagram to communicate the level of congestion being encountered by drivers. Exhibit 12 is a heat diagram, where “heat” represents congestion. In these diagrams, the color scale on the right shows the colors that represent freeway speeds: dark blue is speeds 60 mph and above, with yellow, orange, and red representing worse conditions down to 10 mph. The left portion represents northbound IH 35 travel speeds in the general purpose lane and the diagram on the right represents the same for southbound. The entire day is shown in each diagram, moving from left to right, as indicated by the time of day shown along the bottom.

The heat diagrams in Exhibit 12 represent the base case in 2035 with no IH 35 construction improvements. As shown, due to the number of trips anticipated for the region and IH 35 in the year 2035, IH 35 congestion is severe. Specifically, the wide bands of red demonstrate that traffic queues are so severe during peak morning and evening periods that queues extend well past the typical morning and evening peak periods: past noon for the morning peak for drivers traveling inbound from north Austin and past 10 pm for drivers traveling outbound to north Austin during the evening peak. Drivers traveling IH 35 to and from south Austin experience similar inbound morning and outbound evening delay, although to a lesser degree.

Overall, the TTI technical team considers these findings to be logical, based upon observed travel times demonstrated for today’s travelers during peak periods. However, as an initial observation, the research team concluded that this arrangement of land uses and transportation capacity is very unlikely to occur. That is, the levels of congestion the model predict for IH 35—in fact, the Central Texas region—will be unacceptable for local residents and business. The MIP Working Group discussed the technical results and concluded that people and businesses will not move here if the transportation infrastructure is insufficient to avoid this level of congestion. Therefore, with impacts to quality of life and economic health predicted to be this substantial, there may be sufficient motivation to approach IH 35 congestion solutions differently.

**Exhibit 12 Scenario 0 Heat Diagrams**

*24-Hour, IH 35 between North Williamson County Line and South Hays County Line on General Purpose Lanes*



## Scenario 1: HOV Lanes

### Description

One express lane added to IH 35 in each direction, HOV 3+ and bus transit access only, configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South.

Based upon Scenario 0, the base case, the tolling assumptions for this scenario are depicted in Exhibit 13. As a reminder, Scenario 0 is consistent with the current CAMPO-adopted MTP, and therefore includes all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

### Assumptions

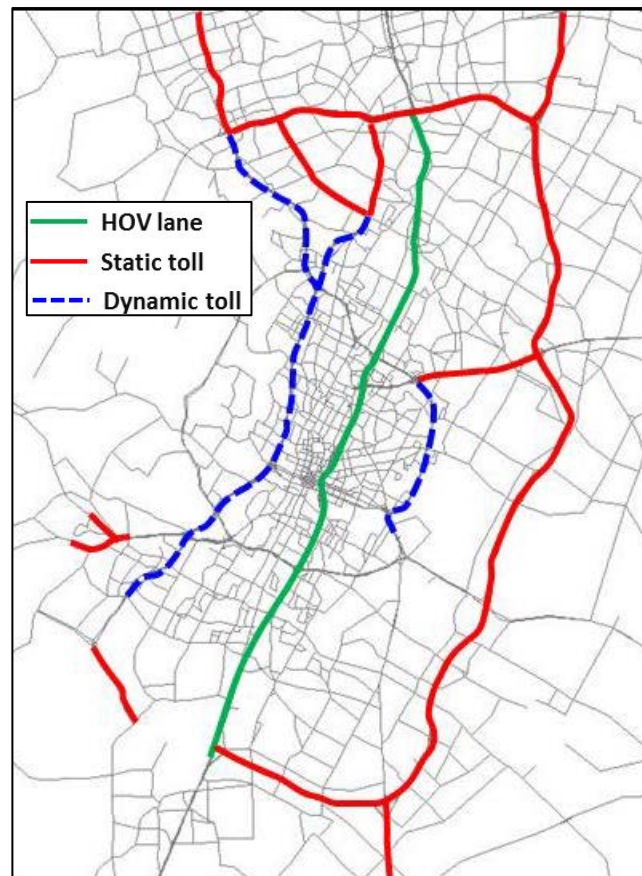
- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- For this scenario, HOV vehicles were assumed to include vehicles with 3 or more persons. Vehicles with 1 or 2 persons are restricted.

### Technical Assessment

As shown in Exhibit 14, Scenario 1 exhibits very little improvement over Scenario 0, the base case. For example, total daily VHT and PHT region-wide go down only 1%. The VHT/PHT reduction for external through trips (trips with both origin and destination outside the study area) experience a slightly better result: a 3% to 4% reduction overall.

Point-to-point travel time values are consistent with the above finding. For perspective, according to 2011 data available to the research team, the average travel time experienced during morning or evening peak period, either northbound or southbound, is 104 minutes (1.7 hours) to cross the three counties of Williamson, Travis, and Hays. By 2035, as presented previously, this time will be on the order of 178 minutes (3 hours) in the southbound direction or 221 minutes

Exhibit 13 Scenario 1 Tolling Assumptions



(3.7 hours) in the northbound direction under Scenario 0, the base case. As shown in Exhibit 14, Scenario 1 exhibits very little improvement or even a worsening condition for some of these movements.

**Exhibit 14 Scenario 1 Performance Measures**

Performance Measure	Scenario 0: Base		Scenario 1: HOV Lanes	
Daily Vehicle-Hours Traveled (VHT) Region-Wide				
Total	3,705,800		3,657,500	
Trips with at least an origin or destination inside the study area	3,687,900		3,640,200	
Trips with both origin and destination outside the study area	17,900		17,300	
Daily Person-Hours Traveled (PHT) Region-Wide				
Total	3,879,300		3,828,700	
Trips with at least an origin or destination inside the study area	3,860,500		3,810,600	
Trips with both origin and destination outside the study area	18,800		18,100	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231	213	228
Using SH 130	177	117	145	94
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301	187	315
Using SH 130	217	315	183	281

These findings for Scenario 1 reflect the fact that the capacity added to IH 35 removes HOV3+ traffic from the surrounding general purpose lanes. The result is general improvement in the travel conditions for all IH 35 users except for drivers traveling northbound across Hays, Travis, and Williamson Counties during the morning peak period, who do experience an increase in travel time.

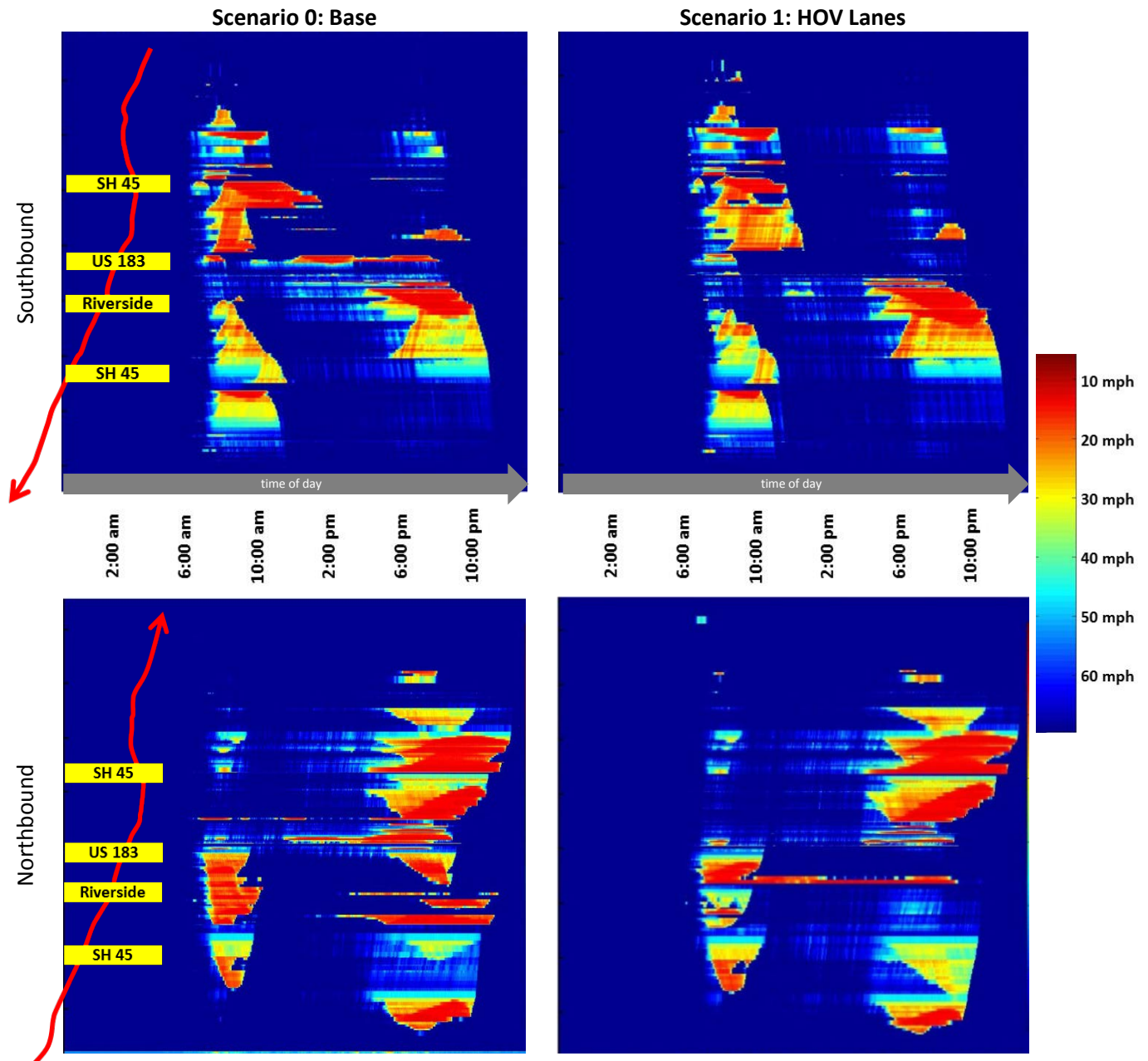
In addition to tabular data, the dynamic traffic assignment tool provides a “heat diagram” to communicate the level of congestion being encountered by drivers on IH 35 in Scenario 1, as shown in Exhibit 15 (a description of how to read a heat diagram is included with Exhibit 12 for Scenario 0). Exhibit 15 includes the heat diagrams for Scenario 0 for comparison.

Under Scenario 1, HOV lanes would be added to provide vehicles with three or more persons (and riders of bus transit vehicles) a travel option along IH 35 which is faster than traffic on the general purpose lanes. As these users clearly will see a benefit to the scenario, the research team focused upon the experience of general purpose lane users. As shown in Exhibit 15, the addition of HOV lanes under Scenario 1 has little impact on the congestion experienced by IH 35 general purpose lanes drivers. This finding is due to the number of trips anticipated for the region and IH 35 in the year 2035.



### Exhibit 15 Scenario 1 Heat Diagram Comparison

24-Hour, IH 35 between North Williamson County Line and South Hays County Line on General Purpose Lanes



As with Scenario 0, the base case, the wide bands of red for Scenario 1 demonstrate that traffic queues are so severe during morning and evening peak periods that queues extend well past the typical morning and evening peak periods: past noon for the morning peak for drivers traveling inbound from north Austin and past 10 pm for drivers traveling outbound to north Austin during the evening peak. Drivers traveling IH 35 to and from south Austin experience similar inbound morning and outbound evening delay, although to a lesser degree.

## Scenario 2: Express Lanes

### Description

Similar to Scenario 1, one express lane is assumed to be added to IH 35 in each direction, HOV 3+ and bus transit access only, configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South.

In addition, allow HOV2 and SOV vehicles paying an auto toll rate and truck vehicles paying a truck toll rate. Congestion on these lanes is “managed” by allowing the toll rate to vary dynamically throughout the day in order to maintain vehicle flow.

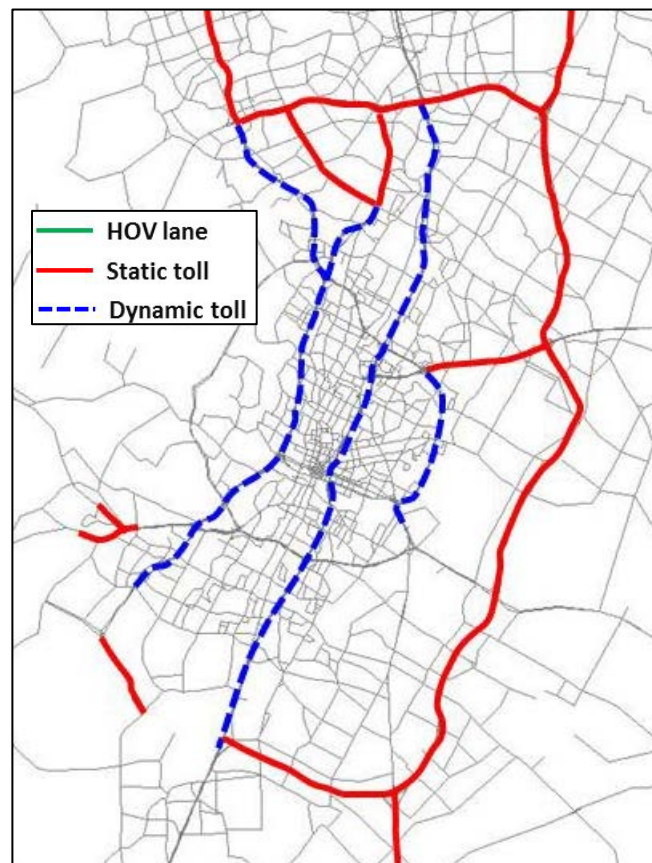
Based upon Scenario 0, the base case, the tolling assumptions for this scenario are depicted in Exhibit 16. As a reminder, Scenario 0 is consistent with the current CAMPO-adopted MTP, and therefore includes all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 by itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

Finally, Scenario 2 most closely represents current local planning efforts toward an interim, short-term improvement—adding one lane for some yet-to-be-determined purpose in each direction to IH 35 within the existing right-of-way.

### Assumptions

- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of each facility, but without considering the tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Min toll (\$0.25) for autos and (\$0.25) for trucks.
  - Max toll (\$200.00).
  - HOV 3+ free.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed and level of service.

**Exhibit 16 Scenario 2 Tolling Assumptions**





- Any HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.

### Technical Assessment

Exhibit 17 details pertinent findings from the Scenario 2 examination. Scenario 2 demonstrates a 5% reduction—from 3.7 million to 3.5 million—in VHT region-wide. PHT, calculated using VHT and vehicle occupancy factors, demonstrates the same percentage reduction. This 5% reduction is not insignificant: this 5% reduction of PHT for the region overall translates into roughly \$1 billion travel time cost savings annually. Through trips experience a reduction of 2% to 3% VHT/PHT, also benefitting from the reduced congestion.

**Exhibit 17 Scenario 2 Performance Measures**

Performance Measure	Scenario 0: Base		Scenario 2: Express Lanes	
Daily Vehicle-Hours Traveled (VHT) Region-Wide				
Total	3,705,800		3,522,500	
Trips with at least an origin or destination inside the study area	3,687,900		3,505,100	
Trips with both origin and destination outside the study area	17,900		17,500	
Daily Person-Hours Traveled (PHT) Region-Wide				
Total	3,879,300		3,687,400	
Trips with at least an origin or destination inside the study area	3,860,500		3,669,200	
Trips with both origin and destination outside the study area	18,800		18,300	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231	176	175
Using SH 130	177	117	145	90
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301	212	310
Using SH 130	217	315	203	294

With regard to point-to-point travel time, under Scenario 0, the base case, travel time to cross the three counties of Williamson, Travis, and Hays is 221 minutes (3.7 hours) in the northbound direction. For Scenario 2, in the northbound direction, travel time for drivers using the IH 35 general purpose lanes during the morning peak period goes down 15%, from 221 minutes (3.7 hours) to 187 minutes (3.1 hours). As a reminder, these point-to-point travel times represent the travel time in 2035, under heavily congested conditions, for a driver using the IH 35 general purpose lanes; a driver using the

dynamically tolled express lanes through Austin would experience a minimum average speed of 45 mph. In the northbound direction, for the IH 35 general purpose lanes during the evening peak period, travel time actually increases slightly over Scenario 0, by 9 minutes.

In addition to tabular data, the dynamic traffic assignment tool provides a “heat diagram” to communicate the level of congestion being encountered by drivers on IH 35 under Scenario 2, as shown in Exhibit 18 (a description of how to read a heat diagram is included with Exhibit 12 for Scenario 0). Exhibit 18 includes the heat diagrams for Scenario 0 for comparison.

Examining the heat diagrams, it is apparent that there is some reduction in localized congestion along IH 35, for example in addressing mid-day congestion in the area between US 183 and Riverside for both the southbound and northbound directions. In addition, in the southbound direction, the congestion represented by the length and width of the red area between SH 45 North and US 183 does appear to improve noticeably. In the evening peak period, however, IH 35 mobility south of Riverside appears only moderately improved.

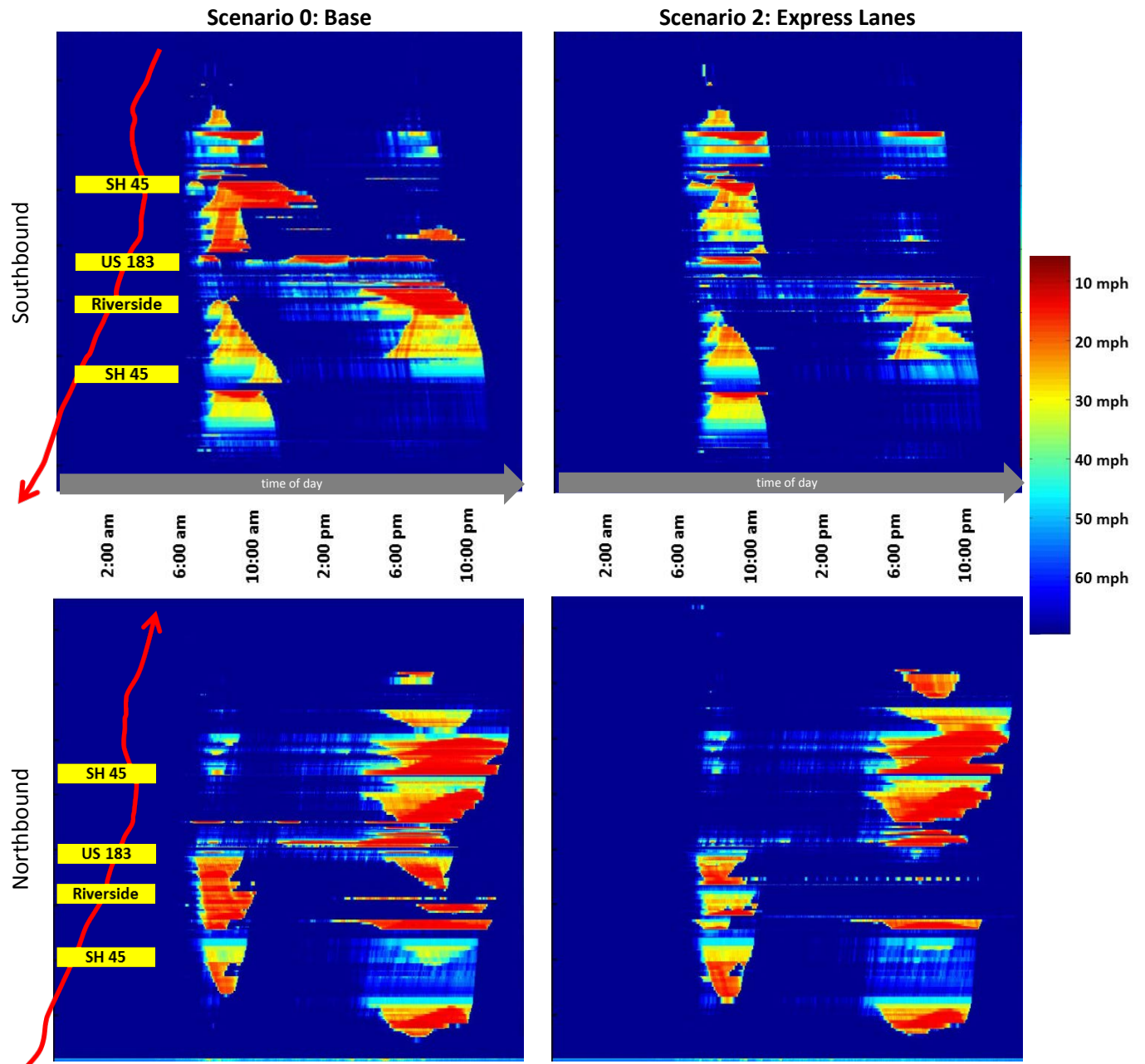
For the northbound direction, the result overall is much the same. During the morning peak period, mobility for commuters between Hays County and downtown Austin improves, as demonstrated by the reduction in red in the heat diagram. However, the section of IH 35 north of US 183 appears to exhibit as brutal a level of congestion during the evening peak period as for Scenario 0, the base case.

As mentioned above, Scenario 2 most closely represents current local planning efforts toward an interim, short-term improvement—adding one lane for some yet-to-be-determined purpose in each direction to IH 35 within the existing right-of-way. Scenario 2 (which was modeled under this research effort as one express lane in each direction) relieves some future congestion versus the base scenario and performed the best overall among the initial Scenarios 0 through 7. Scenario 7, based upon a similar concept overall, demonstrates comparable region-wide results.

Much more analysis will be necessary, and some is already underway, to consider specifics of this express lane configuration. Such a study should consider the issue of maximizing facility efficiency; the concept’s potential for non-traditional funding of construction and maintenance; as well as other social and environmental considerations necessary for any such transportation project. With regard to a tolling strategy, given the findings of this study regarding the magnitude of potential users, it is likely that express bus transit will be the only reasonable exception to the tolls; any other toll-free usage, for example by carpools, is likely to compromise the operational efficiency of the express lane facility.

## Exhibit 18 Scenario 2 Heat Diagram Comparison

24-Hour, IH 35 between North Williamson County Line and South Hays County Line on General Purpose Lanes



## Scenario 3: System-Wide Dynamic Pricing

### Description

Similar to Scenario 1, one express lane is assumed to be added to IH 35 in each direction, HOV 3+ and bus transit access only, configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South.

Similar to Scenario 2, allow HOV2 and SOV vehicles paying an auto toll rate and truck vehicles paying a truck toll rate. Congestion on these lanes is “managed” by allowing the toll rate to vary dynamically throughout the day in order to maintain vehicle flow.

