MEDIUM-RANGE STRATEGIES TO IMPROVE TRAFFIC CONDITIONS ON FM 1472 (MINES ROAD)

TTI Project 409218
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Interagency Cooperation Agreement – Technology Transfer & Technical Support Services for the Laredo District – Transportation Planning

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The TxDOT Laredo District requested that the Texas A&M Transportation Institute (TTI) conduct an analysis of approximately 5.25 miles along the FM 1472 (Mines Road) corridor from Loop 20 (now called IH 69W) to FM 3338 (Las Tiendas Road). The purpose of the analysis was to identify potential short-term, medium-range, and long-range improvement strategies for improving mobility and increasing safety along the corridor. Separate technical memoranda describe the results of the short-term and long-range analyses[1][2]. This technical memorandum covers the analysis of potential medium-range strategies.

The medium-range strategy analysis involved two main sets of activities: (a) identify and evaluate potential medium-range strategies along FM 1472, and (b) evaluate potential effects on the medium-range strategies because of the anticipated completion of Hachar Loop and Vallecillo Road. The results of the first part of the analysis indicate that the following medium-range strategies would provide the most benefits to the study corridor:

- Add third northbound through lane between Killam Industrial Boulevard and Interamerica Boulevard.
- Expand Killam Industrial Boulevard intersection by providing dual westbound to southbound left-turn lanes, a westbound to northbound free right-turn lane, dual southbound to eastbound left-turn lanes, a southbound to westbound free right-turn lane, an eastbound to northbound dual left-turn lane, and dual northbound to westbound left-turn lanes.
- Add third southbound through lane between A F Muller Boulevard and Interamerica.
- Provide dual eastbound to southbound right-turn lanes at the Interamerica intersection.
- Extend northbound to westbound left-turn bay at the Trade Center Intersection.
- Extend northbound to westbound left-turn bay at the Pan America Intersection.
- Optimize signal timing and phasing at the intersections that would experience geometric changes or traffic operational changes.

The results of the second part of the analysis indicate the following:

- Adding Hachar Loop and Vallecillo Road would alleviate congestion on the study corridor. During the morning peak, average delay per vehicle could decrease by as much as 67 percent in 2018 and by 45 percent in 2038 (assuming the short-term strategies have been implemented). During the afternoon peak, the delay reduction could be as much as 75 percent in 2018 and 32 percent in 2038.
- Implementing the medium-range strategies once Hachar Loop and Vallecillo Road are in place would result in significant improvements in system performance, both in terms of delay per vehicle and travel time. More specifically (depending on the simulation scenarios):

[1] Kraus, E., Ding, L., Li, J., Sanchez, A., and Quiroga, C. (2016). *Short Term Strategies To Improve Traffic Conditions On FM 1472 (Mines Road).* College Station, Texas: Texas A&M Transportation Institute.
[2] Holik, W., Li, J., Quiroga, C., Venglar, S., and Kraus, E. (2016). *Long-Range Strategies To Improve Traffic Conditions On FM 1472 (Mines Road).* College Station, Texas: Texas A&M Transportation Institute.

- System-wide average delay per vehicle could decrease an additional 17-50 percent in 2018 and 12-38 percent in 2038.
- Northbound travel time on FM 1472 between Killam Industrial Boulevard and the Con-Way Truckload Facility could decrease an additional 6-25 percent in 2018 and 10-55 percent in 2038. Southbound travel time could decrease an additional 3-17 percent in 2018 and 10-60 percent in 2038.

MEDIUM-RANGE STRATEGIES TO IMPROVE TRAFFIC CONDITIONS ON FM 1472 (MINES ROAD)

INTRODUCTION

The Texas Department of Transportation (TxDOT) Laredo District requested that the Texas A&M Transportation Institute (TTI) conduct an analysis on FM 1472 (Mines Road) to identify potential strategies to improve mobility and safety along the corridor. The focus of the analysis includes short-term, medium-range, and long-range improvement strategies. Separate technical memoranda describe the results of the short-term and long-range analyses. This technical memorandum covers the analysis of potential medium-range strategies. TTI's involvement was necessary to take advantage of the following research initiatives in which TTI researchers have been involved over the last few years, which had the potential to considerably accelerate the implementation of research findings into standard business practices at the department:

- Recent involvement in the development of Corridor SIMulation (CORSIM) environment modules[3], including driver behavior algorithm development and testing.
- Recent involvement in the development of a Highway Capacity Manual-styled analytical methodology for investigating vehicle trajectory data for signal control delay calculations[4], including analyzing different levels of simulation outputs.
- Knowledge of the limitations of "typical" truck passenger car equivalency (PCE) values included in the Highway Capacity Manual (HCM) and software packages such as Synchro, which are based on research conducted in the mid-1990s. Team members were aware of recent research conducted in Florida,[5] which developed PCE values considering factors such as geometric characteristics, traffic demand, and truck fleet composition.
- Extensive experience supporting and assisting public agencies in Texas in the implementation and application of emerging travel forecasting modeling techniques.
- Leading-edge research experience developing and implementing algorithms for performing travel time studies using GPS and GIS techniques, [6] as well as recent research using archived travel time data from various data sources such as INRIX, Google Maps, and other data aggregators.
- Recent research experience on the benefits of raised median access management techniques, [7,8] including delay and crash reductions compared to two-way-left-turn lanes.

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[3] Li, J., & Washburn, S. S. (2011). Implementing two-lane highway simulation modeling into CORSIM. *Procedia-Social and Behavioral Sciences*, *16*, 293-305.
[4] Li, J., & Washburn, S. S. (2014). Improved operational performance assessment for two-lane highway facilities. *Journal of Transportation Engineering*.
[5] Washburn, S. S., & Ozkul, S. (2013). *Heavy Vehicle Effects on Florida Freeways and Multilane Highways* (No. TRC-FDOT-93817-2013).
[6] Quiroga, C. A., & Bullock, D. (1998). Travel time studies with global positioning and geographic information systems: an integrated methodology. *Transportation Research Part C: Emerging Technologies*, *6*(1), 101-127.
[7] Frawley, W. E., & Eisele, W. L. (2004). *Investigation of access point density and raised medians: Crash analysis and micro-simulation* (No. FHWA/TX-05/0-4221-P1,).
[8] Eisele, W. L., Schrank, D. L. & Lomax, T. J. (2005, January). Incorporating Access Management into the Texas Transportation Institute's Urban Mobility Report. In *Presented at the Transportation Research Board's 84th Meeting*.

In connection with these research initiatives, TxDOT was interested in facilitating the transfer of research findings to TxDOT district officials. As part of this process, TxDOT requested that TTI conduct several meetings with district officials to describe in detail critical elements related to the analysis, including, but not limited to, assumptions; analysis scope, methodology, and limitations; feasibility of implementation; and local characteristics.

The medium-range strategy analysis involved two main sets of activities: (a) identify and evaluate potential medium-range strategies along FM 1472, and (b) evaluate potential effects on the medium-range strategies because of the anticipated completion of Hachar Loop and Vallecillo Road. Figure 1 shows the extent of the first part of the analysis, i.e., approximately 5.25 miles along FM 1472 from Loop 20 (now called IH 69W) to FM 3338 (Las Tiendas Road). As a reference, Figure 1 also shows the study limits for the short-term analysis. Figure 2 shows the approximate location of Hachar Loop and Vallecillo Road, which provided the basis for the second part of the analysis.

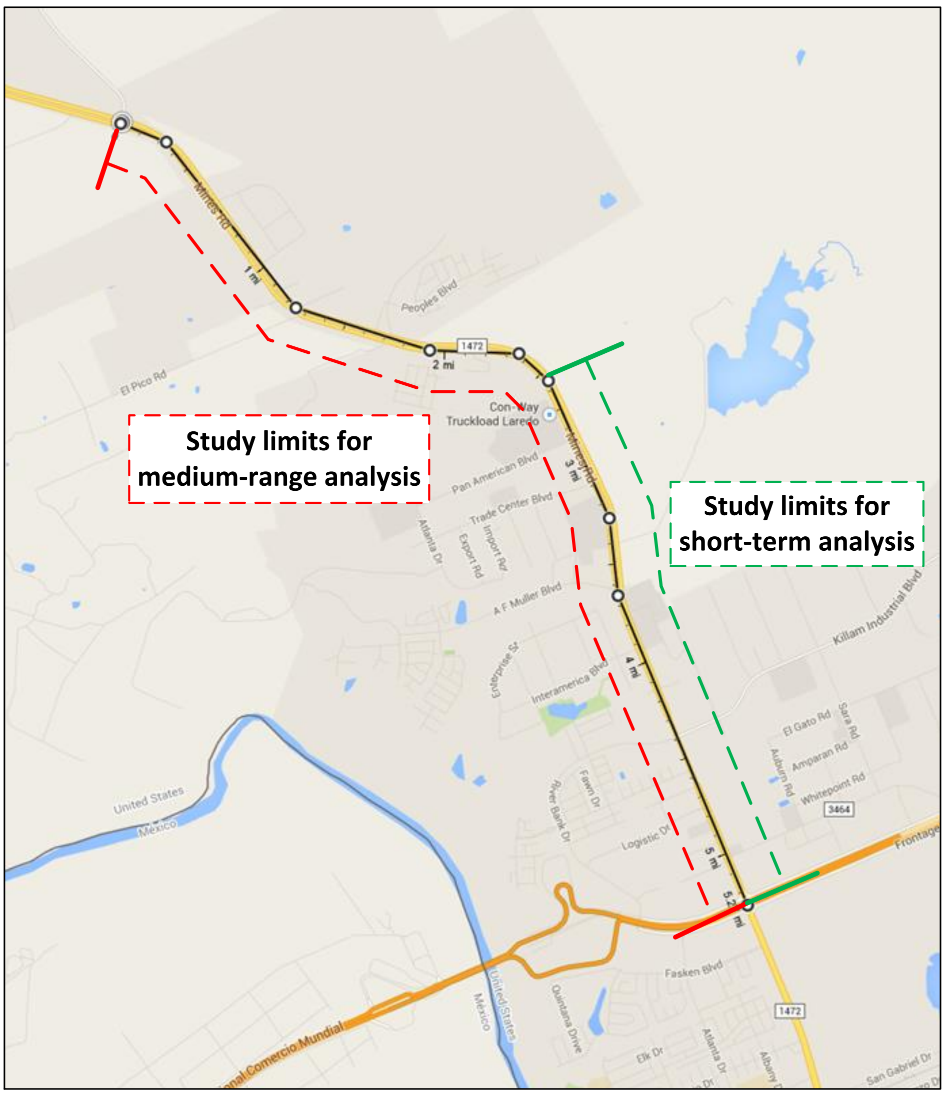


Figure 1. Study Limits along FM 1472 Corridor.

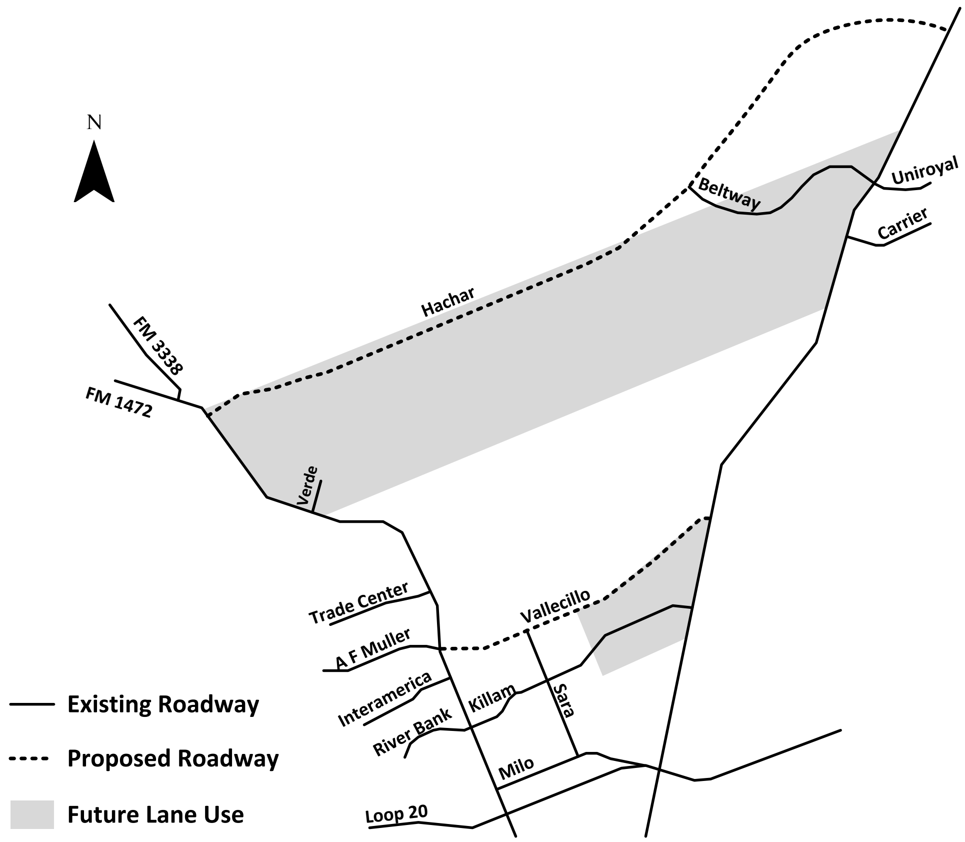


Figure 2. Hachar Loop and Vallecillo Road, Laredo, Texas.

ANALYSIS OF MEDIUM-RANGE STRATEGIES

This section summarizes the first part of the analysis, which focused on evaluating the impacts of potential medium-range strategies and identifying the ones that would actually provide improvements to the study corridor.

Potential Medium-Range Strategies

At the beginning of the short-term analysis, TxDOT prepared a preliminary list of potential short-term, medium-range, and long-range strategies. The list was subsequently refined during discussions with TxDOT officials to differentiate short-term strategies from medium-range strategies more clearly. Table 1 provides the details of the potential medium-range strategies that were selected for the analysis.

Table 1. Potential Medium-Range Strategies.

Location	Medium-Range Strategy
Pan American Boulevard	• Add dual EB to SB right-turn lanes. • Add third SB through lanes south of Pan American Boulevard to A F Muller Intersection. • Add length to NB to WB left-turn lanes. • Optimize signal timing and phasing as needed.
Trade Center Boulevard	• Add dual EB to SB right-turn lanes. • Extend the length of the left-turn lanes. The length of the dual NB to WB left-turn bay might be too short. • Optimize signal timing and phasing as needed.
A F Muller Boulevard	• Replace existing signalization intersection with a superstreet intersection configuration. • Optimize signal timing and phasing as needed.
Interamerica Boulevard	• Add third SB through lanes north of Interamerica Boulevard to A F Muller Boulevard. • Provide dual EB to SB right-turn lanes. • Optimize signal timing and phasing as needed.
Killam Industrial Boulevard	• Add third NB through lane between Killam Intersection and Interamerica Intersection. • Provide dual WB to SB left-turn lanes. • Provide WB to NB free right-turn lane. • Provide dual SB to EB left-turn lanes. • Provide SB to WB free right-turn lane. • Provide dual EB to NB left-turn lanes. • Provide dual NB to WB left-turn lanes. • Optimize signal timing and phasing as needed.

For the analysis of the medium-range strategies, TTI assumed that all recommended short-term strategies would be in place. Relevant short-term improvements, such as the construction of raised medians at Pellegrino Court and Wolf Creek Drive to prevent northbound to southbound truck U-turns at both intersections, were also assumed to be in place.

TTI used the corridor simulation capabilities in SimTraffic 9 to analyze potential medium-range strategies. The goal was to determine the anticipated benefits of each potential strategy in terms of corridor traffic improvements, and then use this information as the basis to compare strategies. The analysis included three sets of activities:

- **Calibrate modeling environment using existing conditions.** TTI created the entire study corridor of 5.25 miles (study limits in Figure 1) in SimTraffic 9 using existing geometric configuration, traffic movement counts, and signal timing for both morning peak and afternoon peak conditions. To calibrate the model, TTI used data from travel time runs, Google travel time data, and INRIX speed data.
- **Implement and validate short-term strategies**. For the short-term analysis, TTI analyzed each individual intersection in isolation. For the medium-range analysis, TTI first tested each short-term strategy at the network level and then applied those strategies that would provide the most study corridor benefits to the existing condition model. The

final models from this exercise served as the baseline for the analysis of potential medium-range strategies.

- **Evaluate medium-range strategies**. TTI evaluated the potential medium-range strategies to determine their anticipated benefit at the corridor level in terms of reduction in travel time and total network delay, and increase in network throughput.

Data Collection

Turning Movement Count Data

TTI collected turning movement counts (TMCs) at all major intersections along the study corridor in September 2014 (intersections south of Killam Industrial Boulevard), March 2015 (intersections north of Killam Industrial Boulevard to El Pico Road), and June 2015 (two intersections at World Trade Center Loop). The data collection at each intersection covered two hours in the morning (7 AM to 9 AM), noon (11 AM to 1 PM), and afternoon (4 PM to 6 PM). For most intersections, the maximum observed volume was from 7:30 AM to 8:30 AM in the morning and 5:00 PM to 6:00 PM in the afternoon. The corresponding hourly traffic counts were therefore used as peak hour volumes for the morning peak and afternoon peak, respectively. In addition, because TMC data were collected at different times and some minor driveways were not included in the data collection, TTI fine-tuned the hourly traffic volumes to make the arriving volume at each approach of an intersection equal to the volumes departing from upstream intersections.

