SANDAG

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Final Study

Submitted to SANDAG
by IBI Group
with CH2MHILL; Cheval Research
December 2013

Cheval Research CH2MHILL IBI GROUP

TABLE OF CONTENTS

ANALYSIS OF FREEWAY OPERATIONAL STRATEGIES RELATED TO THE USE OF MANAGED LANES BY TRUCKS

EXECUTIVE SUMMARY

DECEMBER 2013

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TABLE OF CONTENTS

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1. SYNOPSIS

BACKGROUND

Trucks are the backbone of the goods movement system in the San Diego region. Trucks carry more than 90 percent of freight volume and truck vehicle miles traveled (VMT) on freeways are expected to grow at a rate faster than that for passenger vehicles. Truck bottlenecks exist and are projected to increase during peak periods, straining the region's multimodal goods movement network and affecting regional economic prosperity. While regional rail capacity is important, it is highly constrained and cannot match the flexibility and reliability of regional truck distribution. Trade and distribution in the region, therefore, is heavily dependent on truck movements. Since the region's roughly 300 miles of urban and rural freeways are not expected to significantly grow, the existing roadway network must simultaneously serve a growing population and growing levels of international and domestic trade.

STUDY OVERVIEW

To address the issue of long-term truck mobility in the region, Caltrans provided SANDAG with a grant to assess the potential for freeway operational truck management strategies in the San Diego region, including the potential for trucks to use the planned network of managed lanes. The "Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks" (Study) was a long-range planning effort and the results are intended to serve as a framework for more detailed future analysis of truck management strategies moving forward. The Study included a literature review, the collection of regional truck data, and interviews with regional trucking industry stakeholders. Specifically, the results of the Study included 1) a truck management strategy "toolbox" for the San Diego region, 2) a high level assessment of truck mobility issue areas throughout the region, 3) a more detailed look at two conceptual corridors (the Otay Mesa Border Area and I-15 from SR 163 to SR 78), and 4) opportunities for improving regional truck data collection. This Executive Summary provides a summary of the findings of the Study; additional information can be found in Technical Memorandums 1 – 6.

SUMMARY OF FINDINGS

The Study found that allowing light-duty (and potentially medium-duty) trucks to use the managed lanes network under certain conditions could capitalize on the region's investment in a managed lanes network and be prudent given the projected increase in truck volumes, the critical role trucks play in goods movement and the regional economy, and the limited potential to shift goods movement to rail and other non-freeway modes. The Study proposes a phased approach to implementation, starting with providing information and incentives for the light-duty, 2-axle commercial trucks that are already legally allowed in the managed lanes (i.e. potential removal of occupancy restrictions and an SOV toll waiver). If this proves successful, the use of the managed lanes by medium-duty, 3- and 4-axle trucks (with length restrictions) could potentially be explored by allowing access to and from the managed lanes via the Direct Access Ramps (DARs) only. A discussion of next steps for the implementation of a Trucks on Managed Lanes Pilot Study and a pilot to improve regional truck data collection is provided at the end of this Executive Summary.

2. BACKGROUND AND PROJECT OVERVIEW

INTRODUCTION

The intent of this Study was to address the issue of long-term truck mobility in the region by assessing the potential for freeway operational strategies for trucks in the San Diego region, including the potential for the allowance of trucks on the planned network of managed lanes. The Study was a long-range planning study and the results are intended to serve as a framework for more detailed future analysis of truck management strategies moving forward.

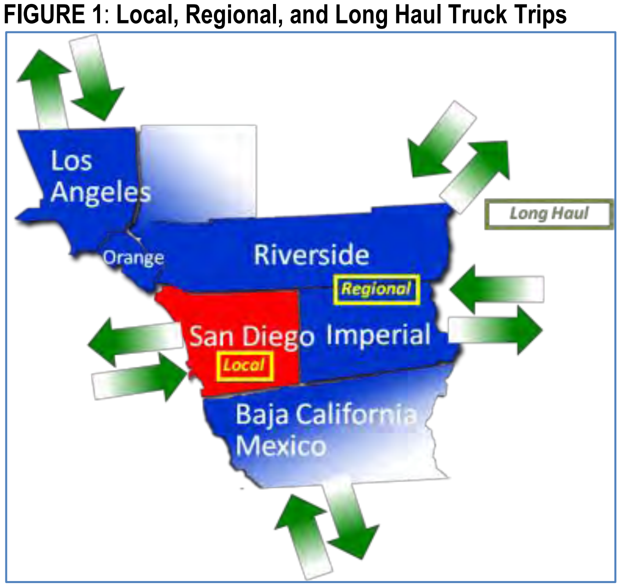
PROJECT TEAM

The Project was lead by the goods movement planning group at SANDAG with consultant support from IBI Group, CH2M HILL, and Cheval Research.

STAKEHOLDER INVOLVEMENT

The Project Team met regularly throughout the Study with two stakeholder groups, the Project Study Team (PST) and the Freight Stakeholders Working Group (FSWG). The PST included representatives from Caltrans, SANDAG, Federal Highway Administration, the Port of San Diego, and trucking industry representatives. The FSWG included PST members and representatives from local jurisdictions, the Port Tenants Association and Port users, California Trucking Association, American Trucking Association, San Diego County Regional Airport Authority, shippers and carriers using the airport, San Diego and Arizona Eastern Railway, Burlington North Santa Fe Railroad, Union Pacific Railroad, warehouse operators, San Diego Regional and Otay Mesa Chambers of Commerce, San Diego World Trade Center, California Highway Patrol, ADMICARGA Baja California short line rail operator, Imperial County Transportation Commission, Southern California Association of Governments, San Diego County Disposal Association, Environmental Health Coalition, Western Maquiladora Trade Association, Owner Operator Independent Drivers Association, California State University Long Beach, Mexamerica, Total Transportation Services, Inc., Fletes Esquer S A de C V, Duran Freight, Lizarraga Freight Forwarding, 4Liberty, Inc., and Colliers International.

FIGURE 1: **Local, Regional, and Long Haul Truck Trips**



TRUCKING INDUSTRY INTERVIEWS

Additionally, numerous freight and trucking industry representatives were interviewed throughout the Study to collect additional stakeholder input. Eighteen interviews and one focus group were conducted with a cross-section of industry representatives. Interviewees included trade associations, shippers, receivers, manufacturers, and trucking companies across the region that represented a range of truck types (light-, medium-, and heavy-duty) and trip types (local, regional, and long haul). The intent of the interviews was to attain a real-world understanding of the mobility and operational issues facing trucking companies that would not otherwise be identified through available truck data.

TABLE 1: **Truck Types**

Category	Example	Description[a]
Light-duty		Smaller and lighter trucks (up to 14,000 lbs), with no more than 2 axles.
Medium-duty		Slightly bigger and heavier trucks (up to 33,000 lbs), with 3 to 4 axles.
Heavy-duty		The largest and heaviest trucks (over 33,000 lbs), with 5 or more axles.

[a] Legal axle weights are assumed for all vehicles.

WHAT ARE MANAGED LANES?

FIGURE 2: I-15 Express Lanes

The term "managed lanes" refers to special-use lanes that are distinct from general purpose lanes in that they are "managed" using strategies such as vehicle occupancy and eligibility, static or dynamic pricing, and/or access control to maintain certain desired operational conditions. Examples of managed lanes include high occupancy vehicle (HOV) lanes, high occupancy toll (HOT) lanes, and dedicated lanes for trucks or buses. For the purposes of this Study, the term "managed lanes" primarily refers to the existing network of HOV and Express Lanes throughout the San Diego region and the planned improvements to this network included in the fiscally constrained 2050 Regional Transportation Plan (RTP).

3. TRUCK MANAGEMENT STRATEGY DEVELOPMENT

LITERATURE REVIEW

The Project Team began by reviewing the recent literature to identify truck management strategies that have been studied or applied elsewhere. The review included domestic and international case studies, a summary of the current relevant regulatory framework in California, and findings from a review of 19 research documents and government reports. The review found that the vast majority of relevant literature is related to truck-only lanes and/or truck-only facilities. While versions of the concept have been studied, there are currently no operating examples of trucks on managed lanes, where the managed lanes are shared by both trucks and passenger vehicles.

TRUCK MANAGEMENT STRATEGIES LIST

Based on the information collected in the literature review, a comprehensive list of potential truck management strategies was initially developed. This list was narrowed down to a final set of seven strategies for further analysis, based off of a fatal flaw review and input from the PST, FSWG, and trucking industry stakeholders. The seven truck management strategies reviewed as part of this Study are briefly described below. More information on each strategy can be found in Technical Memorandum #3: Strategy Development.

1. **Base-case scenario (current RTP improvements):** This strategy considers what the future looks like for goods mobility in the region if no new actions are taken to address truck mobility (this scenario assumes full build out of improvements identified in the fiscally constrained and currently adopted San Diego 2050 RTP).

2. **Traffic organizational strategies at freight gateways & distribution hubs:** This strategy includes coordinated communication and infrastructure-based strategies to optimize truck traffic flow at key trucking gateways and distribution hubs.

3. **Travel demand management (TDM) strategies to be developed with truckers and shippers/receivers:** This strategy involves working with shippers/receivers to facilitate the shifting of trucks to off-peak travel times through TDM strategies.

4. **Trucks on the planned network of HOV/HOT Managed Lanes (restricted access):** This strategy would allow trucks restricted access to the network of managed lanes, for example during off-peak periods, for off-peak directions, and/or for certain truck types.

5. **Designated truck lanes (e.g. truck routes, by-pass, or truck climbing lanes, etc):** This strategy would include the construction of new lanes designated for trucks on an existing facility, such as truck bypass lanes, truck routes, or truck climbing lanes.

6. **Separate dedicated truck-only facilities:** This strategy would involve developing brand-new, dedicated truck-only facilities.

7. **Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and lane assignment:** This strategy would use ITS and ATM technologies (both external and in-vehicle) to improve truck mobility and safety and optimize the use of existing freeway capacity.

CURRENT REGULATORY FRAMEWORK

The current California Vehicle Code (CVC) restricts trucks with 3 or more axles to speeds of 55 mph and the right-hand lane (CVC Sections 22406 and 21655). Additionally, the California Highway Patrol website notes that "HOT lanes may not be used by vehicles restricted to a 55

MPH speed limit."[1] Trucks with 2 axles, however, are not subject to these restrictions. Federal legislation that guides the use and operation of HOV/HOT lanes is currently silent on the issue of trucks. However, U.S.C. Title 23, Section 166 requires state agencies to monitor HOV lane performance if high occupancy toll vehicles or low emission vehicles are allowed to use the lanes and to take action to improve lane operations if the average operating speed falls below minimum requirements.

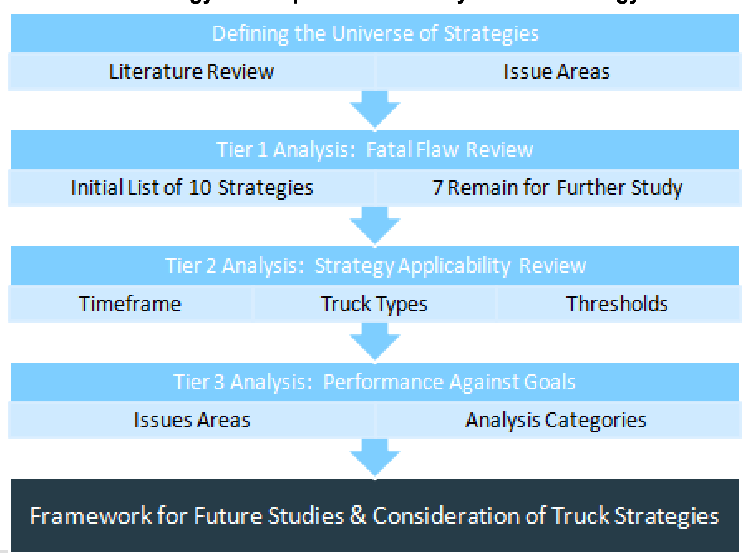
4. STRATEGY ANALYSIS METHODOLOGY

A three-tiered analysis approach was used to assess the truck management strategies, as described below:

- Tier 1 - Preliminary Strategy Screening: Fatal Flaw Review
- Tier 2 - Quantitative Strategy Analysis: Strategy Applicability Review
- Tier 3 - Final Strategy Analysis: Performance Against Goals

The three tiers included a preliminary strategy screening/fatal flaw review (conducted as part of the strategy identification process), a review of strategy applicability to the San Diego region using local data, and a review of each strategy against the project goals and key issue areas. The three-tiered analysis methodology was developed by the project team with review and feedback from the PST and the FSWG. More information on each tier of analysis and the analysis results are provided in Technical Memorandum #5: Strategy Analysis.

FIGURE 3. Strategy Development and Analysis Methodology



DATA COLLECTION AND NEEDS ASSESSMENT

As part of the Tier 2 analysis process, local truck data were collected to help identify issue areas throughout the region. The project team collected and reviewed truck data from the following sources: the SANDAG Truck Model, Regional Weigh-In-Motion Sites, the San Diego Regional Occupancy and Classification Study, and the Statewide Integrated Traffic Records System (SWITRS) database.

One of the key findings from the data collection effort was the identification of the major truck gateways and distribution hubs in the region, as shown in Figure 4. The gateways include places where goods enter and leave the region (e.g. the Otay Mesa Port of Entry) and the distribution hubs include places that contain manufacturing or warehouse districts. The map

[1] http://www.chp.ca.gov/html/hot_hov.html

was generated based on information from the SANDAG truck model and information from the industry stakeholder interviews.

FIGURE 4. Trucking Gateways and Distribution Hubs

More information on the data collection process and results are available in Technical Memorandum #4: Data Collection. Additionally, numerous truck data gaps were identified as a result of the truck data collection effort. Data gaps included: a general lack of truck origin/destination and trip purpose data, accident details where trucks are involved, and a general lack of truck volume and classification data throughout the region's freeway and highway network. More information on this topic is summarized in Technical Memorandum #6: Data Needs Assessment.

ISSUE AREAS AND ANALYSIS CATEGORIES

As part of the literature review, several key issue areas and analysis categories were identified for consideration as part of the Study, as shown in Figure 5.

FIGURE 5: Truck Management Strategy – Issue Areas and Analysis Categories

The issue areas and analysis categories were used to conduct the Tier 3 Final Strategy Analysis. This means that, for each strategy, the project team looked at how it would impact goods movement, if it would require legislative changes, if the industry would support it, if it would be supported by the broader community, how it would impact local economic development and the environment, how safety and traffic operations would be affected, and any major engineering or financial issues associated with the strategy. The assessment was completed using a consumer reports style rating system which is described and documented in Technical Memorandum #5: Strategy Analysis.

KEY STUDY OUTCOMES

There are four key outcomes of the three-tiered analysis process (Figure 6). The first is an overall summary of findings for each of the seven strategies, including the general strengths and challenges of each strategy. This provides the region with a truck management strategy 'toolbox' that can be used in future studies (see Section 5 of this document). The second outcome is a high level assessment of the issue areas for truck mobility throughout the region, as determined through the data collection process, and the initial identification of potential strategies for each location (described in Technical Memorandum #5: Strategy Analysis). The third is a more detailed look at how the strategies might apply to two conceptual corridors in the region: I-15 from SR 163 to SR 78 and the Otay Mesa Border Area (see Section 6 of this document). The fourth key study outcome is an assessment of the truck data gaps in the region, and recommendations for how truck data collection might be improved (described in Technical Memorandum #6: Data Needs Assessment). Information on a pilot project to improve the collection of truck data in the region is also provided in Section 7 of this Executive Summary.

FIGURE 6: Key Study Outcomes

5. STRATEGY ANALYSIS RESULTS

INDUSTRY INTERVIEWS

Freight and trucking industry representatives from a wide variety of operation types and sizes of companies participated in industry interviews. Trucking industry representatives indicated that they support strategies that improve mobility and safety for trucks in the region. However, they also indicated that strategies that increase their costs or decrease their current operational autonomy and access to facilities would not be supported. For the border region, truckers indicated that they support strategies that assist them in addressing the most urgent problems first, including designated access to and from the ports of entry/exit that harmonize with local business access. Truckers expressed concerns about strategies with components that mixed their larger vehicles (eighteen wheelers) with smaller passenger vehicles, and overall, supported strategies that isolated, dedicated, or designated facilities or lanes for purposes of ingress, egress, climbing, by-pass, and expediting through-trucks. Truckers also expressed general opposition to new tolls, unless the value added to their operations is tangible. Truckers appreciated being included as an essential stakeholder in the strategy analysis and planning process. More information on the industry interview findings is provided in Technical Memorandums #4: Data Collection and Technical Memorandum #5: Strategy Analysis.

SUMMARY OF STRATEGY ANALYSIS RESULTS

A brief overview of the strategy analysis results for each strategy is provided in Table 2, including key strengths, key challenges, and a summary of findings. Based on the results, each strategy was given a "thumbs-up," "neutral," or "thumbs-down" rating. A "thumbs-up" rating means the strategy performed well throughout the analysis process, is potentially applicable in multiple locations throughout the region, and is generally recommended for further consideration and study. A "neutral" rating means the strategy has key strengths that merit it remaining in the region's truck management strategy "toolbox;" however, it appears to have limited applicability in the region for the immediate future. A "thumbs-down" rating means the strategy did not perform well and is not recommended for further consideration at this time. The top-performing, "thumbs-up" strategies include Strategy #2: Traffic Organizational Strategies at Freight Gateways and Distribution Hubs, Strategy #4: Trucks on the Planned Network of HOV/HOT Lanes (Restricted Access), and Strategy #7: ITS/ATM and Lane Assignment. More information on the findings for each strategy, including the strategy-specific industry feedback and Tier 2 and Tier 3 analysis results, is available in Technical Memorandum #5: Strategy Analysis.

6. CONCEPTUAL CORRIDORS

To select the conceptual corridors, the project team looked for locations with heavy truck volumes that could serve to demonstrate a variety of the truck management strategies, if implemented, and allow lessons learned to be applied elsewhere in the region. Specifically, the project team looked for freeway corridors with plans for four managed lanes (two in each direction) and DARs to allow for the testing of the managed lanes strategy, as well as locations reported by stakeholders as experiencing high truck delay and needing fixing "sooner than later." The locations selected include the I-15 corridor from SR 163 to SR 78 and the Otay Mesa Border Area, which includes SR 905 and the SR 905/I-805 Interchange. More information on the Conceptual Corridor findings is available in Technical Memorandum #5: Strategy Analysis.

I-15 CORRIDOR

This key trucking corridor has a system of managed lanes already in place and is projected to experience an increase in truck volumes by 2050 in both directions. The potential strategies reviewed for this corridor included Strategies #3, #4 and #7, which are described below and illustrated in Figure 7.

Strategy #3: TDM Strategies to be Developed with Truckers and Shippers/ Receivers

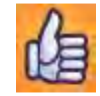
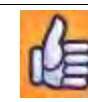
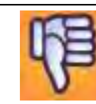
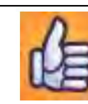
The TDM strategy was evaluated in this corridor because of its location immediately adjacent to the Rancho Bernardo Trucking Distribution Hub. However, review of local data revealed that auto and truck traffic are not peaking at the same time in this location, so a TDM strategy to shift trucks to off-peak travel times does not appear to be necessary.

Strategy #4: Restricted Access for Trucks on the Planned Network of Managed Lanes

Two potential levels of implementation of Strategy #4 are recommended for consideration along the I-15 corridor.

Level 1: The first level is removing the existing occupancy restrictions and single occupancy vehicle (SOV) toll for 2-axle, commercial trucks. Two-axle trucks are already allowed in the managed lanes; however, they must have two or more passengers to use the lanes for free or pay the toll. The trucking industry interviews revealed that the majority of truckers do not know that 2-axle trucks are allowed. A preliminary step to implementing this strategy could be to conduct outreach to truckers and enhance the signage in the corridor to encourage permitted use of the lanes. Further, because commercial trucks do not often have more than one driver, a next step could be removing the occupancy restrictions to allow commercial 2-axle trucks to access the lanes for free, similar to a carpool. The 2-axle commercial trucks could access the

TABLE 2: Truck Management Strategy Toolbox – Summary of Analysis Results

Strategy	Key Strengths	Key Challenges	Summary of Findings
1. Base Case Scenario (Current RTP Improvements)	N/A - The base case scenario is unique because all of the other strategies were compared to the base case scenario. As such, the Tier 2 and Tier 3 analysis procedures were not applicable to the base case scenario.		Multiple growing demands on the region's freeways (combined with limited capacity to shift goods to rail) will impair the efficient movement of trucks in the region. Additional truck management strategies should be considered to preserve long-term truck mobility and regional competitiveness.
2. Truck Organizational Strategies at Gateways / Hubs	May improve truck mobility where implemented; supported by industry; no legislative changes required; serves all truck types; relatively low capital and O&M costs expected.	Benefits will likely be localized to the area of improvement and have less affect on regional truck mobility.	This strategy's ability to improve truck mobility, reduce delays, and route trucks more appropriately through the region's trucking gateways and distribution hubs makes it an easy "low-hanging fruit" strategy that is a "win-win" for multiple stakeholders. 
3. Truck Travel Demand Management	Comparatively low cost strategy; supported by other facility users; some industry support and examples of success when the right conditions are present.	Shifting to off-peak can increase costs for both truckers and shippers/receivers; trucks are already driving off-peak when they can; shippers/receivers control schedules; could conflict with neighborhood noise curfews.	Interviewees indicated this strategy is not a "silver bullet" and the review of the local data found that there are not many locations throughout the region where the required conditions (truck and auto traffic peaking at the same time) are present. If conditions change, this strategy could be revisited in the future. 
4. Restricted Access for Trucks on the Managed Lanes Network	May improve travel times and reliability for light-duty and possibly medium-duty trucks; maximizes existing and planned improvements; generally supported by industry.	Some legislative changes required; access and safety concerns for larger, heavy-duty trucks; key design and routing issues should be considered; potential policy considerations.	The strategy performed well for certain truck types (light-duty and medium-duty) when certain conditions are met. Use of managed lanes by heavy-duty trucks is not recommended due to the safety and operational concerns expressed by industry. A pilot study is discussed in Section 7. 
5. Designated Truck-Only Lanes	Increased separation of autos and trucks would improve truck mobility, safety, and overall operations; supported by industry.	Higher cost, capital improvement with potential right-of-way constraints; possible legislative challenge due to capacity expansion component.	Due to the high costs and the potential right-of-way and legislative issues, this strategy is only recommended for consideration in bottleneck locations where the truck volumes and local conditions warrant this level of investment 
6. New Truck-Only Facilities	Increased separation of autos and trucks would improve truck mobility, safety, and overall operations; supported by industry if conditions warrant.	High capital and O&M costs; potential right-of-way and legislative issues; potential community opposition.	Current and projected truck volumes do not merit this level of investment. Due to this and the high expected capital and O&M costs, this strategy is not recommended for implementation in the San Diego region. 
7. ITS/ATM and lane assignment	Optimizes the use of existing capacity; improves safety and mobility for all users; supported by industry; reduces air emissions; cost-effective.	Dynamic lane assignment could require legislative changes; some industry concern with changeable message signs potentially causing distracted driving.	This strategy is "win-win" and has the potential to optimize the use of existing freeway capacity and improve travel times and reliability for all users. The strategy is anticipated to be cost-effective and is likely aligned with improvements already planned. 

managed lanes from either the Intermediate Access Points (IAPs) or the DARs. Since 2-axle trucks are currently allowed, this would serve as a good step to assess the following: 1) whether access to the managed lane system benefits trucks, 2) the degree of acceptance by other facility users, and 3) how the strategy would affect the capacity and operational function of the managed lanes. Additionally, FasTrak transponders could be required (which would help ensure non-commercial, 2-axle trucks (such as pick-up trucks) with a single occupant do not try to use the managed lanes for free).

Level 2: Due to strong industry feedback regarding operational and safety concerns, medium-duty 3- to 4-axle trucks should not be allowed to access the managed lanes via the IAPs, and heavy-duty trucks with 5 or more axles should be restricted from the managed lanes entirely. However, if Level 1 is successful, the next step could include allowing medium-duty trucks (3 to 4 axles) that meet maximum length restrictions to access the managed lanes via the DARs. This would be more complex and several factors would need to be considered prior to implementation. To test the strategy along I-15 the project team looked at several factors, including pavement index, the ability of trucks to make the turns onto the existing DARs, and the capacity of the managed lanes.

- **Pavement Index:** The project team compared pavement structural sections between the general purpose lanes and managed lanes at three locations along I-15. Initial results showed that, as built, the pavement structural sections are similar to the existing general purpose lanes and could likely accommodate trucks.
- **DAR Truck Turning Radii**: For the DARs, turning radii were tested for standard truck lengths in the light-, medium-, and heavy-duty truck categories for two sample DARs along the I-15 corridor. For these DARs, it was determined that overall, light-duty and medium-duty trucks (with lengths up to certain measurements[2]) could likely make the turns, while most heavy-duty trucks would experience challenges.

  Managed Lane Capacity: Based off of one count taken at the I-15 Hale Ave. DAR, the express lanes experience about 1,200 vehicles per hour (vph) during the peak, out of capacity of about 4,000 vph. Carpools/vanpools and transit make up about 30 percent of AM peak traffic and 52 percent of PM peak traffic, with SOVs making up the remainder. This means that trucks could currently be added to the lanes without displacing the carpools/vanpools and transit they were designed to serve. But, additional counts are necessary at different locations to verify this.

If Level 2 were implemented, additional considerations would need to include truck routing to and from the DARs. More information on this strategy is included in Section 7 of this document.

Strategy #7: ITS/ATM and Lane Assignment

To improve overall operational flow & safety on the general purpose lanes for all users (including passenger vehicles and all types of trucks, regardless of size), variable speed limits and dynamic lane assignment could be implemented to help maximize truck throughput along the I-15 corridor. In addition, dynamic truck routing in conjunction with the existing Integrated

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[2] For light-duty, 2-axle trucks, the standard truck length assumed was a wheelbase of 20 feet. For medium-duty, 3 to 4 axle trucks, the standard truck length assumed for non-articulated trucks was a wheelbase of 25 feet and for articulated trucks it was a kingpin to rear-axle length of 25.5 feet and a steering axle to rear axle length of 38 feet. The truck lengths used were based on AASHTO's 2011 standard truck classifications as presented in the software program, Auto Turn. For more information, please see Table 5 in Technical Memorandum #5: Strategy Analysis.

Corridor Management (ICM) program (based on real-time response to incidents and congestion levels) could optimize the use of existing corridor capacity and improve truck travel times.

OTAY MESA BORDER AREA

The Otay Mesa Border Area was selected as a conceptual corridor because it experiences a high percentage of truck traffic along SR 905, La Media Road, Siempre Viva Road and other key arterials. Key challenges include long, unmanaged queues during peak commercial vehicle traffic hours, a lack of services for drivers, and conflicts with local access to businesses. The potential strategies reviewed for this area included Strategies #2, #5, and #7, which are described below and illustrated in Figure 8.

Strategy #2: Traffic Organizational Strategies at Freight Gateways and Distribution Hubs

To address the existing problems with truck back-ups, blocked-drive-ways and queuing off of Siempre Viva Rd. and the northern end of La Media, communication based strategies could be implemented that complement the existing Otay Mesa POE Truck Route Improvements underway by the City of San Diego[3]. Improvements could include creating truck queuing waiting areas/lots for southbound trucks waiting to cross the border. The lots could have services for truckers (e.g. restrooms and trash receptacles) to create a more enjoyable crossing experience. This would require an organizational/enforcement strategy, such as taking ticket numbers and crossing when your number is called. Trucks could be routed to the lots through static and dynamic signage (based on current congestion levels at the border).

Strategy #5: Designated Truck Lanes (e.g. Truck By-Pass, Truck Routes, or Climbing Lanes)

To address potential increases in truck volumes and percentages at the SR 905/I-805 Interchange, for northbound traffic, a dedicated truck lane could potentially be added to the ramp from westbound SR 905 to northbound I-805. For southbound traffic, an existing lane could potentially be converted to a dedicated truck lane on the flyover from southbound I-805 to eastbound SR-905. For both options, issues with right of way (ROW) constraints, costs, and steep slopes, would need to be addressed, prior to implementation.

Strategy #7: ITS/ATM and Lane Assignment

To improve traffic flow along SR 905 for trucks coming to/from the U.S.-Mexico border, dynamic lane assignment could potentially allow trucks on all lanes on SR 905. This would require a gantry with dynamic message signs indicating when trucks are allowed in each lane. To improve traffic flow, southbound trucks heading toward the existing Otay Mesa border crossing could be assigned to the right two lanes and through trucks or trucks heading to the future border crossing could be assigned to the left two lanes. The pavement profile for the left lanes on SR 905 approaching SR 11 and the Otay Mesa East POE would be able to support the weight of trucks. Caltrans is already seeking an exemption for SR 11 to allow trucks in the left hand lane, so implementing this strategy could be well-timed. Additionally, an automated notification system could notify truckers in advance of congestion issues at the border and suggest alternate routes/times of day, so truckers can make their travel decisions based on

[3] The first phase of improvements (completed in May 2011) included adding an emergency vehicle lane to the truck-only road between Drucker Lane and the inspection facilities at the POE. The second phase of the project will extend Britannia Boulevard to the south, add one truck lane and emergency lane, and extend the truck road parallel to the border between Britannia Boulevard and La Media Road. It also will add a second lane to the truck route between La Media Road and Drucker Lane. Construction of the second phase is scheduled to be complete in FY 2016.

complete information. This could be implemented in conjunction with southbound border wait time systems currently under consideration by Caltrans and SANDAG. Notification could occur through CMS signs located along SR 905 and key surface streets.

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FIGURE 7: Potential Strategy Applicability along I-15 from SR 163 to SR 78

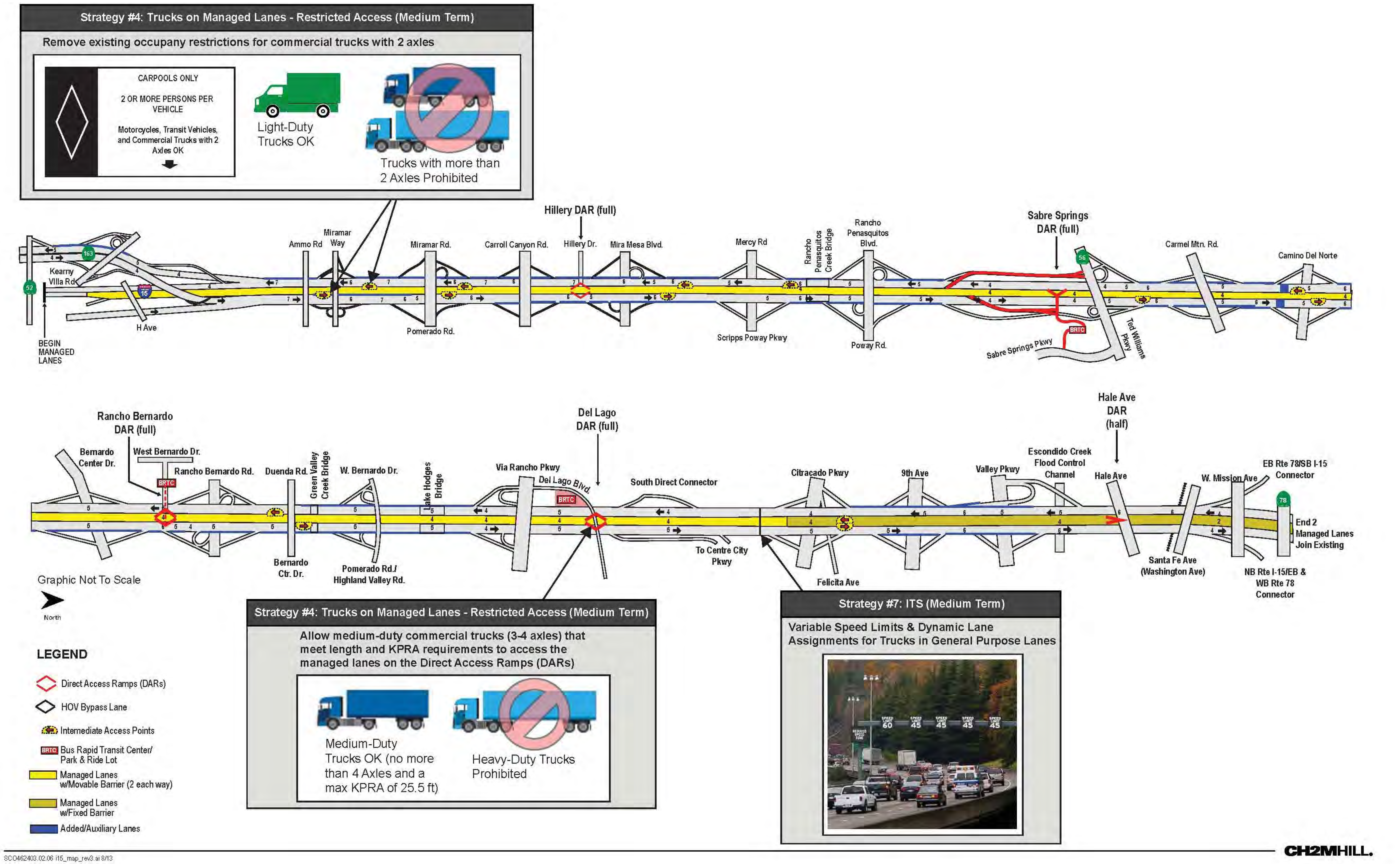

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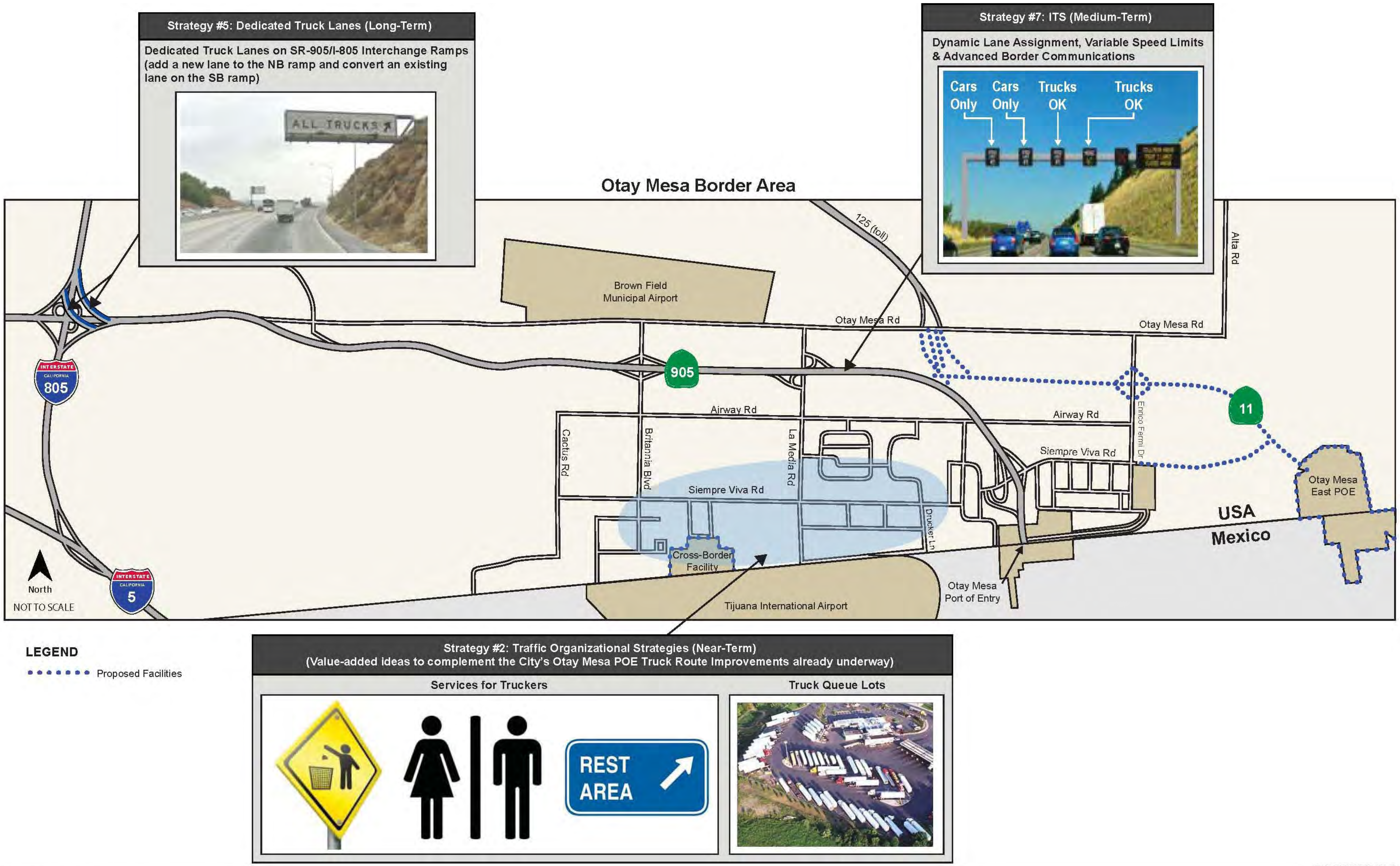
FIGURE 8: Potential Strategy Applicability in the Otay Mesa Border Truck Gateway



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7. IMPLEMENTATION OPPORTUNITIES AND NEXT STEPS

The strategies summarized in this document and analyzed as part of the overall project effort are intended to provide a framework of options and opportunities for the further review and study of specific freeway operational strategies for truck movement in the region. Future consideration and integration of some of these strategies into the region's transportation planning and infrastructure improvement processes are critical to maintaining future goods movement mobility.

In addition to a framework for on-going and future regional and corridor planning efforts, the project did identify two near-term implementation opportunities that could be undertaken within the next couple of years by SANDAG, Caltrans, and partner agencies. The implementation opportunities are not meant to test all recommended strategies, but rather leverage some near term opportunities specifically related to enhanced truck data collection and the ability to test regional perceptions to some of the more active freeway management strategies for trucks. These implementation opportunities are described below and include some near term enhanced truck data collection and a trucks on managed lanes pilot study.

TRUCK DATA COLLECTION NEXT STEPS

The Project Team found several gaps in regional truck data collection and availability, particularly with regard to truck volume and classification data. Truck volumes have substantial influence upon traffic operations, safety, emissions, and regional economic productivity. Figure 9 displays the high-level architecture concept for enhancing regional vehicle and truck classification and count data. This approach was developed via meetings with Caltrans and SANDAG staff and is based on:

- **Enhancement of the Field Sensor Network:** Three levels of improvements to the field sensor network are proposed as part of this concept:

  1. **Update, Calibration, and Maintenance of Existing Weigh-In-Motion (WIM) Sites:** Some of the WIM sites are not fully operational or are providing sporadic data. These sites are generally sited in important locations, and the data they can provide is still highly useful. The sites should be checked, and repaired as necessary.

  2. **Calibration and Use of Side-Fire Radar Sites for Supplement Vehicle Classification:** It is possible to utilize some of the existing Caltrans Vehicle Detection System (VDS) to provide supplemental classification data. The VDS in District 11 generally consists of three types of devices:

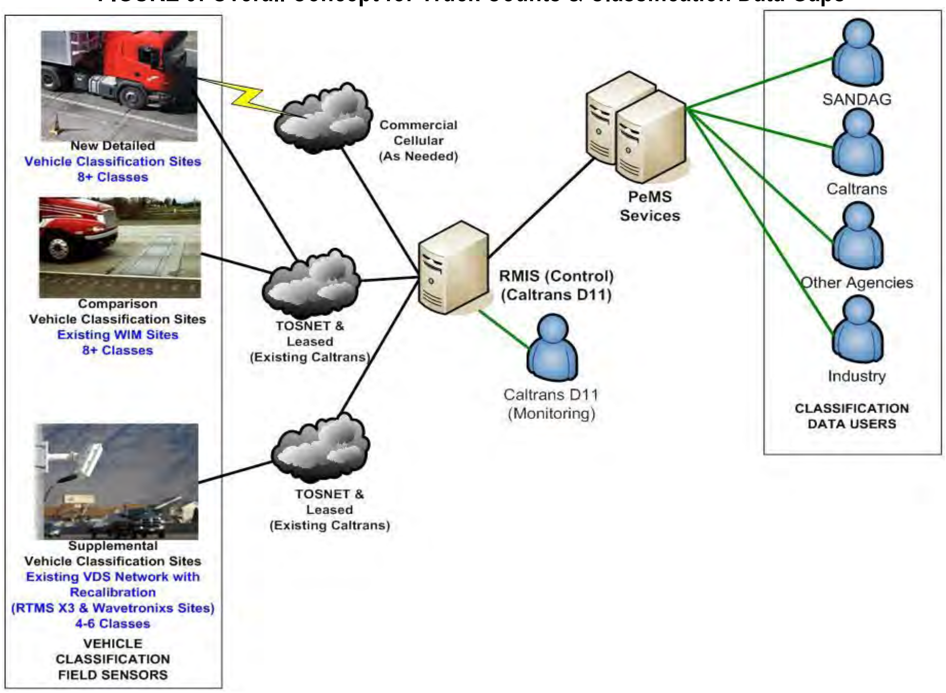
     - Caltrans Radar Sites – Radar-based VDS sites have been deployed along substantial segments of the freeway network. They consist of two different devices, RTMS x3 and Wavetronix 125 with slightly different configurations. The Wavetronix sites seem to provide the best near-term opportunity to provide accurate data with minimal recalibration effort.

     - Loop-based VDS – Generally these exist with two loops in each lane of traffic along many freeways and highways in the region. If implemented with both loops active they can provide relatively accurate classification data. Discussions with Caltrans indicate that currently the majority of loop VDS only have one set of loops active. There are 42 sites in the region that have dual-loops activated, but the associated software requires updating to calculate lengths and separate vehicle detection into classification bins or categories. In addition there is a project underway to post-process data from these sites in an attempt to provide classification data, but the results and accuracy of this approach have not yet been fully confirmed.

- Nokia Radar Sites – There are a number of VDS that are not controlled by Caltrans, but provide data to Caltrans and regional information systems. These sites are not considered as part of a vehicle classification approach as there is no agency control over configuration, maintenance, and management.

3. D

FIGURE 9: Overall Concept for Truck Counts & Classification Data Gaps



of Detailed Vehicle Classification Sites: Both SANDAG and Caltrans indicated a desire to obtain the most detailed vehicle classification data possible. In general, this is viewed as being able to group trucks and vehicles into 8 to 10 classification bins at a minimum with a high levels of accuracy. Due to the issues with the existing WIM sites, both in terms of reliability and coverage, additional detailed truck classification sites should be deployed to provide better reliability, accuracy, and coverage. Several potential technologies exist that could be deployed.

- **Routing of Data Back Through RMIS/Caltrans:** As many of the sites are already connected to Caltrans field communications networks and are routed through the Caltrans D11 Traffic Management Center, it should be possible to largely utilize existing infrastructure and systems to support the existing, supplemental, and detailed vehicle classification sites. Some modifications may be required to software interfaces to support the detailed vehicle classification sites. Under this approach, basic monitoring and maintenance of the vehicle classifications sites would reside with Caltrans.

- **Use of PeMS as a Data Collection & Dissemination Resource:** Based on discussions with Caltrans and SANDAG, it seems that PeMS is already able to support the desired classification data. PeMS is an excellent resource for collecting this data and making it available; however, it is generally used to look at individual sites and the data would have to be placed into other tools to look at regional patterns and trends. PeMS should be accessible by all potential data users including Caltrans, SANDAG, and industry, etc.

Preliminary high level cost estimates were developed for this pilot effort, and full implementation would cost between $1 million and $1.25 million. Near-term implementation of a set of supplemental sites could be accomplished for approximately $295,000. It is important that any implementation effort include long-term maintenance and monitoring activities to ensure continued proper operation and calibration of the sensors. Funding for this effort has not been identified. The primary responsible implementing agencies would need to be SANDAG and Caltrans. Significant planning and coordination effort would be needed to establish agreed upon truck classifications. These efforts should include participation from the commercial trucking industry. There is possible synergy between future truck data collection and future Integrated Corridor Management (ICM) program implementation. For example, enhanced vehicle classification data could substantially enhance the near real-time predictions of traffic conditions used by the ICM program to rate and suggest response plans.

TRUCKS ON MANAGED LANES NEXT STEPS: IMPLEMENTATION PILOT

Meetings about the broader concepts of integrating truck mobility and the utilization of the managed lanes network led to discussions about methods to test public perceptions and the desire or willingness of industry for trucks to make use of the managed lanes. Given the restrictions proposed for truck types on managed lanes as part of this Study, discussions centered on public perceptions and policy more than safety and engineering design concerns.

As a result of these meetings, including participation from the Caltrans Corridor Directors and Caltrans and SANDAG staff, the potential for a near-term pilot was discussed that could allow restricted truck traffic onto the I-15 Managed Lanes. The following concept lays out guidelines and objectives for such a pilot if deemed appropriate by SANDAG and Caltrans leadership[4] in the future.

During an initial pilot, it is advisable to allow only light-duty, 2-axle trucks into the managed lanes. This does not require legislative action, as these trucks would already be able to use the lanes legally if they meet occupancy and/or toll payment requirements. The objectives of the pilot could be to:

- Test the policy concepts of more fully utilizing the managed lanes network to balance truck traffic and improve overall corridor mobility.
- Test public perceptions of trucks in the managed lanes.
- Test trucking industry views on the use of managed lanes to assess: value to industry, types of trucking users and trip types most likely to use the lanes, and truck driver views of using the lanes in terms of safety perception, and accessibility.
- Test overall mobility impacts to determine if trucks impact average speed trends or the managed lanes speed objective of 45 mph or greater.

The major shift for the pilot would be to encourage the potential use of the managed lanes by light-duty, 2-axle trucks, which could include:

- **Signage Adjustments:** Current signage along I-15 does not specifically preclude trucks, but does not note that light trucks are allowed. Signage could be temporarily adjusted to make the potential use of the managed lanes by light-duty trucks clear.
- **Marketing Activities:** Marketing and communications actions could be taken to gain involvement of potential trucking fleets and make users of the managed lanes aware of the pilot project.

[4] Although decision makers would include SANDAG and Caltrans leadership, coordination with California Highway Patrol would also be needed.

- **Toll Rate Adjustments:** In order to encourage pilot program participation, trucks may be provided transponders, but special toll rates or temporary discounts could be considered to encourage involvement.

The pilot program for light-duty trucks on the I-15 Managed Lanes would include the following efforts:

- **Policy Exploration Phase:** Vet the pilot program with SANDAG and Caltrans Executive Management and the SANDAG Board to ensure the goals and duration of the pilot program are understood. The overall duration of the pilot should allow for at least six months of operational testing.
- **Project Objectives and Charter:** Define the primary objective of the pilot program to assess whether or not the use of the region's managed lanes network by trucks is a viable alternative for improving overall corridor mobility and ensuring long-term goods movement sustainability. Also set clear objectives to test industry and public perception of the approach and confirm that light-duty truck traffic can be operated without significant traffic operations impacts.
- **Design and Implementation:** As noted, some signage changes and adjustments would be needed. In addition, Changeable Message Signs (CMS) may be used to post program messages and announcements. Depending on program details, it may be necessary to implement some temporary changes to tolling systems and programs, as well as add information to SANDAG, Caltrans, and Express Lanes websites. Finally, additional vehicle classification data should be collected for the managed lanes. This could include calibration of side-fire or loop based vehicle detection sites.
- **"Before" Data Collection:** A period of detailed "before conditions" data should be collected for the entire corridor, including speeds, volumes, vehicle classifications, accidents, and Freeway Service Patrol activity.
- **Marketing Activities:** Marketing and communications activities should be conducted with industry to ensure they are aware of and utilize the program. In order for the pilot program to properly test public perceptions, it is important that trucks be present in the facility at reasonably anticipated levels.
- **Pilot Operations and Assessment Period:** The pilot operations period should be at least six months, during which operations are closely monitored and data is collected on an on-going basis.
- **Public and Industry Perceptions:** During the pilot operations period, survey known I-15 Managed Lanes users to assess their perceptions and reactions; conduct similar surveys with industry participants. Any public or industry complaints would be logged during the pilot program period.
- **Post-Pilot Evaluation & Policy Confirmation:** Following the pilot program period, assess the overall success and regional perceptions of the pilot program. If the pilot program has proven to provide goods movement mobility value while not impacting traffic operations or perceptions of the managed lanes as a useful and effective option for faster and safer travel along the corridor, then further policy review could be considered.

If the pilot program proves successful, further consideration could be made of a broader policy regarding the use of managed lanes by trucks, including truck type and time of day restrictions, and adjustments to managed lanes design. If success leads to the desire to expand truck on managed lanes opportunities, then the region should consider legislative, design, and policy changes appropriate to allowing both light- and medium-duty trucks onto the managed lanes, with the restrictions discussed in greater detail as part of this Study.

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Technical Memorandum #1: State-of-the-Practice for Managing Trucks on Freeways and Managed Lanes and Applications for the San Diego Region

TO:	Andrea Hoff and Christina Casgar, SANDAG
FROM:	CH2M HILL
DATE:	March 21, 2012
CC:	IBI Group, Cheval Research

This technical memorandum provides a review of literature to identify approaches that are currently applied or have been considered in domestic and international locations for managing trucks on freeways (including freeways with managed lanes, dedicated truck lanes, and other truck management strategies). The memo is intended to serve as a reference tool for truck lanes-related information, research, and best practices available in California, the United States, and internationally. The memo consists of the following sections:

- Section 1: Introduction/Background – Provides a brief overview of the SANDAG 2050 RTP Goods Movement Strategy as it relates to trucks, what is meant by the term managed lanes, and the various types of truck management strategies that are being studied and implemented elsewhere. The section ends with a summary of the current regulatory framework in California as it relates to the use of managed lanes by trucks. *(Pages 2-7)*
- Section 2: Case Studies – Reviews applications of truck management strategies, including: domestic - existing projects/projects in construction, domestic - planned projects/projects under study, and international applications. *(Pages 8-15)*
- Section 3: Literature Review – Describes findings from a review of research documents and government reports, including national level studies, local studies, managed lane studies, dedicated truck lane studies, tolling studies, truck lane restriction studies, and perspectives of the trucking industry, as they relate to the use of trucks on managed lanes and truck management strategies. *(Pages 16-29)*
- Section 4: Conclusions – Summarizes our findings and provides recommendations of key topics for further consideration. *(Page 30)*

A list of works cited is provided at the end of this memo.

Section 1: Introduction/Background

San Diego 2050 RTP - Goods Movement Strategy

In October 2011, the SANDAG Board of Directors adopted the SANDAG 2050 Regional Transportation Plan (RTP) and Sustainable Communities Strategy (SCS), which included a Goods Movement Strategy for the region. The strategy notes that the majority of freight travels by truck in the San Diego region and that the major corridors used by commercial trucks are I-5, I-805, and I-15 (for north-south travel) and SR 94/125, I-8, and SR 905 (for east-west travel) (SANDAG, 2011).

FIGURE 1: 2050 REVENUE CONSTRAINED HIGHWAY NETWORK – PROPOSED LOCATIONS OF MANAGED LANES

Source: 2050 SANDAG RTP

The RTP includes projects to ease congestion for trucks at the border crossing at Otay Mesa and the Port of San Diego connector roads along Harbor Drive. Additionally, the RTP calls for the phased implementation of new managed lanes along multiple corridors through 2050, including several of the region's primary truck routes, as shown in Figure 1.

Other proposed freeway improvements in the RTP include operational improvements on SR 52, SR 54, SR 67, SR 94, and SR 125, in addition to mention of the potential use of managed lanes by trucks. The RTP also includes an Airport Multimodal Accessibility Plan which details a multimodal strategy to improve airport access for multiple users, including trucks.

The goal of this study is to begin to assess freeway operational strategies related to the use of managed lanes by trucks for the San Diego region.

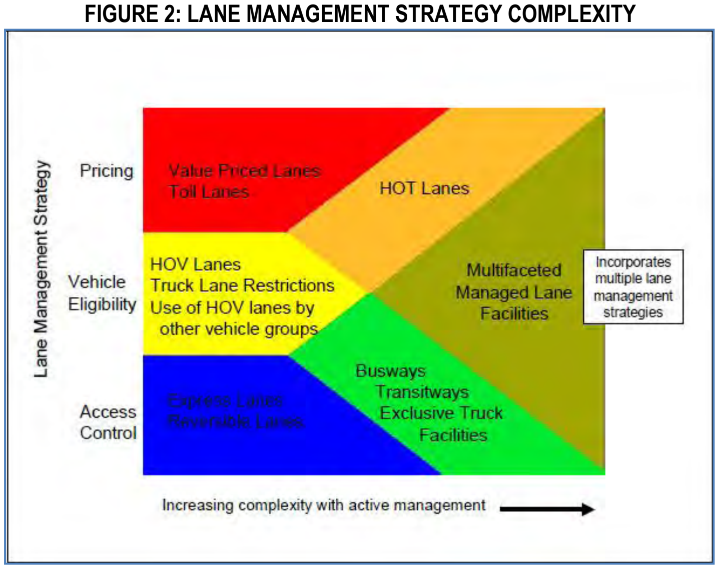
What are Managed Lanes?

As defined in the *Literature Review Synthesis and Overview of Managed Lane Systems* report prepared for the San Diego Regional HOV/Managed Lanes System Planning and Implementation Guide, the term "Managed Lanes" encompasses a wide variety of operational strategies (Caltrans D11 and SANDAG, 2012). Specifically, according to the Federal Highway Administration (FHWA), there are four common elements of the managed lanes concept:

1. The managed lane concept is typically a "freeway-within-a-freeway" where a set of lanes within the freeway cross section is separated from the general purpose (GP) lanes.
2. The facility incorporates a high degree of operational flexibility so that operations can be actively managed over time to respond to growth and changing needs.
3. The operations of and demand on the facility are managed using a combination of tools and techniques to continuously maintain a desired condition, such as a minimum speed.
4. The principal management strategies can be categorized into three groups: pricing, vehicle occupancy and eligibility, and access control.

Managed lanes can include high-occupancy vehicle (HOV) lanes (not priced), value priced lanes or high-occupancy toll (HOT) lanes, and exclusive or special use lanes (such as bus-only or truck-only lanes). Figure 2 describes the variety of management strategies that may be implemented as part of a managed lanes system. On the left of the diagram are the applications of a single operational strategy – pricing, vehicle eligibility, or access control - and on the right are the more complicated managed lane facilities that blend more than one of these strategies.

FIGURE 2: LANE MANAGEMENT STRATEGY COMPLEXITY



Source: FHWA, 2004

FIGURE 3: I-15 EXPRESS LANES IN SAN DIEGO

Source: Caltrans D11 and SANDAG, 2012

The focus in the San Diego region is primarily on managed lanes that start as HOV lanes and have the potential to be converted to HOT lanes, as needed, with some exceptions. Currently, the I-15 Express Lanes shown in Figure 3 are the only operational managed lanes in the San Diego region. The I-15 Express Lanes system provides a four lane "expressway within a freeway" for 20 miles from State Route 163 (SR 163) and SR 78. The lanes include a movable barrier, which allows Caltrans to adjust the number of lanes in each direction. There are nine direct access points to and from the general purpose lanes in each direction (approximately every two miles) and four direct access ramps (with a fifth planned for 2014) from transit stations along I-15. Additionally, in early 2014, a new high-frequency Bus Rapid Transit (BRT) system to downtown will operate in the Express Lanes (Caltrans D11 and SANDAG, 2012).

The I-15 Express Lanes are free for carpools, vanpools, motorcycles, and zero-emission vehicles (with approved white stickers issued by the California Department of Motor Vehicles). Solo drivers can use the lanes with a prepaid FasTrak account and pay a toll based on the distance and rate per mile at the time the lanes are entered. Signs display both the minimum and maximum tolls to be paid by solo drivers upon entering the lanes, which are based on a dynamic pricing system recalculated every three minutes. Only light trucks and sport-utility vehicles are allowed to use the Express Lanes; commercial trucks with more than two axles are currently prohibited[1].

What are Managed Facilities for Trucks?

There are a variety of approaches to managing trucks on highways. The following are examples of truck on managed lane approaches that are being studied and/or implemented elsewhere:

Trucks on HOV/HOT Lanes

This approach could involve a variety of strategies, including full, unrestricted shared access, or permitting trucks to use HOV/HOT lanes but restricting them to certain times of day or lanes, or providing various pricing options. While light-duty trucks (2 axles or less) are typically allowed in HOV and HOT lanes (for example, on the I-680 Express lanes in Alameda County[2] and the I-15 express lanes in San Diego), trucks with three or more axles are often prohibited from using HOV/HOT lanes in the United States.

1 http://fastrak.511sd.com/fastrak/faq

2 http://www.680expresslane.org/FAQ_&_Brochure.asp#8

Truck-only Toll (TOT) Lanes

Truck-only Toll (TOT) Lanes are dedicated truck lanes that are tolled. TOT lanes may be barrier separated to improve safety and can be built to withstand greater vehicle weights, thus potentially enabling the removal of weight and length restrictions currently in place on most mixed-traffic highways (ODOT, 2009). The intent of TOT lanes is to attract the trucking industry to use them because the cost of the toll would be more than offset by the additional safety and productivity gains from using the TOT lanes (due to reduced travel times, increased travel time reliability, reduced accident risk, and the potential for more lenient weight and length restrictions). While the American Trucking Association has voiced opposition to commercial vehicle tolls on existing interstates, it has expressed support for the voluntary use of TOT lanes, when truckers are still allowed the choice of a non-tolled alternative (VDOT, 2006).

While there are currently no known examples of operating TOT lanes in the United States, TOT lanes have been studied extensively (for example, in Oregon and Georgia) and are currently being considered as part of Alternative 6C in the I-710 Corridor Project north of Long Beach, CA. Additionally, the I-4 / Selmon Expressway Connector is a new north-south toll road project currently under construction in Florida. The project will provide exclusive truck lanes for direct access to the Port of Tampa (with toll rates increasing based on the number of axles) and remove heavy truck traffic from local roads (FDOT, 2013).

Dedicated Truck Lanes

Dedicated truck lanes (also called truck-only lanes or commercial motor vehicle-only lanes) are lanes designated for use by trucks. The purpose of dedicated truck lanes is to separate trucks from other mixed-flow traffic to enhance safety and/or stabilize traffic flow[3]. Priority and/or dedicated lanes for trucks can help to optimize truck speeds and reduce crashes involving trucks and the associated long-term lane closures that can increase congestion-related greenhouse gas emissions (PennDOT, 2012). There are a few dedicated truck lanes in the United States, though they are rare and more are being studied. Of those that do exist, it is common to require trucks to use the dedicated truck lanes, while not expressly prohibiting their use by other vehicles as well.

Dedicated truck lanes typically include physically separate truck lanes from general purpose highway lanes, either through the construction of barriers or through grade-separated structures. Non-exclusive truck lanes are often separated from auto traffic through the use of rumble strips and permit autos to weave through them at access/egress ramps (NCHRP and NCFRP, 2010).

FIGURE 4: I-5 / I-405 INTERCHANGE BYPASS, LOS ANGELES

Source: FHWA, 2011

Interchange bypass lanes, as shown in Figure 4, are a form of dedicated truck lane that allow specified vehicles, such as trucks and buses, to

3 http://www.dot.ca.gov/hq/traffops/trucks/ops-guide/truck-lanes.htm

bypass interchange bottlenecks. This approach has been implemented in California and Oregon to allow trucks to bypass merging auto traffic at major interchanges and improve traffic operations (PennDOT, 2011).

ITS Applications for Commercial Vehicle Operations

ITS applications for commercial vehicle operations are designed to enhance communication between motor carriers and regulatory agencies. Such systems can improve vehicle flow and throughput and reduce emissions, and can complement the other truck management strategies described in this report. Example technologies include electronic registration and permitting programs, electronic exchange of inspection data, electronic screening systems, and applications to assist operators with fleet operations and security (PennDOT, 2011). ITS applications for managed lanes could include active traffic management technologies such as variable speed limits, variable message signs, and lane assignment to enhance mobility for trucks.

Lane Restrictions

Truck lane restrictions are common throughout the United States. Many states prohibit trucks from using the far left lane of a freeway because it promotes a more orderly mix of traffic, improves throughput, increases sight distance in leftmost lanes, generally improves safety, and still permits the orderly movement of trucks. Additionally, lane restrictions through construction zones are often used to move trucks away from workers and from leftmost lanes that may be narrower than outside lanes. Sometimes truck restrictions are implemented on entire corridors to limit trucks by weight, number of axles, or to completely prohibit them from using a corridor. Other types of common truck restrictions include restrictions by speed, network, and time of day (PennDOT, 2011). For example, in Texas trucks are not allowed on I-10 on weekdays during daylight hours when traffic flows are heaviest (Sisiopiku & Cavusoglu, 2011).

Current Regulations

The current California Vehicle Code (CVC) includes maximum speeds and restrictions to the right lane for trucks. The relevant sections of the CVC are summarized below[4]:

- Section 22406 of the CVC specifies that "motortrucks or truck tractors having three or more axles or any motortruck drawing any other vehicle . . . may not be driven on a highway at speeds in excess of 55 miles per hour."
- Additionally, Section 21655 of the CVC specifies that any vehicle subject to the provisions of Section 22406 "shall be driven in the right-hand lane for traffic or as close as practicable to the right edge or curb . . . (when a specific lane or lanes have not been designated)". Additionally, "on a divided highway having four or more clearly marked lanes for traffic in one direction", vehicles subject to Section 22406 may also be "driven in the lane to the immediate left of that right-hand lane. When overtaking and passing another vehicle proceeding in the same direction, the driver shall use either the designated lane, the lane to the immediate left of the right-hand lane, or the right-hand lane."

[4] http://www.dot.ca.gov/hq/traffops/trucks/ops-guide/truck-lane-use.htm

- Section 21655.5 of the CVC specifies that "the Department of Transportation and local authorities, with respect to highways under their respective jurisdictions, may authorize or permit exclusive or preferential use of highway lanes for high-occupancy vehicles . . . and shall place and maintain, or cause to be placed and maintained, signs and other official traffic control devices to designate the exclusive or preferential lanes, to advise motorists of the applicable vehicle occupancy levels, and, except where ramp metering and bypass lanes are regulated with the activation of traffic signals, to advise motorists of the hours of high-occupancy vehicle usage. No person shall drive a vehicle upon those lanes except in conformity with the instructions imparted by the official traffic control devices." A motorcycle, a mass transit vehicle, or a paratransit vehicle that is clearly and identifiably marked on all sides of the vehicle with the name of the paratransit provider may be operated upon those exclusive or preferential use lanes unless specifically prohibited by a traffic control device."

- Section 21654 of the CVC requires that "any vehicle proceeding upon a highway at a speed less than the normal speed of traffic moving in the same direction . . . shall be driven in the right-hand lane for traffic or as close as practicable to the right-hand edge or curb, except when overtaking and passing another vehicle proceeding in the same direction or when preparing for a left turn at an intersection or into a private road or driveway."

These regulations combine to create a legislative framework where it is currently common for managed lane facilities to specifically prohibit large trucks. This is true for the I-680 and I-580 Express Lanes in the San Francisco Bay Area and the I-15 Express Lanes in San Diego, as well as in other regions, such as the I-95 Express Lanes in Miami (Caltrans D11 and SANDAG, 2012). The California Highway Patrol also currently notes that "HOT lanes may not be used by vehicles restricted to a 55 MPH speed limit."[5]

[5] http://www.chp.ca.gov/html/hot_hov.html

Section 2: Case Studies

Domestic - Existing Projects / Projects in Construction

The following dedicated truck facilities are in existence in California, primarily along the I-5 freeway[6].

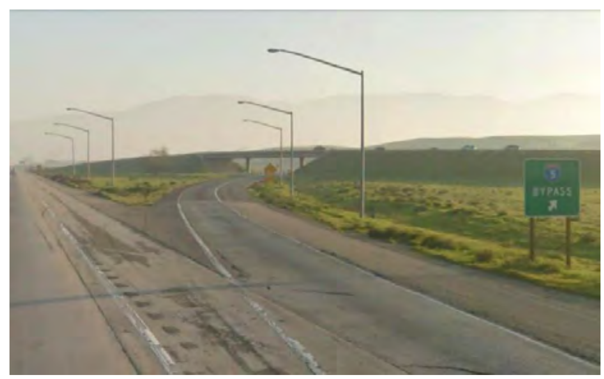
1) **I-5 at SR 14**: Northbound and southbound truck lanes exist for about 2.5 miles in each direction. The lanes were constructed about 30 years ago to help separate slower moving trucks from faster auto traffic on the grade. A picture is provided in Figure 5.
2) **I-5 at SR 99**: North of Los Angeles, near the Grapevine, this truck bypass lane is less than a half mile long and is designed to place truck merges further downstream of merging auto traffic. A picture is provided in Figure 6.
3) **I-5 at I-405:** This truck bypass lane at the I-5/I-405 interchange north of Los Angeles is also designed to allow trucks to bypass merging auto traffic (PennDOT, 2011). A picture is provided in Figure 7.

After the implementation of truck facilities on I-5, the number of crashes involving trucks decreased by 85 percent (Sisiopiku & Cavusoglu, 2011).

FIGURE 5. TRUCK LANES ON I-5 AT SR 14

Source: Google Maps

FIGURE 6. TRUCK BYPASS ON I-5 AT SR 99



Source: Google Maps

FIGURE 7: TRUCK BYPASS ROUTE AT THE I-5/I-405 INTERCHANGE

Source: Google Maps

I-5 - Truck Lanes from SR 14 to Kern County Line

This project is under construction and includes a new truck lane project on I-5 north of Los Angeles from SR 14 to Pico Canyon Road[7]. Using State Highway Operation Protection Program (SHOPP) and local sales tax Measure R funds, the truck lanes started construction in May 2012 and are expected to be completed in FY 2014. The project is adding truck lanes to the outside of southbound I-5 by paving the median area and outside shoulder,

6 http://www.dot.ca.gov/hq/traffops/trucks/ops-guide/truck-lanes.htm

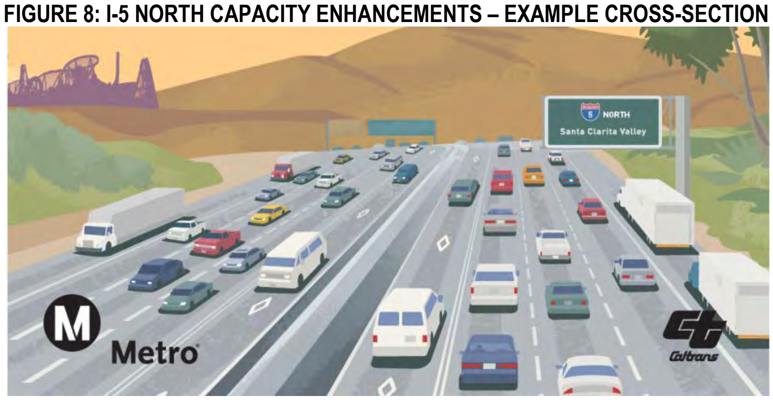
7 http://www.metro.net/projects_studies/30-10_highway/images/AHP_I_5_to_SR14_KernCnty.pdf and http://www.metro.net/projects/i-5-n-capacity-enhancements/overview-fact-sheet/

and shifting the mixed-flow lanes inward. Median retaining walls and two short sections of outside retaining walls will be built to accommodate the widening[8]. Future phases include adding HOV lanes (Phase 2a), extending the truck lanes north to Parker Rd (Phase 2b) and extending both the carpool and truck lanes north to the Kern County Line (Phase 3). Once completed, the entire project will include approximately 43 miles of truck lanes and approximately 12 miles of HOV lanes.