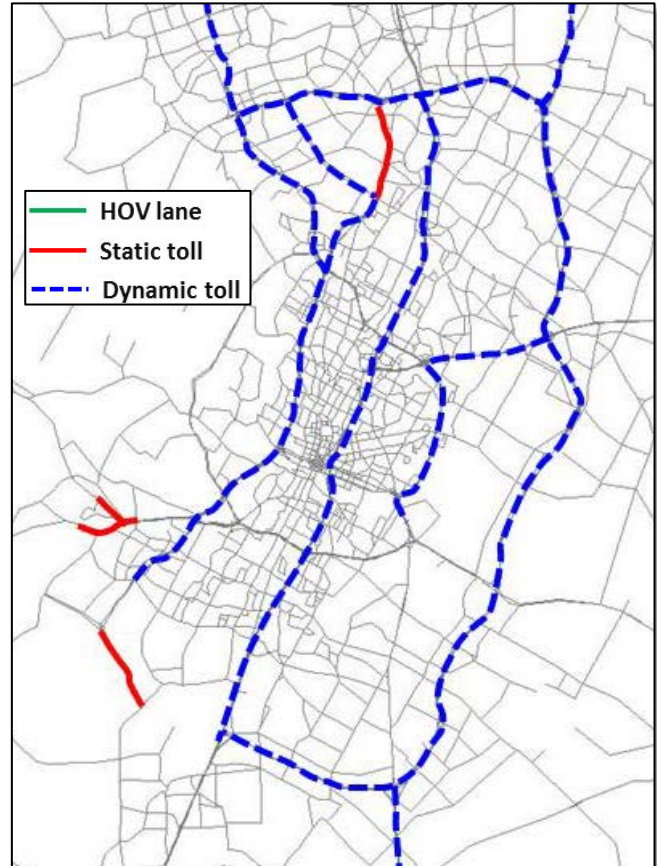
In addition, allow toll rates to vary dynamically for IH 35 and other north-to-south tolled facilities in the CAMPO-adopted plan system, specifically SH 130, SH 45 Southeast, US 183 south tolled mainlanes, and tolled express lanes along Loop 1 (MoPac).

Based upon Scenario 0, the base case, the tolling assumptions for this scenario are depicted in Exhibit 19. As a reminder, Scenario 0 is consistent with the current CAMPO-adopted MTP, and therefore includes all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

**Exhibit 19 Scenario 3 Tolling Assumptions**

### Assumptions

- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating as part of a regional tolling system, maximizing the efficiency of the entire system, including varying the tolling rates to improve the dispersion of traffic among facilities.
- Dynamic tolling assumptions for IH 35:
  - Min toll (\$0.25) for autos and (\$0.25) for trucks.
  - Max toll (\$200.00).
  - HOV 3+ free.
- HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.



- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed and level of service.

### Technical Assessment

Exhibit 20 presents the performance measures for Scenario 3. As shown, Scenario 3 in fact provides very little improvement over Scenario 0, the base case. For example, total daily VHT region-wide only goes down 1%. Person-hours, which are calculated using VHT and vehicle occupancy factors, demonstrate a similar result. Point-to-point travel times are similarly disappointing. This overall finding for Scenario 3 was initially surprising to the research team, given the initial promise of system-wide efficiencies.

**Exhibit 20 Scenario 3 Performance Measures**

Performance Measure	Scenario 0: Base		Scenario 3: System-Wide Dynamic Pricing	
Daily Vehicle-Hours Traveled (VHT) Region-Wide				
Total	3,705,800		3,677,900	
Trips with at least an origin or destination inside the study area	3,687,900		3,660,300	
Trips with both origin and destination outside the study area	17,900		17,600	
Daily Person-Hours Traveled (PHT) Region-Wide				
Total	3,879,300		3,850,000	
Trips with at least an origin or destination inside the study area	3,860,500		3,831,600	
Trips with both origin and destination outside the study area	18,800		18,400	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231	192	196
Using SH 130	177	117	163	82
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301	189	312
Using SH 130	217	315	187	285

Factors which appear to be influencing the region-wide results for Scenario 3 include:

- The broad level of overall congestion system-wide provides little opportunity for improvement resulting from system-wide coordination of toll rates. That is, there are few available options to entice drivers away from excessively congested routes.

- At the same time, the available option—most obviously SH 130 to the east—is sufficiently out of the way for many of the trips being taken.

Finally, the researchers noted that the fixed trip table assumption (discussed under the section General Technical Assumptions Applicable to All Scenarios) might be limiting the potential of this scenario. That is, if drivers in the model were allowed the flexibility of changing their destinations (say, a retail destination) in response to congestion and the congestion pricing assumptions being tested under Scenario 3, there might be a higher impact on reducing IH 35 congestion and regional congestion overall.

Point-to-point travel times for Scenario 3 demonstrate mixed results in comparison to Scenario 0. In the heat diagram analysis, shown in Exhibit 21 comparing Scenario 3 to Scenario 0, the base case, slightly more promising results were exhibited for IH 35. For instance, in the southbound direction during the morning rush hour, the length of congestion (represented by the horizontal width of the red bands) is noticeably reduced. Likewise, a period of congestion that starts during the noon hour and extends to 8 pm around the downtown Austin area (between US 183 and Riverside) disappears under Scenario 3. Of note, the evening rush hour demonstrates generally worse traffic congestion in the southbound direction under Scenario 3.

For the northbound direction, the Scenario 3 morning peak period exhibits very little difference from Scenario 0. The noon hour period of congestion is reduced similar to the southbound direction. For the evening rush hour, the commute from downtown Austin to the north appears mostly the same as Scenario 0. Inbound traffic from the south toward downtown does experience marginal improvement under Scenario 3.

Overall, Scenario 3 did not offer the benefits that the Working Group and research team hoped that it would: tolling the area's primary roadways to maximize system efficiency seemed like it could offer significant benefits. However, as was noted above with regard to the fixed trip table, this technology depends upon other flexibility in the system that could not be modeled with the existing CAMPO travel demand model. An additional indication of the findings from Scenario 3 is that there may not be much additional capacity available in the Central Texas roadway system to take advantage of using system-wide dynamic pricing. That is, other facilities such as Loop 1/MoPac and US 183 are similarly congested.

A clear recommendation resulting from the examination of Scenario 3 is further work to maximize system efficiency, including in particular:

- Reviewing other primary travel corridors serving Central Texas, including further development of US 183, LP 360, RM 620, as well as continued investigation of approaches to utilize SH 130.
- Examining other north-south arterial roadways such as Red River, North Lamar, Burnet Road, and Pleasant Valley to maximize efficiency for local travel, including light synching and multimodal access.
- Continuing to address the most critical bottlenecks to system-wide efficiency, for example connections between primary facilities or the operation of systems conducting high levels of



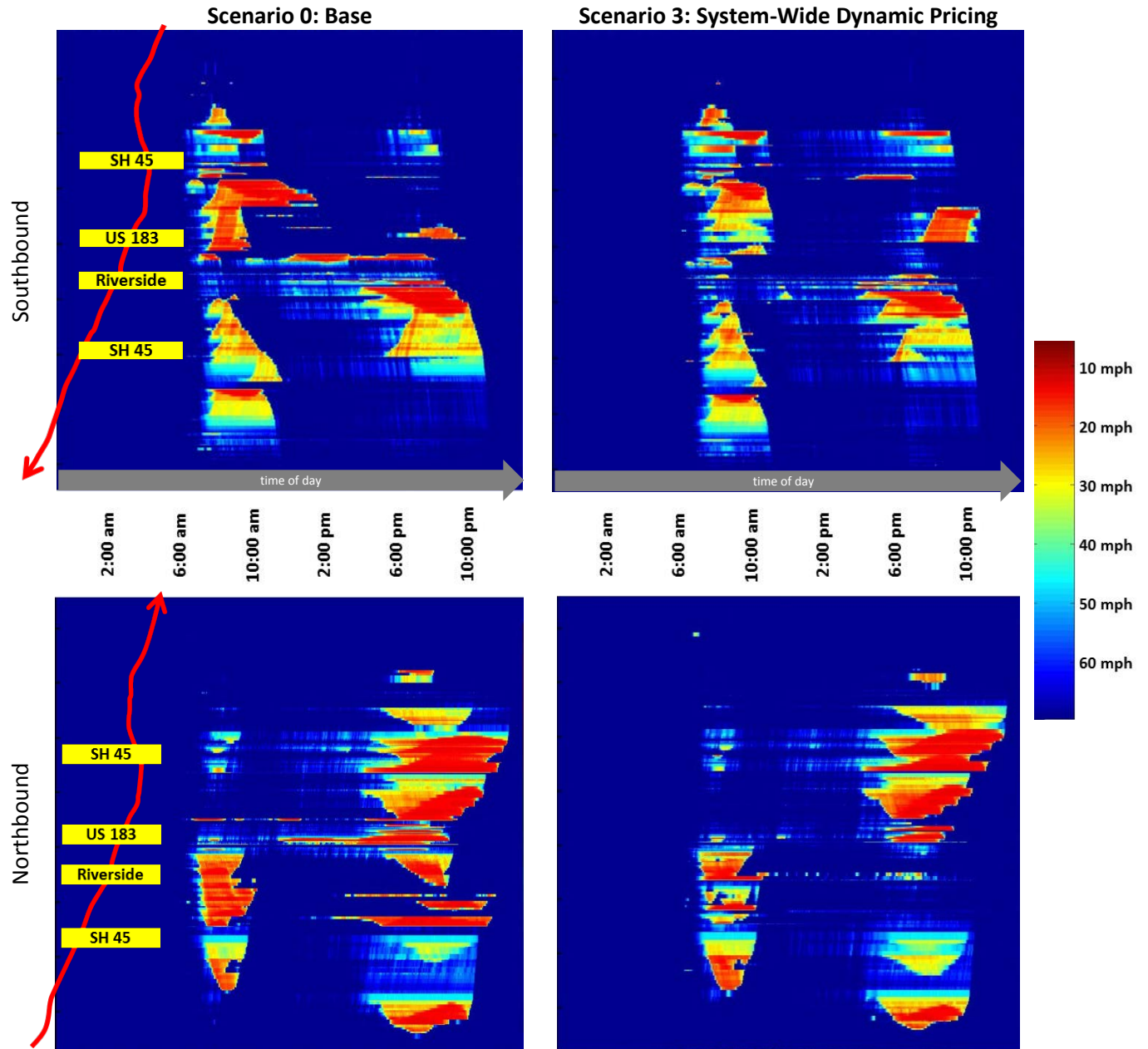
peak-period traffic such as Austin's downtown roadway network connection to IH 35 and Loop 1/MoPac.

- Exploring options for additional parallel capacity to IH 35, for example a potential US 183 South connection to SH 45 south of SH 71.

These findings and recommendations are merely a starting point; the ideas proposed by the Working Group require further discussion and exploration to determine the best mobility options for Central Texas.

## Exhibit 21 Scenario 3 Heat Diagram Comparison

24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes



## Scenario 4: My35 Conversion Plus

### Description

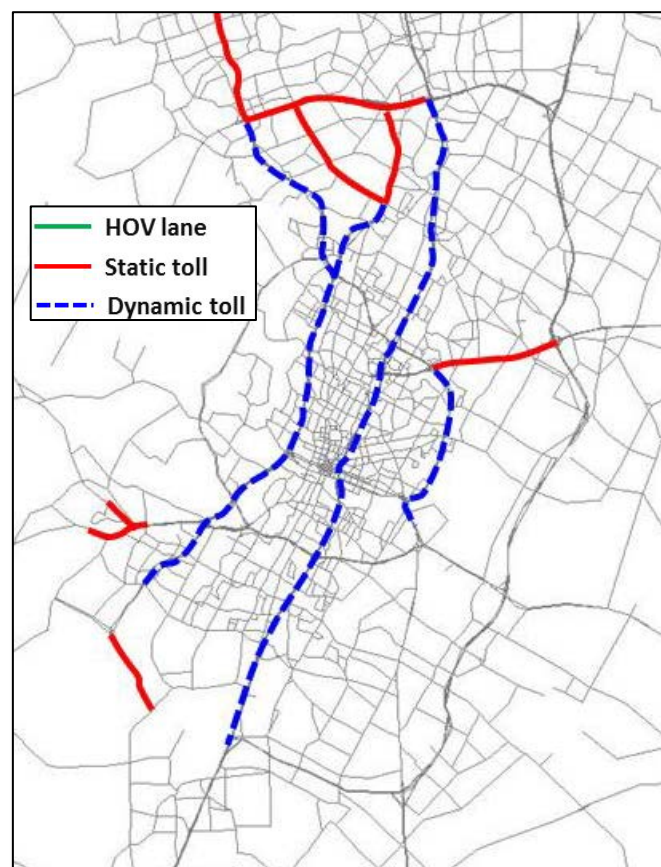
Scenario 4 is based on a concept derived by local stakeholders as part of the My35 statewide study. It includes one express lane added to IH 35 in each direction. The lane configuration and ramp access were coded between 51st Street and William Cannon according to the City of Austin study in the summer of 2012. In addition, one existing IH 35 general purpose lane between SH 45 North and SH 45 South is assumed to be converted into an express lane, which presents a critical caveat: federal law currently prohibits the conversion of existing general purpose lanes on an Interstate facility to tolled lanes. This study explores this scenario to see if benefits merit exploring an exception. These express lanes are assumed to be tolled dynamically, with HOV3+ and bus transit using the lanes for free. Tolls along SH 130/SH 45 Southeast around Austin are removed completely and SH 130 is redesignated as Interstate to SH 130/SH 45 Southeast.

The tolling assumptions for this scenario are depicted in Exhibit 22. As a reminder, all scenarios are based upon the current CAMPO-adopted MTP, and therefore include all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

### Assumptions

- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of the each facility, but without considering tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Minimum toll (\$0.25) for autos and (\$0.25) for trucks.
  - Maximum toll (\$200.00).
  - HOV 3+ free.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed and level of service.

**Exhibit 22 Scenario 4 Tolling Assumptions**



- HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.

### Technical Assessment

Exhibit 23 shows the performance measures for Scenario 4, My35 Conversion Plus. The region-wide VHT and PHT values are unremarkable, demonstrating almost no change from Scenario 0, the base case, except for the case of external through trips. In the case of trips with both an origin and a destination outside the study area, Scenario 4 actually represents a net worsening by 3% of the VHT/PHT measures. This result of worsening region-wide statistics for external through trips is an indicator of what is occurring at the route level for both IH 35 and SH 130.

**Exhibit 23 Scenario 4 Performance Measures**

Performance Measure	Scenario 0: Base		Scenario 4: My35 Conversion Plus	
Daily Vehicle-Hours Traveled (VHT) Region-Wide				
Total	3,705,800		3,689,200	
Trips with at least an origin or destination inside the study area	3,687,900		3,670,800	
Trips with both origin and destination outside the study area	17,900		18,400	
Daily Person-Hours Traveled (PHT) Region-Wide				
Total	3,879,300		3,861,900	
Trips with at least an origin or destination inside the study area	3,860,500		3,842,600	
Trips with both origin and destination outside the study area	18,800		19,300	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231	189	236
Using SH 130	177	117	166	85
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301	177	336
Using SH 130	217	315	163	338

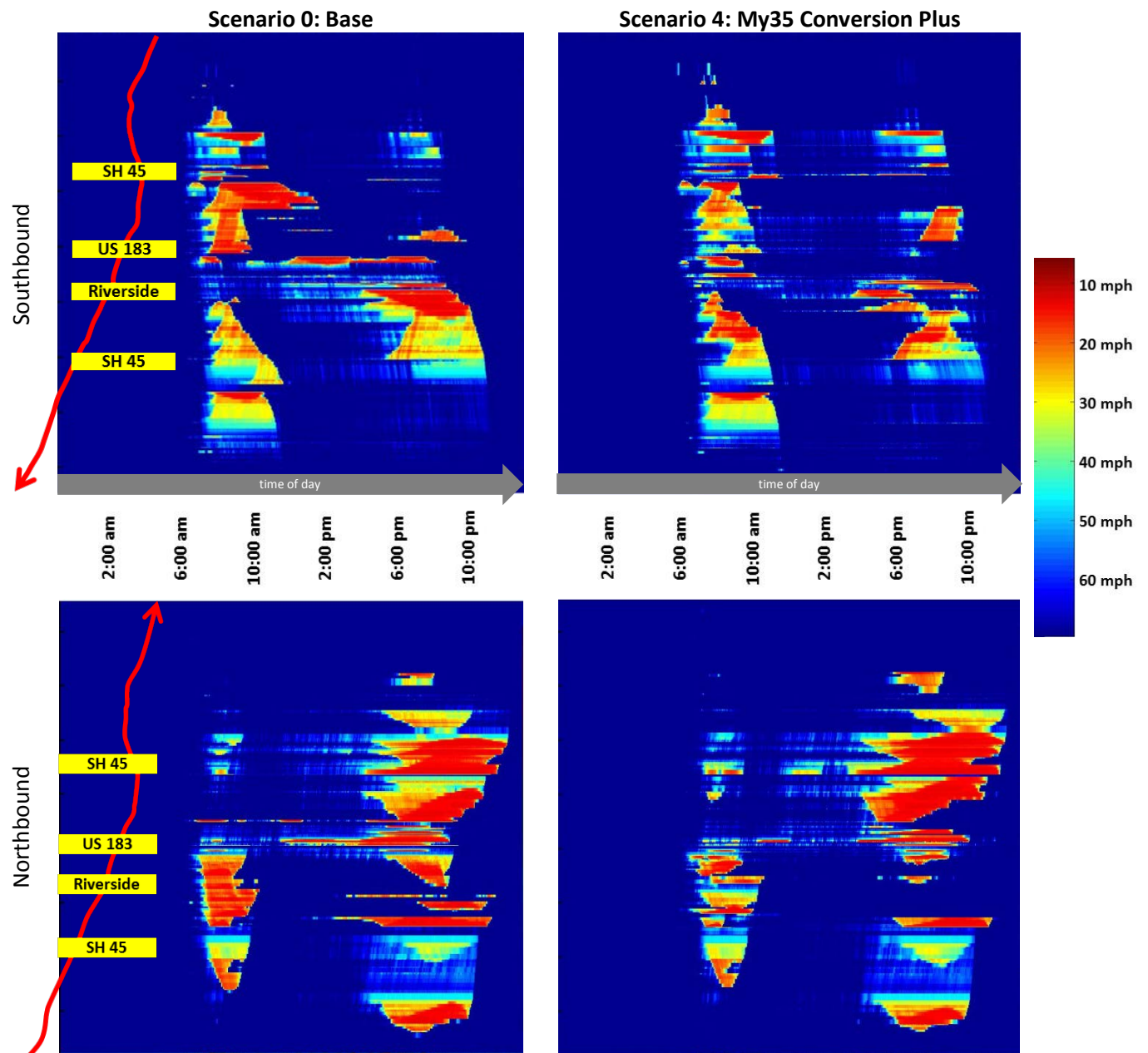
Point-to-point travel times are mixed for Scenario 4. It demonstrates positive results for the northbound direction during the morning peak period: 177 minutes down from 221 for IH 35, and 163 minutes down from 217 for SH 130. However, Scenario 4 exhibits increases during both morning and evening peak periods for IH 35 in the southbound direction. The increase in the southbound direction during the

morning peak period is especially concerning, given that this movement is the worst movement identified in Scenario 0 already.

The heat diagram analysis for Scenario 4 is shown in Exhibit 24.

### Exhibit 24 Scenario 4 Heat Diagram Comparison

*24-Hour, IH 35 between North Williamson County Line and South Hays County Line on General Purpose Lanes*



The heat diagram provides some interesting insights into the statistics presented in Exhibit 23. For instance, one notable aspect of the Scenario 4 southbound heat diagram is that Scenario 4 does significantly improve the inbound commute experience for drivers coming from the north end of the study area headed toward downtown Austin during the morning commute. This is apparent from the substantial reduction in the width of red between SH 45 and Riverside. And yet the total point-to-point travel time for southbound travel during the morning peak went up under Scenario 4 over Scenario 0. The heat diagram demonstrates that the gain in travel time in this direction is due to the additional congestion (red bands, in the heat diagram) after downtown Austin, headed south. Similarly, still in the southbound direction, Scenario 4 does appear to offer some advantages in improving the evening peak commute for the area south of Riverside. And yet, north of US 183, Scenario 4 demonstrates worsening conditions.

In the northbound direction, Scenario 4 demonstrates minor improvement during the morning peak period, but little in the evening peak period. Especially for the movement of commuters outbound from downtown Austin, this scenario appears to offer little advantage.

Overall, the researchers found Scenario 4 to offer little quantitative advantage from the regional perspective. However, the findings for the operational effects for southbound travelers, especially for the inbound morning direction from Williamson County, do validate the effort of examining this scenario.



## Scenario 5: My35 Swap

### Description

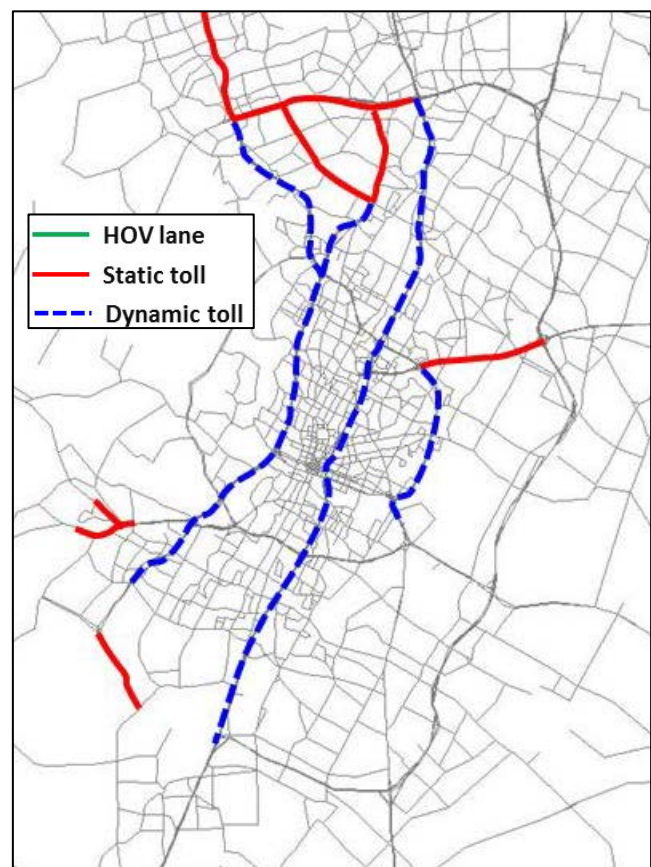
Scenario 5 explores a concept derived by local stakeholders as part of the My35 statewide study. No added capacity. Toll all existing IH 35 mainlanes dynamically during am and pm peak periods (6-9 am and 4-7 pm); HOV3+ and bus transit ride for free. This scenario does present a critical caveat: federal law currently prohibits the conversion of existing general purpose lanes on an Interstate facility to tolled lanes. This study explores this possibility to see if benefits merit exploring an exception. Remove tolls from SH 130/SH 45 Southeast completely and redesignate Interstate to SH 130/SH 45 Southeast.