Travel Time Data

It is normally preferred to collect travel time data at the same time that TMCs are performed (i.e., September 2014 and March 2014). However, it was not possible to conduct travel time runs until June 2015 due to changes in the analysis approach. As a result, a gap existed between TMC data collection and travel time runs. Readers should also note that the school near the study corridor was in session when TMCs were collected, but not in session when travel times were measured. To address the uncertainty in traffic demand with versus without school traffic, TTI gathered travel time information using three data sources:

- **TTI's travel time runs**. TTI conducted travel time runs on FM 1472 from Loop 20 to the Con-Way Truckload Facility on June 11, 2015 as part of the short-term analysis (see Figure 1). North of the Con-Way Truckload Facility, FM 1472 normally operates at free flow conditions, even during peak hours. Travel time data included 7 AM to 9 AM, 11 AM to 1 PM, and 4 PM to 6 PM.

- **Google travel time data**. Google Maps provides travel times between two points along a user-selected route based on data gathered anonymously from Android mobile phone users (typically GPS-based locations or, alternatively, triangulation using cell tower locations). Google Maps displays travel times as a range. Presumably, the lower bound represents free flow conditions and the upper bound takes into account delays that have been observed at that particular time in the past. Google Maps shows travel times in 20-

minute intervals. In addition, Google Maps provides a visual indication of traffic conditions using color-coded 1/8-mile (or 660 ft) roadway segments, e.g., blue represents free flow conditions, yellow represents some delays, and red represents significant delays. Google does not release exact details of the procedure to gather, process, or analyze the data. Therefore, users do not have access to specific details, e.g., the source of the data, how many data points were used for the estimate, or even what the travel time ranges actually represent. In addition, at least for the travel time data along FM 1472, Google Maps estimates travel time data for a typical Monday (every 20 minutes), a typical Tuesday (every 20 minutes), and so on.

TTI wrote a computer program to automate the extraction of color-coded bands and travel time data from Google Maps. The program enabled the collection of screenshot images at 20-minute intervals for weekdays between 6 AM and 8 PM. The program converts the corresponding traffic condition color for each roadway segment into an individual Microsoft Excel cell. The result was two space-time diagrams representing 'average' traffic conditions on FM 1472 in the northbound and southbound directions (Figure 3, Figure 4).

A close review of the trends in Figure 3 and Figure 4 reveals that traffic is more congested in the northbound direction than in the southbound direction, and that Mondays and Fridays experience more delay than the remaining weekdays. The intersections with the most congestion are Killiam Industrial Boulevard, Trade Center Boulevard, and Pan American Boulevard.

- **INRIX speed data**. INRIX gathers and aggregates data collected from a wide range of anonymous GPS-equipped devices. TxDOT acquired a license to use the INRIX speed data for statewide mobility analysis applications, and has shared that data with TTI for several years to identify and analyze congested corridors around the state. TTI received copies of both 2013 and 2014 INRIX speed data along FM 1472. The INRIX speed data are provided in 15-minute intervals for each day of the week, from Monday through Sunday. Spatially, the INRIX speed data are provided along segments that could vary from 0.95 miles to 1.63 miles long. This makes the INRIX data more disaggregated temporally, and more aggregated spatially, than the Google Maps data.

  TTI calculated travel times along the study portions of FM 1472 (Loop 20 to the Con-Way Truckload Facility) based on the corresponding INRIX speed data (Figure 5, Figure 6). The results show that the northbound traffic experienced more delay than southbound traffic in the morning, while the southbound traffic experienced more delay than northbound traffic in the afternoon. Consistent with the Google travel time, travel times based on INRIX speed data show that Mondays and Fridays experience more delay than the remaining weekdays. A comparison between 2013 and 2014 travel time data indicates that northbound travel times were lower each day of the week in 2014. However, southbound travel times significantly increased on Mondays and Fridays in 2014.

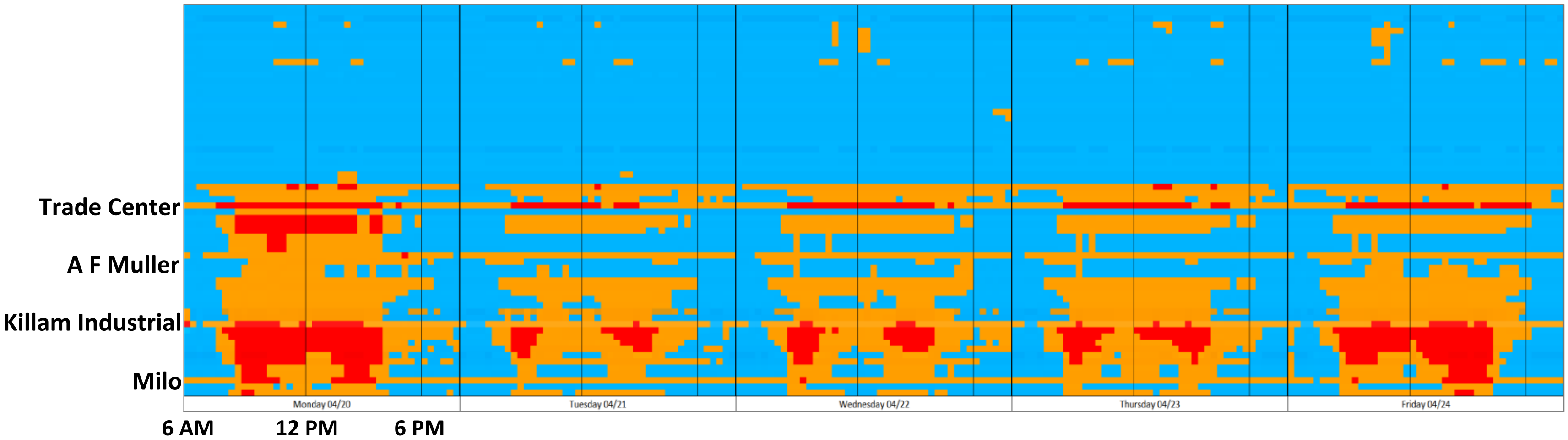


Figure 3. Google Maps Traffic Condition Trend – Northbound Direction.

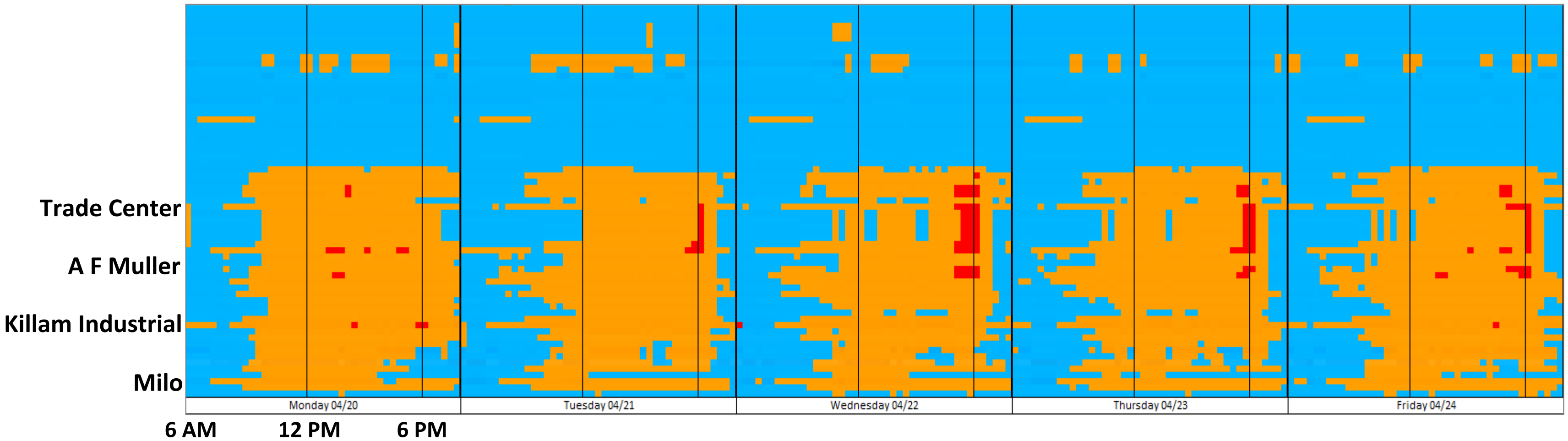
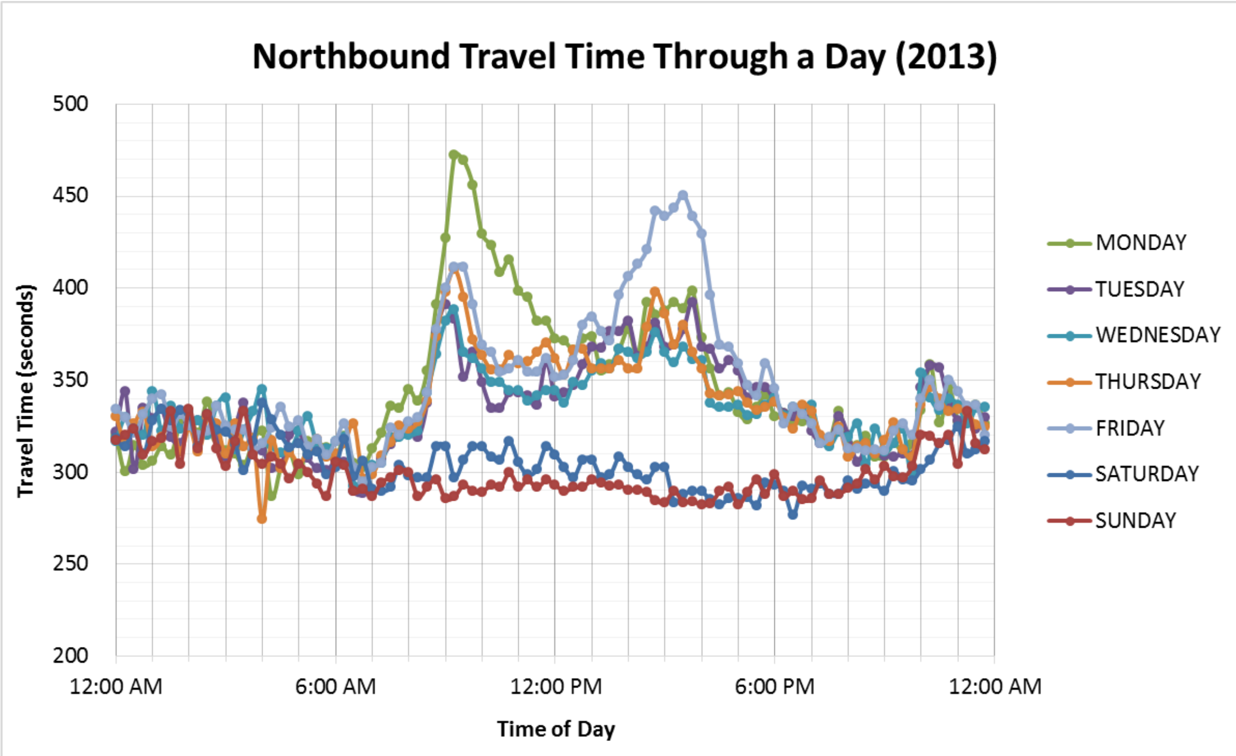


Figure 4. Google Maps Traffic Condition Trend – Southbound Direction.



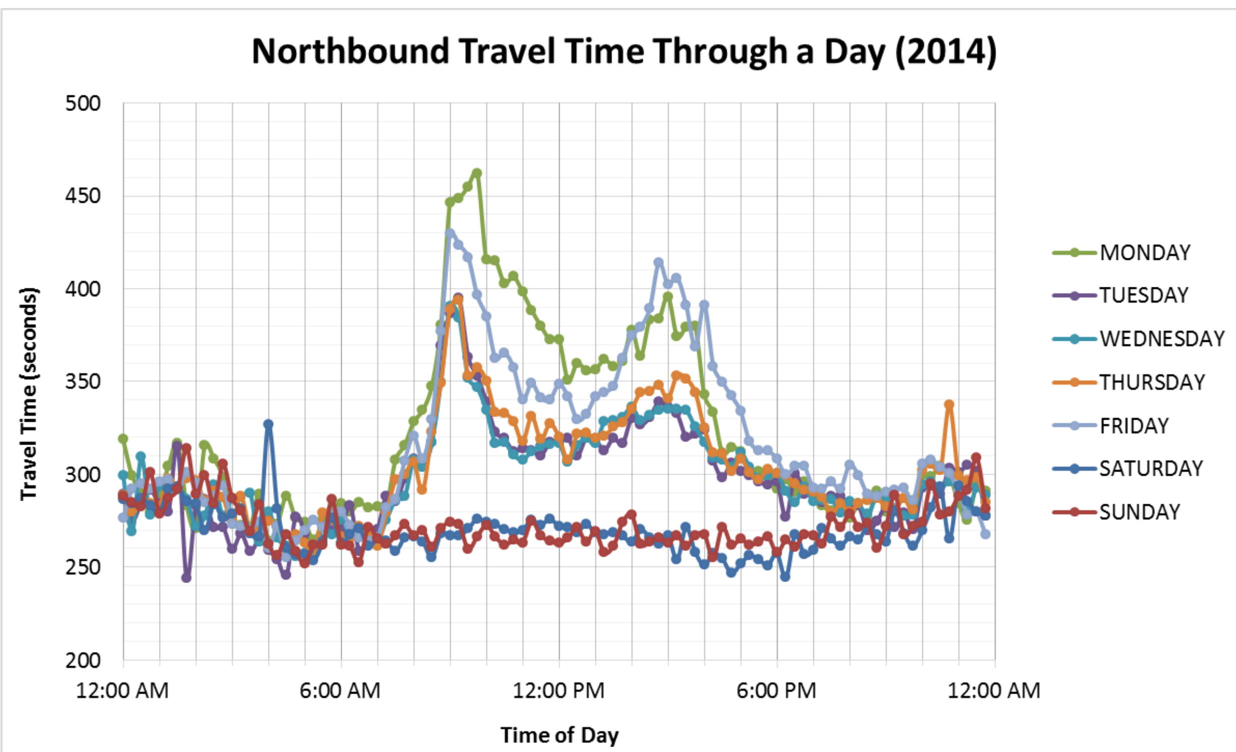
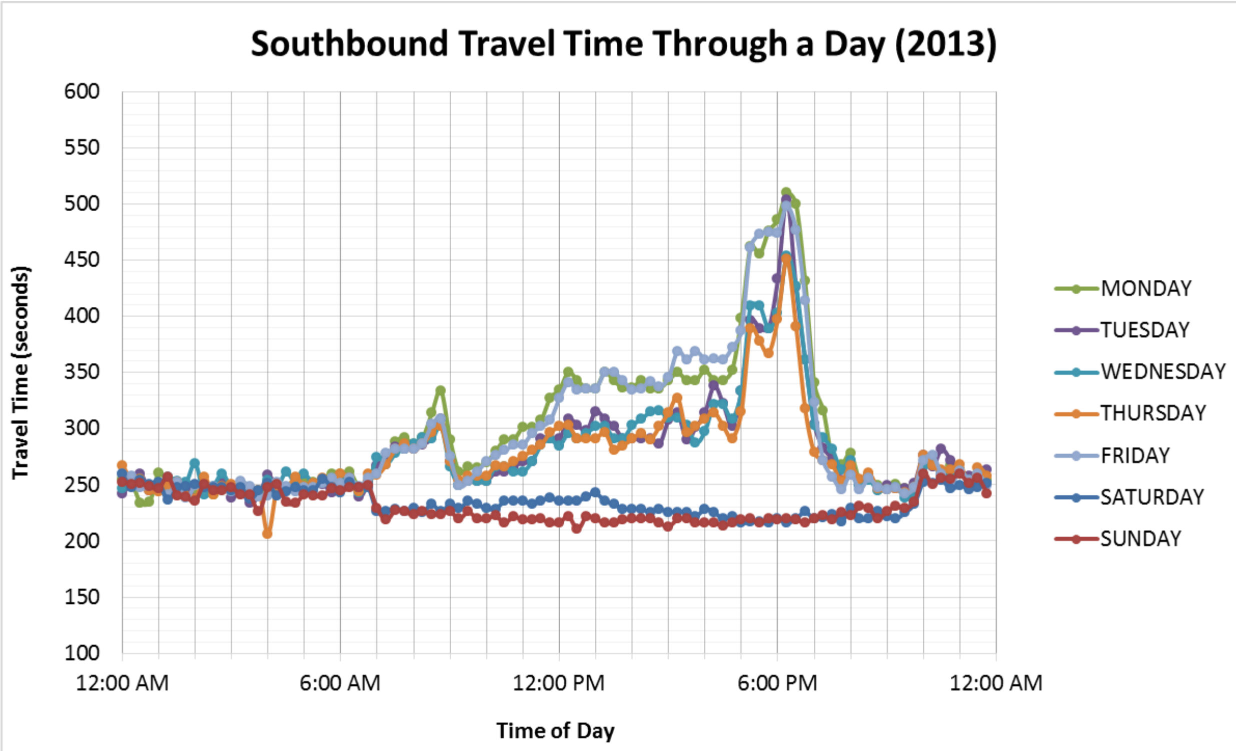


Figure 5. Northbound Travel Time of a Week Based on 2013 and 2014 INRIX Speed Data.