The purpose of the project is to use the carpool and truck lanes to relieve congestion and provide a faster and safer commute on I-5 through Santa Clarita, which is the third-largest city in Los Angeles County and is expected to grow by an additional 10percent by 2035. The project cites that population growth is quickly outstripping existing roadway capacity and that traffic volumes on I-5 are projected to double by 2030. The project aims to ease traffic delays, improve goods movement, absorb traffic growth due to population increase (both residential and commercial), and enhance safety by separating truck traffic from passenger vehicles.

Phase 2 is estimated for completion in 2025 and Phase 3 is estimated for completion in 2036. However, the Los Angeles County Metropolitan Transportation Authority (LA Metro) is currently considering a concept to accelerate the construction of Phase 2a by having vehicles with one (all hours) or two (peak hours only) passengers pay a toll to use the new lanes (i.e. launch them as HOT lanes rather than HOV lanes). The HOT lanes would be managed so that speeds do not fall below 45 miles per hour and the tolls would help raise the money needed to build the lanes sooner.

FIGURE 8: I-5 NORTH CAPACITY ENHANCEMENTS – EXAMPLE CROSS-SECTION



Source: LA Metro[9]

Dual-Dual Roadway, New Jersey Turnpike

A 32 mile segment of the New Jersey Turnpike was expanded to two separate roadways in the 1970s. It restricts the inner roadway to cars only, but allows cars, trucks, and buses to use the outer roadway, as shown in Figure 8 (Sisiopiku & Cavusoglu, 2011).

8 http://i-5info.com/antelope-valley-freeway-sr-14-to-pico-canyon-road/

9 http://www.metro.net/projects_studies/I5enhancements/images/I5_factsheet.pdf

FIGURE 8: DUAL-DUAL PORTION OF NEW JERSEY TURNPIKE

Source: Fitzpatrick, Brewer & Venglar, 2003

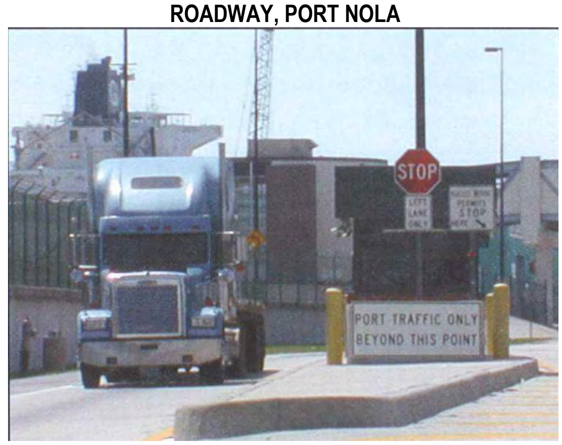
According to turnpike authority personnel, safety concerns and congestion on New Jersey roads led to the implementation of the dual-dual facility (Sisiopiku & Cavusoglu, 2011).The objective of the dual-dual roadway was to improve operations and safety by separating heavy vehicles from light vehicles and to increase capacity in the most heavily traveled section of the Turnpike. It was also intended to provide greater flexibility for using the roadway during periods of heavy congestion such as a major incident, since dynamic message sign (DMS) technology could be applied to warn approaching drivers and divert them to the less congested roadway. Similar geometric design criteria were used on each section of roadway to allow trucks to be on either side, if needed, during an incident or maintenance (Fitzpatrick, Brewer & Venglar, 2003).

In 2001, the total annual truck traffic volume on the New Jersey Turnpike was 27,649,048 vehicles, with an estimated rate of growth of truck traffic on the facility of 7 percent annually (Sisiopiku & Cavusoglu, 2011).

Tchoupitoulas Truckway, New Orleans, Louisiana

The Port of New Orleans, Louisiana, receives 70 percent of the cargo arriving in Louisiana, 80 percent of which is carried by trucks. As the two-lane, asphalt road to the Port deteriorated and the Port truck traffic began to spill into local neighborhoods (including historic districts) causing citizen concerns, the need to address traffic flow issues in the area became evident (FDOT, 2002). In 1983, the city restricted trucks from this historic area and built the Tchoupitoulas Truckway as an exclusive truck facility to address the needs of freight transportation (Sisiopiku & Cavusoglu, 2011).

FIGURE 9: MAIN ENTRANCE TO THE TCHOUPITOULAS ROADWAY, PORT NOLA



Source: FDOT, 2002

The facility is a 3.5 mile heavy duty roadway with one 12-ft. lane in each direction and 8-ft. shoulders on both sides. The truckway is able to handle 2,000 trucks per day with pavement that consists of 17½ inches of concrete and is comparable to airport runway specifications that accommodate the landing of 747 jets. The path of the roadway parallels the riverbank and includes a floodwall which also serves as a noise barrier for local neighborhoods and a security barrier for the port (FDOT, 2002).

The Tchoupitoulas truckway is free to enter, but only commercial vehicles or pre-approved vehicles on port-related business are passed through the security areas (see Figure 9). Access to the port roadway is limited to four points (two with 24-hour access), but only local deliveries are allowed access anywhere other than the east end of the facility. The port utilizes ITS technologies, including automated vehicle initiative (AVI) and optical container readers (FDOT, 2002).

Domestic - Planned Projects / Projects Under Study

Southern California Association of Governments (SCAG) Truck-Only Lanes (I-710 and SR 60)

The Southern California Association of Governments (SCAG) is working toward a system of truck-only lanes extending from the San Pedro Bay Ports to downtown Los Angeles along I-710, connecting to an east-west segment, and finally reaching I-15 in San Bernardino County. The system aims to address the growing truck traffic on core highways through the region and serve key goods movement industries while minimizing negative impacts on communities and the environment. According to SCAG, “truck-only freight corridors are effective, as they add capacity in congested corridors, improve truck operations and safety by separating trucks and autos, and provide a platform for the introduction and adoption of zero- and/or

FIGURE 9: STUDY AREA FOR THE I-710 CORRIDOR

Source: SCAG, 2012

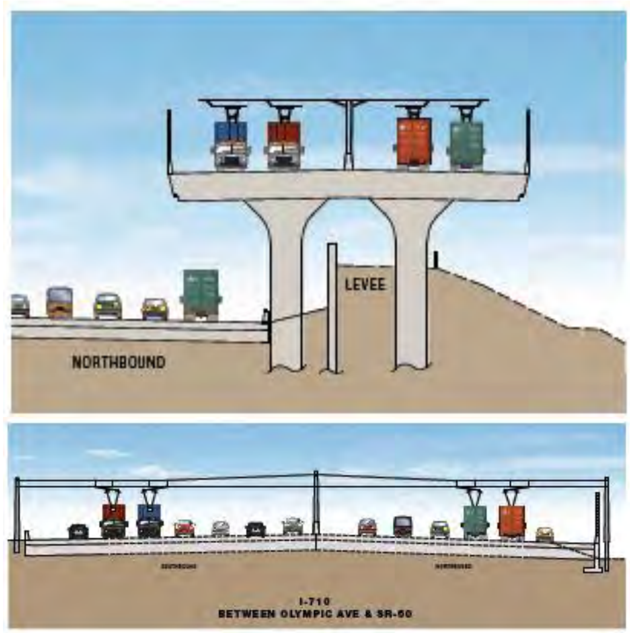
near zero emission technologies" (SCAG, 2012).

Progress toward a regional freight corridor system is underway – specifically the draft EIR/EIS for the I-710 segment was released in June 2012 and the recently adopted 2012–2035 RTP/SCS includes a refined concept for the SR 60 east-west corridor component of the system and connections to an initial segment of I-15. Each project is described briefly below.

I-710

The purpose of the I-710 Corridor Project is to 1) improve air quality & public health 2) improve traffic safety 3) modernize the freeway design 4) address projected traffic volumes, and 5) address projected growth in population, employment and activities related to goods movement (Caltrans and Los Angeles County MTA, 2012). Depending on the specific study corridor segment, average daily two-way truck volumes along the I-710 ranged from 10,300 to 42,100 (9 to 50 percent of total traffic volume) in 2008 and are projected to increase to between 20,100 to 74,400 (11 to 63 percent of total traffic volume) by 2035. Additionally, from 2004 to 2007, truck-related accidents in the study area ranged from 29 to 36 percent of the total number of accidents, which was higher than the State average (Caltrans and Los Angeles County MTA, 2012).

FIGURE 10: CROSS SECTIONS PROPOSED FOR I-710 UNDER ALTERNATIVES 6B AND 6C



While a preferred alternative has not yet been selected, the Draft EIR/EIS evaluated 4 Build and 1 No Build Alternative, including:

- Alternative 1: No Build
- Alternative 5A: I-710 Widening and Modernization
- Alternative 6A: I-710 Widening and Modernization, Plus a Freight Corridor
- Alternative 6B: I-710 Widening and Modernization, Plus a Zero-Emission Four-Lane Freight Corridor (Zero-Emission Vehicles)
- Alternative 6C: I-710 Widening and Modernization, Plus Tolled Freight Corridor

The freight corridor included in Alternative 6A includes a separated four-lane freight corridor that would be restricted to the exclusive use of heavy-duty trucks (5+ axles). The freight corridor would be both at-grade and on an elevated structure with two lanes in each direction and have exclusive, truck-only ingress and egress ramps to and/or from the freight corridor.

Alternative 6B would also include the freight corridor described above, but would restrict its use to zero-emission trucks rather than conventional trucks. This proposed zero-emission truck technology is assumed to consist of trucks powered by electric motors and produce zero tailpipe emissions. The zero-emission trucks would receive electric power while traveling along the freight corridor via an overhead catenary electric power distribution system. Alternative 6B also includes the assumption that all trucks using the freight corridor would have an automated control system that would steer, brake, and accelerate the trucks under computer control while traveling on the freight corridor. This would safely allow for trucks to travel in groups of 6–8 trucks to increase the capacity of the freight corridor.

Alternative 6C includes all of the components of Alternative 6B, but would also toll the trucks using the freight corridor. Tolls would be collected using electronic transponders, which would require overhead sign bridges and transponder readers (similar to the SR 91 toll lanes in Orange County) where no cash toll lanes are provided. The toll pricing structure would provide for collection of higher tolls during peak travel periods.

SR 60 - East-West Freight Corridor (EWFC)

The SCAG 2012–2035 RTP/SCS includes the creation of new, truck-only lanes near SR 60, that could fall anywhere within a five-mile span of the existing corridor, shown in Figure 11. The concept also includes an initial segment of I-15 that would connect to the EWFC and reach just north of I-10. Approximately 50 percent of the region's warehousing space and 25 percent of its manufacturing employment lies along the identified route. Truck traffic is projected to double on all east-west freeways by 2035 and traffic on SR-60 is expected to increase 115 percent without the project. The EWFC would carry

FIGURE 11: POTENTIAL EAST-WEST FREIGHT CORRIDORALONG SR 60

Source: SCAG 2012 – 2035 RTP

FIGURE 12: BENEFITS OF AN EAST-WEST CORRIDOR STRATEGY

Mobility	▪ Truck delay reduction of approximately 11% ▪ All traffic delay reduction of approximately 4.3% ▪ Reduces truck volumes on general purpose lanes—42–82% reduction on SR-60
Safety	▪ Reduced truck/automobile accidents (up to 20–30 per year on some segments)
Environment	▪ 100% zero-emission truck utilization removes 4.7 tons NOx, 0.16 tons $PM_{2.5}$, and 2,401 tons CO_2 daily (2.7–6% of region's total)
Community	▪ Preferred alignment has least impact on communities ▪ Removes traffic from other freeways ▪ Zero- and/or near- zero-emission technology (ZET)—reduces localized health impacts
Economic	▪ Supports mobility for goods movement industries, which comprise 34% of SCAG regional economy and jobs

Source: SCAG 2012 – 2035 RTP

between 58,000 and 70,000 clean trucks per day that would be removed from adjacent general purpose lanes and local arterial roads. The corridor is anticipated to have numerous benefits, as highlighted in Figure 12. Additional study of possible alignments will be conducted, including an alternatives analysis completed as part of a full environmental review.

I-70 Dedicated Truck Lanes

In 2011, the I-70 Dedicated Truck Lanes Feasibility Study Report was completed. This study looked at the opportunities, benefits, costs and risks associated with the construction and operation of dedicated truck lanes on approximately 800 miles of I-70 through Missouri, Illinois, Indiana and Ohio. The I-70 corridor, shown in Figure 13, is a key component of the freight supply chain connecting these states to national and global markets. Increasing congestion, capacity constraints, concerns about safety and potential loss in economic competitiveness are projected to continue to impact I-70 and adjacent facilities in the future. Depending on the specific study corridor segment, average daily traffic volumes for trucks ranged from 10,207 to 16,869 (18 to 34 percent of total traffic volume) in 2009 and are projected to increase to between 21,911 to 35,222 (20 to 35 percent of total traffic volume) by 2045. In 2009, the corridor experienced 10,444 crashes, 26 percent of which involved trucks. By 2045, the corridor is expected to have approximately 30,500 crashes, 59 percent of which would involve trucks. As truck traffic doubles under the No Build scenario, by 2045 total crashes are projected to triple, passenger vehicle crashes are projected to increase 50 percent and truck crashes are projected to increase almost 700 percent.

FIGURE 13: I-70 DEDICATED TRUCK LANES – STUDY CORRIDOR

Source: FHWA, 2011

The study findings confirmed that congestion and safety problems exist on the I-70 Corridor and that truck traffic contributes to these problems. Approximately 50 percent of the commodity movements on the corridor are within the corridor and most are for short distances where Class I freight rail is not competitive. Phase 1 of the study concluded that, due to the analysis of the return on investments and cost avoidance, there is a business case for dedicated truck lanes on I-70. The Phase 2 findings confirmed that dedicated truck lanes would benefit the regional economy and provide safety and congestion improvements significantly more than maintaining the I-70 Corridor in its current configuration or adding general purpose lanes (FHWA, 2011).

I-81 Variable Tolling for Trucks, Virginia DOT

Within Virginia, I-81 runs 325 miles from the Tennessee border northeast to the West Virginia border near Winchester, VA. Although the terrain is mountainous, the route is used by a large volume of interstate passenger vehicles, commercial trucks, and local traffic. The combination of mountainous alignment, large truck percentages, and increasing vehicle volumes in the I-81 corridor has led to numerous perceived safety and operational problems along the corridor (VDOT, 2006). Specifically, the highway was designed for 15 percent truck traffic; however, by 2005 trucks accounted for somewhere between 20 and 40 percent of total traffic (Rakha, Flintsch, Ahn, El-Shawarby & Arafeh, 2005).

Several lane management strategies were studied in 2005 using traffic simulation software, including the separation of heavy-duty trucks from light-duty traffic, the restriction of trucks to specific lanes, and the construction of climbing lanes at strategic locations. Overall, the study found that a physical separation of heavy-duty trucks from regular traffic would offer the maximum benefits and that restricting trucks from the use of the leftmost lane would offer the second-highest benefits in terms of efficiency, energy, and environmental impacts (Rakha, Flintsch, Ahn, El-Shawarby & Arafeh, 2005).

In 2006, the Virginia Department of Transportation (VDOT) completed a different study examining the potential effects of applying variable road pricing by time of day on I-81 to manage the demand for truck travel and encourage trucks to travel during off-peak hours (VDOT, 2006). The results of this study are summarized below:

- At best, variable pricing for trucks was estimated to result in modest daytime to overnight shifts in the range of 1 to 2 percent.
- The existing large volume of trucks using I-81 at night and the lack of a daytime peak meant that daytime variable tolls were not needed to spread truck traffic between peak periods.
- To effectively shift time of day truck usage patterns, it was found that the variable tolls would need to be supplemented with targeted incentives to encourage customers to change their goods shipping and receiving schedules. In the best case scenario, such initiatives could result in up to a 10 percent shift in truck trips from day time to overnight.
- Longer haul trips were estimated to be most likely to divert to parallel interstates, while shorter haul trips were estimated to be more likely to divert to local secondary roads (potentially causing the need for local truck bypass lanes). For trips throughout the entirety of the state, few available alternate routes meant that diversion would cause significant additional travel.
- Diversion to intermodal rail would have little impact on truck congestion on I-81 as the maximum estimated diversion rate of 6 percent would be offset by projected traffic growth increases within 3 years.
- High general toll levels were estimated to have significant negative impacts on the competitiveness of Virginia industries due to higher transportation costs. However, variable tolls were estimated to have lower economic impacts since a truck would only be shifted to overnight hours (rather than to other jurisdictions).

Ultimately the study recommended phasing implementation by starting with tolling at existing weigh stations and then moving to additional tolling through Open Road Toll gantries. Traditional toll plazas were not recommended due to problems associated with facility sizing and location choice, increased travel times, and high investment costs.

Georgia DOT Truck Lane Needs Identification Study

The first time trucks were restricted to right lanes in the United States (except to pass or to make a left-hand exit) was in Georgia in 1986. Twenty years later, Georgia's State Road and Tollway Authority considered constructing separate truck-only lanes as a measure to ease traffic congestion in the metro Atlanta region, and a statewide truck lane needs-identification study was completed. The study included the construction of truck-only lanes on I-75, I-85 North, I-20 West, and I-285 in metro Atlanta. It was found that, the introduction of truck-only lanes would shift truck traffic to those lanes from general-purpose lanes and, as a result, reduce congestion in the general purpose (GP) lanes. Moreover, a reduction in the number of crashes was projected (Sisiopiku & Cavusoglu, 2011).

City of Portland Sustainable Freight Action Plan

According to the Port of Portland Commodity Flow Forecast, demand for freight movement in Portland will double from 1997 to 2030 (City of Portland, 2012). Additionally, 67 percent of all freight in the region moves by truck at some point, which is projected to grow to 73 percent by 2030. In development of Portland's Sustainable Freight Strategy, representatives from companies or industries that produce, receive, and move products in Portland's Central City provided this input:

- Sustainability is directly associated with freight productivity and fewer trips and miles
- Freight carriers can reduce their carbon footprint by improving fleet performance
- Customers are already adapting their shipping/receiving schedules to avoid peak hours of traffic
- Restricting truck size does not necessarily lead to efficiency; one large truck can be more sustainable than multiple smaller trucks with respect to fuel use, emissions produced, and the number of on-street loading areas needed

While the focus of this strategy is on freight solutions within Portland's Central City, sample actions in the plan that could be relevant for solving freight-related congestion and air quality issues on San Diego freeways are listed below:

- **Off-hours Delivery:** Increase off-hour and night-time deliveries within the Central City and implement an off-hour delivery pilot program. Implement an education program for carriers and their customers to demonstrate how off-peak delivery programs can benefit them. Evaluate city code and related policies to identify potential barriers for off-hour/night-time deliveries (i.e., noise issues).
- **Electric-Hybrid Delivery Vehicles:** Tailor incentives to encourage electric/hybrid delivery vehicle use by private urban consolidation centers[10] that operate and serve in the Central City area.

[10] Urban consolidation centers are physical centers that perform break-bulk (inbound), load consolidation (outbound), stocking, customer collection, product handling, pricing/labeling, and waste removal/recycling. Their potential benefits (i.e., reduced heavy commercial trips in city centers, reduced pollution, noise and fuel

- **Multi-Modal Freight Strategies:** Coordinate with the MPO and Port to develop a regional rail strategy to identify needed infrastructure improvements and potential funding sources to improve both Class I and short-line rail service. Evaluate the feasibility of developing urban consolidation centers to allow small shippers competitive access to Class I rail services. Coordinate with Portland's planning and development agencies, and the Class I railroads to identify land use and zoning issues and potential public-private partnership opportunities.

Some of these strategies are already being implemented in San Diego. For example, the San Diego Airport Authority recently created a central receiving plant to eliminate truck traffic from Harbor Drive. Additionally, the Airport Authority recently mandated hybrid/electric vehicle conversion for taxis and delivery vehicles. These types of urban freight strategies may help to complement the freeway-based truck mobility strategies that are the focus of this study.

International

International truck lane projects, as summarized in Table 1, involve projects in England, Ireland, the Netherlands, and France, although implementation has been minimal (Transport Canada, 2011). The Port of Dublin, Ireland, built a 2.8 mile tunnel in 2006 to better connect the port with the regional highway network, but the tunnel now serves all vehicle types requiring tolls by time-of-day and type of vehicle. The Port of Rotterdam has two exclusive truck lanes which opened in 1993 and 1998. One is 3 miles in length and the other is 2 miles long, with both operating as single-lane truck roadways. There was a plan to open these lanes to a limited number of cars that would have paid a toll, but this plan was shelved in 1999. The government of France planned truck facilities as part of the A86 Paris (outer) ring road but, to date, those plans have not resulted in facilities for trucks only.

TABLE 1: SUMMARY OF INTERNATIONAL TRUCK LANE PROJECTS

Facility	Location	Length	Role	Comments
Truck lanes	London & Newcastle, UK	Varies – short	Freight facility access	All minor in length
Former truck-only tunnel	Port of Dublin, Ireland	2.8 miles	Freight facility access	Facility is now open to all traffic with tolls for passenger vehicles
Exclusive truck lanes	Port of Rotterdam, NL	2 miles & 3 miles	Freight facility access	Two facilities; proposals to allow toll access for cars
A86 west tunnel	Paris, France	4.3 miles	Rural corridor	Planned as truck lane - opened as a mixed-traffic facility

Source: Transport Canada, 2011

consumption) must be weighed against the additional costs (capital and operating costs of the consolidation center, additional handling stage in the supply chain, security, liability, customer service issues) (City of Portland, 2012).

Section 3: Literature Review

The following section provides a brief summary of the research documents and government reports reviewed as they relate to the use of trucks on managed lanes and truck management strategies. The review begins with national level reports, followed by studies local to the Southern California region. This is followed by a review of research generally related to managed lanes, dedicated truck lanes, tolls for trucks, truck lane restrictions, and perspectives of the trucking industry. Where findings are related to the topics presented in Exhibit 1 of the study's Scope of Work (market demand/user acceptance, timing, operations/safety, design/system compatibility, and policy), they are noted with the appropriate corresponding heading. Conclusions and a summary of the lessons learned from each study are provided in Table 3 at the end of this report.

National Level Studies

Transportation, Invest in our Future: Future Needs of the US Surface Transportation System (AASHTO, 2007)

This report is a general review of current trends in nation-wide transportation, including freight and trucks, and identifies future needs. It emphasizes the strong need to accommodate significant increases in truck traffic over the next few decades. "Truck tonnage is expected to increase 114 percent between 2004 and 2035. Today's Interstates carry an average of 10,500 trucks per day per mile. By 2035, this figure will increase to 22,700 trucks per day per mile." The report suggests implementing pricing to encourage trucks to use off-peak times to relieve congestion or building truck-only lanes.

Approaches to Mitigate Freight Congestion (US Government Accountability Office, 2008)

This report notes that FHWA has calculated that delays caused by highway bottlenecks cost the trucking industry more than $8 billion per year. The report describes the challenges to freight mobility in the U.S., including competition from non-freight projects for public funds and community support, lack of coordination between government and private stakeholders, and the lack of a clear federal strategy for freight transportation. Technologies and projects currently in place or in development that could improve freight mobility are examined, with a focus on solutions applicable to ports. One truck-related approach mentioned is truck-only lanes and the I-70 corridor study in the Midwest is cited as an example.

NCFRP Report 14: Guidebook for Understanding Urban Goods Movement (NCFRP, 2012)

This guidebook reviews how goods move about the country, including different types of carriers, supply chains, and different modes of transport. It also touches on the importance of reliability and time for the freight industry, explaining that more dense areas can cost businesses a lot of lost money in time and fuel from sitting in traffic. The report also contains a section on regulations regarding the movement of goods; however, it primarily focuses on local design elements such as parking, loading docks, intersection design, and restrictions on which roadways trucks may use within urban areas (residential streets, etc.), idling regulations, and truck size and weight. It does not discuss highways or managed lanes. This report would be useful for consideration of local truck circulation solutions within urban areas. They summarized their key findings as follows:

- Long-term planning for freight in urban development is essential.
- Harmonizing truck access and loading regulations along with enforcement strategies within and across regions can bring about significant efficiency savings to both the local community and logistics providers.
- Urban consolidation centers are a proven system for reducing freight vehicle impacts in urban centers and should be seriously considered as part of city planning.
- Altering access regulations to allow off-peak supply can help reduce the impacts of freight vehicles on urban centers.

Local Studies

San Diego and Imperial Valley Gateway Study (SANDAG, 2010)

This report is primarily concerned with forecasting freight volumes in San Diego and Imperial Counties through 2050. Trucks are the primary mode of freight transportation in the San Diego and Imperial County region, with a volume of almost 50 times the next largest mode (rail). The 2050 forecast predicts that trucks will continue to be the dominant mode of transportation, carrying over 96 percent of total freight volume, and that truck traffic will increase four-fold during that period. However, the report cautions that I-5, I-805 and I-15 are nearing capacity levels, and there is a lack of dedicated truck lanes, passing lanes and truck bypass routes.

Goods Movement in Southern California: The Challenge, the Opportunity, and the Solution (SCAG, 2005)

This report summarizes recent work done by the Southern California Association of Governments (SCAG) that focused on solutions to the issues of goods movement in Southern California, including facilitating Asian trade to benefit Southern California business and jobs. The report develops a model that quantifies (in dollars) the benefits of separate truck lanes based on both travel time savings and improved travel time reliability.

Market Demand/User Acceptance: In the scenarios investigated in the report, the value of time saved varies from $103 to $490 per trip. It is suggested that transportation firms can use this model to predict whether it would be worth it to invest in fees to use dedicated truck lanes (that would help repay the cost of building the system). If a toll of $0.86 per mile (in 2005 dollars) to use the truckway were assessed to repay the cost of building it, firms using it would earn a significant return on investment from the system with a speed and reliability cost savings from 5.4 to 11.1 times the fee per trip.

Managed Lane Studies

Building Flexibility into Managed Lanes: The Next Generation (Fuha, 2009)

This article advocates for the design of managed lanes that are flexible and adaptable based on changing traffic patterns, changing user demand, and likely technological changes. Overall, the report recommends agencies planning managed lane systems consider “big picture” questions, such as:

- Is retaining managed lane flexibility more prudent than designating a managed lane for just one use, such as HOV, HOT lanes or truck lanes?
- Should flexibility be built into the plan if the primary demand comes from and is projected to come from one user group?

In relation to the use of managed lanes by trucks, the report notes that flexible managed lanes could be made available with a prioritized hierarchy that reflects regional, state or federal policy. For example, in a large metropolitan area, weekday peak-period access to flexible managed lanes could be assigned according to a prioritized sequence, such as:

1. Buses
2. 3+ vans and carpools
3. 2-occupant carpools
4. Toll paying SOVs

Additionally, the report notes that during off-peak or non-commuting periods, pricing policy might allow or encourage lane availability to trucks, possibly at no charge, to induce such traffic away from less desirable routes, or charge a fee if there is a travel time advantage over other travel lanes and no attractive alternate routes. The report states that “designating managed lanes for exclusive use by trucks may be too limiting at certain times and in certain locations where flexible applications would yield greater overall benefits.”

The report provides the following examples of challenges experienced in jurisdictions when a managed lane project was adapted later for different functionality:

- Bus Transit to HOV. The El Monte HOV lanes were designed originally for an exclusive bus transitway system, with most access ramps running through transit centers and park-and-ride lots. The same focus on transit occurred on the Houston, Texas, transitway system. When officials realized that these lanes could also accommodate vanpools and carpools, simply opening them to these new users created safety and operational problems at the ramps.
- HOV to HOT. Modifying HOV lanes to accommodate pricing has impeded adoption due to the larger number of vehicles traveling the lanes and potentially clogging access through transit facilities. When the operation policy was changed for Denver, Colorado’s, I-25 Denver HOT lane project to allow SOVs to use the HOV lanes, the downtown oriented access ramps had to be lengthened and modified to account for the added volume of traffic.

The report suggests that these challenges would have been easier to address if the managed lane facility had been designed in accordance with prevailing design standards for general traffic use and full lane capacity, regardless of the intended use.

Design/System Compatibility: To facilitate the implementation of flexible managed lanes, the author suggests structuring the environmental assessment process for a broad umbrella of strategies, even prior to determining access locations, user mix preferences, or pricing policies. The author states that this approach would allow for more flexibility than recommending one particular type of managed lane, such as an HOV or a tolling alternative. One example provided is the I-10 (Katy Freeway) in Houston, Texas, where the lanes were called "special use lanes" during the environmental process. A supplemental document was filed in the course of design when the operational strategy and specifics were known.

The report states that while detailed design requirements must be addressed case by case, there are no compelling physical or operational barriers that would negate the consideration of flexible managed lanes that serve an array of potential users. The following are examples of considerations that should be made for different types of vehicles:

- Passenger vehicles. Single-direction lanes are acceptable where optimum free-flow is typically in the 45 to 50 mph (65 to 80 km/h) range.
- Trucks. Opportunities for passing need to be provided where grades or lengths of several miles or longer are involved. Allowing truck drivers to use full-depth traffic bearing shoulders may be a way around the need for additional dedicated passing lanes.

Dedicated Truck Lane Studies

Dedicated Truck Lanes as a Solution to Capacity and Safety Issues on Interstate Highway Corridors (Burke, 2005)

This paper focuses on the I-80 corridor in Iowa and how to address capacity and safety issues, while staying within a reasonable budget. The alternatives identified include:

- Adding a new travel lane in each direction,
- Adding an additional unrestricted through lane,
- Upgrading US Hwy 30 (a parallel route to I-80) by adding two lanes of traffic,
- Incorporating lane restrictions, and
- Truck-only lanes – the report notes that "dedicated trucks lanes achieve optimum feasibility when truck volumes exceed 30 percent of the total vehicle mix, peak hour volumes exceed 1,800 vehicles per lane-hour, and off-peak volumes exceed 1,200 vehicles per lane hour."

Design/System Compatibility: The author focuses on truck-only lane design, and notes that truck-only lanes could be separated by a barrier, built with the median of existing highways, and have separate entry/exit ramps. Additional key features include:

- The need for adequate space for deceleration and lane changes, as well as a passing and/or breakdown lane
- The pavement and structures for the designated truck lanes could be stronger and more durable than typical pavement
- Transponders could be used for tolling (to collect information on VMT, weight, and size, etc)
- Allowing Longer Combination Vehicles (LCVs) [11] could increase demand for the truck lanes, and help reduce fuel consumption and emissions

Examine the Transportation Efficiency of Truck Lanes (Transport Canada, 2011)

This report provides an overview of research on truck lanes around the world and how the research could apply within the specific context of the Highway 20/ 401 corridor in the Continental Gateway in Canada (Quebec and Ontario). The report reviews U.S. implemented projects; U.S. corridor and planning studies; academic and policy studies; and international truck lane projects. The review of case studies found that the primary objectives of truck lane projects are improvements in safety and enhanced mobility for both goods and people. Another common motivation is increased productivity, particularly in cases where LCVs could be legalized on truck lanes. Table 2 contains a summary of advantages and disadvantages of truck lanes for different users and categories.

The report suggests that while there is no consensus, the overall economic benefits of truck lanes outweigh the costs, once you take into account safety, travel time savings, and productivity enhancements.

Timing/Criteria: The report notes that truck volumes are usually the main determining factor in evaluating the need for truck lanes. Key findings in the report from studies regarding criteria for implementing truck lanes are below:

- Implementing exclusive truck facilities can have several benefits "where corridors are highly congested and truck volumes are sufficiently high (greater than 20,000 daily).
- The Florida DOT model uses weights of each of the following variables: truck volume (75 percent), truck percentages (5 percent), truck crashes (5 percent), and highway level-of-service (15 percent).
- One study recommends that preliminary screening for truck lanes include locations with average daily traffic of 100,000 vehicles per day (both directions) with at least 25 percent trucks on four lanes. The corresponding LOS would be "E" for urban areas and "F" for rural areas."

Costs: Additionally, the report reviewed several projects that evaluated the use of tolls to cover a portion of the costs of a truck lane facility. The report found that only the New Jersey Turnpike has successfully generated sufficient toll revenue to cover operating costs.

[11] Longer combination vehicles are tractor-trailer combinations with two or more trailers that may exceed 80,000 pounds gross vehicle weight (GVW). LCVs are not allowed on California interstates and State routes, though they are allowed to operate on local streets and roads with permits from local jurisdictions.

However, the New Jersey Turnpike does not operate as an exclusive truck roadway, and its success is thought to come from its uniqueness in serving a corridor that has few other viable options. Revenues from operating truck lanes in congested urban areas that can be reliably counted on will likely fund only about half of their construction, maintenance, and operation costs in the best of cases. While separated lanes are ideal for safety, they can be cost prohibitive, and truck lane concepts that reapportion existing lanes would show much better financial performance due to the significantly lower capital costs involved.

TABLE 2: LITERATURE-SUPPORTED ADVANTAGES AND DISADVANTAGES OF TRUCK LANES AND SECTORS AFFECTED

	Expected Advantages	Disadvantages & Cautions
Safety	• Reduced number of crashes (T,C,S) • Reduced fatalities (T,C,S) • Reduced or stable vehicle conflicts (with possible corresponding impact on crashes) (T,C) • Safety enhancements on facilities with dedicated access ramps to TLs (T,C)	• Some analyses pointing to little safety improvement (T,C,S) • Disturbances in weaving areas when trucks restricted to right lane (T,C)
Goods & People Mobility	• Cars are not impeded by slower moving trucks resulting in higher speeds in car only lanes (C) • Congestion from passenger car traffic or incidents does not impede truck (T) • 2 lane TLs are found to be preferred to a 1 lane TL for operational flexibility. (T,C,S)	• Underutilization of truck lane capacity can be problematic, both in real terms and in public perceptions, if passenger car lanes are congested (C) • Limited access points to truck lanes significantly reduce demand (T)
Infrastructure Cost	• Decrease in pavement deterioration rate on highways, both on general purpose lanes, and on truck lanes if pavement is designed to higher load standards(S)	• Construction costs not necessarily reduced because all lanes may be built to the same standards to accommodate trucks diverting from TLs due to incidents or maintenance (S) • More segregated lanes are required to achieve the same level of service as general purpose lanes (S)
Productivity	• If truck lanes are linked to allowing long combination vehicles, significant productivity increases could be achieved where these vehicles are currently restricted (T) • Reduced truck travel times and increased travel time reliability can lead to increased productivity (see mobility above) (T)	• Productivity benefits may not be as pronounced in Canada as predicted for the United States, because Canadian truck weight restrictions are already less stringent than those in the US (T) • Mandatory tolled truck lanes leading to lower productivity when toll outweighs operating savings is a reason for lack of industry support (T) • Productivity decreases for commuters if TLs implemented through conversion of general purpose lanes (C)
Revenue Generation	• New Jersey Turnpike, financed primarily through tolls, is a financial success. The Turnpike is unique due to its long length and limited availability of route alternatives (S) • A basic tolled truck way estimated to need 2-4000 trucks per day to be self-supporting (S) • Congestion pricing is an option (S)	• Tolls not projected to cover construction costs of SR-60 (S) • I-81 corridor in Virginia received opposition from trucking industry as a result of tolls (S)
Land Use/ Accessibility	• Truck lanes provide better travel time accessibility for land closest to truck lane access points near the corridor (T) • Connector role improves efficiency of access to major truck traffic generators.	• Little, if any, accessibility improvement for households (C)
Social Environmental	• Reduced stop and go from truck lanes can reduce truck emissions (S) • If truck lanes are linked to allowing longer combination vehicles, use less fuel and produce fewer emissions to move the same amount of goods than smaller trucks (S)	• Diversion of trucks to new corridors would involve diversion of emissions, noise and vibration (S) • Mode shift from intermodal rail to truck may occur as a result of improved truck lane reliability, leading to increased emissions and fuel consumption. (S)

Advantage/Disadvantage is experienced by (T) trucking industry, (C) passenger car drivers, (R) rail industry, (S) society/government

Source: Transport Canada, 2011

NCHRP Report 649 / NCFRP Report 3: Separation of Vehicles—CMV-Only Lanes (NCHRP and NCFRP, 2010)

This report contains a vast amount of information about implementing Commercial Motor Vehicle (CMV)-only lanes[12] as a method for decreasing congestion and increasing safety. It presents a review and discussion of a wide range of issues relevant to planning, designing, and evaluating CMV-only lanes, provides a comparative evaluation of the performance of a number of CMV-only lane studies, and includes an Appendix with a compendium of CMV-only lane development information. The report also discusses planning and process issues related to CMV-only lanes, configuration and design issues, integration with ITS, LCV operations, and tolling and privatization.

[12] The report uses the term “CMV-only” lanes interchangeably with the term “truck-only” lanes.

The report draws together the results of a number of different studies that all concluded that truck-only lanes of different configurations provide positive benefits and may be a preferred choice for improvements in both long-haul corridors and urban corridors. However, the report caveats that using standard travel demand models for evaluating CMV-only lanes can have some problems (such as not taking into account safety and reliability benefits) and mentions that simulation models may be a more useful and reliable method. Despite this shortcoming in many of the studies assessed, the report notes that the performance evaluations generally demonstrated that in corridors with high volumes of truck traffic, truck-only lanes would provide benefits to both freight users and non-freight users (who would continue to use mixed-flow facilities). While the report does not define what is meant by “high volume”, it does offer key quantitative factors that should be considered in assessing the feasibility of truck-only lanes (described further in the Timing/Criteria section below). The report notes that common alternatives considered when evaluating CMV-only lanes as part of a study include equivalent capacity in multipurpose lanes, CMV-only lanes with and without LCV operations and/or tolling, HOV/HOT lanes or other types of special purpose lanes, and increased rail capacity. The report also notes that stakeholders, in particular the trucking industry, should be involved in planning CMV-only lanes (especially in regards to issues such as tolling).

Some key findings in the report related to truck-only lanes in long haul intercity corridors include:

- Trucking productivity can potentially be improved due to increased average truck speeds and the potential to allow LCVs (which can increase productivity due to increased payloads). Specific examples of benefits from various case studies are provided in the report.
- The separation of autos from truck traffic on long-haul intercity corridors can reduce accident-rates and improve safety by reducing auto-truck conflicts. Two studies showed accident rate reductions ranging from 44 to 47 percent.
- In selecting potential corridors, the highest priority should be given to corridors that do not have rail service or that have very congested rail systems. In these cases, it is appropriate to look at the tradeoffs between adding new LCV lanes and investments in rail systems.

Some key findings in the report related to truck-only lanes in urban corridors include:

- Results consistently indicate that truck-only lanes have higher safety benefits compared to mixed-flow lanes. However, the results are inconclusive in understanding the “true” incremental safety benefits of truck lanes because of methodological limitations discussed further in the report.
- The addition of a truck-only lane will only provide mobility benefits over the addition of a general purpose lane if it diverts a significant amount of truck traffic from the GP lanes to the truck-only lane during congested peak periods. However, current assessments are typically based on daily models, which do not consider differences in time-of-day distributions of trucks and autos, which is critical for a true understanding mobility impacts. The authors note that, assuming future modeling improvements, the mobility

benefits of truck-only lanes for the general public (autos), rather than for trucking companies, may be the strongest selling point to policy makers.

- In areas around ports and intermodal terminals, studies show that new truck routes or truck-only lanes can relieve pressure on mixed-flow freeways by providing alternative routes that are better aligned with existing and forecasted truck flows. Truck-only lanes are often more effective in providing relief in these situations than adding general purpose capacity because the truck-only lanes can be designed to meet the specific routing needs of trucks accessing port and intermodal facilities.

Additional key findings in the report related to timing/criteria, costs, and market demand/user acceptance are summarized below:

Timing/Criteria: The report notes that the feasibility of implementing truck-only lanes on urban corridors is a direct function of corridor demand and system characteristics, including:

- truck and auto traffic volumes,
- the percentage of trucks,
- time-of-day variations in truck and auto traffic volumes, and
- contribution of truck traffic to peak-period congestion,
- truck routing and O-D patterns,
- length of corridor
- number of lanes

The study provides a review of quantitative thresholds that numerous studies have recommended for use when screening potential corridors for CMV-only lane projects. Such thresholds can help ensure that CMV-only lanes provide meaningful benefits, such as travel time savings and improved travel time reliability for facility users. While conditions in the field can be difficult to quantify, the use of thresholds can help planners gauge, at a high level, whether the region’s conditions warrant the concept. The following CMV-only lane planning thresholds are cited in the report:

- Mainline Volumes
    - Peak hour > 1,800 vehicles per hour per lane (vphpl) (Janson)
    - Off-peak hour > 1,200 vphpl (Janson)
    - Two-way average daily traffic (ADT) > 120,000 OR at least 15,000 per lane (Douglas[13])
    - ADT > 100,000 (Battelle)
- Heavy Truck Volumes
    - Two-way average daily traffic (ADT) > 20,000 for 10 miles OR the corridor should provide access to major freight generators at the termini (Douglas)

[13] J. G. Douglas, *Handbook for Planning Truck Facilities on Urban Highways*, August 2004.

- Heavy Vehicle Percentage
  - > 30 percent (Janson)
  - 25 percent trucks (Battelle)
- Lane configuration
  - At least two general purpose lanes and two truck-only lanes in each direction (Douglas)

The report also notes that cost-benefit analyses showed that truck diversion rates to truck-only lanes of 50 to 85 percent would be needed to make truck-only lanes a viable alternative and that diversion rates of 60 to 70 percent would be best since 80 percent and above begin to produce congestion on truck-only lanes. Additional benefit-cost analysis findings are provided in the report.

Costs: The report included estimated baseline cost components for both long-haul and urban corridor alternatives, which are summarized below for reference:

- Total baseline costs for long haul corridor alternatives (2008 dollars):
  - $5.8 billion for adding additional mixed-flow lanes
  - $10.5 billion for truck-only lanes
  - $11.2 billion for truck-only lanes that include LCV operations
- Total baseline costs for urban corridor alternatives (2008 dollars):
  - $800 million for mixed-flow lanes
  - $1 billion for truck-only lanes (without LCV)

Market Demand/User Acceptance: The report also notes that a number of studies have suggested that tolling CMV-only lanes may present a viable means of financing system capacity improvements, since trucks have a higher value of time than autos (and may therefore be willing to pay a higher price for congestion relief). Key findings in the report related to the tolling of truck-only lanes in urban corridors include:

- The performance of truck-only lanes is a direct function of truck diversion (from general purpose to truck-only lanes), and tolls can directly impact the level of truck diversion (when the usage of truck-only lanes is voluntary).
- For tolled urban corridors, the highest diversion from GP lanes to truck-only lanes occurs under the no-toll scenario: 50 to 90 percent of total truck traffic along the corridor; A toll of $0.07 per mile drops the estimated diversion rate to 30 to 70 percent, and a toll of $0.15 per mile drops the diversion rate further to 10 to 30 percent.

The report suggests that variable tolling could work to “maximize the truck diversion, utilization, and revenue potential of truck lanes along corridors with varying congestion, and truck and auto volume characteristics by time of day.”

Evaluating Designated Truck Lane Strategies for an Urban Freeway Corridor (Sisiopiku & Cavusoglu, 2011)

This study examines the potential role of truck lane strategies in addressing traffic congestion issues in Birmingham, Alabama, specifically on a section of I-65 extending from I-459 to I-20/59. The paper investigates the potential operational impacts from implementing various truck lanes scenarios using VISTA – a traffic simulation and modeling tool. Strategies examined included adding a general purpose lane, adding a new shared-use truck lane, adding a new exclusive truck-lane, converting an existing lane to a shared-use truck-lane, and converting an existing lane to an exclusive truck-lane. The study noted that truck management strategies should be chosen with consideration of the availability of right of way (ROW), local travel patterns, geometric characteristics of the roadway of interest, and capital and operational cost considerations. The study concluded that the optimal strategy for the area would be the conversion of one existing general purpose lane to a shared-use truck lane, based on the following findings:

- A general purpose lane conversion to a truck lane is only justified where truck volumes represent at least 12 percent of total traffic volumes.
- The performance of the exclusive truck lane option improves as the percentage of truck users increases.
- Dedicated truck lanes work better under the shared traffic option (i.e., when cars are allowed to use the truck lane) rather than the exclusive truck-use option.
- The addition of a lane improves the network performance; however, designation of the added lane as a truck lane had little to no impact on traffic operations.

Design/System Compatibility: The article also provides the following design considerations for truck lane facilities:

- Trucks tend to follow each other closely, causing signs to be blocked by the lead vehicle. The placement of traffic signs should be considered carefully to enhance visibility.
- Differences in acceleration rates, stopping distances, weaving capabilities, and roll stability are special characteristics of trucks that cause them to behave differently than other modes. Separating trucks from other traffic spatially and/or by time of day can alleviate auto/truck conflicts.

Dedicated Truck Lanes: An Innovative Way Forward (Bucklew, 2012)

This article reviews existing literature addressing the concept of dedicated truck lanes, including a summary of safety and congestion issues. Safety and congestion issues that could potentially be addressed by dedicated truck lanes include crashes involving large trucks, irregular traffic flow caused by differential acceleration/deceleration rates of cars and trucks, and the impacts of vehicle weight on pavement life cycle. Additional benefits could include improved air quality, and less fuel consumption resulting in a reduced carbon footprint. Some potential issues related to dedicated truck lanes discussed in the article include complex and time-consuming funding arrangements and agreements, the need for right-of-way acquisition, environmental challenges and bridge design.

Costs: The author discusses the I-70 Dedicated Truck Lanes Feasibility Study as evidence that dedicated truck lanes can be financially feasible, highlighting a return on investment, cost avoidance, and business benefits. However, the author suggests that traditional funding mechanisms are inadequate for most new large corridor projects, and that public-private partnerships could provide a solution. New technology that could provide efficient and cost-effective solutions is discussed, including managed lanes, information technology and intelligent transportation systems (ITS). The author describes using wireless technology to create virtual dedicated truck lanes along corridors with significant truck volumes as an example.

The Potential for Reserved Truck Lanes and Truckways in Florida (FDOT, 2002)

This report summarizes the current literature on the topic as of 2002. At that time most research showed that truckways were not merited due to limited truck volumes and/or high cost. A methodology was developed and a GIS model was used to identify locations that could be suitable for an exclusive truck facility. The model identified "hot spots" based on truck-related crashes; truck volumes; percentage of trucks; highway level of service; proximity to airports; proximity to seaports; and proximity to other intermodal facilities.

The report describes the corridors in Florida identified by the model and suggests the following strategies: constructing signed and striped trucked lanes, median truck lanes, reducing tolls on toll roads for trucks, and making existing HOV lanes available in the off-peak hours to trucks only. In relation to the latter strategy, the report cites a 1996 WashDOT study that used a traffic simulation model to assess cooperative (trucks sharing with buses and/or HOV) and exclusive (truck-only) lane strategies in the Seattle metropolitan area. The study found that time, miles, and money could potentially be saved when trucks are allowed to share the underutilized HOV lanes with cars and buses. The report also recommends further analysis of the economic trade-off related to the high cost of providing truck lanes and the potential savings due to safety improvements and less pavement damage on "non-truck" routes.

Tolling Studies

White Paper #7: Truck-only Toll (TOT) Lanes (ODOT, 2009)

This paper discusses the potential for truck-only toll (TOT) lanes in Oregon. It reviews proposed TOT lanes throughout the nation (as of 2009) and examines issues including design and configuration, estimating market demand, and financial feasibility. Key findings from the report are described below:

Design/System Compatibility: TOT lanes must be designed to accommodate heavier loads, provide staging areas for assembling and disassembling LCVs, and on/off ramps must allow heavy vehicles safe access to and from highway facilities. ROW requirements must be considered to provide an adequate cross-sectional configuration.

Market Demand/User Acceptance: The extent to which trucks will be attracted to TOT lanes depends on the relationship between the value that truckers get from the facility and the price being charged.

- **Long Haul:** In long-distance TOT configurations, the main value to truckers comes from allowing LCV on the toll lanes, thereby providing productivity benefits for the special lanes. If the toll rate is set so that the increased productivity exceeds the value of the toll, some truckers may be attracted to the new lanes. Also, long-distance trucks may see little benefit to time savings for distances that are only a small percentage of the total travel time of the trip.
- **Urban:** For urban TOT lanes, the value of the lane derives from the opportunity for a truck to reduce travel time and improve travel-time reliability by avoiding congestion. Because trucks tend to operate all day, but auto use tends to peak during morning and evening commute periods, one potential issue is that urban TOT lanes will be unlikely to attract truck traffic during off-peak automobile periods.

Financial: Feasibility of TOT lanes must be determined on a case-by-case basis. For urban TOT lanes, the costs of construction are likely to be high and the revenue potential limited to a few hours of the day.

When Should We Provide Separate Auto and Truck Roadways? (International Transport Forum, 2009)

This paper examines the general benefits and potential uses of separate lanes for automobiles and trucks. Two options for separate truck lanes are discussed, untolled and tolled. Truck-only toll lanes and roads have been studied and found to be potentially feasible. The study discusses the I-70 corridor as an example. The study develops arguments for toll truck highways, including:

1. Productivity gains due to truckers being able to haul more freight payload per unit of fuel and drive cost.
2. Operating and maintenance cost savings due to shifting heavier truck traffic to lanes designed with pavements that can withstand higher weights, which can reduce the cost of maintenance costs on other lanes.

Another benefit discussed in the report is that car-only lanes could be designed to different standards because they do not have to accommodate the height and weight of trucks.

Guide for Geometric Design and Operational Factors That Impact Truck Use of Toll Roads (Poe, 2010)

This article is a guide for geometric design of toll roads that helps identify factors that can impact truck use. The article refers to the toll roads in Texas, most notably in congested urban areas, such as Austin, Dallas, and Houston. The article argues that if toll roads and managed lanes can be constructed to better serve truck operations and increase safety for truck drivers, then these facilities will be more attractive to the trucking industry. The article points out that truck use of toll roads or managed lanes could also result in the following benefits:

- A reduction in truck travel times, improving freight movement efficiency
- More predictable travel times, allowing expansion of just-in-time delivery options
- An improvement in domestic and international competitiveness

- The maintenance of consumer goods pricing
- A reduction in truck idle time due to congestion, which would reduce fuel consumption and improve air quality
- An improvement in facility capacity by removing many trucks from the general purpose lanes and making better use of toll or managed lanes
- A reduction in incident impacts (fewer lanes blocked, easier to access and clear) by concentrating trucks to a designated lane
- A reduction in pavement rehabilitation costs by concentrating heavy loads in a single lane (i.e., only a single lane would have to be rehabilitated and this lane could eventually be reconstructed for additional strength); and
- A more comfortable driving environment for those intimidated by driving near trucks.

Design/System Compatibility: The report makes the following geometric design recommendations for consideration by highway designers focused on the design of toll roads and managed lanes to accommodate trucks:

- Thoughtfully select design speed for mainlane roadways, ramps, and interchanges
- Use low maximum grades on vertical alignment
- Include climbing lanes to minimize truck loss of speed and potential speed differentials
- Avoid use of long downgrades
- Increase the lengths of vertical curves to increase sight distance for truck drivers
- Lengthen acceleration lanes from entrance ramps to provide trucks adequate space to reach mainline design speeds
- Lengthen deceleration lanes to exit ramps to allow trucks to fully exit before decreasing speeds from mainline design speeds

Operations/Safety: The report offers the following traffic engineering and transportation operational recommendations for consideration of trucks in the design of toll roads and managed lanes:

- Give proper consideration of the truck demand and truck classes expected to use a toll road or managed lane
- Use static dual speed curve warning signs to alert truck drivers to the appropriate speed in negotiating ramps and direction connections
- Provide informational signing and variable message signing in proper placement for better visibility for large trucks
- Use continuous, longitudinal rumble strips to assist in alerting truck drivers to the edge lines of traveled ways
- Use barrier curve delineation systems on curves needing special attention from truck drivers to negotiating ramps and direct connections

Another potential factor that can attract truck drivers described in the report is a strong incident management program. As an example, the report describes the North Texas

Tollway Authority's automated incident detection system (called "NICE"), which identifies roadway conditions, including stalled vehicles and/or debris in the roadway.

Truck Lane Restriction Studies

Identifying the Impact of Truck-lane Restriction Strategies on Traffic Flow and Safety Using Simulation (Liu & Garber, 2007)

This study evaluated the impact of different truck lane restriction strategies on operational performance. The study presents recommended truck lane restriction configurations based on a facility's number of lanes, traffic volumes, and the percentage of trucks.

Operations/Safety: The measure of effectiveness used in the study to evaluate the impact of different lane restrictions on operational performance was the frequency of conflicts based on lane changes, average speeds, speed distribution, and volume distribution. Due to the lack of existing highway locations with different lane restrictions, a traffic simulation tool was used (PARAMICS V3.0) to conduct the analysis. The effectiveness of different lane restrictions was evaluated for 14,400 different simulation scenarios with varying lane restriction strategies, traffic conditions (volume, truck percentage) and geometric characteristics (gradient, speed limit, interchange density). The following criteria were used as guidelines for the application of truck lane restrictions based on the results from both the safety and operational analyses:

- A truck lane restriction should provide a traffic situation of LOS C or better on a restricted lane, and LOS D or better on an unrestricted lane
- If the LOS has been as low as E, no restriction should be applied
- There should be no significant increase in frequency of merging conflict
- There should be a significant decrease in lane-changing conflict or rear-end conflict
- Reducing lane-changing conflicts has a higher priority than reducing rear-end conflicts in deciding the application of lane restrictions when there is a conflict between the influences of the lane restriction on them

FIGURE 14: COMPREHENSIVE TRUCK LANE RESTRICTION RECOMMENDATIONS

(a) 3-lane freeway section

Volume (vphpl)	Truck Percentage (%)				
	5	15	25	40	50
<100	NA	NA	NA	NA	NA
100 - 500	NA	NA	NA	R2/3	R2/3
500 - 1000	R2/3	R2/3	R1/3	R1/3	R0/3
1000 - 1500	R2/3	R1/3	R0/3	R0/3	R0/3
1500 - 2000	R0/3	R0/3	R0/3	R0/3	R0/3

(b) 4-lane freeway section

Volume (vphpl)	Truck Percentage (%)				
	5	15	25	40	50
<100	NA	NA	NA	NA	NA
100 - 500	NA	NA	NA	R3/4	R3/4
500 - 1000	R3/4	R3/4	R2/4	R1/4	R1/4
1000 - 1500	R1/4	R1/4	R0/4	R0/4	R0/4
1500 - 2000	R0/4	R0/4	R0/4	R0/4	R0/4

(c) 5-lane freeway section

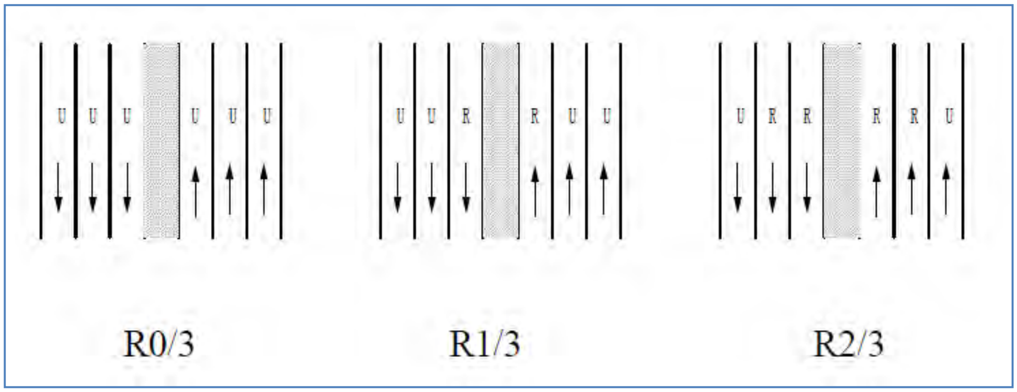
Volume (vphpl)	Truck Percentage (%)				
	5	15	25	40	50
<100	NA	NA	NA	NA	NA
100 - 500	NA	NA	NA	R3/5	R3/5
500 - 1000	R4/5	R3/5	R2/5	R2/5	R1/5
1000 - 1500	R1/5	R0/5	R0/5	R0/5	R0/5
1500 - 2000	R0/5	R0/5	R0/5	R0/5	R0/5

Source: (Liu & Garber, 2007)

Using the above criteria, the truck lane restrictions shown in Figure 14 are recommended by the report, based on truck percentages and total traffic volumes on 3- to 5-lane freeway sections.

Note that Rn/N means restricting truck from using the n leftmost lanes on N-lane (in each direction). An example for a 3-lane section is provided in Figure 15, where "R" represents a truck-restricted lane (e.g. trucks are restricted from using such lanes, and a "U" represents a non-truck-restricted lane (e.g. trucks are allowed to use such lanes).

FIGURE 15: EXAMPLE TRUCK LANE RESTRICTION SCENARIOS



Source: (Liu & Garber, 2007)

The findings in this study are relevant to the San Diego region for better understanding the conditions under which variations in truck lane restrictions might serve as beneficial truck management strategies.[14]

Perspectives of the Trucking Industry

Documentation analyzing or addressing the use of managed lanes by trucks is not readily available through publicly accessible trucking industry organizations or their web-based document archives. Very brief commentary supporting off-peak general traffic access and other creative uses of HOV lanes has been expressed by the trucking industry in California, via the California Trucking Association Facebook page. Other trucking industry association pages also indicate that, in general, the industry is aware of current federal and state regulations prohibiting the use of HOV or HOT lanes by any vehicle that is towing a trailer, has three or more axles, or is restricted for any other reason to the 55 MPH speed limit in California and other states. However, the position of the trucking industry and other freight industry stakeholders has not been expressed through accessible publications to date, and will be further explored during discussions with industry representatives during the interviews for this project.

However, studies have been conducted to assess the perspectives of the trucking industry on tolling, two of which are summarized below. Additionally the American Trucking

[14] Due to current California law (CVC Section 22406 & 21655), any changes to existing truck lane restrictions would first require changes to state legislation.

Association has issued a position paper on this topic stating that the organization opposes the imposition of tolls on existing lanes of interstate highways, other than HOV lanes.[15]

NCHRP Web-Only Document 185 / NCFRP Web-Only Document 3: Truck Tolling: Understanding Industry Tradeoffs when Using or Avoiding Toll Facilities (NCHRP and NCFRP, 2011)

This report discusses the findings of a study to determine the value that shippers, trucking companies, and truck drivers seek from toll roads. A profile of the trucking business was developed, including shippers, trucking companies, and third party logistic service providers. Then, a research team conducted interviews with these businesses and distributed an internet survey to industry representatives to gather statistically valid findings of their willingness to pay for toll roads, given specific parameters for the value they would receive in time savings. There were 965 respondents to the internet survey and more than 200 interviews conducted as part of the study.

Market Demand/User Acceptance: The study concluded that across all segments of the trucking industry—including different types of drivers, and different types of trucking operations—there are overwhelmingly negative attitudes about toll roads and an extremely low willingness to pay even a token toll for different time savings scenarios. The research found that because respondents had such overwhelmingly negative attitudes about toll roads, they were not able to ascribe a true value to the benefits that toll roads provide. Where some drivers did express a willingness to pay for toll roads, the reasons seemed to be that they were familiar with toll roads or could clearly see the time savings benefits of a toll road in certain situations. The broad conclusion was that toll roads are viewed negatively because a large cross section of the trucking industry is not monetizing the benefits of toll roads to their business.

The report concludes with the following recommendations for helping to overcome the opposition to toll roads by different segments of the freight industry:

- **"Transition" to Toll Facilities for Trucking Companies:** The report found that there is greater acceptance of toll facilities, where the trucking industry has more familiarity with them—either in driving in urban environments with toll roads, or when they have the opportunity to use them on a regular basis. A potential solution would be to develop a transition period to "ramp up" tolls on new facilities over five to 10 years to enhance familiarity and comfort with them.
- **Offering Additional Value over the Status Quo:** The report found that both the general public and trucking companies do not want to pay tolls for highways that they once received for "free." Providing clearer value for-money for trucking companies by developing toll roads with higher weight limits and/or that allow longer combination vehicles could make toll roads attractive to trucking companies.
- **Toll Policy Awareness, Education and Outreach:** The report found that there is a clear need and opportunity to communicate the benefits of toll facility finance and that this could help enhance acceptance of tolling. The benefits of toll finance are cited as faster

[15] http://www.truckline.com/AdvIssues/HighwayInf_Fund/Tolls/Issue%20Paper%20-%20Tolls%20on%20the%20Interstate%20System.pdf

and more certain delivery of critical infrastructure, congestion relief, more expansive truck service facilities, and higher weight limits and allowance for longer combination vehicles.

Exploring Truck Driver Perceptions and Preferences: Congestion and Conflict, Managed Lanes, and Tolls (Adelakun & Cherry, 2009)

This paper focuses on identifying perceptions of truck drivers on urban congestion and safety challenges and gauges their interest in potential geometric or operational solutions. The study surveyed 500 long-haul truck drivers in Knoxville, Tennessee.

Market Demand/User Acceptance: The key findings are related to market demand/user acceptance and are summarized below:

- The most problematic factors on Knoxville's urban highways were identified as: aggressive drivers, congestion, car lane changing behavior, and merging vehicles.
- Most respondents supported moving truck lanes to the inside travel lanes to avoid merging and lane changing cars, either through traditional truck lanes restrictions or truck-only lanes
- Respondents were polarized for and against the existing truck lanes restrictions in Tennessee that mandate trucks use the right two lanes.
- The mean willingness to pay to avoid ten minutes of congestion was about $2.00.

Section 4: Conclusions

A review of the relevant literature and case studies reveals that the San Diego region is not alone in facing increasing freight mobility challenges both currently and in the future. Several regions have examined or are in the process of examining potential truck management strategies on freeways and in urban areas. The most common of these appear to be lane restrictions and the assessment of dedicated truck lanes (which may be exclusive, shared, and/or tolled) and may exist for short segments (e.g. bypasses, climbing lanes) or the length of an entire corridor. Less common appears to be the consideration of pricing strategies for trucks within the general purpose lanes or the inclusion of certain classes of trucks on HOV and/or HOT lanes, though examples can be found of each.

While truck management strategies have the potential to promise numerous benefits, such as travel-time savings, improved travel-time reliability, improved safety, and improved productivity (for the trucking industry), corridor-based assessments must be conducted to identify the type and extent of truck management strategies warranted based on numerous factors, such as truck volumes and percentages, truck travel demand (local and/or long-haul), auto and truck peak-travel periods, and market demand under various scenarios (e.g. variable access restrictions and/or fees based on time of day). Additionally, community acceptance and environmental factors will be vital for determining an appropriate set of solutions for the San Diego region moving forward and any truck management strategy must be developed hand in hand with the trucking industry.

A summary of the lessons learned from each study are provided in Table 3. Additionally, key questions that that will shape the potential strategies evaluated as part of this study include:

- To what extent will the region's truck-related mobility challenges be derived from local or regional (long-haul) truck travel demand?
- To what extent could truck travel be shifted away from peak auto travel periods through the use of incentives and/or tolls? Through coordination with local shippers and receivers?
- Are there key locations/bottlenecks throughout the region where truck-only lanes or bypasses may be warranted?
- To what extent should the call for managed lanes on the region's freeways include dedicated truck-only lanes? What combination of truck lane restrictions, HOV/HOT lanes, shared use HOV/HOT lanes (i.e. that allow access for trucks), and dedicated truck lanes would be most effective for San Diego's key trucking corridors?
- Should the managed lanes being proposed for the region's freeways include flexible designs that could adapt to changing needs and/or users over time?
- How will the system of HOV/HOT lanes being proposed impact auto and truck mobility? Would the mobility improvements likely to be experienced in the general purpose lanes be enough to help offset future freight-related congestion?

- To what extent would state and/or local policy need to be changed to support the truck management strategies that will be evaluated as part of this study?
- To what extent could ITS strategies be used to optimize existing capacity and enhance truck mobility and safety throughout the region?