The tolling assumptions for this scenario are depicted in Exhibit 25. As a reminder, all scenarios are based upon the current CAMPO-adopted MTP, and therefore include all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

### Assumptions

- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of each facility, but without considering tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Min toll (\$0.25) for autos and (\$0.25) for trucks.
  - Max toll (\$200.00).
  - HOV 3+ free.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed and level of service.
- HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.

Exhibit 25 Scenario 5 Tolling Assumptions



- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.

### Technical Assessment

Scenario 5 performance measures are shown in Exhibit 26. Overall, Scenario 5 demonstrates some improvement to region-wide system statistics, and notable improvement to point-to-point travel times for IH 35 and SH 130.

**Exhibit 26 Scenario 5 Performance Measures**

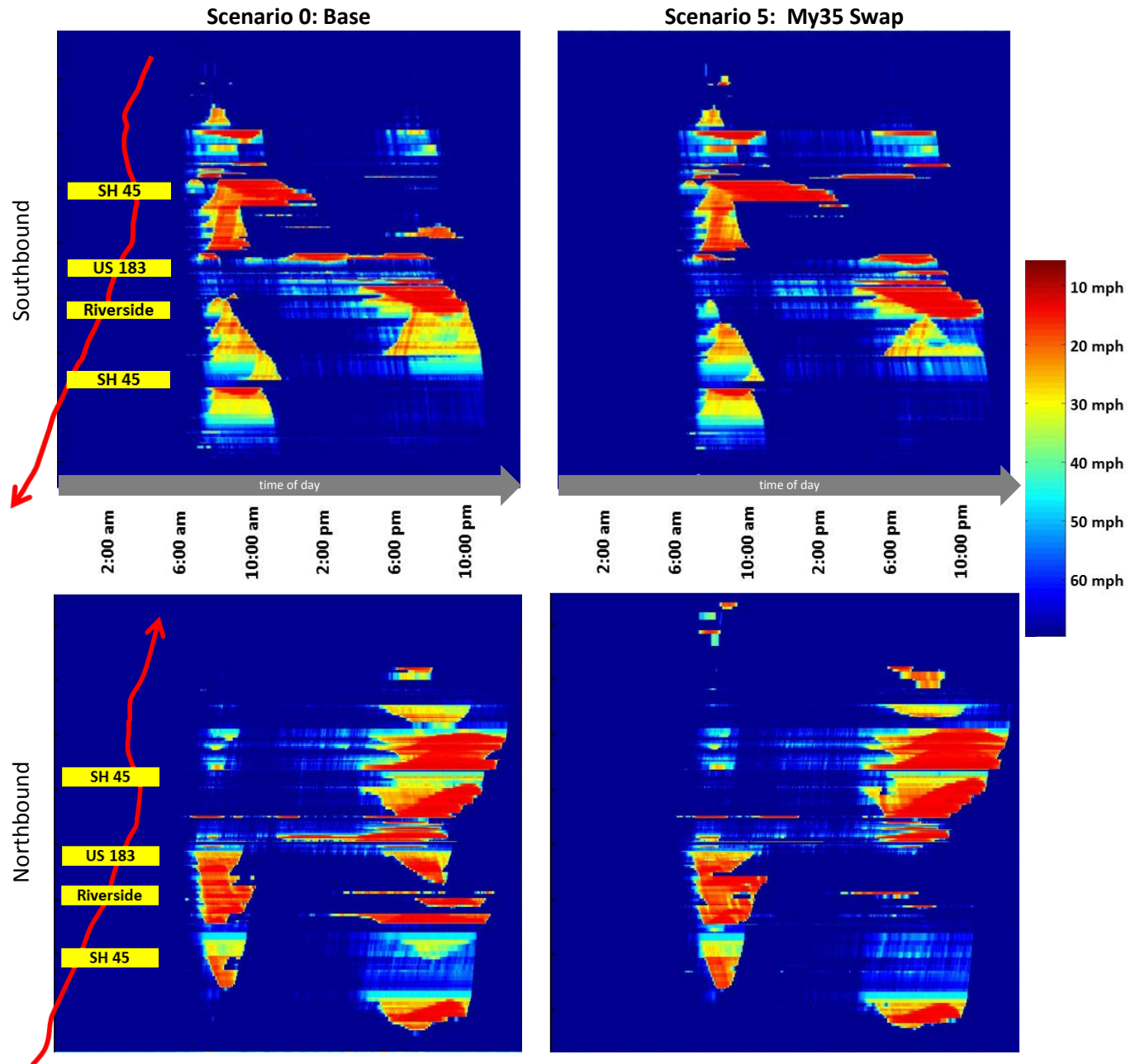
Performance Measure	Scenario 0: Base		Scenario 5: My35 Swap	
Daily Vehicle-Hours Traveled (VHT) Region-Wide				
Total	3,705,800		3,787,600	
Trips with at least an origin or destination inside the study area	3,687,900		3,769,100	
Trips with both origin and destination outside the study area	17,900		18,500	
Daily Person-Hours Traveled (PHT) Region-Wide				
Total	3,879,300		3,964,900	
Trips with at least an origin or destination inside the study area	3,860,500		3,945,500	
Trips with both origin and destination outside the study area	18,800		19,400	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231	174	153
Using SH 130	177	117	142	83
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301	179	293
Using SH 130	217	315	185	275

With respect to region-wide change, Scenario 5 demonstrates a solid 2% reduction in system-wide VHT/PHT for total trips, and a 3% reduction for through trips. Point-to-point travel times exhibit the most reduction in the southbound direction in the evening peak period and the northbound direction in the morning peak period.

Exhibit 27 presents the heat diagrams for Scenario 5. In the southbound direction, Scenario 5 exhibits extended queuing in the morning and evening peak periods, as demonstrated by the widened bands of red in the horizontal (time) direction. In the northbound direction, Scenario 5 demonstrates some improvement to evening rush hour mobility between SH 45 and US 183, but otherwise minimal improvement to worsened conditions.

## Exhibit 27 Scenario 5 Heat Diagram Comparison

24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes



## Scenario 6: Capacity Addition through Core

### Description

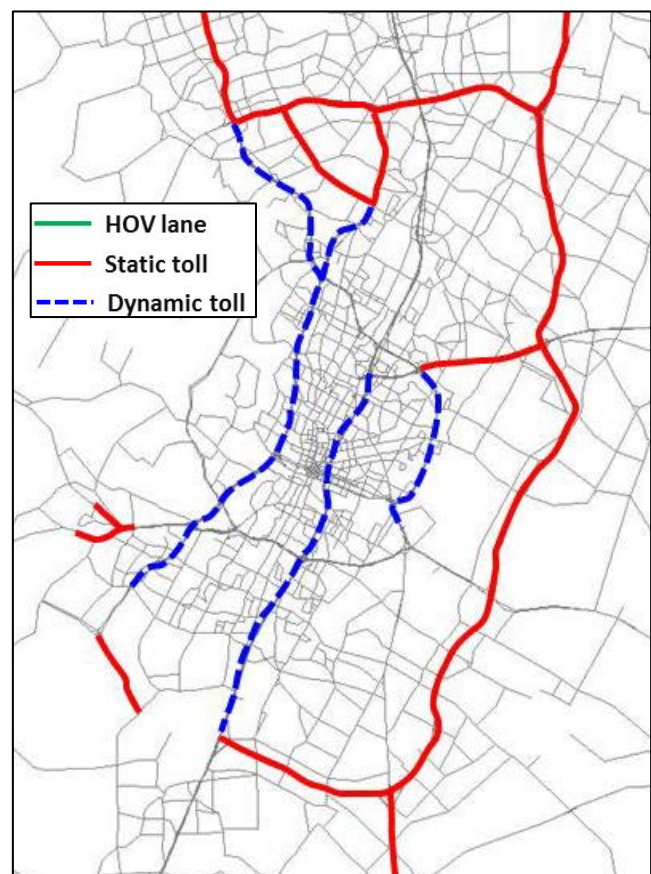
Explores a concept frequently discussed as an ultimate need to address future congestion. Concept was examined as three additional express lanes in each direction, depressed or tunneled, and dynamically tolled; HOV3+ and bus transit ride for free.

### Other Scenario Features

The tolling assumptions for this scenario are depicted in Exhibit 28. As a reminder, all scenarios are based upon the current CAMPO adopted MTP, and therefore include all 2035 CAMPO adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

- Assumptions
- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of each facility, but without considering tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Min toll (\$9.94) for autos and (\$31.58) for trucks.
  - Max toll (\$200.00).
  - HOV 3+ free.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed and level of service.
- HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.

**Exhibit 28 Scenario 6 Tolling Assumptions**



## Technical Assessment

Scenario 6 performance measures are detailed in Exhibit 29. These results, overall, were the most illuminating of the initial scenarios, because of the largely anecdotal perception by many Central Texans that the IH 35 mobility issues are mostly the result of through traffic, and particularly through trucks. The general theory behind examining this scenario was that additional through capacity bypassing the central Austin core would serve the through traffic and improve general purpose lane mobility on existing IH 35. As Exhibit 29 measures demonstrate, this theory proved to be largely false.

**Exhibit 29 Scenario 6 Performance Measures**

Performance Measure	Scenario 0: Base		Scenario 6: Capacity Addition through Core	
Daily Vehicle-Hours Traveled (VHT) Region-Wide				
Total	3,705,800		3,736,000	
Trips with at least an origin or destination inside the study area	3,687,900		3,717,700	
Trips with both origin and destination outside the study area	17,900		18,400	
Daily Person-Hours Traveled (PHT) Region-Wide				
Total	3,879,300		3,910,900	
Trips with at least an origin or destination inside the study area	3,860,500		3,891,700	
Trips with both origin and destination outside the study area	18,800		19,200	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231	204	204
Using SH 130	177	117	168	128
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301	203	315
Using SH 130	217	315	204	316

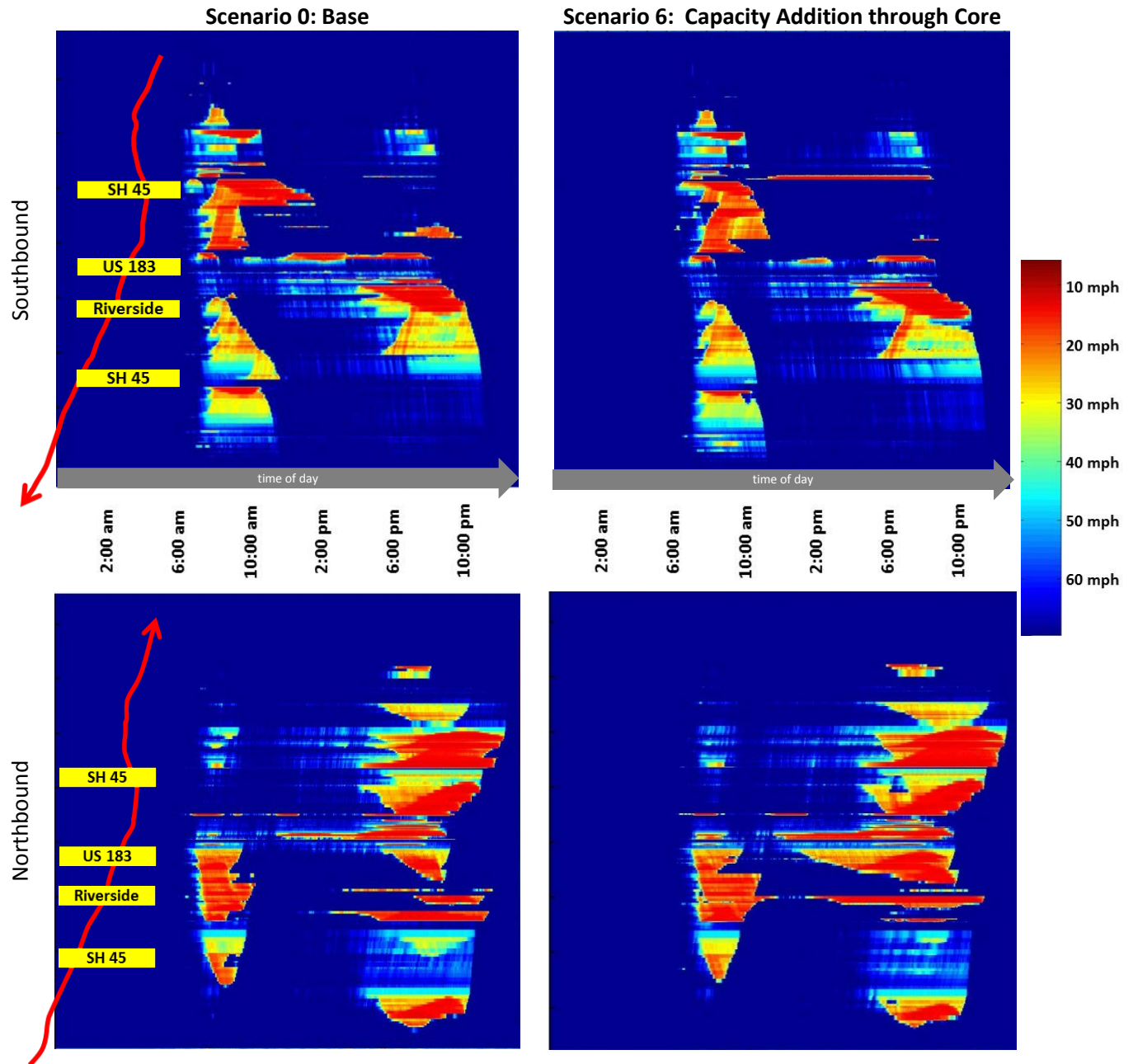
As shown in Exhibit 29, region-wide system measures of VHT and PHT went down only 1% for total daily travel, although through travelers did see a reduction of 2% to 3%. The point-to-point travel time results are mixed.

Exhibit 30 presents the heat diagrams for Scenario 6 alongside those for Scenario 0, the base case. As a reminder, the heat diagrams consider the conditions along the IH 35 existing general purpose lanes and not the express lanes proposed to be added under Scenario 6. For the additional express lanes, three lanes in each direction, it should be noted that the capacity on these lanes was not filled and the dynamic tolling mechanism was not called. That is, the tolls remained at the minimum toll value because there was insufficient congestion on the express lanes to warrant a higher tolling rate. Therefore, these express lanes may be assumed to be operating at free-flow speeds with associated advantageous travel times.



### Exhibit 30 Scenario 6 Heat Diagram Comparison

24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes



Looking more closely at the heat diagram in Exhibit 30, the southbound direction of the IH 35 general purpose lanes includes an improvement during the morning rush hour for the inbound direction, and yet a localized congestion band around SH 45 appears to be a bottleneck (this could be an issue easily resolved with an operational or modal coding adjustment). The southbound evening rush hour appears slightly worsened.



In the northbound direction, congestion appears slightly worse during the morning peak period (wider bands of red), and roughly the same during the evening peak period.

Scenario 6 results were illuminating, owing to a largely anecdotal perception by many Central Texans that existing IH 35 mobility issues are mostly the result of through traffic, particularly through trucks. The general theory prior to this research study had been that additional through capacity bypassing central Austin would serve through traffic and improve IH 35 general purpose lane mobility. In contrast, for the three express lanes added in Scenario 6, the analysis demonstrated that the capacity on these lanes was not filled and the dynamic tolling mechanism was not triggered. That is, the tolls remained at the minimum toll value because there was insufficient congestion on the express lanes to warrant a higher tolling rate. Thus, the results for Scenario 6 contradict the theory of through traffic being largely the cause of IH 35 congestion.

Overall, the results for this scenario prompted the researchers to suggest to the MIP Working Group an additional analysis to expand both the length of the proposed improvement (up to SH 45 North), as well as expanded access points along the entire length between SH 45 North and SH 45 South. This additional scenario is presented as Scenario 6 Expanded under the Supplemental Analyses section of this report.

## Scenario 7: Downtown Austin Alternative

### Description

Suggested as an alternative for consideration by a local stakeholder group, this scenario is most similar to Scenario 2, with the exception of testing an alternate configuration for the mainlanes, frontage roads, ramps, and cross-streets between Martin Luther King Jr. Boulevard and Holly Street. As with Scenario 2, Scenario 7 closely represents current local planning efforts toward an interim, short-term improvement—adding one lane for some yet-to-be-determined purpose in each direction to IH 35 within the existing right-of-way—except for the area of Downtown Austin.

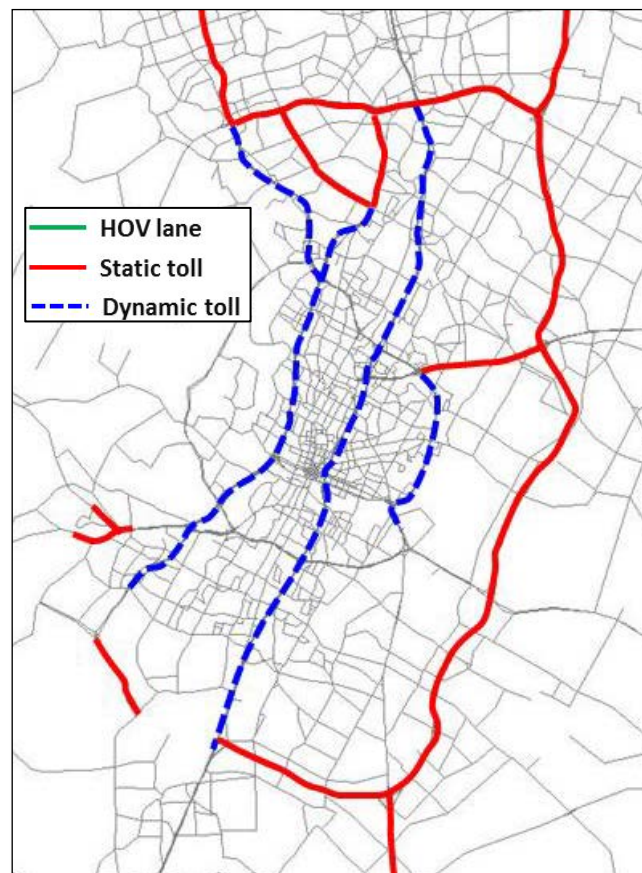
### Other Scenario Features

As for all the scenarios examined for this study, a starting assumption is the 2035 CAMPO-adopted plan roads and transit network consistent with the current CAMPO-adopted plan. Tolling assumptions are shown in Exhibit 31. All scenarios based upon the current CAMPO-adopted MTP include all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

One express lane is added to IH 35 in each direction, allowing HOV 3+ and bus transit access with no toll. HOV2 and SOV vehicles pay an auto toll rate and truck vehicles pay a truck toll rate. Express lane configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South, except for the area between Martin Luther King Jr. Boulevard and Holly Street.

Between Martin Luther King Jr. Boulevard and Holly Street, the concept assumes that IH 35 mainlanes and the additional express lanes are below ground level, providing additional ground-level space for land development and IH 35 cross-connectivity. Lane widths and access configuration were provided for this scenario by a local stakeholder group.

**Exhibit 31 Scenario 7 Tolling Assumptions**



## **Assumptions**

- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of each facility, but without considering tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Min toll (\$0.25) for autos and (\$0.25) for trucks.
  - Max toll (\$200.00).
  - HOV 3+ free.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed and level of service.
- Any HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.

## **Technical Assessment**

Scenario 7 performance measures are presented in Exhibit 32. Scenario 7 demonstrates a 5% reduction—from 3.7 million to 3.5 million—in VHT region-wide. PHT, calculated using VHT and vehicle occupancy factors, demonstrates the same percentage reduction. This 5% reduction is not insignificant: as explained for Scenario 2, this 5% reduction of PHT for the region overall translates into roughly \$1 billion travel time cost savings annually.

With regard to point-to-point travel time, Scenario 7 demonstrates generally positive results except for the morning northbound direction.