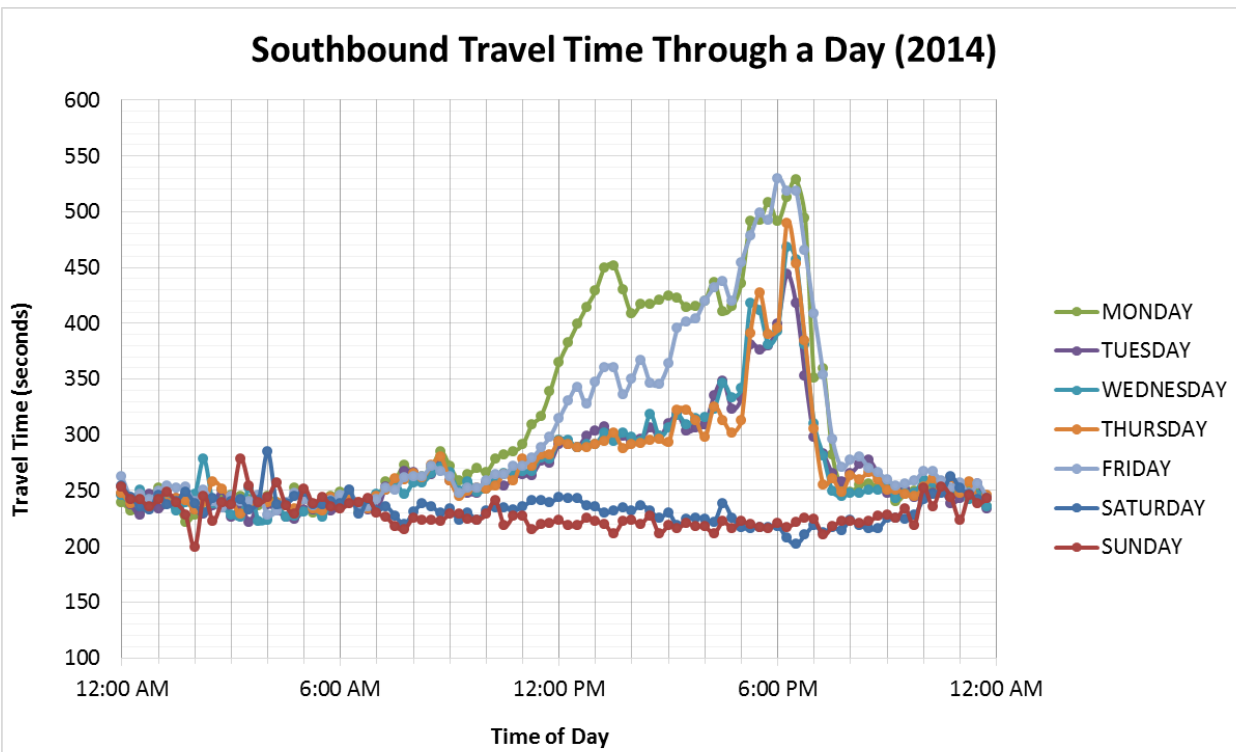
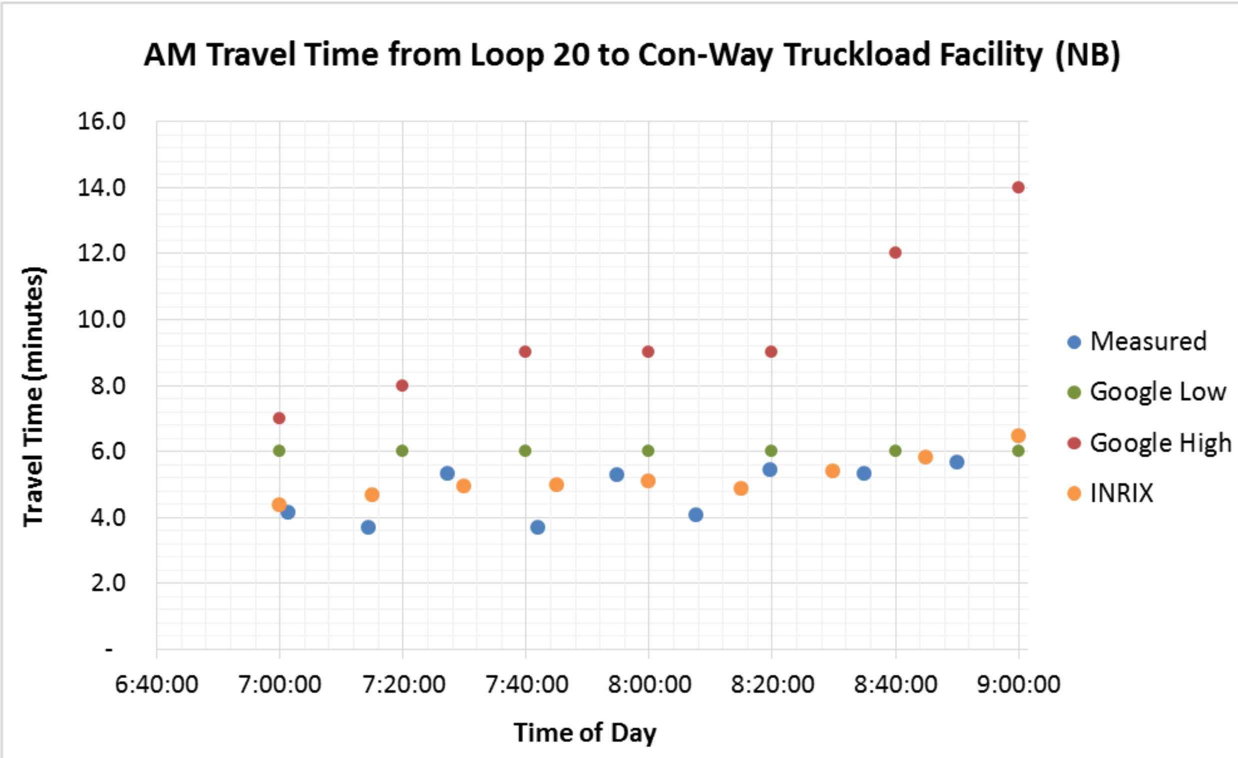


Figure 6. Southbound Travel Time of a Week Based on 2013 and 2014 INRIX Speed Data.

Because TTI conducted travel time runs on Thursday, June 11th, 2015, all Google and INRIX data points used for the analysis were from a typical Thursday. Figure 7 shows travel times on FM 1472 during the morning peak. In the northbound direction, TTI's measured travel times ranged from 3-5 minutes and were generally lower than the other data sources. Google Maps' travel times ranged from 6-14 minutes, with the high values increasing progressively from about 7 minutes at 7 AM to about 14 minutes at 9 AM. INRIX's travel times ranged from 4-6 minutes. They also increased progressively from about 4 minutes at 7 AM to 6 minutes at 9 AM. In the southbound direction, TTI's travel times ranged from 4-6 minutes and were generally consistent with Google Maps' low travel times and INRIX's travel times. Google Maps' low travel times ranged from 5-6 minutes, with the high values increasing progressively from 7 minutes at 7 AM to about 9 minutes at 9 AM. INRIX's travel times ranged from 4-4.5 minutes. They generally stayed constant from 7 AM to 9 AM.

Figure 8 shows travel times on FM 1472 around Noon. In the northbound direction, TTI's measured travel times ranged from 5-7 minutes and were generally consistent with Google Maps' low travel times and INRIX's travel times. Google Maps' travel times ranged from 6–12 minutes, with the high values increasing from 10 to 12 minutes at Noon. INRIX's travel times ranged from 5–5.5 minutes. They generally stayed constant from 11 AM to 1 PM. In the southbound direction, TTI's measured travel times ranged from 5-8 minutes and were generally equal to or higher than the other data sources. Google Maps' travel times ranged from 6–10 minutes, with the high values ranging from 9-10 minutes. INRIX's travel times ranged from 4.5–5 minutes. They generally stayed constant from 11 AM to 1 PM.

Figure 9 shows travel times on FM 1472 during the afternoon peak. In the northbound direction. TTI's measured travel times ranged from 5-6 minutes and were generally consistent with Google Maps's low travel times and INRIX's travel times. Google Maps' travel times ranged from 6–12 minutes, with the high values decreasing progressively from 12 minutes at 4 PM to 8 minutes near 6 PM. INRIX's travel times ranged from 5–5.5 minutes. They generally stayed constant from 4 PM to 6 PM. In the southbound direction, TTI's measured travel times ranged from 6-11 minutes and were generally higher than the other data sources. Google Maps' travel times ranged from 6-14 minutes, with the high values varying from 10-14 minutes between 4 PM and 6 PM. INRIX's travel times generally increased from 5 minutes at 4 PM to about 7 minutes at about 5:30 PM.



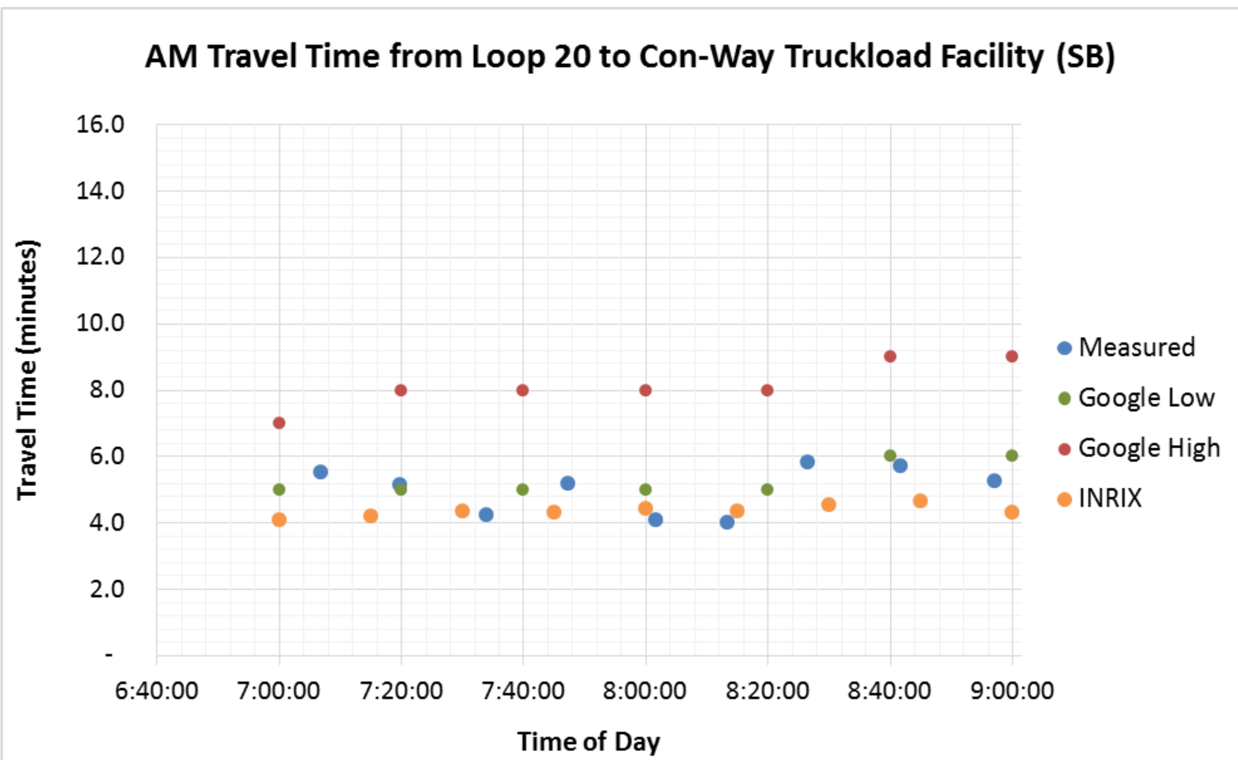
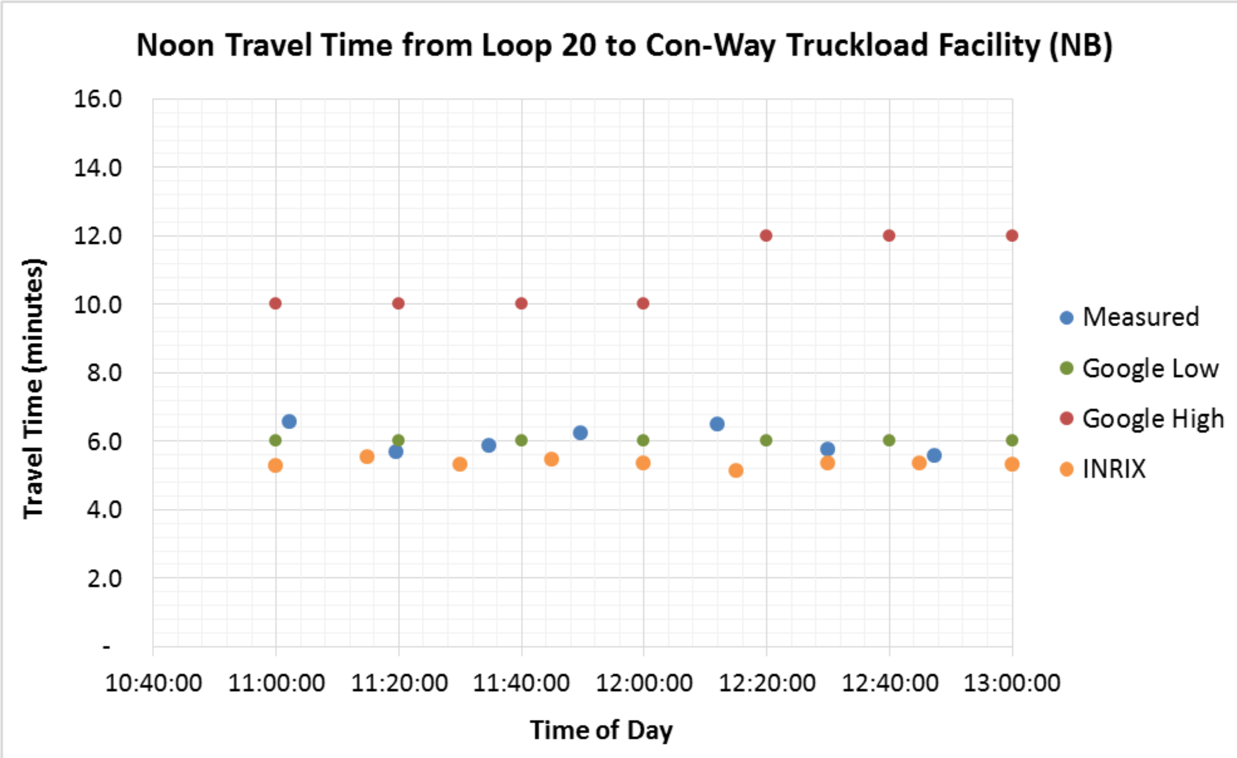


Figure 7. Travel Time Comparison – Morning Traffic.