TABLE 3: SUMMARY MATRIX OF LESSONS LEARNED FOR THE SAN DIEGO REGION

Key Finding	Study
General Benefits and Costs	
Truck use of separate truck-only lanes could result in the following benefits: • A reduction in truck travel times, improving freight movement efficiency • More predictable travel times, allowing expansion of just-in-time delivery options • An improvement in domestic and international competitiveness • The maintenance of consumer goods pricing • A reduction in truck idle time in congestion, which also reduces fuel consumption and improves air quality • An improvement in facility capacity by removing many trucks from the general purpose lanes and making better use of toll or managed lanes • A reduction in crashes and incident impacts (fewer lanes blocked, easier to access and clear) by concentrating trucks to a designated lane • A more comfortable driving environment for those intimidated by driving near trucks	Poe, 2010
Some of the benefits of truck-only lanes include improvements in traffic flow caused by the differences in acceleration/deceleration rates of cars and trucks. Some potential issues related to dedicated truck lanes include complex and time-consuming funding arrangements and agreements, the need for right-of-way acquisition, environmental challenges, and design challenges.	Bucklew, 2012
Additional benefits of separate truck-only lanes includes: • Trucking industry productivity gains due to truckers being able to haul more freight payload per unit of fuel and drive cost • Public sector operating and maintenance cost savings due to shifting heavier truck traffic to lanes designed with pavements that can withstand higher weights. Car-only lanes could be designed to different standards because they do not have to accommodate the height and weight of trucks.	International Transport Forum, 2009
Planning	
Plan to accommodate the significant increases in truck traffic over the next few decades. To relieve congestion, consider building truck-only lanes or implementing pricing to encourage trucks to use off-peak travel times.	AASHTO, 2007
Invest public funds in freight mobility projects (especially in and around ports), coordinate with private stakeholders, and consider technologies to improve freight mobility, including truck-only lanes.	USGAO, 2008
Stakeholders, in particular the trucking industry, should be involved in planning truck-only lanes (especially in regards to issues such as tolling).	NCHRP Report 649/NCFRP Report 3, 2010

Truck management strategies should be chosen with consideration of the availability of right of way (ROW), local travel patterns, geometric characteristics of the roadway of interest, and capital and operational cost considerations.	Sisiopiku & Cavusoglu, 2011
In selecting potential corridors for long-haul intercity truck-only lanes, give the highest priority to corridors that do not have rail service or that have very congested rail systems. In these cases, it is appropriate to look at the tradeoffs between adding new LCV lanes and investments in rail systems.	NCHRP Report 649/NCFRP Report 3
When estimating benefits of truck-only lanes, consider simulation models rather than travel demand models (since standard travel demand models may not take into account the safety and reliability benefits of truck-only lanes).	NCHRP Report 649/NCFRP Report 3
Urban Freight Mobility	
To improve freight mobility in dense urban areas, consider the following: • Conducting long-term planning for freight • Investing in urban consolidation centers • Altering access regulations to allow off-peak supply • Harmonizing truck access, loading regulations, and enforcement strategies within and across a region	NCFRP Report 14, 2012
In areas around ports and intermodal terminals, new truck routes or truck-only lanes can relieve pressure on mixed-flow freeways by providing alternative routes that are better aligned with existing and forecasted truck flows. Truck-only lanes are often more effective in providing relief in these situations than adding general purpose capacity because the truck-only lanes can be designed to meet the specific routing needs of trucks accessing port and intermodal facilities.	NCHRP Report 649/NCFRP Report 3
The addition of a truck-only lane in urban corridors will only provide mobility benefits over the addition of a general purpose lane if it diverts a significant amount of truck traffic from the GP lanes to the truck-only lane during congested peak periods. Truck diversion rates from GP lanes to truck-only lanes of 50 to 85 percent are needed to make truck-only lanes a viable alternative. Diversion rates of 60 to 70 percent are best since 80 percent and above begin to produce congestion on truck-only lanes.	NCHRP Report 649/NCFRP Report 3
Time, miles, and money can potentially be saved when trucks are allowed to share underutilized HOV lanes with cars and buses.	FDOT, 2002
The mobility benefits of urban truck-only lanes for the general public (autos), rather than for trucking companies, may be the strongest selling point to policy makers.	NCHRP Report 649/NCFRP Report 3, 2010
Safety and Operations	

Results consistently indicate that truck-only lanes in urban corridors have higher safety benefits compared to mixed-flow lanes.	NCHRP Report 649/NCFRP Report 3
The separation of autos from truck traffic on long-haul intercity corridors can reduce accident-rates and improve safety by reducing auto-truck conflicts. Two studies showed accident rate reductions ranging from 44 to 47 percent.	NCHRP Report 649/NCFRP Report 3
Various truck lane restriction configurations are recommended by this report to optimize operational performance based on a facility's number of lanes, traffic volumes, and the percentage of trucks. Specific recommendations based on the results of this report's analysis are shown in Figure 14.	Liu & Garber, 2007
The results of this study show that truck drivers may support moving truck lanes to the inside travel lanes to avoid merging and lane changing issues with passenger vehicles, either through traditional truck lanes restrictions or truck-only lanes.	Adelakun & Cherry, 2009
Design	
Design managed lanes that are flexible and adaptable to changing traffic patterns, changing user demand, and likely technological changes over time. Specifically, design lanes and access points for all categories of users, including passenger vehicles, buses, and trucks, to allow for changes in use over time. To allow for this flexibility in use, structure the environmental assessment process for a broad umbrella of strategies, even prior to determining access locations, user mix preferences, or pricing policies.	Fuha, 2009
When designing truck-only lanes consider: • Barrier separation with separate entry/exit ramps • Adequate space for deceleration and lane changes • A passing and/or breakdown lane • Stronger and more durable pavement and structures to accommodate trucks • Incorporating transponders for tolling (to collect information on VMT, weight, and size, etc) • Designing to allow the potential for Longer Combination Vehicles (LCVs)	Burke, 2005
When designing truck-only lanes consider: • Place traffic signs with consideration of visibility for large trucks (given close following distances) • Consider truck-specific acceleration rates, stopping distances, weaving capabilities, and roll stability.	Sisiopiku & Cavusoglu, 2011
Design TOT lanes to accommodate heavier loads and provide staging areas for assembling and disassembling LCVs. Additionally, ROW requirements must be considered to provide an adequate cross-sectional configuration.	ODOT, 2009

<table>
<tr><td>Designers of toll roads and managed lanes to accommodate trucks should do the following:
• Thoughtfully select design speed for mainlane roadways, ramps, and interchanges
• Use low maximum grades on vertical alignment
• Include climbing lanes to minimize truck loss of speed and potential speed differentials
• Avoid use of long downgrades
• Increase the lengths of vertical curves to increase sight distance for truck drivers
• Give proper consideration of the truck demand and truck classes expected to use a toll road or managed lane
• Use static dual speed curve warning signs to alert truck drivers to the appropriate speed in negotiating ramps and direction connections
• Use continuous, longitudinal rumble strips to assist in alerting truck drivers to the edge lines of traveled ways
• Use barrier curve delineation systems on curves needing special attention from truck drivers to negotiate ramps and direct connections</td><td>Poe, 2010</td></tr>
<tr><td>Timing/Criteria</td><td></td></tr>
<tr><td>The feasibility of implementing truck-only lanes on urban corridors is a direct function of corridor demand and system characteristics, including:
• Truck and auto traffic volumes
• The percentage of trucks
• Time-of-day variations in truck and auto traffic volumes, and the contribution of truck traffic to peak-period congestion
• Truck routing and O-D patterns
• Length of corridor
• Number of lanes</td><td>NCHRP Report 649/NCFRP Report 3, 2010</td></tr>
<tr><td>Additional criteria that should be considered when implementing truck-only facilities are:
• The amount of truck-related crashes
• Highway level of service
• Proximity to airports and seaports
• Proximity to other intermodal facilities</td><td>FDOT, 2002</td></tr>
<tr><td>Barrier separated dedicated trucks lanes achieve optimum feasibility when:
• Truck volumes exceed 30 percent of the total vehicle mix
• Peak hour volumes exceed 1,800 vphpl
• Off-peak volumes exceed 1,200 vphpl</td><td>Burke, 2005</td></tr>
</table>

Example exclusive truck lane implementation criteria include: • Highly congested corridors where truck volumes are greater than 20,000 per day • Corridors with average daily traffic of 100,000 vehicles per day (both directions) with at least 25 percent trucks on four lanes. The corresponding LOS is "E" for urban areas and "F" for rural areas." • Criteria can be weighted as well; the Florida DOT model weights truck volumes at 75 percent, truck percentages at 5 percent, truck crashes at 5 percent, and highway levels-of-service at 15 percent.	Transport Canada, 2011

The following thresholds for implementing truck-only lanes are cited in the report:
• Mainline Volumes
    o Peak hour > 1,800 vehicles per hour per lane (vphpl) (Janson)
    o Off-peak hour > 1,200 vphpl (Janson)
    o Two-way average daily traffic (ADT) > 120,000 OR at least 15,000 per lane (Douglas)
    o ADT > 100,000 (Battelle)
• Heavy Truck Volumes
    o Two-way average daily truck traffic (ADT) > 20,000 for 10 miles OR the corridor should provide access to major freight generators at the termini (Douglas)
• Heavy Vehicle Percentage
    o > 30 percent (Janson)
    o 25 percent trucks (Battelle)
• Lane configuration
    o At least two general purpose lanes and two truck-only lanes in each direction (Douglas)
	NCHRP Report 649/NCFRP Report 3, 2010

A general purpose lane conversion to a truck lane is only justified where truck volumes represent at least 12 percent of total traffic volumes.	Sisiopiku & Cavusoglu, 2011
Tolling	
Separate truck lanes can produce benefits to the trucking businesses in terms of both travel time savings and improved travel time reliability. This 2005 SCAG study estimated that a toll of $0.86 per mile (in 2005 dollars) would equate to a speed and reliability cost savings to trucking businesses in the range of 5.4 to 11.1 times the fee per trip.	SCAG, 2005
The performance of truck-only lanes in urban corridors is a direct function of truck diversion (from general purpose to truck-only lanes), and tolls can directly impact the level of truck diversion (when the usage of truck-only lanes is voluntary). For tolled urban corridors, the highest diversion from GP lanes to truck-only lanes occurs under the no-toll scenario: 50 to 90 percent of total truck traffic along the corridor; A small toll of $0.07 per mile can drop the estimated diversion rate to 30 to 70 percent, and a slightly higher toll of $0.15 per mile can drop the	NCHRP Report 649/NCFRP Report 3, 2010

diversion rate further to 10 to 30 percent. Variable tolling could work to "maximize the truck diversion, utilization, and revenue potential of truck lanes along corridors with varying congestion, and truck and auto volume characteristics by time of day.	
The extent to which trucks will be attracted to TOT lanes depends on the relationship between the value that truckers get from the facility and the price being charged. For long-distance TOT lanes, the main value to truckers comes from allowing LCVs on the toll lanes, thereby providing productivity benefits for the TOT lanes. If the toll rate is set so that the increased productivity exceeds the value of the toll, some truckers may be attracted to the new lanes. For urban TOT lanes, the value of TOT lanes comes from the opportunity for a truck to reduce travel time and improve travel-time reliability by avoiding congestion. One issue is that urban TOT lanes will be unlikely to attract truck traffic during off-peak periods, when un-tolled general purpose lanes are operating in free-flow conditions.	ODOT, 2009
Across all segments of the trucking industry—including different types of drivers, and different types of trucking operations—there are overwhelmingly negative attitudes about toll roads and an extremely low willingness to pay even a token toll for different time savings scenarios. Often, toll roads are viewed negatively because a large cross section of the trucking industry is not able to ascribe and monetize the true value of toll road benefits to their business. To overcome opposition to toll roads by different segments of the trucking industry consider a slow transition to toll facilities to increase user comfort and acceptance, providing clearer value for-money by developing toll roads with higher weight limits and/or that allow longer combination vehicles, and focusing on education and outreach so that the benefits of toll finance (such as faster delivery of critical infrastructure, congestion relief, more expansive truck service facilities, and the potential for increased trucking productivity) are fully understood.	NCHRP Web-only document 3 and NCFRP web-only document 185, 2011
Cost-Effectiveness	
The overall economic benefits of truck lanes typically outweigh the costs, once you take into account safety, travel time savings, and trucking industry productivity enhancements. While separated lanes are ideal for safety, they can be cost prohibitive. Truck lane concepts that reapportion existing lanes can show better financial performance due to the significantly lower capital costs involved.	Transport Canada, 2011
Overall, truck-only lanes can provide positive benefits in both long-haul corridors and urban corridors.	NCHRP Report 649/NCFRP Report 3, 2010
The high cost of providing truck lanes should be compared to the potential savings from improved overall safety and reduced pavement damage on "non-truck" routes.	FDOT, 2002
Feasibility of TOT lanes must be determined on a case-by-case basis. For urban TOT lanes, the costs of construction are likely to be high and the revenue potential limited to only a few hours of the day.	ODOT, 2009

Funding	
Traditional funding mechanisms can be inadequate for new large truck-only lane projects, and public-private partnerships should be considered.	Bucklew, 2012

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Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Technical Memorandum #2: Issue Identification

TO:	Andrea Hoff and Christina Casgar, SANDAG
FROM:	CH2M HILL, IBI Group, Cheval Research
DATE:	April 5, 2013
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This memorandum identifies a preliminary list of issues associated with truck operational strategies related to the use of managed lanes by trucks as identified in the literature review, based on the study team's professional experience, through feedback from the Project Study Team (PST) meeting held on November 28, 2012, and preliminary comments from regional trucking industry and cross-border trade representatives. The memo consists of the following sections:

- Section 1: Regional Context and Problem Statement
- Section 2: Summary of Potential Issues for Analysis
- Section 3: Categorization of Truck Types

Section 1: Regional Context and Problem Statement

Regional Context

The San Diego region is one of the largest metropolitan regions in the State of California and one of the most geographically and culturally diverse areas in the country. Home to a population of more than three million people and covering over 4,199 square miles of land, it is the southernmost region in California, bounded to the south by Mexico, Riverside and Orange Counties to the north, Imperial County to the east, and spanning 70 miles of coastline to the west.

Situated between major production, trade, and population centers, San Diego possesses a wide array of transportation and infrastructure assets. Goods movement in the San Diego region involves a complex system of interstate highways and state routes which link two air cargo operations, a major commercial international border crossing, two marine terminals (Port of San Diego), and the largest shipyard and largest Navy base on the West Coast. All of these regional assets are in place to meet the mobility needs of the region's three million residents and to carry some 120 million tons of truck-borne freight.

While regional rail capacity is important, it is highly constrained and cannot match the flexibility and reliability of regional truck distribution. Trade and distribution in the region, therefore, is heavily dependent on truck movements. The region's roughly 300 miles of urban and rural freeways are not expected to significantly grow. This roadway network must simultaneously serve a growing population and growing levels of international trade. Additionally, this same system must carry the goods that satisfy the local demand of area residents and tourists (domestic truck flows). These domestic truck flows will continue to account for most of the region's truck traffic. In addition, the Otay Mesa border crossing processes about 1.4 million trucks annually and accommodates more than $25 billion worth of goods, which makes it the busiest commercial crossing between California and Mexico and the third busiest along the entire United States-Mexico border. In short, truck traffic, a derived demand generated by personal consumption and inputs to the production process, will continue to grow, and trucks will place increasing pressure on the region's highways.

The region's southern border with Mexico is connected to the region's northern border with Riverside and Orange County via State Route 905, Interstate 805 (I-805), Interstate 5 (I-5) and Interstate 15 (I-15); the major east/west freeways include Interstate 8, State Route 54 and State Route 52. All of these freeways are experiencing increasing peak period traffic congestion that is expected to grow commensurately with the steady population and job growth projected for the region (4.4 million residents, 1.9 million jobs, and 1.5 million housing units by 2050). Increased congestion on the region's highways leads to congestion on local streets, impacting communities and raising safety issues related to conflicts between trucks and passenger vehicles. Higher truck volumes also can contribute to truck-related crashes.

Problem Statement

The problem statement below was initially developed by the project team based on preliminary data and the literature review, and further refined based on feedback from the Project Study Team (PST).

In the San Diego region, trucks are the backbone of the goods movement system. Trucks carry more than 90% of freight volume in the San Diego region and travel nearly 2 million vehicle miles each day on the region’s freeways. Truck vehicle miles traveled (VMT) on freeways are expected to grow 1.5 million by 2035, reaching an estimated 7% of the all freeway VMT and growing at a rate faster than that for personal vehicles. In 2007 over 127 million tons of goods, valued at nearly $225 billion were transported in San Diego by trucks.

Truck bottlenecks exist on freeways during peak periods and at freight gateways (e.g. land and sea ports of entry), straining the region’s multimodal goods movement network. Therefore, it is prudent to review and update truck freeway operational strategies. This is important for both personal and freight safety and mobility objectives, and is critical to regional economic prosperity.

Managed lanes (ML) are becoming an increasingly common option by which the region is addressing the need to reduce congestion, increase throughput, and enhance flexibility on freeways. Therefore, a concurrent investigation is needed of the potential benefits and challenges for use of MLs by trucks and of other operational strategies. Such an investigation will help to ensure that various types of truck traffic (e.g. long and short haul or parcel delivery) are considered as part of the region's overall transportation system that includes goods movement.

Based on input from private and public sector freight stakeholders, this study will assess near term and long range concepts for accommodating and managing trucks on the region's freeways, while considering: driver needs and perspectives, incident management needs, community and environmental impacts, data collection needs, and implications for the larger goods movement system. The overall goal is to define the roles and opportunities for these concepts in the long-term mobility planning for the region.

Section 2: Summary of Potential Issues for Analysis

The following section provides a list of the potential issues to be evaluated as part of this study. The introduction of freeway operational strategies for trucks that work in harmony with managed lanes initiatives for personal vehicles requires an understanding of a wide range of issues, which are summarized at a high level in this section. Table 1 at the end of this section lists and differentiates the planning considerations which will be included as part of this analysis versus the implementation issues that will be analyzed in future, more detailed, studies. Note that specific issues related to individual strategies will be discussed in more detail as the strategies are refined and once specific study corridors are identified.

Planning

- **Economy:** How will the various potential truck management strategies affect the local and regional economy and economic prosperity? How will it affect the ability of the trucking industry to efficiently perform operationally and financially? How will it affect the trucking industry's ability to continue to support essential goods movement functions in the region?
- **Border issues:** How will border issues and the projected growth in goods movement from Mexico affect truck mobility in the region? How will coordination with adjacent and near-by counties including Orange, Los Angeles, Riverside, and Imperial be addressed?
- **Community acceptance & environmental justice:** Which truck management strategies will be most acceptable to local communities? How will implementing (or not implementing) the various potential truck management strategies affect adjacent communities in terms of emissions, noise, and vibrations?
- **Environment**: What is the impact of the various potential truck management strategies on local and regional air quality and greenhouse gas emissions?
- **Timing/thresholds:** At what point in the future should truck management strategies be implemented? What are the thresholds for determining the appropriate timing of implementation for each corridor? Potential thresholds could include goods movement throughput, LOS, travel time delay, truck percentage, percent of truck crashes, peak-hour truck volumes, and cost/benefit measures for the trucking industry.

- **Data availability:** What data need to be collected now and in the future to improve truck mobility on the region's highways? What are current data availability limitations?
- **Coordination with other planning studies:** How can the region best integrate trucks on managed lanes strategies with ongoing and future plans for managed lanes implementation?

Policy

- **Legislative challenges:** Would changes to current CA legislation be required for the effective implementation of truck management strategies? For example, how would current truck speed and lane limitations affect the viability of strategies such as variable pricing, dedicated truck-only lanes, and trucks on HOV/HOT lanes? How would current restrictions on longer-combination vehicles affect the viability of strategies that allow them on dedicated truck-only facilities?
- **Organizational roles:** Which organizations should be involved going forward on strategy development and implementation? Which organizations should be in lead roles? What are the appropriate roles for the private sector?

Safety

- **Crash avoidance:** How would the various potential truck management strategies impact crash rates with autos and other mixed traffic? What would be the impact on overall safety and crash-rate reduction? If trucks are kept in dedicated truck facilities, as opposed to in shared managed lanes facilities, what real and perceived safety issues are achieved?
- **Trucking industry liability:** How would the various potential truck management strategies impact the general liability of the trucking industry?
- **Incident management:** How would incident management be handled under the various truck management strategies being considered? In particular, how would the shared use of HOV/HOT lanes by trucks impact incident management plans for these lanes?

Operations

- **Efficient transportation operations:** How would the various potential truck management strategies impact travel time savings and reliability for trucks? For all users? In particular, how would the shared use of HOV/HOT lanes by trucks impact the requirement to maintain a continuous minimum speed in these lanes? There may be a need to consider different strategies during peak and off-peak periods, and for different facilities as well as various vehicle eligibility and pricing rates.
- **ITS solutions:** How could ITS applications be used to enhance truck mobility in the region (either in isolation or in combination with the various potential truck management strategies)? For example, what role could Active Traffic Management (ATM) strategies such as variable speed limits play in reducing speed differentials between passenger vehicles and trucks to enhance safety? How could in-vehicle technologies improve safety and truck routing?
- **Lane assignments:** Would changing the lane restrictions and/or assignments for trucks based on the truck volumes, percentage, and number of lanes on a freeway provide

operational benefits on the highways in the San Diego region? Truck size, weight, and maneuverability are considerations that affect lane assignment especially on mixed use facilities where there are vehicle speed and size disparities.

User Acceptance

- **User needs/trip type:** What is the characterization of trip types (local, regional, and long-haul) for trucks in the region? Local, regional, and long-haul truck trips have varying needs and lend themselves differently to the various truck management strategies under consideration. For example, the level and frequency of accessibility for the trucking industry will vary by trip type. Some strategies will serve different users (e.g. DARs would serve regional & long-haul trips more than local truck trips). Type of freight also affects hours of operation (such as perishables requiring delivery in the early AM) and markets served.
- **Acceptability of pricing strategies:** To what extent would pricing strategies provide a return on investment to the local trucking industry (e.g. in the form of travel time and reliability savings)? What is the local trucking industry's willingness and ability to pay flat or variable fees based on their perception of received value? How is this impacted by whether the fees are required (i.e. trucks must used priced facilities) or voluntary (i.e. non-priced options remain available to trucks)? The trucking industry expects a free option to any fee-based facility.
- **Longer-combination vehicles:** How would market demand/user acceptance change if the legal framework were changed to allow longer-combination vehicles on truck-only facilities?
- **Balancing market realities with possible behavior change:** What market issues would impact the local trucking industry if asked to shift their travel to off-peak hours in response to incentives and/or pricing? How much do shippers/receivers drive trucking pickup and delivery schedules? How can trucking industry bear or share the responsibility of fees or costs imposed for peak usage of facilities if hours of operation are driven by their customers (shippers or receivers)?
- **HOV/HOT lane user acceptance:** What would be the acceptance level of HOV/HOT lane users if trucks were permitted to share the lanes (users include carpools, hybrids, single occupant vehicles, buses, and motorcycles)? If the performance in managed lane facilities is degraded due to the presence of trucks, this would likely weaken support for trucks on managed lanes strategies among transportation agencies and the general public. Would acceptance levels change if trucks were only permitted to use certain lanes or were restricted to off-peak travel times on the lanes? Community outreach will be important.

Engineering Issues

- **Pavement design:** Would changes to existing pavements need to be made to accommodate trucks in HOV/HOT lanes? How would this impact project costs? Could the construction of dedicated truck-only facilities provide long-term cost savings in the form of reduced design and maintenance costs in general purpose lanes?

- **Access issues:** What kind of access/egress would be required to allow trucks to use the planned system of HOV/HOT lanes in the region? What kind of access/egress would a system of dedicated truck-only lanes require to effectively serve users? What types of separation between ML and GP lanes (striped buffer versus concrete barrier) are required to support trucks on MLs? What classes of vehicles could be expected to safely use existing or planned HOV/HOT lanes located left of the number one lane (considering weight, size, and maneuverability)? What is the potential for elevated/designated/direct access structures for trucks at key trip generation locations?
- **ROW constraints:** If truck-only lanes and/or facilities are considered along key truck corridors or intermodal connectors, what is the ROW that would be needed to allow for sufficient truck mobility and safety (e.g. passing lanes and/or shoulders, etc)? If sufficient ROW is not available or too costly, what is the potential for elevated structures or the conversion of existing general purpose lanes?
- **Phasing:** Are there opportunities to incorporate potential strategies into current projects underway? Can current and future managed lane projects in the region be designed to allow for maximum flexibility?

Costs/Funding

- **Cost effectiveness:** What are the potential costs/benefits of pricing strategies to recover any capital and maintenance costs of the various truck management strategies under consideration?
- **Funding/prioritization:** With limited resources for implementation of truck management strategies, what types of evaluation criteria should be used to prioritize the funding of truck management strategies?

TABLE 1: ABILITY OF CURRENT STUDY EFFORT TO ANALYZE EACH ISSUE

Issue for Analysis	Planning Issue to be Analyzed as Part of Current Study	Implementation Issue Best Addressed in Future Study
Planning Issues		
Economy	x	
Border issues	x	
Community acceptance & environmental justice	x	x
Environment	x	x
Timing/thresholds	x	
Data availability	x	
Coordination with planning studies	x	
Policy Issues		
Legislative challenges	x	
Organizational roles		x
Safety Issues		
Crash avoidance	x	x
Trucking industry liability	x	x
Incident management	x	x
Operations Issues		
Efficient transportation operations	x	
ITS solutions	x	x
Lane assignments	x	
User Acceptance Issues		
User needs/trip type	x	
Acceptability of pricing strategies	x	
Longer-combination vehicles	x	x
Potential for behavior change	x	
HOV/HOT lane user acceptance	x	
Engineering Issues		
Pavement design	x	x
Access issues	x	x
ROW constraints		x
Phasing		x
Cost/Funding Issues		
Cost-effectiveness	x	x
Funding/prioritization		x

Section 3: Categorization of Truck Types

The trip purpose and the type of truck are important to consider when designing trucks on managed lanes strategies, as different strategies will be more beneficial to certain categories of trucks than others.

For the purposes of this study, local, regional, and long-haul trips are defined as follows:

- Local – Originates and terminates within San Diego County
- Regional – Originates or terminates within Southern California (defined as all bordering counties and Los Angeles County)
- Long-haul – Starts or ends in San Diego County, but travels outside the region; OR both originates and terminates outside the region.

In general, local trucks are likely to consist primarily of light & medium vehicles; regional trucks are likely to consist of an even distribution of light, medium, and heavy vehicles; and long-haul trucks are likely to consist primarily of heavy vehicles.

The FHWA truck weight classifications based on Gross Vehicle Weight Rating are described below:

- Light vehicles (Class 1-4) – Up to 14,000 lbs
- Medium vehicles (Class 5-6) – 14,001 – 26,000 lbs
- Heavy vehicles (Class 7) 26,001 – 33,000 lbs, and (Class 8)d 33,001 and above

Note: Trucks less than 33,000 lbs are not required to adhere to some California Air Resources Board (CARB) requirements.

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Technical Memorandum #3: Strategy Development

TO: Andrea Hoff and Christina Casgar, SANDAG

FROM: CH2M HILL, IBI Group, Cheval Research

DATE: January 18, 2013; Revised June 3, 2013

This memorandum summarizes the preliminary set of potential truck management strategies for the San Diego region, and describes how this set of strategies was developed. The resulting strategies were developed considering findings from the literature review, the study team's professional experience, feedback from SANDAG and the Project Study Team (PST), and comments from regional trucking industry and cross-border trade representatives. The strategies identified herein will be further refined and developed in future phases of this study and serve as a starting point for further analysis and review as the study proceeds.

Strategy Development Process

In December 2012, the study team prepared Technical Memorandum #1: State-of-the-Practice for Managing Trucks on Freeways and Managed Lanes and Applications for the San Diego Region. This memo contains a review of literature to identify truck management strategies that have been studied or applied in domestic and international locations. The review included:

- A brief overview of the SANDAG 2050 RTP Goods Movement Strategy (adopted in October 2011) as it relates to trucks.
- A summary of the current regulatory framework in California as it relates to the use of managed lanes by trucks.
- A description of types of truck management strategies that are being studied or have been implemented in other locations.
- Identification of dedicated truck facilities and truck lane projects that are existing, planned, or being studied.
- Findings from a review of 19 research documents and government reports as they relate to the use of trucks on managed lanes and truck management strategies.

Also in December, the study team prepared Technical Memorandum #2: Issue Identification which identified a list of issues associated with truck management and operational strategies. The memo included:

- The regional context for truck movements in San Diego and a problem statement for the study developed in close coordination with SANDAG.
- Potential issues to be considered and evaluated during the study, including issues related to planning, policy, safety, operations, user acceptance, engineering, and cost/funding.
- Classifications of trucks based on Gross Vehicle Weight Rating (light vehicles: up to 14,000 lbs; medium vehicles: 14,001 – 26,000 lbs; heavy vehicles: 26,001 lbs +)[1].
- Categorization of truck trip types based on origin and destination (local, regional, long-haul).

PST meetings were held on November 28, 2012 and on January 9, 2013 to discuss the preliminary list of issues and truck management strategies:

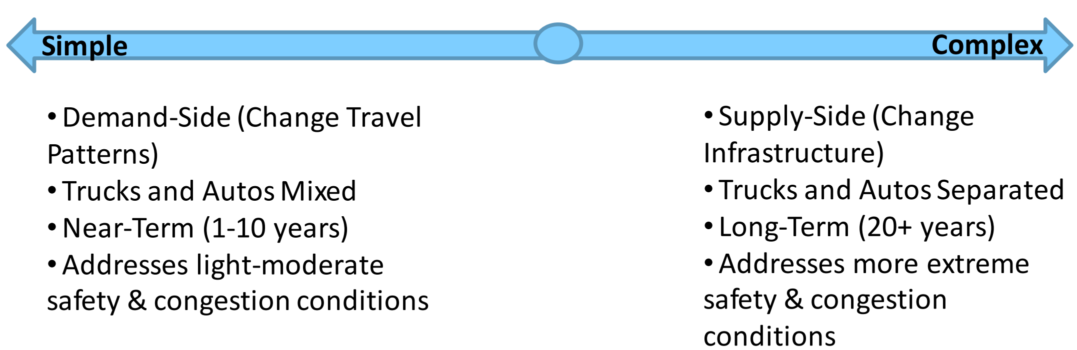
- During the Nov. 28 meeting, the topics discussed included: Literature Review, Preliminary Data Review, Strengths-Weaknesses-Opportunities-Threats (SWOTs) Analysis, and Draft Problem Statement.
- During the Jan. 9 meeting, the topics discussed included: Summary of Potential Issues for Analysis, Categorization of Truck Types, and List of Truck Management Strategies.

A list of ten strategies were initially developed then narrowed down to seven broad truck management strategies, which are carried on to be further analyzed as the study proceeds. The following section describes these strategies.

Strategy Descriptions

Based on these efforts and the associated input from the PST, the study team defined and developed an initial set of ten potential truck management strategies. The strategies represent a rough hierarchy ranging from simple to more complex, as shown in Figure 1.

FIGURE 1: HIERARCHY OF TRUCK MANAGEMENT STRATEGIES



Each of the ten potential strategies is summarized on the following pages. Each numbered item represents a strategy concept, with the additional information that follows representing

[1] Additional categories of truck classification, such as the number of axles and truck lengths, will also be considered as part of this study.

variations/options for that strategy and related thoughts and considerations. The unconstrained list of ten strategies was narrowed down to seven strategies after a fatal flaw review by the PST. Three strategies were found to either be redundant and could be included within other strategies, or found to be inadequate to improve truck mobility in the region. The remaining seven strategies will be refined for evaluation purposes later in the study in order to identify those strategies that are most applicable to the San Diego region. The initial ten strategies are described in the following section. After each strategy discussion, there is a brief summary of comments that were received from the PST and stakeholders.

The PST and stakeholder feedback is not meant to provide a comprehensive analysis of the strategies, but rather highlight some key ideas or concerns that surfaced during project meeting discussions.

1.) Base-Case Scenario (Do Nothing)

Description: Consider what the future looks like for goods mobility in the region if no new actions are taken to address truck mobility. The costs and benefits of all other strategies will be compared to the base case.

Relative Cost: No cost with respect to strategy implementation, but significant and growing costs to the trucking industry with respect to the impacts of congestion on travel mobility and reliability.

Timeframe: Not applicable.

Potential Issues: This strategy does not address the problem statement; current and future truck bottlenecks would remain.

PST and Stakeholder Feedback:

- It is useful to have the base case scenario included to understand what will happen if no new actions to improve truck mobility are taken.
- It will also be important to understand the problems that exist today. Fix those first, and then focus on planning to alleviate future anticipated problems.
- While this study should help to document future conditions, it can be unusual for the trucking industry and other stakeholders to try to think of planning 40 or so years in advance. It will be important to glean this information from the trucking industry stakeholder interviews.
- It will be important to ensure that the recommended strategies apply to the truck types and truck trip types most common in the San Diego region.

2.) Traffic Organizational Strategies at Freight Gateways & Distribution Hubs

Description: This strategy includes coordinated strategies to optimize truck traffic flow at key locations. The strategies implemented could range from simple to more complex and include:

- Intelligent Transportation Systems (ITS)/Communication strategies, such as the use of variable message signs and 511 announcements to provide real-time information to truckers to help them avoid congestion and bottlenecks.
- Infrastructure-based strategies, such as dedicated trucks lanes or facilities in key bottleneck locations.

Relative Cost: The communication-based strategies are comparatively low in cost, as the strategies are not as capital-intensive as some of the other strategies. System enhancements to upgrade the timeliness and accuracy of real-time traveler information in the San Diego region could be more expensive. Infrastructure-based strategies would be more expensive.

Timeframe: Short (0 to 10 years); Mid-term (11 to 20 years), and long-term (over 20 years)

- The communication-based components of this strategy could be implemented in the short-term. The infrastructure based components of this strategy would require longer planning windows and would be best implemented in the medium- to long-term.

Potential Issues: This strategy could include implementation on some local arterials (in addition to highways) where conditions merit.

PST and Stakeholder Feedback:

- The communication/ITS components of this strategy are an “easy win” (meaning high benefits for low cost) and would also likely have strong community acceptance. For example, in Barrio Logan residents are advocating for specific truck routes through their community and this strategy could assist with that goal.
- Using strategies on arterials will protect neighborhoods and would be a good transition to the broader issue of trucks on managed lanes and other freeway operational strategies.
- Consider developing a planning-level toolbox for local jurisdictions (designating truck routes, truck parking and loading zones for trucks, etc). Also consider the use of communication strategies and real-time information at key locations.
- This strategy is similar to Strategy #10: ITS/ATM (see page 13) and could potentially be combined.

3.) Travel Demand Management Strategies to be Developed with Truckers and Shippers/ Receivers

Description: This strategy involves working with shippers/receivers to facilitate the shifting of trucks to off-peak travel times through travel demand management strategies, potentially based on pricing incentives and fees. The focus is on shifting travel patterns rather than on capital investments.

Relative Cost: Fairly low, as the strategy is not capital-intensive.

Timeframe: Can be implemented in the near term (0 to 10 years).

Potential Issues:

- Off-peak schedules may increase labor costs for receivers (overtime).
- The strategy may not be feasible for all goods/deliveries, based on operating time windows for both truckers and delivery points. Shippers may also already be doing this, where possible.

PST and Stakeholder Feedback:

- A good example of a project where costs are distributed is PierPass (Ports of Los Angeles and Long Beach). Facilities charge a $120 Pier Pass fee to the shippers (Beneficial Cargo Owners) instead of the trucker. This is preferred since truckers are not well suited to function as collection agencies for fees that should really be charged to the shipper, and ultimately passed on to the consumer.
- Driver safety is a component of this as well as the need for truck rest stops. San Diego is somewhat of a cul-de-sac, due to its geographical location. Could the addition of truck stops in San Diego help shift truck travel patterns by making it easier for truckers to take their break in San Diego to avoid peak congestion periods?

4.) Trucks on the Planned Network of High Occupancy Vehicle / High Occupancy Toll (HOV/HOT) Managed Lanes (Full-Shared Access)

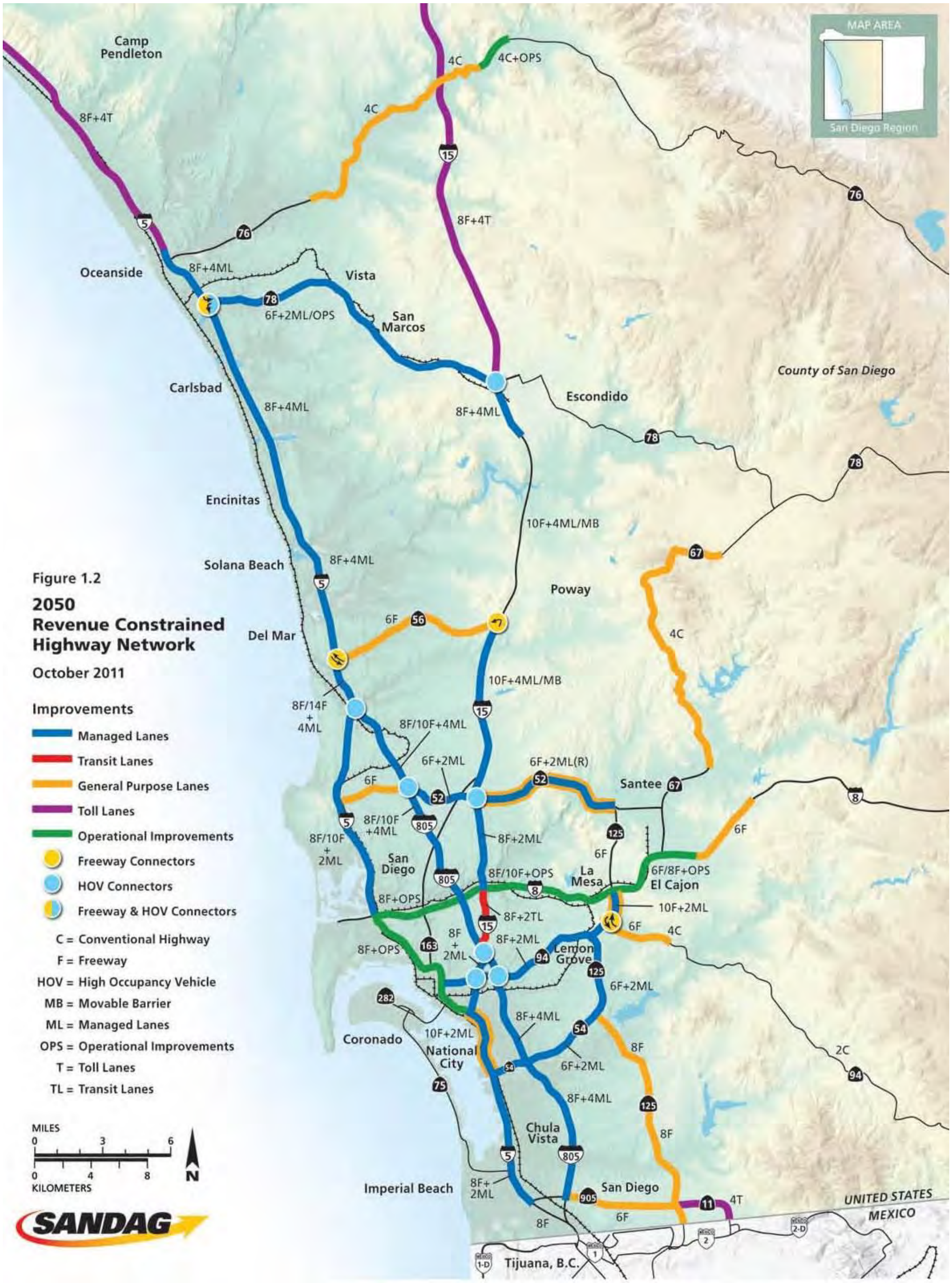
Description: This strategy would allow full unrestricted access of trucks on HOV/HOT lanes. Tolling options could include non-tolled, a flat toll, or a variable toll (based on time-of-day or travel speeds, etc). If tolled, the use of the lanes could be made optional, therby continuing to allow trucks non-tolled access to the general purpose lanes. Figure 2 shows the Revenue Constrained Highway Network from the SANDAG 2050 Regional Transportation Plan adopted in October 2011 and Table 1 lists the facilities that comprise the full build out of this managed lane network.

Relative Cost: Significant, as trucks on managed lanes would require: construction improvements to accommodate trucks, including pavement thickness, entry and exit points, and revised incident management practices.

Timeframe: Mid-term (11 to 20 years) to long-term (over 20 years).

Potential Issues: Access issues for trucks entering and exiting the managed lanes (weaving issues across multiple lanes).

FIGURE 2: 2050 REVENUE CONSTRAINED HIGHWAY NETWORK – PROPOSED MANAGED LANES LOCATIONS



Source: 2050 SANDAG RTP (adopted October 2011), Figure 1.2, page 1-9

TABLE 1: 2050 REVENUE CONSTRAINED HIGHWAY NETWORK – PROPOSED MANAGED LANES LOCATIONS (TABLE)

Facility	# of General Purpose Lanes per Direction	# of Managed Lanes per Direction
I-5 between Oceanside and I-805	Generally 4	2
I-5 between I-805 and I-8	4 to 5	1
I-5 between I-15 and SR 905	4 to 5	1
I-15, south of the existing Express Lanes to SR 52	5	2*
I-15 between SR 52 and I-5	4	1**
I-805 between I-5 and SR 905	4 to 5	2
SR 52 between I-805 and SR 125	3	1
SR 54 between I-5 and SR 125	3	1
SR 78 between I-5 and I-15	3	1
SR 94 between I-5 and SR 125	4	1
SR 125 between SR 54 and I-8	3 to 5	1

Source: 2050 SANDAG RTP (adopted October 2011), Figure 1.2, page 1-9
* - Moveable barrier to facilitate peak period operations (up to 4 express lanes in the peak direction of travel)
** - Between I-8 and I-805, the I-15 managed lanes would function as transit lanes only. Only transit vehicles would be allowed to use the managed lanes.

- Safety issues related to lane access and incident management on the managed lanes (particularly where only one managed lane is present).
- Operational issues related to traffic congestion and speed differentials (with the shared use of managed lanes by both autos and trucks).
- Engineering issues related to the use of managed lanes by trucks (e.g. impacts to pavement, direct access ramps, etc).
- Legislative issues related to existing truck speed and lane restrictions in California.

PST and Stakeholder Feedback:

- Current legislation would need to be revised to allow trucks of more than two axles in the HOV/HOT lanes.
- It is unlikely that this strategy will be acceptable to HOV drivers (even in off peak hours) due to safety perceptions and speed differentials between autos and large trucks.
- Can the direct access ramps be designed to accommodate large trucks?
- How would continuous access (i.e., no barriers) to HOV lanes affect truck accessibility? Some lanes are planned to have barriers, while others are not.
- There would be safety issues related to weaving if trucks have to merge across the general purpose lanes to access/exit the managed lanes.
- Incident management would be an issue for managed lane facilities with only a single lane.

5.) Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access)

Description:
Similar to Strategy #4, this strategy would also allow trucks on HOV/HOT lanes. However, truck access would be restricted to off-peak periods, off-peak directions, assigned to certain lanes, or certain truck types. Options for restricting access include:

- Off-peak use only (restrict truck access to off-peak periods).
- Non-peak direction of travel only (such as northbound away from San Diego in the AM peak, or southbound towards San Diego in the PM peak).
- Lane restrictions (trucks restricted to certain lanes in the HOV/HOT system when more than one lane is available). This could potentially involve the use of moveable barriers (such as on I-15) to allow for the use of trucks to use managed lane facilities during peak periods in the peak direction of travel.
- Restrictions by type, size, or weight of truck. For example, certain light duty trucks could be allowed to use the lanes, while larger trucks remain restricted.

Tolling options could include non-tolled, a flat toll, or a variable toll.

Flexible managed lane facilities could be made available with a prioritized hierarchy that reflects regional, state, and/or federal policy. As examples:

- Designating managed lanes for exclusive use by trucks may be too limiting at certain times and in certain locations, where flexible applications would yield greater overall benefits.
- During off-peak or non-commuting periods, pricing policies might allow or encourage lane availability to trucks (possibly at no charge) to induce truck traffic away from less desirable routes.
- Fees for truck access could be charged if there is a travel time advantage over other travel lanes and there are no attractive alternate routes.

Relative Cost: Significant, as managed lanes would be constructed to accommodate trucks from the standpoint of factors including pavement thickness, entry and exit points, and incident management.

Timeframe: Mid-term (11 to 20 years) to long-term (over 20 years).

Potential Issues:

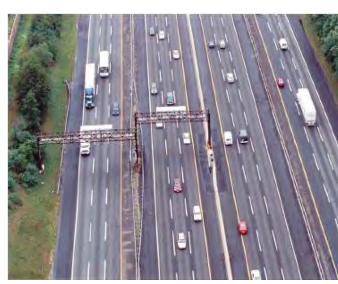
- Access issues for trucks entering and exiting the managed lanes (weaving issues across multiple lanes).
- Safety issues related to lane access and incident management on the managed lanes (particularly where only one managed lane is present).

- Engineering issues related to the use of managed lanes by trucks (e.g. impacts to pavement, direct access ramps, etc)
- Legislative issues related to existing truck speed and lane restrictions in California.
- Public acceptance (HOV)
- Safety issues related to use of managed lanes that are buffer separated.

PST and Stakeholder Feedback:

- This strategy would be very difficult unless punitive measures are implemented for trucks using the road infrastructure during other times. Truckers often need to work the same hours as their customers, 8 am - 5 pm pattern and customers expect most deliveries during "normal" business hours. The only exceptions include long haul truckers and deliverers of certain perishables that travel in the middle of the night to be ready for an early morning market (fresh fish, meat, or other perishables). Any strategy dealing with operating times would need to take into consideration changing hours of service rules for truckers.
- Both Strategy 4: Trucks on Managed Lanes (Full Access) and Strategy 5: Trucks on Managed Lanes (Restricted access), have elements that are very troubling. Strategy 5, while difficult, may be a bit more implementable.
- Consider a restriction by fuel type. Incentivize trucking companies to use clean fuels by allowing hybrid and electric trucks to access the managed lanes.
- Consider a restriction by truck type or size. Perhaps smaller trucks could benefit from use of the managed lanes.
- Are the direct access ramps being designed to accommodate large trucks?
- There would be safety issues related to weaving if trucks have to merge across the general purpose lanes to access the managed lanes.
- Incident management would be an issue for managed lane facilities with only a single lane.

6.) Designated Truck Lanes (Conversion of General Purpose Lanes)



Description: This strategy would designate lanes for trucks along key corridors and locations, through the conversion of existing general purpose lanes. Trucks would be required to use the designated lanes; autos could be either permitted or restricted from the lanes. Tolling options could include non-tolled, a flat toll, or a variable toll. If tolled, the use of the lanes could be made voluntary by continuing to allow trucks non-tolled access to the general purpose lanes.

Relative Cost: Potentially significant, based on considerations including pavement thickness, number and type of entry and exit points, and incident management concerns.

Timeframe: Near-term (0 to 10 years) to mid-term (11 to 20 years).

Potential Issues:

- Community acceptance (removing general purpose lane capacity would be controversial).
- Safety and traffic operations (auto weaving in and out of the designated truck lane to access freeway ramps).
- Legislative (existing MAP-21 requirements to maintain the same number of toll-free lanes, when adding new toll lanes).[2]

PST and Stakeholder Feedback:

- This option, if tolled, is not currently possible. According to MAP-21, a general purpose lane cannot be taken in order to toll it.
- A strategy that reduces capacity for autos by restricting them from a lane could be problematic and controversial, as it may worsen existing highway congestion conditions.
- Converting an existing general purpose lane to a truck-only lane would be challenging. Direct access ramp (DAR) access may be required on the left hand side and merging and weaving issues with passenger vehicles would occur on the right hand side (and would not provide much benefit over the current right lane restrictions in California).
- A potential beneficial component of this strategy is the option for varying truck lane access by time of day (dynamic lane assignment). This is similar to possibilities under the active lane management strategy (Strategy #10). This strategy could potentially be combined with Strategy #10.

7.) Designated Truck Lanes (Construction of New Lanes on Existing Facilities)

Description: This strategy is similar to #6, but instead of converting general purpose lanes, this strategy would include the construction of new lanes designated for trucks on an existing facility. Trucks would be required to use the designated lanes; autos could either be permitted or restricted from using the lanes. Tolling options could include non-tolled, a flat toll, or a variable toll. If tolled, the use of the lanes would be optional by continuing to allow trucks non-tolled access to the general purpose lanes.

2 USC Section 129(a)(1)(B)

Designated truck lanes may be separated by barriers or rumble strips to improve safety, and can be built to withstand greater vehicle weights. The intent of designated truck lanes is to attract the trucking industry to use them because the value proposition for the tolls would more than offset safety and productivity gains from using the lanes (due to reduced travel times, increased travel time reliability, reduced accident risk, and the potential for more lenient weight and length restrictions).

Relative Cost: High due to the planning, design, and construction of new lanes.

Timeframe: Long-term (over 20 years).

Potential Issues:

- Capital cost requirements could be high.
- Adequate right-of-way may not be available in developed areas.
- Appropriate ingress/egress of trucks to the dedicated facility (may be difficult to serve all truck trip types).
- Community acceptance could be challenging (due to potential impacts to local residences and businesses and/or the controversy of spending the funds to build a new highway facility).
- Environmental (could have an air quality and greenhouse gas benefit if traffic flow improves).

PST and Stakeholder Feedback:

- Truckers overwhelmingly favor this option with caution expressed about the potential cost of such improvements. This strategy directly clashes with efforts to move away from capacity expansion in the era of SB 375 and in air quality non-attainment areas. Under federal air quality conformity regulations, any expansion of freeway lanes requires justification as to why a transit option was not selected.
- Additional research is needed to know why similar projects in the San Diego region have been constructed but are not operated as such (i.e. I-5/805 and 56 by-pass lanes).

8.) Separate Dedicated Truck-Only Facilities (Construction of New Facilities)

Description: Similar to strategy #7, this strategy would involve developing a system of dedicated truck-only facilities/roadways. However, this system would be separate facilities, as opposed as new lanes on existing facilities. Trucks would be required to use the facilities, and autos would not be permitted. There is potential for the allowance of longer-combination vehicles (LCVs) with appropriate legislative changes. Tolling options could include non-tolled, a flat toll, or a variable toll. If tolled, the use of the lanes could be made voluntary by continuing to allow trucks non-tolled access to the general purpose lanes.

Dedicated truck lanes would separate trucks from other mixed-flow traffic to enhance safety and/or stabilize traffic flow. Priority and/or dedicated lanes for trucks can help to improve truck speeds and reduce truck/auto crashes as well as the associated long-term lane closures that can increase congestion-related greenhouse gas emissions. There are a few dedicated truck lanes in the United States, although they are rare (more are being studied). Of those that do exist, it is common to require trucks to use the dedicated truck lanes, while not expressly prohibiting their use by other vehicles as well.

Relative Cost: High due to the planning, design, and construction of new truck-only facilities.

Timeframe: Long-term (over 20 years).

Potential Issues:

- Capital cost requirements could be high.
- Adequate right-of-way may not be available in developed areas.
- Appropriate ingress/egress of trucks to the dedicated facility (may be difficult to serve all truck trip types).
- Community acceptance could be challenging (due to potential impacts to local residences and businesses and/or the controversy of spending the funds to build a new highway facility).
- Environmental (could have an air quality and greenhouse gas benefit if traffic flow improves).

PST and Stakeholder Feedback:

- Truckers typically strongly support this strategy; however, the concept clashes with regional efforts to move away from capacity expansion in the era of SB 375 and in air quality non-attainment areas.

9.) Variable Tolling Strategies for Trucks in General Purpose Lanes (Based on Traffic Conditions or Time of Day)

Description: This strategy would toll trucks on freeways based on traffic conditions or time of day, with the aim of shifting truck travel to off-peak periods. Tolling options include non-tolled, a flat toll, or variable tolls.

Relative Cost: Moderate – while this strategy does not require new physical infrastructure, it does require technology mechanisms (in-vehicle devices, toll transponders and overhead gantries) that toll trucks using existing freeway lanes. This strategy requires legislative changes which would be expensive due to litigation.

Timeframe: Mid-term (11 to 20 years) to long-term (over 20 years).

Potential Issues:

- Legislative issues (tolling existing general purpose lanes is currently not allowed under existing legislation).
- User acceptance (the toll would not offer the trucking industry any tangible benefits in the form of improved travel times or travel time reliability).
- Community acceptance (truck traffic would likely shift to parallel arterials that are not designed for trucks to avoid the toll, impacting neighborhoods).

PST and Stakeholder Feedback:

- This strategy would not be popular among the trucking industry and would not improve truck mobility.
- Any tolls charged to trucks will ultimately be passed on the consumer. If tolling is considered for this or any of the strategies, all trucks should be tolled, not just certain types of trucks. The trucking industry is generally not supportive of tolling concepts, and would legally challenge unless non-tolled options remain the same area.
- Tolls tend to shift trucks onto alternate facilities, for example 125 is not used very much by trucks because it is tolled. If the toll were removed, it would help shift some truck traffic off of I-805.
- Consider the inverse – what about tolling all passenger cars, but not trucks?
- Tolls on existing highways often force trucks to secondary roads and safety incidents can increase.

10.) Intelligent Transportation Systems (ITS)[3]/Active Traffic Management (ATM)[4] and Lane Assignment

Description: This strategy uses ITS and ATM technologies (both external and in-vehicle) to improve truck mobility and safety. ITS applications for

[3] ITS is a term that refers to a broad array of strategies for advancing transportation safety, mobility, and environmental sustainability by integrating communication and information technology applications into the management and operation of the transportation system across all modes.

[4] ATM refers to dynamically managing & controlling traffic based on prevailing conditions to improve safety, respond to recurring & non-recurring congestion, and increase throughput & reliability. ATM includes the management of traffic operations in real-time, distributing current roadway & traveler information, deploying a range of operational strategies, and using integrated systems & coordinated response mechanisms. Example ATM strategies include speed harmonization, lane control, advanced queue warnings, temporary shoulder usage, and dynamic signing and advisory traffic routing, among others.

commercial vehicle operations can also enhance communication between motor carriers and regulatory agencies.

Examples to improve truck mobility and safety include variable speed limits by lanes (to help reduce speed differentials), dynamic routing of trucks, and lane-keeping technologies (in-vehicle systems that help drivers stay in control behind the wheel). Examples to improve communications and efficiencies include electronic registration and permitting programs, electronic exchange of inspection data (i.e. instantaneous credential and safety-related electronic screenings that can allow some trucks to bypass weigh and inspection stations), and applications to assist operators with fleet operations and security.

Relative Cost: Modest (relative to alternatives that require new infrastructure).

Timeframe: Near-term (0 to 10 years) to mid-term (11 to 20 years).

Potential Issues:

- Legislative issues (existing truck lane restrictions in CA may be an issue for dynamic truck lane assignment).
- Telematics may change rapidly in the future; the innovation curve will be fast and steep.
- Strategy may be challenging to enforce.
- Implementation would likely occur in phases (benefits may be difficult to realize immediately).

PST and Stakeholder Feedback:

- In general, this strategy makes sense in concept and is technically feasible" since it would help to optimize the efficiency of the existing system, in a cost effective fashion, without adding capacity.
- In practicality, when should these types of strategies be implemented? Do they need to pencil out from a cost perspective? Do these strategies really assist in getting better person throughput?
- If you have a corridor where accidents are a concern, this strategy could assist with accident avoidance.
- This strategy would also benefit and fold into the concurrent Caltrans Managed Lanes Study, The study is looking at laying conduit, fiber optics, etc. to allow for the potential implementation of ITS/ATM and tolling technologies, even if it is not known exactly know what will be implemented yet.
- This strategy could provide value by monitoring speed, volume, and congestion on the existing network; provision of robust congestion data is necessary even if lanes are not actively managed.

Fatal Flaw Discussions and Review

The PST discussed and analyzed all ten strategies and it was determined that three strategies were either redundant as stand-alone strategies or inappropriate for further analysis at this time. These strategies are described below:

- **Strategy # 4: Trucks on the Planned Network of High Occupancy Vehicle / High Occupancy Toll (HOV/HOT) Managed Lanes (Full, Unrestricted Access).** The project team heard multiple concerns from both trucking industry and broader community stakeholders related to access, operations, and safety related to the allowance of full, unrestricted access for trucks on the planned network of HOV/HOT lanes. Additionally, current legislation would need to be revised to allow trucks of all sizes in the HOV/HOT lanes and there are no solid successful examples of this strategy operating elsewhere in the United States.
- **Strategy #6: Designated Truck Lanes (Conversion of General Purpose Lanes).** Converting an existing general purpose lane to a truck-only lane would be challenging. If lanes were designated truck-only on the left hand side of the freeway, direct access ramp (DAR) access may be required and if the lanes were on the right hand side, weaving issues with passenger vehicles could occur(and would not provide much benefit over the current right lane restrictions in California). Additionally, converting a general purpose lane from auto to truck is highly controversial and the potential to then manage the truck lane with tolls would additionally require a change in existing legislation. Also, designation for trucks in one particular lane could be accomplished under Strategy #10 (ITS/ATM) through dynamic lane assignment, simplifying the analysis.
- **Strategy # 9 – Variable Tolling Strategies for Trucks in General Purpose Lanes (Based on Traffic Conditions or Time of Day).** Tolling strategies for trucks in general purpose lanes does little to meet the problem statement goal of enhancing truck mobility. While mobility for passenger vehicles may be somewhat improved by shifting truck traffic to alternate times of day or routes, the toll would be punitive in that it would not offer the trucking industry any tangible benefits in the form of improved travel times or travel time reliability, or a non-tolled option. Also, tolls can cause diversion of trucks to alternate routes that are not designed to accommodate trucks. Strong opposition and litigation would be expected from trucking industry, negative impacts could occur within local communities due the diversion of trucks onto local arterials, and it would also be legislatively difficult to implement as tolling existing general purpose lanes is currently not allowed under existing legislation.

Due to the reasons described above, the project team and PST agreed to narrow the strategy list to seven broad strategies as follows.

Final Strategy List for Analysis

1. **Base Case Scenario:** Consider what the future looks like for goods mobility in the region if no new actions are taken to address truck mobility.

2. **Traffic Organizational Strategies at Freight Gateways & Distribution Hubs:** Coordinated strategies to optimize truck traffic flow at key locations. The strategies implemented could range from simple to more complex and include ITS/Communication strategies (such as the use of variable message signs and 511 announcements to provide real-time information to truckers to help them avoid congestion and bottlenecks) and infrastructure-based strategies (such as dedicated trucks lanes or facilities in key bottleneck locations).

3. **Travel Demand Management Strategies with Truckers and Shippers/ Receivers:** Facilitate the shifting of trucks to off-peak travel times, based on pricing incentives and fees.

4. **Restricted Access for Trucks on the Planned Network of HOV/HOT Managed Lanes:** Allow restricted access to the network of managed lanes, for example during off-peak periods, for off-peak directions, and/or assign trucks to certain lanes.

5. **Designated Truck Lanes:** The construction of new lanes on existing facilities, such as truck bypass lanes, truck routes, or climbing lanes.

6. **Separate Dedicated Truck-only Facilities:** The construction of new facilities dedicated for trucks.

7. **Intelligent Transportation Systems/Active Traffic Management and Lane Assignment:** Use technologies (both external and in-vehicle) to improve truck mobility and safety. Optimize the operational flexibility of the freeway through lane assignment, active speed management, and/or dynamic signage.

These seven potential strategies will serve as a starting point for further analysis and review as the study proceeds.

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Technical Memorandum #4: Data Collection

IBI Group, CH2M HILL, Cheval Research

June 7, 2013; Revised August 26, 2013

Table of Contents

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Technical Memorandum #4: Data Collection

TO: Andrea Hoff and Christina Casgar, SANDAG

FROM: IBI Group, CH2M HILL, Cheval Research

DATE: June 7, 2013; Revised August 15, 2013

1. Introduction

This memorandum describes the data collection process, methodology, and findings conducted to support the analysis of the potential truck management strategies identified in Technical Memorandum #3: Strategy Development. This memo includes a summary of both current and projected truck operations and safety data along the region's freeways, as well as findings from trucking industry stakeholder interviews conducted as a part of this study. The memorandum concludes with a discussion of the recommended corridors and gateways/hub focus areas to evaluate truck management strategies in the region.

2. Background

2.1 Trucking Industry Overview

The trucking industry in the San Diego region has characteristics of any major metropolitan area in the United States and some unique characteristics based on San Diego's position on the Pacific coast and adjacent to the international border with Mexico. The types of trucking are diverse and include a mix of local, regional, and long-haul operations. Regional trucking operations supporting through- freight movement to and from the U.S.-Mexico border, and to and from the Ports of Los Angeles and Long Beach must traverse San Diego County. Port trucking operations at those two ports are largely containerized with some break bulk freight destined for all points served by those ports internationally and domestically. Likewise, local trucking operations must also serve the large San Diego area population by bringing goods into the region and distributing those goods for local consumption. San Diego is not a high-production and distribution region compared with Los Angeles and the Inland Empire (Riverside, San Bernardino, and Ontario metropolitan areas), so many laden vehicles are coming into the County from external origins for local distribution or cross-border operations.

Additionally, the Port of San Diego has become a less congested West Coast alternative for automobiles, fruit, Hawaii-bound cargo, and bulk cement. Movement of these goods is supported by regional and long-haul car haulers, refrigerated trucking operations, and bulk product trucking operations. Hawaii-bound cargo is supported by trucking operations of all types. The importation of windmills and other large ancillary equipment at the Port of San Diego has also recently been supported by specialty oversize trucking operations and other long-haul carriers. San Diego also hosts a variety of light manufacturing operations and food and beverage distribution operations, and the trucking operations that support them. Air freight and construction are further supported by respective specialty trucking operations within the County.

Trucking in San Diego locally, regionally, and beyond will be required to adapt to the changes in the region's demographics. All trucking operations are responsive to shippers and receivers who are, in kind, responsive to the needs and demands of the population. As the population grows, trucking will need to expand to accommodate an increased need for food, clothing, supplies, consumer goods, vehicles, fuel, agricultural products, construction and building materials, and manufacturing materials. The American Trucking Association estimates truckload volumes will grow nationally 3.2% through 2018 and 1.1% annually between 2019 and 2024. Less-than-truckload volume should grow nationally 3.5% annually through 2018 and by 2.4% until 2024[1]. Furthermore, San Diego's truckers will also need to respond to increased goods movements expected due to increases in cross-border trade in the coming decades.

Therefore, the importance of mobility through the region is as important as mobility within the region for the trucking companies tasked with moving both local and through freight. The interviews conducted as part of this data collection effort seek to provide real-world information to validate statistical and model data collected throughout this study and to support the assessment of truck management strategies that make sense for both the region and the truck transportation industry.

3. Trucking Industry Stakeholder Interviews

3.1 Trucking Industry Interview Methodology

Approach to Interviews

The intent of the trucking and trade industry interviews was to attain a real-world understanding of the mobility issues facing trucking companies operating in the San Diego region. The interviews are not intended to provide a statistically significant data set; instead, their purpose is to supplement and validate statistical and model data compiled by the project team. Sixteen interviews and one focus group were conducted. The goal was to identify problem areas and efficiency issues that would not otherwise be identified by traffic and transportation data collection and model analysis.

Interviewee Selection

Interviewees were selected to represent a cross-section of the types of trade and trucking operations currently conducting business within San Diego. Representatives of trade associations, shippers, receivers, manufacturers, and trucking companies were included among the interviewees. The major focus for this study was on truck transportation operations, thus the largest group were the trucking companies.

Different types of trucking operations will be affected somewhat differently by the identified freeway truck management strategies. The operational characteristics of a cross-border container hauler are very different than those of a local beverage distributor or an air freight

[1] American Trucking Association, U.S. Freight Forecast to 2024 (June 26, 2013)

carrier. Trucking companies were selected so that a variety of operational characteristics may be broadly considered in strategy development and analysis. The following interview selection factors were used to achieve a variety of interviewees:

- Base of operation
- Range of operation
- Size and weight of vehicles
- Type of operation

Each of the interview selection factors is discussed in the following sections.

Base of Operations

For the purposes of this study, major truck trip production areas within the County were identified. The list below identifies areas where truck activity was deemed to be elevated enough to warrant a better understanding of trucking operations and challenges in those areas. During the selection process, at least one interviewee was sought within each of the identified truck trip activity areas. These areas also coincide with the trucking gateways and distribution hubs that were formalized later in the study and are discussed in the Key Findings section of this document (see Figure 65).

- Vista/SR 78 Corridor
- Mira Mesa/Sorrento Valley
- Scripps Poway Parkway
- Kearny Mesa
- San Diego Int'l Airport
- Port of San Diego (10th Avenue Marine Terminal and National City Marine Terminal)
- National Distribution Center (Adjacent to Port of San Diego, National City Marine Terminal)
- El Cajon/Santee
- Military Bases
- US/Mexico International Border
- Based outside the San Diego Region (including, but not limited to, Baja California, Mexico, and the counties of Imperial, Riverside, San Bernardino, Orange, and Los Angeles.)
- Other Regional

Range of Operations

For the purposes of this study, ranges of operations were categorized as local, regional, or long-haul to describe the length of a truck trip and where it originates and terminates, and they are defined as follows:

- **Local** – Truck trip originates and terminates within San Diego County. SANDAG model data refers to this type of trip as Internal-Internal. (Shown in red)

- **Regional** – Truck trip originates or terminates in San Diego County, but travels to or from another location within Southern California (for this study, defined as all bordering counties, Baja California/Mexico, and Los Angeles County). (Shown in blue)
- **Long-haul** – Truck trip originates or terminates in San Diego County, but travels outside the region (defined above), **OR,** originates **and** terminates outside the region, traveling through San Diego County (also known as "through freight"). (Shown in green)

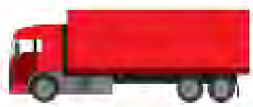
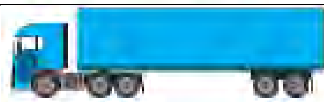
Figure 1 – Local, Regional and Long-Haul Truck Trips

Local, regional, and long-haul operators, or a combination thereof, were sought as interviewees for the study. Each type of trip represents different needs in terms of requirements for services, parking, driver accommodations, hours of service, fuel requirements, and operational flexibility. Interviewees were selected that represented each range of operation category, and often more than one category.

Size and Weight of Vehicles

For the purpose of this study, trucks were divided into three major categories, light-duty, medium-duty, and heavy-duty, as described in Table 1 below:

Table 1 – Truck Classification

Category	Example	Description[a]
Light-duty		Generally smaller and lighter trucks (up to 14,000 lbs), with no more than 2 axles.
Medium-duty		Generally slightly bigger and heavier trucks (up to 33,000 lbs), with 3 to 4 axles.
Heavy-duty		Generally the largest and heaviest trucks (over 33,000 lbs), with 5 or more axles.

a. Truck weights were revised slightly from the definition included in Technical Memorandum #2: Issue Identification. This was done to more closely align the truck type definitions with the definitions used in the SANDAG truck model.

Trucking companies were selected that had vehicles in each representative category so that any particular operational characteristics for that category may be considered in strategy development and evaluation.

Type of Operation

The following types of operations represent different types of freight and conveyances with diverse operational requirements. Therefore as interviewees were selected, a cross-section of different types of operations were incorporated as selection factors. The type of operation indicates a broad category of trucking operations that have unique operational characteristics. The operation types used as selection factors include the following:

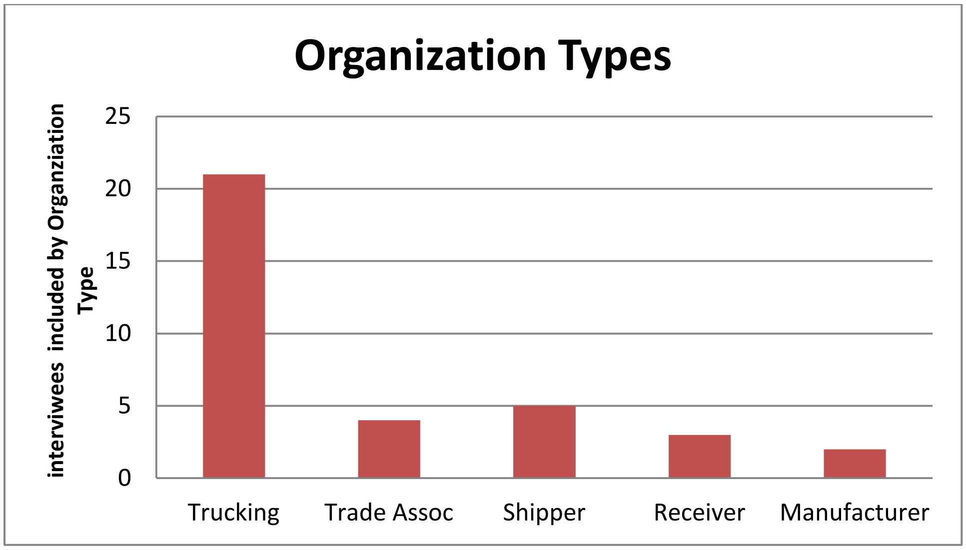
- Food and Beverage Distributors
- Small Package Carrier
- US/Mexican Cross-Border Carrier
- Produce Carrier
- Container Carrier
- Less than Truckload (LTL) Carriers
- Dry Freight Carrier
- Major Grocery Carrier
- Air Freight Carrier
- Military Support Operations

Overview of Selected Interviewees in the Region

Thirty potential interviewees were identified that satisfied the goal of incorporating each of the previously identified selection factors. A total of 17 individual interviews and one focus group were conducted.

The following chart indicates the number of individuals or companies within each organization type that participated in the interviews or focus group.