**Exhibit 32 Scenario 7 Performance Measures**

Performance Measure	Scenario 0: Base		Scenario 7: Downtown Austin Alternative	
Daily Vehicle-Hours Traveled (VHT) Region-Wide				
Total	3,705,800		3,529,582	
Trips with at least an origin or destination inside the study area	3,687,900		3,512,686	
Trips with both origin and destination outside the study area	17,900		16,896	
Daily Person-Hours Traveled (PHT) Region-Wide				
Total	3,879,300		3,694,810	
Trips with at least an origin or destination inside the study area	3,860,500		3,677,123	
Trips with both origin and destination outside the study area	18,800		17,687	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231	198	205
Using SH 130	177	117	155	98
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301	195	318
Using SH 130	217	315	175	282

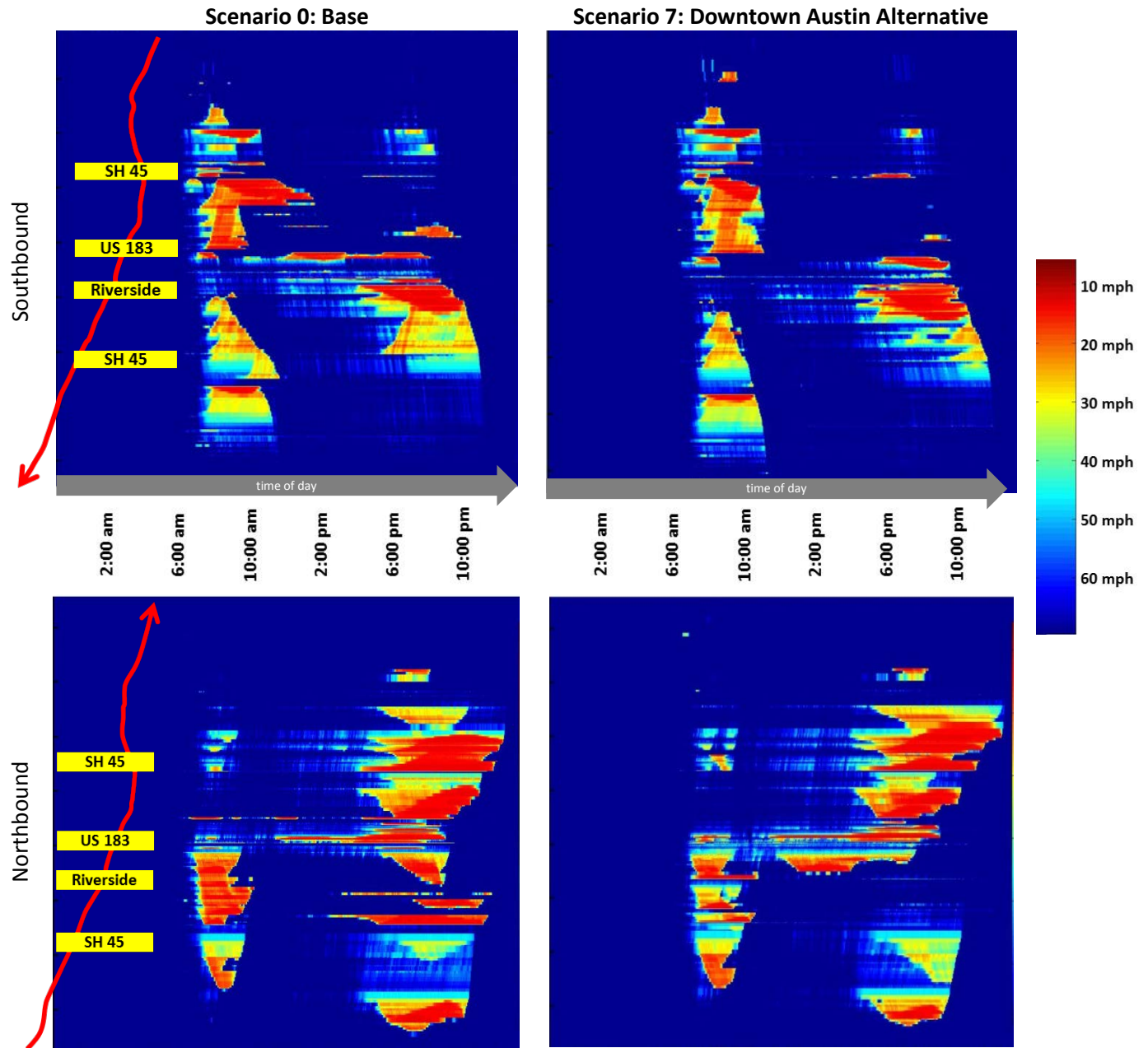
Exhibit 33 presents the heat diagram that communicates the level of congestion being encountered by drivers on IH 35. This exhibit includes the heat diagrams for Scenario 7 with Scenario 0 for comparison.

These heat diagrams demonstrate some reduction in localized congestion along IH 35, for example in addressing mid-day congestion in the area between US 183 and Riverside in the southbound direction. In addition, in the southbound direction, the congestion represented by the length and width of the red area between SH 45 North and US 183 does appear to improve noticeably. In the evening peak period, however, IH 35 mobility south of Riverside appears slightly worse.

For the northbound direction, the result overall is mixed. During the morning peak period, mobility for commuters between Hays County and downtown Austin improves, as demonstrated by the reduction in red in the heat diagram. However, the section of IH 35 north of US 183 appears to exhibit a still brutal level of congestion during the evening peak as for Scenario 0, the base case. The area between SH 45 and Riverside during the evening peak period appears much improved.

### Exhibit 33 Scenario 7 Heat Diagram Comparison

24-Hour, IH 35 between North Williamson County Line and South Hays County Line on General Purpose Lanes



As mentioned above, Scenarios 2 and 7 most closely represent current local planning efforts toward an interim, short-term improvement—adding one lane for some yet-to-be-determined purpose in each direction to IH 35 within the existing right-of-way. At the region-wide level, Scenario 7, like Scenario 2, relieves some future congestion versus the base scenario and these two scenarios performed the best overall among the initial scenarios. For point-to-point travel times, Scenario 7 appears generally better.



However, in comparing the Scenario 2 and Scenario 7 heat diagrams, Scenario 7 does appear to demonstrate some additional localized queuing.

Much more analysis will be necessary, and some is already underway, to consider specifics of this express lane configuration if it continues to move forward. Such a study should consider the issue of maximizing facility efficiency; the concept's potential for non-traditional funding of construction and maintenance; as well as other social and environmental considerations necessary for any such transportation project. With regard to a tolling strategy, given the findings of this study regarding the magnitude of potential users, it is likely that express bus transit will be the only reasonable exception to the tolls; any other toll-free usage, for example by high-occupancy vehicles, is likely to compromise the operational efficiency of the express lane facility.

## Summary of Comparative Findings

Several performance measures were used to analyze the initial scenarios, Scenario 0 through Scenario 7. This section provides comparisons for those scenarios (more information for each scenario was presented in the previous section).

### Performance Measure: Region-Wide Person-Hours Traveled

PHT represents the total daily time spent by people using Central Texas roadways (the five counties in the CAMPO model study area). Because this metric is extracted from the DTA meso-scopic simulation, it does not include people traveling by non-personal vehicle modes. That is, it does not include people's trips by walking, bicycling, or bus or rail transit.

As summarized in Exhibit 34, auto and truck drivers in Central Texas will spend an average of 3.88 million hours on the road in 2035 under Scenario 0, the base case. As a reminder, Scenario 0 includes no capacity improvements to IH 35. This translates to approximately \$80 million of travel time cost per day, based on person- and truck-values-of-time. While the percentage reductions demonstrated by the scenarios reported in Exhibit 34 are in the single digits, a 5% reduction in regional travel time translates into roughly \$1 billion in travel time cost per year.

**Exhibit 34 Person-Hours Traveled, Scenarios 0-7**

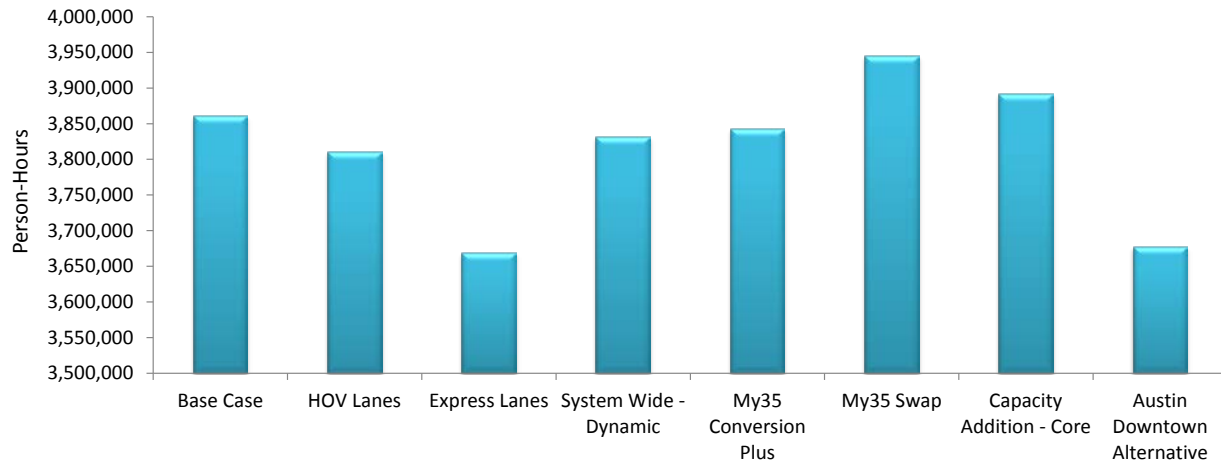
*(Daily 24-hour Period)*

	Scenarios							
	0	1	2	3	4	5	6	7
	Base	HOV Lanes	Express Lanes	System-Wide Dynamic Pricing	My35 Conversion Plus	My35 Swap	Capacity Addition through Core	Downtown Austin Alternative
Person-Hours Traveled	3.88 M	3.83 M	3.69 M	3.85 M	3.86 M	3.96 M	3.91 M	3.69 M
Percent Change (%)	-	-1%	-5%	-1%	0%	2%	1%	-5%

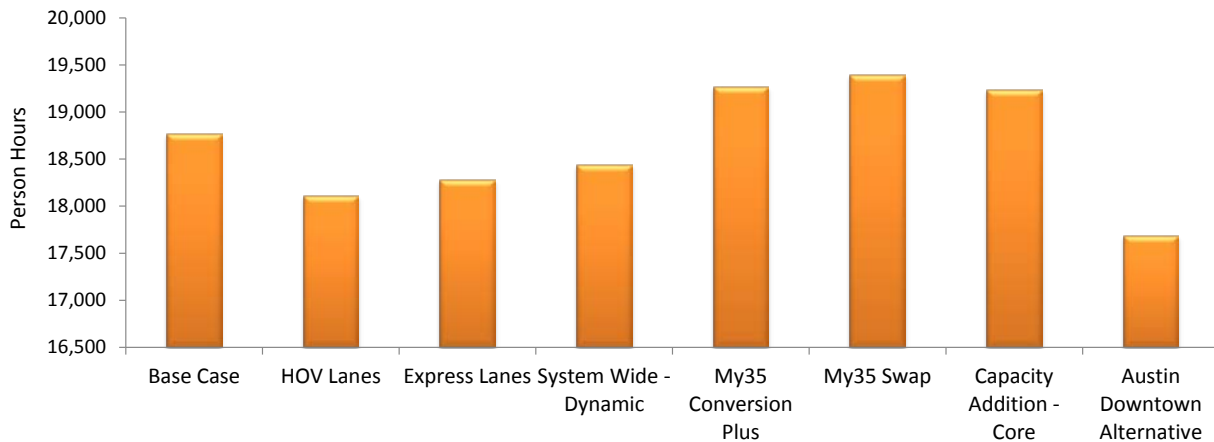
### Performance Measure: Region-Wide Person-Hours Traveled by Internal and External Travel

Total PHT can be disaggregated into two groups: trips internal to the study area (trips with either an origin or destination within the five-county study area) and trips external to the study area (trips with both origin and destination outside the study area). The distribution of PHT by these two sub-groups is summarized in Exhibit 35 for internal trips and Exhibit 36 for external trips. One interesting observation is that each group, if provided only the PHT metric for evaluating these scenarios, would prefer a different scenario. And yet, Exhibit 35 and Exhibit 36, presented as they are, appear to have similar weight. Looking closely at the vertical axis, it is clear that internal trips represent a much higher percentage of PHT occurring within the Central Texas study area. This observation demonstrates a key finding for this modeling effort: Central Texans and travelers with a reason to stop in the area have a much greater impact on Central Texas congestion than through travelers.

**Exhibit 35 Person-Hours Traveled, Scenarios 0-7, Internal Trips Only**



**Exhibit 36 Person-Hours Traveled, Scenarios 0-7, External Trips Only**



Another way to look at Exhibit 35 and Exhibit 36 is that Central Texans and those stopping in the area experience a much greater share of the area's congestion than through travelers. To be clear, the figures above for person-hours traveled do not represent the number of people in each group, but the hours each group spends on the road in Central Texas over a typical 24-hour period. One substantial factor behind this statistic is that the proportion of through travelers represents a small number of the total people using Central Texas roadways. Another factor is that the internal trips group includes drivers who come from outside of the study area but make a stop inside the area. The information regarding these different populations—Central Texas residents staying within the study area, visitors to the area stopping for business or personal reasons in the study area, and drivers traveling straight through the study area without stopping—is considered so important that the research team conducted further investigation into this issue, summarized under the Supplemental Analysis section starting on page 71.

### Performance Measure: IH 35 Travel Time

A metric of specific interest is the peak-period travel time along IH 35 through the study area by scenario. This metric considers the travel time derived using the DTA meso-scopic analysis. It does not include people's trips by walking, bicycling, or bus or rail transit, only by auto or truck vehicle.

Exhibit 37 summarizes the travel times experienced during the morning and evening peak periods by through travelers entering and exiting the Austin metropolitan area using IH 35 in 2035. For perspective, according to 2011 data in the analysis of the 100 most congested Texas road segments (source: <http://www.txdot.gov/inside-txdot/projects/100-congested-roadways.html>), the average travel time experienced during both peak periods in both directions was 104 minutes to cross the three counties of Williamson, Travis, and Hays. By 2035, the base scenario shows the travel times for the four combinations of direction and peak periods grow to between 178 minutes and 301 minutes. Most of the scenarios improve these travel times, but all of the averages appear to be at least an hour longer than today's travel times.

#### Exhibit 37 IH 35 Travel Time (min), Scenarios 0 through 7

*IH 35 General Purpose Lanes, between North Williamson County Line  
and South Hays County Line in 2035*

	Scenarios							
	0	1	2	3	4	5	6	7
	Base	HOV Lanes	Express Lanes	System-Wide Dynamic Pricing	My35 Conversion Plus	My35 Swap	Capacity Addition through Core	Downtown Austin Alternative
Southbound (AM)	178	213	176	192	189	174	204	198
Southbound (PM)	231	228	175	196	236	153	204	205
Northbound (AM)	221	187	212	189	177	179	203	195
Northbound (PM)	301	315	310	312	336	293	315	318

As an example of congestion faced by a typical commuter, the average 2011 morning and evening travel times in 2011 between Round Rock and downtown Austin and between Buda and downtown Austin are just over 32 minutes (according to the same 2011 data of the 100 most congested Texas road segments). As with Exhibit 37, Exhibit 38 and Exhibit 39 show more detailed comparisons of direction and time-of-day using the IH 35 general purpose lanes under each scenario. Some of the individual travel times in Exhibits 38 and 39 are near the 32 minute value, but all of the averages are well above today's travel times. Congestion will be better with some design and operating options, but travel times will be longer than today in all of the scenarios tested.

**Exhibit 38 IH 35 Travel Time (min), Scenarios 0 to 7: Morning Inbound in 2035**

*IH 35 General Purpose Lanes*

	Scenarios							
	0	1	2	3	4	5	6	7
	Base	HOV Lanes	Express Lanes	System-Wide Dynamic Pricing	My35 Conversion Plus	My35 Swap	Capacity Addition through Core	Downtown Austin Alternative
Round Rock to Austin CBD (AM)	99	92	69	62	94	94	104	109
Buda to Austin CBD (AM)	119	115	82	107	93	119	140	83

**Exhibit 39 IH 35 Travel Time (min), Scenarios 0 to 7: Evening Outbound in 2035**

*IH 35 General Purpose Lanes*

	Scenarios							
	0	1	2	3	4	5	6	7
	Base	HOV Lanes	Express Lanes	System-Wide Dynamic Pricing	My35 Conversion Plus	My35 Swap	Capacity Addition through Core	Downtown Austin Alternative
Austin CBD to Round Rock (PM)	193	217	207	203	230	189	227	196
Austin CBD to Buda (PM)	157	171	125	141	149	104	136	122



## KEY FINDINGS

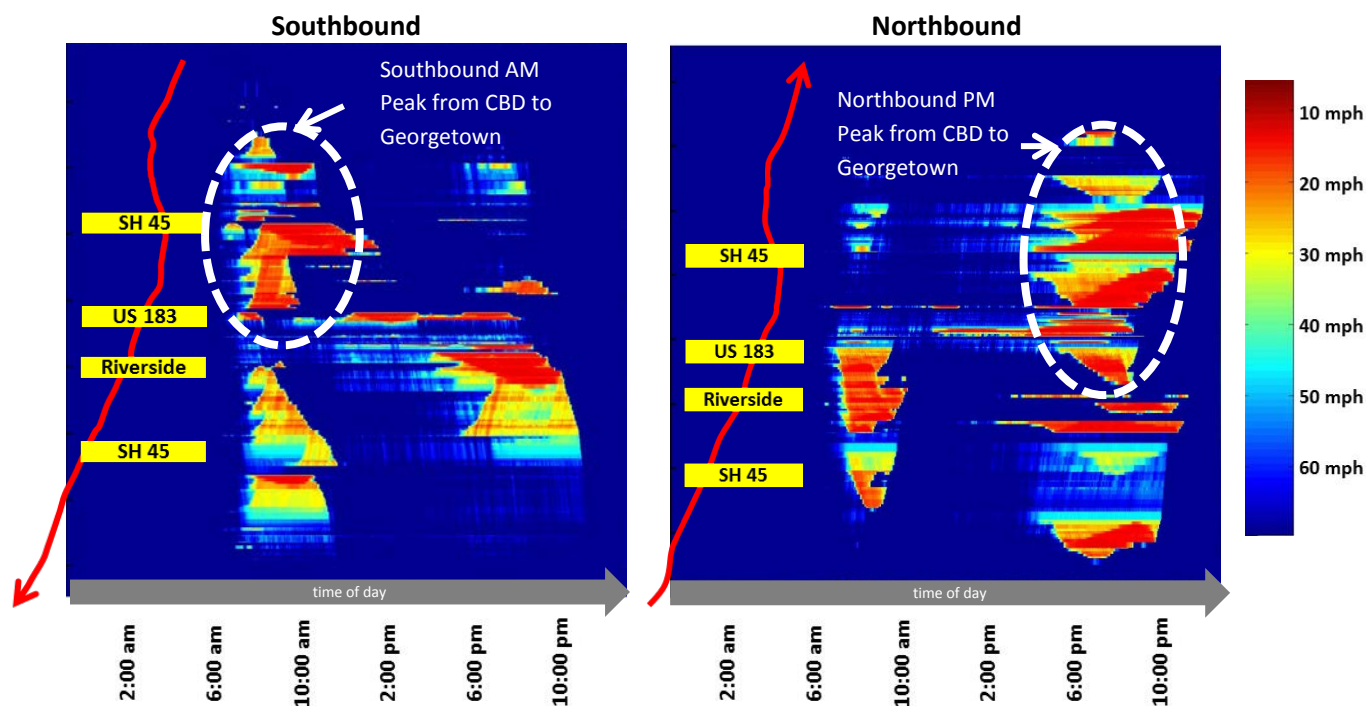
This section summarizes the technical findings about the capacity-addition and policy change scenarios described in the previous section. The scenario examinations revealed some surprising findings.

### Key Finding: The Problem is Huge

The most dramatic finding is that IH 35 congestion is fairly intractable in response to adding capacity in the initial scenarios tested. This finding is best illustrated in the heat diagram for Scenario 0, the base case for 2035 (Exhibit 40, presented previously). These diagrams represent the base case in 2035 with no IH 35 construction improvements. Unfortunately, due to the level of travel demand anticipated for the region and IH 35 in the year 2035, the heat diagrams for the seven scenarios examined showed only minor improvements, resulting in very similar heat diagrams. Other performance measures, including resulting point-to-point travel times for individual vehicles, also showed very little change among the initial scenarios examined. Basically, traffic “swamps” the IH 35 corridor and the Austin region in 2035. In addition, peak-period congestion is so bad that it extends into off-peak periods, for example as late as 10 pm.

#### Exhibit 40 Scenario 0 Base Case Heat Diagram

*24-Hour, IH 35 between North Williamson County Line and South Hays County Line on General Purpose Lanes*



## **Key Finding: The Problem is Central Texas Travelers**

As an additional finding resulting from analyzing the model results, the research team identified an apparent contradiction between a common perception voiced in Central Texas regarding the cause of IH 35 congestion and reality: that is, Central Texans and people making stops in Central Texas have a much greater impact than drivers traveling straight through the area. Although the focus of this modeling research was the long-term future, modeled by considering the year 2035, the researchers did additional research in the course of this study into the balance of travel occurring by through travelers versus local travelers and confirmed that Central Texans contribute the large majority of congestion, despite the common perception that through travelers are the root of the problem.

The magnitude of commuter and other local traffic using IH 35 is substantial and increasing due to local projected population and employment growth. Thus, through traffic (the traffic that many think should be bypassing Austin) is not the primary cause of Central Texas IH 35 congestion problems. As described above, study findings indicate that commuters or other trips with an origin or destination in the Austin area are the major factor influencing IH 35 congestion, not through travelers.

Attempts to re-route truck traffic from IH 35 to SH 130 will have limited impact on IH 35 congestion for two reasons. First, much of the truck traffic has an origin or destination or both near the corridor, making IH 35 a necessary or desirable route. Second, the analysis indicates that truck trips that are traveling through the Austin metropolitan area without stopping generally find the path afforded by IH 35 to be most efficient to allow them to meet their delivery schedule. The effect of congestion on business planning and development was not part of this study.

## **Key Finding: A Managed Lane Provides an Option to Severe Congestion—But with Only One Lane, It Is a Limited Option**

Any of the added managed access facilities provides IH 35 users a travel option to bypass the extensive congestion anticipated for the IH 35 general purpose lanes in 2035. The value of this option cannot be overstated: without adding a managed lane of some type, IH 35 users have only the choice of congested general purpose lanes or similarly congested alternative routes. Because these lanes are managed (typically by tolling), operational performance is maintained at a minimum level of service. The minimum level of operational performance assumed for the purpose of this study was an average speed of 45 mph along managed express lanes.

As mentioned above, Scenarios 2 and 7 most closely represent current local planning efforts by a partnership of agencies toward an interim, short-term improvement, that of adding one express lane in each direction to IH 35 within the existing right-of-way. Of the initial scenarios examined, both Scenario 2 and Scenario 7 relieve some future congestion versus the base scenario and performed the best overall among the initial scenarios.

## **Key Finding: Long-Term Solution Must Include More than Added Capacity**

This modeling research demonstrates that Central Texas cannot “build its way out of congestion” on IH 35. Examination of the initial set of scenarios demonstrates that, as capacity is added to IH 35, traffic moves to IH 35 from other streets and roads that operate with even worse congestion, in essence

“re-filling” the road. As described above, Central Texas drivers fill any capacity added to IH 35. Therefore, additional capacity provides little relief to peak-hour IH 35 general purpose lane congestion. And, because population and jobs are projected to grow so much in the corridor, any open road space created by new lanes is quickly filled. As the regional measures such as total daily vehicle-miles traveled demonstrate, adding capacity to IH 35 improves system-wide measures because these additional trips using IH 35 are better served. Additional capacity with controlled access, either by HOV restrictions or tolling, provides users a mobility option that is not present under the base scenario. However, the travel experience along the IH 35 general purpose lanes does not substantially improve as a result of any of the scenarios that only add roadway capacity.

### **What Does This Mean?**

The study team concluded that this effort demonstrates a very unlikely future. That is, the levels of congestion predicted for IH 35—in fact, the Central Texas region—will be unacceptable for local residents and business. In discussions with the MIP Working Group regarding these technical results, there is heightened concern that the levels of congestion demonstrated by this study would dampen the area’s growth in population and employment because people and businesses will quite simply not move here if the transportation infrastructure is insufficient to avoid this level of congestion. Therefore, with impacts predicted to be this substantial to quality of life and economic health, such levels of congestion will likely be unacceptable to future residents and businesses, so that the area’s growth is in fact, unsustainable.