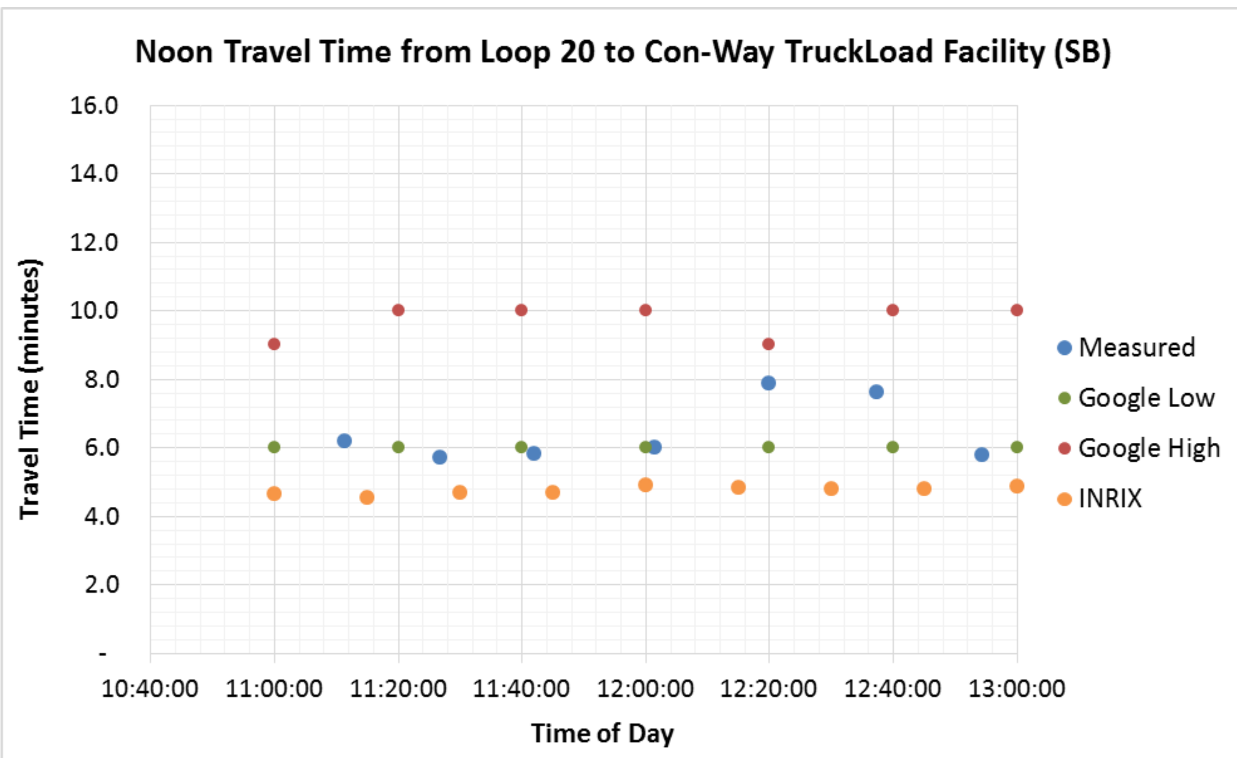
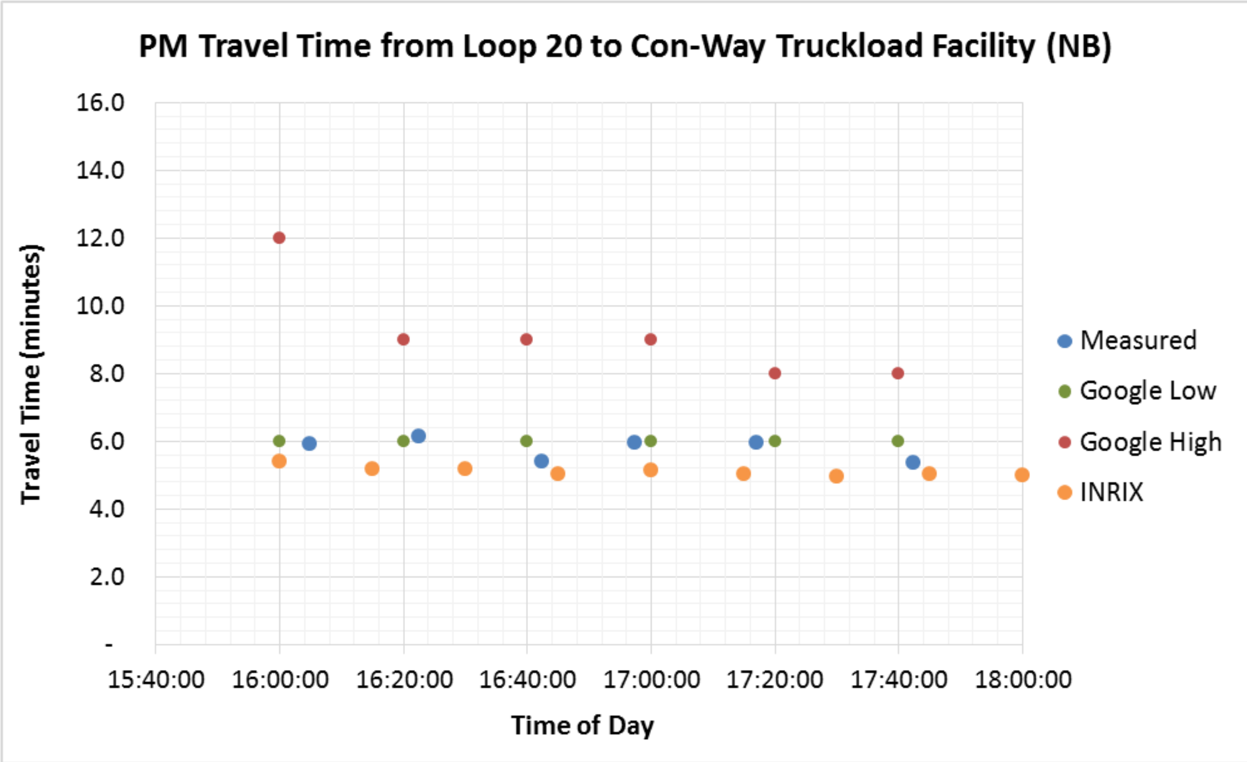


Figure 8. Travel Time Comparison – Noon Traffic.



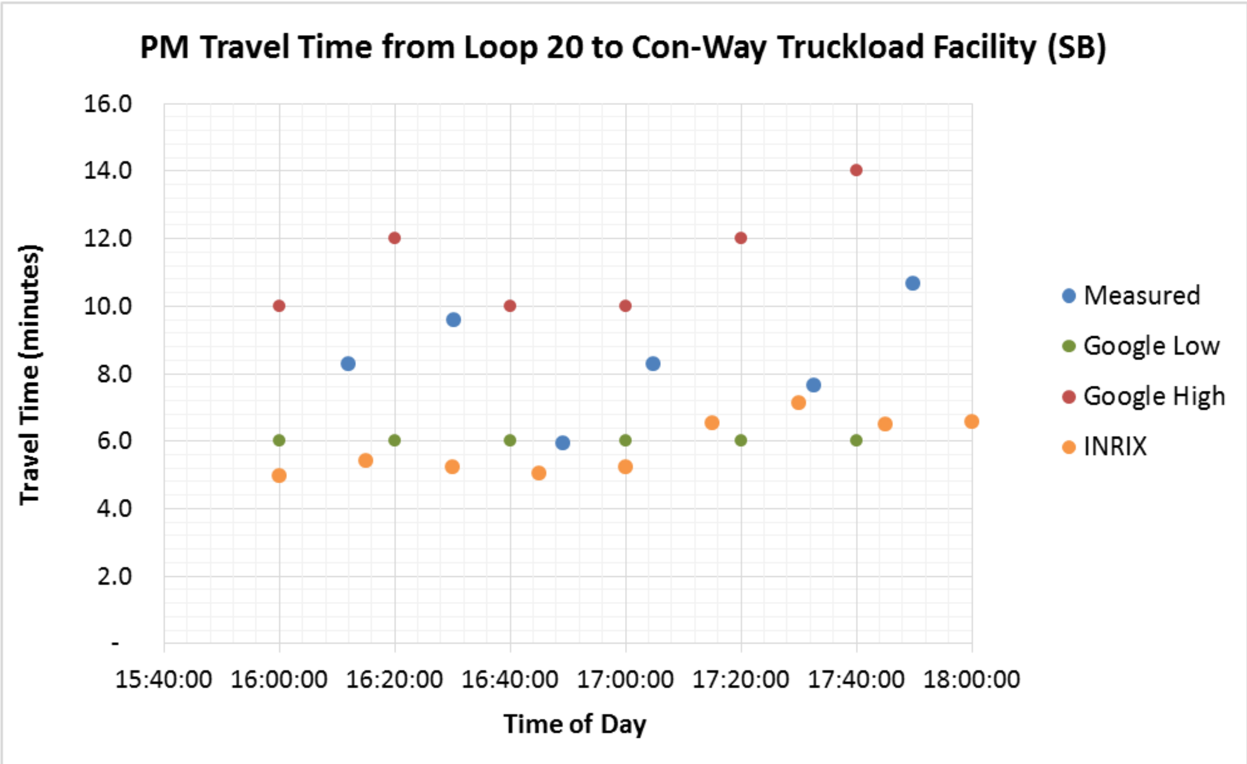


Figure 9. Travel Time Comparison – Afternoon Traffic.

Simulation Experiments and Analysis

TTI conducted three sets of simulation experiments in the SimTraffic 9 environment: (a) modeling and calibration of existing conditions; (b) implementation of short-term strategies; and (c) evaluation of medium-range strategies in the scenario where the short-term strategies have been implemented.

Modeling and Calibration of Existing Conditions

The simulation included the existing roadway configuration, adjusted traffic counts (to ensure that the arriving volume at each approach of an intersection equaled the volume departing from an upstream intersection), and existing signal timing for both morning peak and afternoon peak. To account for the characteristics of the truck fleet in the study area, TTI used a modeled truck fleet consisting of 60 percent 70-ft long trucks and 40 percent 30-ft long tractors. The simulated travel time results of the testing corridor (from Loop 20 to the Con-Way Truckload Facility) from the initial models indicated a need for calibration. TTI calibrated the model of existing conditions based on the following:

- Peak hour volume. TTI collected TMC data for two hours in the morning (7-9 AM) and afternoon (4-6 PM). To account for the situation where the true peak might be outside these two periods, TTI examined 24-hour data collected with road tube counters near Killam Industrial Boulevard on the same day of the TMC collection. With this information, TTI identified the northbound peak hour volume from 8-9 AM and the southbound peak hour volume from 6-7 PM.
- Driver parameters. In general, there are more trucks in the afternoon than in the morning. TTI modified the speed parameters and headway parameters in SimTraffic 9 based on the assumption that drivers tend to keep longer headways from the vehicles ahead and lower their speeds when the truck percentage is high. TTI determined appropriate values for these parameters through trial and error.

The result of this effort was two calibrated models that represented existing conditions in the morning peak and afternoon peak along the study corridor.

Implementation of Short-Term Strategies

The short-term analysis involved an evaluation of potential short-term improvements in isolation, i.e., without accounting for network-level effects. This approach was necessary because of the urgency with which preliminary results for the short-term analysis were needed. However, it was clear that a more adequate evaluation of the short-term strategies would require information and analysis at the network level.

As part of the medium-range analysis, TTI applied each short-term strategy to the calibrated models that represented existing conditions (see previous section). The result of the analysis provided an indication of situations where the short-term strategies were still feasible as well as situations where it would be necessary to adjust the list of recommended short-term strategies.

Table 2 provides a summary of short-term strategies, including recommended adjustments to the strategies where necessary. In general, most of the recommended short-term strategies were still feasible, expect for specific strategies at Old Milo Road, Killam Industrial Boulevard, and Interamerica Boulevard.

Table 2. Recommended Short-Term Strategies.

Location	Short-Term Strategies	Modified Short-Term Strategies	
		AM Peak	PM Peak
Con-Way Truckload Facility	• Close median.	Implement as recommended	Implement as recommended
Pan American Boulevard	• Optimize signal splits within 150-second cycle.	Implement as recommended	Implement as recommended
Trade Center Boulevard	• Add overlap phase for EB right turn with NB left turn. • Optimize signal splits within 75-second cycle.	Implement as recommended	Implement as recommended
A F Muller Boulevard	• Use superstreet configuration. • Optimize signal splits within 75-second cycle.	Implement as recommended	Implement as recommended
Interamerica Boulevard	• Eliminate SB left/U turn. • Add overlap phase for EB right turn with NB left turn. • Optimize signal splits within 150-second cycle.	Southbound U-turns cannot be eliminated because A F Muller intersection will be changed to superstreet configuration. The original EB to NB left-turn vehicle will have to make a SB to NB U-turn at Interamerica Intersection.	Implement as recommended
Killam Industrial Boulevard	• Change WB through lane to through right shared lane. • Optimize signal splits within 150-second cycle.	Implement as recommended	Signal optimization should consider allocating less green time for WB to SB left-turn traffic, otherwise it would result in continuous SB traffic south of Killam Industrial Boulevard, which may block any turning traffic and both Wolf Creek Intersection and Pellegrino Intersection.
Old Milo Road	• Eliminate SB to EB movement and WB to SB movements by closing median. • Optimize signal splits within 150-second cycle.	Closing median would aggravate congestions at adjacent intersections, so the first strategy was removed.	The first strategy was removed. The second strategy was modified to: optimize signal splits within 75-second cycle.
Loop 20	• Optimize signal timing and phasing using a full-phase diamond configuration.	Implement as recommended	Implement as recommended

In addition to the validated short-term strategies, TTI modified the median configurations at Wolf Creek and Pellegrino intersections to reflect the new construction of raised medians at these locations. Because the medians prevent U-turn maneuvers for trucks, which were previously allowed, TTI made the following assumptions for the simulation purposes:

- At Pellegrino Court, half of the U-turn trucks would turn left at Pellegrino Court and travel on Albany Drive, Logistic Drive, and southbound FM 1472. The remaining half of U-turning trucks would go straight and make a U-turn at Killam Industrial Boulevard.
- At Wolf Creek Drive, all U-turning trucks would go straight and make a U-turn at Killam Industrial Boulevard.
- To accommodate U-turns at the northbound approach of the intersection at Killam Industrial Boulevard, the existing exclusive left-turn lane was changed to a left-turn and U-turn shared lane.

The results in Table 3 show that implementing the short-term strategies would reduce the average northbound travel time during the morning peak by approximately 5 minutes. However, there would not be significant improvements in northbound travel time during the afternoon peak or in southbound travel time in either peak. Table 3 also shows that the total network delay would decrease both during the morning and afternoon peaks. TTI calculated the percentage of traffic served at the end of each one-hour simulation by dividing the number of vehicles entering the network by the number of vehicles exiting the network. A larger percentage indicates more vehicles were served during the simulated hour, which means fewer vehicles were queued and stored along FM 1472. The percentage of traffic served during a simulation hour increased in both peaks.

Table 3. Comparison of Performance Measures between Existing Conditions and Improved Conditions by Short-Term Strategies.

Performance Measure	Existing Condition		Short-Term Strategies Applied		Change By Implementing Short-Term Strategies	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Average northbound travel time (minutes)	15	9	10	9	5	0
Average southbound travel time (minutes)	8	12	8	12	0	0
Total delay (hour)	359	581	263	518	-96	-63
Percentage of traffic served by the network during the simulation hour	95%	97.5%	99.7%	98.4%	4.7%	0.9%

Evaluation of Medium-Range Strategies

TTI tested and evaluated the medium-range strategies listed in Table 1 assuming that all the short-term strategies have been implemented as described in the previous section. TTI tested six simulation scenarios, as summarized in Table 4. In general, each scenario added to the previous scenario. For example, Scenario 2 included the strategy in Scenario 1, expansion of the intersection at Killam Industrial Boulevard, and optimization of the signal timing and phasing of this intersection. This methodology enabled the determination of implementation strategy thresholds beyond which the marginal benefit could be considered negligible.

Table 4. Simulation Scenarios for Medium-Range Strategies.

Implementation Scenario	Description
1	• Add third NB through lane between Killam Industrial Boulevard and Interamerica Boulevard.
2	• Strategy from Scenario 1. • Expand Killam Intersection 1) Provide dual WB to SB left-turn lanes; 2) Provide WB to NB free right-turn lane; 3) Provide dual SB to EB left-turn lanes; 4) Provide SB to WB free right-turn lane; 5) Provide EB to NB dual left-turn lane; 6) Provide dual NB to WB left-turn lanes. • Optimize signal timing and phasing at Killam Intersection.
3	• Strategies from Scenario 2. • Add third SB through lane between A F Muller Boulevard and Interamerica Boulevard. • Provide dual EB to SB right-turn lanes at Interamerica intersection. • Optimize signal timing and phasing at Interamerica intersection.
4	• Strategies from Scenario 3. • Extend NB to WB left-turn bay at Trade Center Intersection. • Provide dual EB to SB right-turn lanes at Trade Center Intersection. • Optimize signal timing and phasing at Trade Center intersection.
5	• Strategies from Scenario 4. • Extend NB to WB left-turn bay at Pan America Intersection. • Provide dual EB to SB right-turn lanes at Pan America Intersection. • Optimize signal timing and phasing at Pan America Intersection.
6	• Strategies from Scenario 5. • Add third SB through lane between Pan America Boulevard and Interamerica Boulevard. • Optimize signal timing and phasing at Trade Center, A F Muller, and Interamerica intersections.

For the strategies that extend left-turn bays (included in Scenarios 4 and 5), TTI first checked whether the existing northbound left-turn bays at Trade Center and Pan America intersection were adequate to accommodate left-turn queues. Table 5 shows existing left-turn storage lengths and simulated queue lengths at both intersections. The existing storage lengths of both left-turn bays were generally adequate for the left-turn demands, but could not accommodate the maximum queues. Readers should note that the simulated queue lengths were based on traffic conditions for a typical Wednesday or Thursday. Queue lengths could be longer on Mondays and Fridays, according to Google Maps' traffic condition trends (Figure 3, Figure 4) and

INRIX's speed data (Figure 5, Figure 6). In addition, simulated queue lengths were based on an assumed truck fleet composition of 60 percent 70-ft long trucks and 40 percent 30-ft long tractors. Output queue lengths could be longer if the percent of full-length trucks is higher. It is worth noting that the 60/40-percent truck split assumption is a network-wide setting in the simulation environment and cannot be adjusted to depict conditions at individual segments or intersections. This has an impact on the capability of the simulation environment to represent real-world conditions at specific locations.