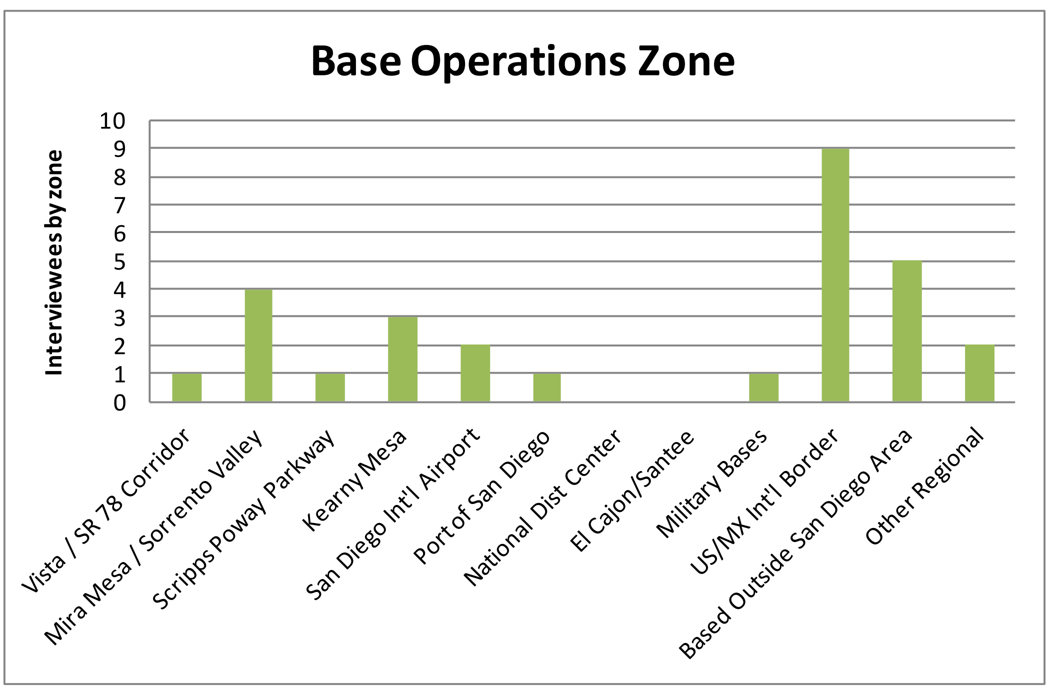
Figure 2 – Organization Types



Base of Operations

All identified base of operation areas were covered by the selected interviewees with two exceptions; the base operation zone interviewees in El Cajon/Santee and the National Distribution Center did not respond or were unable to participate within the time required for this study.

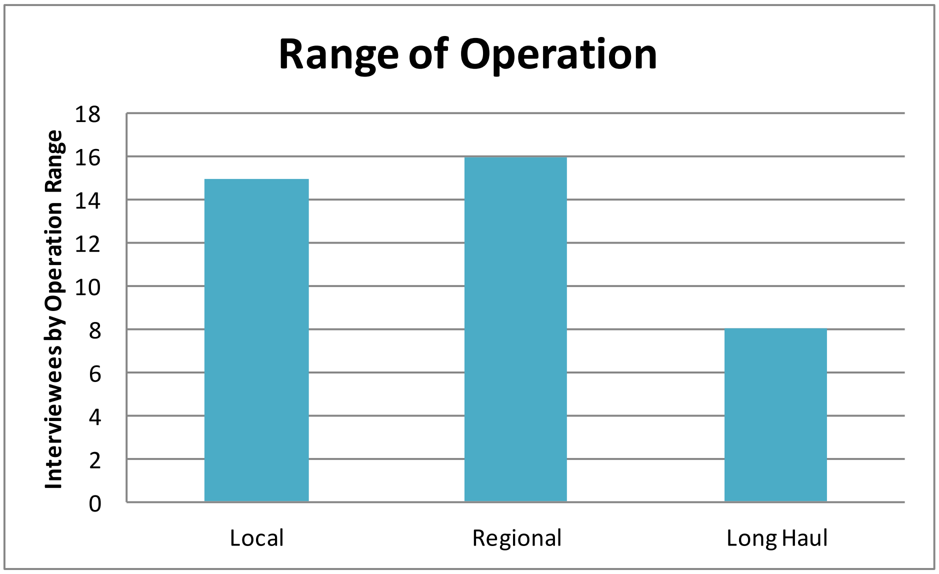
Figure 3 – Base Operations Zone



Range of Operation

Most interviewees had a combination of both regional and local ranges of operations. The numbers in the chart below represent the total type of operations, where some interviewees had more than one type within their organization.

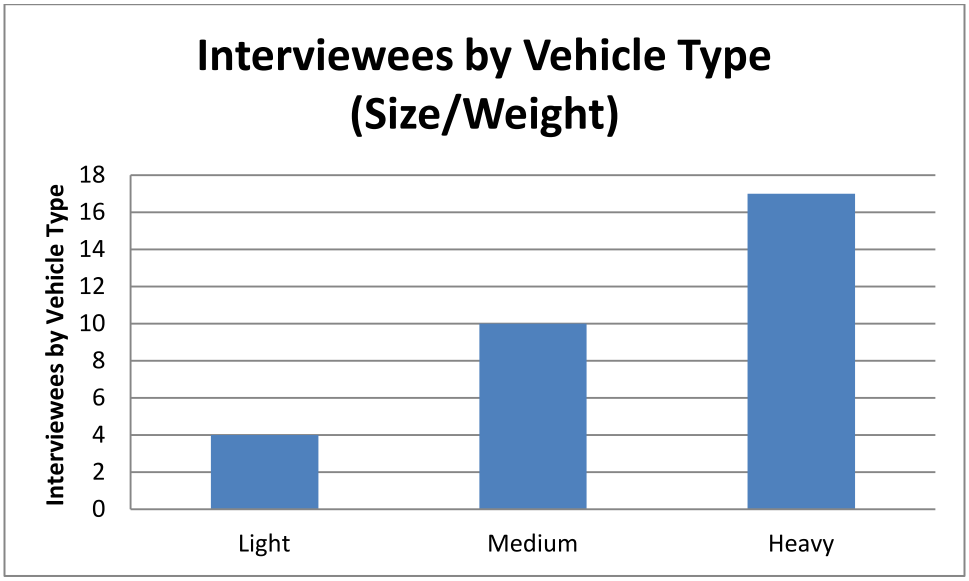
Figure 4 – Range of Operations



Size and Weight of Vehicles

This chart represents the dominant type of vehicle in the interviewee's truck fleet. This chart does not represent the number of vehicles in the fleets. Although only three interviewees had light vehicles in their fleets, the largest number of vehicles operating locally are in the class of light vehicles. Most interviewee fleets were comprised of heavy vehicles (tractor/trailer combinations).

Figure 5 – Interviewees by Vehicle Type



Interview and Focus Group Scheduling and Implementation

Potential interviewees were contacted by telephone or in-person at local trucking and trade industry events and meetings. Individual interviewees were company executives or operations managers. Appointments often included a number of individuals within the company that provided complementary operational expertise. Appointments were scheduled for 60 minutes. Most interviews averaged about 90 minutes, with permission of the interviewee. Most interviews required between two and four weeks lead time. Interviewees were provided with project background information and a summary of the information that would be requested during the interview.

For this study, a focus group was formed with selected interviewees to ensure that the border trucking and trade community concerns were documented accurately and comprehensively. The international border with Mexico is a major and important trucking operation zone with an active community interested in participating in the region's planning processes. Ten border trucking and trade industry representatives were selected to participate in this focus group. This meeting was scheduled for 75 minutes and included a presentation of potential truck management strategies for comment by the group.

Interview Questions and Format

The intent of the interviews was to attain a real-world understanding of the mobility issues facing trucking companies operating within the San Diego region, and to validate quantitative data sources. The interviews and focus group assisted in identifying problem areas and efficiency issues that would not otherwise be identified by traffic and transportation data collection and model analysis. Given these goals, the interview instrument was developed as a guide to assist the project team in understanding what problems currently exist on the San Diego region's freeway and major arterial systems and why they are problems for certain types of trucking operations or vehicle types. Finally, the interviews were an opportunity for the project team to listen to ideas and solutions that the trucking and trade community thought would be most applicable and helpful in improving operating conditions, in the near and long term.

The interview was conducted in two parts. The first part focused on demographic information about the interviewee's transportation operations (e.g. fleet size, vehicle types, operational hours, seasonal fluctuations, etc.). The second part focused on current problem areas and presented potential strategies for addressing truck mobility on San Diego regional freeways and then asked for comments and additional ideas.

Interviews were conducted confidentially. Interview data summarized in this report will not disclose the identity of any individual respondent. This approach allowed respondents to discuss their operational and transportation issues candidly and to protect any competitively sensitive information.

The Interview Guide is provided in Appendix A.

3.2 Trucking Industry Interviews Summary

Demographics Summary

Interviewees included both trucking companies and trade associations that represent trucking and trade communities. Trucking company interviewees were asked to think about their current operations and provide some basic information about their fleet, operations, and current highway operational issues and problems.

Interviewees were asked about their fleet size and the truck types (i.e. the number of light, medium, heavy trucks in their fleet).

Interviewees represented a diverse cross-section of operation types and included both large and small companies; they included owner-operators with a single truck operation and major trucking and distribution operations in San Diego comprising a large number of vehicles and truck movements within and through the County.

Table 2 represents a snapshot of the interviewees and their respective type and size of operation. Among the respondents, there were eight that participated in a Cross-Border Trade and Trucking Focus Group. Their responses have been consolidated in the remainder of the discussion and will be represented in subsequent sections under respondent ID# 1. There were also four trade association representatives interviewed; their demographic information is not applicable due to their representation of a larger group of stakeholders.

This demographic information is intended to provide a sense of the types of companies and organizations that represent the opinions and information conveyed in the remainder of the interview summary sections.

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Table 2 – Snapshot of Interviewee Demographics

				Heavy	Heavy	Medium	NA	Light
Respondent ID #	**Interview or Focus Group**	**Operation Type**	**Base of Operation**	**Tractors (3 axle)**	**Tractors (2 axle)**	**Straight Trucks**	**Trailers/Chassis/Containers**	**Other Light Vehicle Types**
1	Focus Group	Cross-border carrier	Tecate	51	0	0	107	0
2	Focus Group	Cross-border carrier	San Diego/Otay Mesa	31	0	0	0	0
3	Interview	Trade Association (Manufacturing)	San Diego/Otay Mesa	NA	NA	NA	NA	NA
4	Focus Group	Cross-border carrier	San Diego/Otay Mesa	16	0	1	75	0
5	Focus Group	Cross-border/Port drayage carrier	San Diego/Otay Mesa	168	0	0	0	0
6	Focus Group	Trade Association (Freight Brokerage)	San Diego/Otay Mesa	NA	0	0	0	0
7	Interview	Major Small package carrier	Los Angeles and San Diego	100	0	395	100	0
8	Interview	Container transport carrier	San Diego/Otay Mesa	Uses for-hire dray operators only	0	0	0	0
9	Interview	Trade Association (Trucking)	National	NA	NA	NA	NA	NA
10	Interview	Air freight carrier	San Diego	15	5	2		
11	Focus Group	Cross-border /Drayage carrier	San Diego/Otay Mesa	34	0	0	0	
12	Interview	Local Distribution Trucking	San Diego	2	38	2		
13	Interview	Beverage/Snack Foods carrier(Local Distribution)	San Diego	0	0	28	0	77 (route vans)
14	Interview	Beverage/Snack Foods carrier (Local Distribution)	San Diego	20	0	0	20	0
15	Interview	Local Distribution carrier (Private)	Los Angeles	3	0	0	4	
16	Interview	Port/produce operation	San Diego	Uses for-hire trucking companies and O-Os Moves 500 containers per week	NA	NA	NA	NA
17	Interview	Trade Association (Trucking)	State of California	NA	NA	NA	NA	NA
18	Interview	Container transport carrier	San Diego (for truckers/owner-operators)	60	0	0	7000 (using rail chassis)	0
19	Interview	Major Grocery Chain carrier	Los Angeles	239	0	0	750	0
20	Interview	Major Small package carrier	San Diego	91	32	4	77	10 (vans)
21	Interview	Beverage Distribution carrier	San Diego	0	62	0	65	0
22	Focus Group	Cross-border carrier /Freight Forwarding	San Diego/Otay Mesa	1	0	0	0	0
23	Focus Group	Freight Forwarder	San Diego/Otay Mesa	NA				
24	Interview	Dry freight carrier	San Marcos	3	0	0	4	
25	Interview	Air freight carrier	San Diego	6	3	10		
26	Interview	Local Distribution carrier	Poway	72	20	1		2 (vans)
27	Interview	Military Support carrier (Trucking & Service Vehicles)	San Diego	43		35		195 (light trucks), 180 (passenger vans)

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Operations Summary

Respondents were asked the following questions during the interviews. A summary of their responses is grouped by operation type.

1. Number of inbound trucks? Per day? Per week? Per Month?
2. Number of outbound trucks? Per day? Per week? Per Month?
3. Are your operations seasonal? Please describe.
4. What locations would you consider your primary trip origins (A general location is ok)
5. What are your primary destinations? (A general location is ok)
6. What major corridors/freeways do your truckers use to traverse the region?
7. What access routes do your truckers use to get to the major corridors?

Truck Movements and Peak Truck Activity

How trucks move in and through San Diego County varies widely across carrier types and the customers that they serve. Truck movements, including the frequency, number, and time of day are primarily driven by the shipper or receiver of the freight being hauled. Respondents to the interviews collectively agreed that truckers respond to the requirements of shippers and receivers and adjust their schedules and routes accordingly.

Small package carriers (Respondent ID #s 7 and 20) are among the most active and numerous in the County. Respondents indicated that consumer goods purchased online have increased volumes over the recent decade and are continuing to trend upward. Respondent # 7 has major consolidation and wide area distribution facilities located outside the County (in Los Angeles or the Inland Empire). Respondent # 20 also has a major consolidation facility in San Diego County. The large facilities send truckloads into the County to distribution facilities located either centrally (for one carrier) or to any of three locations (for the other carrier). These movements typically take place during early morning off-peak hours. A combination of tractor trailers and smaller vehicles (either straight trucks or package vans) then distribute the packages to their final destinations. The smaller package vehicles operate at varying hours, including during peak traffic hours

Cross-border carriers (Respondent ID #s 1, 2, 4, 11, 22, 23 and 5) and container carriers (Respondent ID #s 8 and 18), including transloaded vehicles and drayage trucks, move much of their freight between the border at Otay Mesa/Mesa de Otay and the Ports of Long Beach and Los Angeles, or to intermodal rail heads in the Inland Empire (east of Los Angeles, in Riverside and San Bernardino Counties). Cross-border carrier truck movements are constrained by the hours of operation of both U.S. and Mexican customs facilities and the shippers and receivers that they serve. Northbound trucks must cross between 6:00 AM and 7:00 PM on weekdays, and 8:00 AM until 2:00 PM on weekends and holidays. Southbound trucks must exit the freeway (SR 905) to local arterials to get into queues to access the outbound U.S. cargo export facility and the Mexican commercial vehicle port of entry. Queues form predominantly on La Media Road and Siempre Viva Rd. The cargo export facility operates from 8:00 AM until 8:00 PM on weekdays, and 9:00 AM until 2:00 PM on weekends and holidays.

Table 3 – Summary of US/Mexican Commercial Vehicle POE Hours of Operation

	Northbound Commercial Vehicle POE	Southbound Commercial Vehicle POE
Weekday Hours	6:00AM – 7:00PM	8:00AM – 8:00PM
Weekend and Holiday Hours	8:00AM – 2:00PM	9:00AM – 2:00PM

Air freight carriers (Respondent ID #s 10 and 25) operating in San Diego schedule their movements around flight schedules. Most third party air freight transportation operations are off-site in San Diego and must use the freeway and/or local arterials to get to the San Diego International Airport (SAN) air freight facilities. Primary access routes include I-5, Harbor Dr., and Pacific Highway. One air freight respondent (#25) also shuttles freight between SAN or a Mira Mesa based warehouse facility and Los Angeles International Airport (LAX) and John Wayne International Airport (SNA) in Orange County, using Harbor Dr., Pacific Highway, and I-5.

Less than truckload (LTL) and local distribution carriers (Respondent ID #s 12, 15 and 26) interviewed for this study are typically daily route-oriented movements serving customers throughout the County. Most provide a variety of supplies and products to other businesses. Two respondents (#s 12 and 26) are based in San Diego County and the third (# 15) is based in Los Angeles, making daily trips into San Diego County. As with other trucking operations, these carriers are bound by their customer's receiving schedules, which may not be off-peak traffic hours. Respondent # 15 delivers most freight in the region between midnight and 7:00 AM. All of these carriers attempt to route their drivers to avoid peak traffic congestion areas when possible. Respondent # 15 uses I-5, I-805, and SR 905. Respondents # 12 and # 26 use all major freeways in the County. Respondent # 26 is based in Poway and is heavily dependent on I-15.

Beverage and snack food distributors (Respondent ID #s 13, 14 and 21) interviewed serve a variety of stores and outlets for groceries, convenience foods, alcoholic and non-alcoholic beverages located throughout San Diego County. These carriers have routine routes that vary slightly with customer inventories and seasonal summer peaks. Respondent # 14 is responsible for stocking distribution centers and has truckloads coming into various locations in San Diego County from 8:00 AM to 10:00 AM, 11:30 - 1:00 PM and then from 5:00 PM staggered throughout the night. This respondent uses I-5 and I-15 to enter the County and I-8. Respondent # 13 is responsible for daily route deliveries and uses most major freeways and arterials in the County without exception. Respondent # 21 also uses most major freeways and is based in the Miramar area; Miramar Road and Mira Mesa Blvd. are major arterials used.

Respondent # 19 represents a major grocery chain with approximately 55 stores in San Diego County. The chain operates its own tractors and trailers and conducts a 24/7 operation delivering only to its own supermarkets. All warehouse and distribution operations are located in Los Angeles and the Inland Empire. Trucks entering the County use I-5 and I-15 respectively, then use all major freeways to reach store locations. Travel and delivery times depend on the commodity to be delivered and store receiving schedules. Many stores are constrained to receive within curfew hours set by local municipalities, shopping center owners, or local community groups (which precludes travel and delivery during off-peak hours).

The Military carrier (Respondent ID # 27) interviewed provides transportation services to four major military installations (Naval Base San Diego, Navy Base Coronado, Naval Base Point Loma, and Marine Corps Air Station (MCAS) Miramar) in the San Diego metropolitan area. This respondent's operation includes an extremely diverse fleet of vehicle types hauling freight, service equipment, and passengers. Trucking operations include heavy tractor-trailer and medium-duty straight trucks. The truck and trailer fleet is comprised of mostly flatbeds, but also includes dry vans, refrigerated vans, end-dumps, tilt-beds, low-boys, roll-offs, cranes, street sweepers, stake beds, fuel tankers, and refused trucks. The operation includes about 800 local round-trips per month to the local Naval bases with occasional trips outside of the San Diego area, but within the region. The truck-trip volumes provided by this respondent include only truck-trips conducted by vehicles in their fleet and do not include for-hire trucks picking up or delivering freight to any of the four bases. The respondent indicated that there is significant for-hire truck activity but was not able to quantify volumes at the time of this interview. This respondent's operations are conducted predominantly from 6:00 AM to 4:30 PM. The greatest difficulty with congestion around the bases is experienced in the morning between 6:15 AM to 7:00 AM. Frequently used local arterials and state routes include SR 75, 8th Street (National City), Harbor Dr., North Harbor Dr., Pacific Highway, SR 282, Orange Ave. (Coronado), Rosecrans Blvd., and Catalina Boulevard. Corridors used include I-5, I-805, I-15, I-8, SR 94 and SR 125.

Major Congestion and Problem Areas

Interviewees were asked the following:

1. What are your major congestion points now?
2. What are any other problems that you are having moving your trucks to their destinations now?

The following section provides a consolidated summary of their responses.

In general, any major traffic congestion hot spot for commuters is also a problem area for trucks. Respondents indicated that it is more difficult for a large vehicle to merge in tight, slow moving traffic where passenger car drivers are less forgiving. They also indicated that additional fuel costs, driver fatigue, wear and tear on the vehicles, labor costs, and service failures are all negative outcomes of congestion delays.

- Improving and creating access for trucks to freeways from congested arterials is highly-important and of particular concern for trucking operations located in the Miramar, Sorrento Valley, Mira Mesa, and San Marcos areas.
- Event-driven and seasonal congestion mitigation is needed around major venues to assist truckers in maintaining predictable delivery schedules. Respondents repeatedly mentioned delays related to traffic at or near the following locations:
    - San Diego County Fair (Del Mar) and Racetrack at Via De La Valle and I-5
    - Comic-Con in downtown San Diego and SR 163
    - MCAS Miramar Air Show along I-15

- Beach event traffic along I-5, from La Jolla to I-8

- Respondents repeatedly expressed safety concerns and frustration with delays at the following highway interchange locations:
  - SR 163/I-8 (congestion and difficulty merging)
  - SR 163 and Friars Rd. (difficulty merging, congestion at southbound exit)
  - The I-805/I-5 merge (both directions in the AM and PM)
  - SR 905/I-805 and SR 905/I-5
  - I-805 northbound in the AM and southbound in the PM
  - Coronado Bridge in the AM (particularly southbound I-5 to SR 75 (Coronado Bridge exit) due to the rapid reduction in lanes requiring quick merges into a single lane)
  - SR 78 at I-15 and I-5
  - Palomar Airport Rd. (congestion, lane change difficulty)
  - San Marcos Blvd. (congestion, lane change difficulty)
  - I-15 in the Rancho Bernardo vicinity (congestion, stop and go traffic speed disparities)
  - I-5 on Fridays (congestion, stop and go traffic speed disparities)
  - I-5 from Oceanside and Carlsbad south to Mission Bay during peak traffic hours on weekdays
  - SR 52 (either direction during peak traffic hours (congestion, stop and go traffic speed disparities))
  - The north end of SR 125 at SR 94 (congestion, difficulty merging)
  - SR 125 at I-8 (congestion, difficulty merging)
  - I-8 signage for wind advisories to far inland
  - Mira Mesa Blvd. during peak traffic hours; I-805/Mira Mesa Blvd. on/off ramps; I-15/Mira Mesa Blvd. on/off ramps
  - Miramar Rd. during peak traffic hours; I-805/Miramar Rd. on/off ramps; I-15/Miramar Rd. on/off ramps
  - I-5 and La Jolla Village Dr. (congestion, stop and go traffic speed disparities)
  - Harbor Dr. and N. Harbor Dr.
  - Arterials serving military base gates (adjacent to Naval Base San Diego, Naval Base Coronado, Naval Base Point Loma, MCAS Miramar as described in the Section: Truck Movements and Peak Truck Activity)

    - La Media Rd. and Siempre Viva Rd. at the US/Mexican border (Long queues along these roadways during peak commercial vehicle traffic hours; no services for drivers; queue not managed; conflicts with local access to businesses and side streets.)

- Receiving hours, restricted routes, and curfews for certain delivery locations were also mentioned as issues precluding off peak travel and delivery for many carriers. Labor costs for night crews at the receiving facilities are prohibitive or undesirable for some businesses. Route restrictions and curfews at delivery locations coinciding with residential neighborhoods are also constraints on flexibility for truckers.
- Access to and availability of parking in downtown delivery locations creates delays in deliveries and increased costs due to parking citations. Some carriers consider this a cost of doing business.
- Unpredictability of congestion is a major factor for carriers; routine congestion can be planned for, whereas delays due to traffic collisions can cause service failures for some carriers (up to and including missed jets at air freight terminals).

Current Truck Focus Areas – Identified by Interviewees

Current truck focus areas were identified through feedback from the trucking industry stakeholder interviewees. Different interviewees identified different areas depending on the type of operation and time of day, day of the week, or season that their drivers used the interchange, on/off ramp, freeway segment, or connecting arterial or roadway. All locations identified are shown in Figure 6 and include:

- Freeway off ramps or on ramps where trucks experience difficulty negotiating merging traffic.
- Freeway off ramps or on ramps where trucks experience significant delays.
- Freeway segments and interchanges where truck operators indicate they are experiencing significant delays during special events, seasonal events, and/or peak commuter traffic hours. (Indicated in Figure 6 with red circles.)

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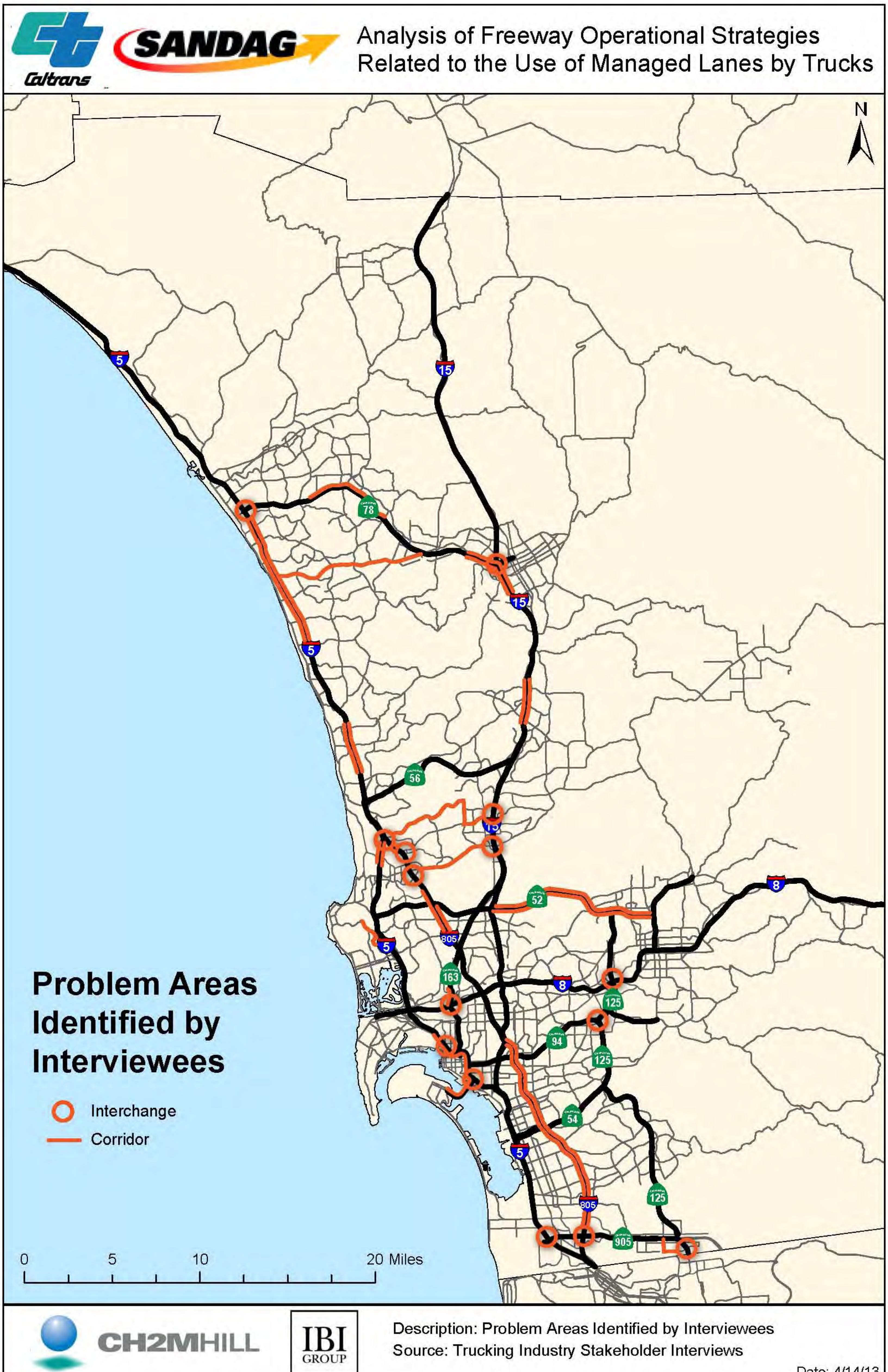
Figure 6 – Problem Areas Identified by Interviewees



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4. Data Collection

4.1 Truck Operational and Safety Data Collection Methodology

Truck operational and safety data sources included:

- SANDAG Truck Model: Forecasts provide daily truck volumes, basic truck classifications, peak hour truck volumes, and various other related forecast data through to the 2050 horizon year for the Regional Transportation Plan (RTP).
- Statewide Integrated Traffic Records System (SWITRS): Includes aggregated truck accident data from 2008 and 2012.
- The San Diego Region Occupancy and Classification Study: Includes regional classification and occupancy counts collected manually by Caltrans and SANDAG. The counts were conducted most recently in 2010 and 2011, and include truck classification for different times of the day.
- Regional Weigh-in-Motion (WIM) Sites: Includes truck count and classification data collected on an on-going basis.

The level and extent of truck specific data available for the region is only a small percentage of the data available for total traffic and auto traffic in general. Most tools, counts, performance monitoring systems, and operations systems in the region do not clearly distinguish between trucks and other traffic. Each of the data sources mentioned above has limitations. The most notable regional limitations to truck operational and safety data are:

- Lack of clear truck origin-destination data whether derived from the travel of the trucks themselves or the various supply chain logistics related to the movement of the trucks.
- Significant gaps in truck count and classification data generally caused by a shortage of WIM sites in the region, particularly the northern portions of the County.
- Limitations in aggregated accident data that do not clearly indicate the cause or level of impact generated through accidents involving trucks.

Methods for addressing these limitations are being addressed in a separate Technical Memorandum as part of this project; however, it is important to understand that the data presented in this Memorandum are subject to constraints and that the individual data sets are best considered together and taken as representative of general trends and areas of priority, rather than hard and fast rules of truck mobility and trends in the region.

SANDAG Truck Model

SANDAG developed a truck model that generates, distributes, and assigns truck trips to all significant freeways, highways, and arterials/roadways in the County. This model is the best source of projected future truck traffic and was used extensively to generate truck daily volumes, truck types, peak hour truck volumes, and related data for the maps. The model is built upon and is consistent with the SANDAG Series 12 forecast model for 2012, 2020, 2035, and 2050. It takes into account the 2050 Regional Transportation Plan (revenue constrained) assumptions with consideration for future projects, projected population growth, and many other factors. For this study, the data extracted were particularly related to truck volumes, classifications, trip productions, employment surveys, and other characteristics.

Some of the key areas of information the model provides are:

- Accurate and reliable inclusion of planned roadway improvements, socio-economic and land use trends, and overall existing and forecast traffic conditions. It is a useful resource for identifying problem areas for truck mobility now and into the future.
- The model forecasts volumes for daily and peak truck traffic and basic breakdowns of light, medium, and heavy truck traffic.
- The model provides a better sense of internal to internal (within the region) truck travel patterns than is available from any other potential source.
- The model uses employment data to generate truck trips. This means it provides a reasonable sense of significant areas of truck trip generation and hubs for goods movement distribution, as well as the growth of these areas over time.

Limitations

The SANDAG truck model may not represent the logistics patterns of full and empty trucks in the border region. The model uses Freight Analysis Framework (FAF) 2 data to derive trips that start or end outside of San Diego –including those coming from Mexico. But, because FAF data measures the flow of commodities (full trucks), it does not capture estimates of empty trucks; therefore the data are adjusted up to match Department of Transportation border crossing data for empty trucks. These complexities may be one reason why the flow of southbound (often empty) trucks appears to be less than northbound trucks.

Additionally, the model generates truck trips internal to the County, but it borrows the internal truck trip rates from the neighboring Southern California Association of Governments (SCAG) model.

The model network codes freeways as one-way links rather than as bi-directional links. This nuance in combination with the need to illustrate travel characteristics at a regional scale, is why most of the data maps in this memo were separated into “north and west” segments and “south and east” segments to provide better clarity (it is difficult to show data in two directions on multiple segments of all corridors in the region on a map).

Statewide Integrated Traffic Records System (SWITRS)

Regional accident data can provide helpful context for the analysis of freeway truck management strategies and how they might be applied to key truck corridors and gateways in San Diego County. Accident data for this study were analyzed at a high level through review of the Statewide Integrated Traffic Records System (SWITRS) database maintained by the California Highway Patrol (CHP). The SWITRS database collects and processes data gathered from a collision scene by three CHP reporting regions: City of San Diego, Oceanside, and El Cajon. SWITRS is the only reasonably available aggregated accident data resource which looks at the overall region and these data provide useful insights to general corridors with higher levels of truck related accidents, severity trends for truck related accidents, and some focus areas for truck related accidents.

Limitations

Although the data set is a useful insight into accident trends over a 5 year period, there are noteworthy limitations to the accuracy of the records. Of the 3,000 recorded truck accidents, a significant portion of the accidents do not have a recorded latitude and longitude. The complete data set also has over 1,000 records that have very minimal information recorded, which suggests that there could be accidents in the data set that involved a truck that were not recorded to be truck related. This data set was collected from SWITRS up to March 1st, 2013; however, there seems to be a drop off in the number of accidents recorded towards the end of the data set, suggesting that there is about a seven month lag in the accidents recorded in the database. CHP acknowledges the limitations in the following statement included within the SWITRS terms of use:

> *This Web site and the SWITRS information are provided on an "as is" and "as available" basis. Due to collision records processing backlogs, SWITRS data is typically seven months behind. Data requested for dates seven months up to the current date will be incomplete. Report data is dynamic and may change from the time of an initial report requested based on the processing of new collision records in the SWITRS database.*
>
> *Although the CHP attempts to maintain the highest degree of accuracy of content on this Web site, you agree to use this information at your own risk. CHP makes no guarantees, representations, or warranties of any kind, express or implied, arising by law or otherwise, including, but not limited to, content; quality; accuracy; completeness; effectiveness; reliability; fitness for a particular purpose; or usefulness. Further, the CHP expressly disclaims liability for errors and omissions in the content of this Web site. Independent verification of this information is strongly recommended before use.*

The SWITRS data set has been summarized These summaries are introduced under the results section later in this document.

Weigh-in-Motion (WIM) Sites

Caltrans weigh in motion (WIM) system that provides 24-hour traffic information at key locations on California highways and provides vehicle classifications for passing traffic. Regional truck classification data serve as a key reference when analyzing the freeway truck management strategies. In particular, these data can provide a sense of the potential impacts of strategies that may only apply to certain general classifications of vehicles. Also, heavy or larger vehicles will typically have a significantly greater impact on traffic operations (in terms of speeds, capacities, etc) than smaller trucks.

The purpose of this data collection effort is to investigate the traffic patterns between truck traffic and all other types of traffic as well as light, medium and heavy truck traffic, which is defined as follows:

- Light Trucks: up to 14,000 lbs
- Medium Trucks: 14,001 – 33,000 lbs
- Heavy Trucks: any trucks heavier than 33,000 lbs

In order to analyze the variations in light, medium, and heavy truck traffic peaks throughout the day, the region's WIM data (over a five year period) was processed for seven stations across key truck corridors in the County. After the data were broken down for each station and each direction of travel, there were 14 data sets that showed when the three different truck traffic types peaked in volume at different times throughout the day. These findings will assist with the assessment of freeway truck management strategies along the corridors with different characteristics. Some of the strategies that apply to only one or two of the truck types (light, medium and heavy) can use this analysis to determine where and when the select strategies might apply.

Limitations

Although the WIM data set offers a great insight into how the truck traffic types are distributed among the key truck corridors, there are several limitations to the accuracy of the WIM records. These limitations must be taken into account when using these data to support whether or not to implement any particular strategy. The WIM data have the following limitations due to the complicated environment that these data are collected from:

- WIM sites can be inoperable/broken down or shut down due to maintenance for a substantial amount of time.
- WIM sites sometimes provide inaccurate vehicle classifications when vehicles pass over the sensors in an irregular manor.
- Several of the classifications include truck types that could fall into more than one of our three truck classifications.

Regional Classification Counts

The San Diego Region Occupancy and Classification Study conducted by SANDAG and Caltrans included data collection at 23 locations from March to June of 2012. The data provide one day of vehicle classification data for all of the types of vehicles that passed by the 23 sites in each direction of travel along key truck corridors in the County.

In order to analyze the variations in the total truck traffic versus the rest of traffic peaks throughout the day, the regional classification and occupancy count data were processed for the 23 sites across key truck corridors in the County. After the data were broken down for each site and each direction of travel there were 28 data sets that showed when the truck traffic and non-truck traffic types peaked in volume at different times throughout the day. These findings will assist with the assessment of the freeway truck management strategies throughout the various corridors in the County. The strategies that influence truck traffic differently throughout the various peak times will be greatly influenced by these data to determine which corridors, directions and times are best to apply any particular approach.

Limitations

Although the regional classification and occupancy count data set offers an insight into how the truck and non-truck traffic types are distributed among the key truck corridors, there are several limitations to the accuracy of the regional classification records. These limitations must be taken into account when using these data to support whether or not to implement any particular strategy. First, the counts are conducted during daylight hours and do not capture classification for all 24 hours of the day. Also, the regional classification and occupancy count data consist of vehicles classified by sight; the following inaccuracies are related to the process of visually counting and classifying vehicles:

- Missing a vehicle due to being overwhelmed by the volume of vehicles,
- Counting a vehicle more than once due to cross over counting of different team members, and
- Classifying the vehicle in the wrong category due to the speed and/or volume of vehicles passing by at any given time.
- Inexperience of the temporary count staff may also be an issue and lead to some inaccuracies.

Despite the limitations of the four data sources summarized in this section, all of them provide a valuable insight into the traffic patterns between truck traffic and all other types of traffic, as well as light-duty, medium-duty, and heavy-duty truck traffic. These data sets serve as a useful reference throughout the process of assessing the freeway truck management strategies and how they might be applied to key truck corridors and gateways in San Diego County. These data summaries and findings are introduced under the results section later in this document.

4.2 Truck Operational and Safety Data Collection Results

This section provides a summary of the data collected from the SANDAG truck model, SWITRS, WIM stations, and the San Diego Region Occupancy and Classification Study. The information is summarized and presented in maps according to the following topics:

- Truck Trip Productions by Transportation Analysis Zones (TAZs)
- Total Average Daily Traffic (ADT) Volumes
- Truck Percentage of ADT and Daily Truck Volumes
- Truck Peak Hour Volumes
- Light, Medium, and Heavy Truck Volumes
- Level of Service
- Regional Weigh-in-Motion Sites
- Regional Classification and Occupancy Counts
- SWITRS Accident Data Summary
- Steep Grades
- Managed Lanes with Direct Access Ramps (DARs)

Truck Trip Productions by Transportation Analysis Zones (TAZs)

The truck trip production maps displayed in this section show the transportation analysis zones (TAZs) from the regional model, shaded to indicate the extent of truck trip productions within each TAZ. A TAZ represents a geographic area within the region where the generation of trips (in this case trucks) are represented within the model. Land use and socio-economic data inputs to the model impact the level of truck traffic generation within each TAZ.

These maps illustrate truck trip productions, not attractions. Productions were mapped because they help identify areas with high concentrations of trucks; attractions tend to be more dispersed and simply reflect heavily populated and commercial areas. The data for these maps were taken from the SANDAG truck model for 2012, 2020, 2035, and 2050. The internal-internal truck trips (trips that begin and end in San Diego County) were linked to their respective TAZ in order to create each map.[2]

The maps in Figures 7 through 10 show average daily truck production volumes by TAZ. These figures represent only the average daily truck productions and exclude all other types of traffic trip productions. The truck traffic production volumes are represented with six different shades of red, with the darker colors representing greater levels of truck trip productions.

- Figure 7 – 2012 Truck Trip Productions by TAZ
- Figure 8 – 2020 Truck Trip Productions by TAZ
- Figure 9 – 2035 Truck Trip Productions by TAZ
- Figure 10 – 2050 South & East Productions by TAZ

Several conclusions can be drawn by examining these maps:

- The TAZs with the highest truck trip productions are clustered into specific regions:
    - SR 78 corridor/Palomar Airport Road
    - US/Mexico border area at Otay Mesa
    - Miramar/Mira Mesa/Sorrento Valley area
    - San Diego International Airport
    - National City Marine Terminal & National Distribution Center
    - 10th Avenue Marine Terminal& 32nd Street Naval Station
    - Camp Pendleton
    - Poway business district
    - Mid-City
    - El Cajon/Santee

[2] The maps do not show internal to external (I-E) or external to internal (E-I) trips. The method used to distribute I-E or E-I trips throughout the region is based on employment density and while the model adequately predicts how many trips go through a gateway into or out of the region, it is less accurate at predicting precisely where they come from or go to. For this reason, external trips are not shown on the truck trip production maps. Despite this limitation, viewing internal to internal truck trip productions is extremely valuable for identifying major truck activity zones in the region, as there is evidence to show that the majority of truck trips in the region are I-I.

- Kearny Mesa
- Rancho Bernardo

- The following three areas displayed the greatest growth in truck productions in terms of expansion and/or internal TAZ truck production:
  - SR 78 corridor/Palomar Airport Road,
  - US/Mexico border area at Otay Mesa,
  - Miramar/Mira Mesa/Sorrento Valley area.
- Unlike some other areas of the country, the San Diego region does not have substantial areas with extremely high levels of truck trip production (similar to larger manufacturing or intermodal operations), and truck trip production is more dispersed along corridors and sub-regions.

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Figure 7 – 2012 Daily Truck Trip Productions by TAZ

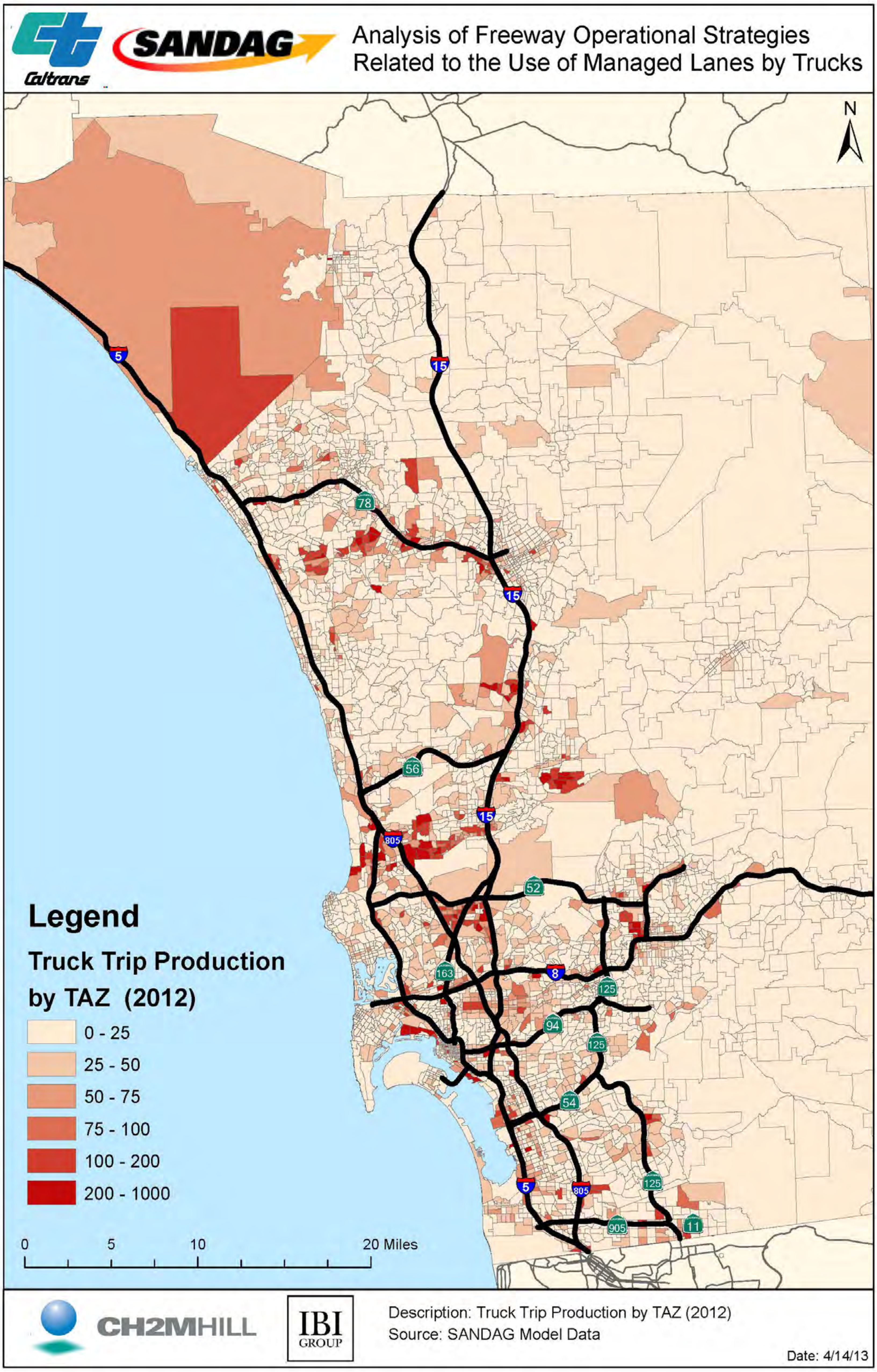


Figure 8 –2020 Daily Truck Trip Productions by TAZ

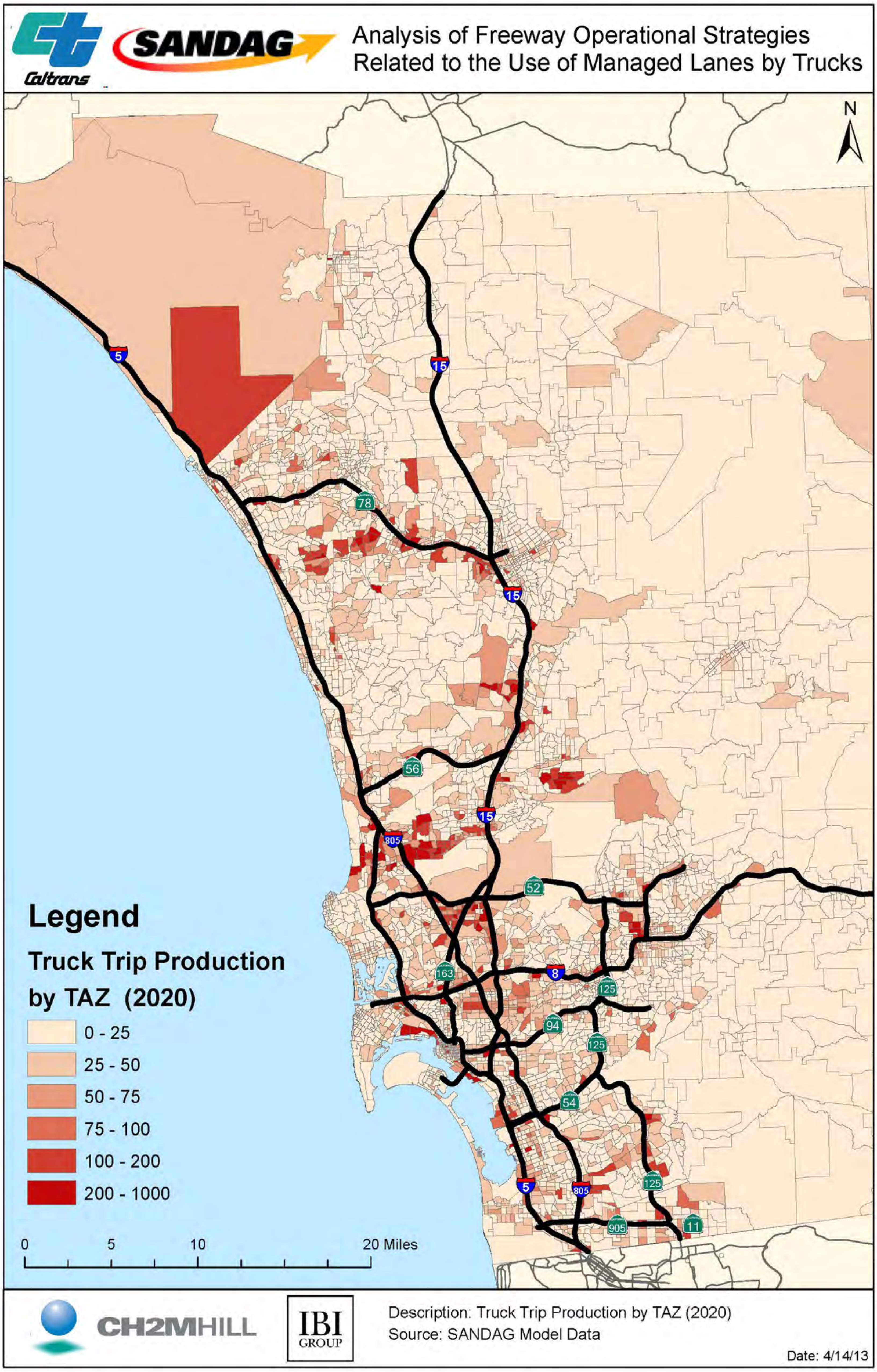


Figure 9 – 2035 Daily Truck Trip Productions by TAZ

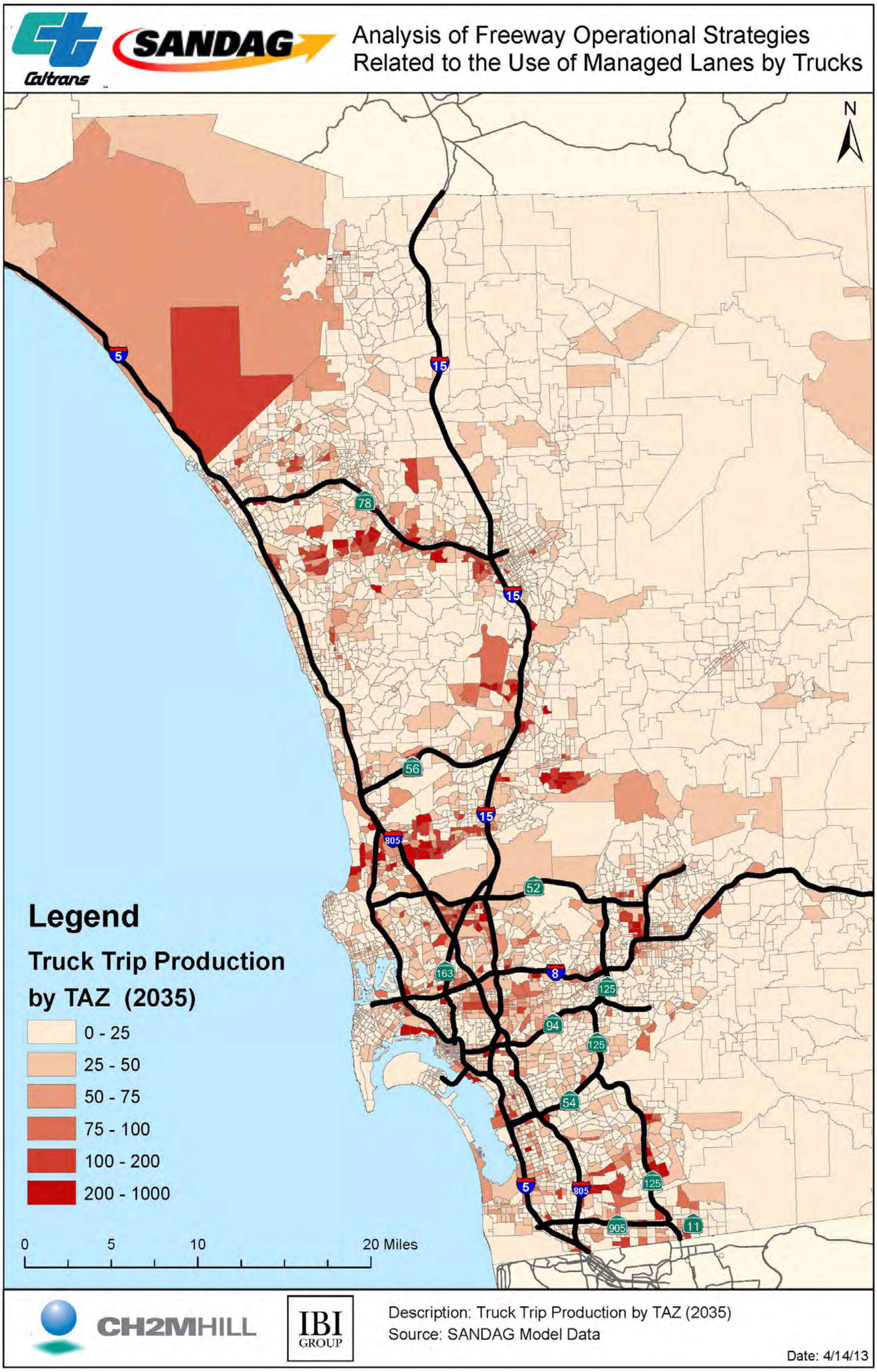
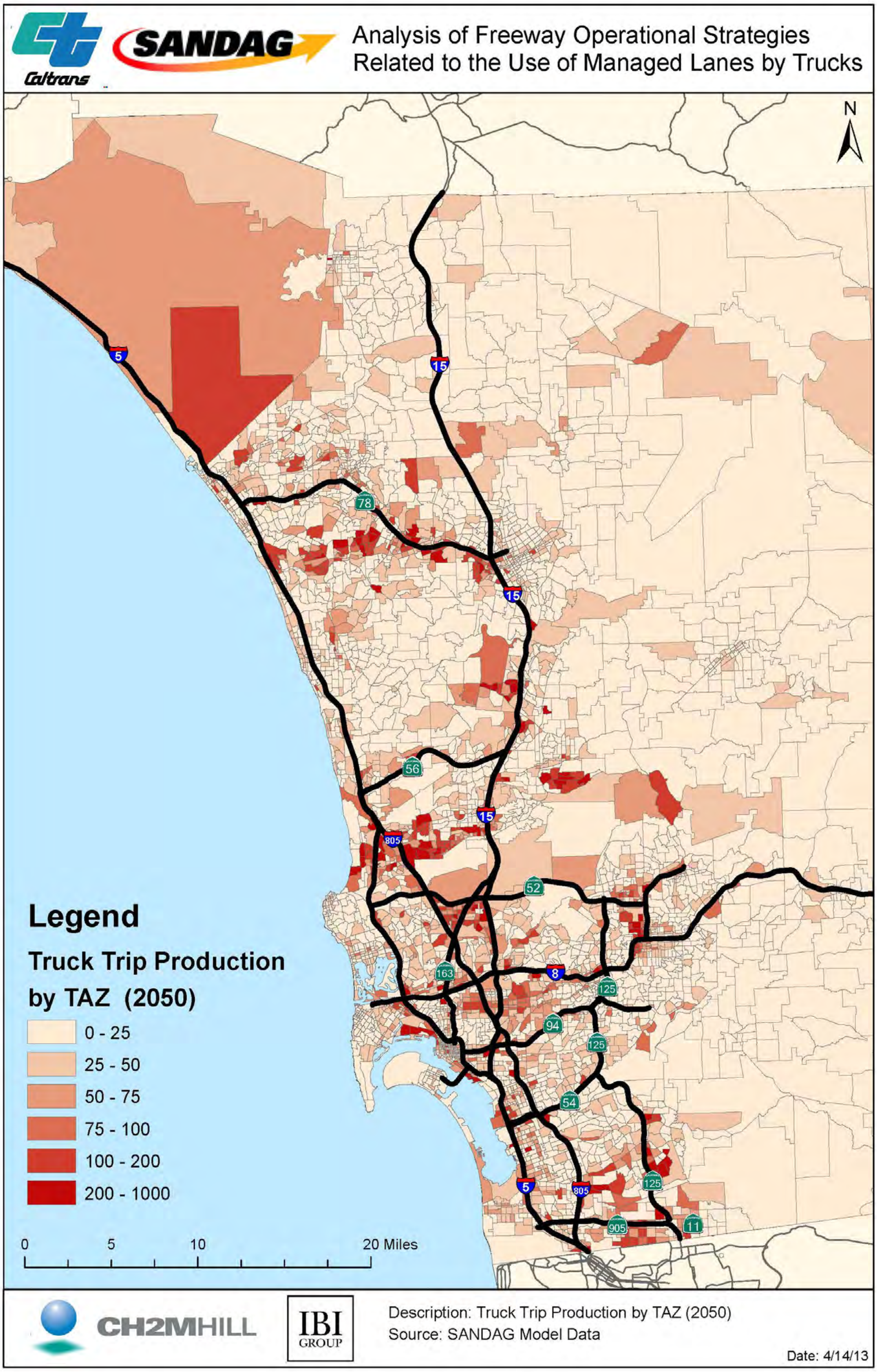


Figure 10 – 2050 Daily Truck Trip Productions by TAZ



Total Average Daily Traffic (ADT) Volumes

The total ADT volumes displayed in the maps below demonstrate the change in total traffic volumes over time in the north-west and south-east directions. [3] The total traffic volumes account for motorcycles, cars and all types of trucks traveling along the general purpose lanes on highways in San Diego County (note the express and HOV lanes are not included). These maps give insight into which freeways have the most traffic and which are less traveled. The data for these maps were taken from the SANDAG forecast model for 2012, 2020, 2035, and 2050. More specifically, the data extracted from the model are representative total ADT values for the freeway corridors, which ranged from 0 – 147,000 vehicles per day.

The maps in Figures 11 through 18 represent the average daily weekday total traffic volumes with the thickness of the green lines that trace the key corridors.

- Figure 11 – 2012 North & West Total Average Daily Traffic Volumes
- Figure 12 – 2012 South & East Total Average Daily Traffic Volumes
- Figure 13 – 2020 North & West Total Average Daily Traffic Volumes
- Figure 14 – 2020 South & East Total Average Daily Traffic Volumes
- Figure 15 – 2035 North & West Total Average Daily Traffic Volumes
- Figure 16 – 2035 South & East Total Average Daily Traffic Volumes
- Figure 17 – 2050 North & West Total Average Daily Traffic Volumes
- Figure 18 – 2050 South & East Total Average Daily Traffic Volumes

The total ADT volumes are represented with seven different line thicknesses, with the thicker lines representing higher volumes. It is useful to consider total ADT in relation to forecast truck volumes because:

- It represents the potential level of conflict between trucks and other traffic,
- It highlights areas where truck mobility is most likely to be impacted by other traffic,
- Very high total ADT volumes may indicate greater difficulty in isolating truck traffic from other traffic, and
- It provides a sense of the potential available capacity as part of the model represented Level of Service (LOS).

Some key conclusions can be drawn by examining these maps:

- Generally, total ADT is greatest along the key trucking corridors in the region, with the possible exceptions of outlying freeway segments and SR 905.
- Forecast total ADTs are anticipated to increase substantially by 2050 which will impact truck mobility along key corridors.

[3] The maps are provided in specific directions since the model separates out the directions of travel on freeways. To provide a single map overview of the whole region, the maps must be directional.