## WHAT WOULD IT TAKE?

A key over-arching finding of the initial scenarios analysis was that the build solutions could not make a substantial impact on IH 35 congestion. A hybrid approach involving several strategies might be able to reduce future IH 35 congestion. The TTI research team explored the question “What Would It Take?” That is:

***What set of travel pattern, land use, and transportation improvement strategies are needed to address congestion on IH 35 in 2035?***

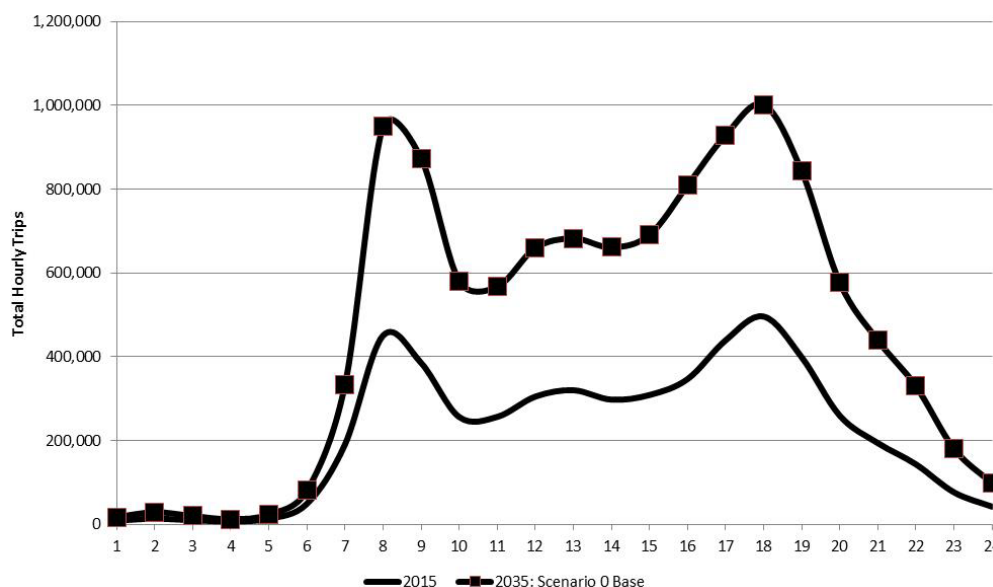
### Why Is IH 35 Future Congestion So Extreme?

Before considering a hybrid approach to address future congestion, it is critical to understand why congestion is anticipated to be so bad. Two factors are at play:

- The growth of population and employment anticipated for 2035 for the Austin metropolitan area is substantial.
- The standard modeling approach is to assume that people will exhibit the same travel behaviors in the future as they do today. This includes making the same number of trips each day, traveling the same average trip length for each type of trip, and choosing the mode of their trip based upon how they choose their mode of travel today.

Therefore, expected growth multiplied by existing travel behaviors results in an expanded number of auto-vehicle trips taken per hour in 2015 versus 2035, as shown in Exhibit 41.

**Exhibit 41 Total Hourly Auto-vehicle Trips for CAMPO Region (2015, 2035)**





As noted in the Key Findings chapter, the congestion resulting from this base assumption is extreme, with the assessment of the technical team being that this represents a “worst case.” The rationale for this being the worst case is that such levels of congestion will likely be unacceptable to future residents and businesses, so that the area’s growth is unsustainable. In this context, the research team developed a hybrid solution strategy for testing.

## **Hybrid Strategy Definition**

IH 35 congestion in 2035 depends on two assumptions:

- Residential and employment growth will continue in the same pattern and rate as estimated in the 2035 CAMPO plan.
- People will continue to exhibit the same daily travel behaviors they have currently.

The hybrid scenario was constructed around a continuation of the first assumption, that of continued growth. The initial analyses found that capacity expansion alone was insufficient to reduce congestion; therefore, the second assumption must change in order to reduce the congestion otherwise forecast for IH 35.

The hybrid strategy starts with the added capacity of Scenario 2, with modifications to the model so that Central Texans’ travel behavior responds more intuitively to anticipated congestion, including:

- Trip reduction (e.g., telecommuting, online university classes, teleshopping, etc.).
- Travelers shorten the distance they travel.
- Peak-period travel spreads into non-peak periods.
- HOV3, transit, and non-motorized travel doubles.

This scenario is further explored as Scenario 2c: “What Would It Take?” presented next. Scenario 2b, which explores HOV options, is presented under the Supplemental Analyses section.

## Scenario 2c: “What Would It Take?”

### Description

Based upon Scenario 2, one express lane is assumed to be added to IH 35 in each direction, HOV 3+ and bus transit access only, configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South.

In addition, allow HOV2 and SOV vehicles paying an auto toll rate and truck vehicles paying a truck toll rate. Congestion on these lanes is “managed” by allowing the toll rate to vary dynamically throughout the day in order to maintain vehicle flow.

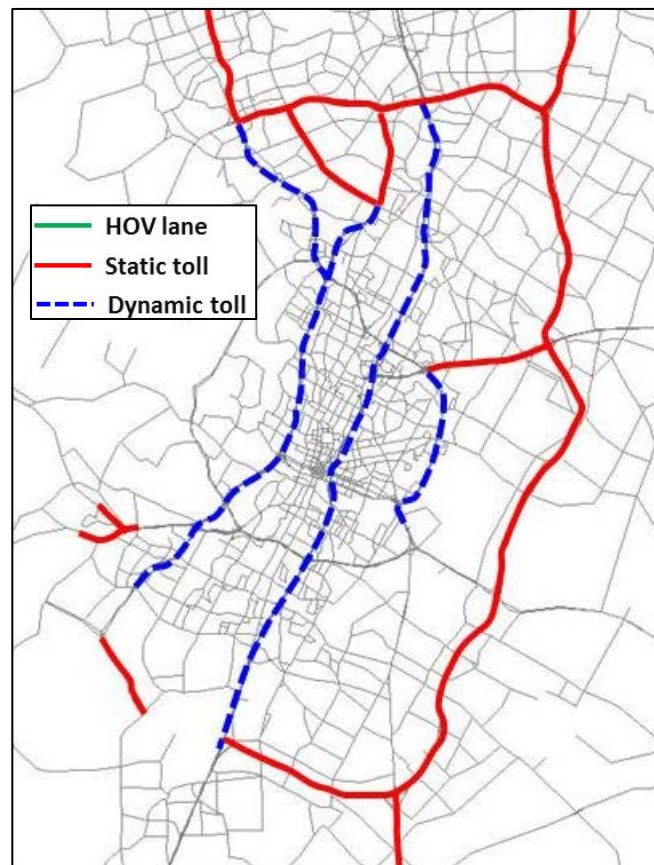
Based upon Scenario 0, the base case, the tolling assumptions for this scenario are depicted in Exhibit 42. As a reminder, Scenario 0 is consistent with the current CAMPO-adopted MTP, and therefore includes all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 by itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

The biggest difference of this scenario from others is that the 24-hour trip table used for the mesoscopic operational analysis has been adjusted. These trip-table assumptions are presented below.

### Trip Table Assumptions

- Each household in the region makes fewer overall trips per day, due to activities such as telecommuting, online educational opportunities, and retail activities, as well as general disincentive to travel due to regional congestion. Reductions made:
  - 40% fewer work trips.
  - 30% fewer university trips.
  - 10% fewer retail trips.
  - 5% fewer non-work trips.
- Travelers shorten travel distances they are willing to make, reflected in an overall reduction in trip lengths by trip purpose input into the model.

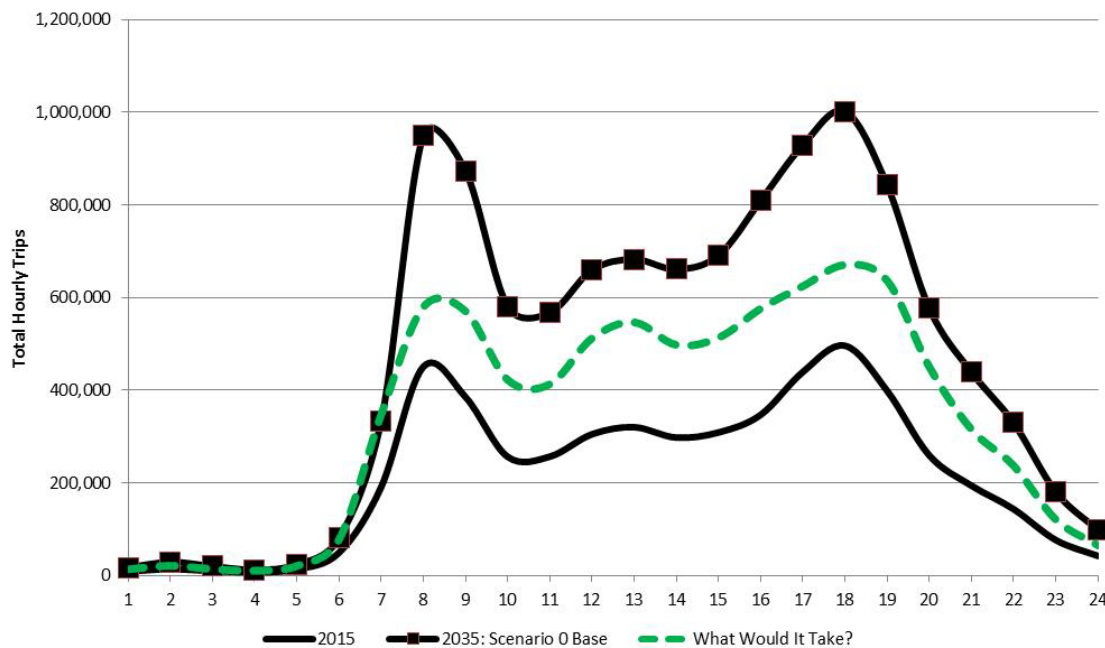
**Exhibit 42 Scenario 2c Tolling Assumptions**



- Factors used to distribute trips across the 24 hours of the day by trip purposes were adjusted to “flatten” the peak periods and distribute trips to off-peak periods.
- Shares of HOV3+, bus and rail transit, and non-motorized travel were each increased by 25%. For HOV3+, this impact is significant, translating into an average of 3.2 SOV vehicles for each HOV vehicle.

As a result of the above trip table adjustments, the total hourly auto vehicle trips for the CAMPO region are significantly reduced, as shown with the green dashed line in Exhibit 43.

**Exhibit 43 Total Hourly Auto-Vehicle Trips for CAMPO Region, Scenario 2c: “What Would It Take?”**



### Other Assumptions

- The biggest change in assumptions for this scenario is the trip table not being fixed, as described above. Otherwise, see section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of each facility, but without considering tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Min toll (\$0.25) for autos and (\$0.25) for trucks.
  - Max toll (\$200).
  - HOV 3+ free.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed.

- HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.

### Technical Assessment

Exhibit 44 details the performance measures of Scenario 2c in comparison to Scenario 0, the base case. The results are exactly as the researchers and the MIP Working Group had expected when defining this scenario: region-wide statistics of VHT are reduced substantially by 49% (to 1.9 million from 3.7 million for all daily travel). The PHT reduction percentage differs from that of VHT under this scenario because of the changes made in trip reduction and modal shifts: PHT daily reduction is 41% compared to Scenario 0. Through trips experience a benefit from this congestion relief, as well.

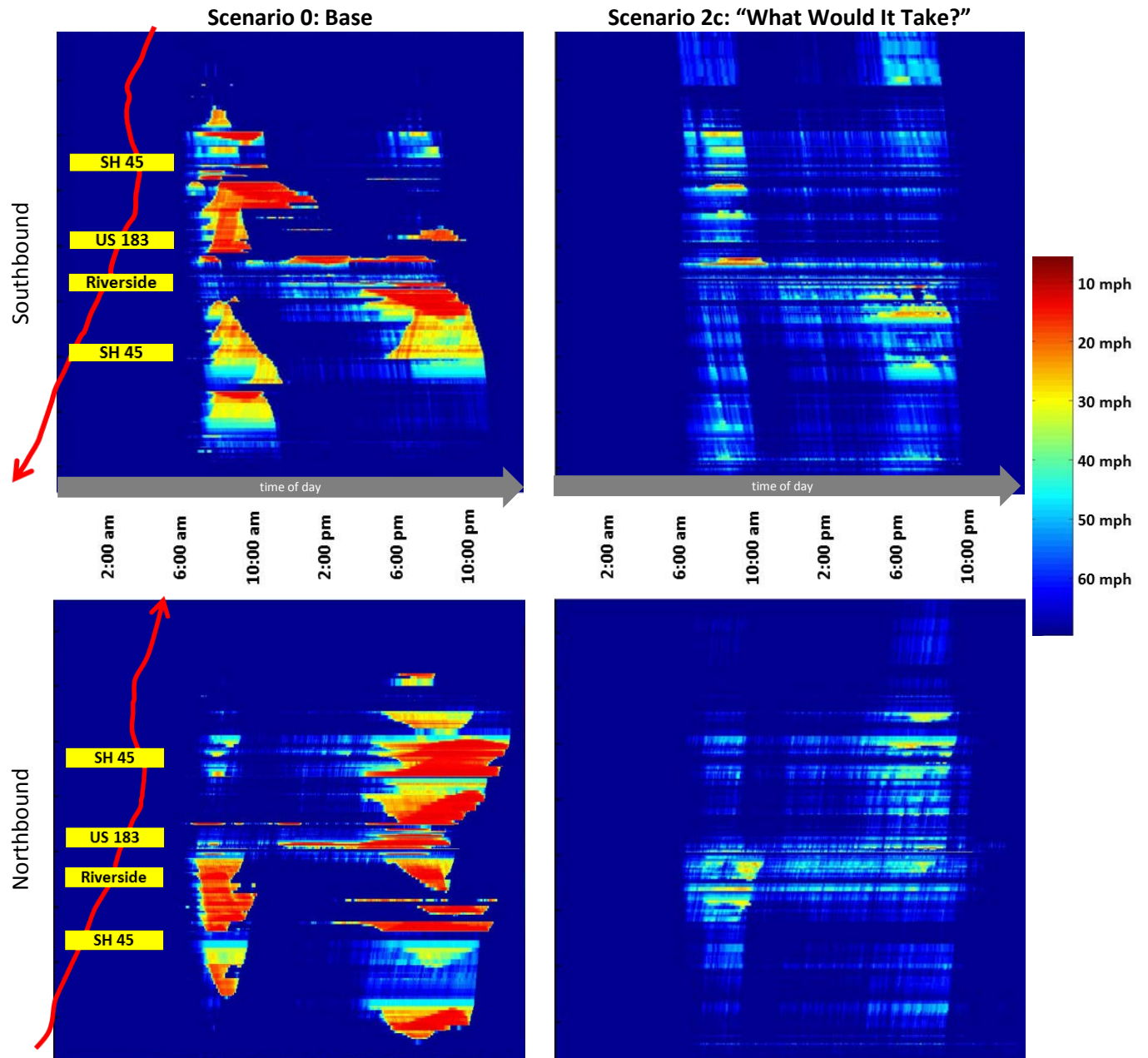
**Exhibit 44 Scenario 2c Performance Measures**

Performance Measure	Scenario 0: Base	Scenario 2c: Express Lanes
<b>Daily Vehicle-Hours Traveled (VHT) Region-Wide</b>		
Total	3,705,800	1,898,900
Trips with at least an origin or destination inside the study area	3,687,900	1,877,300
Trips with both origin and destination outside the study area	17,900	21,600
<b>Daily Person-Hours Traveled (PHT) Region-Wide</b>		
Total	3,879,300	2,273,200
Trips with at least an origin or destination inside the study area	3,860,500	2,247,400
Trips with both origin and destination outside the study area	18,800	25,900

Exhibit 45 provides the heat diagram for Scenario 2c alongside that for Scenario 0. Exhibit 46 is provided for the reader's convenience, including the comparison between Scenario 2c and the original Scenario 2. As shown in these exhibits, Scenario 2c demonstrates that IH 35 traffic congestion can be substantially addressed by several significant changes: the red areas representing the lowest speeds have substantially disappeared, and areas where red is still visible appear to represent localized bottlenecks which could be addressed individually through operational improvements. Of course, the changes in system capacity and travel behavior necessary to effect such an improvement are significant.

## Exhibit 45 Scenario 2c Heat Diagram Comparison to Scenario 0

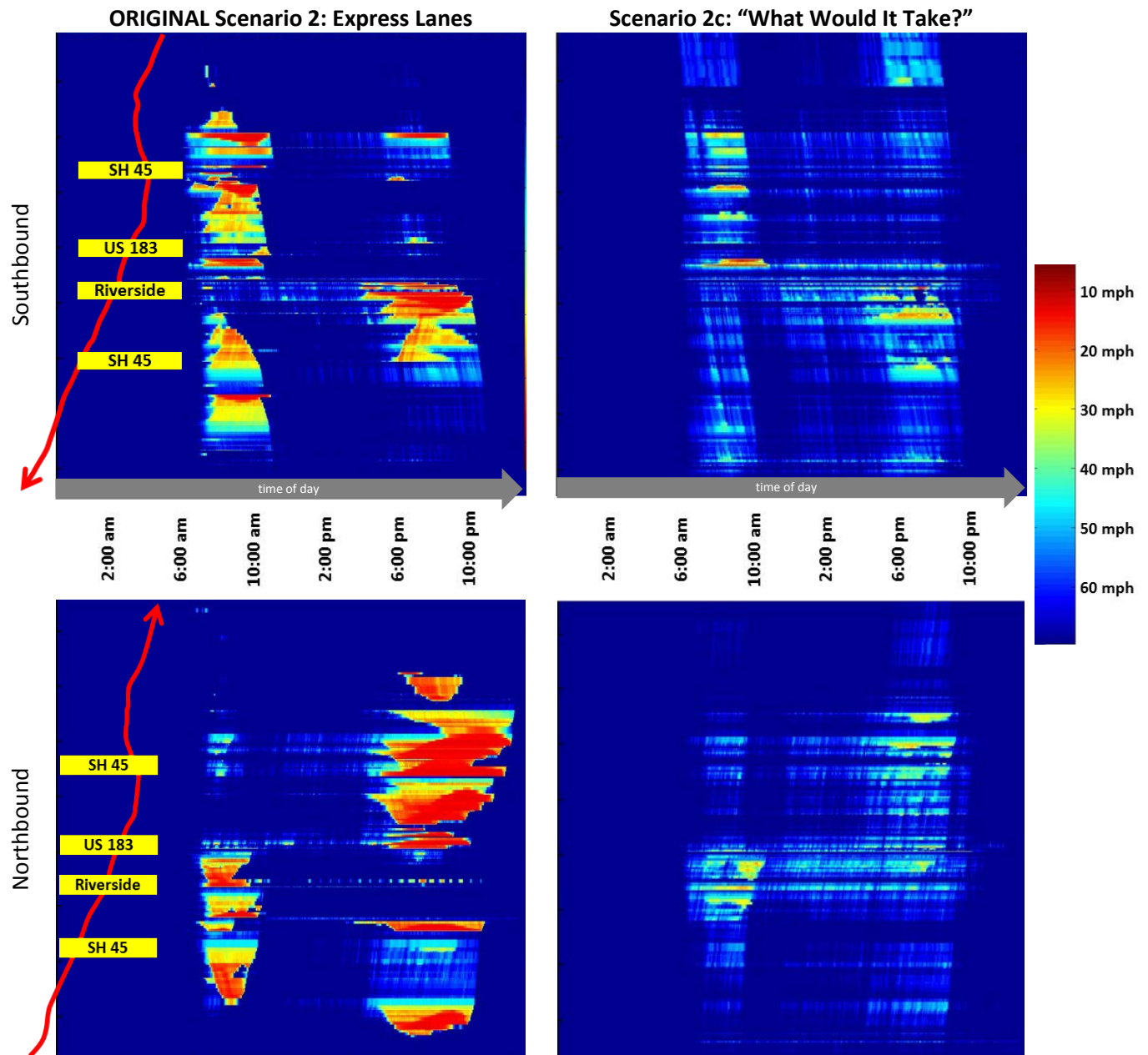
24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes





## Exhibit 46 Scenario 2c Heat Diagram Comparison to Scenario 2

24-Hour, IH 35 between North Williamson County Line and South Hays County Line on General Purpose Lanes



### What Hybrid Scenario Findings Mean for IH 35

The results of Scenario 2c are striking. They show that the findings of the initial alternatives analysis are not pre-ordained. In fact, Scenario 2c demonstrates the power of employing several significant strategies at one time: capacity expansion and managing the capacity (the express lanes on IH 35), trip reduction by households, more efficient travel (trip length reduction), and modal shift to public transit and non-motorized modes. The overall impact of Scenario 2c is substantial, but it must be noted that the changes assumed in the scenario will require significantly different travel choices.



## SUPPLEMENTAL ANALYSES

### Introduction

In the course of the study, the research team conducted various additional follow-up analyses in addition to the initial scenario analysis and “What Would It Take” exercises described above. These include:

- Consideration of through traffic and truck routing.
- HOV3+ paying a toll on the express lanes.
- Expansion of Scenario 6 in length and local access.
- A technology-based strategy for addressing congestion.

The remainder of this chapter presents the findings from these additional analyses; these findings influence the recommendations made in the final section, Next Steps.

### Through Traffic and Through Truck Routing

Of course, IH 35 is not just a roadway of local importance to Central Texas. IH 35 is an Interstate facility connecting Texas and the United States to both Mexico and Canada. In the course of this pre-conceptual study, the researchers were confronted with this challenge: how to reconcile a local anecdotal perception that through trips, especially trucks, are a major cause of daily traffic congestion on IH 35, when overall the technical analysis demonstrates a more nuanced picture.

#### Understanding Through Trips Generally

One challenge identified during this study is a fundamental lack of high-quality, recent data on through traffic on IH 35 through Central Texas. While there are Bluetooth readers located at various points along IH 35 study area, these readers are best applied for travel time analysis rather than traffic counts. The technical limitations include the absence of controlled count data locations and poor information on Bluetooth device usage across different user groups. Various factors play a role in limiting travel data and information, including individual privacy protections as well as business concerns about protecting their proprietary interests and competitive edge. One unfortunate result is that there are only limited data available to understand this issue of through-travel versus travelers stopping in the area.