- **Table 5. Comparison between Existing Left-Turn Storage Length and Simulated Queue Length at Trade Center and Pan America.**

	NB Left-Turn Storage Length (ft)	Simulated Queue Length			
		AM Peak		PM Peak	
		Maximum Queue (ft)	Average Queue (ft)	Maximum Queue (ft)	Average Queue (ft)
Trade Center Intersection	225	345	143	242	122
Pan America Intersection	175	218	74	226	55

To determine the required left-turn storage length for both Trade Center and Pan America intersections, TTI used the storage length formula in the TxDOT *Roadway Design Manual* to conduct the calculations:

$$L = (V/N)(2)(S)$$

where:

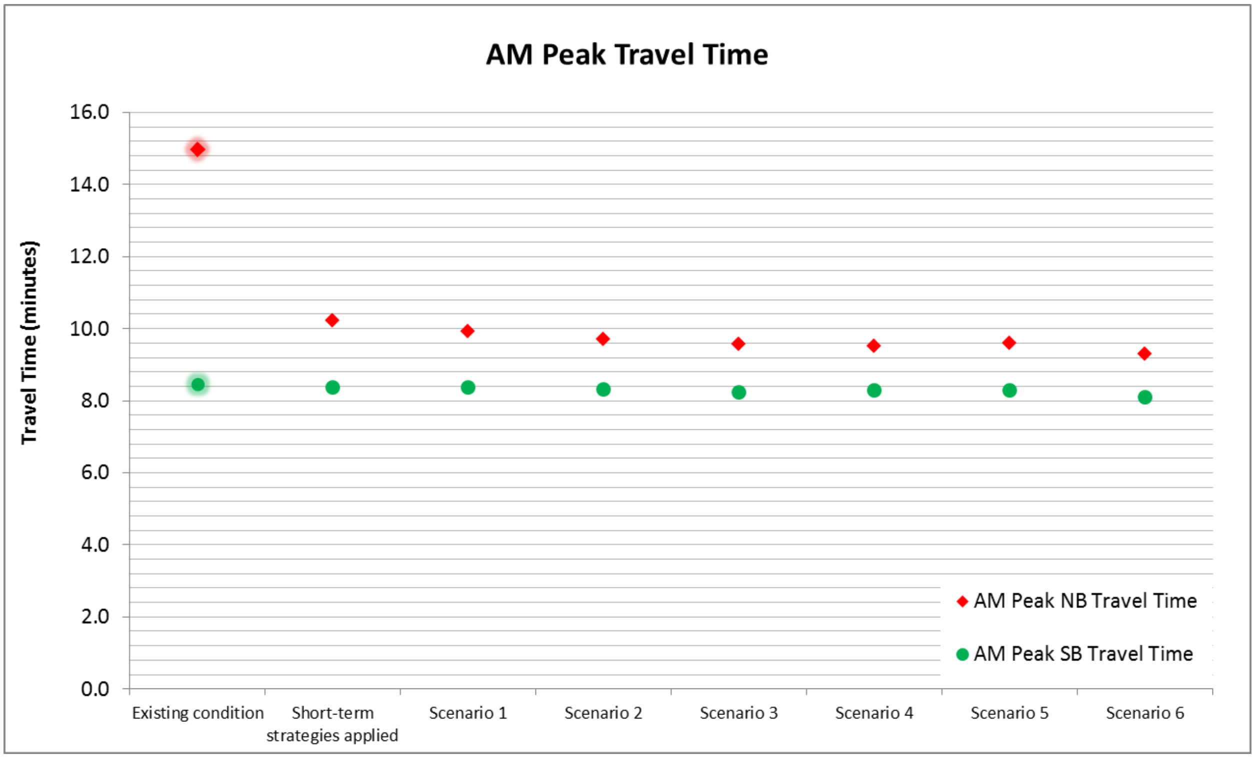
L = storage length in feet
V = left-turn volume per hour, vph
N = number of cycles
2 = a factor that provides for storage of all left-turning vehicles on most cycles; a value of 1.8 may be acceptable on collector streets
S = queue storage length, in feet (or meters), per vehicle

Assuming a truck fleet consisting of 60 percent 70-ft long trucks and 40 percent 30-ft long tractors, a stopped truck would need roughly 2.5 times the space of a typical passenger car that is stopped at the same intersection. As a result, TTI converted truck volumes to equivalent passenger car volumes by multiplying the truck volume by 2.5. Under these conditions, the required storage length would be 530 ft at the Trade Center intersection and 688 ft at the Pan America intersection. Additional space would be necessary for the turn bay transition length and a deceleration distance. The TxDOT *Roadway Design Manual* suggests a deceleration distance of 345 ft and a taper length of 100 ft for the current traffic conditions. This results in 975 ft for the extended left-turn bay at Trade Center intersection and 1133 ft for the extended left-turn bay at Pan America intersection. The values of left-turn bay lengths were implemented in Scenarios 4 and 5 accordingly.

TTI executed 10 runs for each scenario in SimTraffic 9, and then used the average output performance measures for the analysis. For comparison purposes, Figure 10 and Figure 11 show the results of the six experiments, as well as existing conditions and short-term strategies. General observations include the following:

- During the morning peak, most of the reduction in travel time would be accomplished by implementing the short-term strategies. By comparison, the reduction in travel time resulting from implementing the medium-range strategies would be relatively small.
- During the afternoon peak, southbound travel times would decrease by applying medium-range strategies, but northbound travel times would increase. A review of the simulation model animations revealed that the main reason is that improved southbound mobility would constrain northbound turning capacity at the Pellegrino intersection, causing severe spillback congestion in the northbound direction.
- The combination of medium-range strategies from Scenario 3 would result in the lowest total delay and highest throughput, providing the most benefits to the network. Furthermore, the results suggest that improvements would be marginal after Scenario 3.

Although the strategies of extending left-turn bays in Scenarios 4 and 5 did not show significant improvements at the corridor level or network level, to account for the variations in weekday traffic and the limitations in the simulation exercise, it would be advisable to extend northbound left-turn bays at both Trade Center and Pan America intersections.



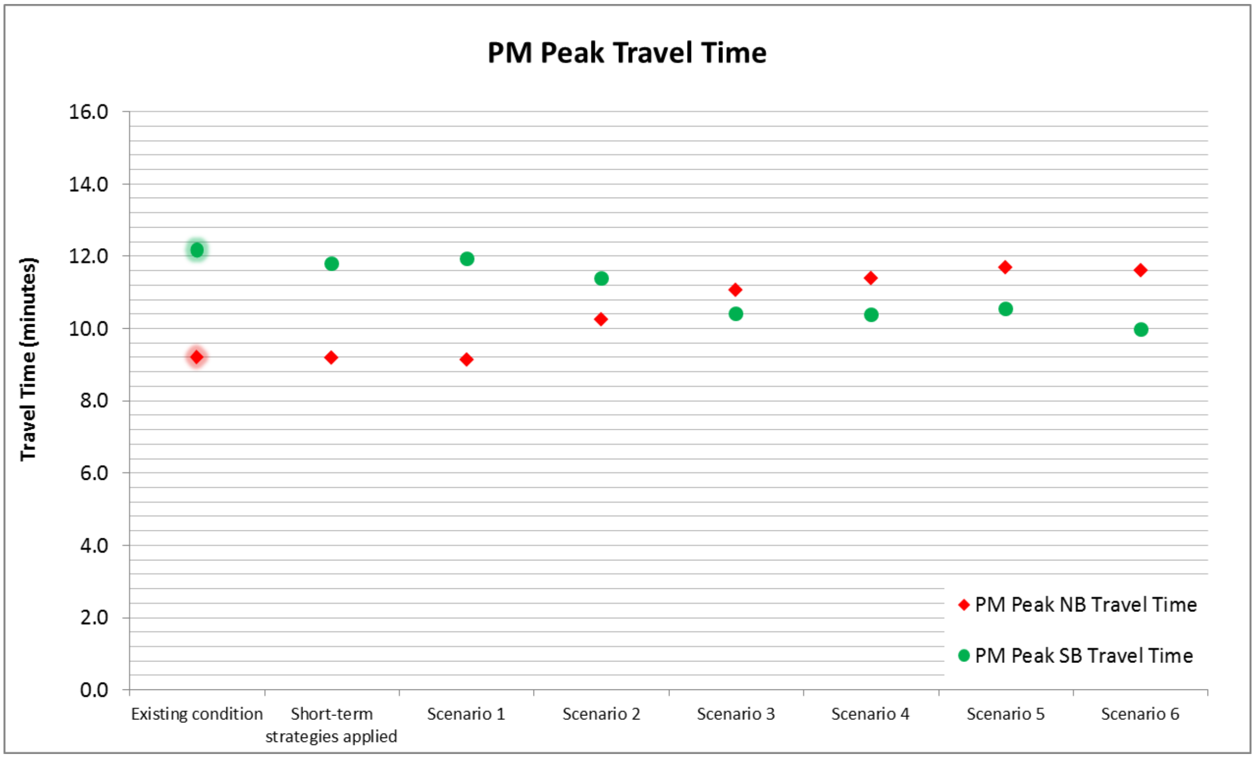
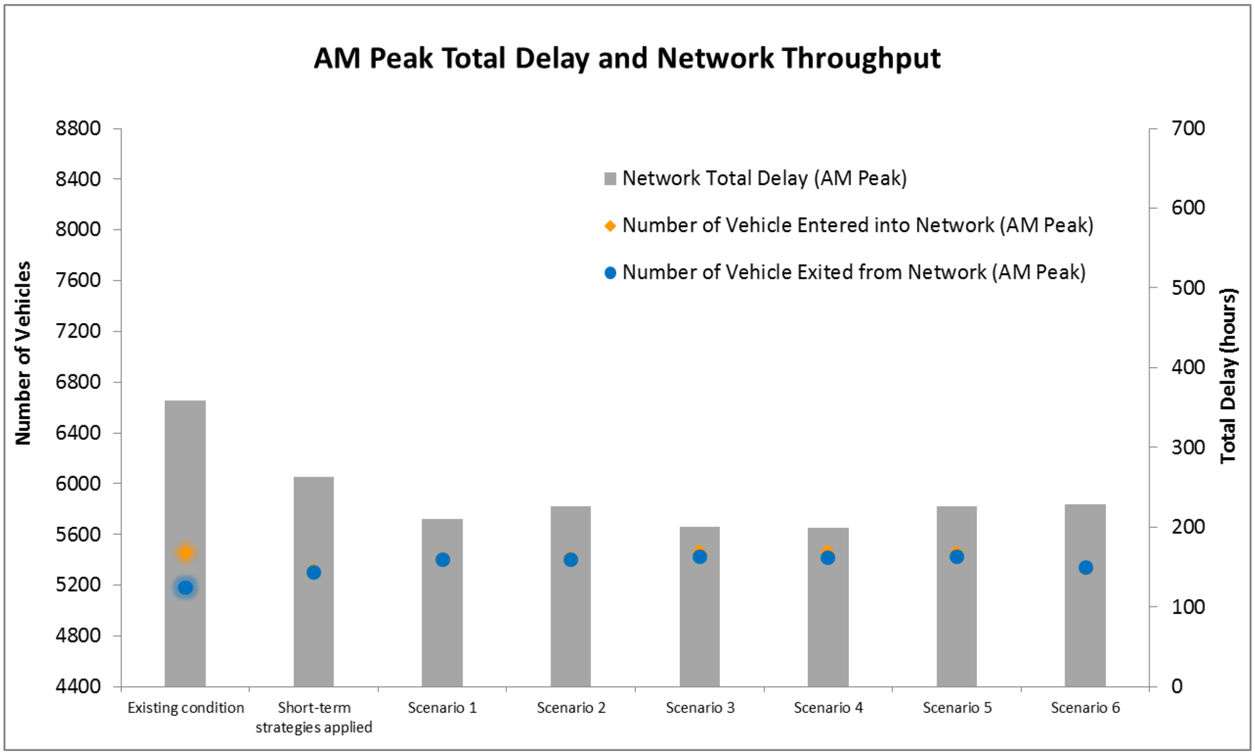


Figure 10. Comparison of Simulated Travel Times.



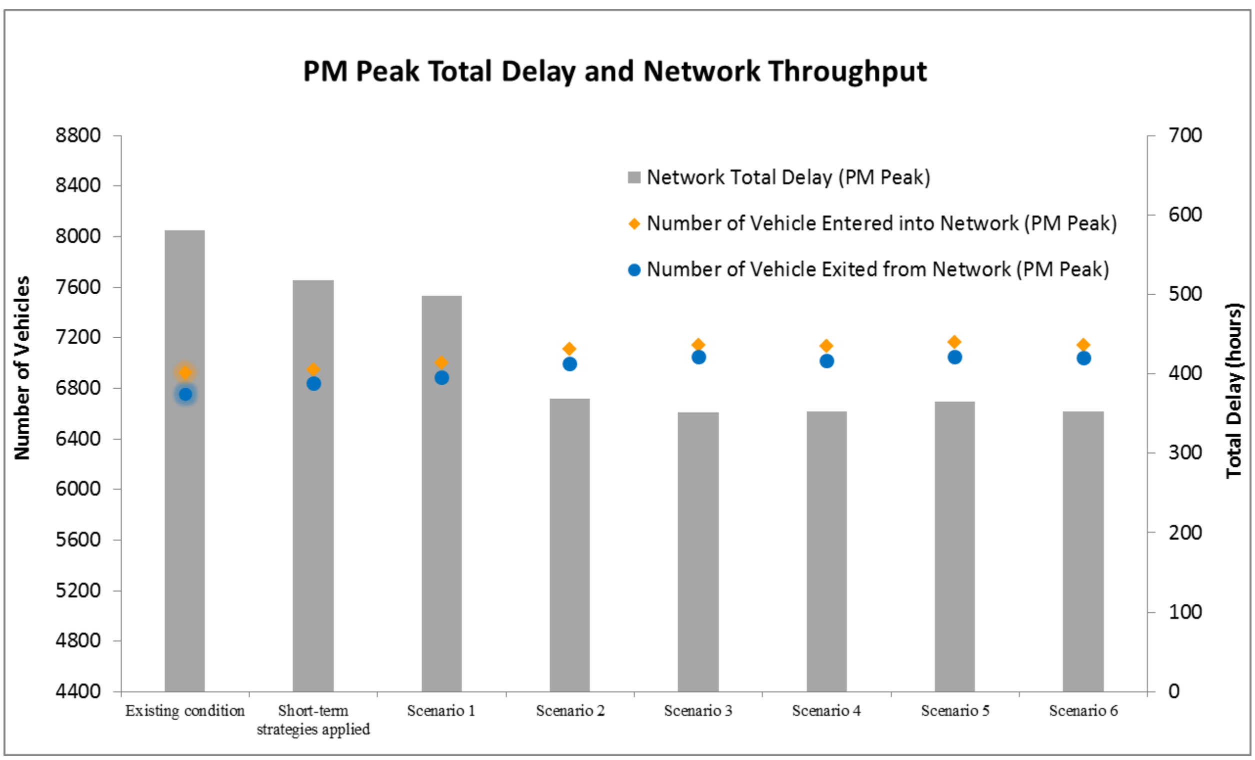


Figure 11. Comparison of Simulated Total Delay and Network Throughput.

EFFECTIVENESS ON MEDIUM-RANGE STRATEGIES BECAUSE OF THE ADDITION OF HACHAR LOOP AND VALLECILLO ROAD

This section summarizes the second part of the analysis, which evaluated potential impacts of the completion of Hachar Loop and Vallecillo Road on the effectiveness of the medium-range strategies. As shown in Figure 2, Hachar Loop and Vallecillo Road are two east-west corridors connecting FM 1472 and IH-35. It was of interest to conduct a high-level analysis to assess to what degree adding these two corridors could alter traffic patterns in the area and, therefore, affect the feasibility of potential medium-range strategies along FM 1472. Per TxDOT's request, TTI performed the analysis over a 20-year horizon, for each 5-year interval from 2018 to 2038.

Data Collection

Historical Daily Traffic Volumes

Figure 12 shows two permanent traffic count stations along the study corridor. Figure 13 shows annual average daily traffic (AADT) data from these stations from 2003-2011. TTI estimated the 2015 AADT using 24-hour traffic counts near the Con-Way Truckload Facility and determined an annual average growth rate. The result (5 percent) was assumed to represent annual growth rates in the short-term (i.e., 2015-2018). Beyond 2018, it is reasonable to assume that the annual growth rate could be lower than 5 percent.

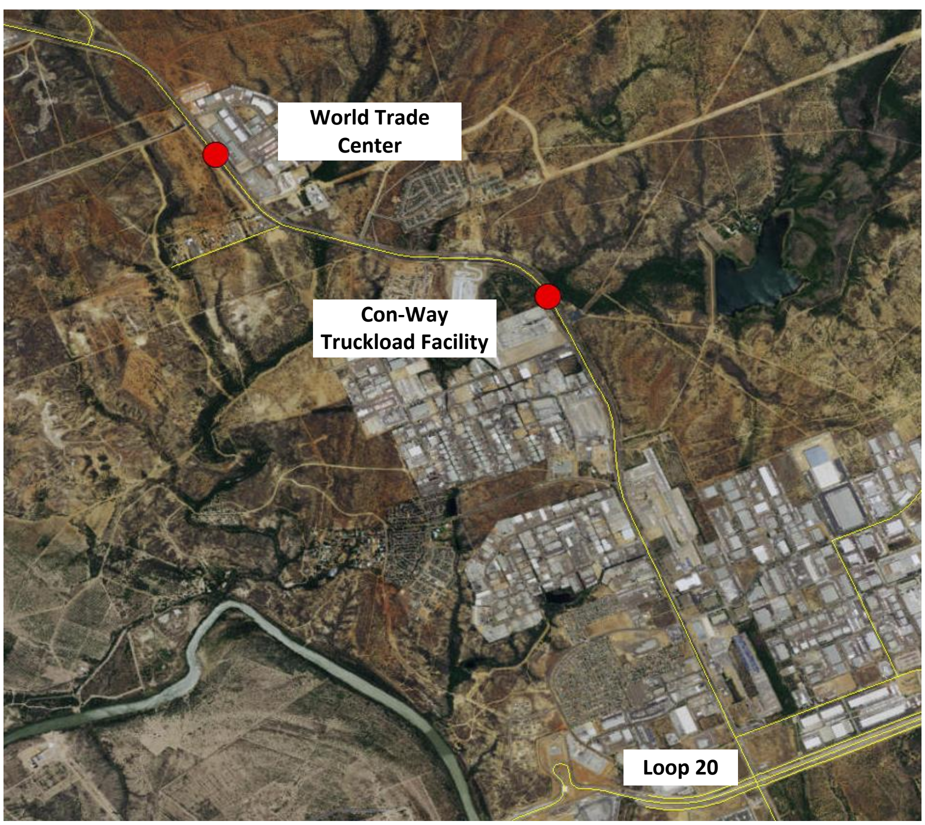


Figure 12. TxDOT Permanent Count Stations, FM 1472 Study Area.