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Figure 11 – 2012 North & West Total Average Daily Traffic Volumes

Figure 12 – 2012 South & East Total Average Daily Traffic Volumes

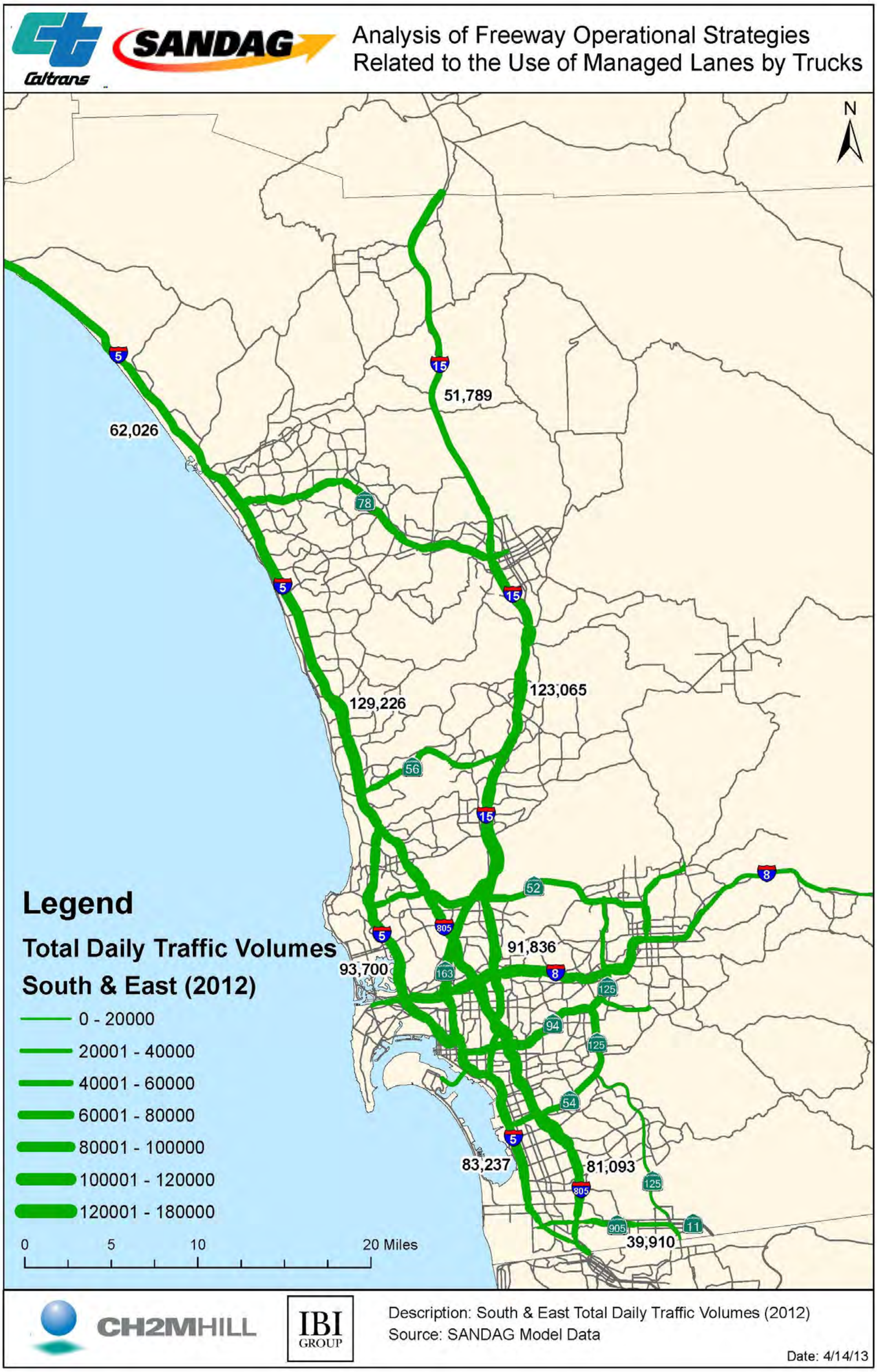


Figure 13 – 2020 North & West Total Average Daily Traffic Volumes

Figure 14 – 2020 South & East Total Average Daily Traffic Volumes

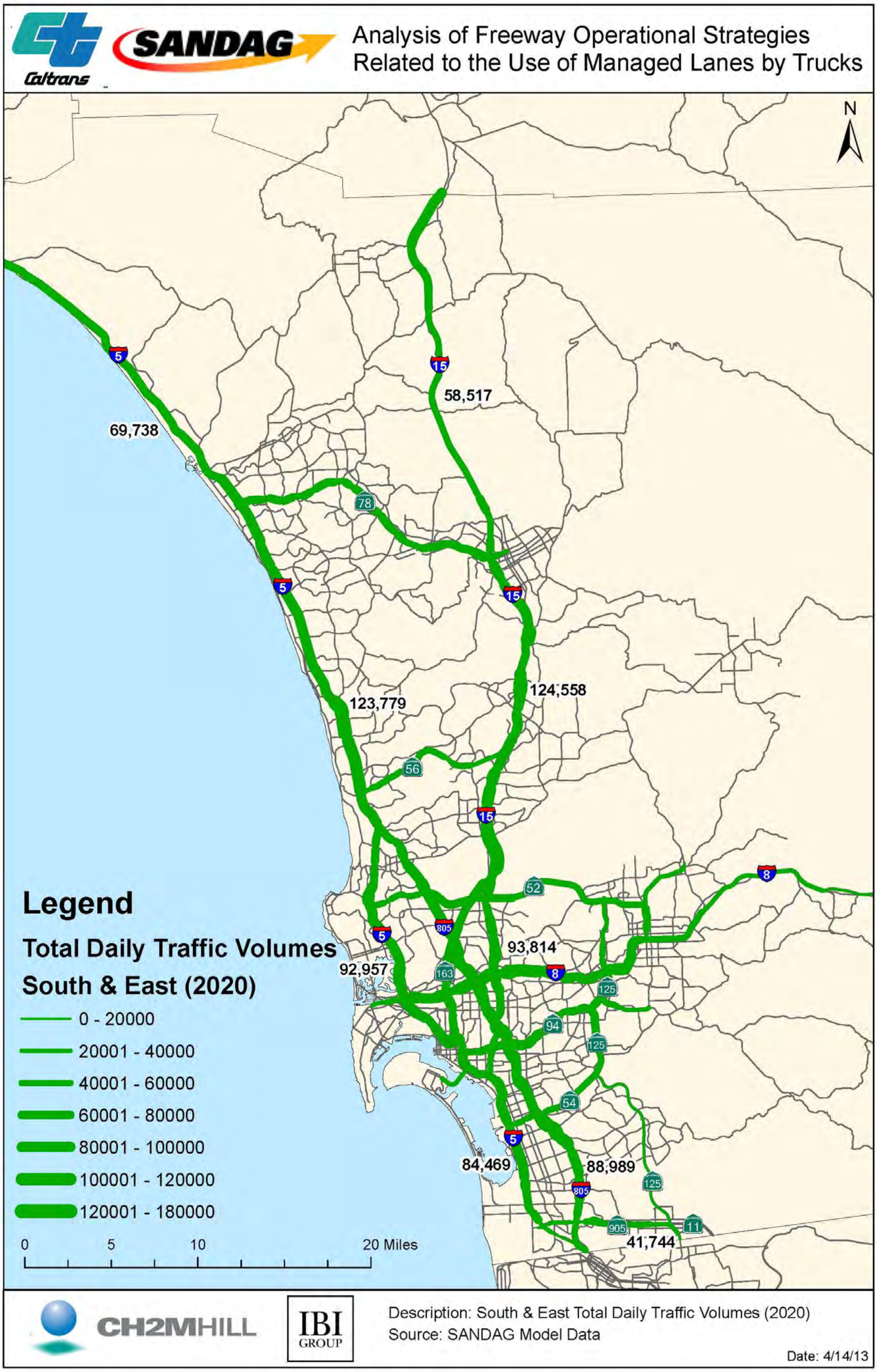


Figure 15 – 2035 North & West Total Average Daily Traffic Volumes

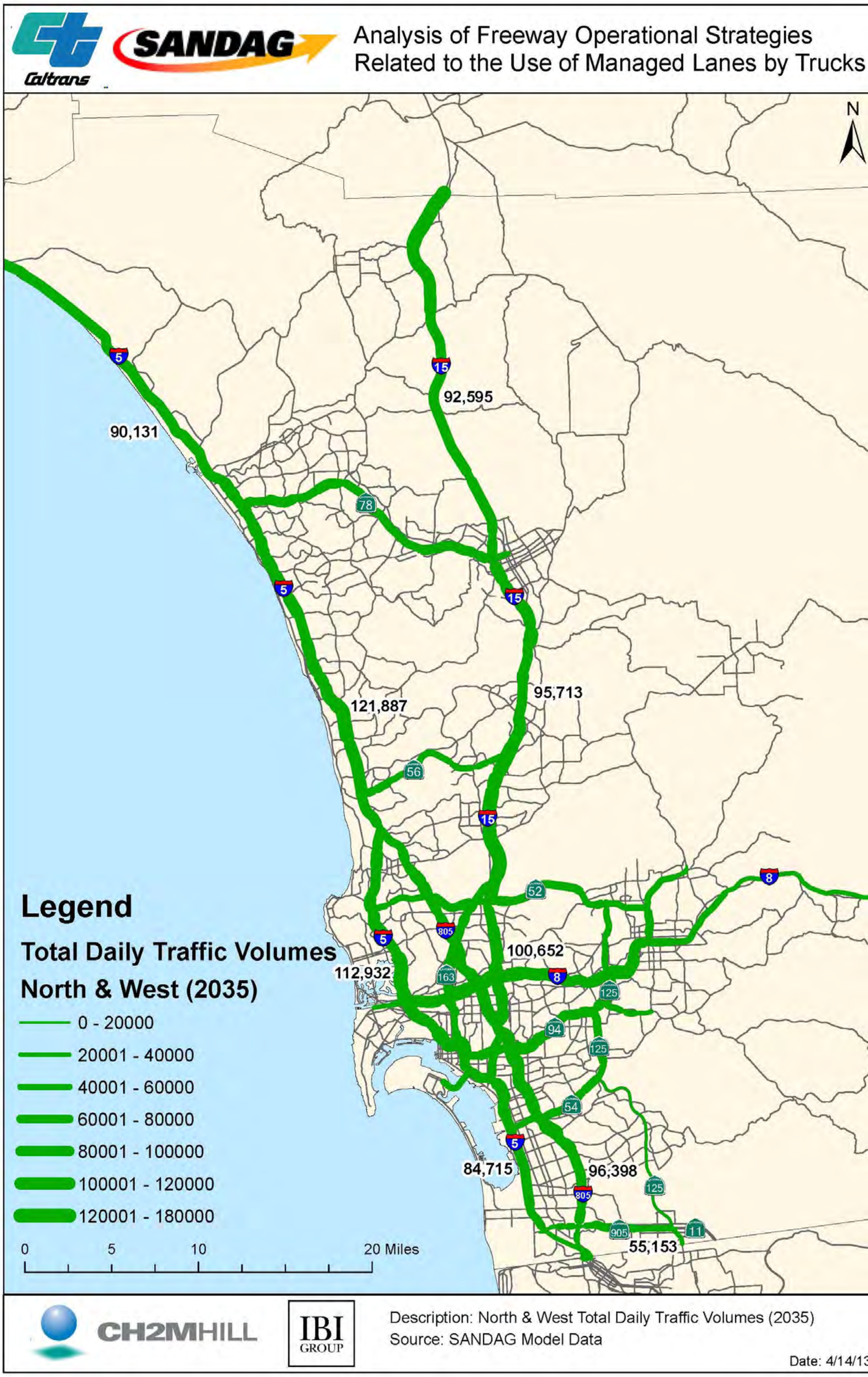


Figure 16 – 2035 South & East Total Average Daily Traffic Volumes

Figure 17 – 2050 North & West Total Average Daily Traffic Volumes

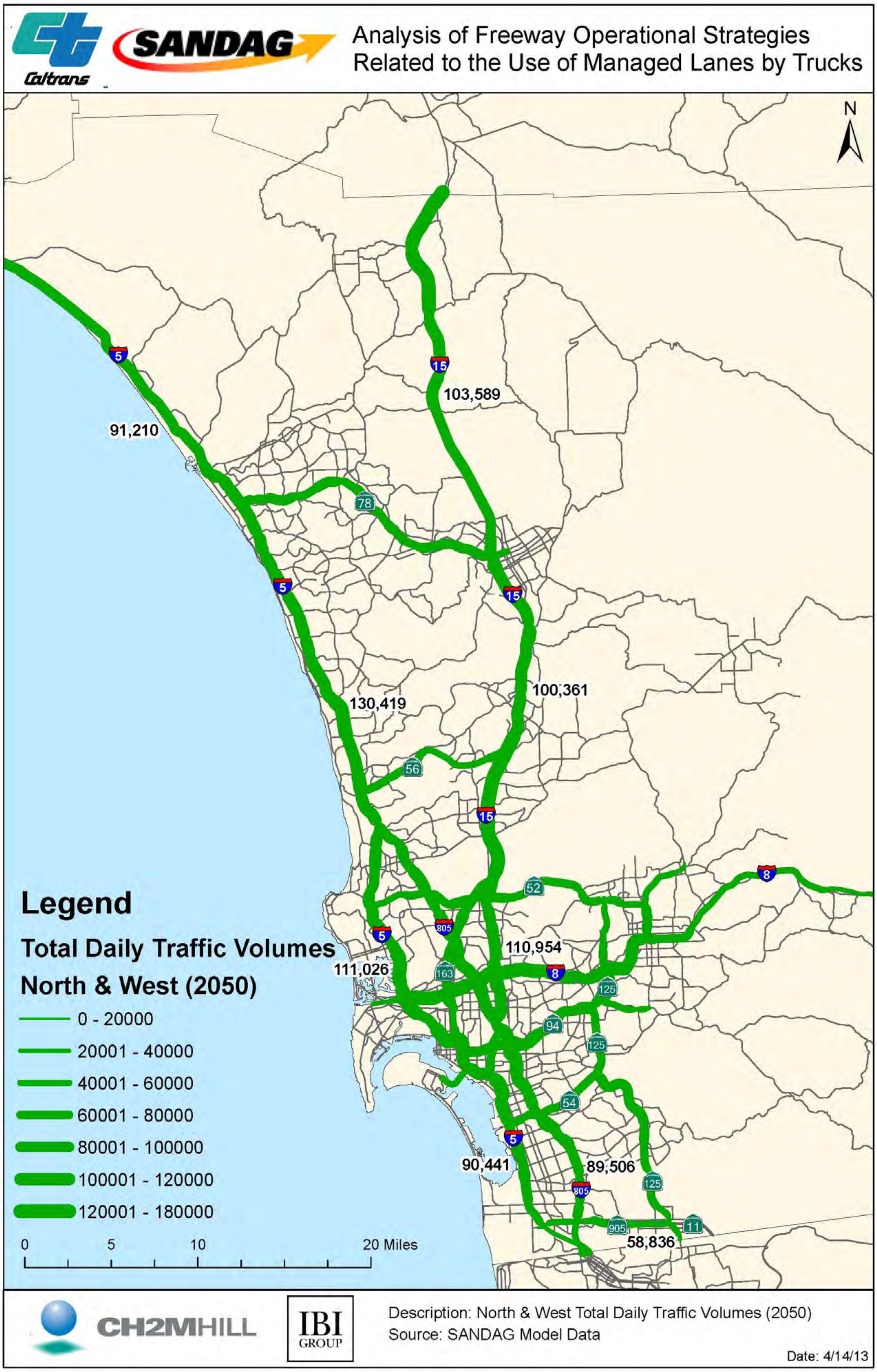
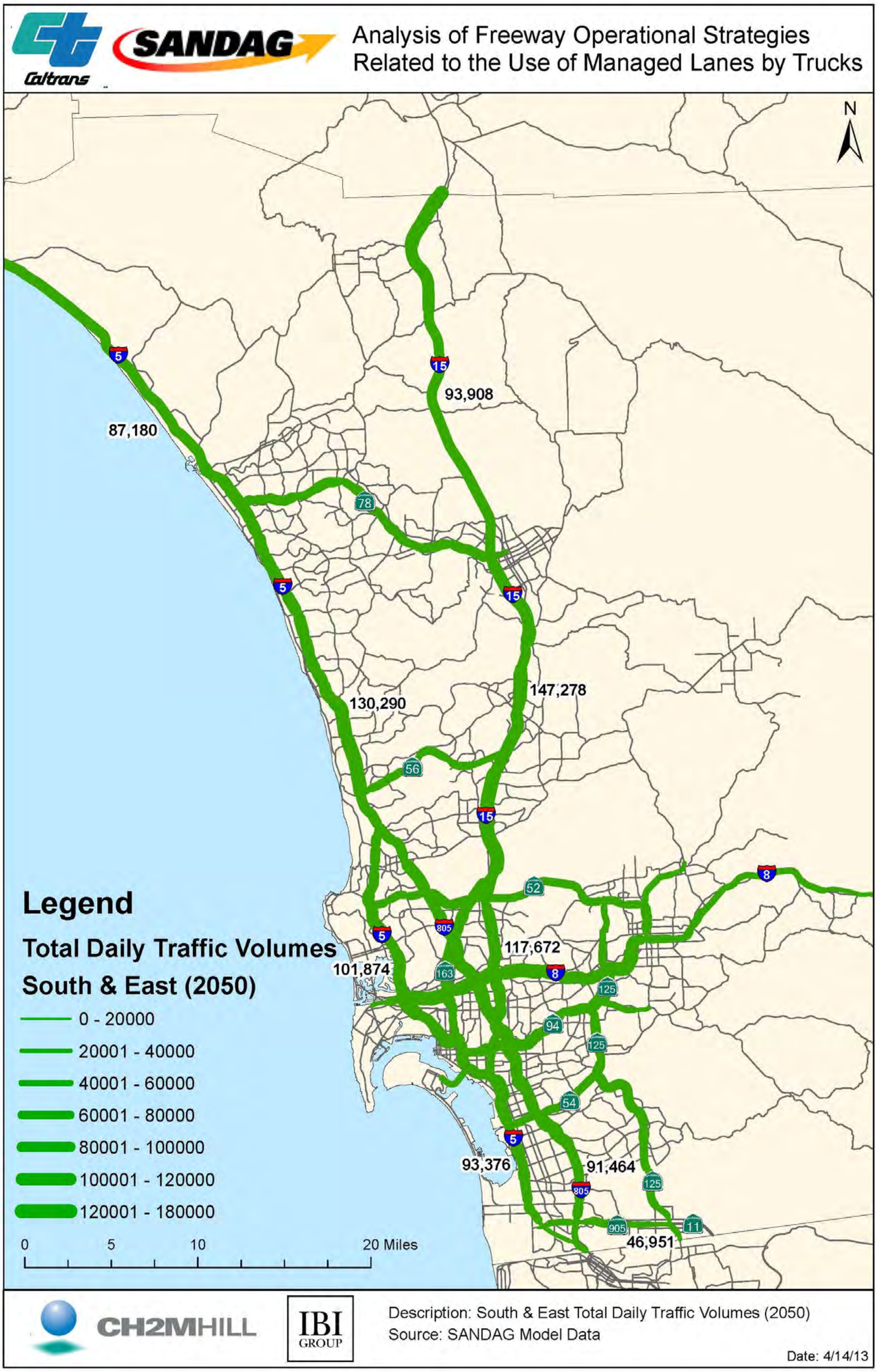


Figure 18 – 2050 South & East Total Average Daily Traffic Volumes



Truck Percentage of ADT and Daily Truck Volumes

The maps on the following pages show average daily weekday truck volumes as well as the truck percentage of total ADT traveling on general purpose lanes in the north-west and south-east directions.[4] These maps give insight into which freeways have the most truck traffic and which are least traveled by trucks. Additionally, by looking at both truck volumes and percentages, it becomes clear which corridors have a high volume of trucks and which corridors have a relatively high volume of trucks in comparison to total traffic. The data for these maps were taken from the SANDAG forecast model for 2012, 2020, 2035, and 2050. The data used from the model were the Truck ADT and the Adjusted Forecasted Volume (AVOL). The Truck ADT values ranged from 0 – 18,000 trucks per day. The truck percentages were calculated by dividing Truck ADT by the AVOL.

The maps in Figures 19 through 26 represent both the average daily truck volumes and the truck percentage of total ADT with both the thickness and colors of the lines that trace the key truck corridors. (Maps showing total average daily truck volumes alone are provided in Appendix B.)

- Figure 19 – 2012 North & West Truck Average Daily Traffic/Truck Percentage of Total Daily Traffic
- Figure 20 – 2012 South & East Total Average Daily Traffic/Truck Percentage of Total Daily Traffic
- Figure 21 – 2020 North & West Total Average Daily Traffic/Truck Percentage of Total Daily Traffic
- Figure 22 – 2020 South & East Total Average Daily Traffic/Truck Percentage of Total Daily Traffic
- Figure 23 – 2035 North & West Total Average Daily Traffic/Truck Percentage of Total Daily Traffic
- Figure 24 – 2035 South & East Total Average Daily Traffic/Truck Percentage of Total Daily Traffic
- Figure 25 – 2050 North & West Total Average Daily Traffic/Truck Percentage of Total Daily Traffic
- Figure 26 – 2050 South & East Total Average Daily Traffic/Truck Percentage of Total Daily Traffic

The daily truck traffic volumes are represented with six different line thicknesses, with thicker lines representing higher volumes. The percentage of the total traffic that is trucks is represented with six variations of color ranging from green (lower percentage of trucks) to red (higher percentage of trucks). Orange and red colors represent truck traffic percentages that can be considered greater than typical. Red colors do not indicate that there is an issue or problem with the percentage of truck traffic, but do highlight those segments where truck traffic is most prevalent.

[4] The maps are provided in specific directions since the model separates out the direction of travel on freeways. To provide a single map overview of the whole region, the maps must be directional.

Several useful conclusions can be drawn by examining these maps:

<u>Average Daily Truck Volumes</u>:

- Model results support industry stakeholder input that the key trucking corridors include SR 905, I-805, I-5, and I-15, with SR 52 and I-8 becoming more pivotal by 2050.
- Daily truck volumes along the segments leading in/out of the region generally are projected to more than triple in volume between 2012 and 2050 forecasts.
- Daily truck forecasts on freeways segments internal to the region are generally estimated to be twice as great as the freeway segments leading outside the region. This would tend to indicate that internal regional truck trips are a substantial proportion of truck trips overall.
- North & west segments are generally forecast to have higher volumes than south & east, particularly near the border region. Discussions with SANDAG modeling staff indicate that this could be due to the way the model forecasts external trips using commodity flow data, which would not fully capture empty truck trips.
- The highest daily truck volumes according to the model are projected to occur on the I-5 and I-15 between SR 52 & SR 78
- By 2035 and 2050, the I-805 is projected to have much higher daily truck volumes, as well as I-5 north of SR 78
- SR 125 is projected to have lower truck volumes, until 2050 when the facility is no longer assumed to be tolled in model.

<u>Truck Percentage of ADT</u>:

- Truck traffic as a percentage of total daily traffic is forecast to substantially increase by 2050.
- North & west percentage data may generally be considered more accurate for some corridors due to the limitations of the model (which applies a nationwide rate for empty trucks and may underestimate empty truck trips in certain corridors).
- Truck percentage data support that the key truck corridors in the region are SR 905, I-805, I-5 and I-15, with SR 52 and I-8 becoming more pivotal by 2050.
- The highest percentages are on the SR 905 and SR 11 near the border.
- The I-5 also has relatively high truck percentages between SR 52 & SR 78.
- In 2050 (NW) I-805 has high truck percentages between the SR 52 & the I-5 merge.
- Only the border region reaches truck percentages over 25 percent.

These maps and the related conclusions can be used to compare the potential applicability and comparative priority of the various truck management strategies being reviewed as a part of this study.

Figure 19 – 2012 North & West Truck Average Daily Traffic / Truck Percentage of Total Average Daily Traffic

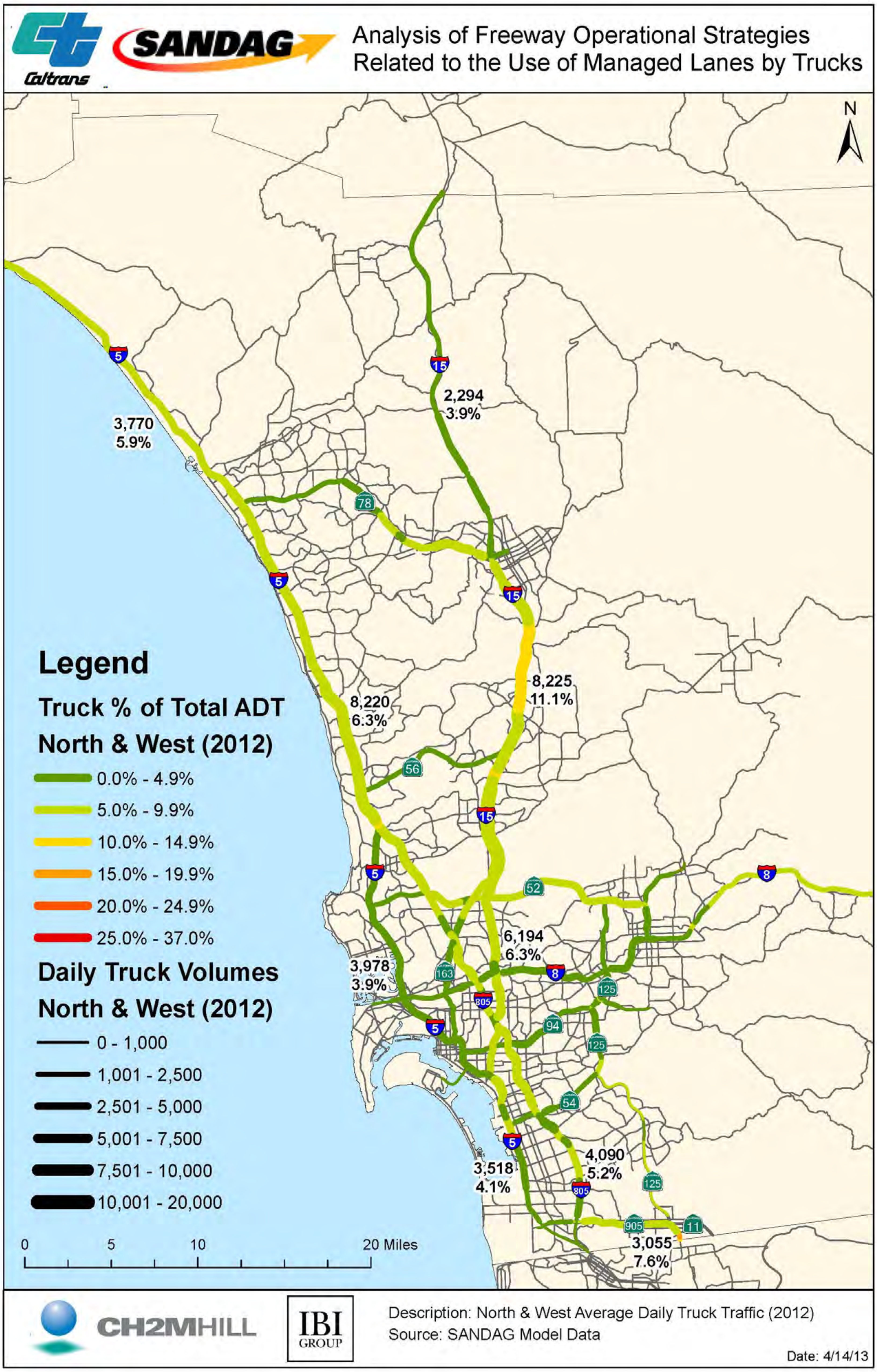


Figure 20 – 2012 South & East Truck Average Daily Traffic / Truck Percentage of Total Average Daily Traffic

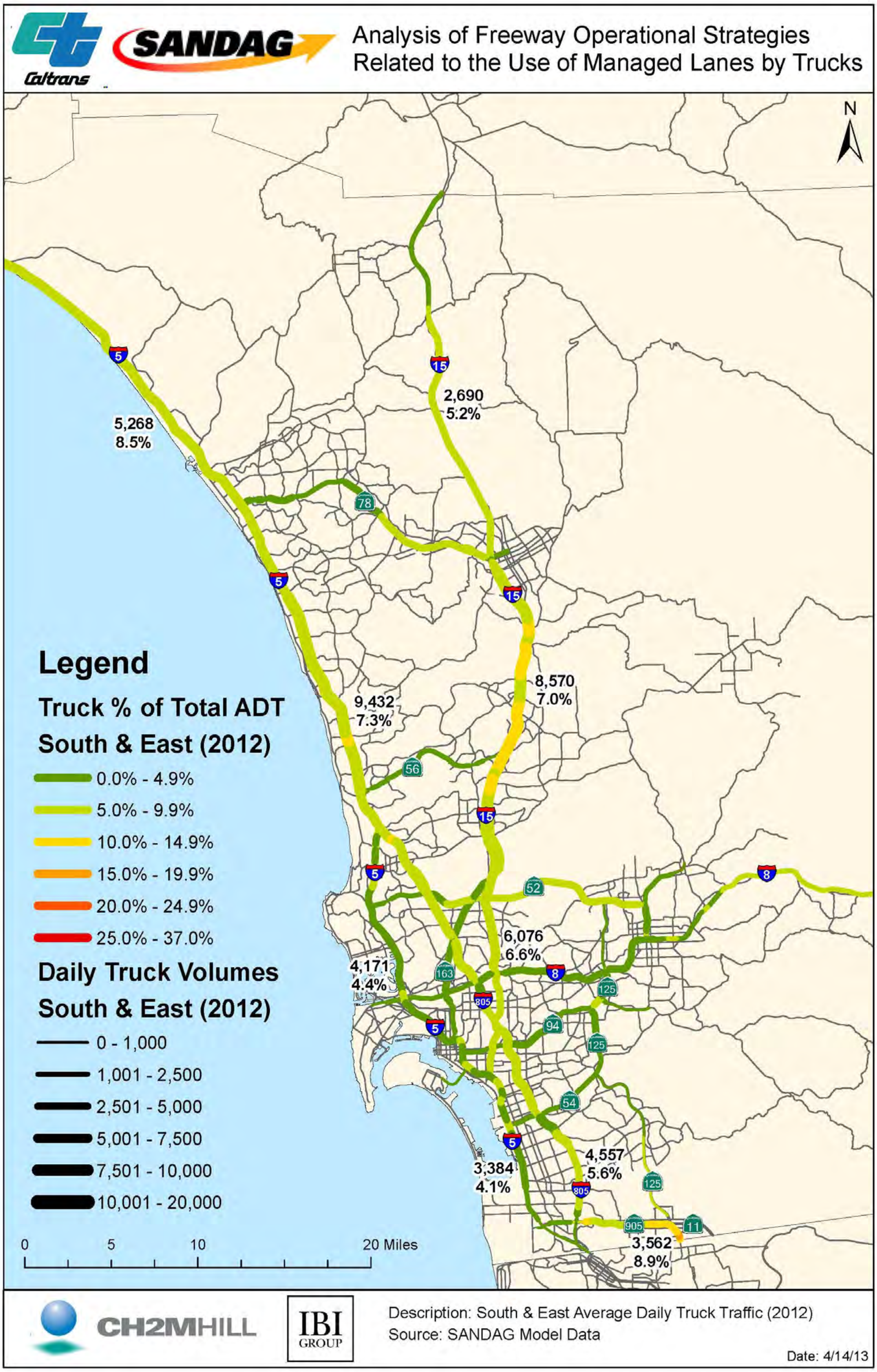


Figure 21 – 2020 North & West Truck Average Daily Traffic / Truck Percentage of Total Average Daily Traffic

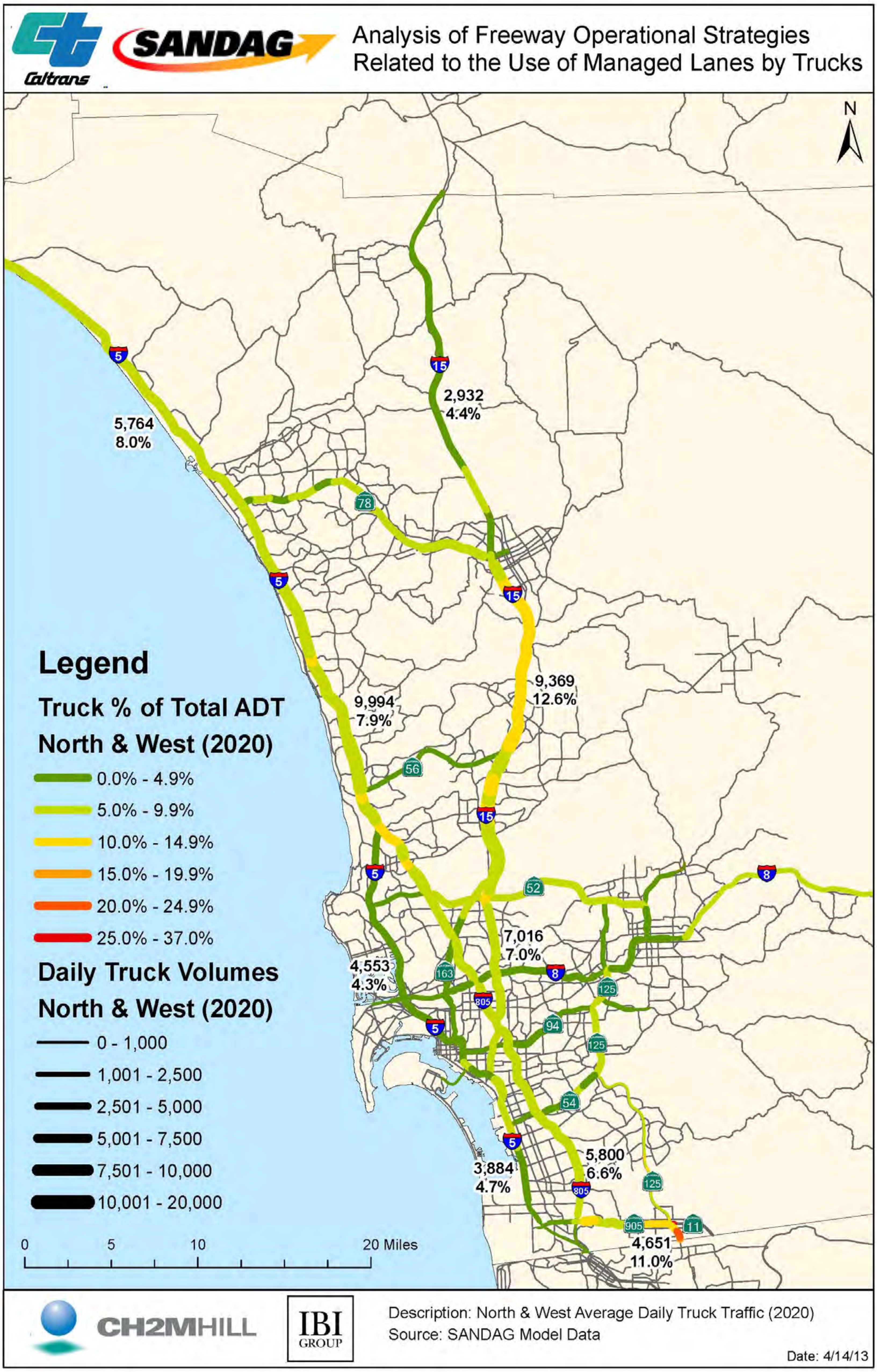


Figure 22 – 2020 South & East Truck Average Daily Traffic / Truck Percentage of Total Average Daily Traffic

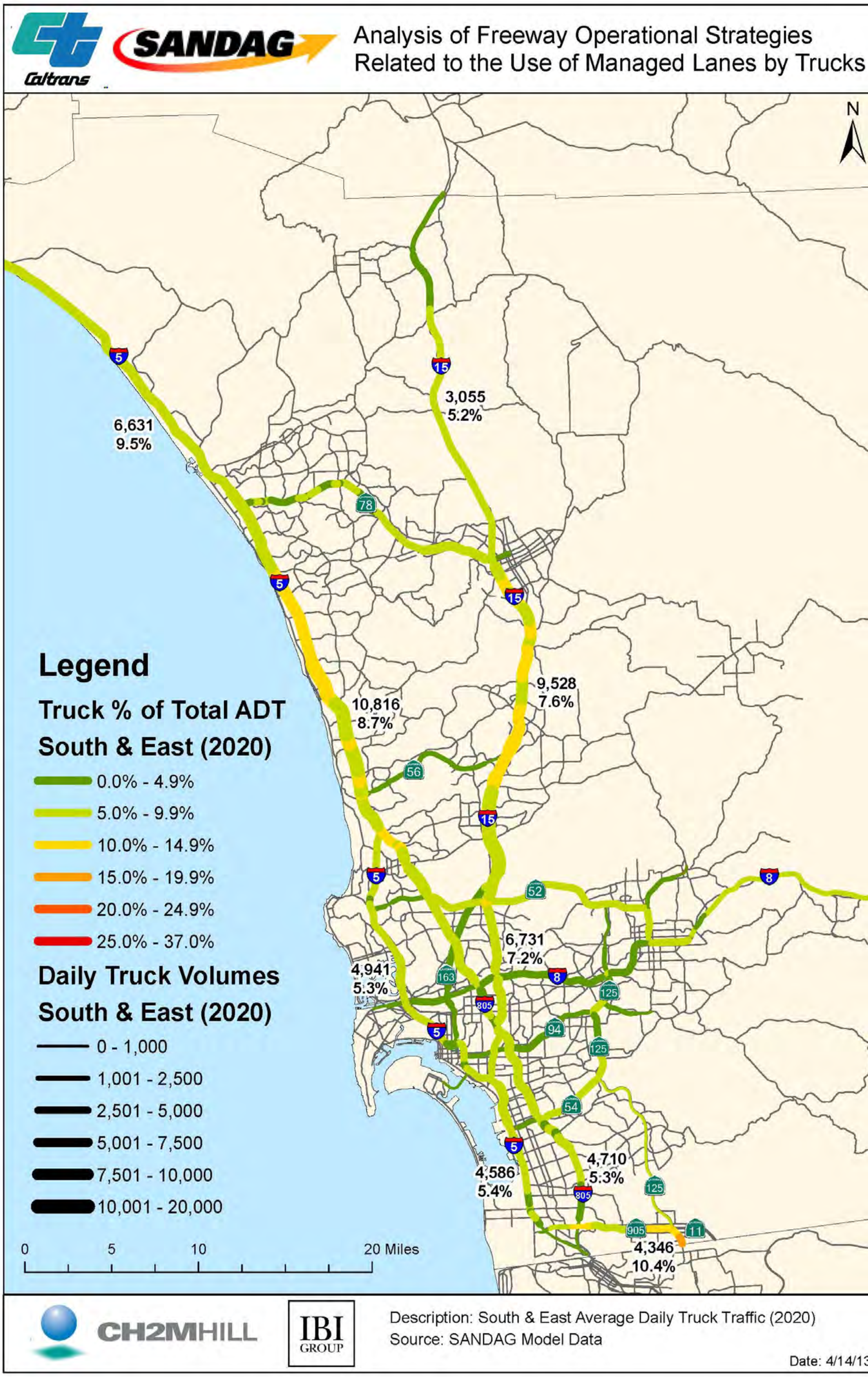


Figure 23 – 2035 North & West Truck Average Daily Traffic / Truck Percentage of Total Average Daily Traffic

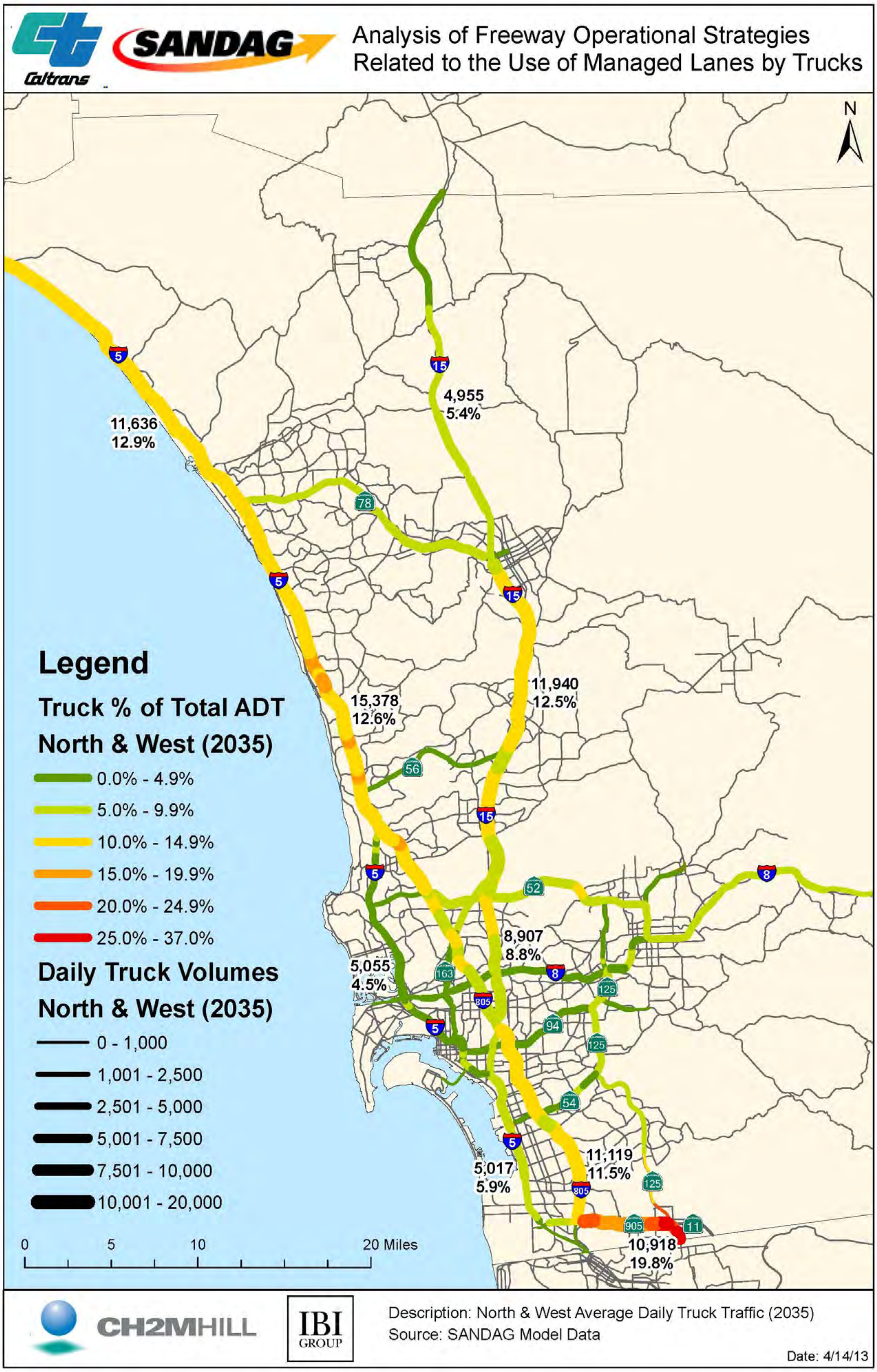


Figure 24 – 2035 South & East Truck Average Daily Traffic / Truck Percentage of Total Average Daily Traffic

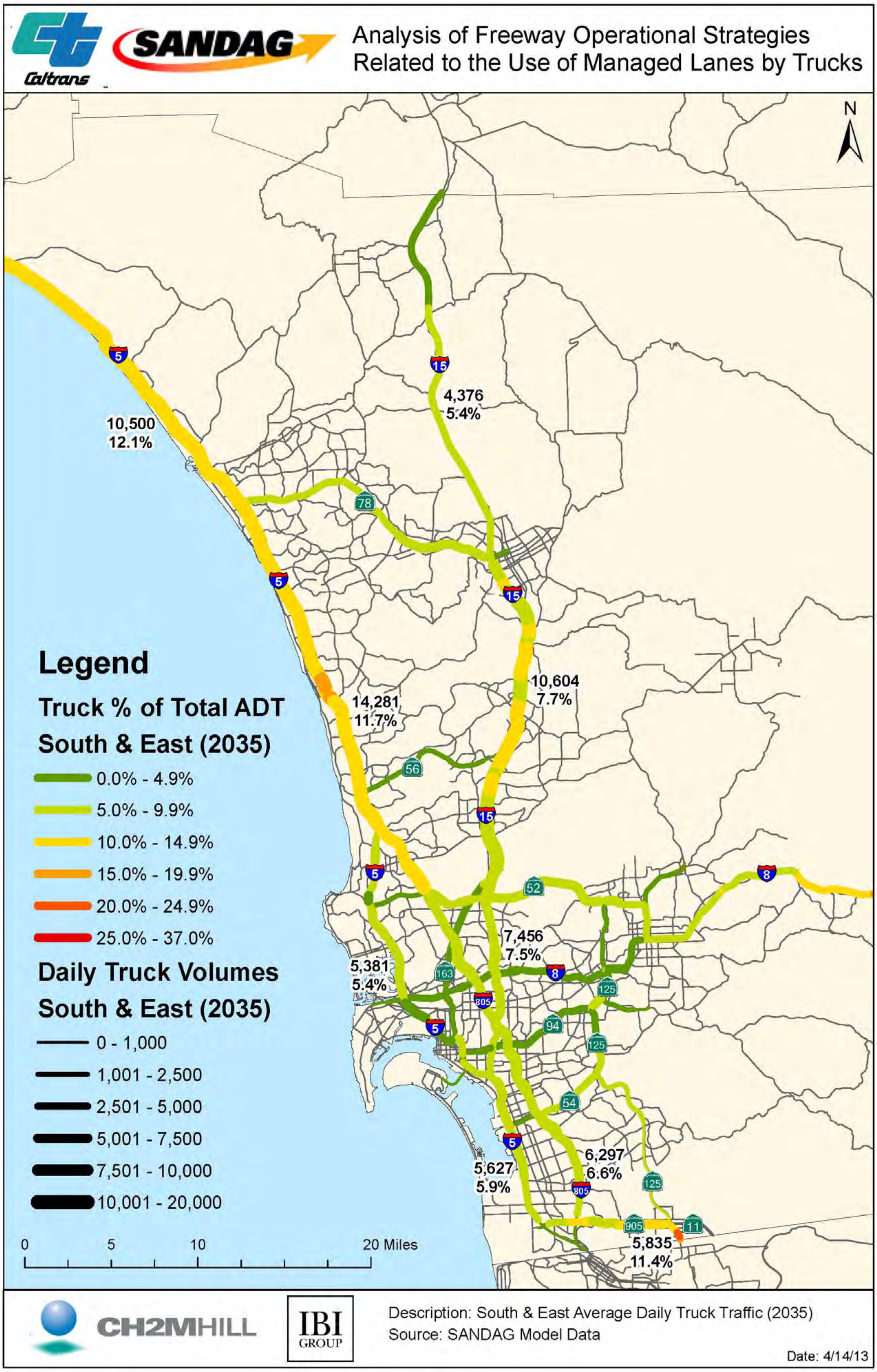


Figure 25 – 2050 North & West Truck Average Daily Traffic / Truck Percentage of Total Average Daily Traffic

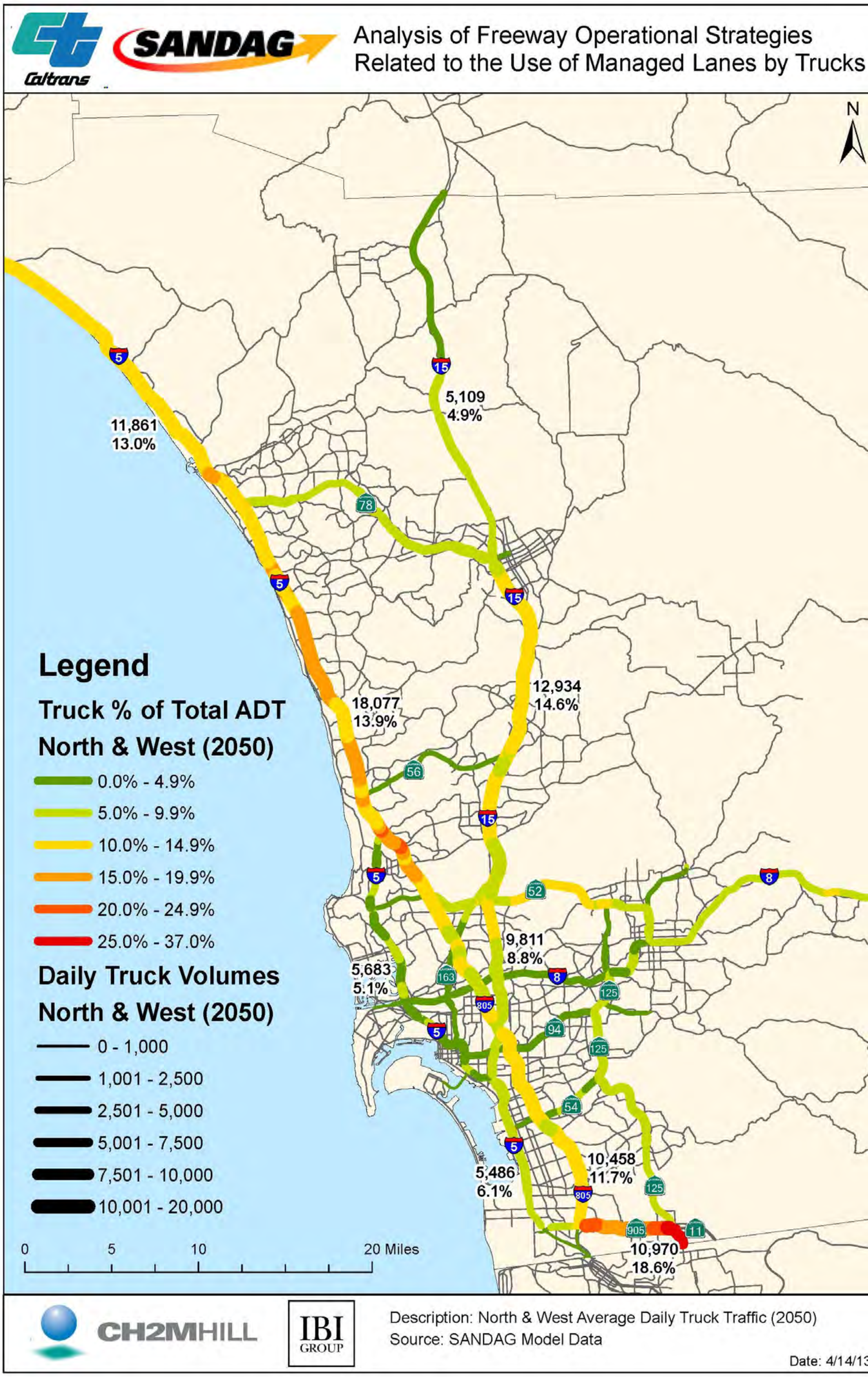
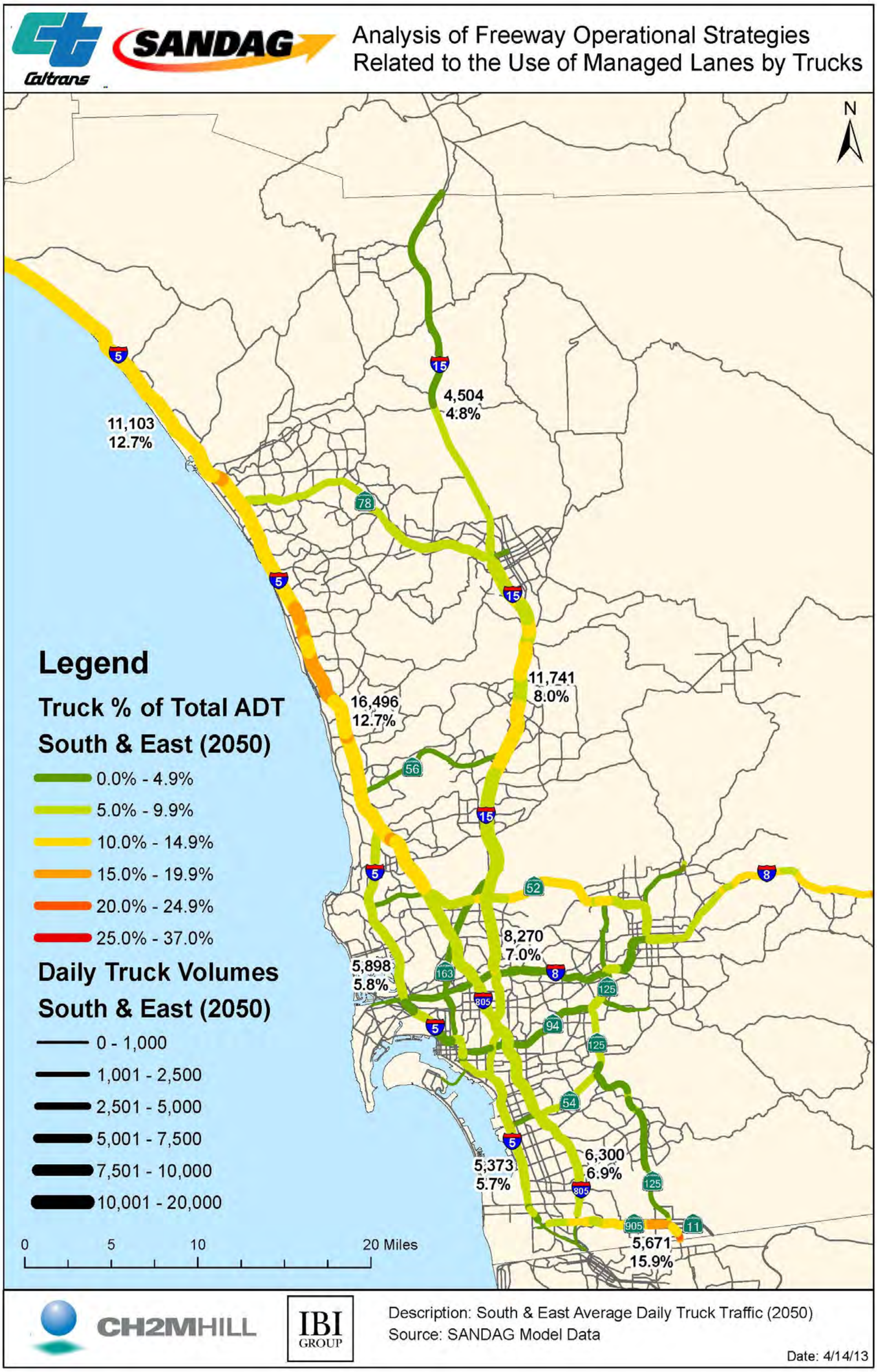


Figure 26 – 2050 South & East Truck Average Daily Traffic / Truck Percentage of Total Average Daily Traffic



Peak Hour Truck Volumes

The peak hour truck volume maps show the truck volumes during the AM and PM peak hours in the north-west and south-east directions. The sixteen maps reveal important truck traffic trends by showing when trucks are travelling in each direction. The data for these maps were taken from the SANDAG forecast model for 2012, 2020, 2035, and 2050. The data extracted from the model were the AM Peak Hour Truck Volumes and the PM Peak Hour Truck Volumes.

The maps in Figures 27 through 42 represent the daily peak truck traffic volumes with the thickness of the brown lines for the AM peak and purple lines for the PM peak that trace the key truck corridors. These figures represent only the peak truck traffic and exclude all other types of traffic. The peak truck traffic volumes are represented with six different line thicknesses that encompass the various truck traffic volumes experienced across the key truck corridors in the County.

- Figure 27 – 2012 North & West AM Peak Hour Truck Volumes
- Figure 28 – 2012 North & West PM Peak Hour Truck Volumes
- Figure 29 – 2012 South & East AM Peak Hour Truck Volumes
- Figure 30 – 2012 South & East PM Peak Hour Truck Volumes
- Figure 31 – 2020 North & West AM Peak Hour Truck Volumes
- Figure 32 – 2020 North & West PM Peak Hour Truck Volumes
- Figure 33 – 2020 South & East AM Peak Hour Truck Volumes
- Figure 34 – 2020 South & East PM Peak Hour Truck Volumes
- Figure 35 – 2035 North & West AM Peak Hour Truck Volumes
- Figure 36 – 2035 North & West PM Peak Hour Truck Volumes
- Figure 37 – 2035 South & East AM Peak Hour Truck Volumes
- Figure 38 – 2035 South & East PM Peak Hour Truck Volumes
- Figure 39 – 2050 North & West AM Peak Hour Truck Volumes
- Figure 40 – 2050 North & West PM Peak Hour Truck Volumes
- Figure 41 – 2050 South & East PM Peak Hour Truck Volumes
- Figure 42 – 2050 South & East PM Peak Hour Truck Volumes

In reviewing these maps, several key conclusions can be made:

- Consistent with daily truck traffic volumes:
  - North & west segments have higher peak hour truck volumes.
  - Highest peak hour truck volumes are on the I-5 and I-15 between SR 52 and SR 78.
- The AM and PM peak hour truck volumes are similar

- The AM and PM peak hour truck volumes as a percentage of daily truck volumes are generally consistent from forecast year to forecast year.
- The AM and PM peak hour truck volumes as a percentage of daily truck volumes are slightly lower than might be anticipated with total traffic on freeway segments, which may indicate that trucks tend somewhat more toward off-peak travel periods. This is consistent with input provided by industry stakeholders.

Figure 27 – 2012 North & West AM Peak Hour Truck Volumes

Figure 28 – 2012 North & West PM Peak Hour Truck Volumes

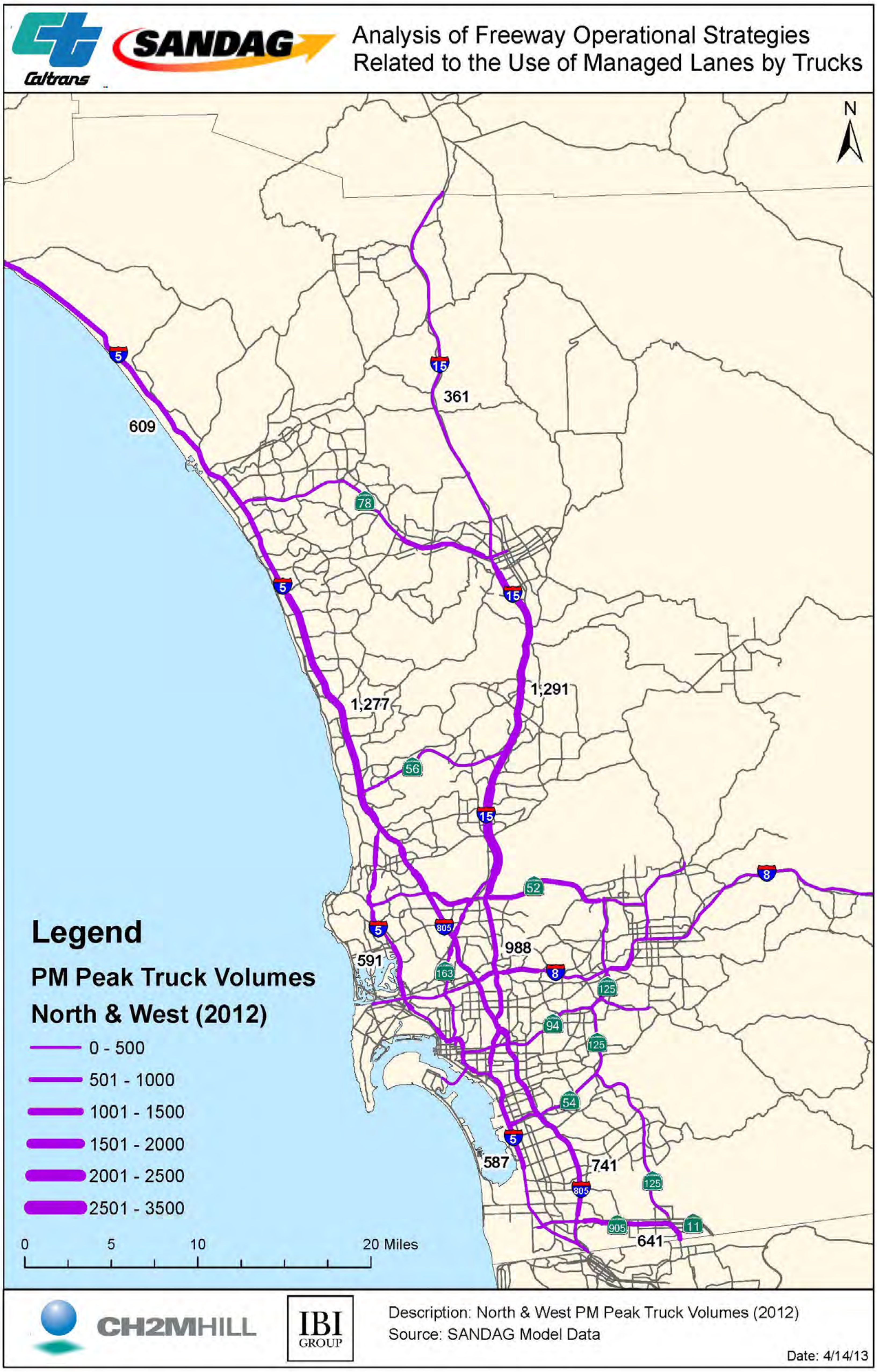


Figure 29 – 2012 South & East AM Peak Hour Truck Volumes

Figure 30 – 2012 South & East PM Peak Hour Truck Volumes

Figure 31 – 2020 North & West AM Peak Hour Truck Volumes

Figure 32 – 2020 North & West PM Peak Hour Truck Volumes

Figure 33 – 2020 South & East AM Peak Hour Truck Volumes

Figure 34 – 2020 South & East PM Peak Hour Truck Volumes

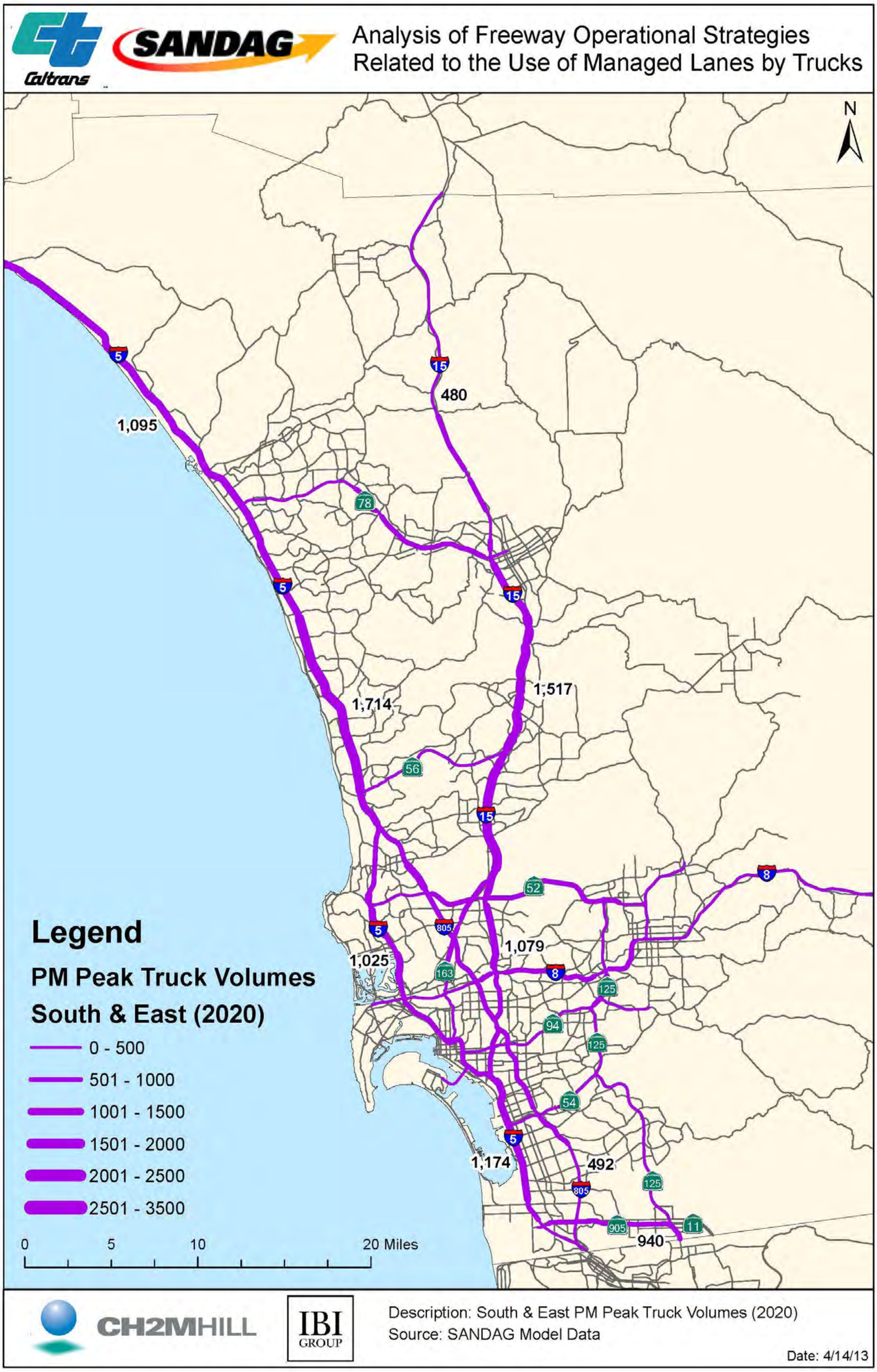


Figure 35 – 2035 North & West AM Peak Hour Truck Volumes

Figure 36 – 2035 North & West PM Peak Hour Truck Volumes

Figure 37 – 2035 South & East AM Peak Hour Truck Volumes

Figure 38 – 2035 South & East PM Peak Hour Truck Volumes

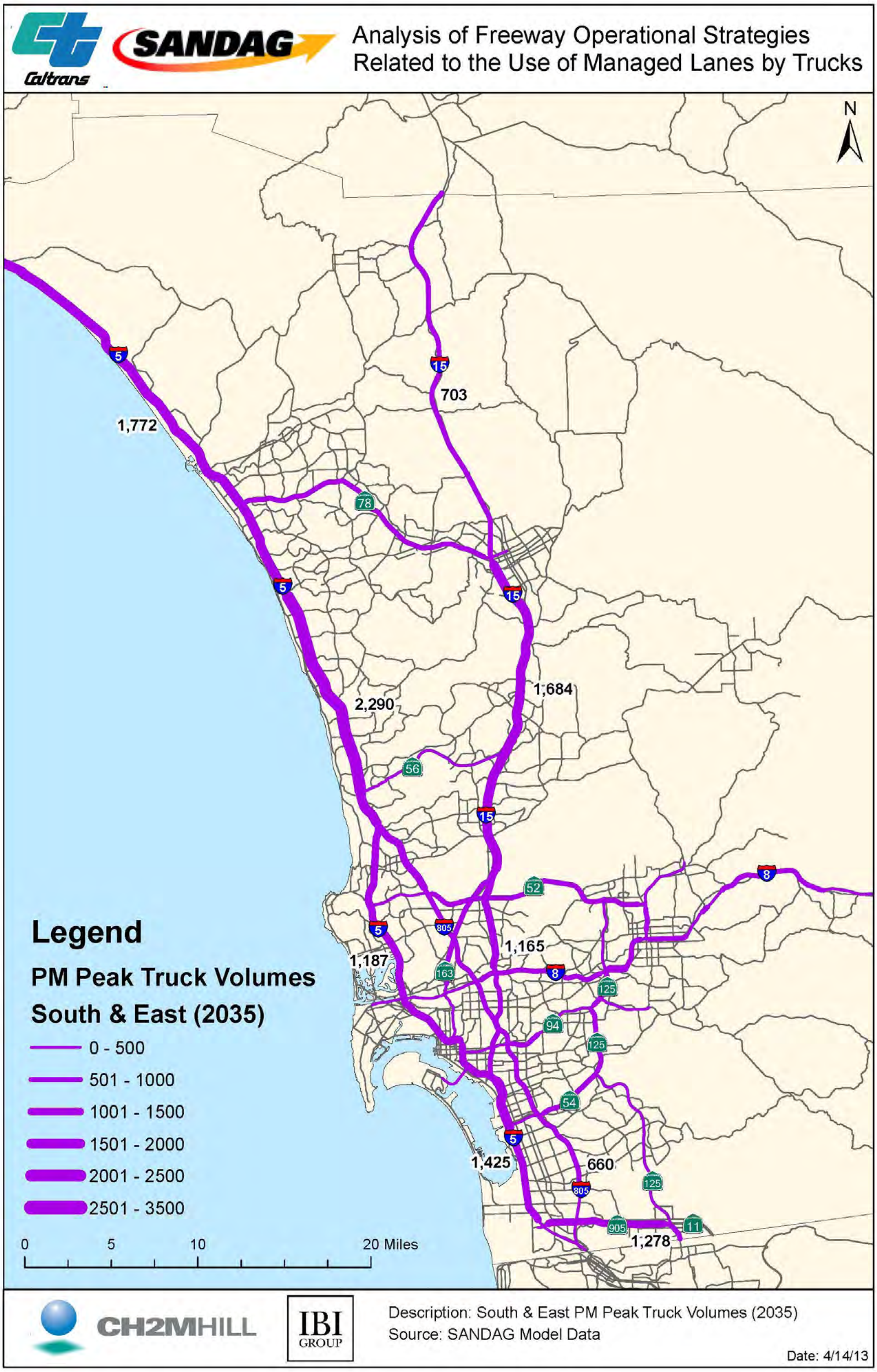


Figure 39 – 2050 North & West AM Peak Hour Truck Volumes

Figure 40 – 2050 North & West PM Peak Hour Truck Volumes

Figure 41 – 2050 South & East AM Peak Hour Truck Volumes

Figure 42 – 2050 South & East PM Peak Hour Truck Volumes

Light, Medium, and Heavy Truck Volumes

The following maps show the amount of heavy trucks as a percentage of total truck traffic in the north-west and south-east directions as well as the percentage of light and medium trucks at specific locations. These maps show where there are a high percentage of heavy trucks and also give an idea of the split between light, medium, and heavy trucks across the region. The data for these maps were taken from the SANDAG heavy truck model forecasts for 2012, 2020, 2035, and 2050. The data used from the model were the light truck volumes, medium truck volumes, heavy truck volumes, and total truck ADT. The model defines these truck types by weight class. Specifically, light-duty trucks are defined as 8,500 – 14,000 lbs; medium-duty trucks are defined as 14,000 – 33,000 lbs, and heavy-duty trucks are defined as > 33,000 lbs. Each percentage was calculated by dividing each type (light, medium, heavy) by the total truck ADT.

The maps in Figures 43 through 50 represent both the average daily truck volumes and the truck type percentages of the total daily truck traffic. Thicker lines represent higher volumes and color indicates percentage of truck type.

- Figure 43 – 2012 North & West Percentage of Trucks by Type
- Figure 44 – 2012 South & East Percentage of Trucks by Type
- Figure 45 – 2020North & West Percentage of Trucks by Type
- Figure 46 – 2020 South & East Percentage of Trucks by Type
- Figure 47 – 2035 North & West Percentage of Trucks by Type
- Figure 48 – 2035 South & East Percentage of Trucks by Type
- Figure 49 – 2050 North & West Percentage of Trucks by Type
- Figure 50 – 2050 South & East Percentage of Trucks by Type

These figures show truck volumes alone and do not show other traffic volumes. The map also labels nine key points across the region to call out percentages of light, medium, and heavy truck traffic experienced at these particular locations.

It was indicated by SANDAG staff that due to the characteristics of the model, medium truck percentages may be somewhat over-estimated as a percentage of total truck trips. These data can be compared for corridor review purposes with existing data from the WIM sites, which are also provided in this memo.

A few key characteristics that can be observed from these maps are:

- The areas that consistently have high percentages of heavy trucks are:
    - I-5 north of SR 78
    - I-15 north of SR 78
    - SR 905/SR 11 near the border
    - I-8 east of SR 125

- Areas with high percentages of heavy truck are near gateways to a neighboring county or Mexico. This is consistent with industry input that longer truck trips tend to be made by larger/heavier trucks.