After researching this issue and the data options available, it was determined that the best, most recent data available on this question are from a Texas Department of Transportation travel survey on external travel conducted in 2005. This data set is, in fact, the data upon which the CAMPO travel model external through travel allocation is based.

The researchers were able to request additional analysis of the original data to better understand through trips using IH 35. Of course, even a re-examination of the data has some limitations:

- The data set is 8 years old, collected in 2005 prior to the opening of SH 130 and SH 45 Southeast, as well as the more recent opening of SH 130 connecting to IH 10.

- Because IH 35 is a high-volume facility, 2005 data collection for IH 35 was based on license-plate matching and does not include the full interview aspect of a typical travel survey station.

Using this data source it was determined that, of the trips occurring along IH 35 between the Williamson/Bell County line and the Hays/Comal County line, non-stop through trips represent approximately 13.7% of total trips. This figure represents both commercial and non-commercial vehicles combined. It is critical to understand that the 13.7% of through trips are defined specifically for the purpose of a travel survey and the travel models that travel surveys traditionally support. As shown in Exhibit 47, the through trip definition under these contexts does not include some trips which might generically be considered through trips. For example, if a driver stops for gas or food along IH 35, this is considered a local trip, because at least one stop in the trip occurred inside the study area, for a retail trip purpose.

**Exhibit 47 Definitions of Local and Through Trips for Traditional Travel Survey and Travel Model**

Local Trips	Through Trips
<p>Trips with either an origin or destination within the five-county CAMPO region:</p> <ul style="list-style-type: none"> <li>• Commuters and other work purposes</li> <li>• School trips</li> <li>• Personal business, medical, shopping</li> <li>• Trips by area visitors</li> <li>• Trucks/commercial vehicles</li> </ul>	<p>Trips with both origin and destination outside the five-county CAMPO region:</p> <ul style="list-style-type: none"> <li>• Long-distance commuters and business trips</li> <li>• Recreational, including tourists</li> <li>• Other personal trips</li> <li>• Trucks/commercial vehicles</li> </ul>

This 2005 survey was confirmed to offer the most recent survey data available for IH 35 external traffic. As this research effort demonstrates, the need for quality data on external travel is vital. Not only is it important to have more recent data, it is equally vital that the data be gathered to provide better insights into the nature of the local stop. That is, a stop at a gas station as the result of passing by is very different from a stop to meet with a business client at a place of work—one may shift easily to an alternate route such as SH 130 and the other likely will not.

Within the limits of the data on through traffic as discussed above, the Scenario 6 results were still illuminating, owing to a largely anecdotal perception by many Central Texans that existing IH 35 mobility issues are mostly the result of through traffic, particularly through trucks. The general theory prior to this research study had been that additional through capacity bypassing central Austin would serve through traffic and improve IH 35 general purpose lane mobility. In contrast, for Scenario 6's additional three express lanes in each direction, the analysis demonstrated that the capacity on these lanes was not filled and the dynamic tolling mechanism was not triggered. That is, the tolls remained at the minimum toll value because there was insufficient congestion on the express lanes to warrant a higher tolling rate. The results for Scenario 6 contradict the theory of through traffic being largely the cause of IH 35 congestion.

## Through Trucks

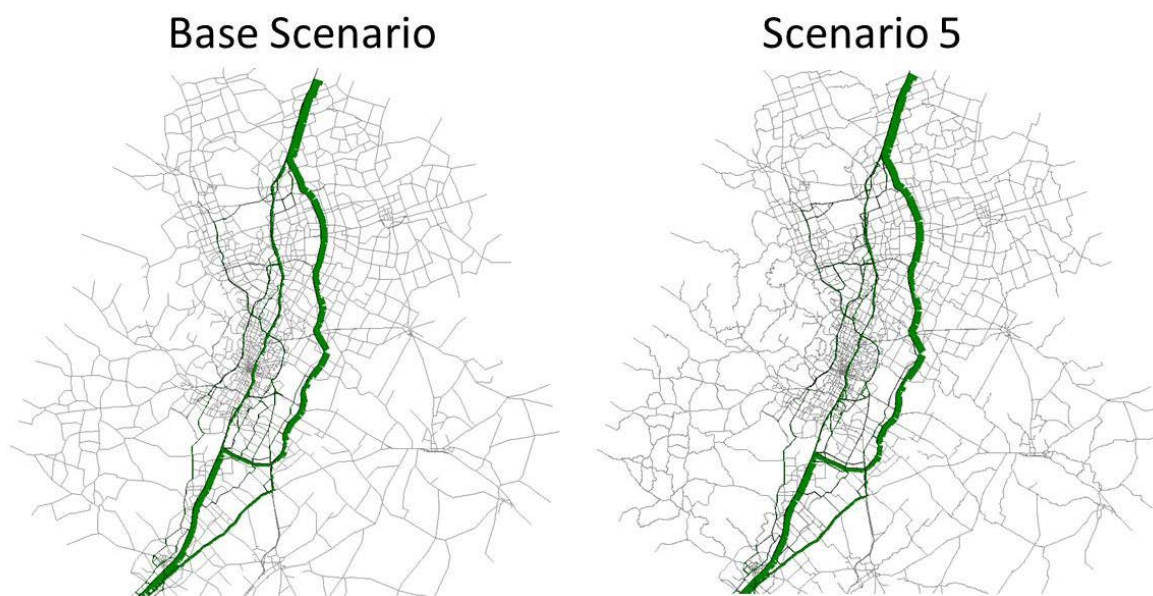
Part of the local anecdotal perception regarding IH 35 congestion is that through truck traffic contributes a substantial part of the congestion. One of the issues explored in the examination of scenarios, then, was the effect each of the scenarios had in moving truck traffic off IH 35 and over to SH 130. Scenarios 3 (System-wide Dynamic Pricing), 4 (My35 Conversion Plus), and 5 (My35 Swap) each represent scenarios which were anticipated to encourage drivers to use SH 130. Among these, Scenario 5 demonstrated the most effectiveness. As a reminder, Scenario 5 includes the swap of tolls on SH 130 over to IH 35 during the morning and evening rush hours, and moving Interstate designation from IH 35 to SH 130. Therefore, it appeared logical that Scenario 5 would exhibit the most truck diversion to SH 130.

**The resulting diversion was less than expected, primarily because, for the year 2035, trucks are already projected by the model to be using SH 130. The comparison of truck flows between Scenario 0, the base case, and Scenario 5 is shown in Exhibit 48; visually, there is little difference. This assessment is confirmed with an examination of the number of through truck trips using SH 130 under each scenario, absolute numbers shown in**

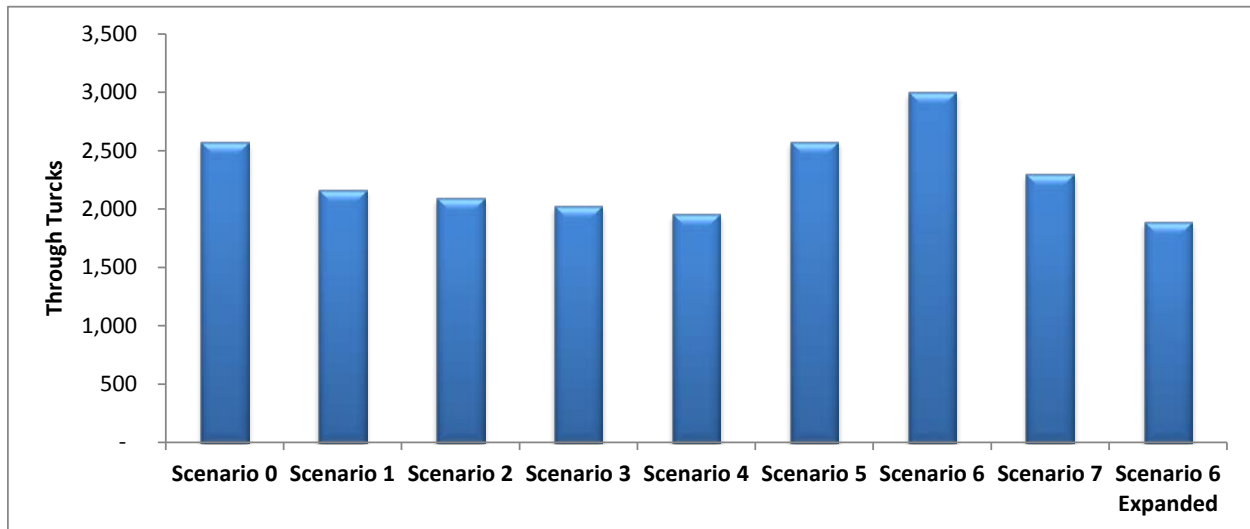
Exhibit 49 and the difference of each scenario from Scenario 0, the base case, in Exhibit 50.

As a reminder, Scenario 1, the HOV lanes scenario, provides some congestion relief for general purpose lanes, which makes IH 35 slightly more attractive for trucks, resulting in fewer trucks using SH 130. For Scenarios 2 through 4 and Scenario 7 express lanes, the minimum toll rate on the IH 35 express lanes is \$0.25 for both autos and trucks and the toll rate varies dynamically (also considering auto versus truck values of time) to maintain the operational performance of the express lanes to at least an average 45 mph.

**Exhibit 48 Comparison of Truck Flows between Base Case and Scenario 5**

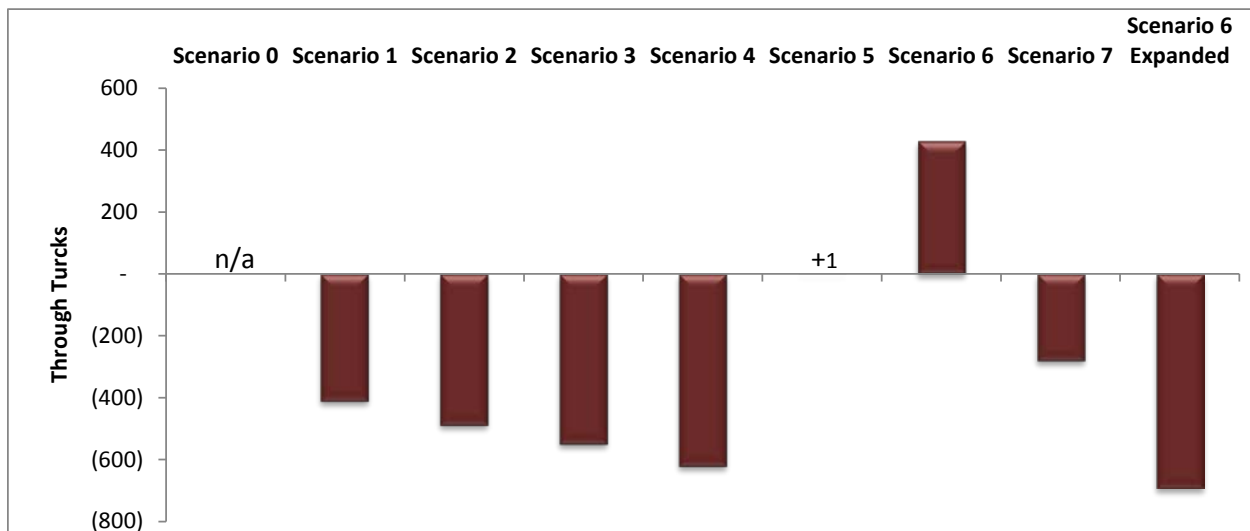


**Exhibit 49 Through Truck Flows Using SH 130 by Scenario**



For Scenarios 2 through 4 and Scenario 7 express lanes, the number of trucks using SH 130 appears to be responding intuitively to these scenarios. As noted above, Scenario 5 is the express lane option with the result closest to Scenario 0, the base case. This appears to be a result of Scenario 5 being less effective in addressing IH 35 congestion overall.

**Exhibit 50 Through Truck Flows Using SH 130 - Comparison to Scenario 0**



The Scenario 6 result of demonstrating a greater number of trucks along SH 130 than IH 35 is reflective of two factors: the limited access of the Scenario 6 configuration made its target audience through trucks only, and yet the minimum toll rate charged on the Scenario 6 express lanes was assumed to be equivalent to that being charged for the SH 130 bypass route. Scenario 6 Expanded relieves so much congestion on the IH 35 general purpose lanes, that through trucks are incentivized to use IH 35.



Overall, these findings demonstrate that through trucks respond similarly to other traveling groups in regard to IH 35 congestion: if IH 35 congestion is relieved, IH 35 becomes a more attractive route for trucks, as well.

These findings do have a major caveat: the external trip table is based upon the 2005 external travel survey, which was conducted prior to SH 130 opening, and certainly prior to the opening of the southern extension of SH 130 to IH 10 that opened in 2012. The research team considers it likely that some external trips are now entering the study area using SH 130 from IH 10, resulting in a different external trip table projection for 2035. No action was taken to effect this change because it would have resulted in more truck trips using SH 130 for all scenarios, resulting in a less conservative examination.

An obvious, key recommendation by the research team for decision-makers is that they seek out and support initiatives to gather better data on travel behavior, including non-stop through travelers and those making a stop. Concerns about individual privacy and the challenge of businesses protecting their competitive advantage have never been higher. However, the value of understanding people's need for transportation and information to support improved system efficiency in serving this need has never been greater, either, and will only increase. New methods of travel behavior data collection including voluntary participation, anonymization of cell phone data, and application of Bluetooth data to expand data sets—these and other methods are emerging to address this need. New methods of travel behavior modeling are desperately needed, methods for instance which allow for more advanced examination of traveler response to policy and operational issues such as those explored here. Most of these efforts require some level of public sector investment and support to ensure the data are usable for studies such as this one. The research team supports additional efforts to gather more recent data, especially to provide better insights into the distribution of traffic traveling through the study area, and to better understand the nature of travel and stops occurring.

The biggest take-away message is that the analysis conducted for this study demonstrates persuasively that the biggest issue is that IH 35 represents a straight line of travel through an area densely populated with homes, businesses, and other places Central Texans want to go. The demographics forecasted for 2035, the year under examination in this study, for the most part continue this existing pattern. Under the scenarios examined here, SH 130 does not offer enough of an advantage over IH 35 to shift drivers away from the straight line path offered by IH 35. The effect of congestion on business planning and development (for example, the need for additional manufacturing plants, distribution centers, trucks or staffing to serve customers and suppliers) was not part of this study.

## Scenario 2b: Express Lanes with No Free HOV

The original direction of the MIP Working Group Technical Subcommittee had been to examine IH 35 express lane scenarios allowing auto vehicles with three or more persons (HOV3+) to use any express lane without paying a toll. As a result of follow-up MIP Working Group discussion, the research team was directed to examine the impact of all HOV vehicles except bus transit paying a toll. The reasons cited by the MIP Working Group were as follows:

- All auto vehicles paying a toll to use the express lanes is consistent with the policy which will be in place for the Loop 1 (MoPac) express lanes that are in implementation phase in the year 2013 and will be in place prior to any express lane implementation on IH 35.
- Policy-makers and operators of express lanes in other metropolitan areas have noted anecdotally the difficulty in changing the policy for users to pay later on if they were allowed to use the facility free of charge initially.
- Given the level of congestion along IH 35 already, it is likely that HOV users will crowd out any capacity for tolling, which may be a critical funding resource for implementing improvements along IH 35.

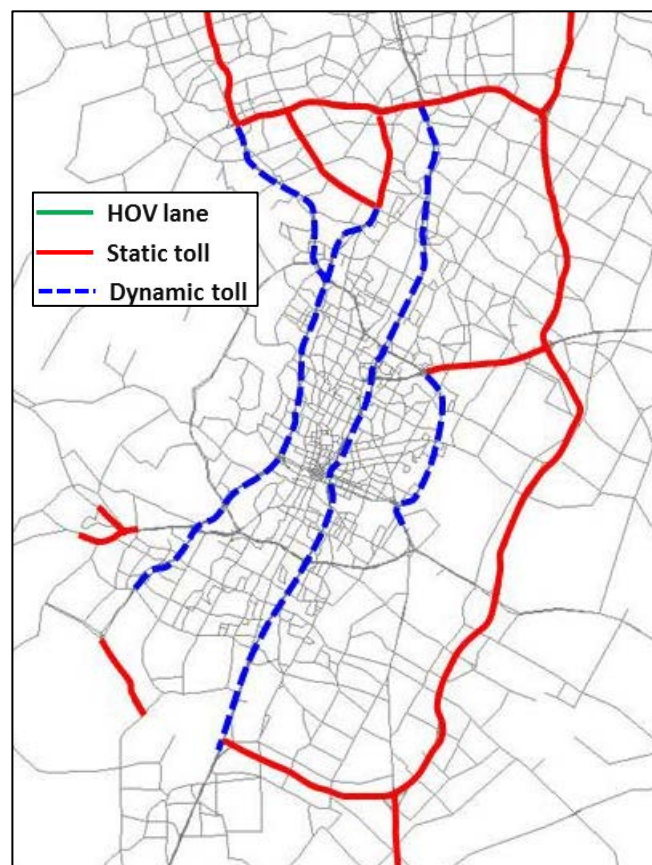
### Description

Similar to Scenario 1, one express lane is assumed to be added to IH 35 in each direction, HOV 3+ and bus transit access only, configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South.

In addition, allow HOV2 and SOV vehicles paying an auto toll rate and truck vehicles paying a truck toll rate. Congestion on these lanes is “managed” by allowing the toll rate to vary dynamically throughout the day in order to maintain vehicle flow.

Based upon Scenario 0, the base case, the tolling assumptions for this scenario are depicted in Exhibit 51. As a reminder, Scenario 0 is consistent with the CAMPO-adopted MTP, and therefore includes all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent they were originally represented in the CAMPO model. Scenario 0 itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

Exhibit 51 Scenario 2b Tolling Assumptions



## Assumptions

- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of each facility, but without considering tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Min toll (\$0.25) for autos and (\$0.25) for trucks.
  - Max toll (\$200).
  - All vehicles except for bus transit pay the auto toll rate.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed and level of service.
- Any HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.

## Technical Assessment

Exhibit 52 displays the analysis results for Scenario 2b. The region-wide system measures demonstrate only slightly less benefit relative to Scenario 0: 4% reduction in VHT/PHT versus 5% for the original Scenario 2. With regard to point-to-point travel time, Scenario 2b delivers reasonable improvements for all movements except for a slight increase for IH 35 northbound during the evening peak period.

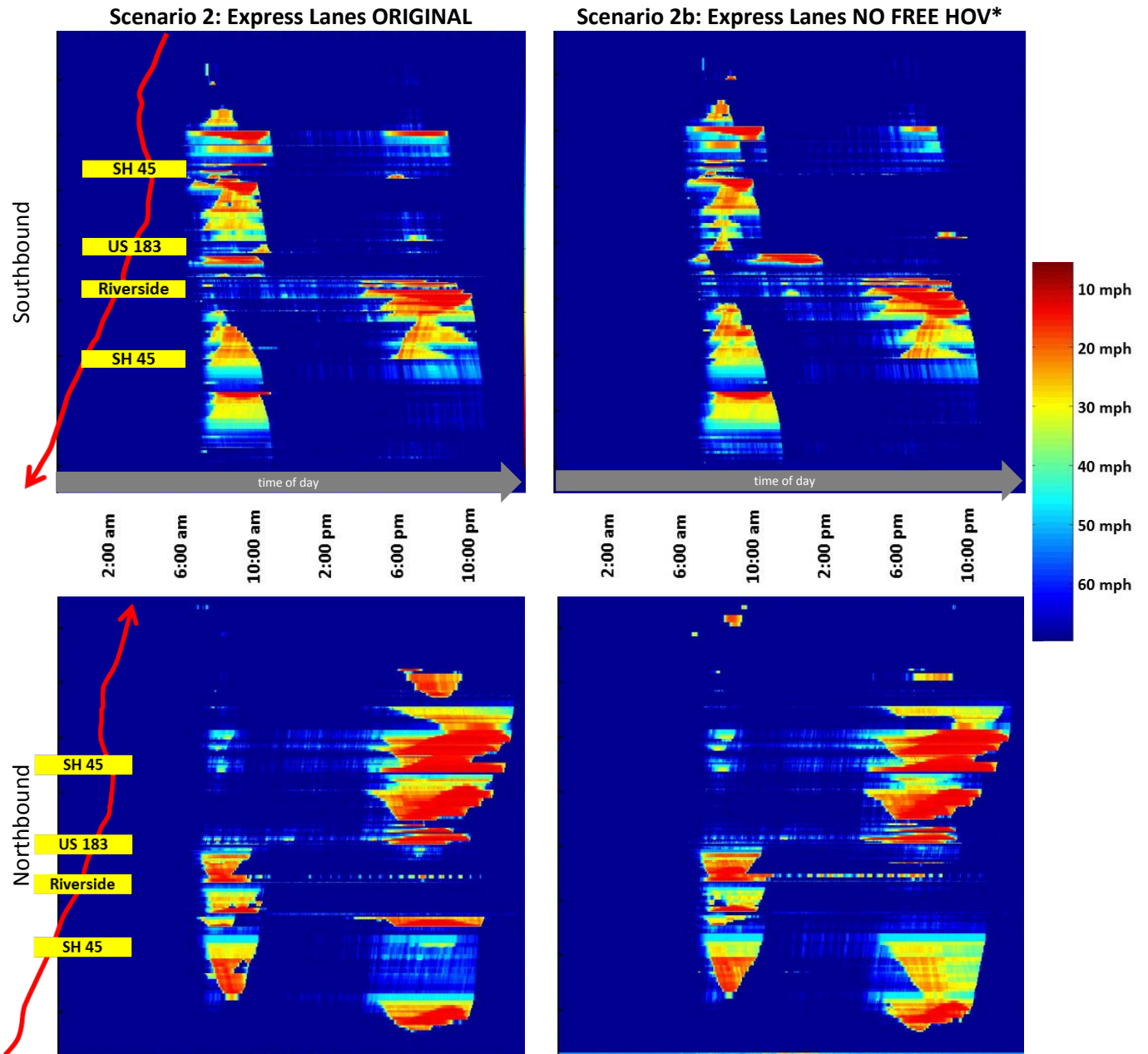
### Exhibit 52 Scenario 2b Performance Measures

Performance Measure	Scenario 0: Base		Scenario 2b: Express Lanes	
Daily Vehicle-Hours Traveled (VHT) Region-Wide				
Total	3,705,800		3,539,720	
Trips with at least an origin or destination inside the study area	3,687,900		3,522,697	
Trips with both origin and destination outside the study area	17,900		17,022	
Daily Person-Hours Traveled (PHT) Region-Wide				
Total	3,879,300		3,705,422	
Trips with at least an origin or destination inside the study area	3,860,500		3,687,603	
Trips with both origin and destination outside the study area	18,800		17,819	
Point-to-Point Travel Time (min), External to External (Southbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	178	231	170	174
Using SH 130	177	117	154	94
Point-to-Point Travel Time (min), External to External (Northbound)	(AM)	(PM)	(AM)	(PM)
Using IH 35 General Purpose Lanes	221	301	210	314
Using SH 130	217	315	209	299

Exhibit 53 shows the heat diagram that communicates the level of congestion being encountered by drivers on IH 35 under Scenario 2b, including a comparison to the original Scenario 2, for which HOV3+ vehicles did not have to pay a toll. Examining the heat diagrams, it is apparent that Scenario 2b results in additional congestion in comparison to Scenario 2. This appears to be a logical result because the HOV3+ vehicles unwilling to pay a toll are now on the IH 35 general purpose lanes.