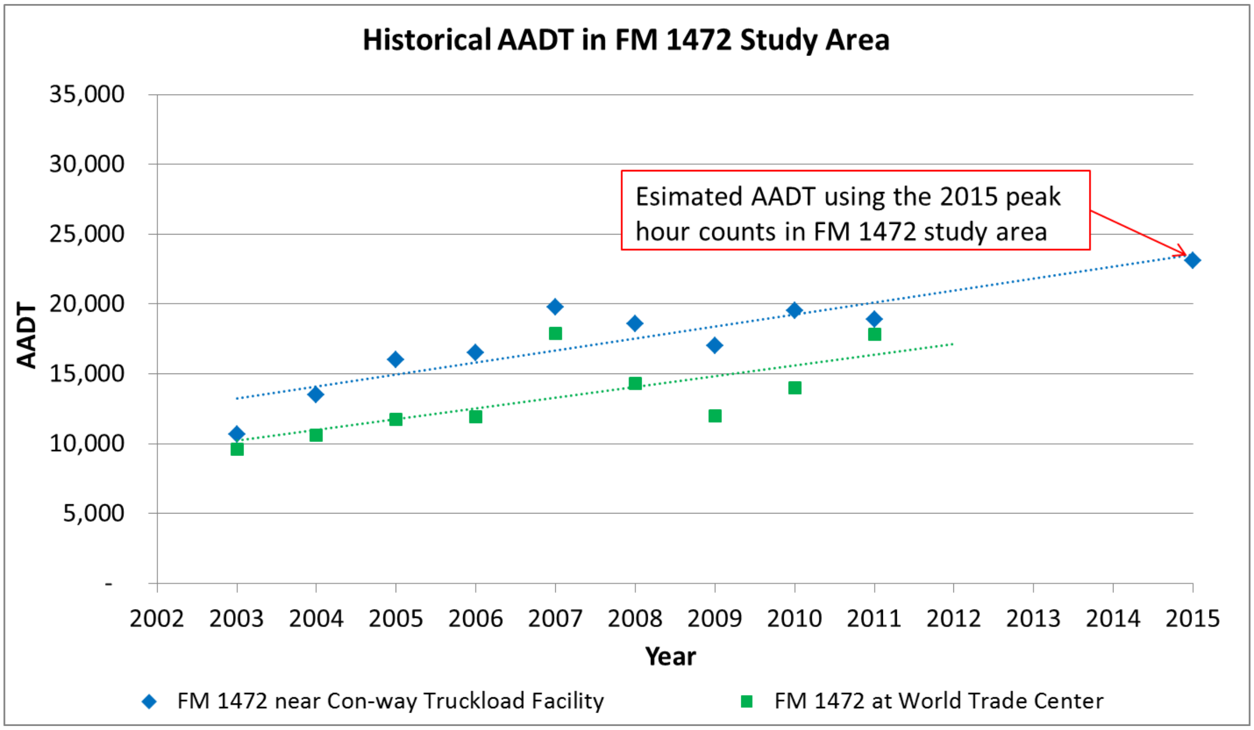


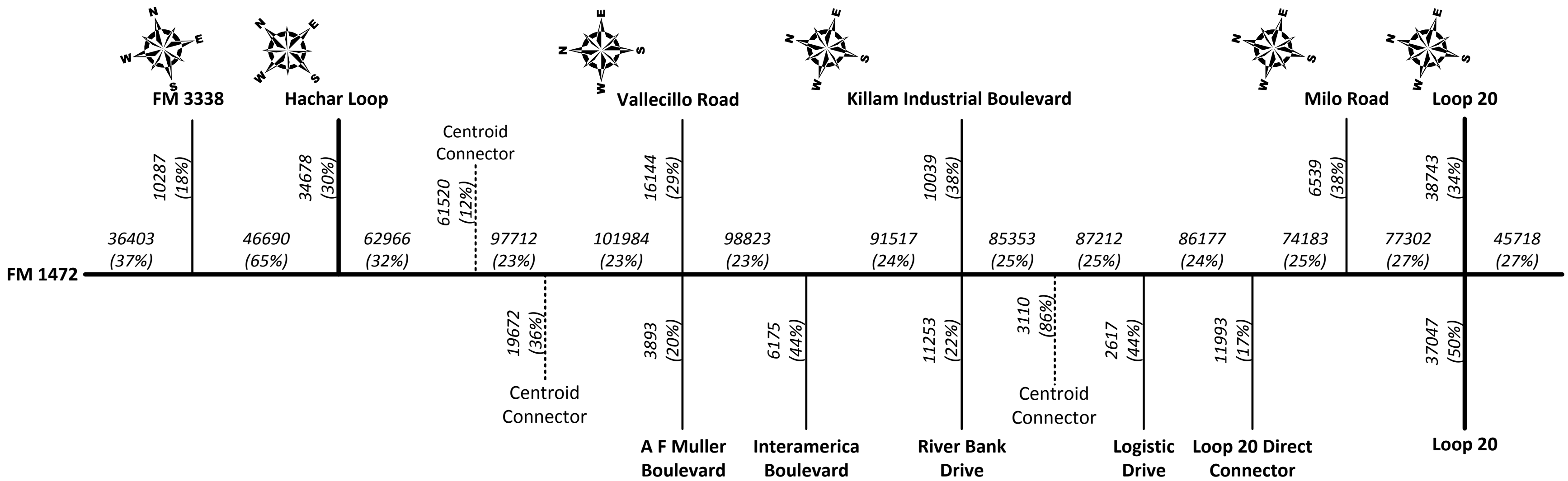
Figure 13. Historical AADT, FM 1472 Study Area.

Travel Demand Model AADT

TTI received travel demand model outputs for 2008 (base year) and 2040 from staff working on the Laredo Urban Transportation Study. A high-level comparison between AADT values for both years suggests that the average annual growth rate for most highway segments could range from 2-4 percent. However, the anticipated average annual growth rate on Hachar Loop could be as high as 14 percent (which is consistent with the assumption of a freeway configuration update for this corridor at some point before 2040).

Figure 14 shows projected AADT values in 2040. A review of these data reveals the following:

- AADT on FM 1472 gradually increases from Loop 20 to A F Muller Boulevard. The maximum AADT on FM 1472 happens north of this intersection.
- The section of FM 1472 between the World Trade Center Loop (south of Hachar Loop) and the Loop 20 direct connector will experience more traffic demand than other sections in the study area.
- The two crossing roads with the highest traffic demand are Loop 20 and Hachar Loop.
- For most of the study corridor, truck percentages range from 23-27 percent.



Note: The numbers in parentheses indicate truck percentages.

Figure 14. AADT along FM 1472 Study Area (Source: 2040 Travel Demand Model).

TMC Data

As a reference, TTI estimated 2015 AADT data from traffic counts collected as part of the short-term analysis. As discussed previously, peak hour volumes occurred from 8:00-9:00 AM and 6:00-7:00 PM. Further, 24-hour traffic counts in both directions between Killam Industrial Boulevard and Logistic Drive (from September 2014) indicated that the morning peak traffic accounted for 7 percent of the daily traffic, while the afternoon peak traffic accounted for 9 percent of the daily traffic. With these percentages, TTI estimated AADT values at several locations. Figure 15 shows a comparison of AADT values between field traffic counts and the travel demand model (which were derived by interpolating AADT values between 2008 and 2040). These results suggest that 2015 AADTs based on the travel demand model would be higher than those values derived from traffic counts, therefore consistent with the assumptions in the travel demand model about the impact of future traffic generator additions in the area.

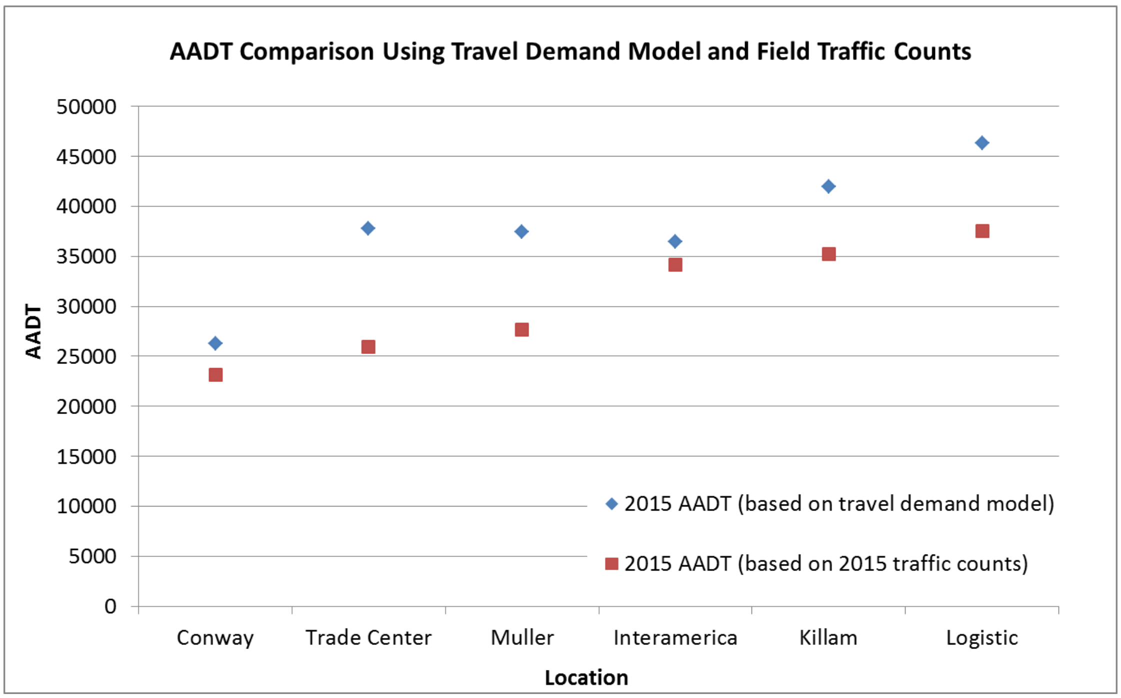


Figure 15. AADT Comparison between Travel Demand Model and Field Traffic Counts.

Simulation Experiments and Findings

TTI simulated two sets of scenarios using SimTraffic 9:

- **Scenarios based on field data**. These scenarios used morning peak hour and afternoon peak hour TMCs on the FM 1472 study corridor. The analysis included three scenarios, as follows:

- o No-build scenario beyond the short-term strategies. For this scenario, the basic assumption was that traffic pattern would remain the same but grow at 4 percent per year from 2018 to 2038.
- o Hachar Loop and Vallecillo Road are in place. If built, these two new arterials would serve as alternative routes to Killam Industrial Boulevard and Loop 20 between FM 1472 and IH 35. Due to the lack of origin-destination information, TTI reassigned the traffic on the study corridor assuming drivers would choose the shortest path. Figure 16 shows conceptually how the current traffic might be affected if Hachar Loop and Vallecillo Road are built. As in the previous scenario, TTI assumed a 4 percent average annual growth rate between 2018 and 2038.
- o Hachar Loop and Vallecillo Road are in place, along with the most effective medium-range strategies. In this scenario, the most effective medium-range strategies (see first part of the analysis section) would be implemented assuming that Hachar Loop and Vallecillo Road are in place. TTI assumed a 4 percent average annual growth rate between 2018 and 2038.

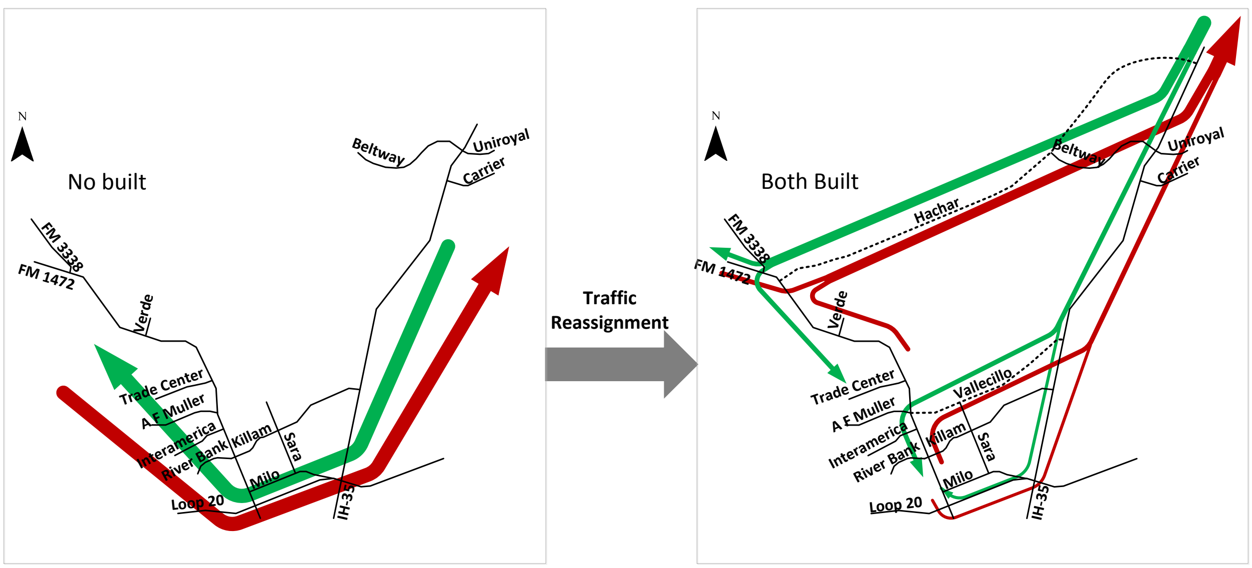


Figure 16. Illustration of Traffic Reassignment for Field Data-Based Scenarios.

- **Scenarios based on travel demand model data.** These scenarios were based on the AADT outputs of the 2040 travel demand model. TTI estimated TMCs based on the AADT outputs, and then used the data as input to simulate peak-hour scenarios. TTI used a 4 percent annual growth rate to estimate traffic volumes for the intermediate years. Because the travel demand model has both Hachar Loop and Vallecillo Road in place, TTI only modeled the following two scenarios:
  - o Hachar Loop and Vallecillo Road are in place.
  - o Hachar Loop and Vallecillo Road are in place, along with the most effective medium-range strategies.

Simulation Results Based on Field Data

Figure 17 and Figure 18 show system-wide average delay for the morning peak hour and afternoon peak hour, respectively. In general, because traffic growth over time did not consider the additional traffic generated by future developments around Hachar Loop and Vallecillo Road, these two new roads would function in the model mainly as alternative routes to Killam Industrial Boulevard and Loop 20. Adding Hachar Loop and Vallecillo Road and then the medium-range strategies would result in additional reductions in system-wide delay. These reductions are consistent throughout the analysis period, although the magnitude varies between the morning peak and the afternoon peak hours:

- During the morning peak (Figure 17), adding Hachar Loop and Vallecillo Road would reduce the average delay per vehicle from 6 to 2 minutes (i.e., a 67 percent reduction) in 2018. In 2038, the average delay per vehicle would drop from 38 to 21 minutes, i.e., a 45 percent reduction. Adding the medium-range strategies to Hachar Loop and Vallecillo Road would result in an additional reduction in average delay per vehicle from 2 to 1 minute (i.e., a 50 percent reduction) in 2018 and from 21 to 13 minutes (i.e., a 38 percent reduction) in 2038.
- During the afternoon peak (Figure 18), adding Hachar Loop and Vallecillo Road would reduce the average delay per vehicle from 8 to 2 minutes (i.e., a 75 percent reduction) in 2018. In 2038, the average delay per vehicle would drop from 68 to 46 minutes, i.e., a 32 percent reduction. Adding the medium-range strategies to Hachar Loop and Vallecillo Road would result in an additional reduction in average delay per vehicle from 3 to 2.5 minutes (i.e., a 17 percent reduction) in 2018 and from 46 to 36 minutes (i.e., a 22 percent reduction) in 2038.

The analysis also included a comparison of travel time estimates. Because of the location of Hachar Loop and Vallecillo Road, the analysis focused on the section of FM 1472 between Killam Industrial Boulevard and the Con-Way Truckload Facility. Figure 19 and Figure 20 show travel time results in both directions for the morning peak hour, and Figure 21 and Figure 22 show the travel time results for the afternoon peak hour.