Figure 43 – 2012 North & West Percentage of Truck Type

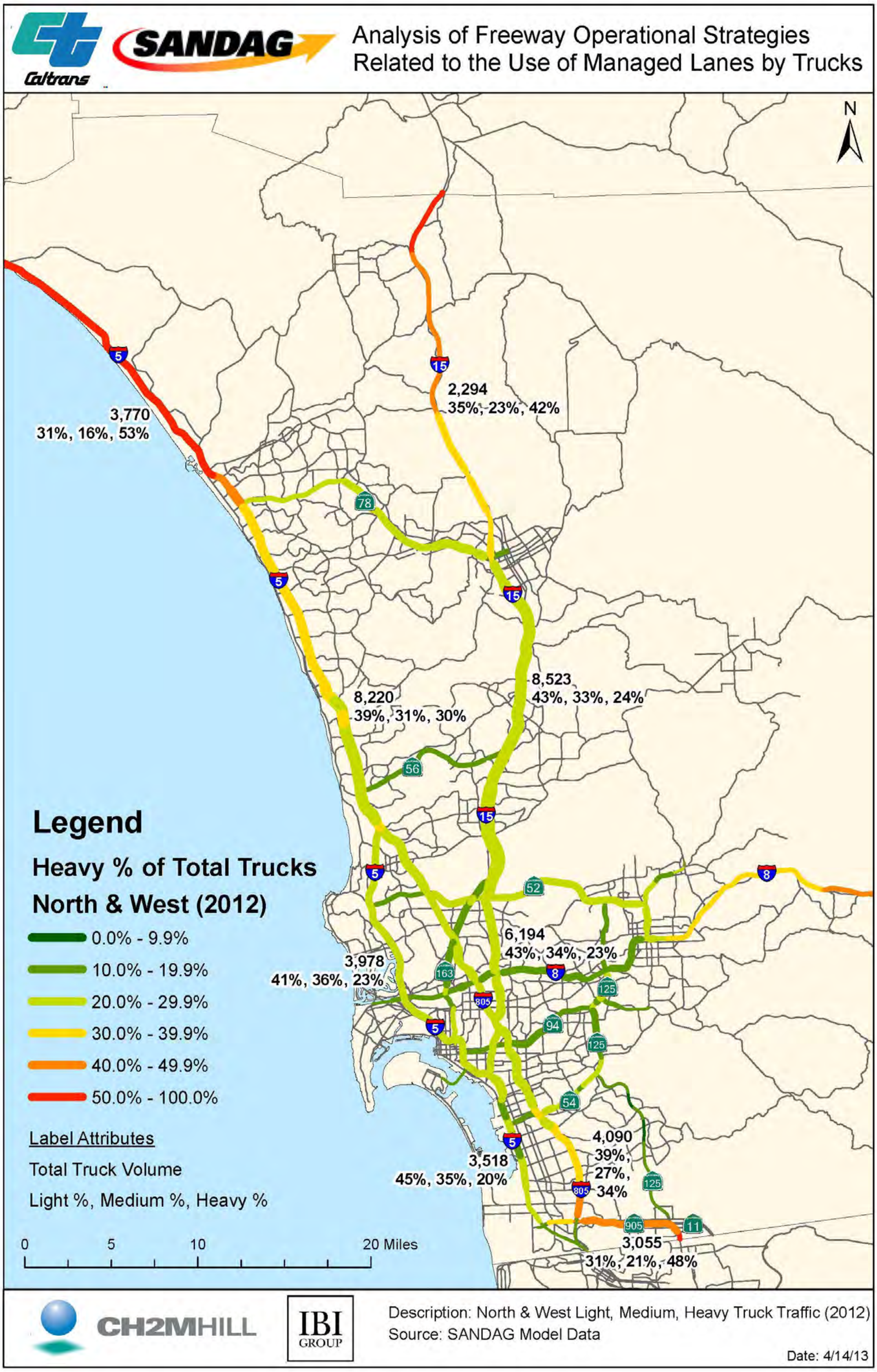


Figure 44 – 2012 South & East Percentage of Truck Type

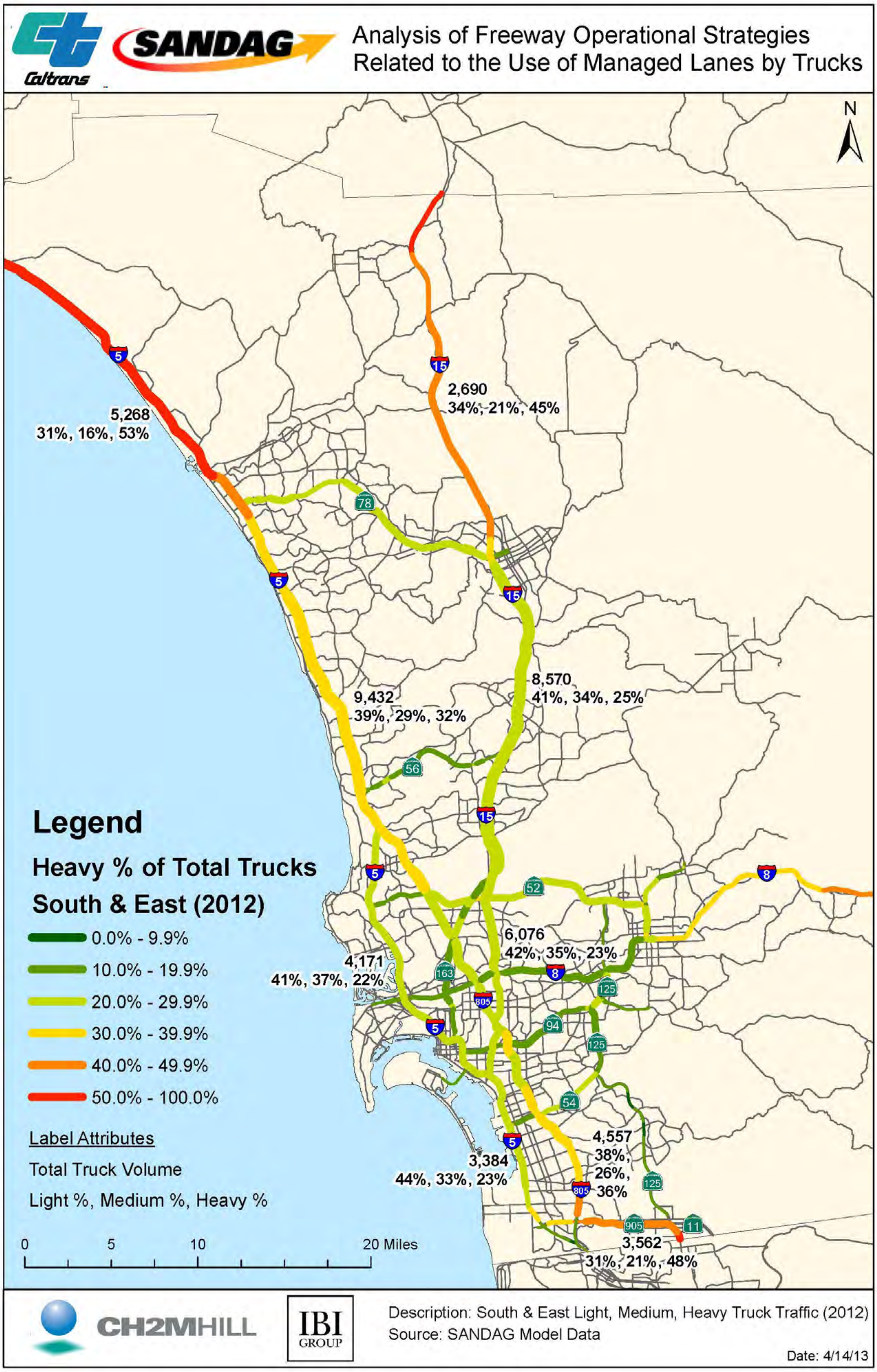


Figure 45 – 2020 North & West Percentage of Truck Type

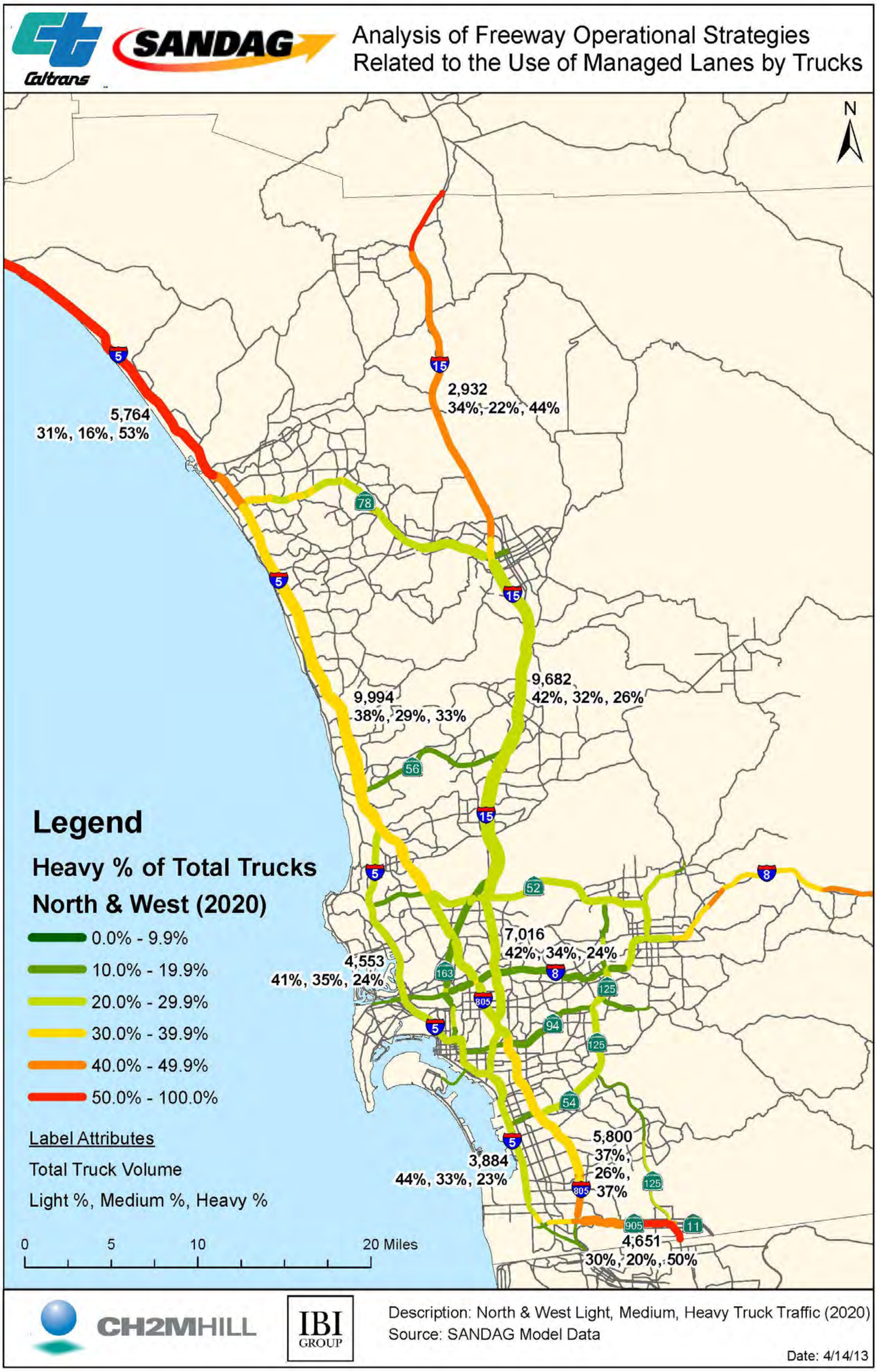


Figure 46 – 2020 South & East Percentage of Truck Type

Figure 47 – 2035 North & West Percentage of Truck Type

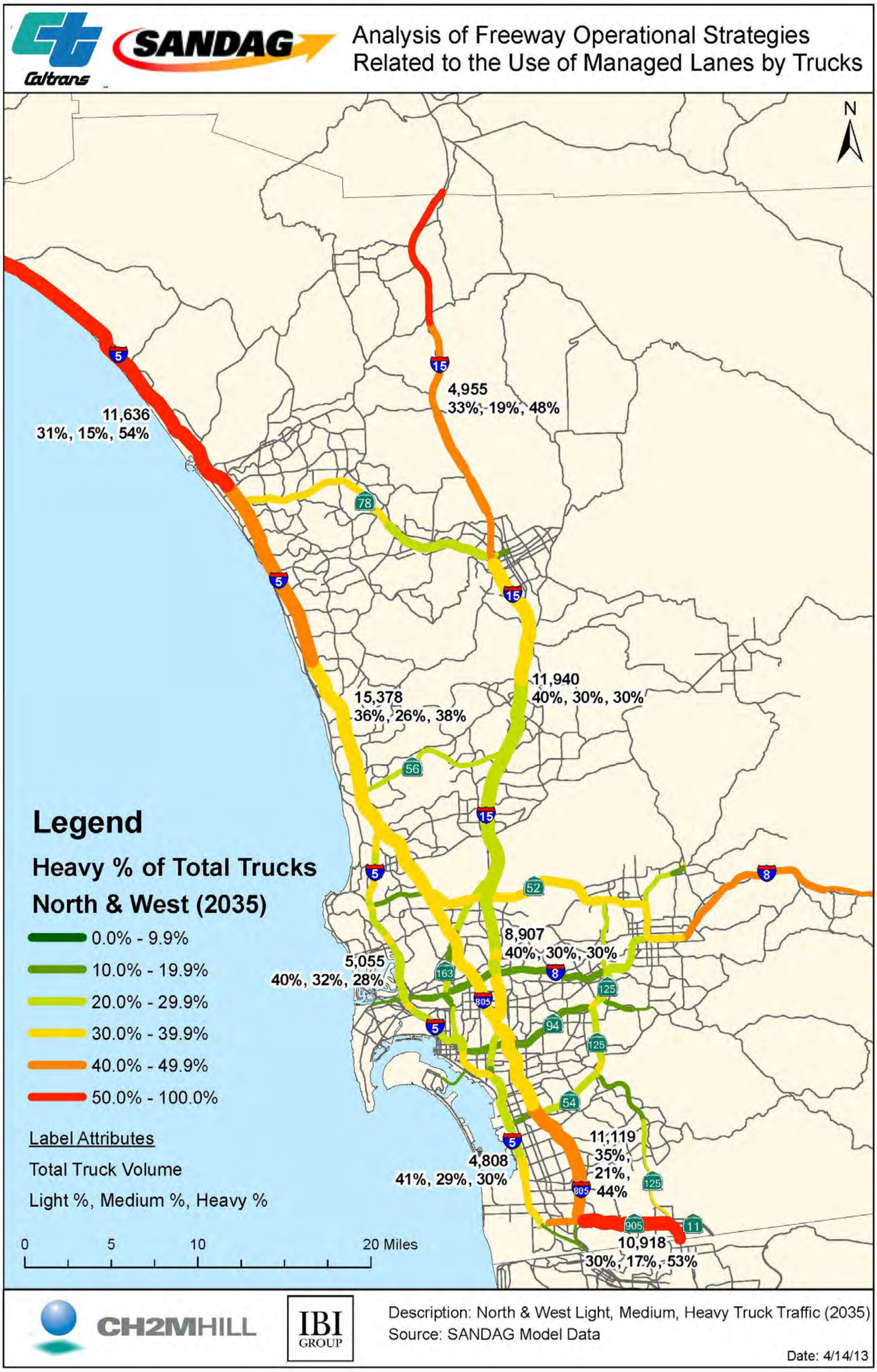


Figure 48 – 2035 South & East Percentage of Truck Type

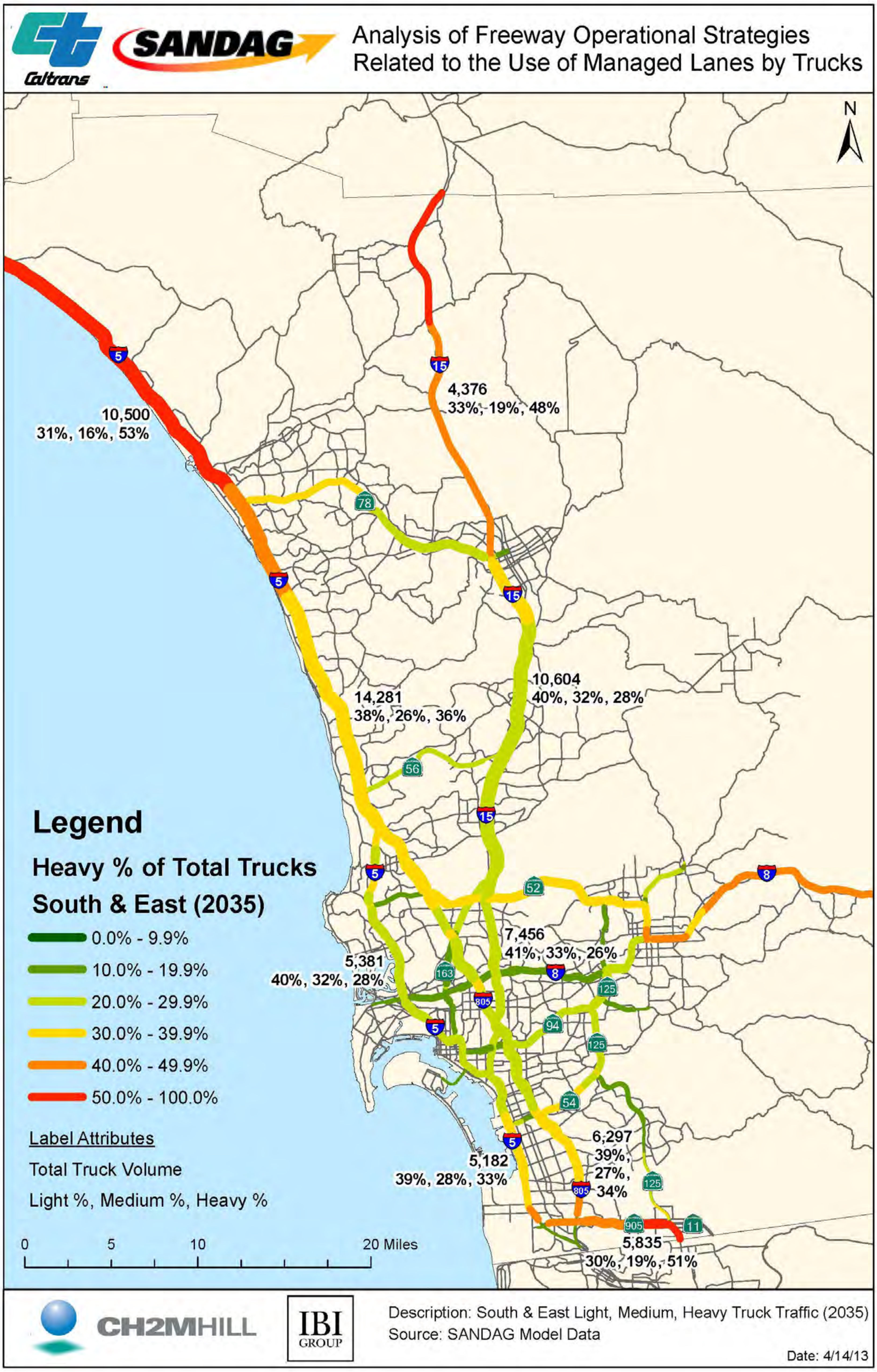


Figure 49 – 2050 North & West Percentage of Truck Type

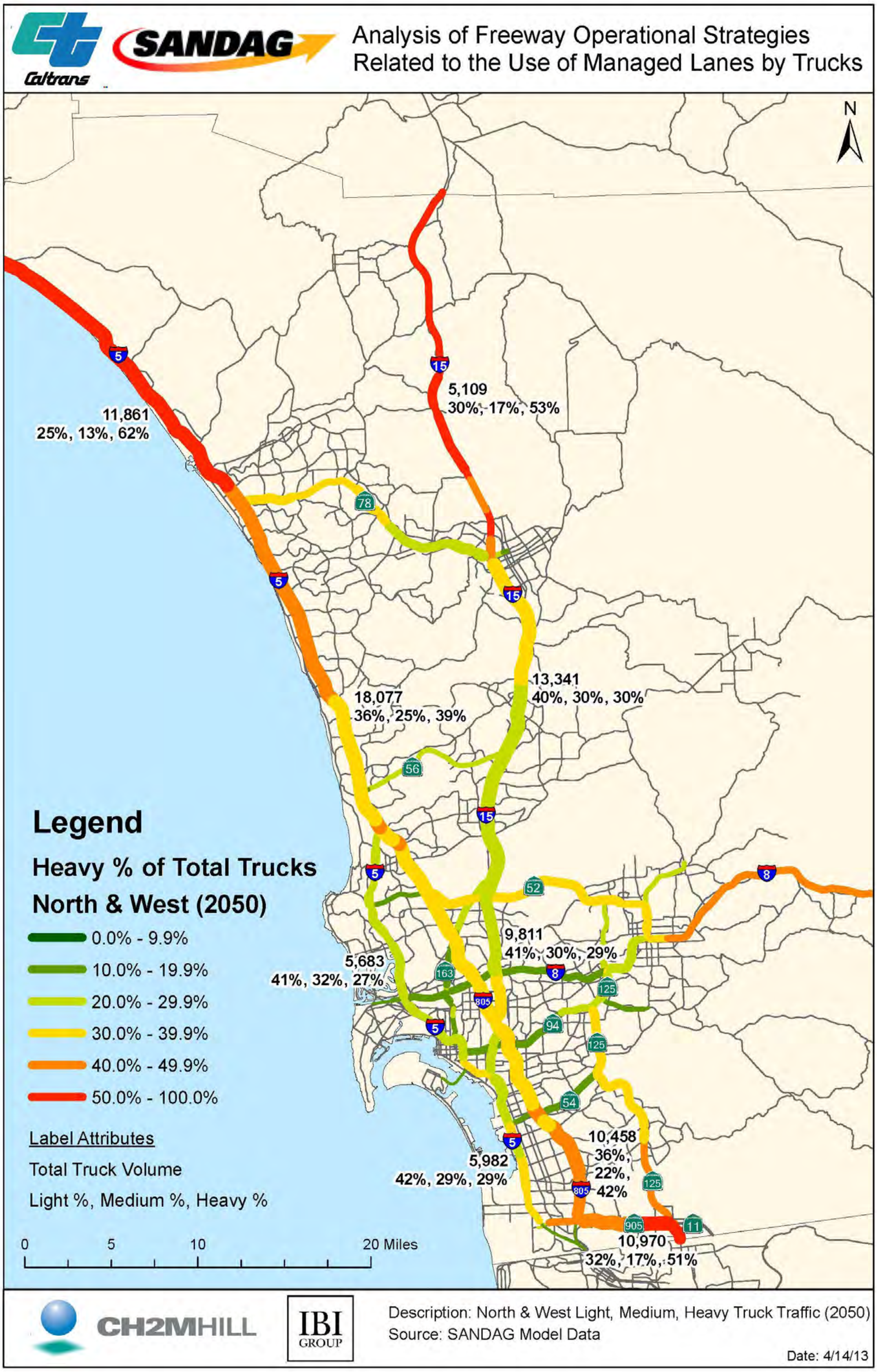
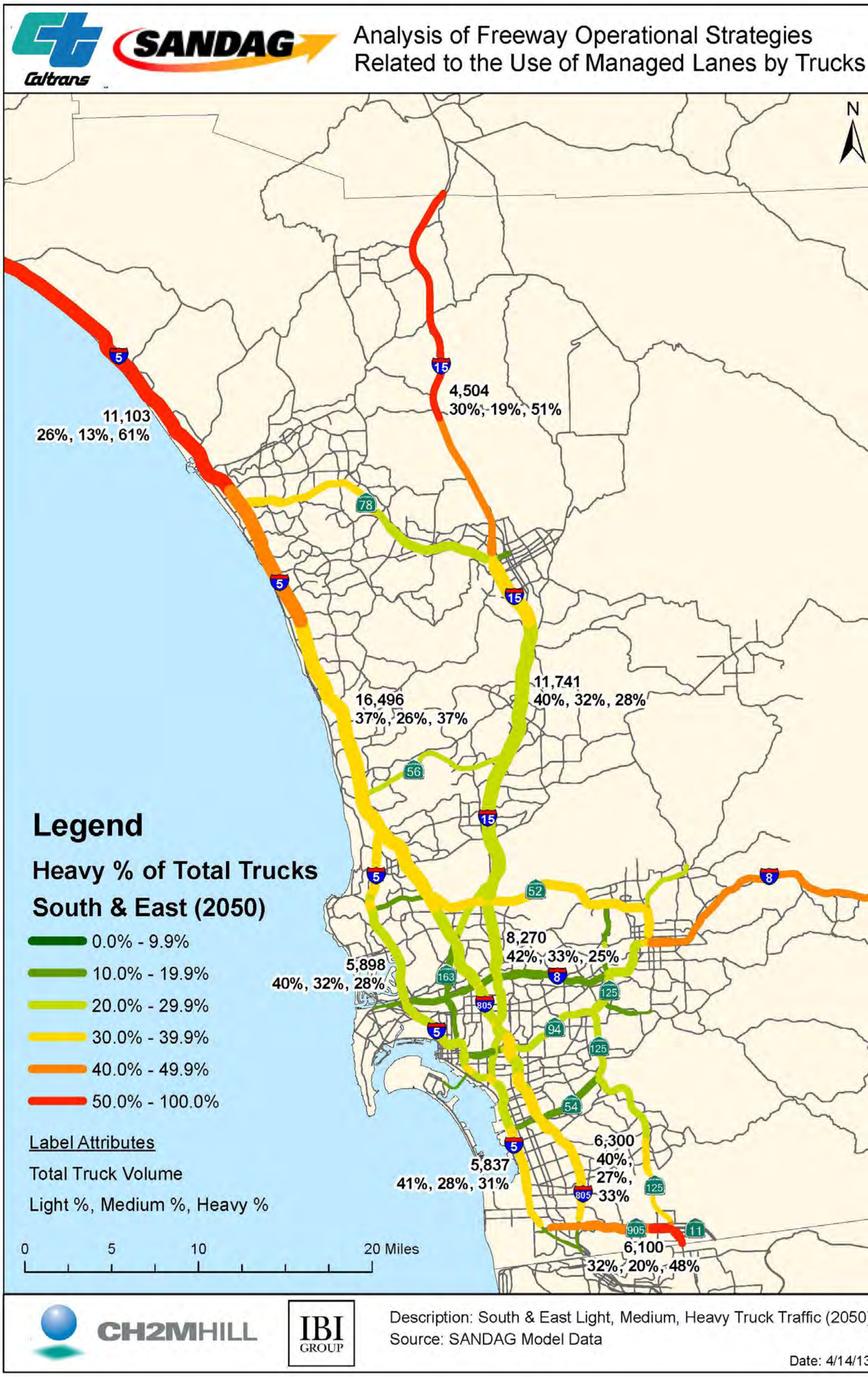


Figure 50 – 2050 South & East Percentage of Truck Type



Level of Service

The following maps show the daily Level of Service (LOS) for total traffic over time in the north-west and south-east directions. LOS indicates level of congestion on corridors. The data for these maps were taken from the SANDAG truck model for 2012, 2020, 2035, and 2050. LOS data from the model is shown in four categories: three free-flow LOS categories, A, B, and C (shown in green) and three substandard LOS categories D (yellow), E (orange), and F (red). Traditionally in transportation analyses on freeways, LOS E and F are considered unacceptable.

Figures 51 through 58 represent the LOS for all types of traffic traveling along the highways in San Diego County. The LOS results displayed in the map take into consideration the improvements already identified in the adopted RTP under the revenue constrained scenario.

- Figure 51 – 2012 North & West Level of Service
- Figure 52 – 2012 South & East Level of Service
- Figure 53 – 2020North & West Level of Service
- Figure 54 – 2020 South & East Level of Service
- Figure 55 – 2035 North & West Level of Service
- Figure 56 – 2035 South & East Level of Service
- Figure 57 – 2050 North & West Level of Service
- Figure 58 – 2050 South & East Level of Service

A few key characteristics can be observed in these maps:

- LOS over the entire region steadily worsens when comparing each progressive forecast year (e.g. comparing 2012 to 2020).
- More coastal and populated areas generally experience lower LOS compared to less populated areas.
- Numerous key truck corridors, including I-5, I-805 and I-15 are forecast to experience LOS categories of E and F along substantial portions of the facilities.
- SR 125 from SR 905 to SR 54 has an acceptable LOS until 2050, when the segment is no longer tolled.
- North & west segments tend to have worse LOS than the south & east segments.

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Figure 51 – 2012 North & West Level of Service

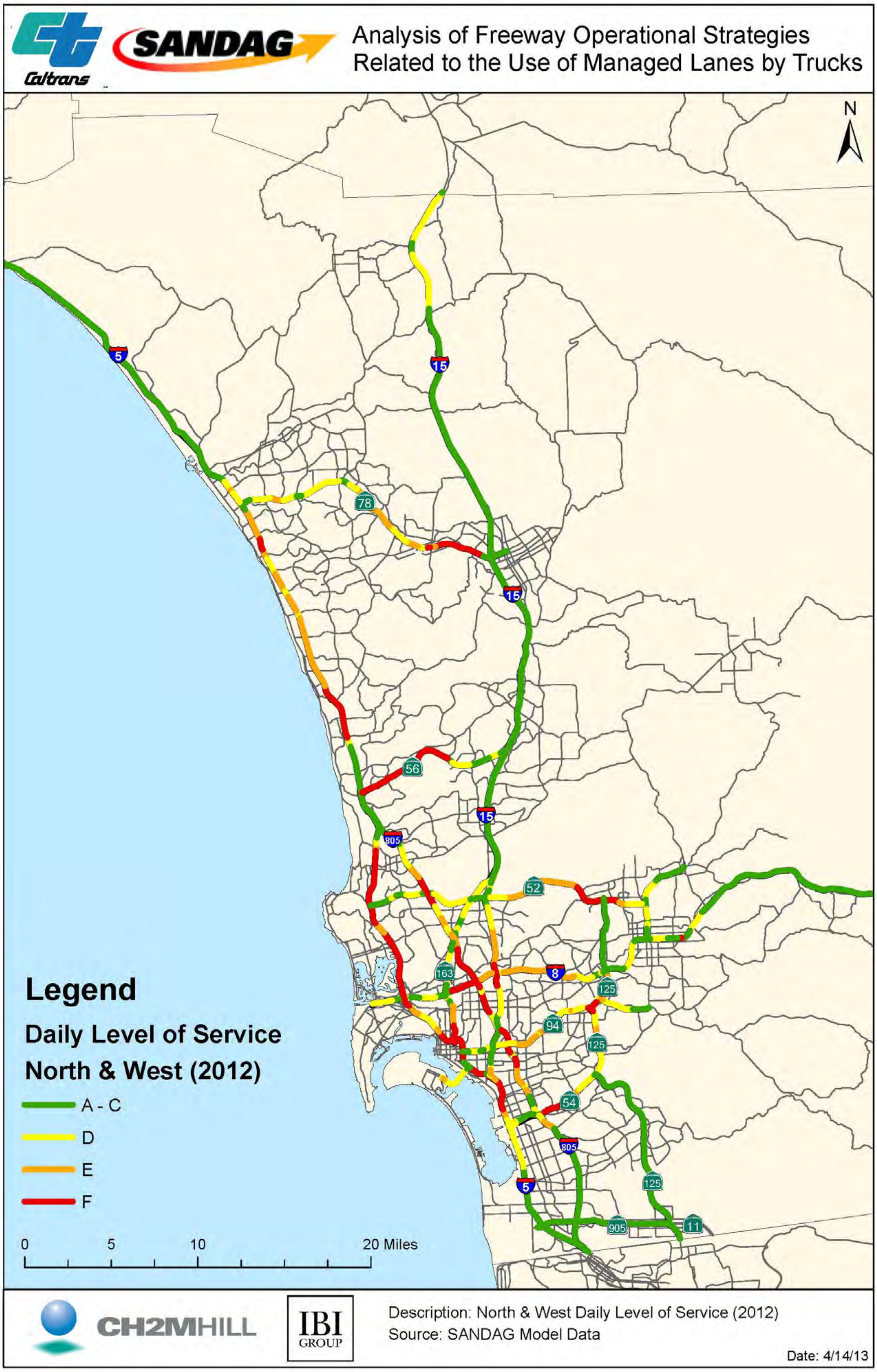


Figure 52 – 2012 South & East Level of Service

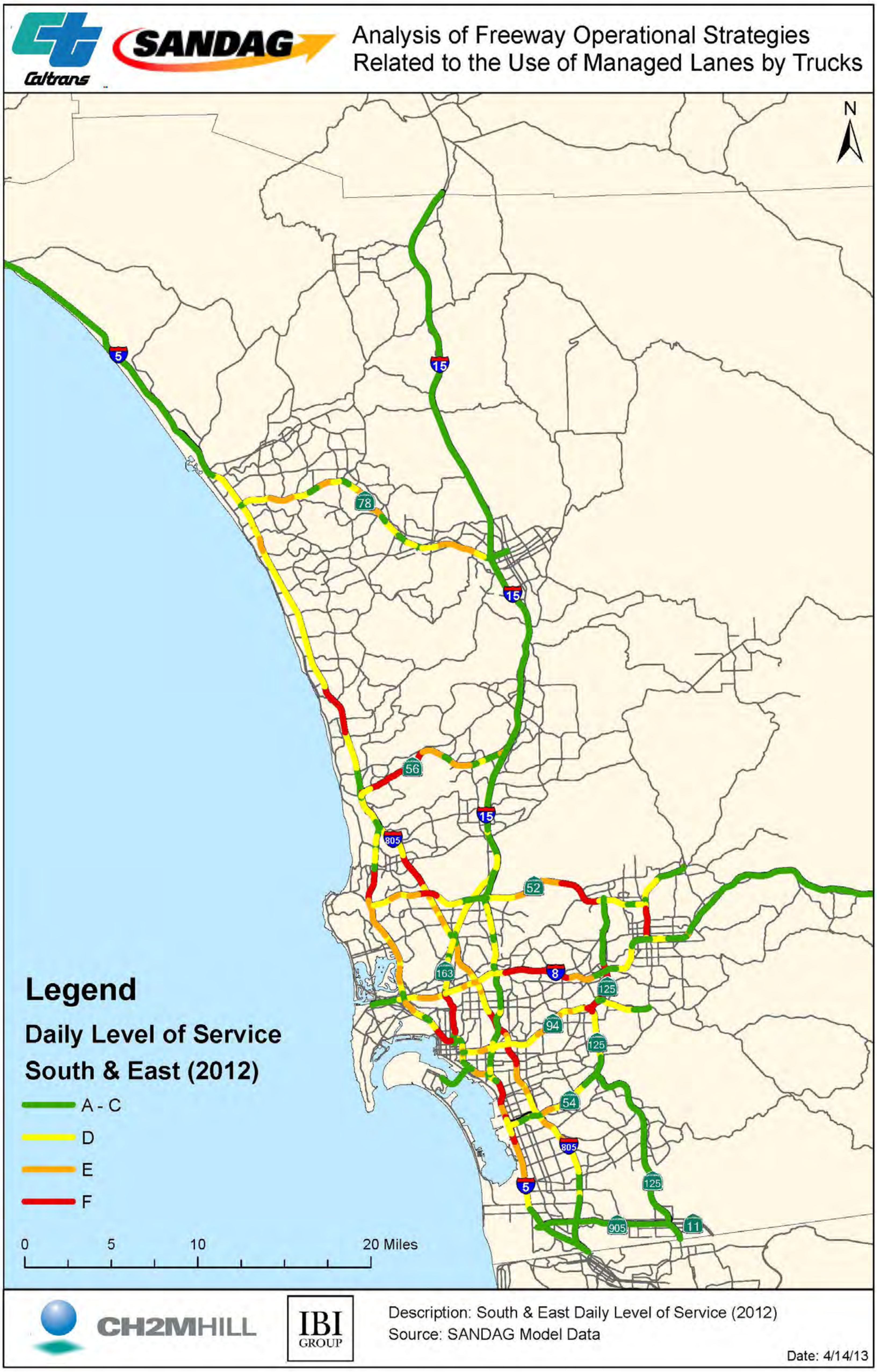


Figure 53 – 2020 North & West Level of Service

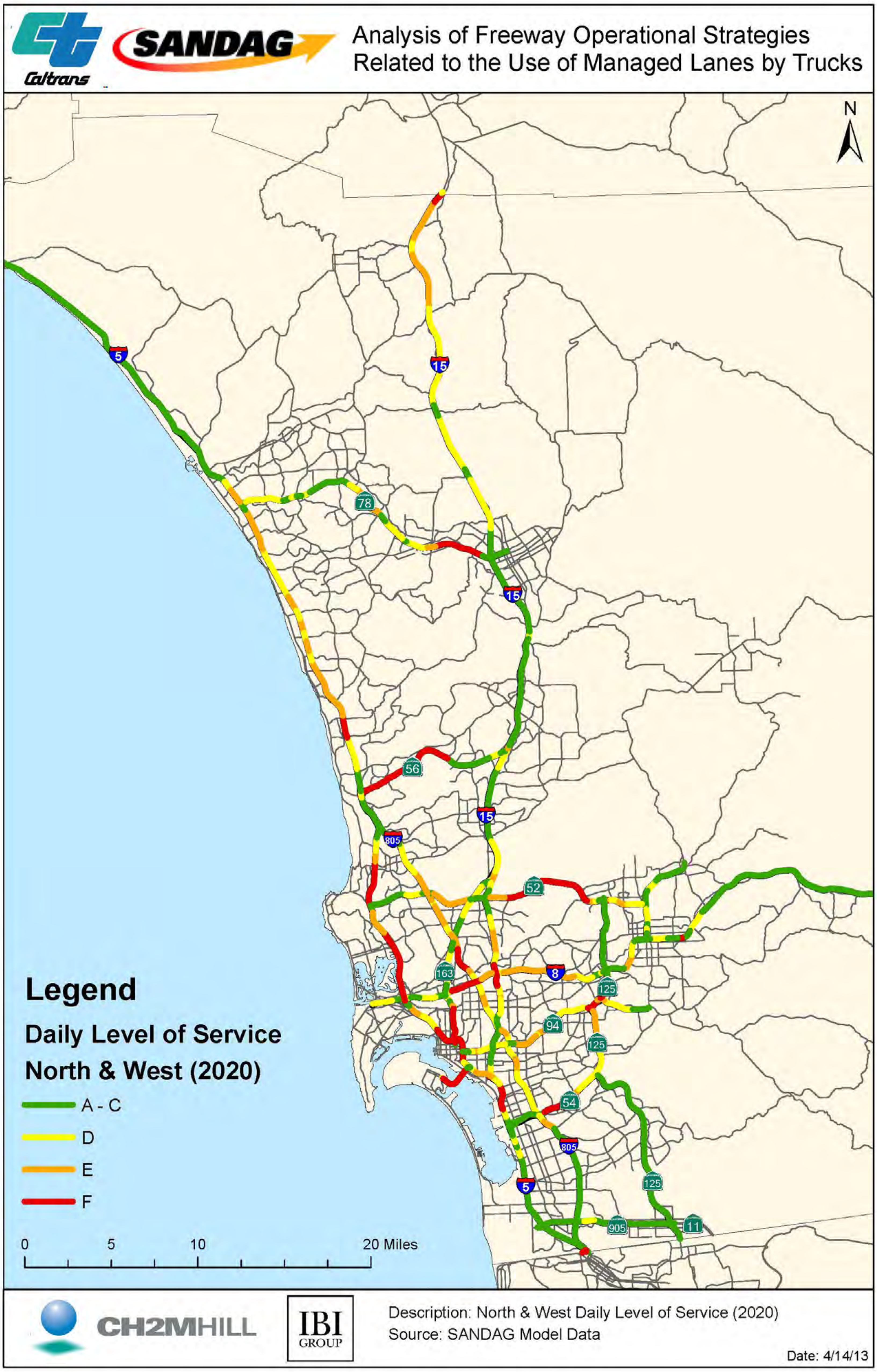


Figure 54 – 2020 South & East Level of Service

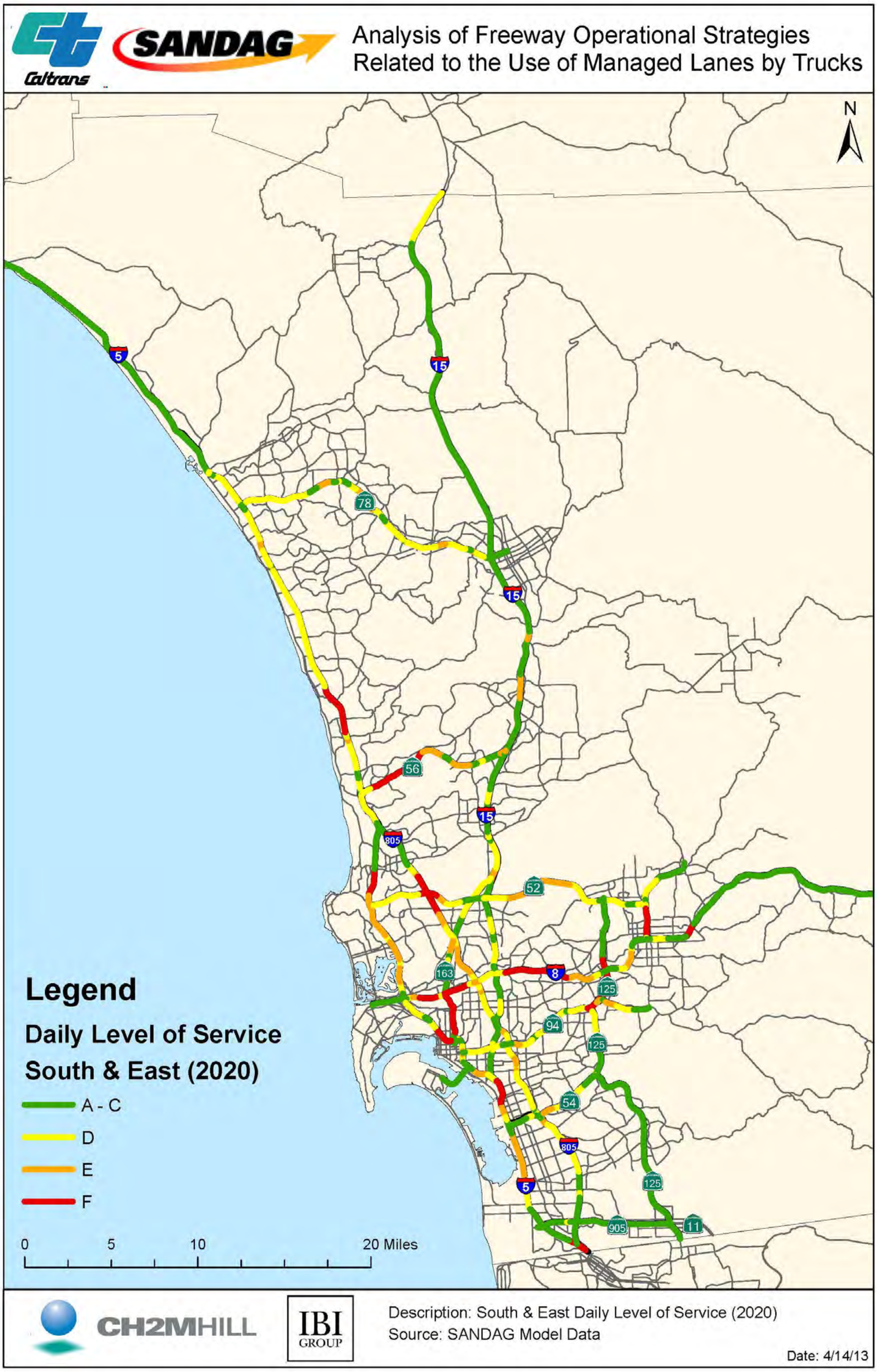


Figure 55 – 2035 North & West Level of Service

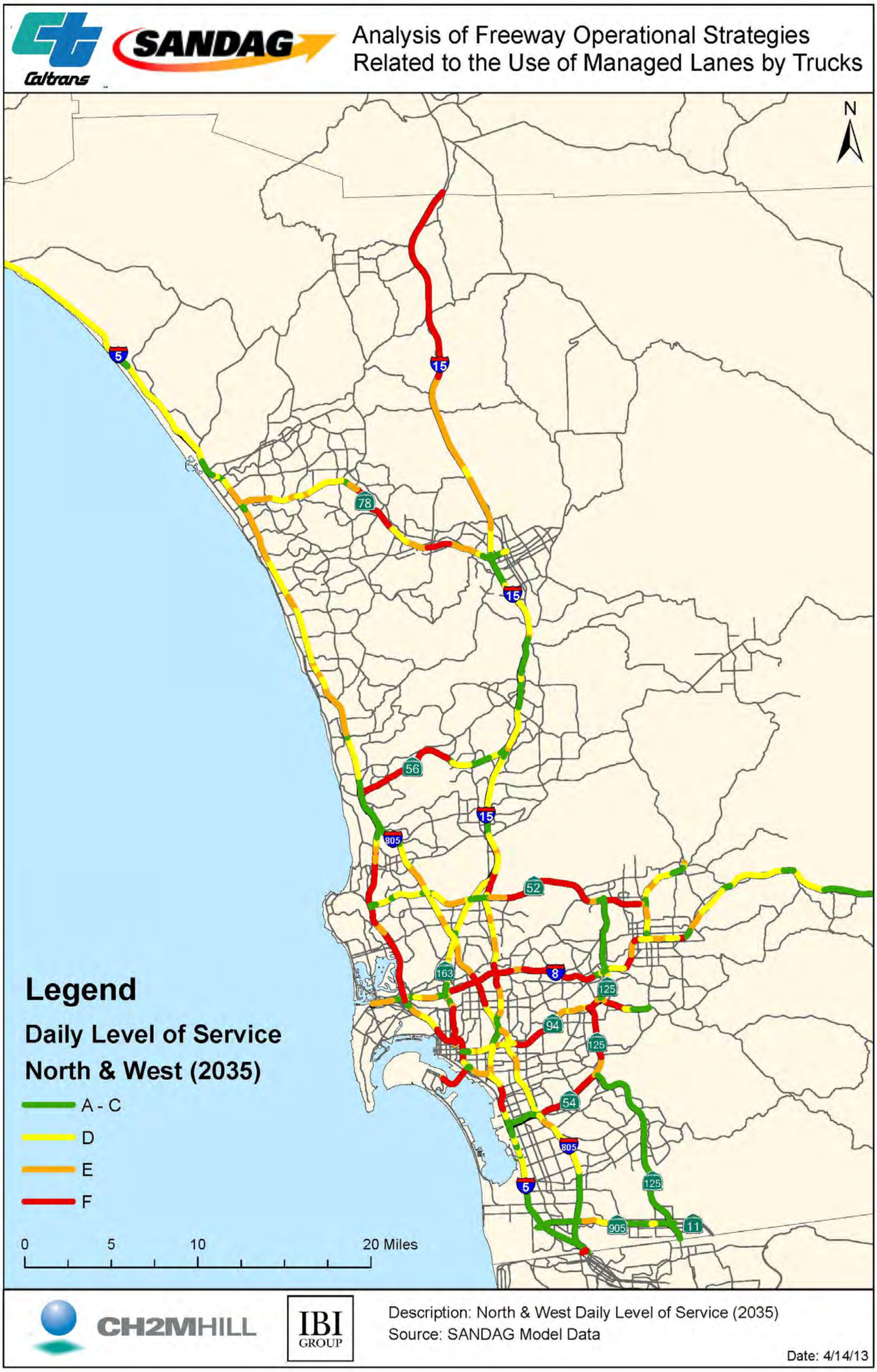


Figure 56 – 2035 South & East Level of Service

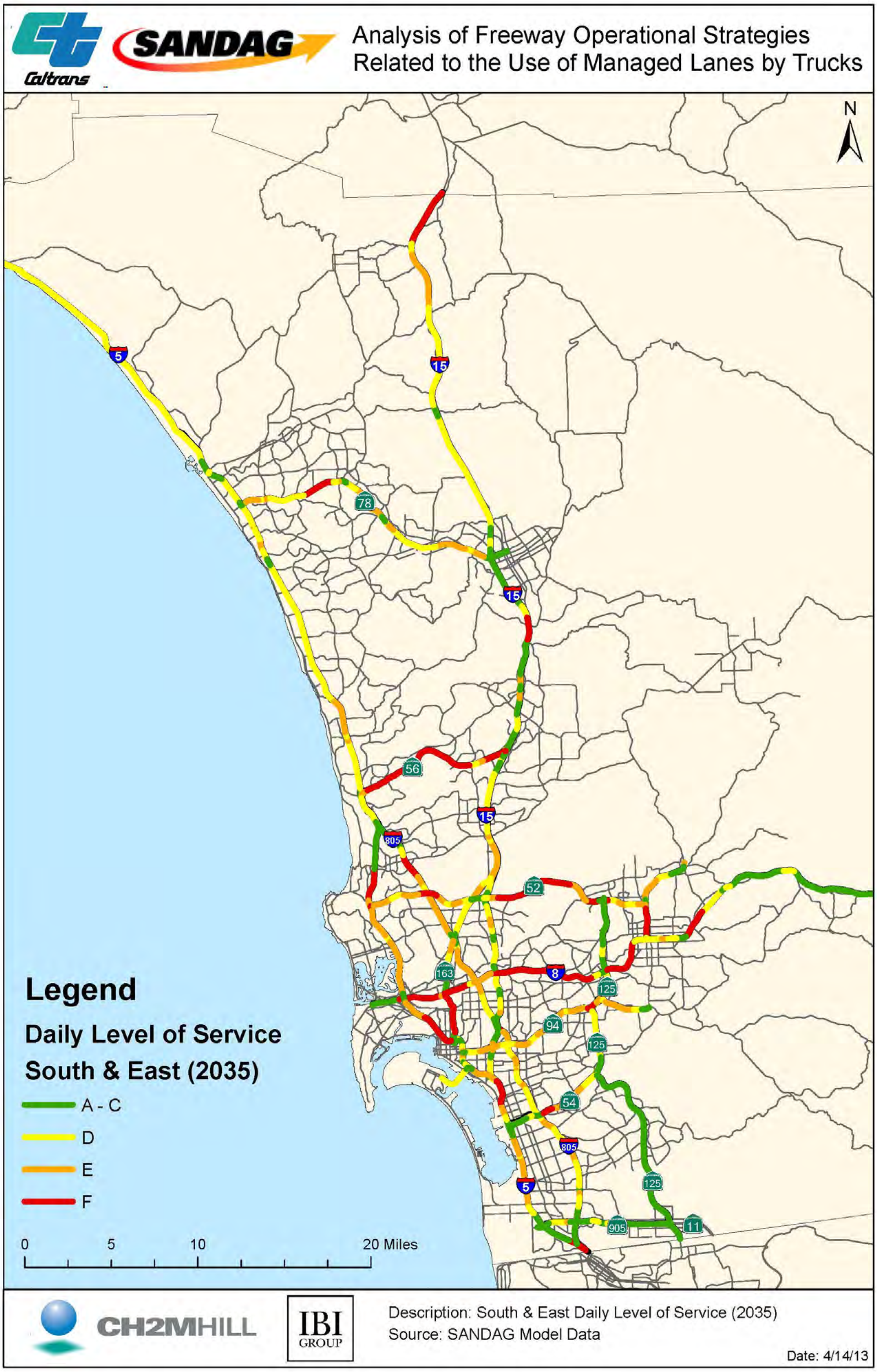


Figure 57 – 2020 North & West Level of Service

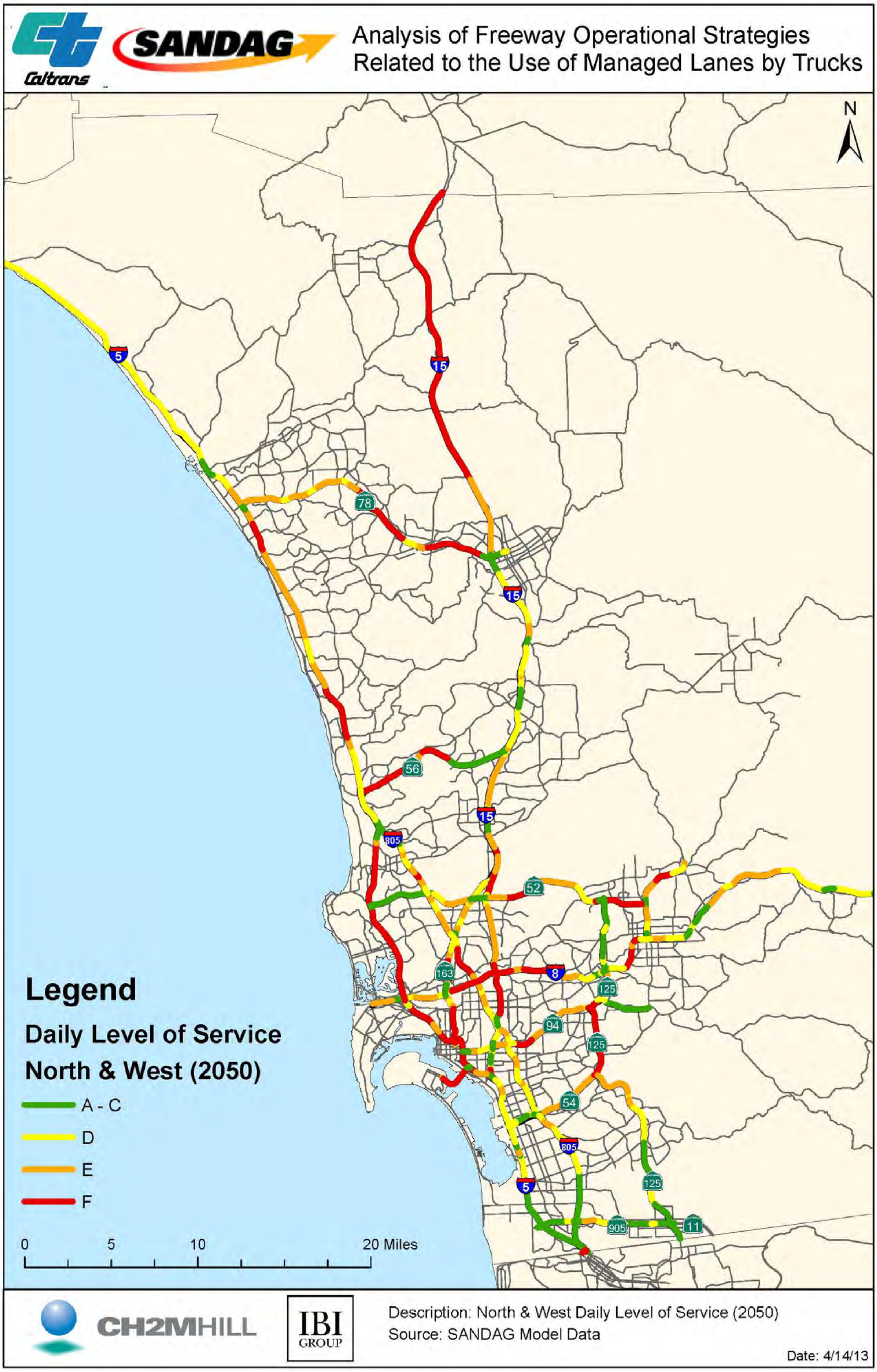
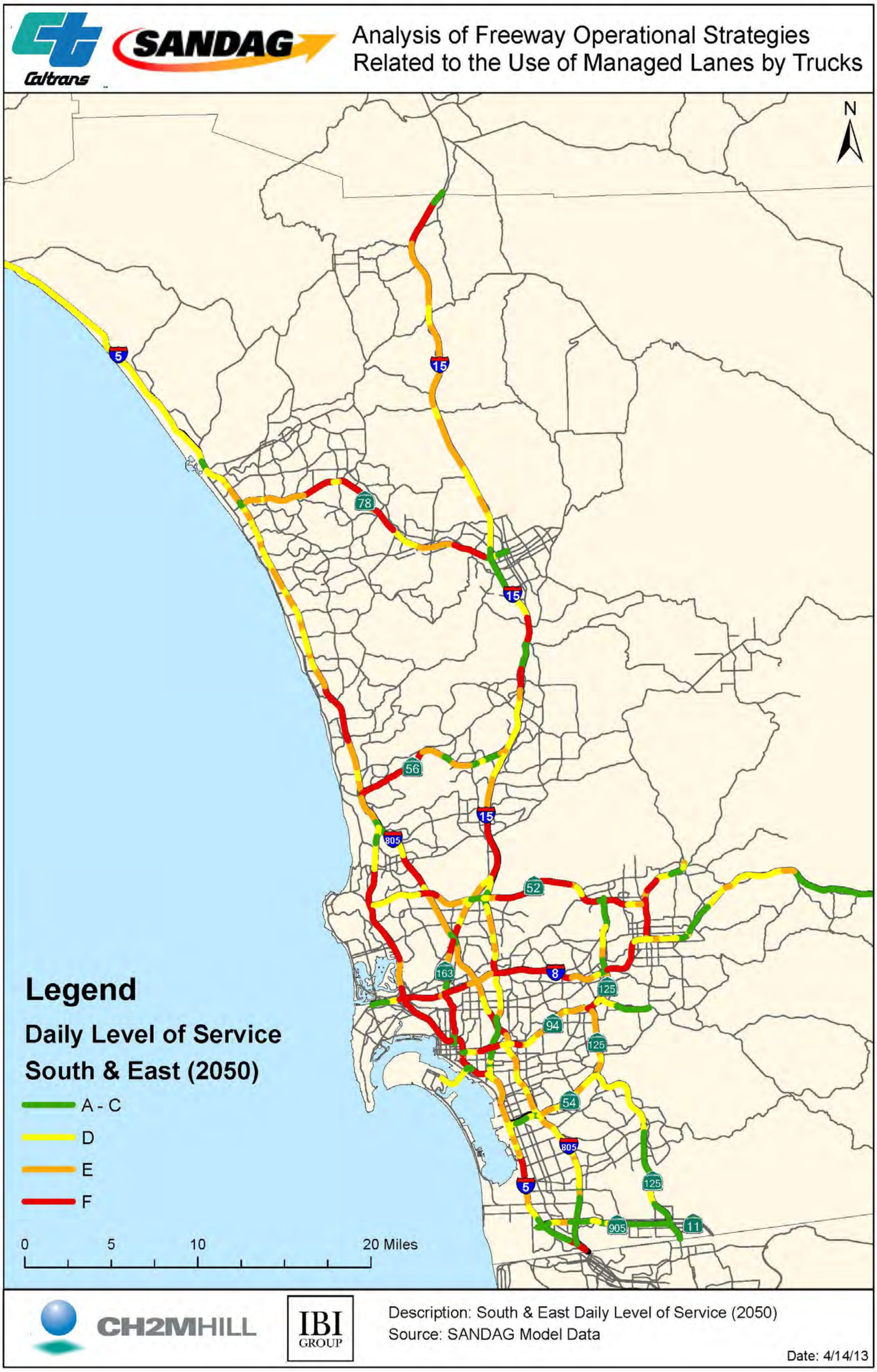


Figure 58 – 2050 South & East Level of Service



Regional Weigh-In-Motion (WIM) Sites

Caltrans maintains seven WIM stations across the County. Stations provide information about types of vehicles along key corridors for truck traffic as seen in Figure 59. The WIM data provide useful insights for the truck management strategies because it is possible to determine the time of day heavy, medium and light trucks use each WIM Corridor.

Using the raw WIM data provided by Caltrans, vehicle classifications were separated into light, medium and heavy trucks using the following conversions:

- Light trucks are considered to be the following WIM vehicle classifications:
  - Single Unit, 2 Axle & 6 Tires
  - Bus
- Medium trucks are considered to be the following WIM vehicle classifications:
  - Single Unit, 3 Axle
  - Single Unit with 4 or more Axles
  - Separate Trailer, Less than 4 Axles
- Heavy trucks are considered to be the following WIM vehicle classifications:
  - Separate Trailer, 5 Axles
  - Separate Trailer, 6 or more Axles

Figure 60 shows truck classifications for north and southbound traffic at each station.

The WIM data have the following limitations due to the complicated environment that the data are collected from:

- WIM sites can be inoperable/broken down or shut down due to maintenance for a substantial amount of time.
- WIM sites sometimes provide inaccurate vehicle classifications when vehicles pass over the sensors in an irregular manor.
- Several of the classifications include truck types that could fall into more than one of our three truck classifications.

Appendix C provides a complete set of WIM data for each location. These data show when certain truck classifications are most prevalent during the day at those locations. Figure 61 shows an example of this for WIM data station number 5. The complete set of time-of-day graphs indicate that the peak traffic times for different truck types varies and this also varies by location. These findings will assist with the assessment of the truck management strategies along the corridors with different characteristics. Some of the strategies that apply to only one or two of the truck types (light, medium and heavy) can use this analysis to determine where and when the select strategies might apply.

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Figure 59 – WIM Locations

Figure 60 – WIM Locations and Truck Types

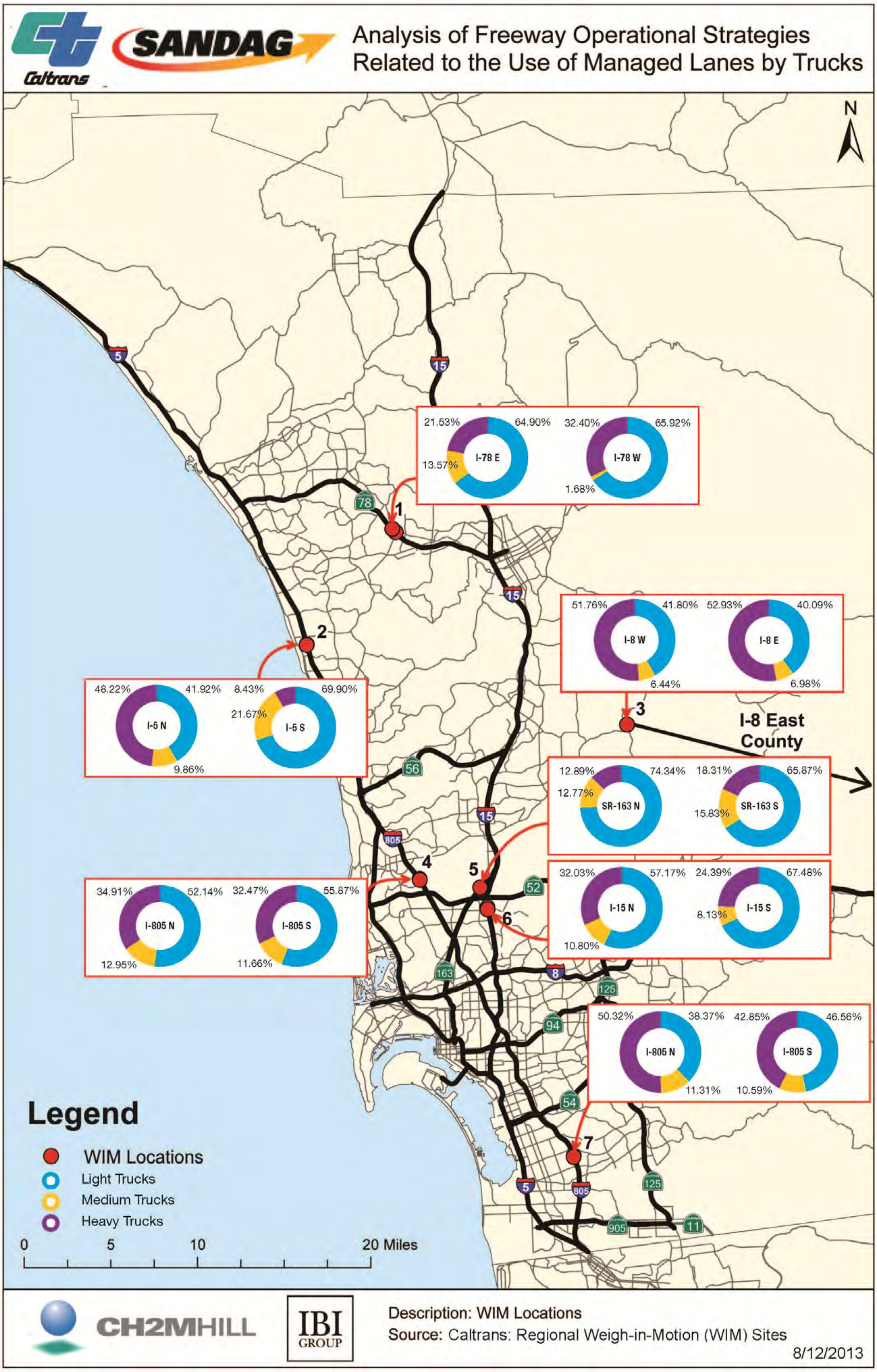
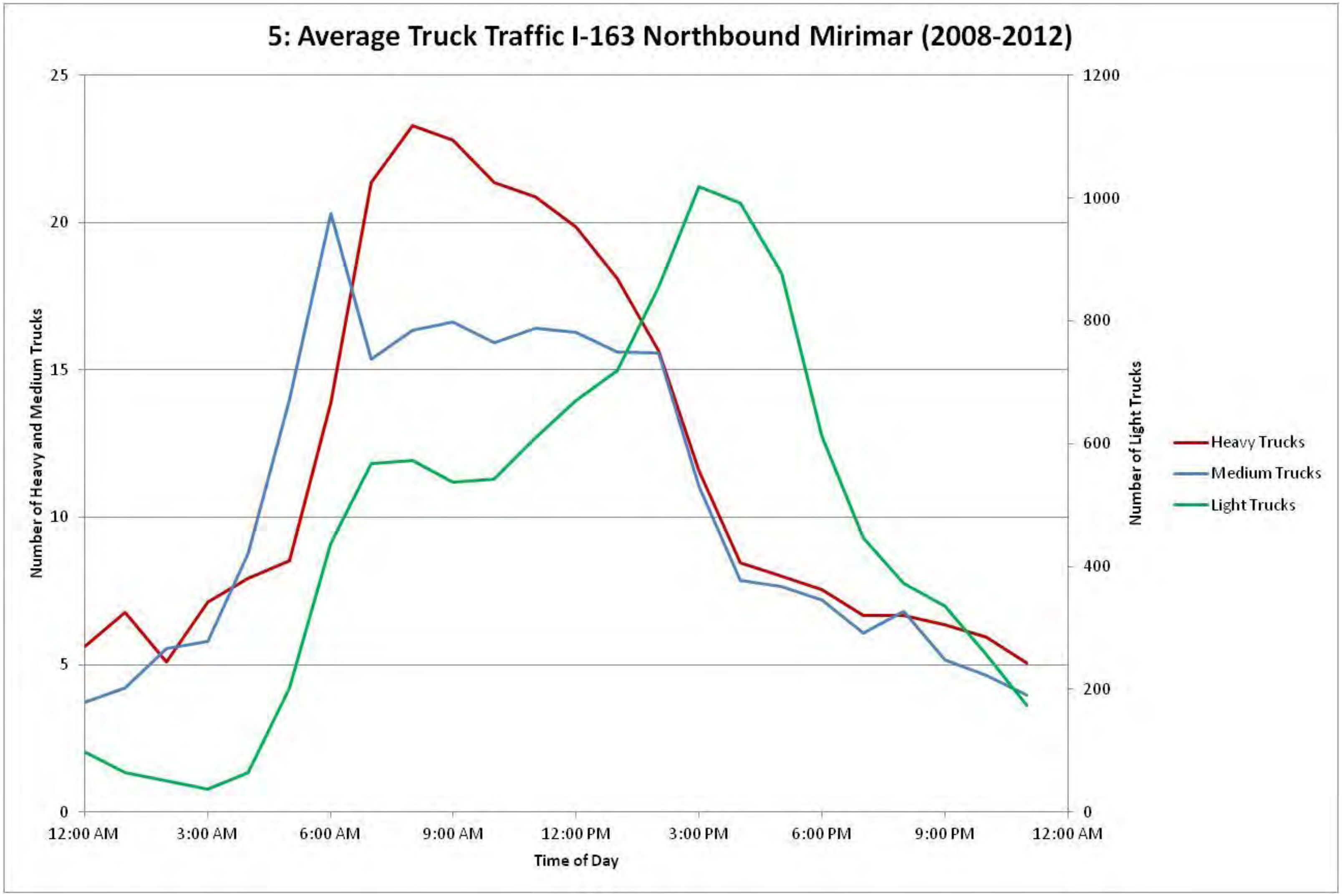


Figure 61 – The Northbound Data Represented for WIM Location 5



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Regional Classification and Occupancy Counts

Caltrans and SANDAG conducted a vehicle class count across 23 locations from March to June of 2012 along the major highways in San Diego County. Figure 62 shows the different count locations. Counts were conducted for one day from 6 AM to 6 PM at each location and included counts of various types of traffic. The data provided from this effort have been processed to show the variations of truck traffic versus other traffic over the course of a day.

The data included vehicle counts in 15 minute increments throughout the day. For some of the data points, vehicle counts were collected for both directions for the entire day, while for the other data points, the data were only collected for one direction in the AM and the other direction in the PM. A summary of the data that are represented at each data point is outlined in Table 4. Data points for locations that are outside of the study area (along SR 67, SR 73 and SR 76) have been omitted from the data analysis.

The data provided for each data point were analyzed to summarize the amount of truck traffic versus other traffic in each direction. Figure 63 is an example of how the vehicle classification data were analyzed to represent the ratio of traffic types throughout the day. In this figure, it is clear that the peak truck traffic time is during the middle of the day, while the other traffic peak times are during the rush hours in the early and later times of the day. The complete set of graphs for all data points is provided in Appendix D.

Although the regional classification and occupancy count data set offers a great insight into how the truck and non-truck traffic types are distributed among the key truck corridors, there are several limitations to the accuracy of the regional classification records. These limitations must be taken into account when using the data to support whether or not to implement any particular strategy. First, the counts are conducted during daylight hours and do not capture classification for all 24 hours of the day. Also, the regional classification and occupancy count data consist of vehicles classified by sight; the following inaccuracies are related to the process of visually counting and classifying vehicles:

- Missing a vehicle due to being overwhelmed by the volume of vehicles,
- Counting a vehicle more than once due to cross over counting of different team members,
- Classifying the vehicle in the wrong category due to the speed and/or volume of vehicles passing by at any given time, and
- Inexperience of temporary count staff can lead to some inaccuracies.