### Exhibit 53 Scenario 2b Heat Diagram Comparison

24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes



\*Bus transit continues to use express lanes for free.



## Scenario 6 Expanded: Capacity Addition through Core

As described previously starting on page 46, the initial analysis of Scenario 6 resulted in both surprising and informative results. As a reminder, Scenario 6 included a large-scale capacity addition of six dynamically tolled lanes between 51st Street (south of US 290 East) and SH 45 South. As noted, the access points were limited to the north and south ends, so that the original configuration was primarily aimed at drivers traveling through the Austin core. Because this population represents a relatively small share of drivers overall, the original Scenario 6 configuration was underutilized. A follow-up examination was performed to:

- confirm the original hypothesis that the reason Scenario 6 had not performed well was due to limited access.
- assess the impact of Scenario 6 with greater access for drivers with Austin core area origins and destinations.

### Description

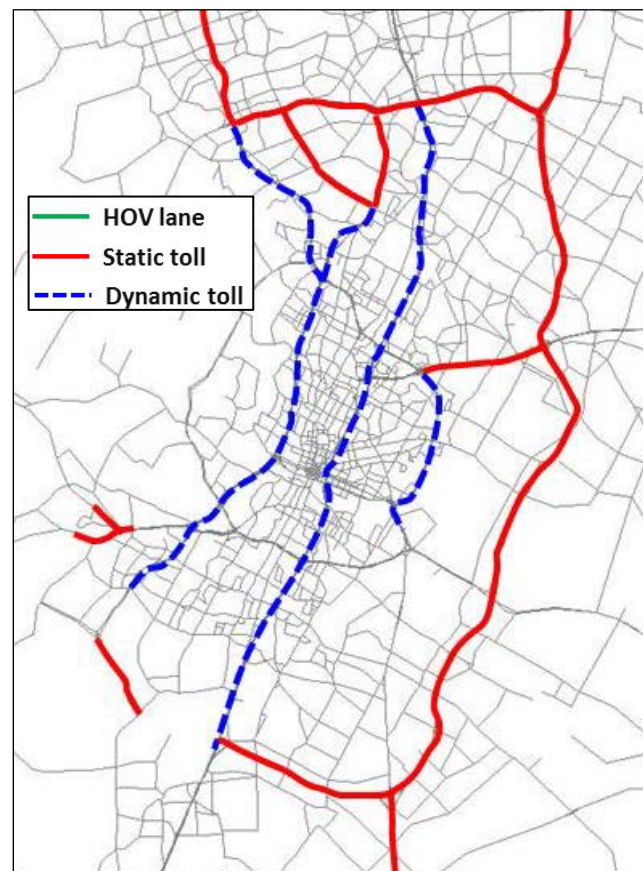
This scenario explores a concept frequently discussed as an ultimate need to address future congestion. Concept was examined as three additional express lanes in each direction, depressed or tunneled, and dynamically tolled; HOV3+ and bus transit ride for free. In contrast to the original Scenario 6, this configuration was extended north to SH 45

North, and includes access points serving SH 45 North, FM 734 (Parmer Lane), US 183/US 290 East, 26th, Martin Luther King Boulevard/15th, 8th/11th, Cesar Chavez, Riverside Boulevard, SH 71/US 290 West, and SH 45 South.

### Other Scenario Features

The tolling assumptions for this scenario are depicted in Exhibit 54. As a reminder, all scenarios are based upon the current CAMPO-adopted MTP, and therefore include all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

**Exhibit 54 Scenario 6 Expanded Tolling Assumptions**





## Assumptions

- See section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of each facility, but without considering tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Minimum toll (\$9.94) for autos and (\$31.58) for trucks for a trip using the entire length of the IH 35 express lanes between SH 45 North and SH 45 South. Vehicles using only a portion of the route would pay a reduced toll. These minimum values are based upon an assumption that the same minimum toll would apply to IH 35 as for the route including SH 45 North, SH 130, and SH 45 Southeast to bypass IH 35 through Austin.
  - Maximum toll (\$200).
  - HOV 3+ free.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed.
- Any HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.

## Technical Assessment

The technical results for Scenario 6 Expanded justified the additional effort to reconfigure the scenario and rerun the dynamic traffic assignment. As shown in Exhibit 55, total daily VHT region-wide went down substantially, from 3.7 million VHT under Scenario 0, the base case, to 2.3 million VHT (39%) as a result of the six lanes of capacity added to IH 35 under Scenario 6 Expanded. The primary impact was for trips with an origin or destination inside the study area. This result is logical, given that these trips are the highest in number occurring in the area, and therefore experience substantial overall congestion and delay over the course of a day.

Through trips, those with neither origin nor destination in the five-county study area, experienced a 3% reduction in VHT, a benefit, as well. Person-hours traveled, calculated based upon vehicle occupancy and VHT, demonstrates a logically similar reduction.

**Exhibit 55 Scenario 6 Expanded Performance Measures**

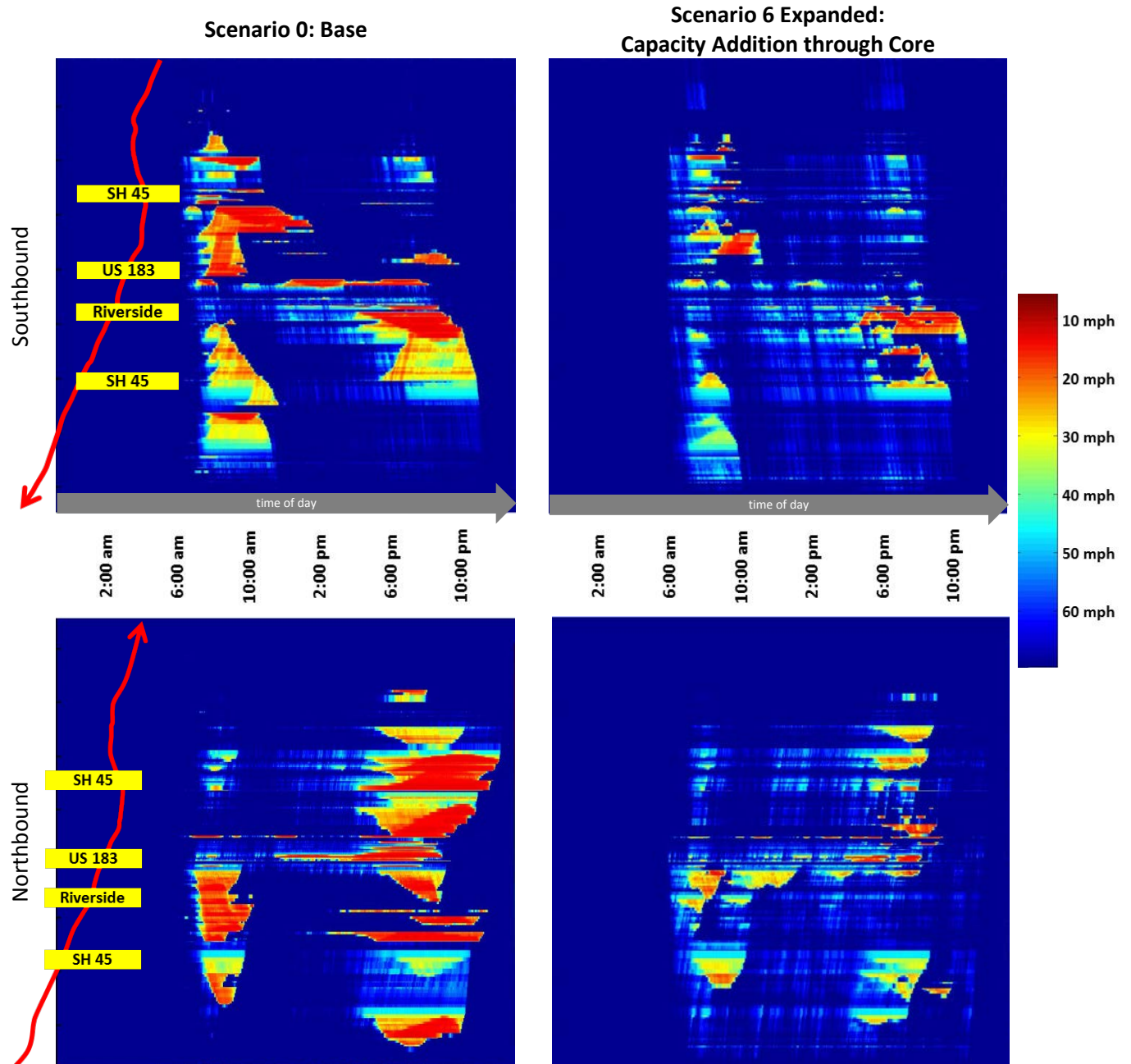
<b>Performance Measure</b>	<b>Scenario 0: Base</b>	<b>Scenario 6 Expanded: Capacity Addition through Core</b>
<b>Daily Vehicle-Hours Traveled (VHT) Region-Wide</b>		
Total	3,705,800	2,270,500 (-39%)
Trips with at least an origin or destination inside the study area	3,687,900	2,253,200 (-39%)
Trips with both origin and destination outside the study area	17,900	17,300 (-3%)
<b>Daily Person-Hours Traveled (PHT) Region-Wide</b>		
Total	3,879,300	2,376,800 (-39%)
Trips with at least an origin or destination inside the study area	3,860,500	2,358,700 (-39%)
Trips with both origin and destination outside the study area	18,800	18,100 (-4%)

For comparison purposes to the other scenarios tested, heat diagrams were generated from the dynamic traffic assignment of Scenario 6 Expanded. Exhibit 56 compares heat diagrams for Scenario 6 Expanded to Scenario 0, the base case. More than any other build-only scenario, Scenario 6 Expanded produces a substantial improvement in both the northbound and southbound directions. For the reader's convenience, Exhibit 57 places the Scenario 6 Expanded results alongside the heat diagram results for the original Scenario 6. As shown, Scenario 6 Expanded clearly provides the congestion relief being sought.

As mentioned previously, this modeling examination was conducted at a pre-conceptual level and for the purpose of identifying project concepts which demonstrate the strongest potential for congestion relief for IH 35 in the long-term. Clearly, Scenario 6 Expanded offers this potential. Of course, as noted previously, Scenario 6 and Scenario 6 Expanded also are likely to have high costs, both in monetary terms and in community and environmental contexts. These aspects would be studied should either concept move forward. The results of Scenario 6 Expanded could also be obtained using advanced technology communications technologies. These are not available to the public, but are expected to be by 2035. In the most optimistic future, communication between vehicles will allow them to travel safely much closer together, allowing existing roads to carry many more vehicles per hour.

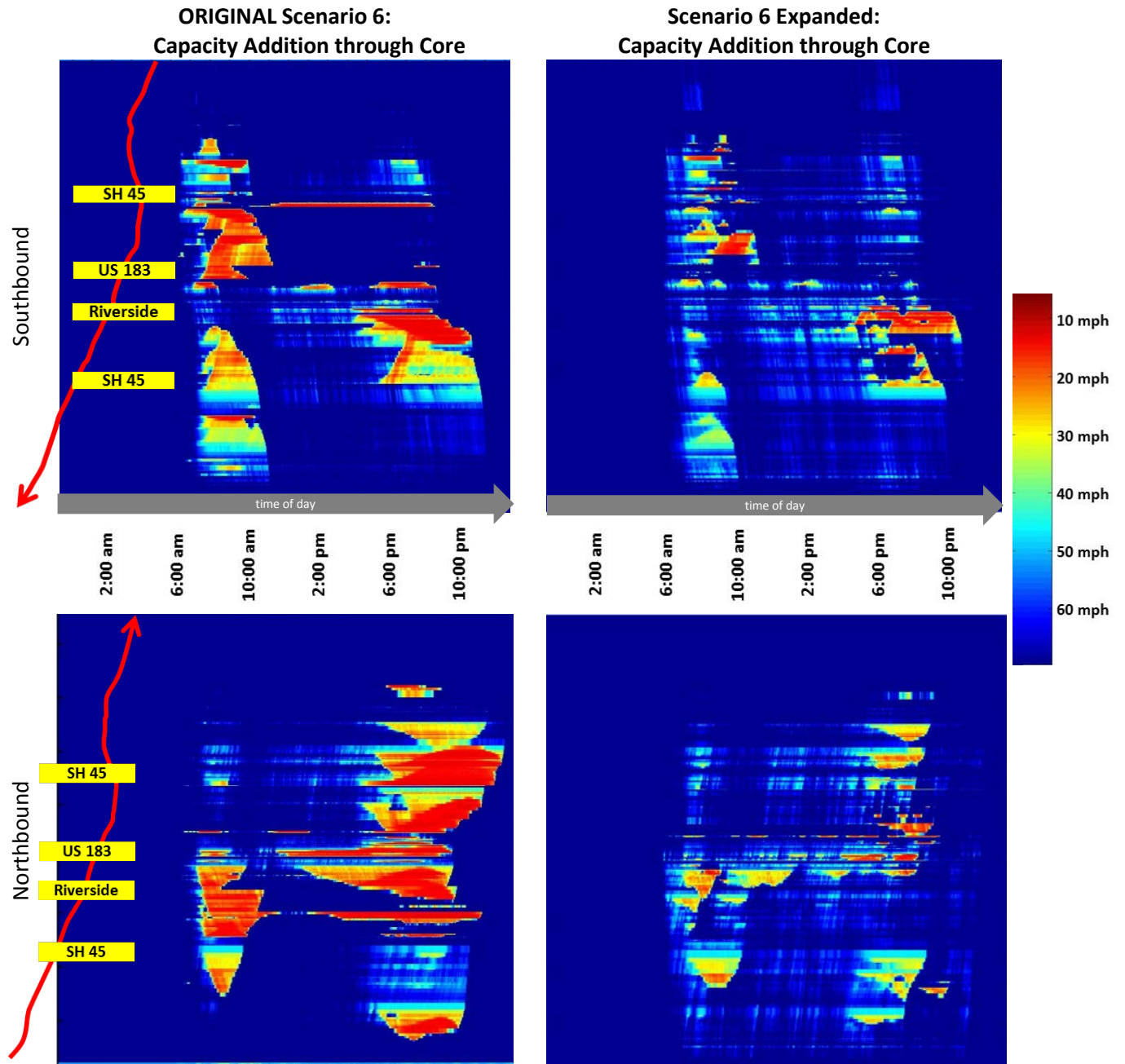
## Exhibit 56 Scenario 6 Expanded Heat Diagram Comparison to Scenario 0

24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes



## Exhibit 57 Scenario 6 Expanded Heat Diagram Comparison to Scenario 6 Original

24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes



## Scenario 2d: Technology Strategy

### Description

Based upon Scenario 2, one express lane is assumed to be added to IH 35 in each direction, HOV 3+ and bus transit access only, configuration and access according to the current City of Austin study between 51st Street and William Cannon, concept extended to SH 45 North and South.

In addition, allow HOV2 and SOV vehicles paying an auto toll rate and truck vehicles paying a truck toll rate. Congestion on these lanes is “managed” by allowing the toll rate to vary dynamically throughout the day in order to maintain vehicle flow.

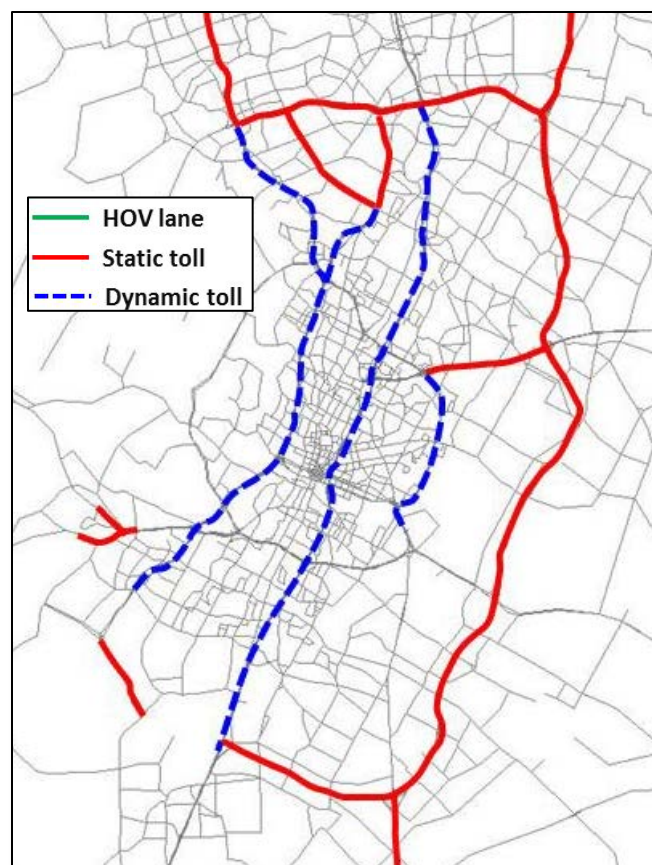
The tolling assumptions for this scenario are depicted in Exhibit 58. Based generally on Scenario 0, this scenario is consistent with the current CAMPO-adopted MTP, and therefore includes all 2035 CAMPO-adopted plan roads and transit network assumptions including bus transit, rail, bicycle, and pedestrian facilities and operational services to the extent to which they were originally represented in the CAMPO model. Scenario 0 by itself includes no additional auto or truck vehicle capacity along IH 35 between SH 45 North and SH 45 South.

The biggest difference of this scenario from others tested under this research is the assumption that drivers of autos have greater flexibility regarding when they can make their trip and what route they take, in response to better driver information. The assumptions driving this flexibility are presented below.

### Technology Assumptions

- Basic logical assumption is that all users benefit from some users adjusting their travel to less-congested time periods and/or routes.
- Scenario assumes that drivers will have use of a smart phone application customized for this purpose. A prototype application is currently available for research purposes called Smartrek®; therefore the technology will almost certainly be available in 2035.
- Several levels of driver market penetration of the Smartrek application were tested (5%, 10%, and 20%), along with several levels of allowable flexibility (15, 30, and 60 minutes) to

**Exhibit 58 Scenario 2d Tolling Assumptions**





vary departure time from that specified in the original origin-destination trip table used for Scenario 0, the base case. The parameters below were used:

- Smartrek used only during peak period.
- 20% driver market share, that is, drivers using the application.
- 60-minute maximum flexibility that drivers are allowed to deviate from their original departure time (not all users will use all 60 minutes).

### **Other Assumptions**

- The biggest change in assumptions for this scenario is the technology assumption, as described above. Otherwise, see section General Technical Assumptions Applicable to All Scenarios on page 18.
- Each facility that is tolled is operating with independent tolling, maximizing the efficiency of each facility, but without considering tolls being applied to the other facilities.
- Dynamic tolling assumptions for IH 35:
  - Min toll (\$0.25) for autos and (\$0.25) for trucks.
  - Max toll (\$200).
  - HOV 3+ free.
- Tolls are assumed to vary dynamically with congestion to ensure that the express lanes maintain at least a 50 mph speed.
- Any HOV facilities identified in the CAMPO plan are assumed to be available for both auto HOV vehicles and bus transit usage.
- For this scenario, HOV vehicles with 3 or more persons are allowed to use the express lanes without paying a toll. Other auto vehicles and trucks are allowed to use the express lanes paying an auto and truck toll rate, respectively.

### **Technology Strategy Sensitivity Testing**

As mentioned above, various sensitivity tests were conducted to assess the impact of different percentages of drivers using the technology application, as well as that of the flexibility allowed (not necessarily utilized) by drivers when they departed for their vehicle trip. Exhibit 59 demonstrates that Smartrek users, the drivers assumed to be using Smartrek or an equivalent technology in 2035, experience a benefit as a result of using the technology themselves, and as more users participate in using the technology. Because the trips can change departure to times outside of the peak period, the average daily travel time is shown; peak-period travel times are much longer.



**Exhibit 59 Technology Strategy: Daily Average Travel Time for Smartrek Users**

<b>Flexibility in Departure Time</b>	<b>5% of drivers use Smartrek</b>	<b>10% of drivers use Smartrek</b>	<b>20% of drivers use Smartrek</b>
<b>15 minutes</b>	24 minutes	not tested	not tested
<b>30 minutes</b>	not tested	21 minutes	17 minutes
<b>60 minutes</b>	not tested	21 minutes	17 minutes

Exhibit 60 demonstrates that non-Smartrek users realize a benefit as well, as a result of the greater system efficiency gained by the Smartrek users being more flexible with regard to departure time and route choice.

**Exhibit 60 Technology Strategy: Daily Average Travel Time for Non-Smartrek Users**

<b>Flexibility in Departure Time</b>	<b>5% of drivers use Smartrek</b>	<b>10% of drivers use Smartrek</b>	<b>20% of drivers use Smartrek</b>
<b>15 minutes</b>	26 minutes	not tested	not tested
<b>30 minutes</b>	not tested	25 minutes	24 minutes
<b>60 minutes</b>	not tested	24 minutes	23 minutes

Exhibit 61 documents the findings from each scenario with regard to total daily travel time savings under each scenario tested. Of note, although the individual users do not see a substantial difference in travel time by having 30-minute or 60-minute flexibility, the regional system does see a favorable impact from more drivers participating in the technology.