- During the morning peak, adding Hachar Loop and Vallecillo Road would result in *northbound* travel times (Figure 19) that increase from 4 minutes in 2018 to 11 minutes in 2038. Adding the medium-range strategies to Hachar Loop and Vallecillo Road would result in travel times that increase from 3 minutes in 2018 to 5 minutes in 2038. In other words, adding the medium-range strategies would result in a 25 percent delay reduction in 2018 and a 55 percent delay reduction in 2038.
- During the morning peak, adding Hachar Loop and Vallecillo Road would result in *southbound* travel times (Figure 20) that increase from 4 minutes in 2018 to 5 minutes in 2038. Adding the medium-range strategies to Hachar Loop and Vallecillo Road would result in travel times that increase from 4 minutes in 2018 to 7 minutes in 2038. In other words, adding the medium-range strategies would increase the travel time per vehicle. The reason is that, after 2028, adding dual eastbound to southbound right-turn lanes at Interamerica intersection would allow enough traffic from Interamerica to enter southbound FM 1472, exceeding the capacity at the Killam intersection.

- Figure 21 and Figure 22 show a similar set of results during the afternoon peak. In general, adding the medium-range strategies to Hachar Loop and Vallecillo Road would result in reductions in travel time in both directions. Specifically, the northbound travel time would decrease from 4 to 3 minutes (i.e., a 25 percent reduction) in 2018, and from 20 to 11 minutes (i.e., a 45 percent reduction) in 2038 (Figure 21). Likewise, the southbound travel time would decrease from 6 to 5 minutes (i.e., a 17 percent reduction) in 2018, and from 49 to 44 minutes (i.e., a 10 percent reduction) in 2038 (Figure 22).

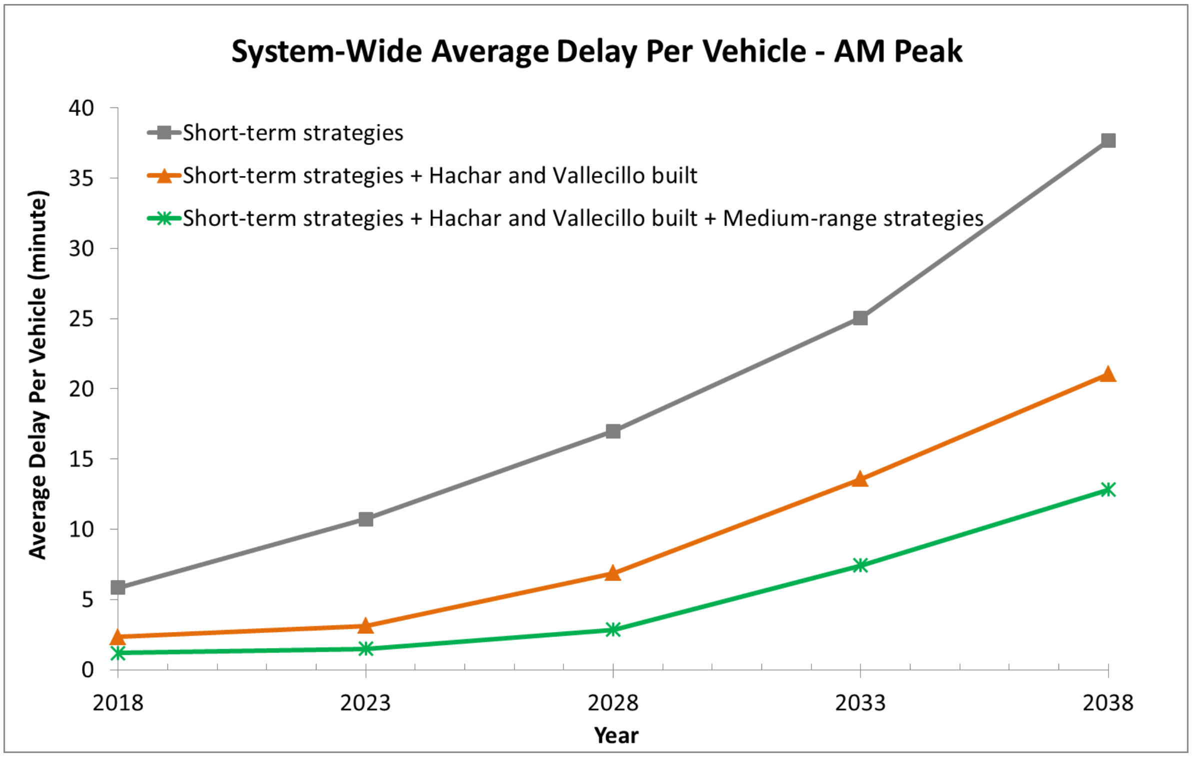


Figure 17. AM Peak Average Delay Results – Field Data-Based Scenarios.

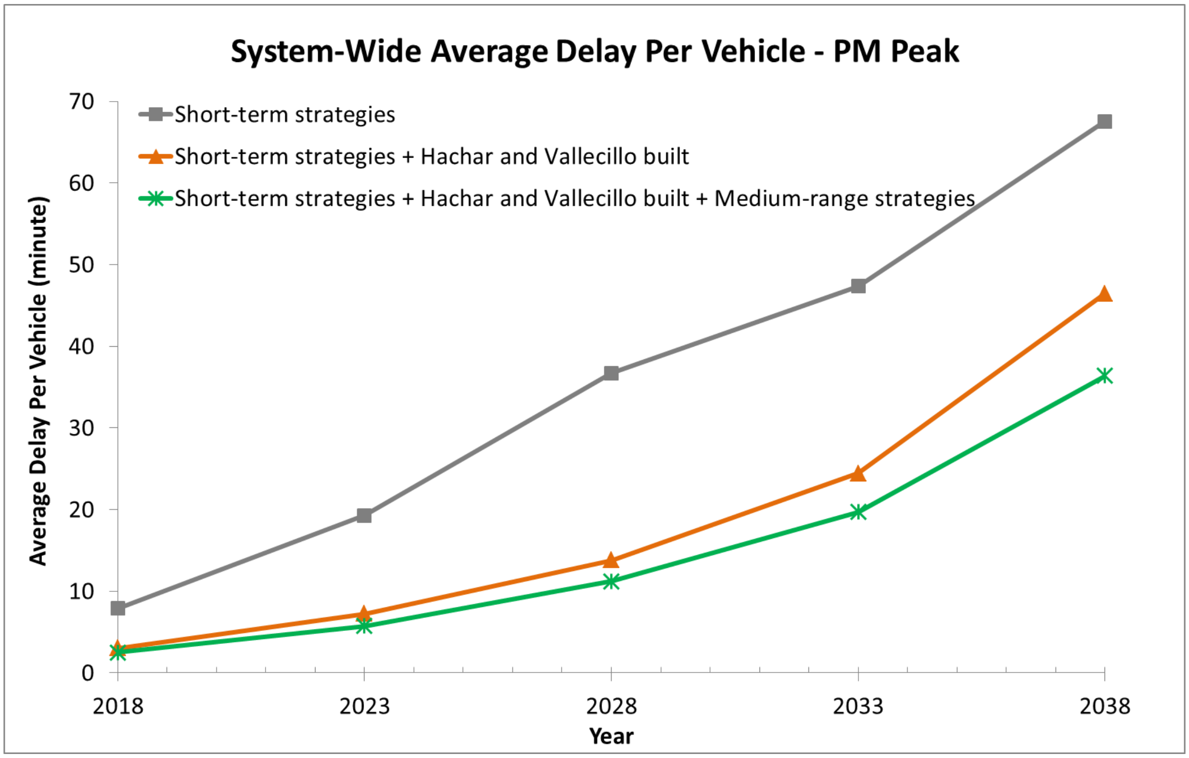


Figure 18. PM Peak Average Delay Results – Field Data-Based Scenarios.

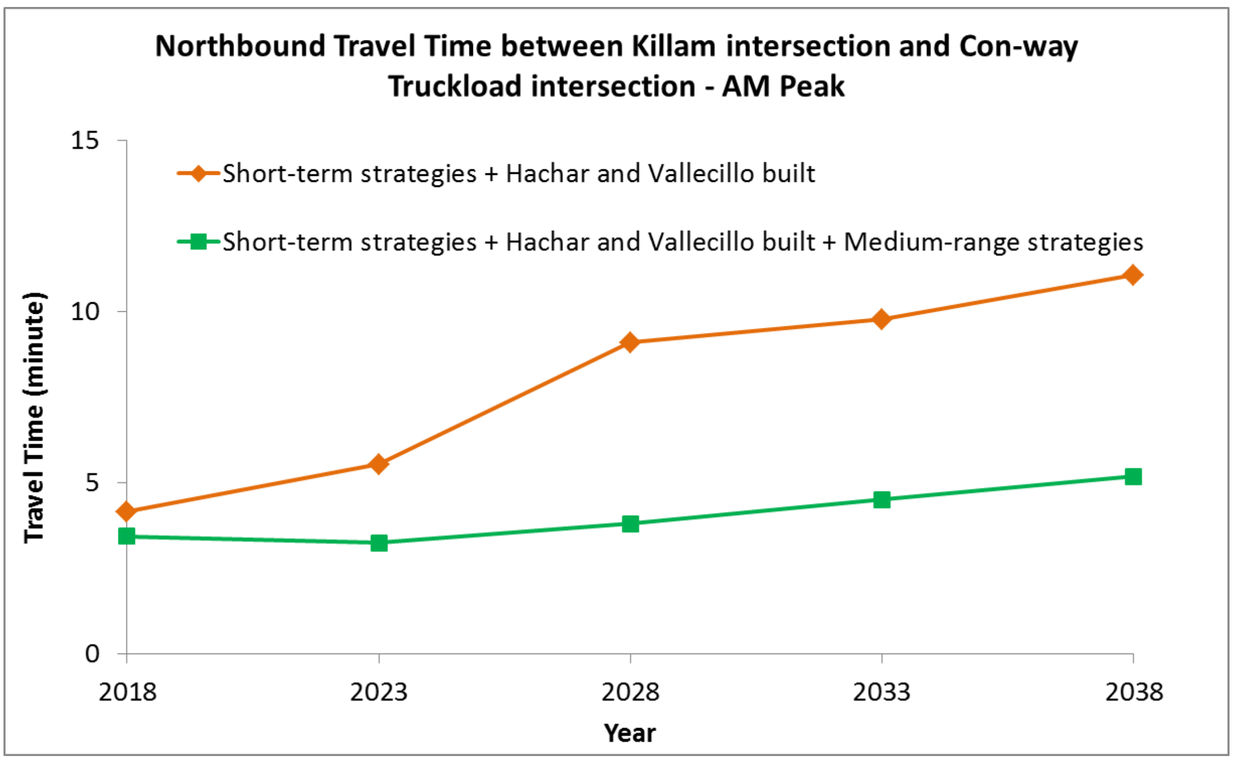


Figure 19. AM Peak Northbound Travel Time – Field Data-Based Scenarios.

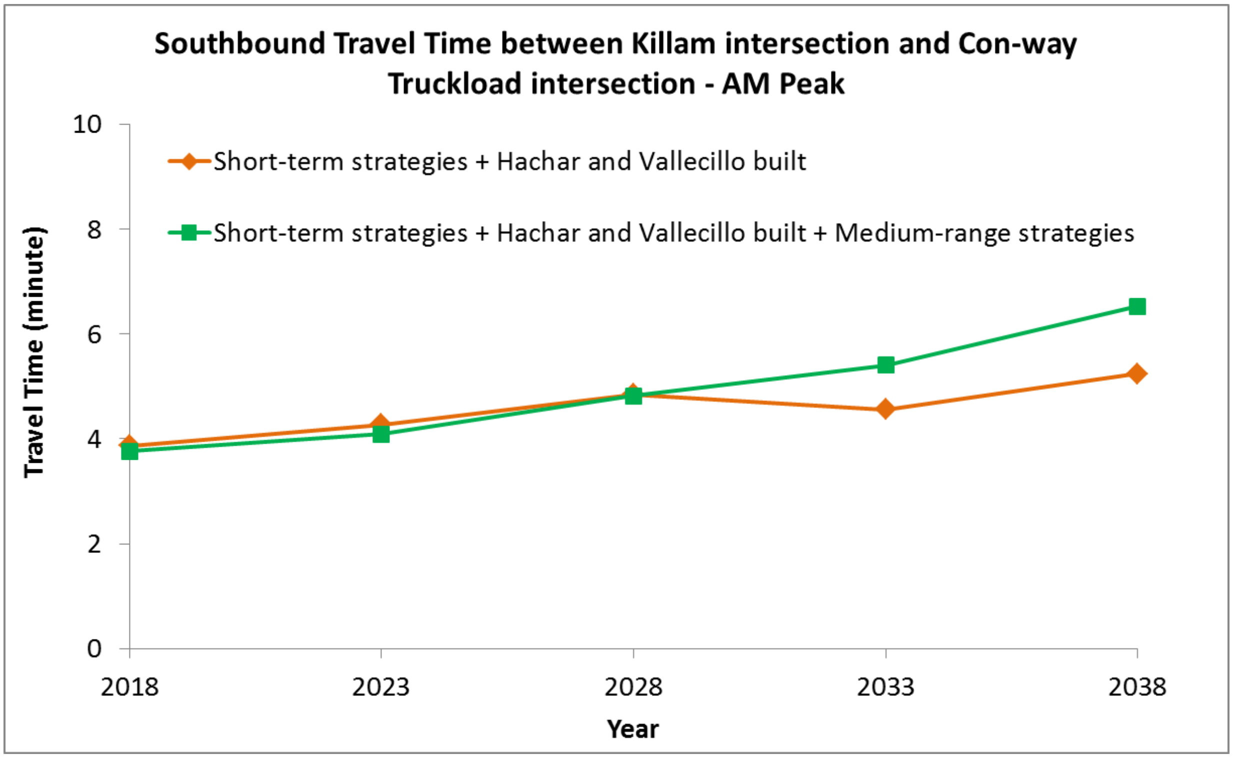


Figure 20. AM Peak Southbound Travel Time – Field Data-Based Scenarios.

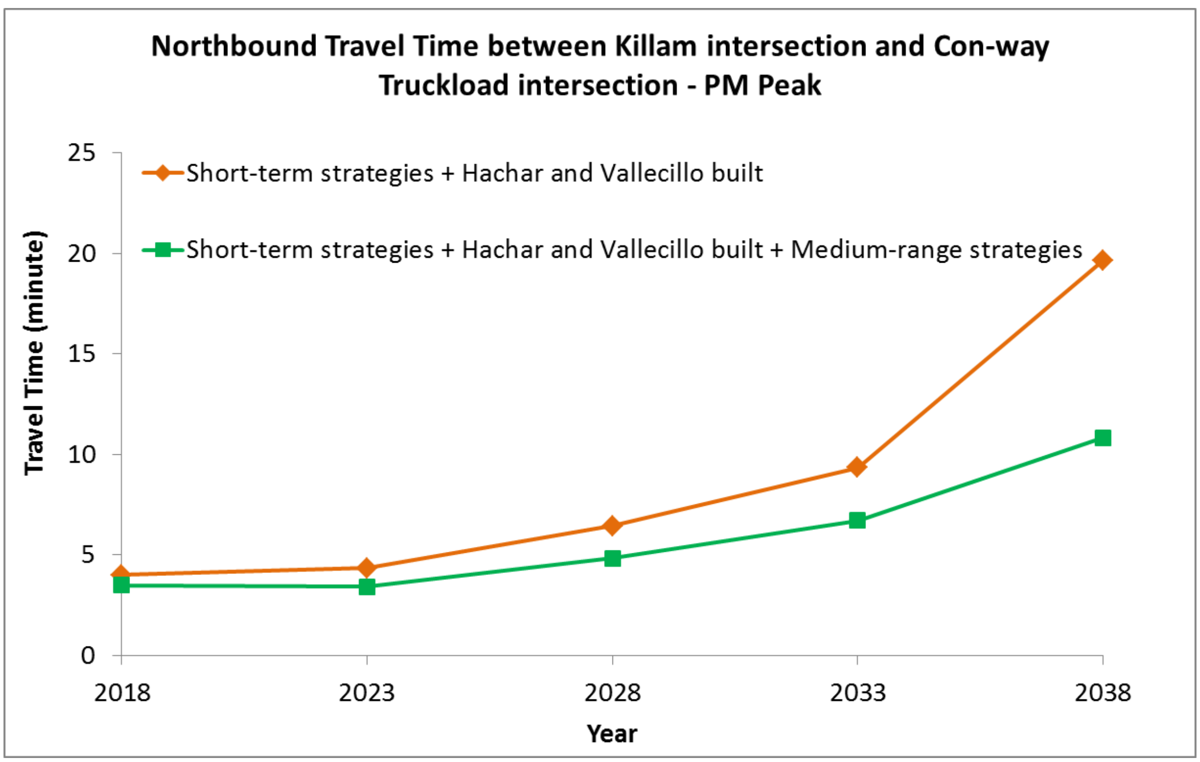


Figure 21. PM Peak Northbound Travel Time Results – Field Data-Based Scenarios.