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Figure 62 – Regional Classification Data Collection Points

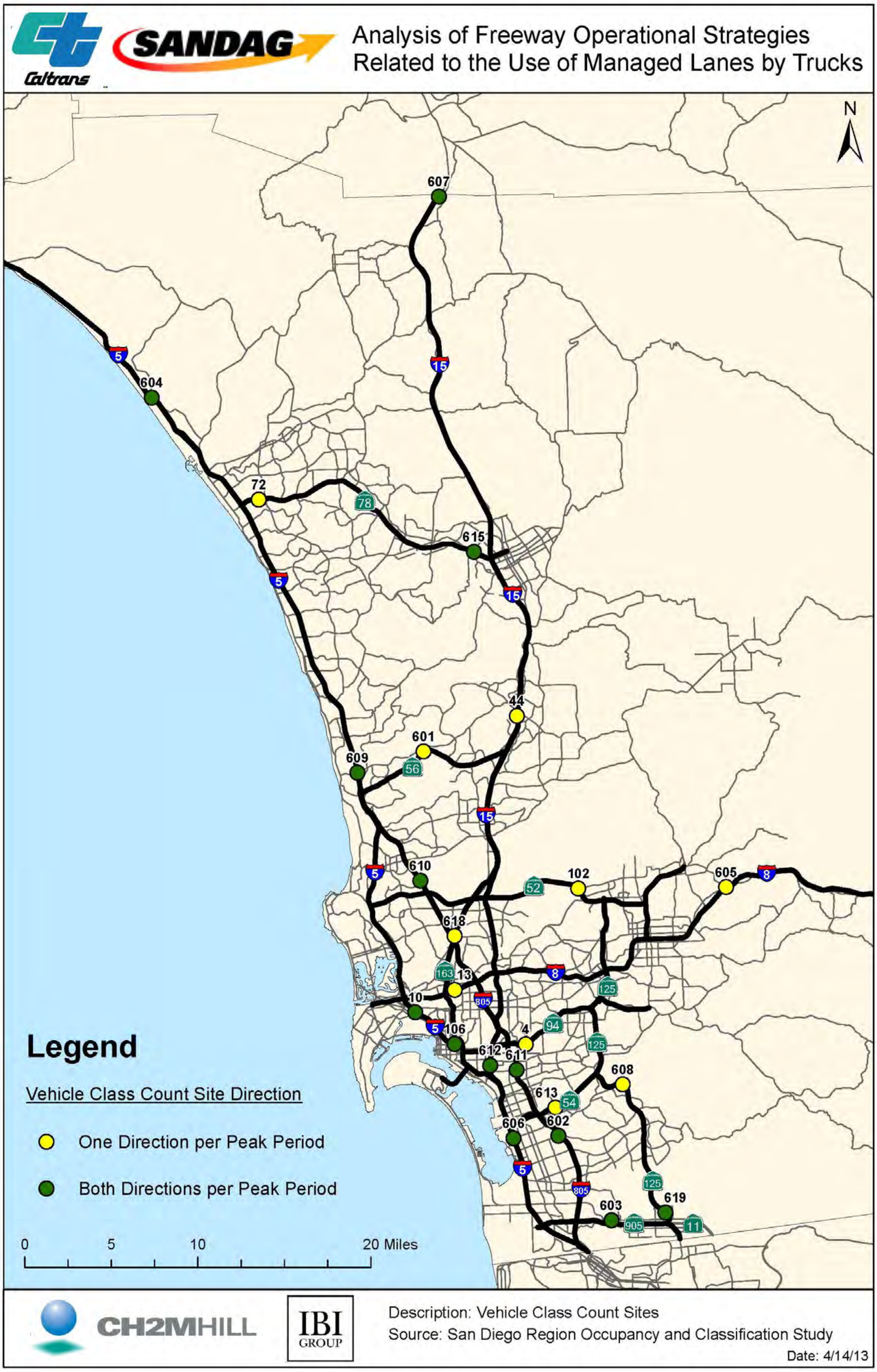

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Table 4 – Summary of Regional Classification Data Provided

Data Point	AM Direction(s)	PM Direction(s)
4	West	East
10	North & South	North & South
13	West	East
44	South	North
72	West	East
102	West	North
106	North & South	North & South
601	West	East
602	North & South	North & South
603	East & West	East & West
604	North & South	North & South
605	West	East
606	North & South	North & South
607	North & South	North & South
608	North	South
609	North & South	North & South
610	North & South	North & South
611	North & South	North & South
612	North & South	North & South
613	West	East
615	East & West	East & West
618	South	North
619	North & South	North & South

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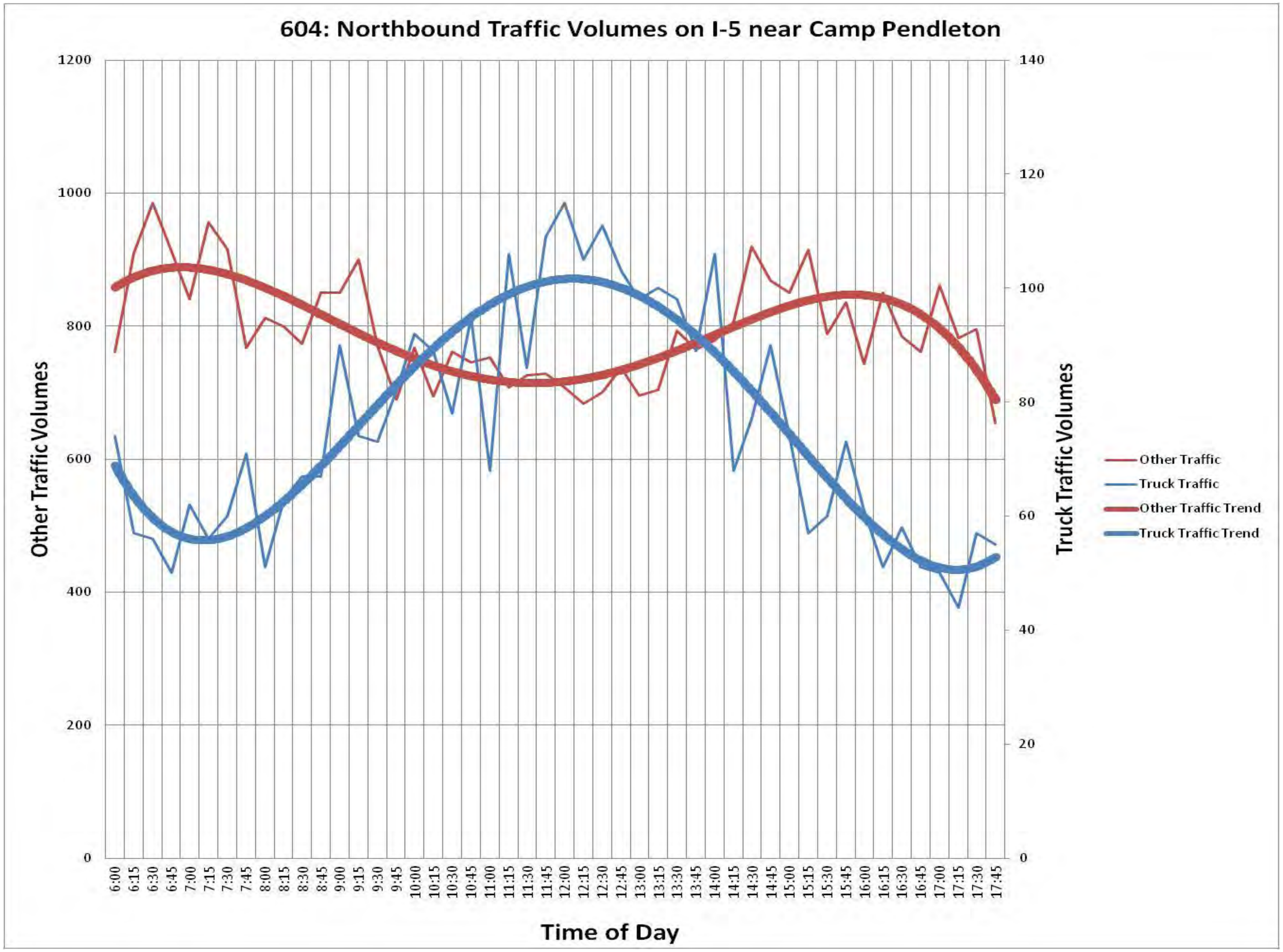
Figure 63 – Vehicle Classification Summary for Point 604



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SWITRS Accident Data Summary

The California Highway Patrol provides accident data through the Statewide Integrated Traffic Records System (SWITRS) for three districts in San Diego County (The City of San Diego, El Cajon, and Oceanside). The data are available for all accidents recorded after January 2002.For this effort the data were analyzed from March 1, 2008 to March 1st 2013. Although the system provides 117 data points for each of the 30,000 accidents recorded over the last five years, there are inconsistencies with how these data are populated for each intersection. Another major limitation to the data is that 43 percent of all the accidents provided through SWITRS did not include a latitude and longitude location.

The following findings were derived from an analysis of the available SWITRS data that will be considered for assessing the potential for truck management strategies:

- Most truck related accidents are spread out fairly evenly across the major truck corridors in the County.
- Fatal truck related accidents seem to occur most frequently in areas of transition between major truck corridors (freeway interchanges).

Steep Grades

All trucks are generally more impacted by steeper than average grades along freeways. What constitutes a steep grade is determined by both the slope and the length of a grade and varies by the type of terrain and facility. However, a common criterion for considering truck management strategies is where the running speed of trucks falls 10 miles per hour or more below the running speed of remaining traffic.[5] These areas represent opportunities for freeway truck management strategies, such as active traffic management, additional truck climbing lanes, or special or adjustable truck restrictions, among others. While it was not the purpose of this study to identify all detailed areas with steeper than average grades, it is useful to highlight some of the general areas where this occurs:

- SR 125 (south) – In the more southern portion of the facility between SR 905 and SR 54 there are a couple of areas with steep grades. Current traffic levels are low enough that truck traffic in these areas does not generate any particular issues on the grades; however, it still may be an area for future consideration.
- I-8 (east) –from Alpine to the Imperial County Line there are substantial areas of significant steep grades which occur over several miles. Currently the freeway accommodates a higher than average percentage of trucks in these areas by providing three lanes of travel in each direction. There are emergency runaway truck ramps in the steepest downhill grade areas.
- I-15 (north) – North of Escondido, I-15 has several areas of lengthy above average grades. These are particularly impactful in the Rainbow area.
- I-5 (between I-805 and SR 78) – In the areas near the lagoons along I-5, there are lengthy above average grades, particularly in the vicinity of Via de la Valle and Manchester Avenue.

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[5] Caltrans, May 7 2012, Highway Design Manual, Chapter 200: Geometric Design and Structure Standards,

- SR 52 (between I-15 and SR 125) – SR 52 has substantial lengthy grades east of Santo Road and west of Mission Gorge Road. In the last few years additional lanes were added to act as climbing lanes for truck traffic.
- I-15, I-805, and SR 163 moving in and out of the Mission Valley area (both northbound and southbound). Grades in these locations were mentioned by numerous trucking industry stakeholders during the interview process.

Each of these areas may have the potential for the unique application of freeway truck management strategies, and all are anticipated to see substantially increasing truck volumes over time.

5. Key Findings and Next Steps

5.1 Major San Diego Freeway Trucking Gateways/Distribution Hubs

As a result of the data collection and analysis process, several key trucking gateways/distribution hubs were identified. Truck gateways are the areas through which major flows of goods travel, such as the Border, the Port of San Diego, and the San Diego International Airport. Truck distribution hubs are those areas that contain numerous manufacturing and warehousing districts and serve as large generators of truck trips.

The key current and projected trucking gateways and distribution hubs throughout the San Diego region identified as part of this study are shown in Figure 64 and are described below:

- **G1: Border Area:** This area includes SR 905 at the Otay Mesa border crossing and some key arterials, such as La Media Road and Siempre Viva Road.
- **G2: National City Marine Terminal & National Distribution Center:** This area includes the terminal and distribution center near the I-5 and SR 54 interchange.
- **G3: 10th Avenue Marine Terminal & 32nd Street Naval Station:** This area includes the 10th Avenue Marine Terminal & 32nd Street Naval Station, west of I-5, near the Coronado Bridge and Barrio Logan.
- **G4: San Diego International Airport:** This area includes the San Diego International Airport and surrounding arterials that provide access to the cargo facilities (e.g. Harbor Dr.).
- **G5: Mid-City:** This area includes the dense, urban area south of I-8 surrounding El Cajon Boulevard.
- **G6: El Cajon/Santee:** This area includes the developed land surrounding the eastern terminus of SR 52, SR 67 and I-8 through El Cajon.
- **G7: Kearny Mesa:** This area includes the developed land surrounding the SR 52, I-805, and I-15 interchanges.
- **G8: Miramar / Mira Mesa / Sorrento Valley:** This area includes the trucking distribution hub in the vicinity of Mira Mesa, Sorrento Valley, and the I-5 and I-805 interchange.

- **G9: Poway:** This area includes Poway, specifically the developed area surrounding Scripps Poway Parkway.
- **G10: Rancho Bernardo:** This area includes Rancho Bernardo, specifically the developed area east of I-15.
- **G11: Palomar Airport Road / SR 78 Corridor:** This area includes the developed area surrounding the SR 78 corridor, the interchanges of SR 78 with I-15 and I-5, and Palomar Airport Road.

Issues and potential strategy solutions for the truck gateways/distribution hubs listed above will be discussed at a high level in Technical Memorandum #6: Strategy Analysis.

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Figure 64 – San Diego Truck Gateways and Distribution Hubs

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5.2 Projected High Volume Truck Zones in the San Diego Region

To identify locations throughout the region where truck management strategies may be helpful, the project team used the data collected to identify future focus areas for the region's trucking freeway corridors and gateways/distribution hubs. These focus areas are shown in Figures 65 and 66 and described further below.

Future Truck Focus Areas - Freeways

The future truck focus areas for the key trucking corridors were identified based on the projected data from SANDAG's Heavy Duty Truck Model for 2035 and 2050. Specifically, the project team looked at freeway corridors where the percentage of trucks out of total traffic volumes is projected to be high for the region (10 percent or greater in one or both directions), and the level of service (LOS) is projected to be fairly poor (E or F). These factors together serve as indicators of locations that may experience safety and operational issues that can hinder goods movement. Additionally, freeway corridors projected to experience truck percentages of total volume over 25 percent are called out. The only area in the region expected to reach this extremely high percentage of trucks is near the Otay Mesa border crossing. This includes SR 11, which, once built, may also reach truck percentages this high in 2050 (though a high level of service is projected to be maintained due to tolling).

As seen in Figure 65, in 2035, freeway corridors that are forecast to have a truck percentage of 10 percent or more combined with a poor LOS include I-5 (between SR 56 and SR 78), portions of I-805 (south of the I-5 interchange), portions of I-15 (mostly near SR 52), SR 52 (near the SR 125 interchange), a section of SR 905 (near the I-805 interchange), and SR 125 (near the SR 54 interchange). Additionally, SR 905 is projected to have truck volumes over 25 percent near the Otay Mesa border crossing. This is displayed graphically in Figure 65.

In 2050, the freeway corridors that are forecast to have a truck percentage of 10 percent or more combined with a poor LOS include the majority of I-5 (from just south of SR 56 to just north of SR 78), major sections of I-805 (north of SR 54 to south of the I-5 interchange), portions of I-15 (near the SR 52 interchange, south of SR 56, and south of SR 78), the majority of SR 52 (east of I-15), and a section of SR 905 (near the I-805 interchange). Additionally, SR 905 is projected to have truck volumes over 25 percent near the Otay Mesa border crossing. This is displayed graphically in Figure 66.

Future Truck Focus Areas – High Truck Volume Gateways/Distribution Hubs

In addition to freeway corridors, high truck volume gateways and distribution hubs were identified based on data from the SANDAG Truck Model and input from the trucking industry stakeholders. The project team assessed those gateways/hubs with the highest projected increases in truck trip productions between 2012 and 2050, by transportation analysis zones (TAZs). This information was combined with the feedback from industry stakeholders to identify the following high volume and high growth gateways/hubs:

- **G1: Border Area:** Example issues in this area include high volumes of trucks crossing the border, long wait times, and a lack of services for truck drivers.
- **G8: Miramar/ Mira Mesa/ Sorrento Valley**: This is generally a high growth area and example issues include congestion at the I-5 and I-805 interchange and along Mira Mesa Boulevard and Miramar Road.

- **G11: SR 78 Corridor/ Palomar Airport Road**: Example issues include truck access and congestion along SR 78 and at the interchanges of SR 78 with I-5 and I-15, which causes trucks to use San Marcos Blvd, Mission Road and South Santa Fe Avenue as alternative routes.

The gateway/hub truck focus areas are displayed graphically in Figures 65 and 66.

Figure 65 – Truck Focus Areas (2035)

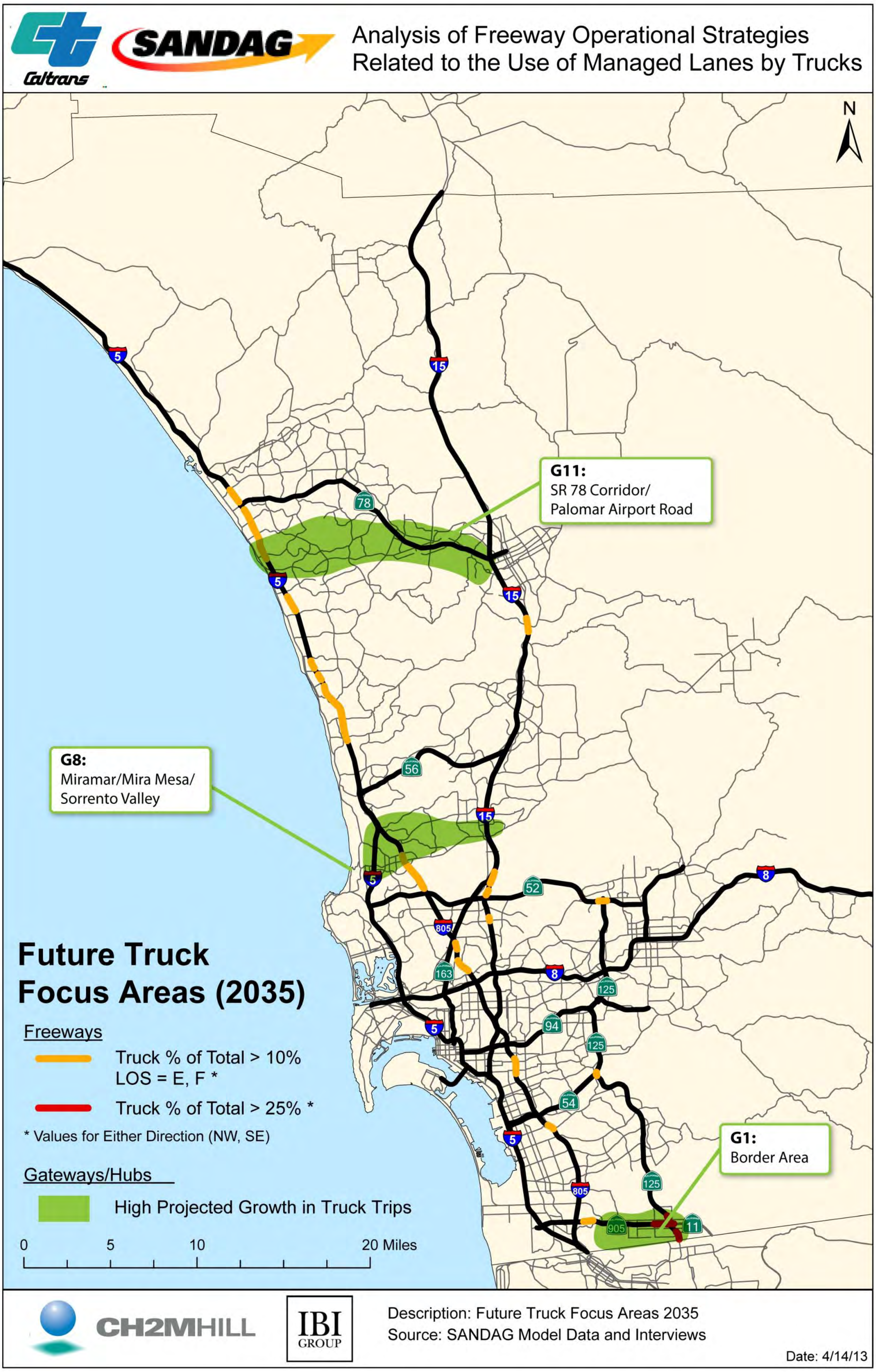
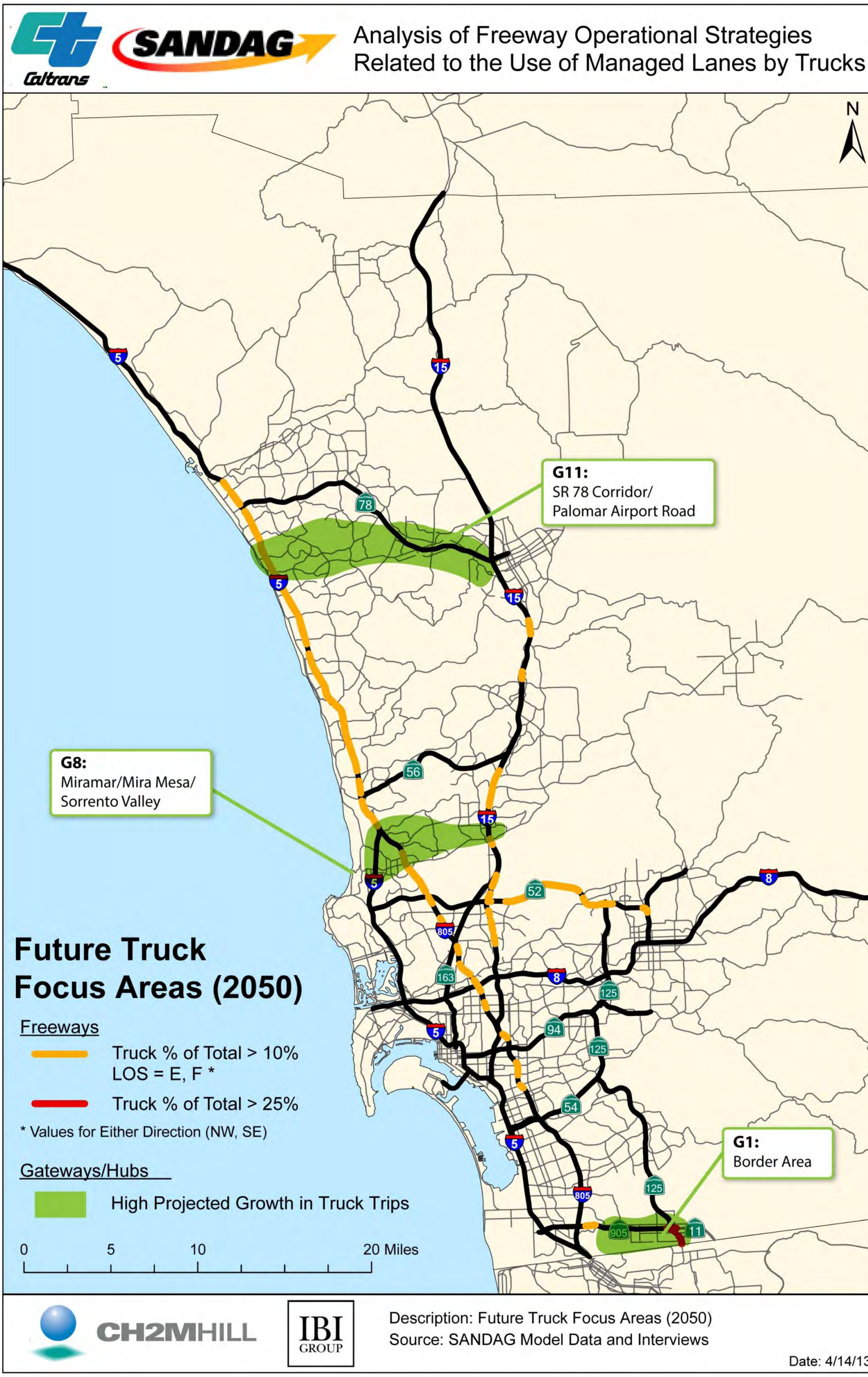


Figure 66 – Truck Focus Areas (2050)



5.3 Next Steps

The data collected and described in this memorandum will be used to assess the strategies identified in Technical Memorandum #3: Strategy Development. The strategy analysis methodology and results will be described in Technical Memorandum #6: Strategy Analysis.

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Appendix A: Interview Guide

Introduction to Project (Provided at Start of Interview)

Managed lanes (ML) are becoming an increasingly common option by which the region is addressing the need to reduce congestion, increase throughput, and enhance flexibility on freeways. Therefore, a concurrent investigation is needed of the potential benefits and challenges for use of MLs by trucks and of other operational strategies. Such an investigation will help to ensure that various types of truck traffic (e.g. long and short haul or parcel delivery) are considered as part of the region's overall transportation system that includes goods movement.

Based on input from private and public sector freight stakeholders, this study will assess near term and long range concepts for accommodating and managing trucks on the region's freeways, while considering: driver needs and perspectives, incident management needs, community and environmental impacts, data collection needs, and implications for the larger goods movement system. The overall goal is to define the roles and opportunities for these concepts in the long-term mobility planning for the region.

Questions/Discussion Topics:

1. Thinking about your current operations… please tell us about the following:
    a. Fleet size and truck types (number of light, medium, heavy trucks)?
    b. Number of inbound trucks? Per day? Per week? Per Month?
    c. Number of outbound trucks? Per day? Per week? Per Month?
    d. Are your operations seasonal? Please describe.
    e. What locations would you consider your primary trip origins (A general location is ok)
    f. What are your primary destinations? (A general location is ok)
    g. What major corridors/freeways do your truckers use to traverse the region?
    h. What access routes do your truckers use to get to the major corridors?
    i. What types of technologies do you (or your drivers) use in your vehicles for operations (communications, routing, vehicle tracking) and management? Please describe.
    j. What are your major congestion points now?
    k. What are any other problems that you are having moving your trucks to their destinations now?
2. Thinking about your future operations… 10, 20, 30 years down the road, please envision, without constraints, what changes would make future truck movements more efficient in the San Diego region…
    a. What do you envision as the most important changes needed along your current routes to make your operations more efficient and safe?

b. What are some ideas for getting your trucks from your hub/point of origin to the freeways more efficiently?

c. Other ideas or comments?

Strategy Comments

3. Other Strategy Specific Questions (to be discussed as applicable):

   a. (3) Travel Demand Management Strategies to be developed with Truckers and Shippers/ Receivers

      i. If delivery schedules were adjusted to allow for more night-time deliveries, would your business see this as a benefit?

      ii. Are there any key shippers/receivers in the San Diego region that, due to their hours or delivery schedule preferences, require your trucks to travel during congested periods?

      iii. Would urban distribution centers on the outskirts of the region be beneficial for long-haul truckers?

      iv. Would this strategy benefit certain industries & truck trip types more than others?

      v. Potential Issues: Off-peak schedules may increase labor costs for receivers (overtime). Not feasible for all freight types/deliveries, based on time requirements for delivery – shippers may already be doing this where possible.

   b. (4) Trucks on the planned network of HOV/HOT managed lanes (restricted access)

      i. Do you use the I-15 express lanes for your trucks that are 2 axles or less? Did you know that you are allowed to do so?

      ii. If occupancy restrictions were removed for trucks, would you use High Occupancy Vehicle lanes (e.g. managed lanes)?

      iii. If current restrictions on HOV/HOT lanes were revised to allow trucks with 3 axles on managed lanes, would your business benefit? Would your business transition to 3 axle vehicles?

      Potential Issue: Access/egress for trucks (would trucks use direct access ramps planned for transit)?Incident management /safety; Legislative - current speed and lane restrictions for trucks with three or more axles; Traffic flow – would lanes be able to maintain minimum required speed of 45 mph with mixed auto and truck traffic? Design/Geometric issues – are managed lanes/DARS being designed to accommodate larger trucks (pavement, turning radii).

   c. (5) Designated Truck Lanes: Construction of New Lanes on an Existing Facility (e.g. truck by-pass lanes, routes, or climbing lanes)

      i. Where do you see a current need for designated truck lanes?

      ii. If LCVs were allowed on designated truck lanes, would your business switch?

iii. Potential Issues: Capital cost requirements, Right-of-way, Access/egress, Community acceptance, Environmental (could have an air quality benefit if traffic flow improves).

d. (6) Separate Dedicated Truck-Only Facilities (Construction of New Facilities)

   i. Where do you see a current or future need for dedicated truck facilities? (Such as, the 905-Port-805-56 bypass idea)

   ii. If LCVs were allowed on a new dedicated truck facility, would your business use LCVs?

   iii. Potential Issues: Capital cost requirements, Right-of-way, Access/egress, Community acceptance, Environmental.

e. (7) Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment

   i. If you didn't have the right lane restrictions during certain times of the day, would that be useful to your drivers?

   ii. What technologies do you see emerging in the future that would enhance your operations and safety? Either in-vehicle or roadside?

   iii. Potential Issues: Legislative (existing truck lane restrictions in CA); Smart technologies may change rapidly in the future; Enforcement; Phasing.

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Appendix B: Total Average Daily Truck Volumes

The truck ADT volumes displayed in the maps below demonstrate the change in weekday truck volumes over time in the north-west and south-east directions. The maps are provided in specific directions as the model separates out the directions of travel on freeways and in order to provide a single map overview of the whole region maps must be directional. These maps give insight into which freeways have the most truck traffic and which are least traveled by trucks. The data for these maps were taken from the SANDAG Heavy Truck Model forecasts for 2012, 2020, 2035, and 2050. More specifically, the data extracted from the model were the Truck ADT values, which ranged from 0 – 18,000 trucks per day. (Note that these maps show average daily truck volumes alone, whereas the maps in the Data Collection Results portion of this memorandum show the same information combined with a display of truck percentage of total ADT.)

The maps in Figures B-1 through B-8 represent the average daily truck volumes with the thickness of the blue lines for each direction of key truck corridors:

- Figure B-1 – 2012 North & West Truck Average Daily Traffic Volumes
- Figure B-2 – 2012 South & East Truck Average Daily Traffic Volumes
- Figure B-3 – 2020 North & West Truck Average Daily Traffic Volumes
- Figure B-4 – 2020 South & East Truck Average Daily Traffic Volumes
- Figure B-5 – 2035 North & West Truck Average Daily Traffic Volumes
- Figure B-6 – 2035 South & East Truck Average Daily Traffic Volumes
- Figure B-7 – 2050 North & West Truck Average Daily Traffic Volumes
- Figure B-8 – 2050 South & East Truck Average Daily Traffic Volumes

These figures represent only the truck traffic and exclude all other types of traffic, the total daily traffic volumes were shown previously in this document. The truck traffic volumes are represented with six different line thicknesses that encompass the various truck traffic volumes experienced across the key truck corridors in the County.

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Figure B-1 – 2012 North & West Truck Average Daily Traffic Volumes

Figure B-2 – 2012 South & East Truck Average Daily Traffic Volumes

Figure B-3 – 2020 North & West Truck Average Daily Traffic Volumes

Figure B-4 – 2020 South & East Truck Average Daily Traffic Volumes

Figure B-5 – 2035 North & West Truck Average Daily Traffic Volumes

Figure B-6 – 2035 South & East Truck Average Daily Traffic Volumes

Figure B-7 – 2050 North & West Truck Average Daily Traffic Volumes

Figure B-8 – 2050 South & East Truck Average Daily Traffic Volumes

Appendix C: Regional WIM Truck Type Data

In this Appendix the truck type data from the Caltrans seven weigh in motion (WIM) stations across San Diego County are summarized for each direction. These 14 truck type summaries are included on the second map of this Appendix and represent the truck traffic types for an average day. The 14 time-of-day graphs that make up the rest of this Appendix represent the truck traffic types and their peak travel times, as explained in the Regional WIM sites section of the document.

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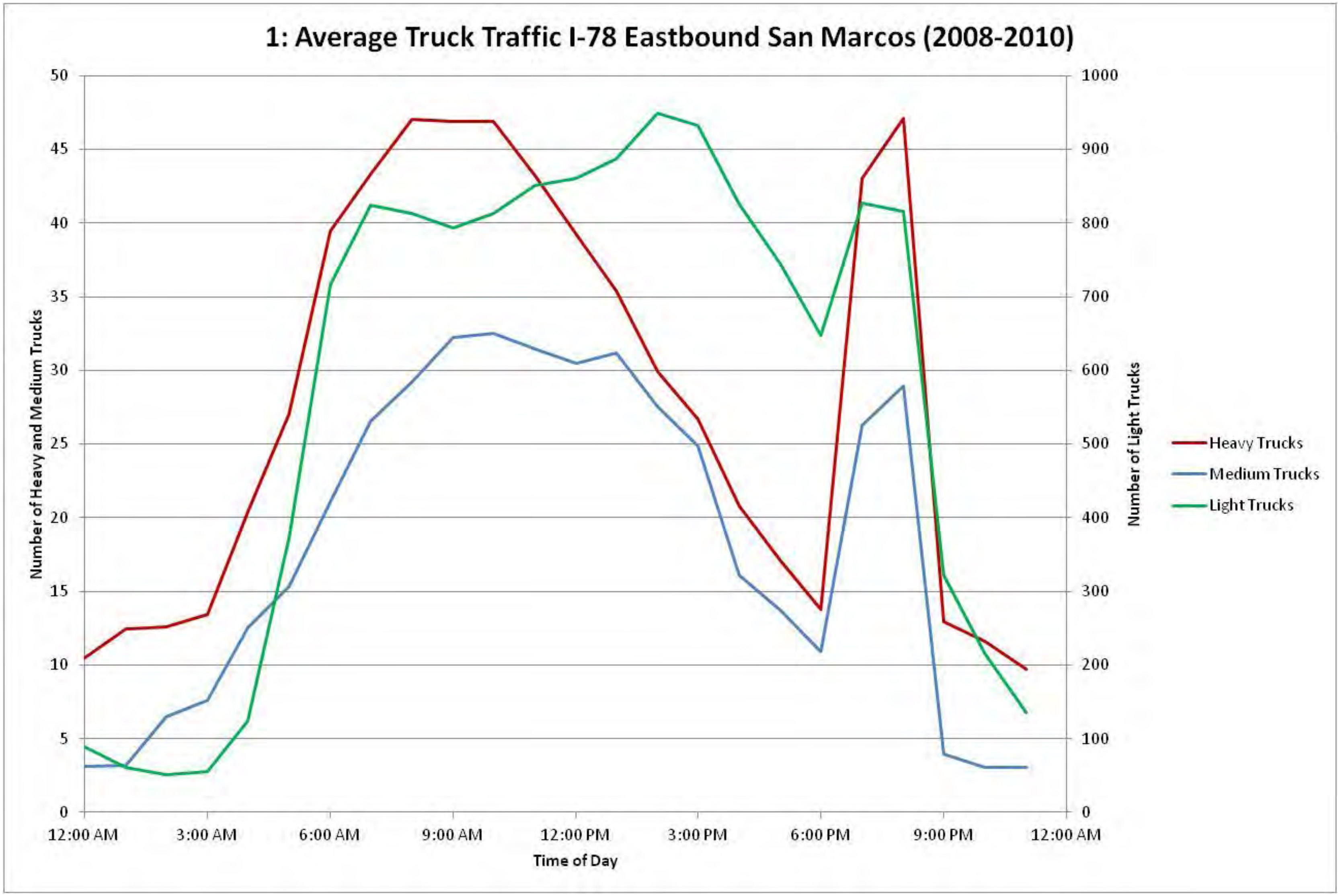
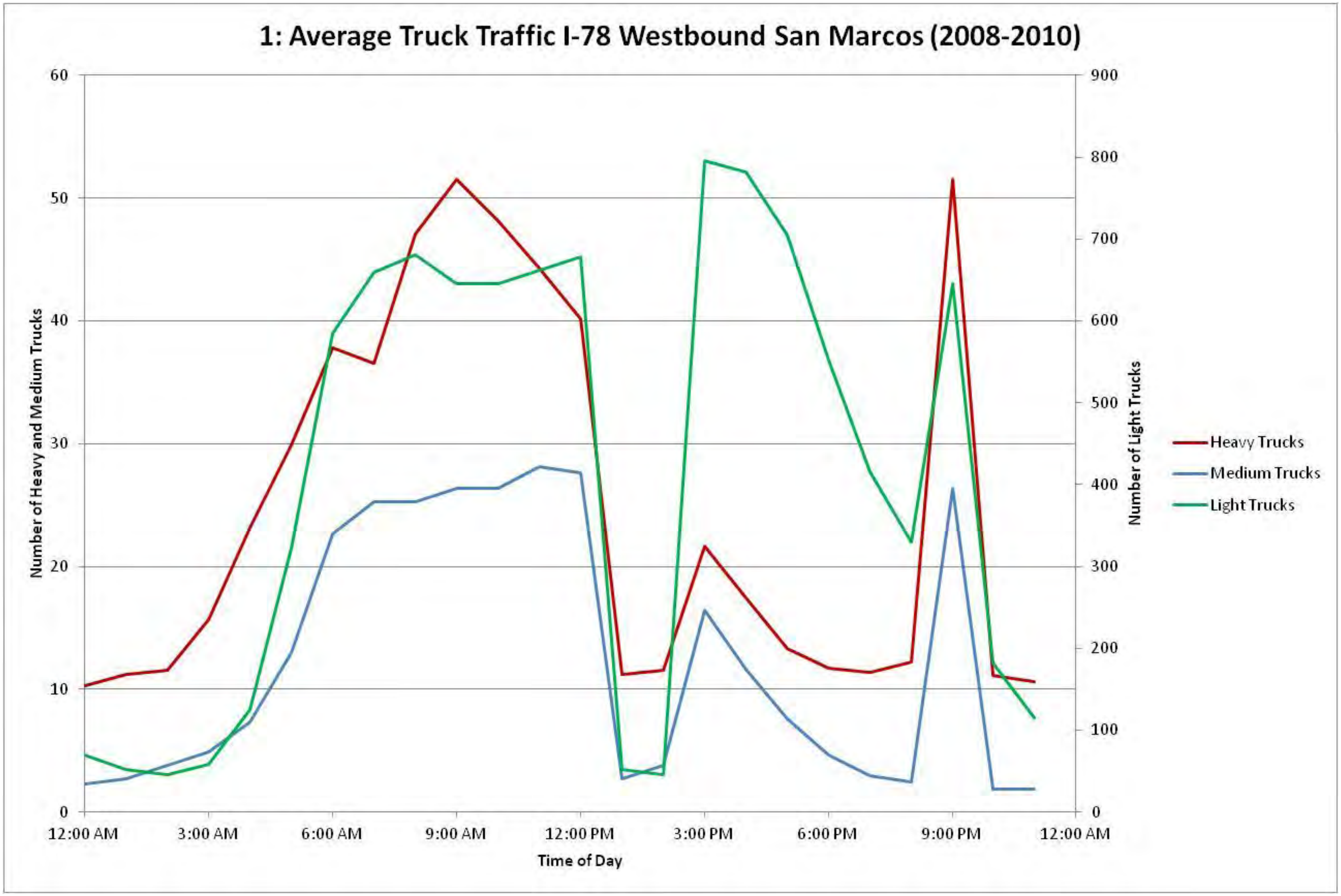
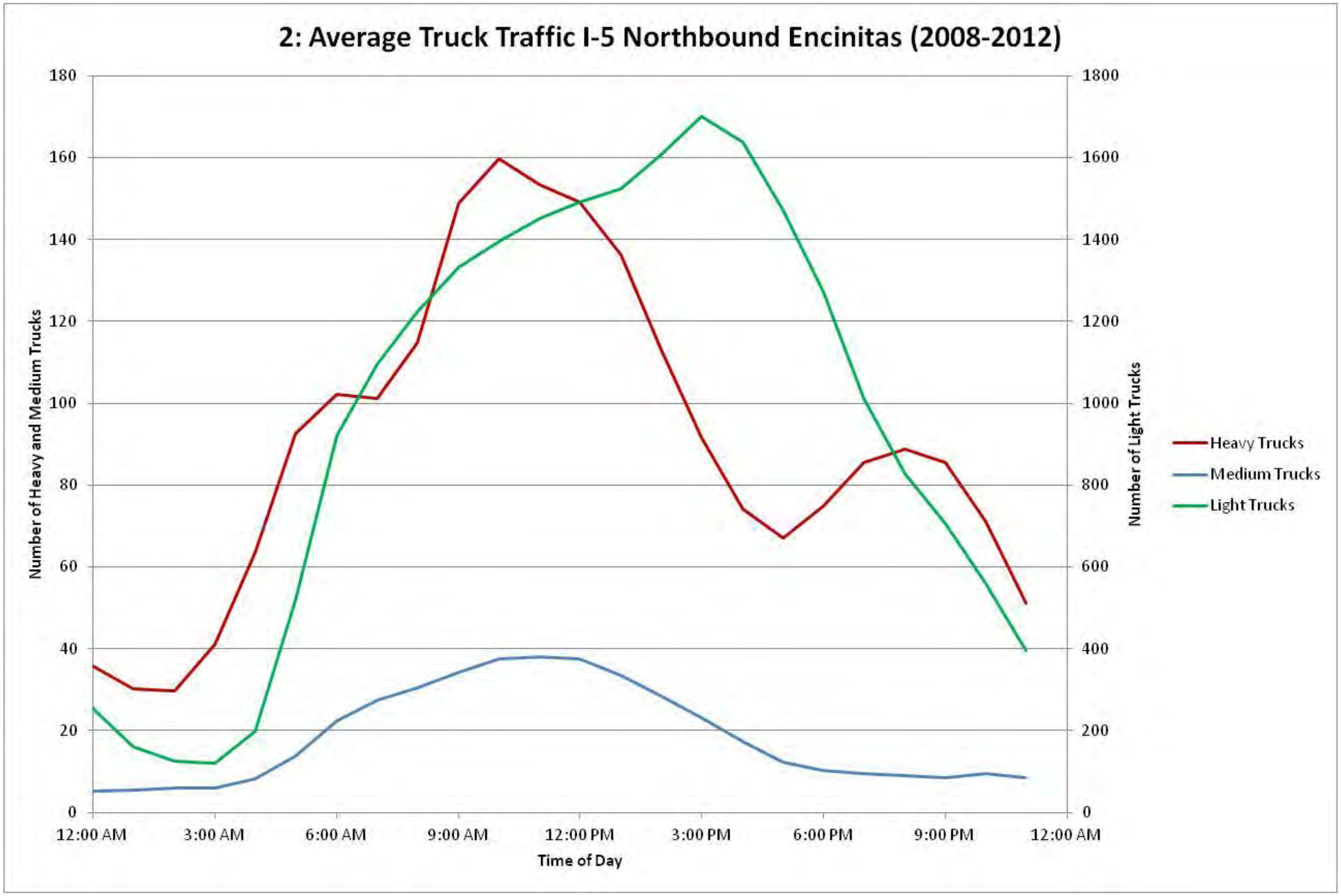
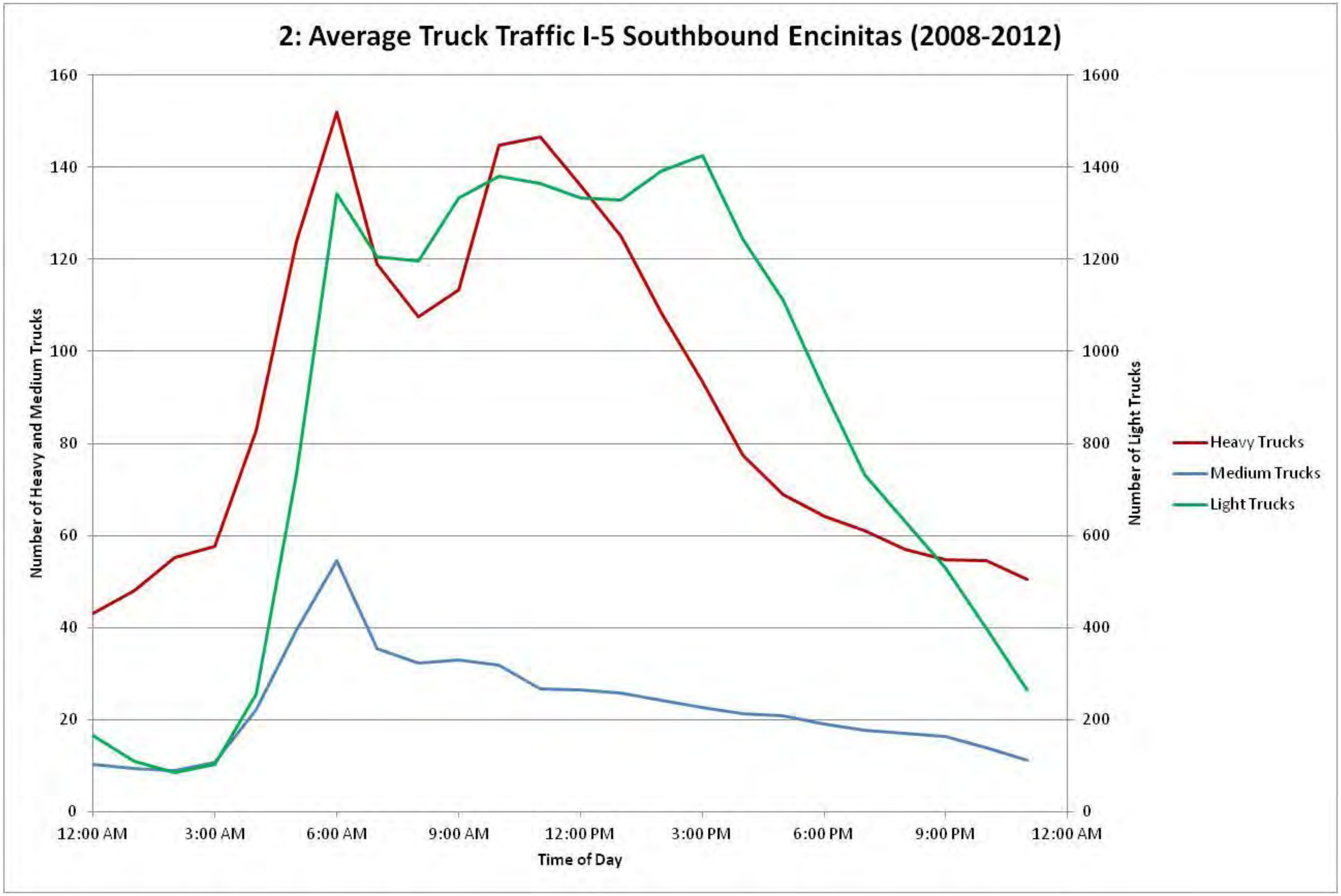
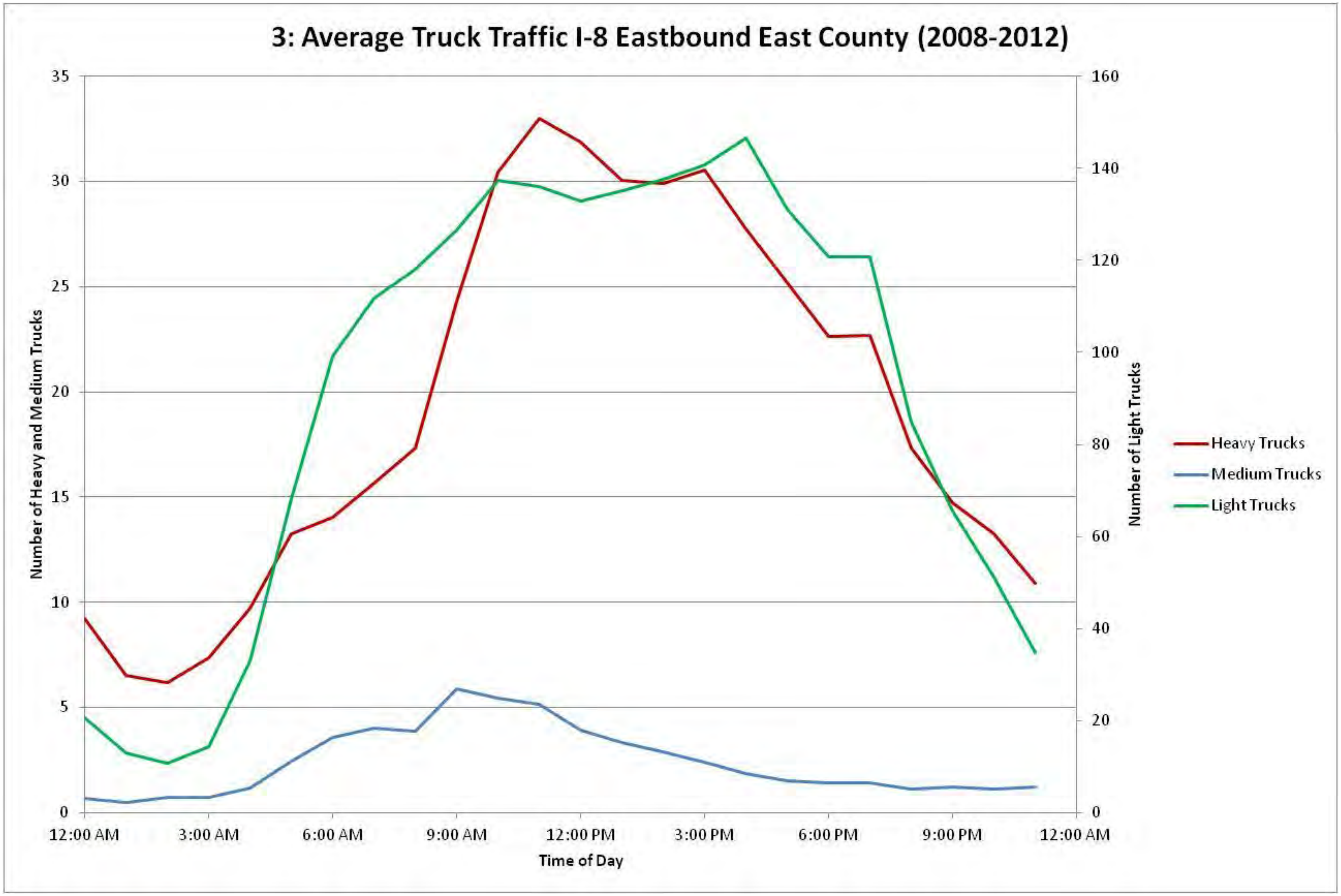

1: Average Truck Traffic I-78 Eastbound San Marcos (2008-2010)
Number of Heavy and Medium Trucks
50
45
40
35
30
25
20
15
10
5
0
1000
900
800
700
600
500
400
300
200
100
0
Number of Light Trucks
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Time of Day
Heavy Trucks
Medium Trucks
Light Trucks

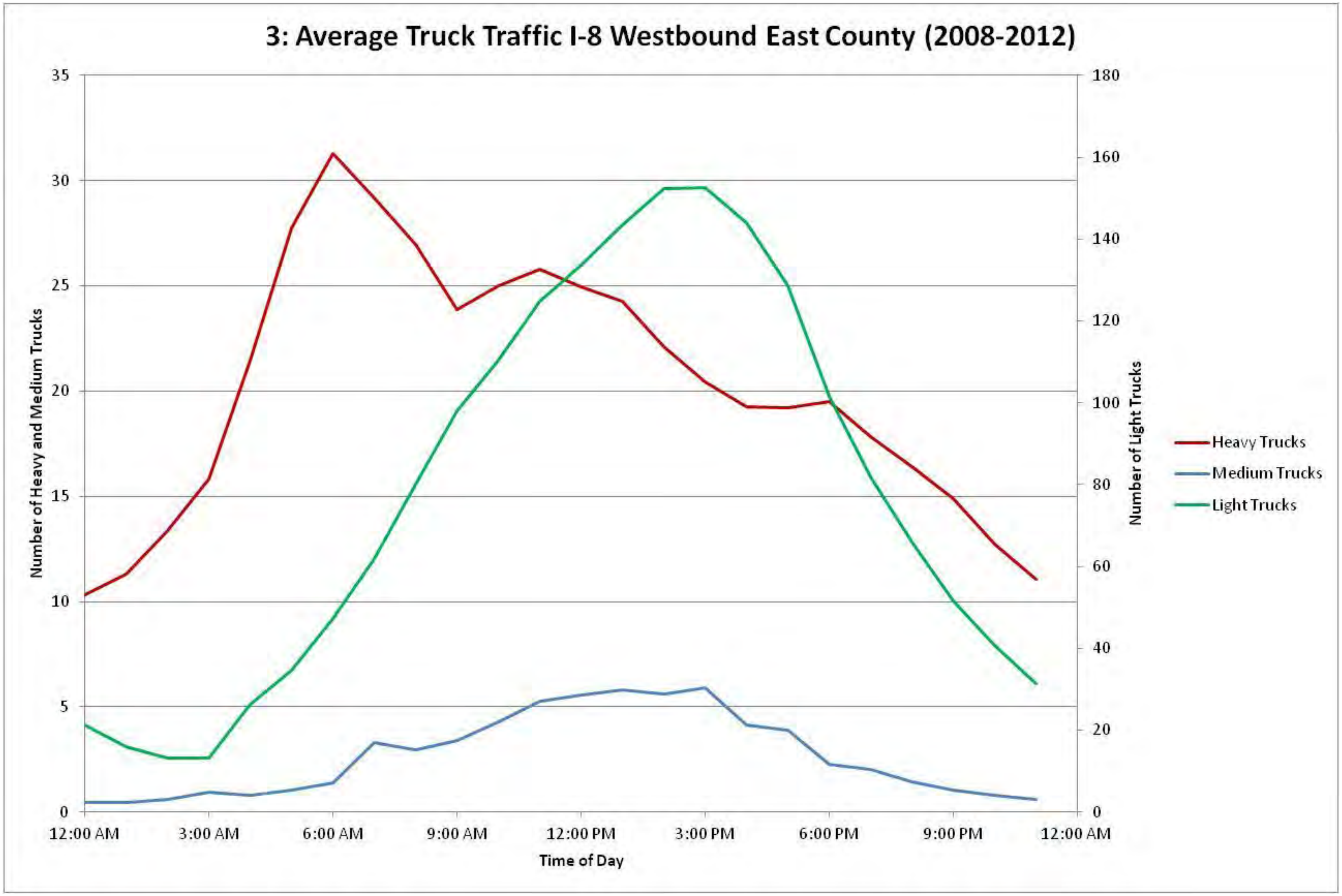

1: Average Truck Traffic I-78 Westbound San Marcos (2008-2010)
Number of Heavy and Medium Trucks
60
50
40
30
20
10
0
900
800
700
600
500
400
300
200
100
0
Number of Light Trucks
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Time of Day
Heavy Trucks
Medium Trucks
Light Trucks


2: Average Truck Traffic I-5 Northbound Encinitas (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
180
160
140
120
100
80
60
40
20
0
1800
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks

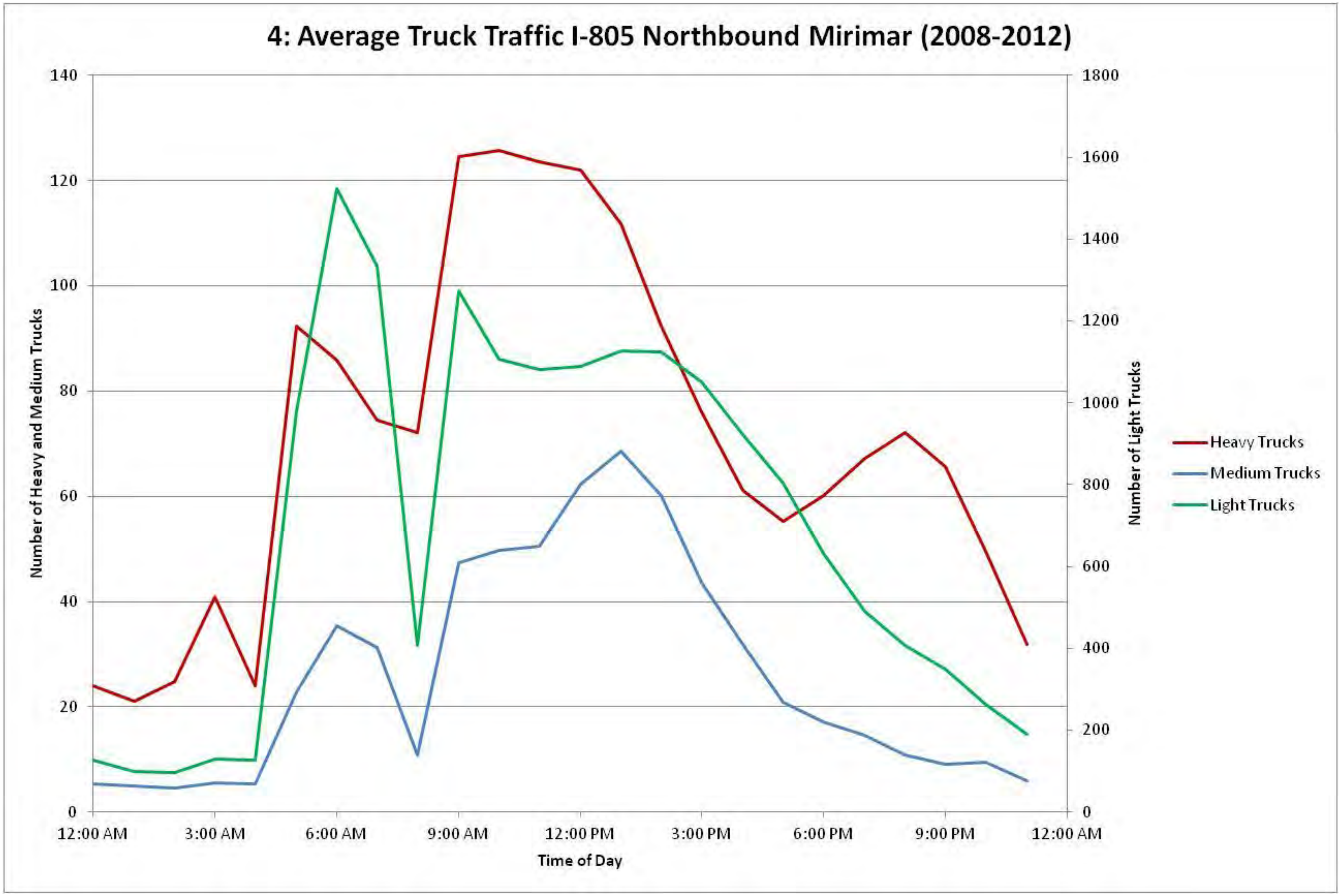


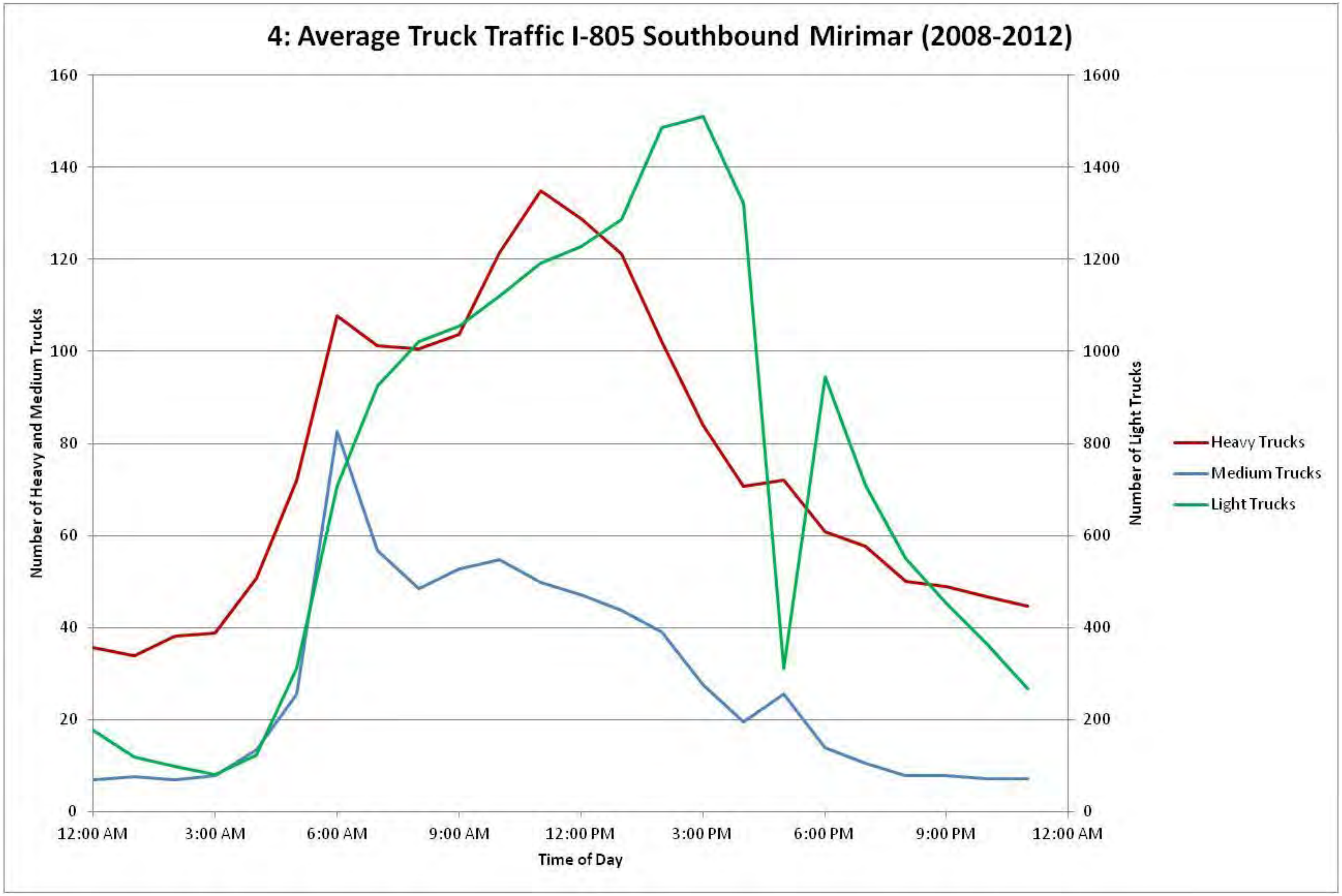
2: Average Truck Traffic I-5 Southbound Encinitas (2008-2012)
160
140
120
100
80
60
40
20
0
1600
1400
1200
1000
800
600
400
200
0
Number of Heavy and Medium Trucks
Number of Light Trucks
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Time of Day
Heavy Trucks
Medium Trucks
Light Trucks

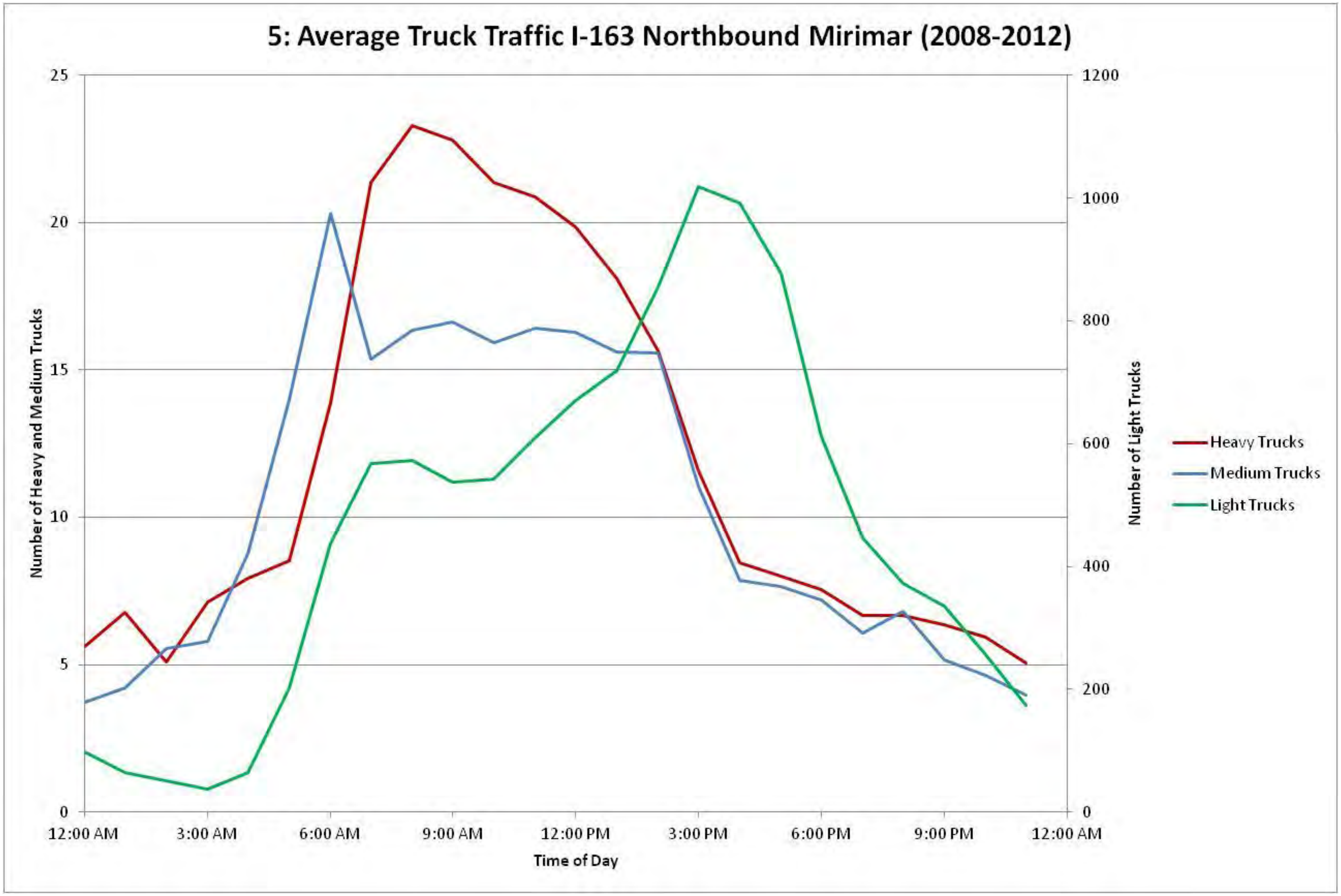

3: Average Truck Traffic I-8 Eastbound East County (2008-2012)
Number of Heavy and Medium Trucks
35
30
25
20
15
10
5
0
160
140
120
100
80
60
40
20
0
Number of Light Trucks
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Time of Day
Heavy Trucks
Medium Trucks
Light Trucks