**Exhibit 61 Technology Strategy: Total Daily Travel Time Savings for All Drivers**

*(% is comparing savings to Scenario 0: Base Case)*

<b>Flexibility in Departure Time</b>	<b>5% of drivers use Smartrek</b>	<b>10% of drivers use Smartrek</b>	<b>20% of drivers use Smartrek</b>
<b>15 minutes</b>	14,000 hours (0.4%)	not tested	not tested
<b>30 minutes</b>	not tested	72,100 hours (2.3%)	111,900 hours (3.5%)
<b>60 minutes</b>	not tested	153,900 hours (4.8%)	215,900 hours (6.8%)

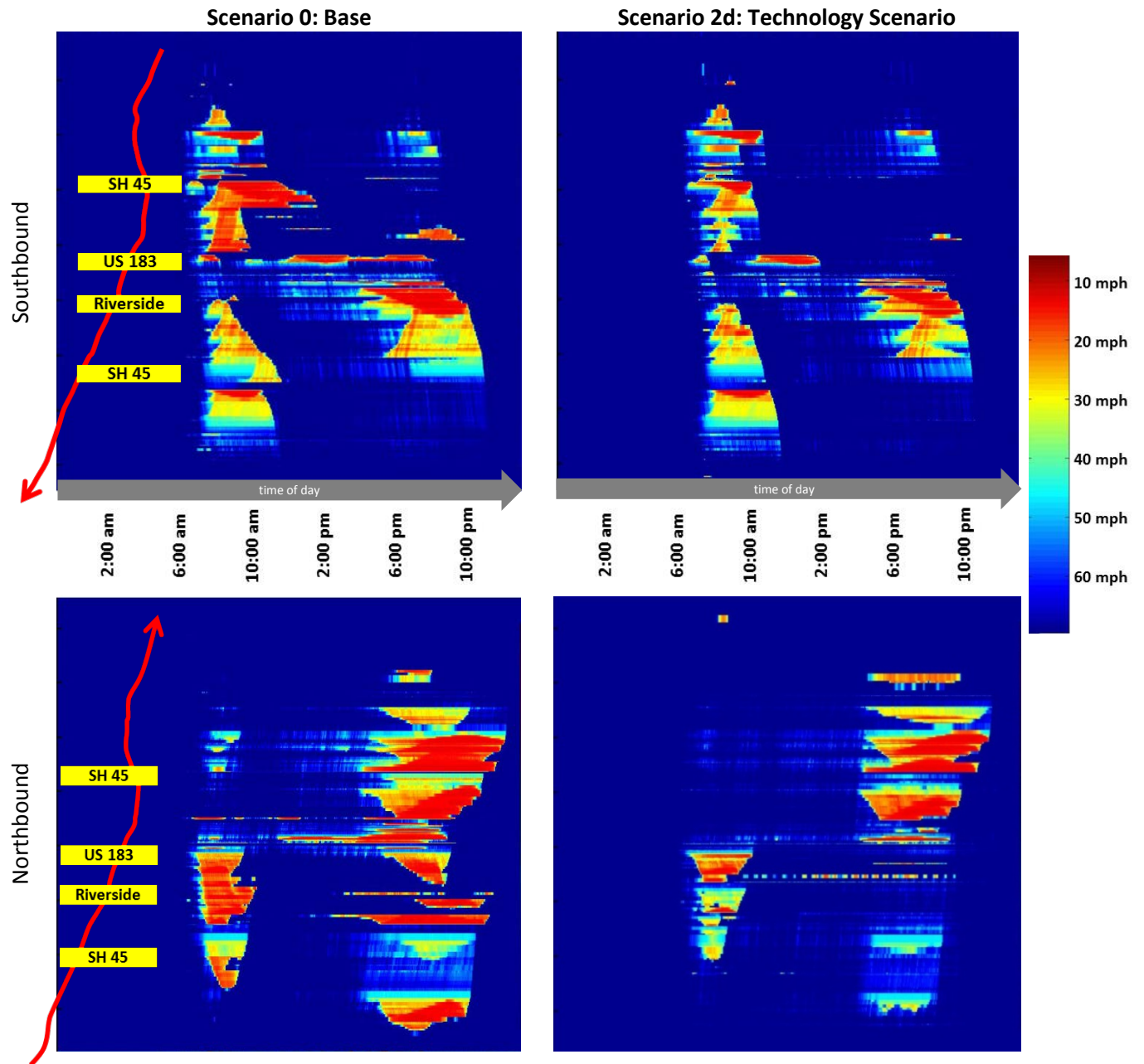
**Technical Assessment**

For comparison purposes to the other scenarios tested, heat diagrams were generated from the dynamic traffic assignment. Exhibit 62 compares Scenario 2d assuming the Smartrek technology or similar implementation to Scenario 0. As shown, there is a noticeable improvement in both the northbound and southbound directions under Scenario 2d. For the reader's convenience, Exhibit 63 places the Scenario 2d alongside the heat diagram results for the original Scenario 2, without the Smartrek technology. As shown, the technology implementation clearly provides an additional improvement to the Scenario 2 results.

Scenario 2d demonstrates the potential of an existing application for providing measurable impact to reduce IH 35 general purpose lane congestion, even under the extremely congested circumstances projected for the year 2035.

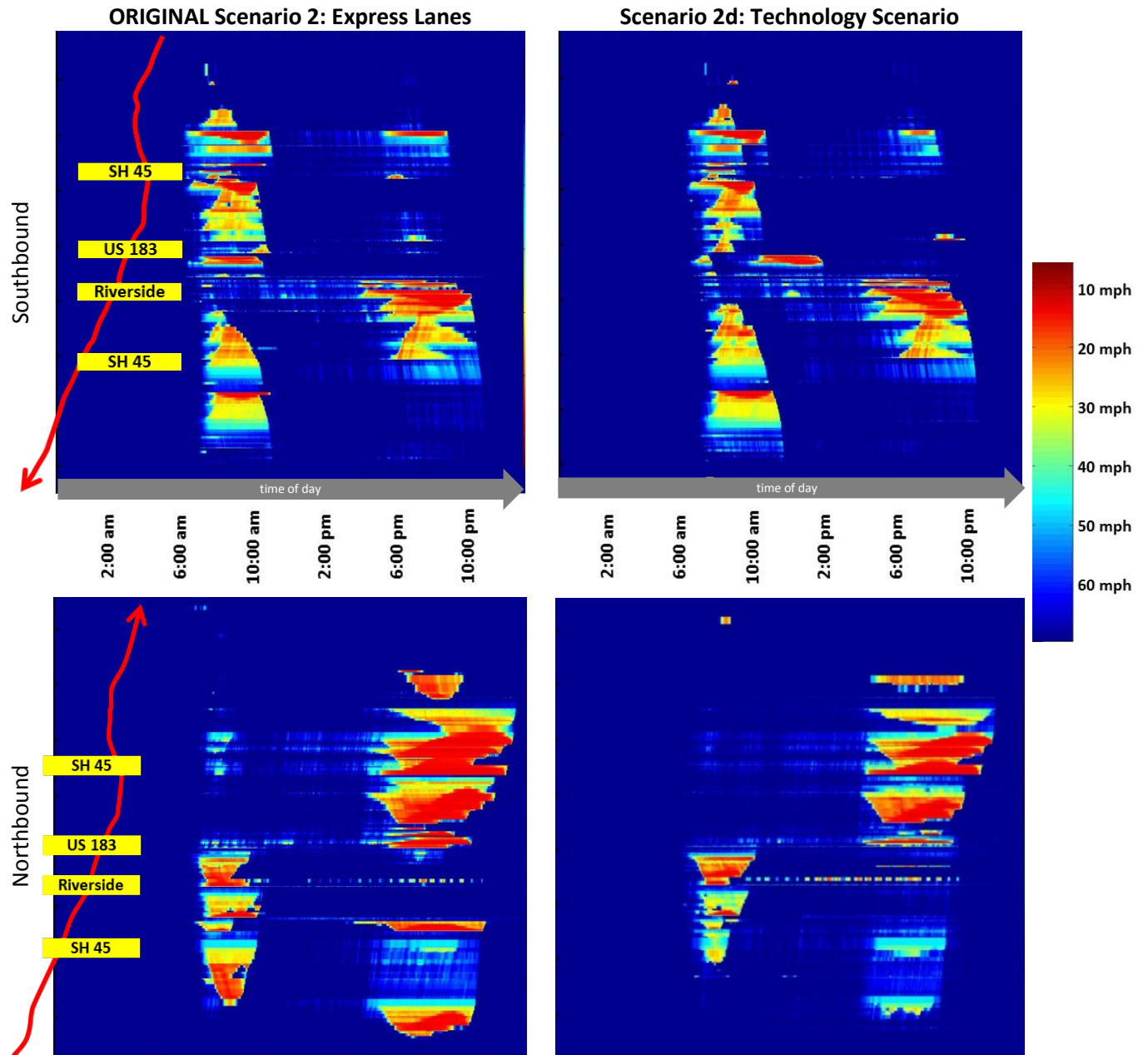
## Exhibit 62 Scenario 2d Heat Diagram Comparison to Scenario 0

24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes



### Exhibit 63 Scenario 2d Heat Diagram Comparison to Scenario 2

24-Hour, IH 35 between North Williamson County Line and South Hays  
County Line on General Purpose Lanes



## Summary of Supplemental Analyses

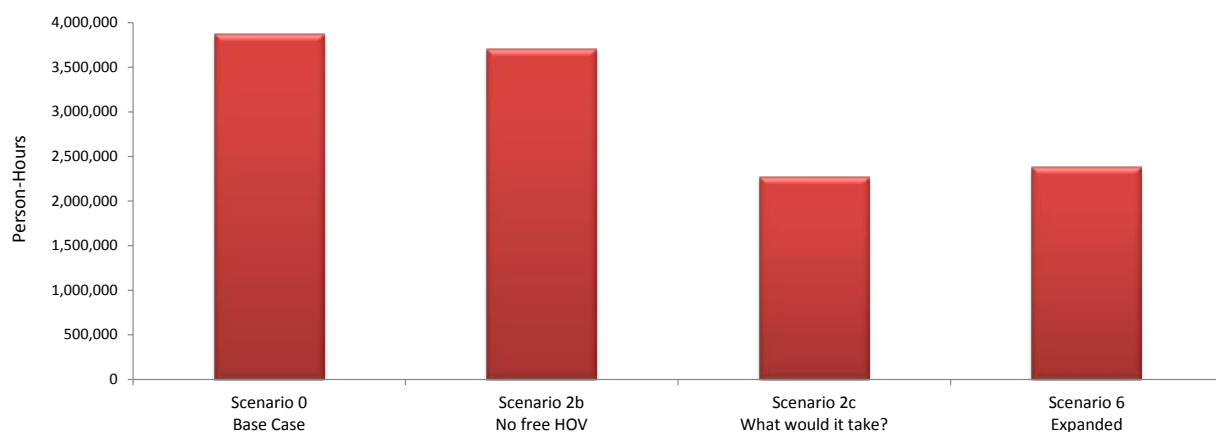
The supplemental analyses described above were conducted in addition to the initial scenario analysis and “What Would It Take” exercises to provide additional perspective on questions raised by the MIP Working Group during the course of the study. The supplemental analyses included:

- Consideration of through traffic and truck routing.
- HOV3+ paying a toll on the express lanes.
- Expansion of Scenario 6 in length and local access.
- A technology-based strategy for addressing congestion.

Among the findings for the individual scenarios, as described above, additional observations include the following, which were presented to the MIP Working Group.

Scenario 2c “What Would It Take” demonstrated substantially more impact on region-wide congestion as measured by daily person-hours of travel, as shown in Exhibit 64 and Exhibit 65. Likewise, Scenario 6 Expanded, which assumes the addition of six tolled express lanes (three each direction) between SH 45 North and SH 45 South, also demonstrates substantial positive benefit with regard to region-wide congestion. Quite coincidentally, Scenarios 2c and Scenario 6 demonstrated comparable results: that is, a hybrid approach reflecting a variety of congestion-fighting strategies had comparable results to a construction-only strategy of adding six lanes to IH 35.

**Exhibit 64 Daily Region-Wide Person-hours of Travel, Supplemental Analyses (2035)**



**Exhibit 65 Daily Region-Wide Person-hours of Travel, Tabular, Supplemental Analyses (2035)**

	<b>Scenario 0 Base</b>	<b>Scenario 2b No Free HOV</b>	<b>Scenario 2c What Would It Take?</b>	<b>Scenario 6 Expanded</b>
<b>Person-hours Traveled</b>	3.88 M	3.71 M	2.27 M	2.38 M
<b>Percent Change (%)</b>	-	-4%	-41%	-39%

Likewise, the Technology Scenario presented in this chapter demonstrated an additional strategy for consideration alongside the various other scenarios tested.

This chapter presented the findings from these additional analyses and these findings were accounted for in the recommendations made in the final chapter, Next Steps.





## NEXT STEPS

This summary and the technical report represent the conclusion of the technical study of long-term scenarios for IH 35 through Central Texas for the Mobility Investment Priorities project.

### What Next?

The findings from this modeling effort provide the MIP Working Group and other Central Texas stakeholders with technical information and perspective on various questions relevant to on-going and future opportunities for improving long-term IH 35 mobility through the Austin Metropolitan area. The scenarios were tested with computer simulation—cost and design feasibility were not examined. These include the findings discussed in the following sections.

#### Implications of Findings for IH 35 Implementation Project

Generally the results of this examination indicate that current efforts to add an express lane in each direction of IH 35 are a positive move. As explained previously, Scenarios 2 and 7 most closely represent this proposed configuration, and the modeling results show that both improve mobility along IH 35, by a combination of providing a mobility option not presently available (if the lanes are managed are operated to maintain uncongested conditions) and by marginally improving mobility along the IH 35 general purpose lanes. The findings of this mobility study should serve to prepare local stakeholders that the overall benefit of this two express lane configuration, without other strategies to address IH 35 and regional mobility, is notable but limited.

Given the findings of this study that internal travel, not through travel, represents a huge proportion of IH 35 users, access to the express lane facility will necessitate careful planning. The most successful express lanes have a minimum number of points of access. Except for the original Scenario 6, the scenarios tested generally assumed open access to the express lanes. However, if drivers are moving on and off the corridor to meet travel needs internal to the study area, the express lanes may lose some utility. Additional detailed analyses will be needed to maximize express lane efficiency.

#### Recommendations for Planning Efforts for IH 35, On-going and To Come

The most profound finding of this modeling effort is the magnitude of the problem exemplified by IH 35 and shared across the Central Texas region. The study showed that IH 35 congestion in 2035 is fairly intractable with adding capacity as the only strategy. Only Scenario 6 Expanded—a configuration with six additional express lanes and extensive access—was shown to substantially improve IH 35 congestion.

As explained in the Key Findings and What Would It Take? sections of this report, IH 35 congestion in 2035 is predicated upon two assumptions:

- Residential and employment growth will continue on its current pace.
- People will continue to exhibit the same daily travel behaviors they have currently.

If the first assumption above is maintained and Scenario 6 Expanded (with six additional express lanes) has questionable viability, the second assumption must change in order to avoid the forecasted IH 35 congestion. A change to the second assumption was explored with Scenario 2c “What Would It Take?” This approach was found to have substantial IH 35 (and region-wide) congestion reduction.

In summary, business as usual is not sustainable. Building additional capacity without changing travel behavior does not appear to provide the level of mobility improvement needed. And the congestion levels are probably higher than would occur—growth would go elsewhere in the region or the U.S.

Regardless of the overall finding of this study, the incorporation of express lanes as one of the travel option strategies for IH 35 was demonstrated to be viable through the analyses of Scenarios 2 and 7. Much more analysis will be necessary, and some is already underway, to consider specifics of this express lane configuration. Undoubtedly, the continued study of this concept should be a high priority for Central Texas, considering the issue of maximizing its efficiency, its potential for non-traditional funding of construction and maintenance, as well as other social and environmental considerations necessary for any transportation project. It is likely that express bus transit will be the only reasonable exception to the tolls: any other toll-free usage, for example by carpools, is likely to compromise the operational efficiency of the express lane facility.

### **Critical Need for the Implementation of Travel Option Strategies**

As alluded to above, one of the most illuminating findings of this modeling effort stemmed from the various strategies that were explored with Scenario 2c “What Would It Take?” and Scenario 2d, the technology scenario. These demonstrated that all options should be seriously considered for addressing long-term future IH 35 mobility. Some of these options are:

- Add capacity.
- Manage capacity.
- Change travel behavior.
- Reduce trips.
- Shift trips to off-peak periods.
- Expand options: HOV, transit, other routes, activity centers.
- Use land more efficiently.
- Leverage new technologies.

This research study clearly points in the direction of exploring a variety of strategies to address long-term IH 35 mobility through Central Texas. Scenario 2c “What Would It Take?” represented a specific mix of demand reduction without exploring the feasibility of this level of reduction and what type of policy-, individual-, and employer-level commitments would be necessary to accomplish it. Scenario 2d, the technology scenario, studied one approach among many existing options and future technology.

One additional area to be explored is the sensitivity of metropolitan-area congestion to future land-use decisions—Central Texas has touched upon this approach in previous region-wide planning efforts. All of these approaches are fundamentally behavioral shifts. A significant unknown is how much these behaviors will or even can be shifted and which strategies—by the public policy/governmental sector, employers and businesses, and individuals—will be most effective. This is clearly a subject for further examination.

An additional recommendation resulting from this study is the need to further maximize the efficiency of the Central Texas system beyond IH 35 as a standalone corridor, for example:

- Maximizing the multimodal options available to Central Texans.

- Reviewing other primary travel corridors serving Central Texas including further development of US 183, LP 360, RM 620, as well as continued investigation of approaches to utilize SH 130.
- Examining other north-south arterial roadways such as Red River, North Lamar, Burnet Road, and Pleasant Valley to maximize efficiency for local travel, including light synching and multimodal access.
- Continuing to address the most critical bottlenecks to system-wide efficiency, for example connections between primary facilities or the operation of systems with high volumes of peak-period traffic such as Austin's downtown roadway network connection to IH 35 and Loop 1/MoPac.
- Exploring options for additional parallel capacity to IH 35, for example a potential US 183 South connection to SH 45 south of SH 71.

These findings and recommendations are merely a starting point; the ideas proposed by the Working Group require further discussion and exploration to determine the best mobility options for Central Texas.

## **Technical Findings & Challenges**

The advanced nature of the approach taken for this study, a multi-resolution modeling approach incorporating regional travel model results and a meso-scopically applied dynamic traffic assignment technique, allowed for several additional observations. Observations regarding technical challenges, data challenges, and communication of complex results are discussed in the following sections.

### **Technical Challenges**

The scale of the IH 35 corridor through the Austin area is of international, national, regional, and local significance, necessitating a geographic approach using a regional level, hence the need to use the Capitol Area Metropolitan Planning Organization (CAMPO) regional model of five counties. Certainly, an even broader scope of model could be justified, although this five-county regional level of analysis presented its own challenges in terms of extensive computational needs and model execution run times. In addition, coding in operational detail for even the five-county roadway network necessitated a generalized approach for this study within the time frame allotted.

### **Data Challenges**

An obvious, key recommendation by the research team for decision-makers is that they seek out and support initiatives to gather better data on travel behavior. Concerns about individual privacy and the challenge of businesses protecting their competitive advantage have never been higher. However, the value of understanding people's need for transportation and information to support improved system efficiency in serving this need has never been greater and will only increase. New methods of travel behavior data collection including voluntary participation, anonymization of cell phone data, and application of Bluetooth data to expand data sets are emerging to address this need. New methods of travel behavior modeling are also needed—methods, for example, that allow for more advanced examination of traveler response to policy and operational issues such as those explored here. Most of

these efforts require some level of public sector investment and support to ensure the data are usable for studies such as this one.

### **Communication of Complex Results**

The meso-scopic modeling approach applied for this study results in an enormous amount of data, which is both an advantage and a disadvantage. The advantages of the approach include providing much more detail and greater perspective on the operational constraints influencing drivers' route choice decisions as well as the delay they experience on various routes over the day. Interpreting and communicating these results to non-technical audiences without overwhelming them represents a challenge in ensuring that all the advantages of meso-scopic modeling are fully realized. Communicating concepts such as delay, queuing, and response to dynamic tolling, for example, can be challenging, and yet is critical for engaging the public in understanding the valuable perspectives uncovered in this study. It is also important to continue to reiterate for non-technical audiences that, while numbers are used for comparison purposes, values shown for travel times and vehicle hours of travel should not be taken as specific predictions.

### **Concluding Comments**

The results of this examination indicate that current efforts to add an express lane in each direction of IH 35 are a positive move. Scenarios 2 and 7 most closely represent this proposed configuration. Both scenarios improve mobility along IH 35 by providing a high-speed and reliable mobility option by marginally improving mobility along the IH 35 general purpose lanes. The findings of this mobility study should serve to prepare local stakeholders that the overall benefit of this two express lane configuration, without other strategies to address IH 35 and regional mobility, is notable but limited. In addition, the analysis indicates the need to carefully consider express lane access points and tolling strategy to maximize the efficiency and quality of service.

For the long-term outlook to year 2035 and beyond, this examination overall demonstrates that Central Texas confronts a harsh reality should population and employment growth trends continue as projected. Of the build-only options tested, the only one found to have a substantial impact in reducing IH 35 congestion was Scenario 6 Expanded, which assumes the addition of six tolled express lanes (three each direction) between SH 45 North and SH 45 South and eight intermediate access points. While Scenario 6 Expanded provides an option for the region to "build its way out of congestion," Scenario 6 is likely to have an extreme cost, both in monetary terms and in community and environmental contexts.

The most profound finding of this modeling effort is the magnitude of the problem exemplified by IH 35 and shared across the Central Texas region: IH 35 congestion in 2035 is fairly intractable if adding capacity is the only strategy. Nonetheless, the positive and constructive finding of this examination is that Central Texas has options to address IH 35 congestion—as a combined approach. As the "What Would It Take?" scenario demonstrates, the same substantial improvement from an additional six lanes of capacity (Scenario 6 Expanded) is equally possible from a hybrid approach (the "What Would It Take?" scenario).

The implications of these findings for Central Texas continue to be discussed by local transportation decision-makers. Before this examination, many of the concepts explored under the initial scenarios

analysis had been held out as promising solutions which would address the IH 35 long-term mobility challenge. Many were predicated upon shifting traffic to SH 130; the results of several of these concepts demonstrate the limitations of this approach. Instead, a key finding of this analysis is that Central Texans, especially commuters, represent a substantial part of IH 35 congestion. Few stakeholders are arguing against commuters—indeed, they represent jobs and a vibrant central city economy.

It is clear that there must be a shift in thinking away from the idea that there is a build solution which can solve the congestion problem. What is needed, instead, is a publicly supported concept that blends aspects of added capacity, operations improvements, and travel option solutions—as well as an answer to the central question of how to effect such a fundamental shift. The researchers acknowledge that getting to this concept will be a challenge. The findings from this study, however, should serve as motivation for approaching IH 35 congestion solutions differently; the return on this effort could very well be preserving the quality of life and economic health of Central Texas.