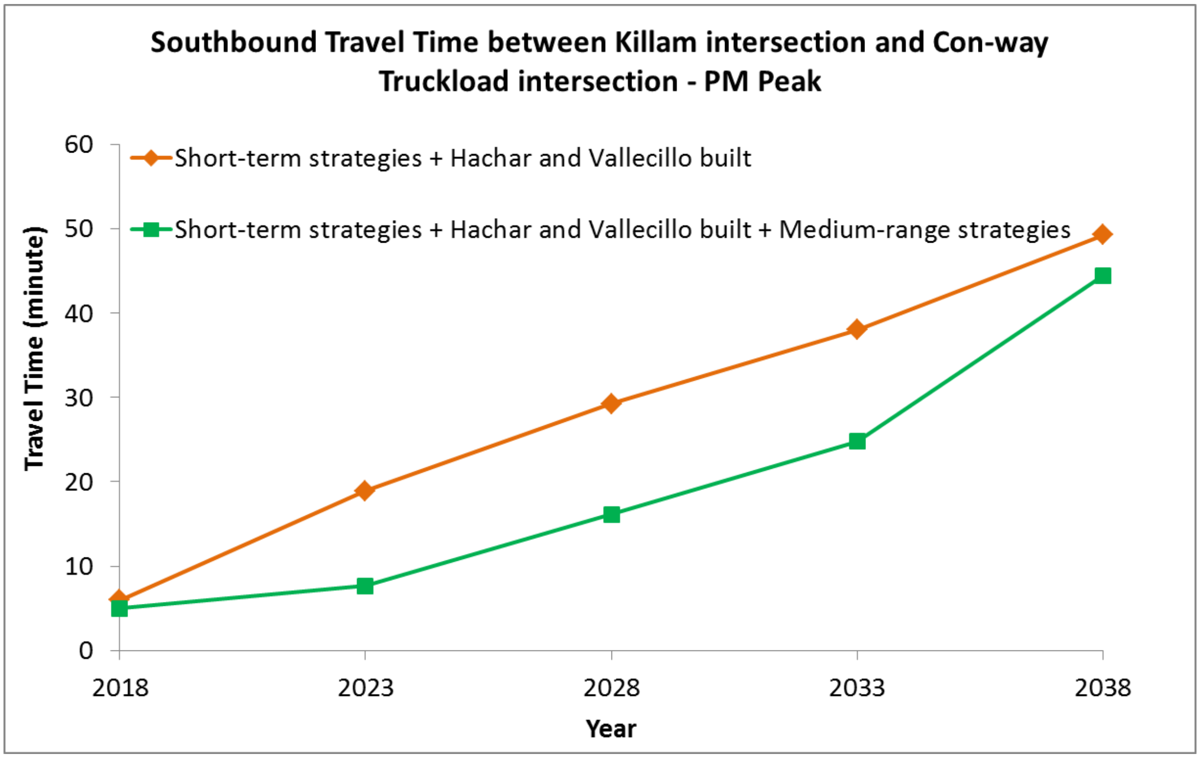


Figure 22. PM Peak Southbound Travel Time Results – Field Data-Based Scenarios.

Simulation Results Based on Travel Demand Model Data

Figure 23 shows system-wide average delay results for the peak hour of the day when using travel demand model-based scenarios. Implementing the medium-range strategies would reduce the average delay per vehicle in the study area from 7 minutes to 5 minutes (i.e., a 29 percent reduction) in 2018, and from 50 to 44 minutes (i.e., a 12 percent reduction) in 2038. Similar to the trends shown in Figure 17 and Figure 18, the results based on travel demand model data shows consistently that implementing the medium-range strategies would improve traffic operations in the study area by reducing average delay. Readers should note that, due to traffic pattern differences between the field data-based scenarios and travel demand model-based scenarios, it would be impractical to compare the results from the two different sets of scenarios.

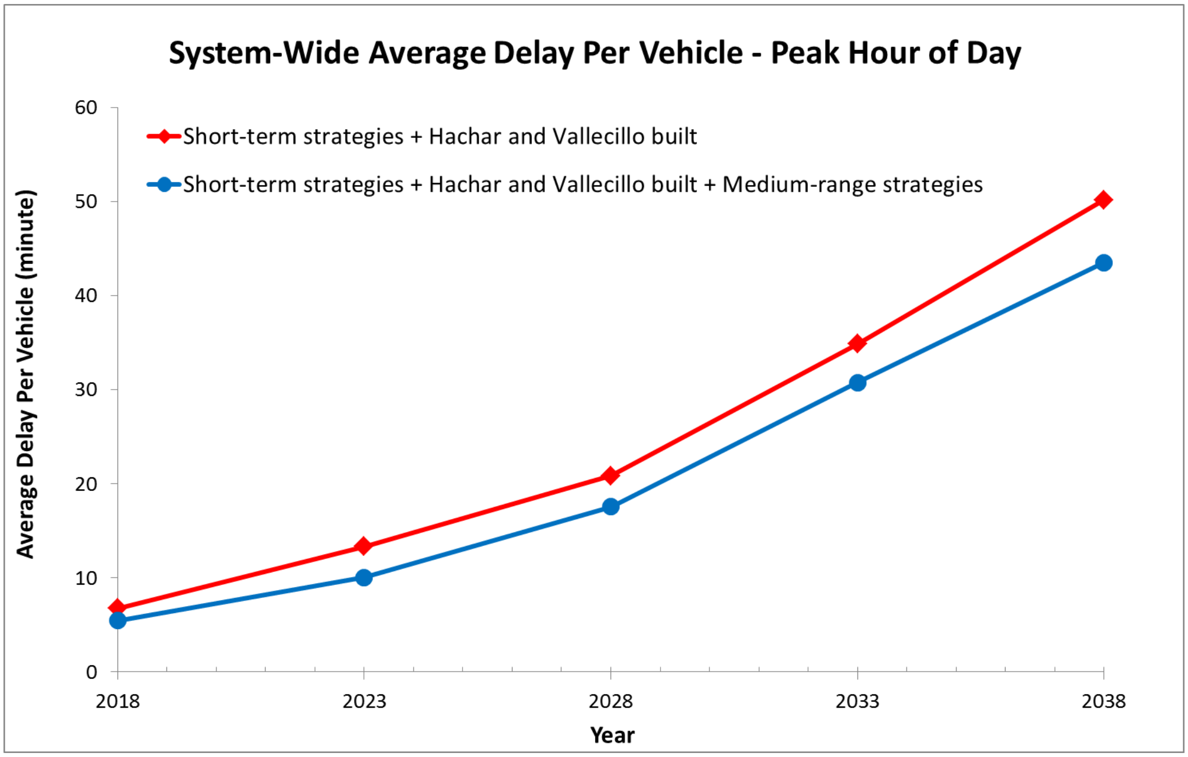


Figure 23. Average Delay Results – Travel Demand Model-Based Scenarios.

Figure 24 and Figure 25 show travel time results in both directions between Killam Industrial Boulevard and the Con-Way Truckload Facility for the peak hour of day with and without the medium-range strategies. As shown in Figure 24, adding the medium-range strategies would result in a reduction in northbound travel time, although this reduction would be more noticeable after 2023. In 2038, the northbound travel time would decrease from 22 to 18 minutes (i.e., an 18 percent reduction) in 2038. As shown in Figure 25, adding the medium-range strategies would have a significant effect in southbound travel times. While adding Hachar Loop and Vallecillo Road would result in travel times that increase from 6 minutes in 2018 to 14 minutes in 2038, adding the medium-range strategies to these two arterials would result in travel times that do not vary significantly. In 2038, the southbound travel time would decrease from 14 to 5.6 minutes (i.e., a 60 percent reduction) because of the medium-range strategies.

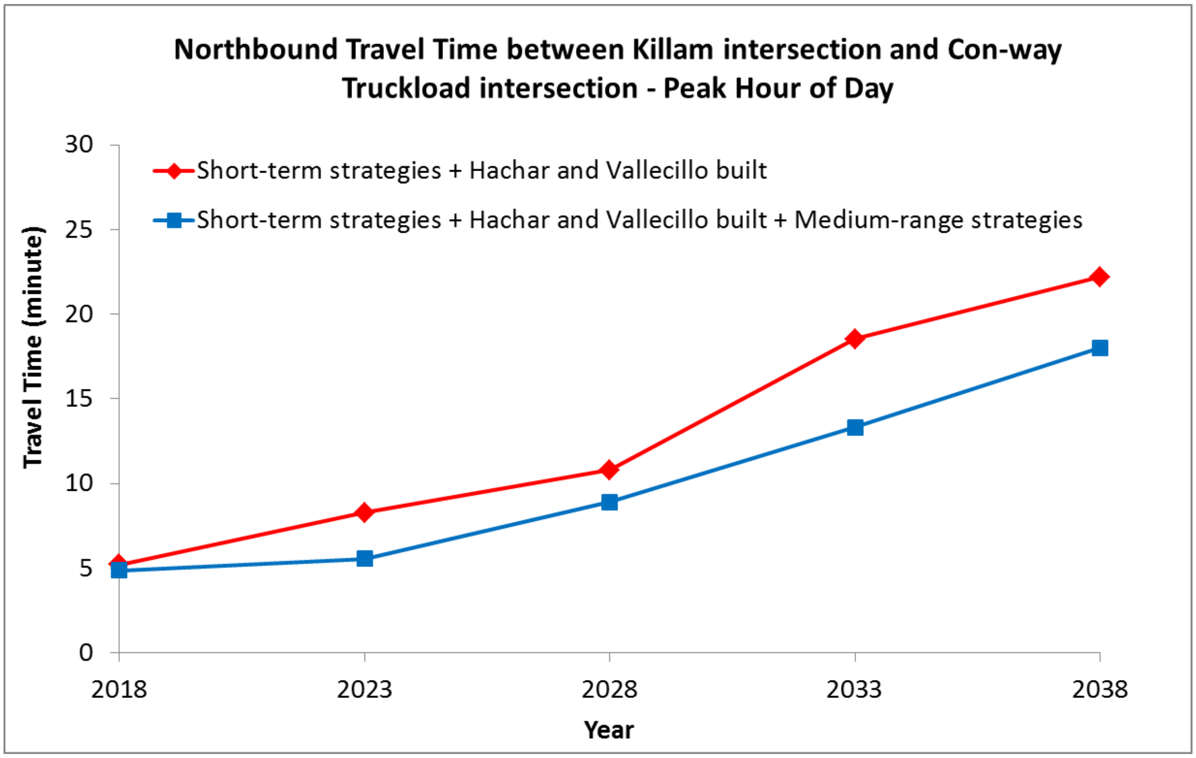


Figure 24. Northbound Travel Time Results – Travel Demand Model-Based Scenarios.

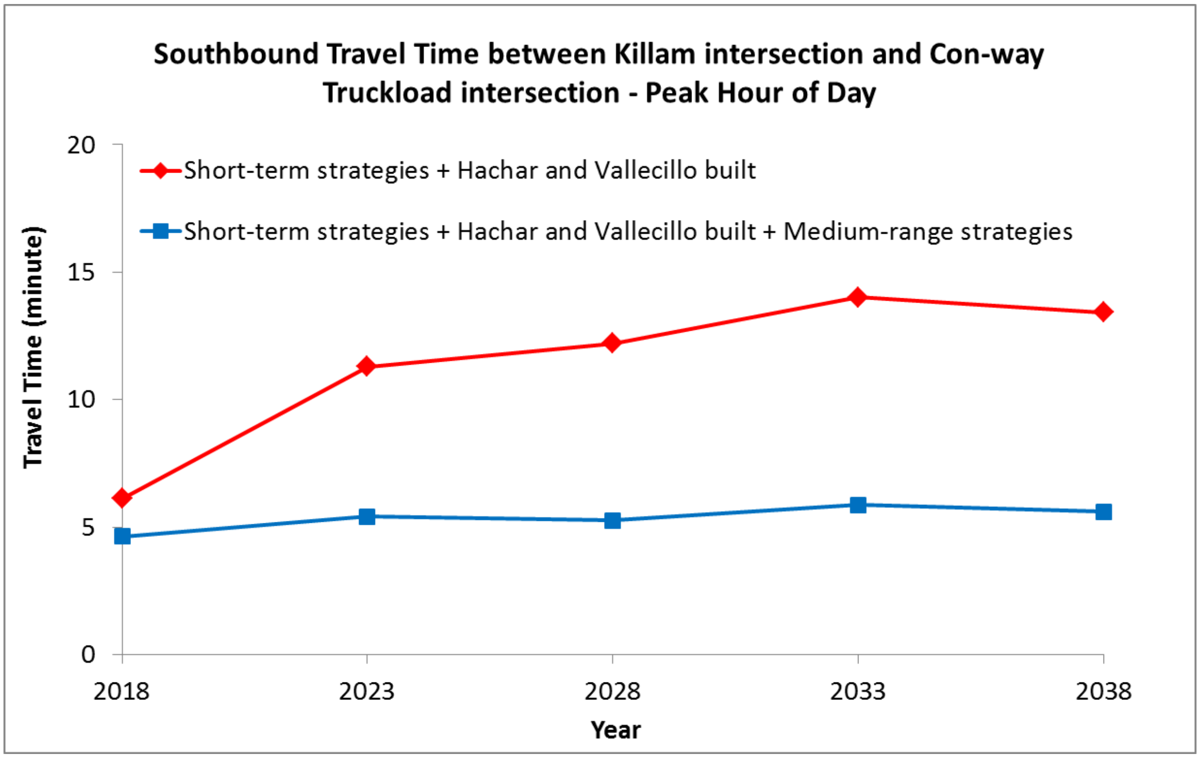


Figure 25. Southbound Travel Time Results – Travel Demand Model-Based Scenarios.

CONCLUSIONS

TTI analyzed the section of FM 1472 from Loop 20 (now called IH 69W) to FM 3338 (Las Tiendas Road) in terms of strategies that should be deployed within two to three years without acquisition of additional right-of-way, to alleviate and improve traffic operations of the corridor. Examples include adding through lanes, adding turning lanes, consolidating and/or redesigning driveways, and adding cable barriers or posts to prevent illegal parking on roadside clear zones.

The medium-range strategy analysis involved two main sets of activities: (a) identify and evaluate potential medium-range strategies along FM 1472, and (b) evaluate potential effects on the medium-range strategies because of the anticipated completion of Hachar Loop and Vallecillo Road. The results of the first part of analysis suggested several effective medium-range strategies including adding through lanes and turn lanes, and extend left-turn bays. The results from the second part of analysis confirmed that the selected medium-range strategies would provide significant additional benefits on top of the benefits provided by Hachar Loop and Vallecillo Road.

The results of the first part of the analysis indicate that the following medium-range strategies would provide the most benefits to the study corridor:

- Add third northbound through lane between Killam Industrial Boulevard and Interamerica Boulevard.
- Expand Killam Intersection:
    - Provide dual westbound to southbound left-turn lanes;
    - Provide westbound to northbound free right-turn lane;
    - Provide dual southbound to eastbound left-turn lanes;
    - Provide southbound to westbound free right-turn lane;
    - Provide eastbound to northbound dual left-turn lane;
    - Provide dual northbound to westbound left-turn lanes.
- Add third southbound through lane between A F Muller Boulevard and Interamerica Boulevard.
- Provide dual eastbound to southbound right-turn lanes at the Interamerica intersection.
- Extend northbound to westbound left-turn bay to 975 ft (including storage length, deceleration length, and taper length) at the Trade Center intersection.
- Extend northbound to westbound left-turn bay to 1133 ft (including storage length, deceleration length, and taper length) at the Pan America intersection.
- Optimize signal timing and phasing at all the intersections with changes.

The results of the second part of the analysis indicate the following:

- Adding Hachar Loop and Vallecillo Road would alleviate congestion on the study corridor. During the morning peak, average delay per vehicle could decrease by as much as 67 percent in 2018 and by 45 percent in 2038 (assuming the short-term strategies have been implemented). During the afternoon peak, the delay reduction could be as much as 75 percent in 2018 and 32 percent in 2038.

- Implementing the medium-range strategies once Hachar Loop and Vallecillo Road are in place would result in significant improvements in system performance, both in terms of delay per vehicle and travel time. More specifically (depending on the simulation scenarios):
    - System-wide average delay per vehicle could decrease an additional 17-50 percent in 2018 and 12-38 percent in 2038.
    - Northbound travel time on FM 1472 between Killam Industrial Boulevard and the Con-Way Truckload Facility could decrease an additional 6-25 percent in 2018 10-55 percent in 2038. Southbound travel time could decrease an additional 3-17 percent in 2018 and 10-60 percent in 2038.
- From the field-data-based scenarios, adding Hachar Loop and Vallecillo Road would reduce system-wide average delay per vehicle. The delay reduction would be up to 66 percent in 2018 and 45 percent in 2038 during the morning peak. During the afternoon peak, the delay reduction could be up to 75 percent in 2018 and up to 32 percent in 2038.
- From both the field-data-based and travel-demand-model-based scenarios, adding medium-range strategies given that Hachar Loop and Vallecillo Road are in place would have the following impacts (depending on the simulation scenarios):
    - The reduction in system-wide average delay per vehicle could be 17-50 percent in 2018 and 12-38 percent in 2038.
    - Northbound travel time on FM 1472 between Killam Industrial Boulevard and the Con-Way Truckload Facility could decrease an additional 6-25 percent in 2018 and 10-55 percent in 2038. Southbound travel time could decrease an additional 3-17 percent in 2018 and 10-60 percent in 2038.