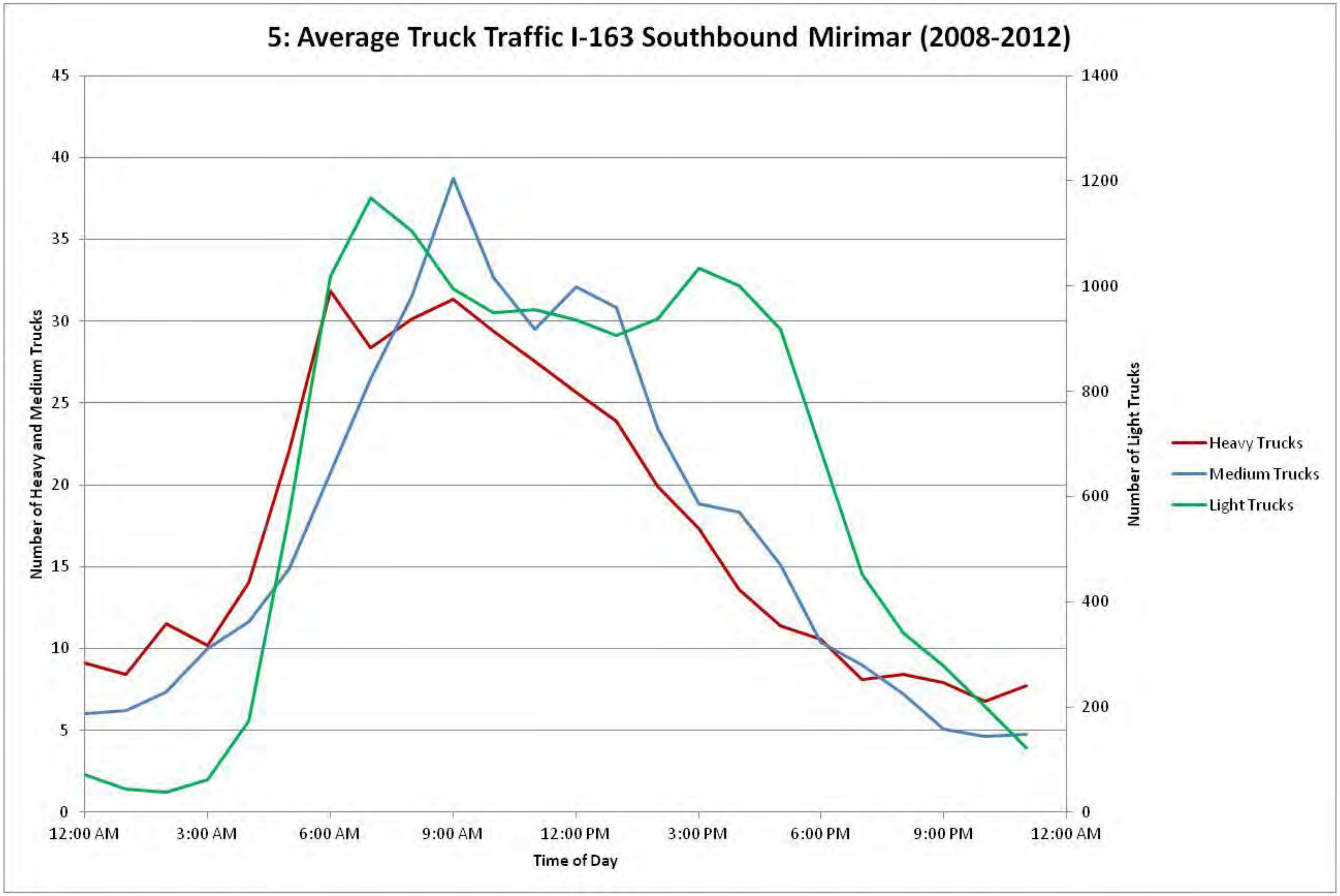


3: Average Truck Traffic I-8 Westbound East County (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
0
5
10
15
20
25
30
35
0
20
40
60
80
100
120
140
160
180
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks

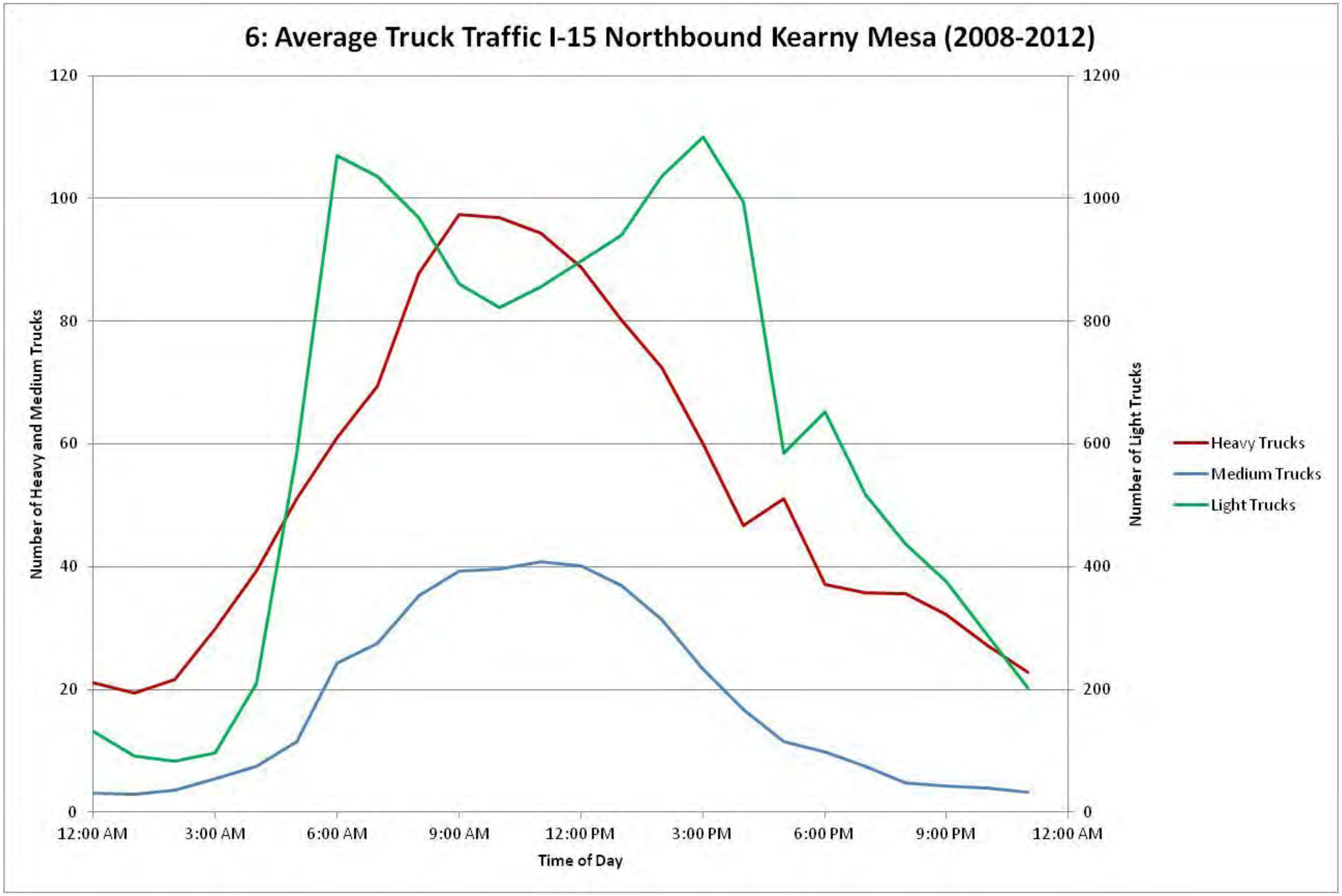

4: Average Truck Traffic I-805 Northbound Mirimar (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
140
120
100
80
60
40
20
0
1800
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks

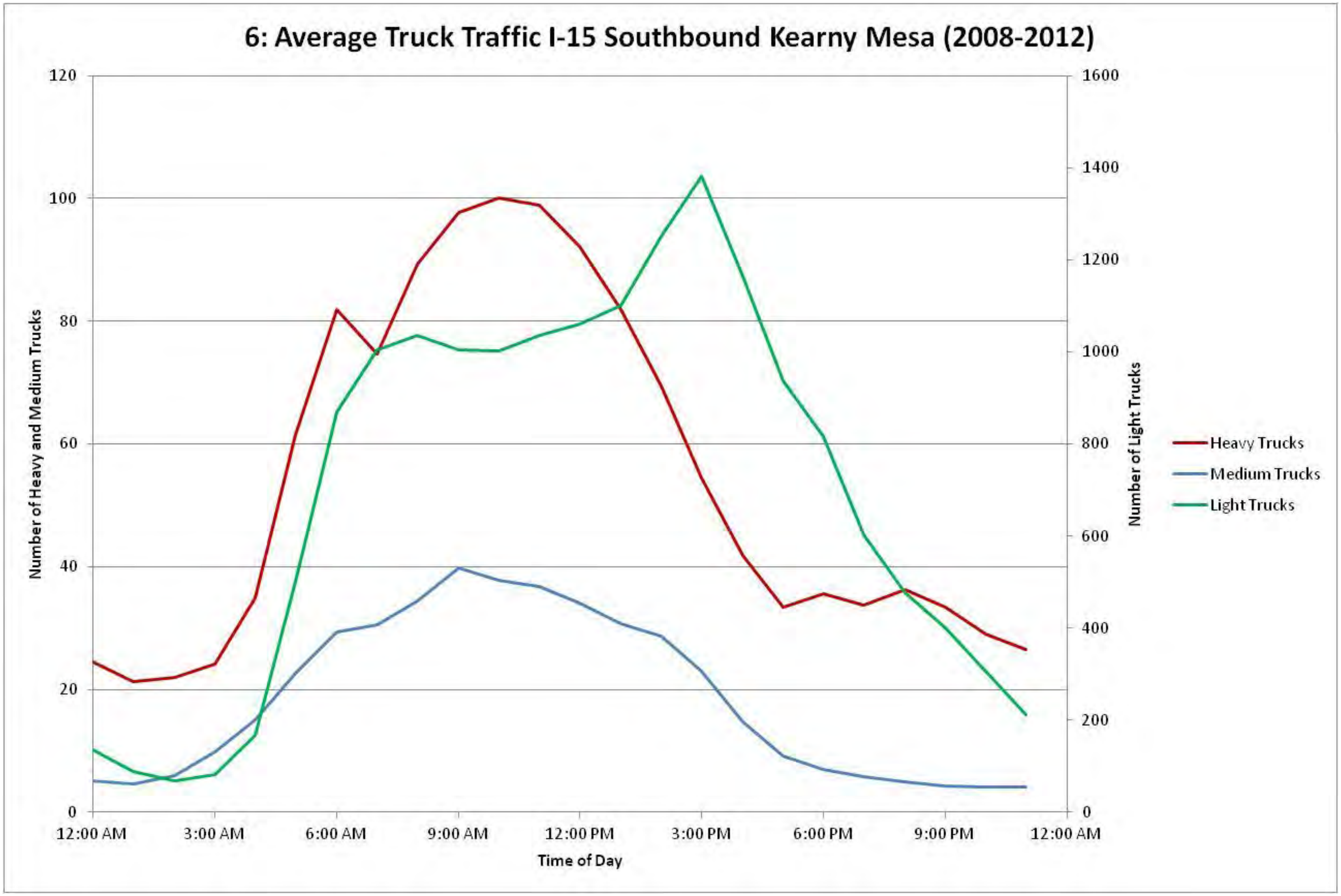

4: Average Truck Traffic I-805 Southbound Mirimar (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
160
140
120
100
80
60
40
20
0
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks


5: Average Truck Traffic I-163 Northbound Mirimar (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
0
5
10
15
20
25
0
200
400
600
800
1000
1200
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks

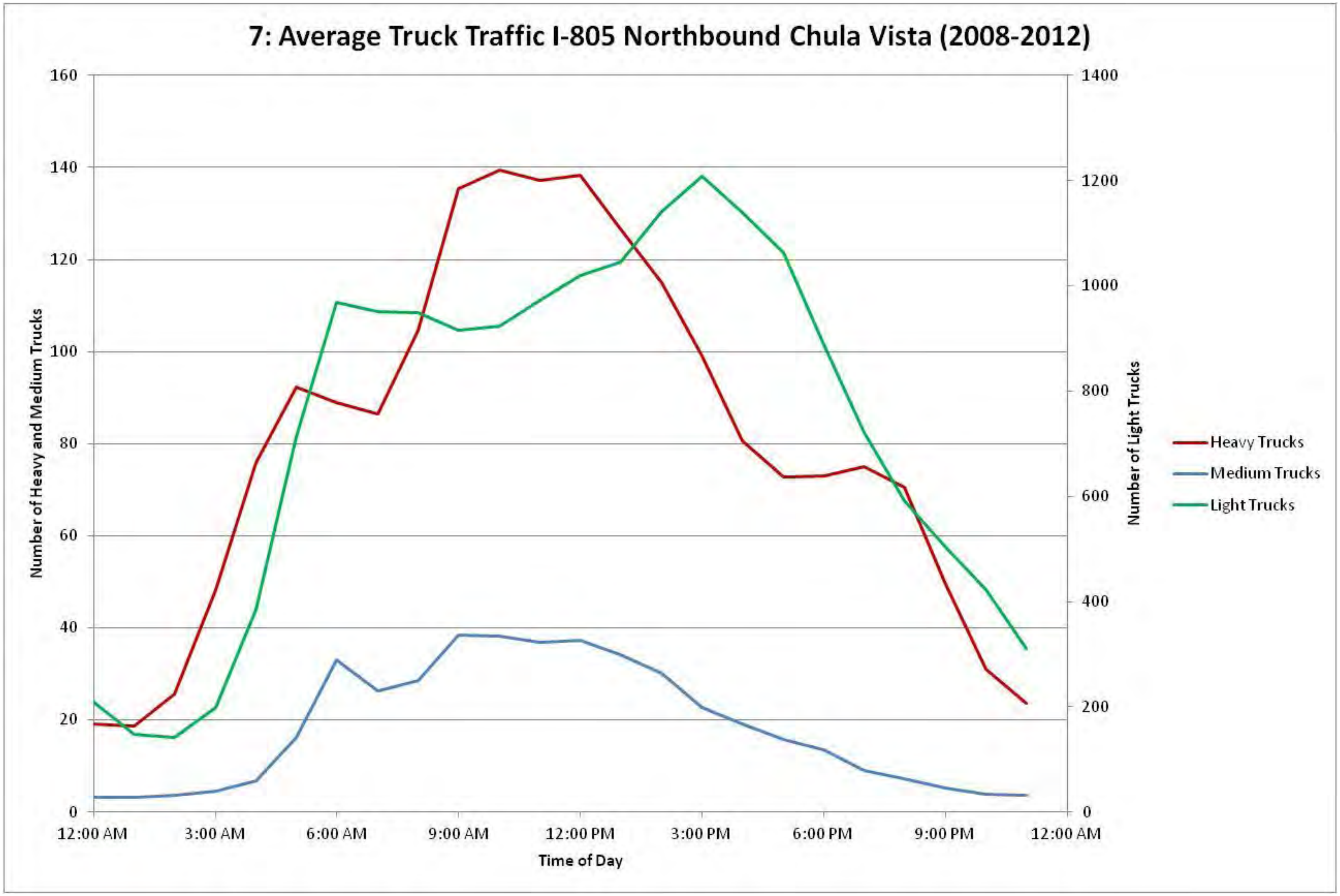


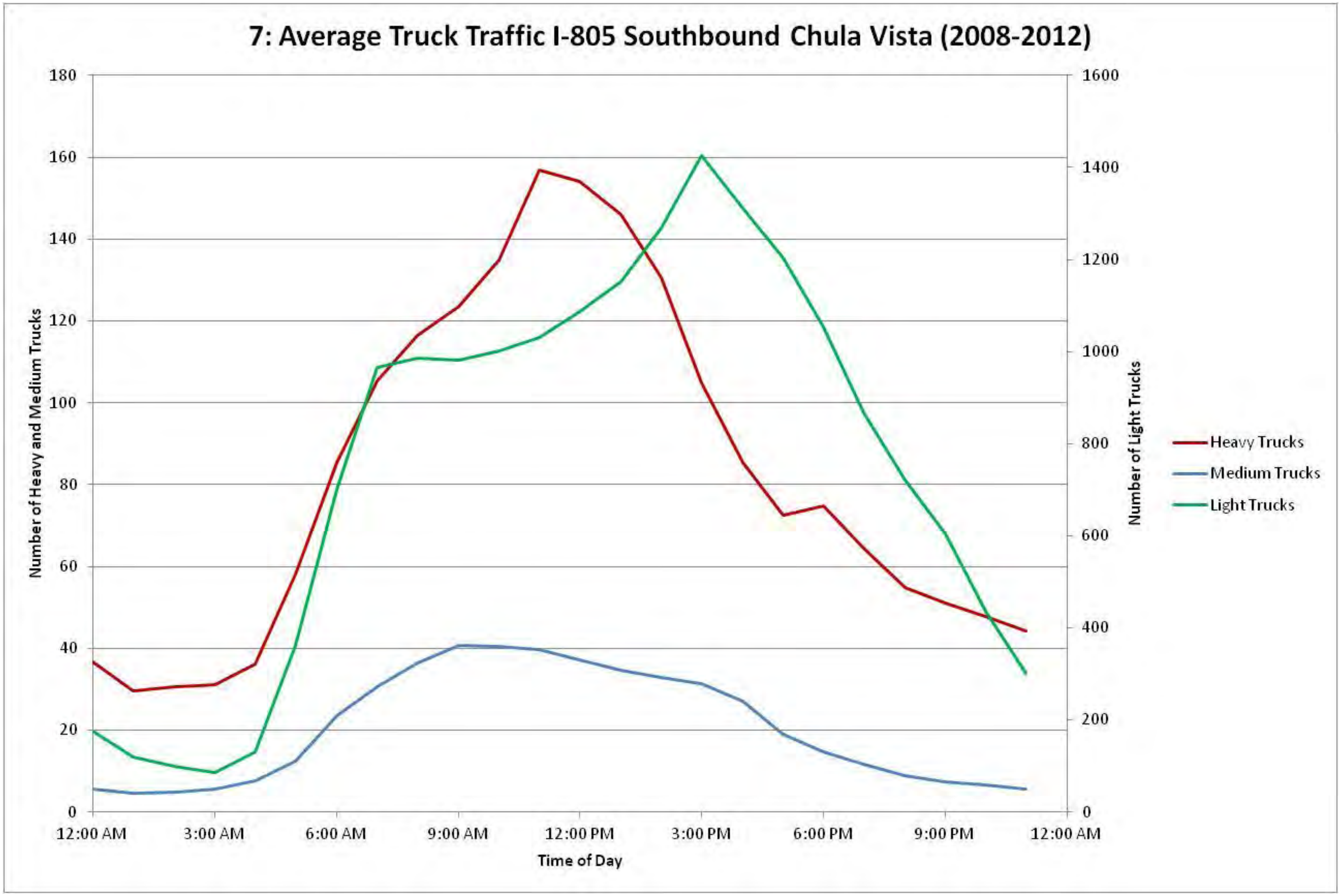
5: Average Truck Traffic I-163 Southbound Mirimar (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
45
40
35
30
25
20
15
10
5
0
1400
1200
1000
800
600
400
200
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks


6: Average Truck Traffic I-15 Northbound Kearny Mesa (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
0
20
40
60
80
100
120
0
200
400
600
800
1000
1200
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks



6: Average Truck Traffic I-15 Southbound Kearny Mesa (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
120
100
80
60
40
20
0
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks


7: Average Truck Traffic I-805 Northbound Chula Vista (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
0
20
40
60
80
100
120
140
160
0
200
400
600
800
1000
1200
1400
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks


7: Average Truck Traffic I-805 Southbound Chula Vista (2008-2012)
Number of Heavy and Medium Trucks
Number of Light Trucks
Time of Day
180
160
140
120
100
80
60
40
20
0
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
Heavy Trucks
Medium Trucks
Light Trucks

Appendix D: Regional Classification and Occupancy Counts

This Appendix includes the complete set of the 46 time of day graphs described in the regional classification and occupancy counts section earlier in the document. The map of the vehicle class count sites illustrates the location of each site that the data were collected from and these numbers correspond to the labels of each time-of-day graph. The graphs are labeled with the corresponding number to which site the vehicle classification data were collected from, along with the direction of traffic and name of each site location.

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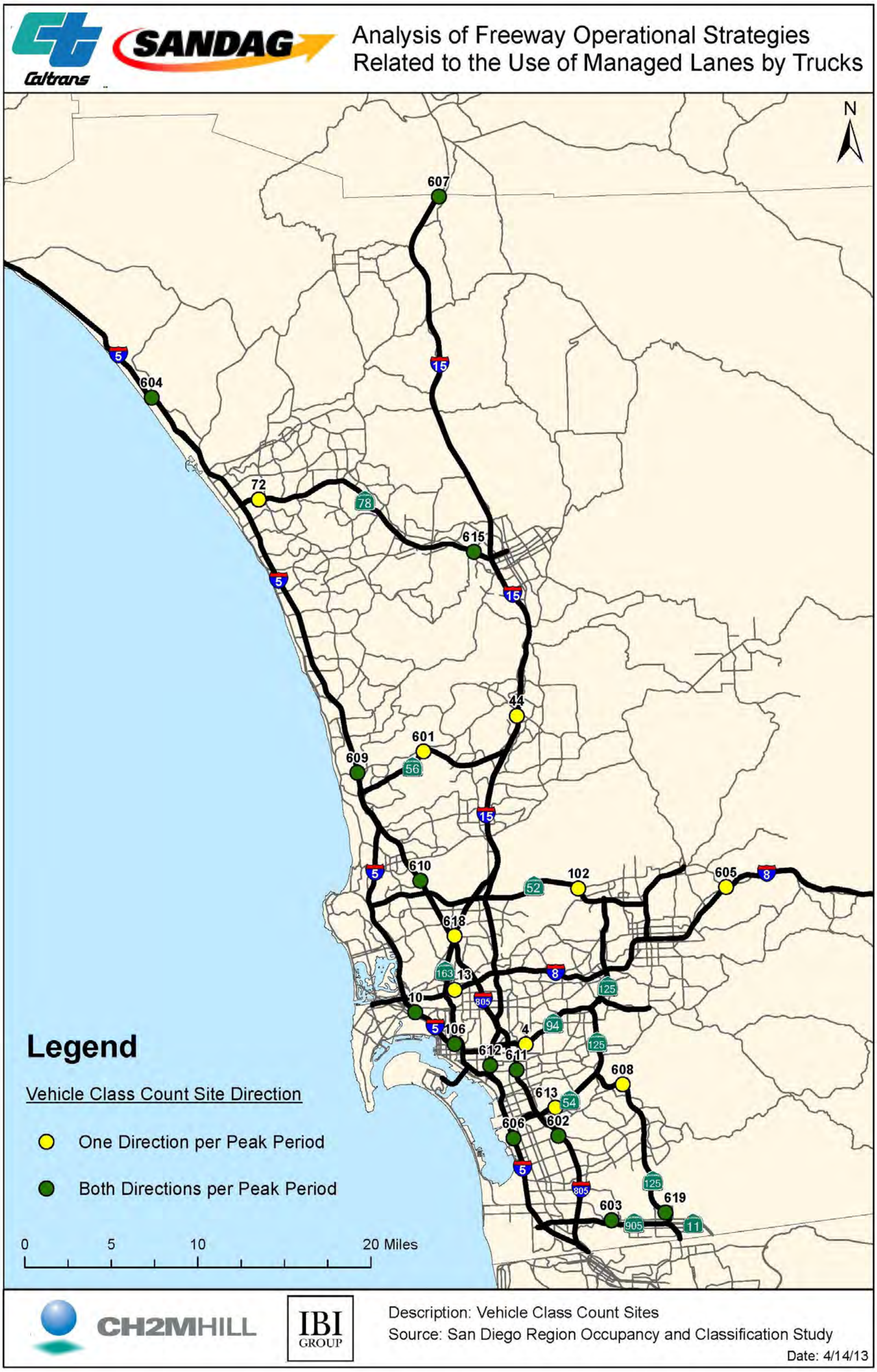
Figure D-1 – Vehicle Class Count Sites



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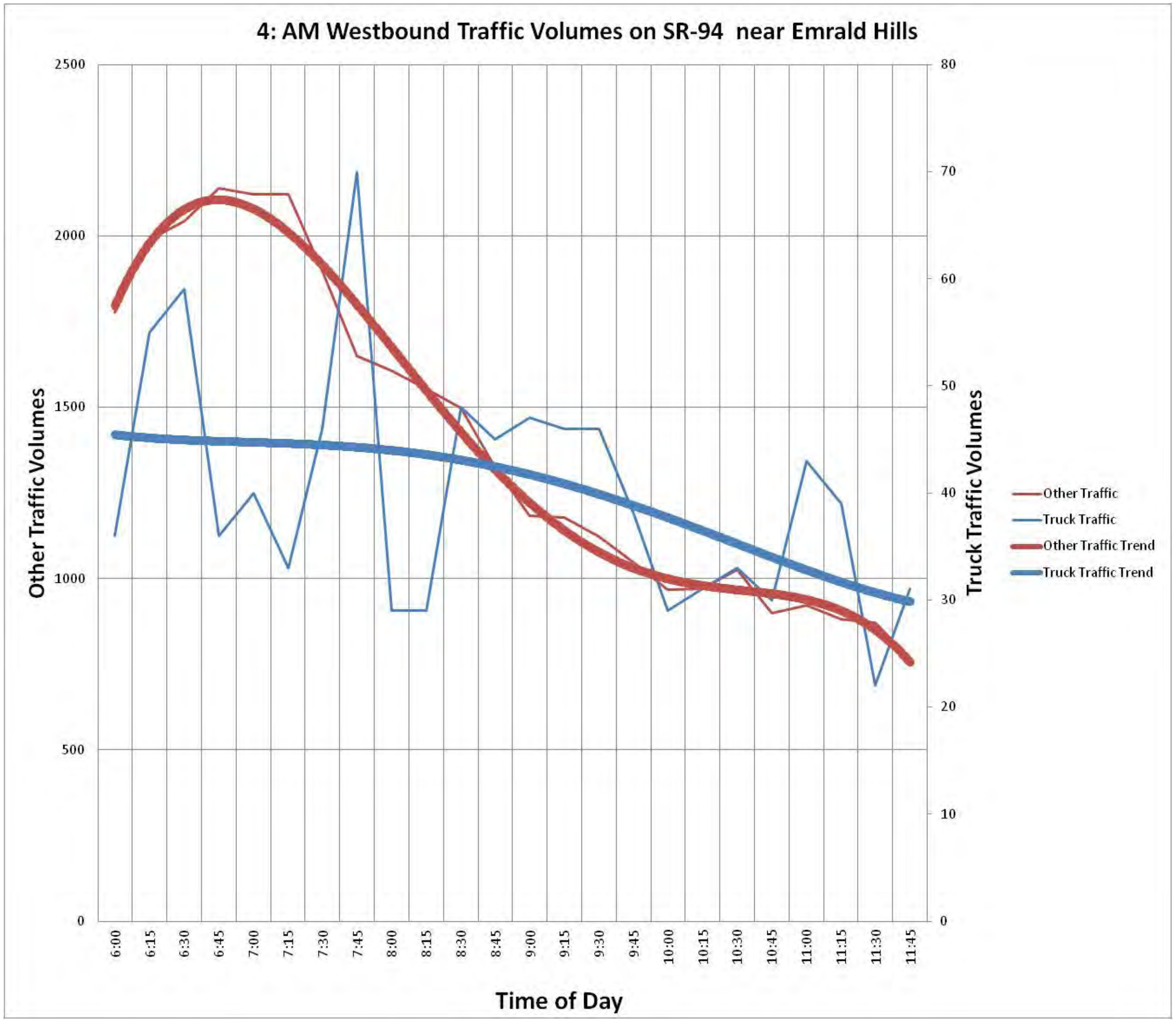
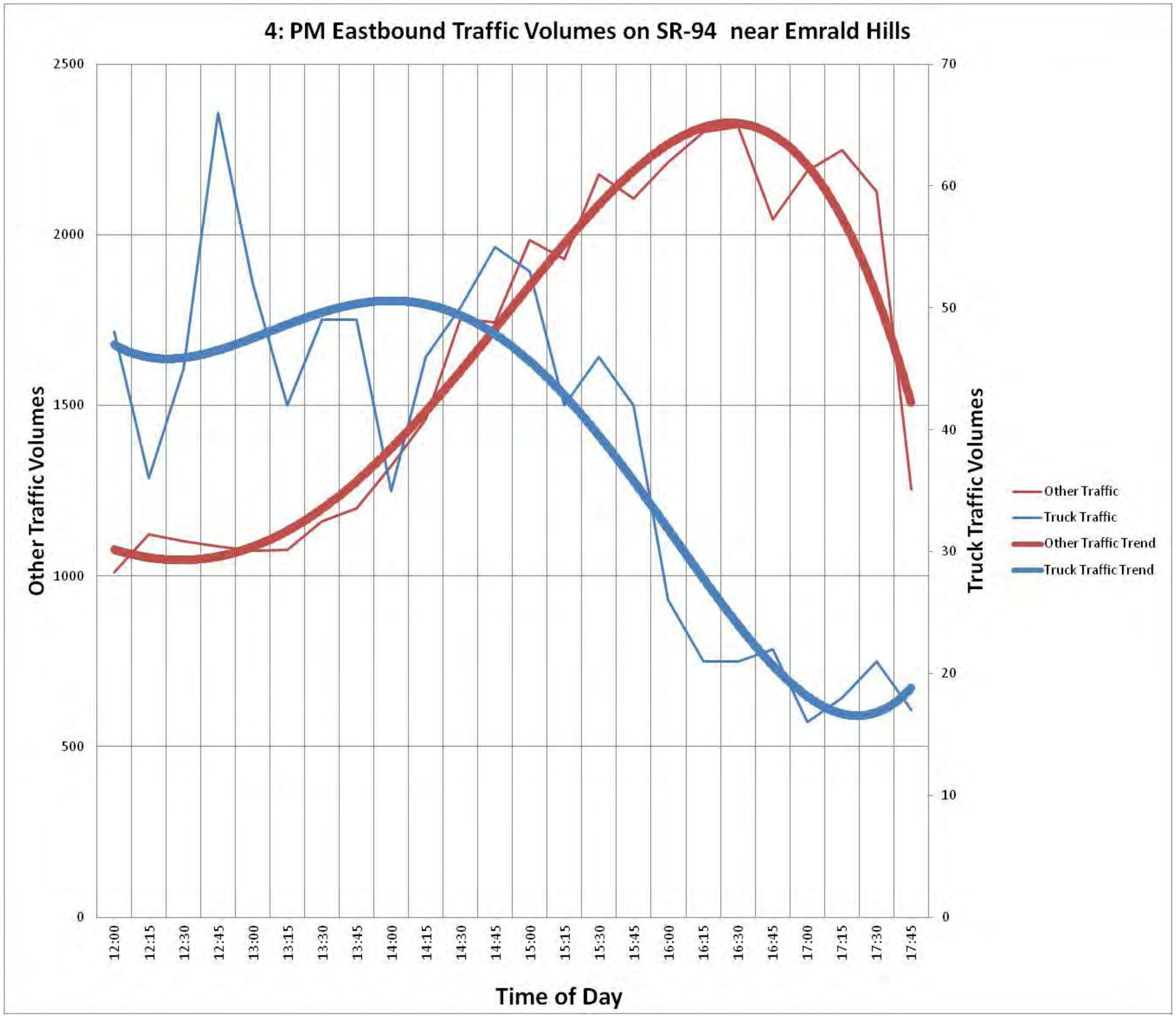
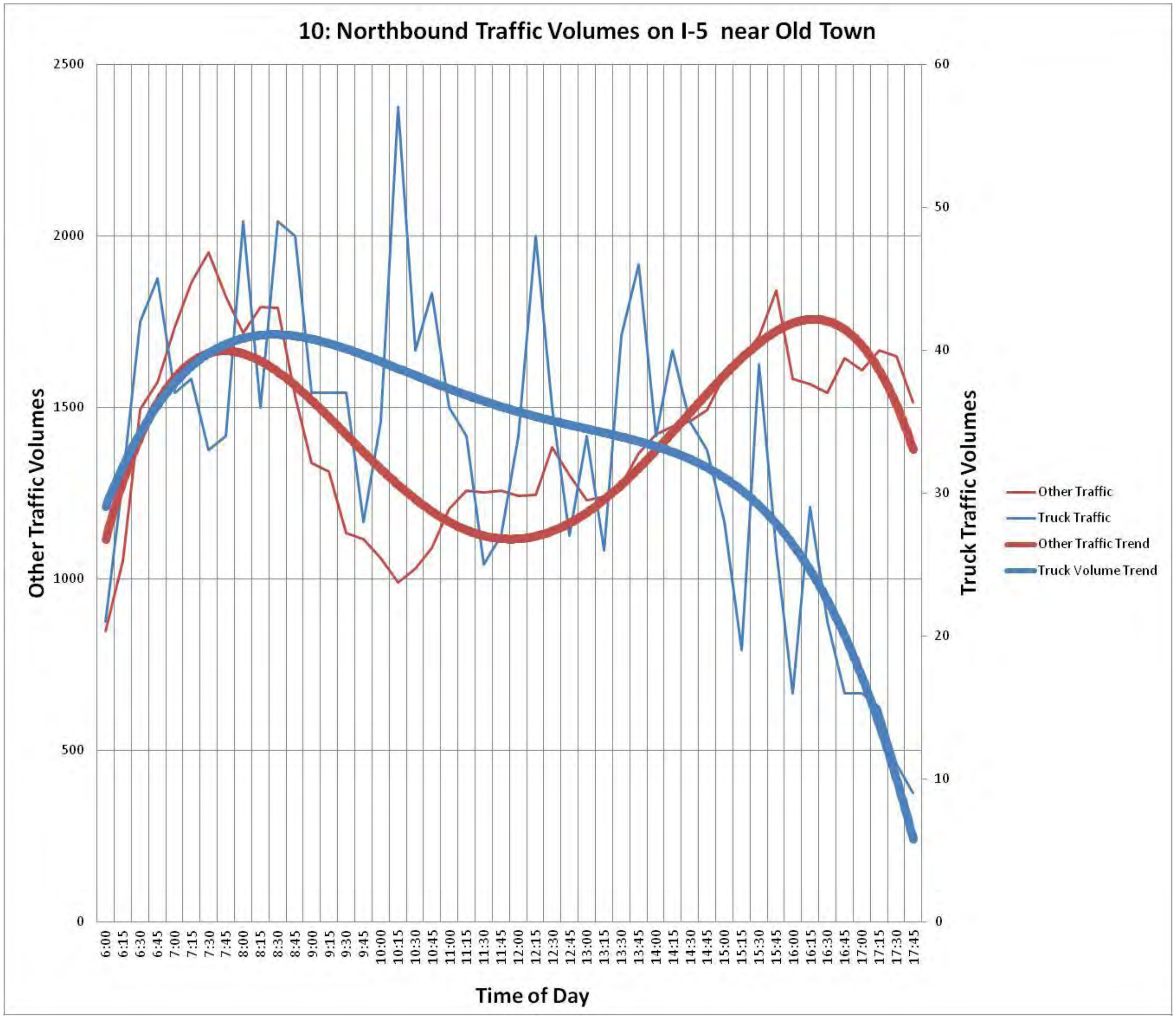
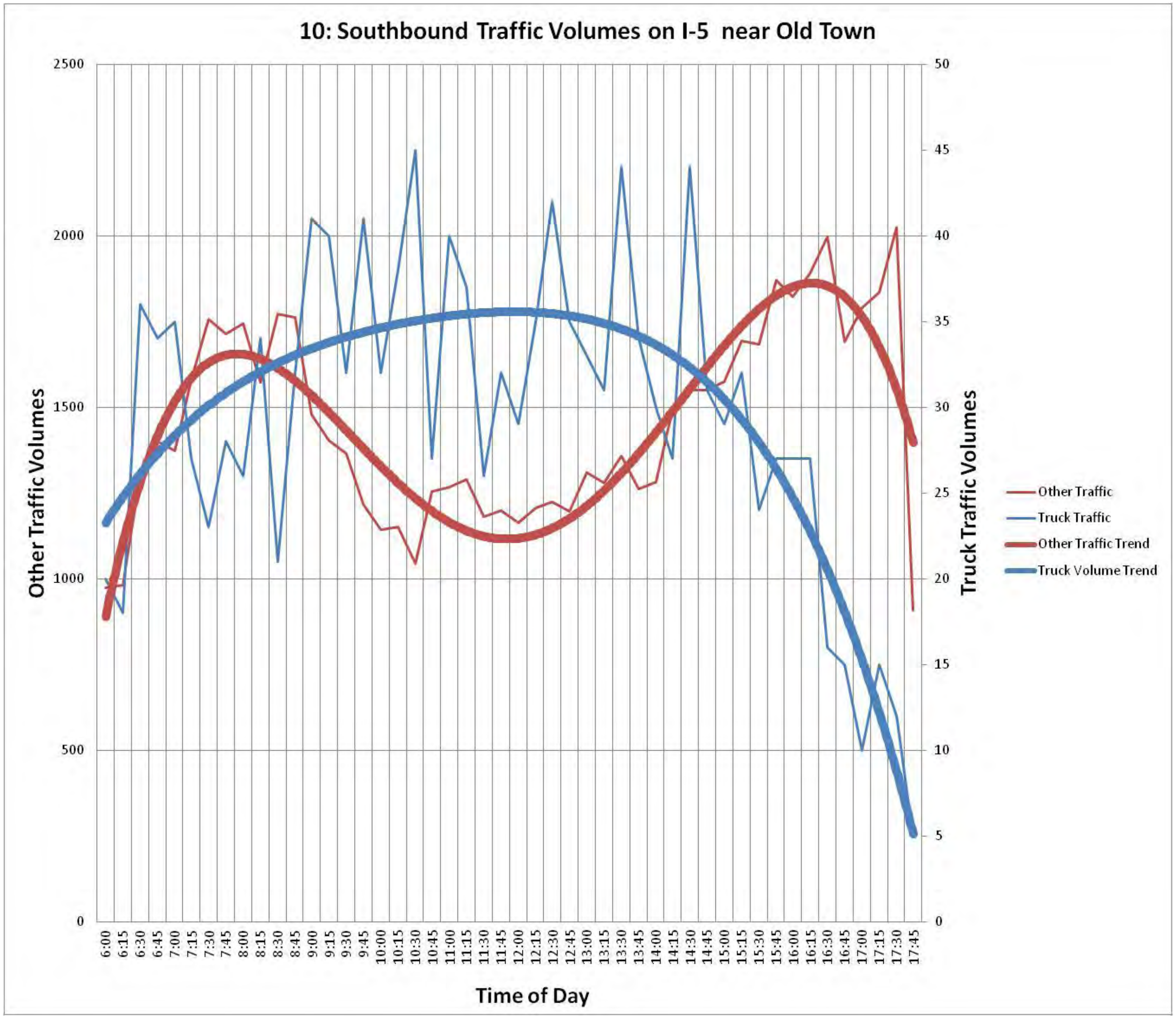

4: AM Westbound Traffic Volumes on SR-94 near Emrald Hills
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
0
500
1000
1500
2000
2500
0
10
20
30
40
50
60
70
80
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

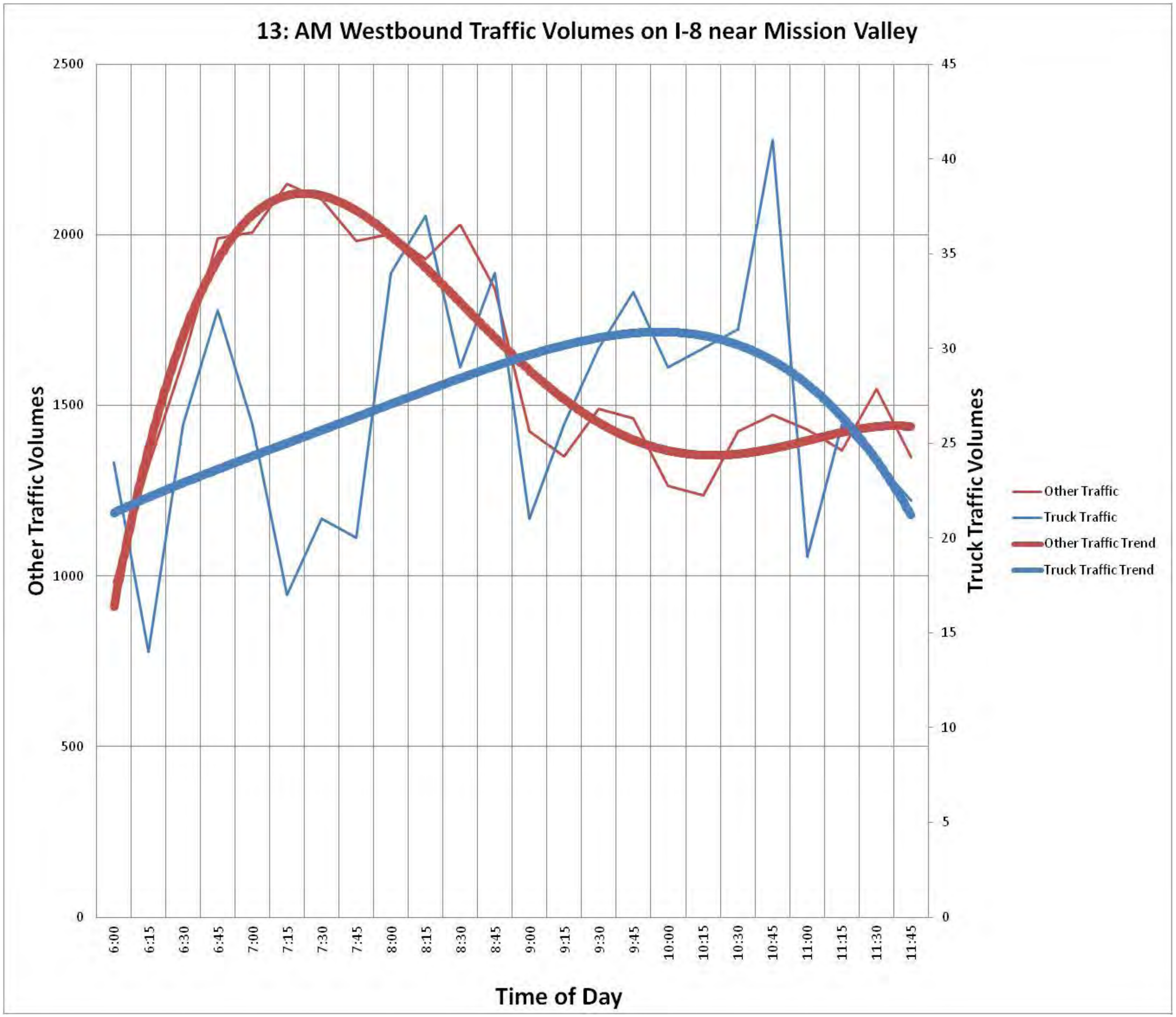

4: PM Eastbound Traffic Volumes on SR-94 near Emrald Hills
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
2500
2000
1500
1000
500
0
70
60
50
40
30
20
10
0
12:00
12:15
12:30
12:45
13:00
13:15
13:30
13:45
14:00
14:15
14:30
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



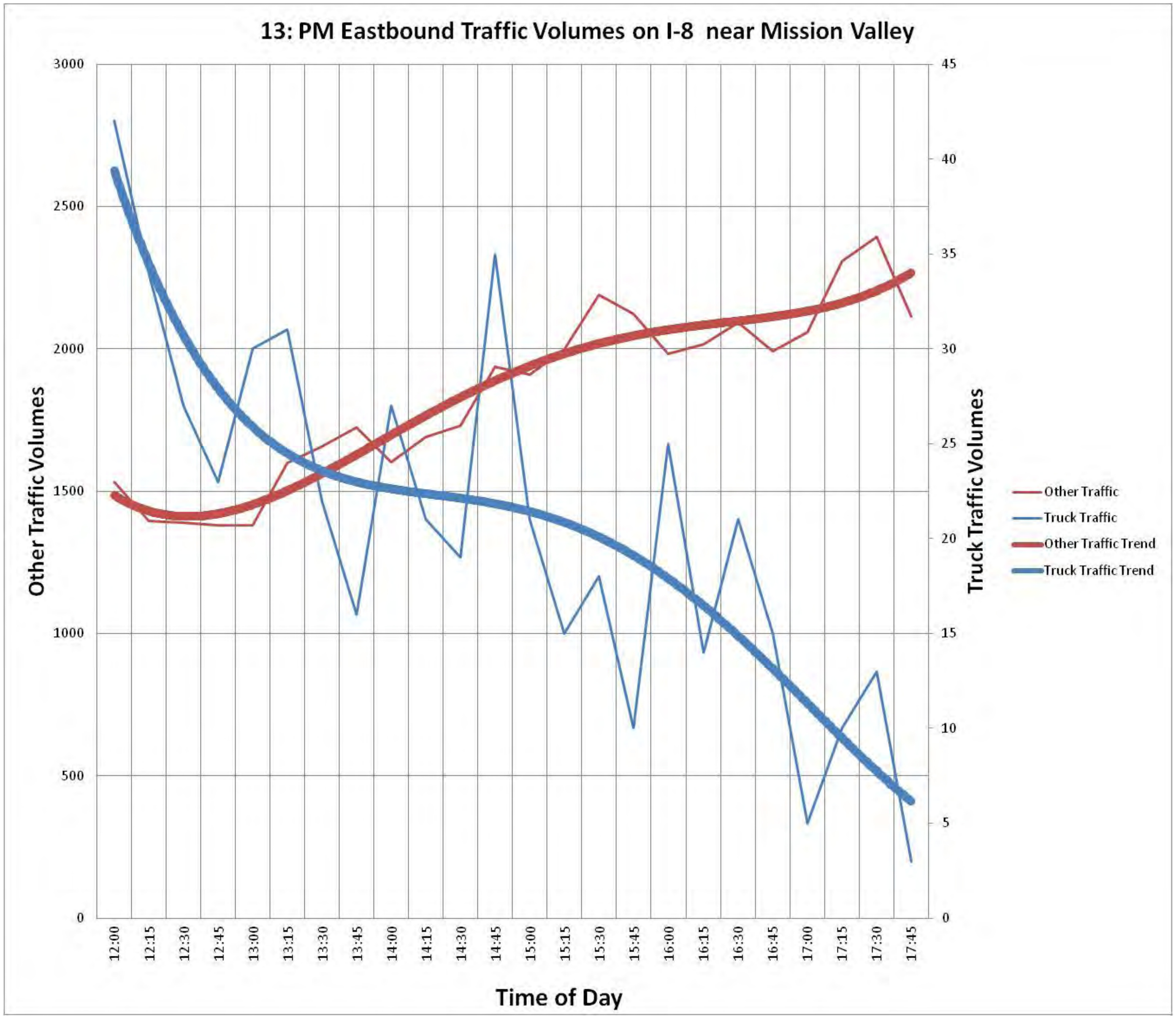
10: Northbound Traffic Volumes on I-5 near Old Town
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Volume Trend

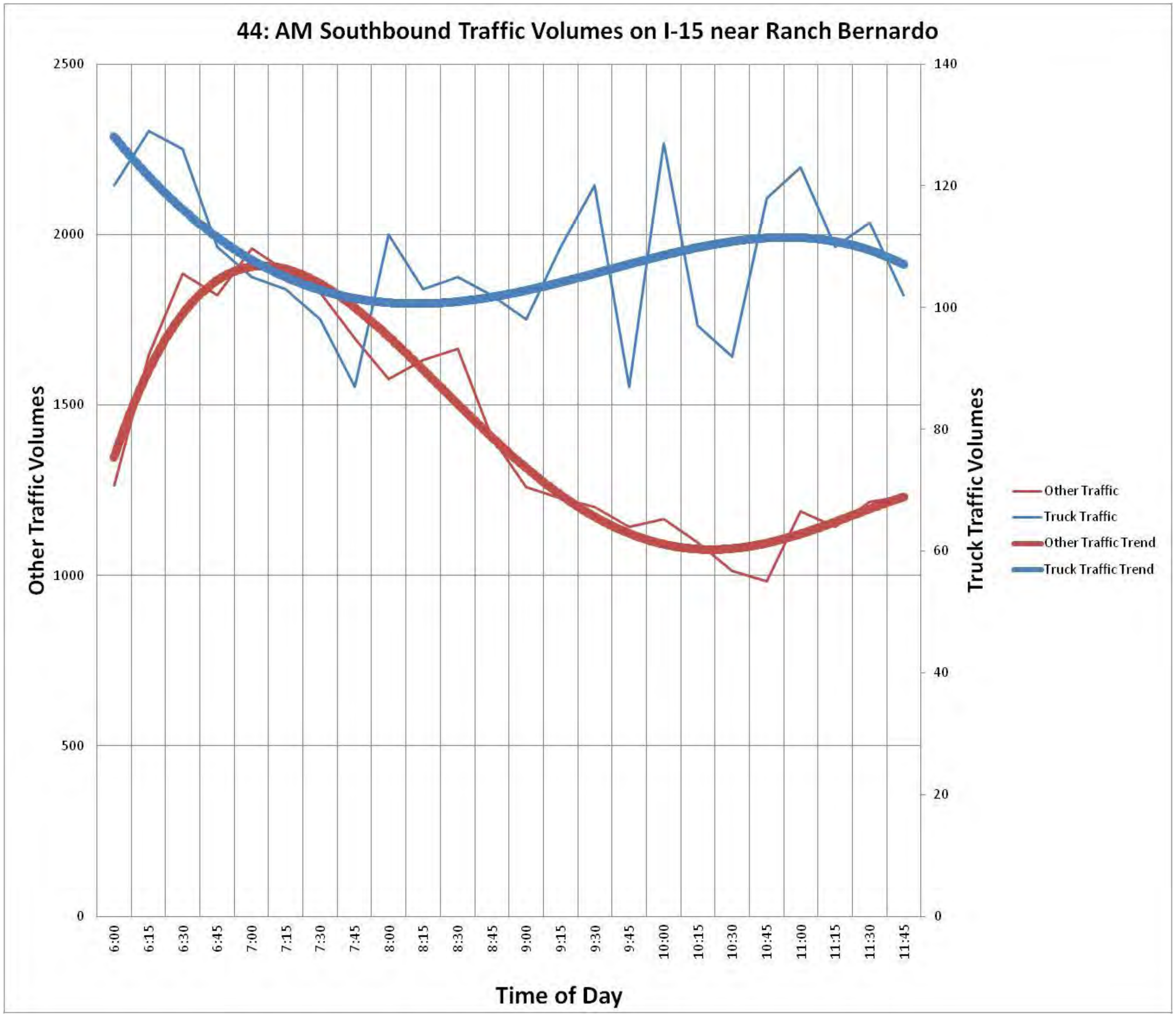


10: Southbound Traffic Volumes on I-5 near Old Town
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
2500
2000
1500
1000
500
0
50
45
40
35
30
25
20
15
10
5
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
12:00
12:15
12:30
12:45
13:00
13:15
13:30
13:45
14:00
14:15
14:30
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Volume Trend

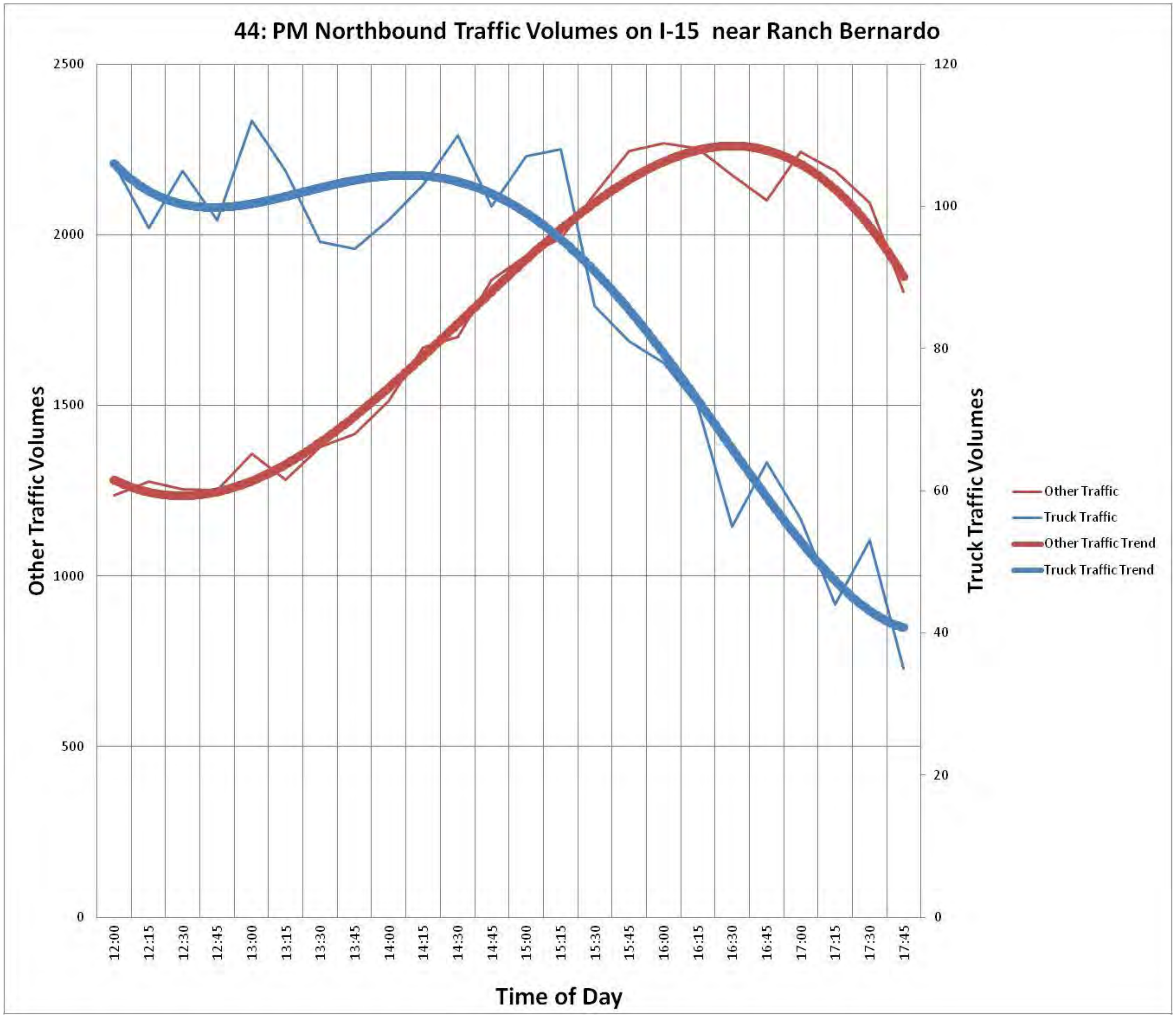


13: AM Westbound Traffic Volumes on I-8 near Mission Valley
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
2500
2000
1500
1000
500
0
45
40
35
30
25
20
15
10
5
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

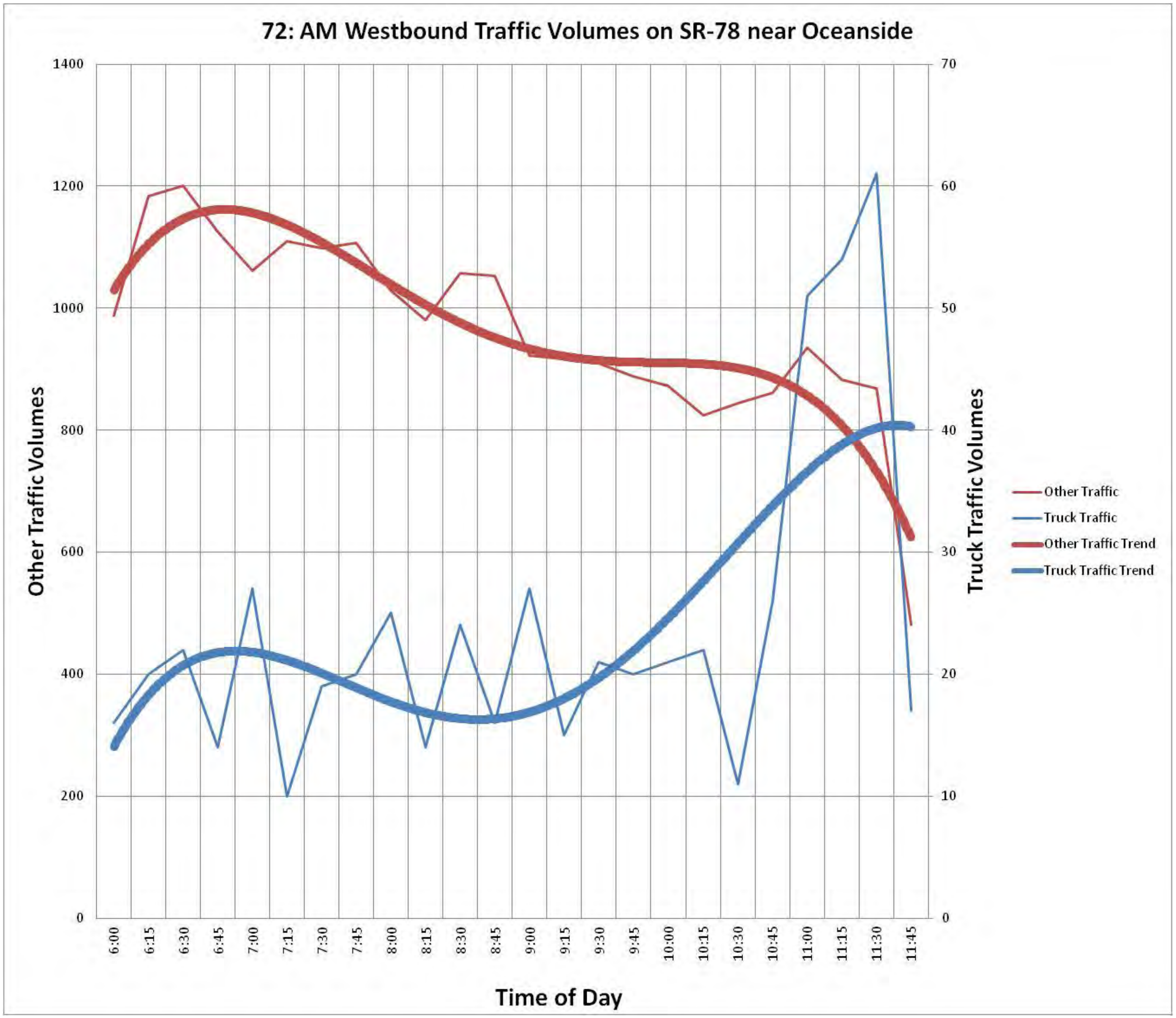

13: PM Eastbound Traffic Volumes on I-8 near Mission Valley
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
3000
2500
2000
1500
1000
500
0
45
40
35
30
25
20
15
10
5
0
12:00
12:15
12:30
12:45
13:00
13:15
13:30
13:45
14:00
14:15
14:30
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

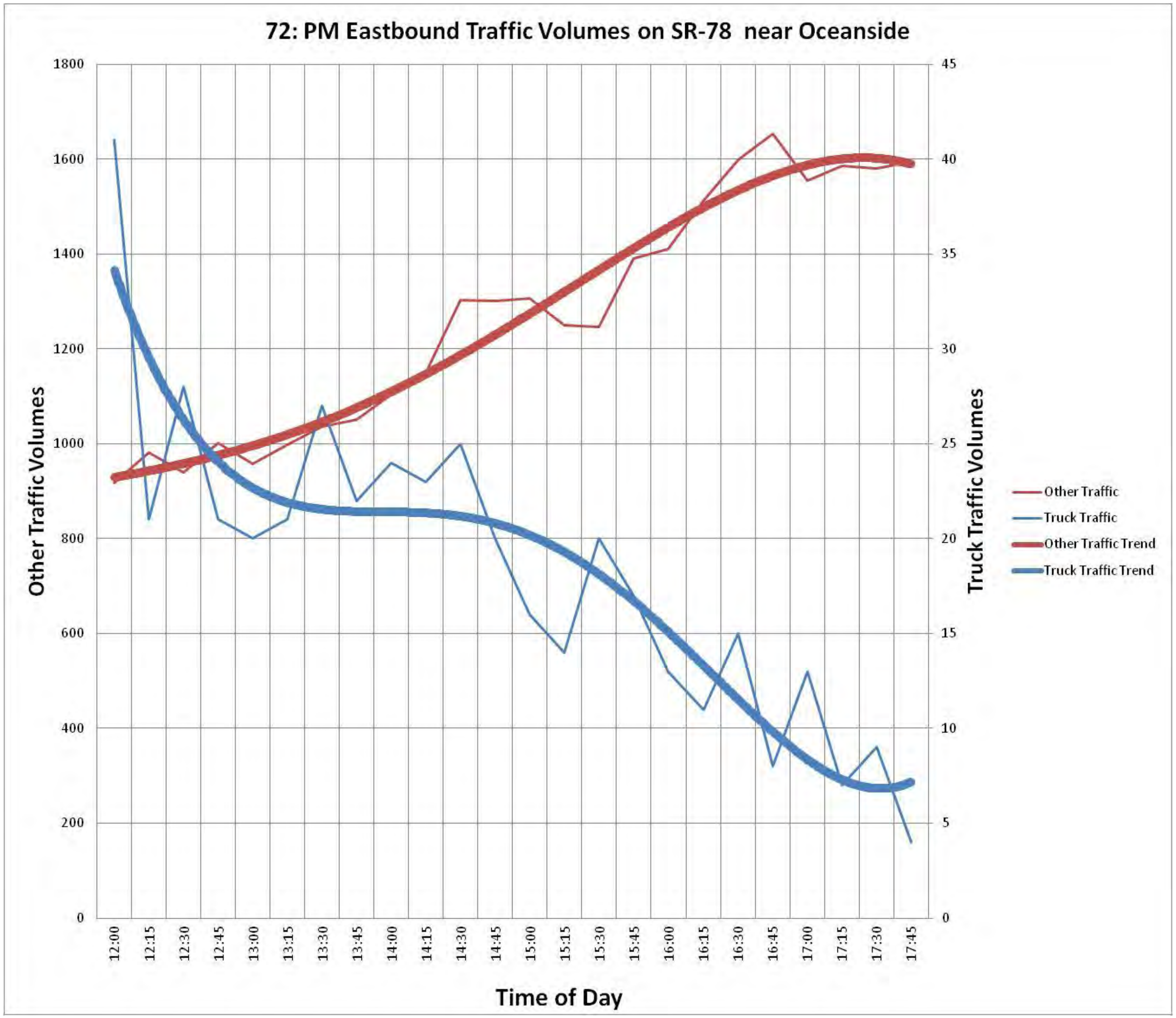


44: AM Southbound Traffic Volumes on I-15 near Ranch Bernardo
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
2500
2000
1500
1000
500
0
140
120
100
80
60
40
20
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

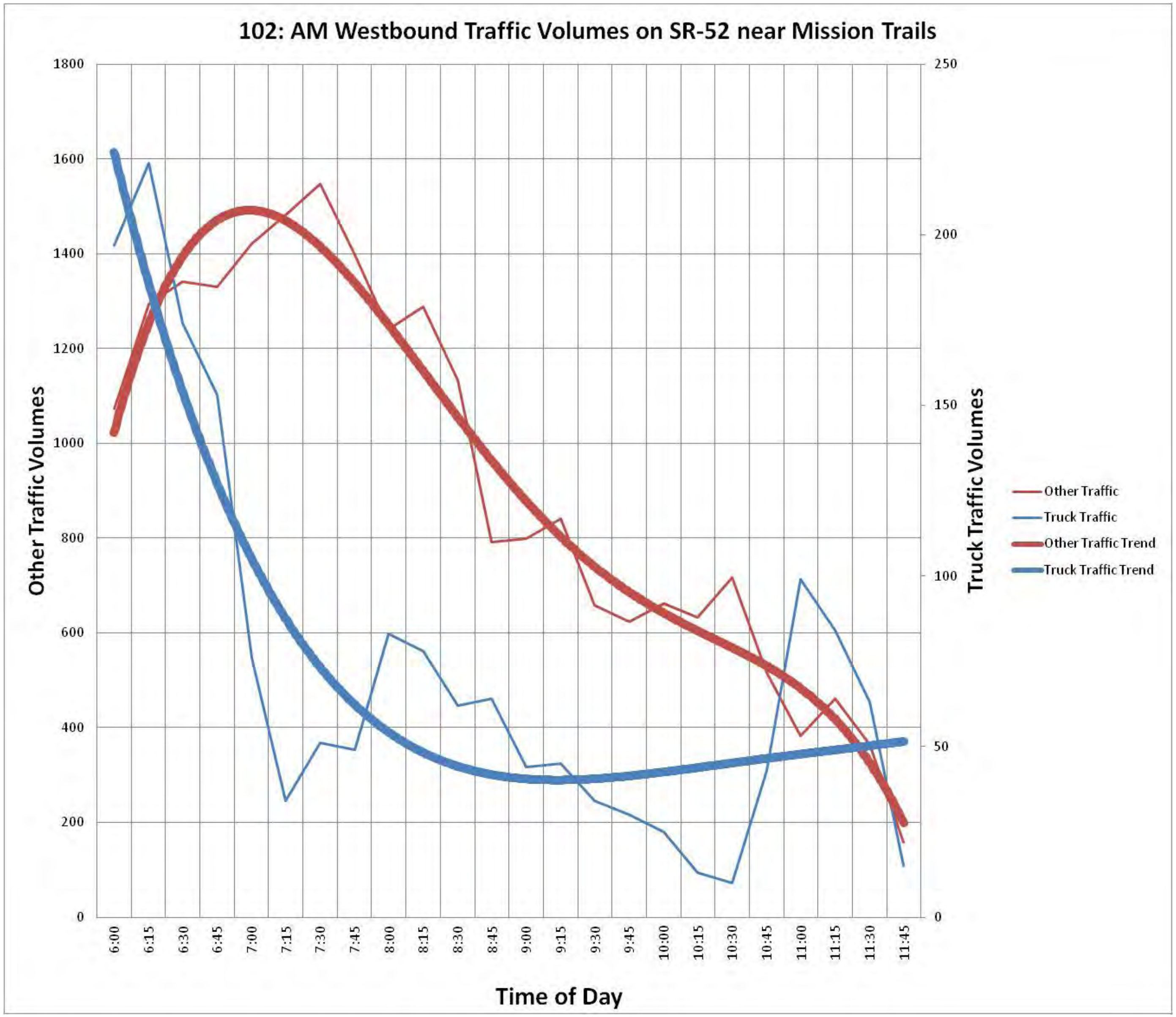


44: PM Northbound Traffic Volumes on I-15 near Ranch Bernardo
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
2500
2000
1500
1000
500
0
120
100
80
60
40
20
0
12:00
12:15
12:30
12:45
13:00
13:15
13:30
13:45
14:00
14:15
14:30
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

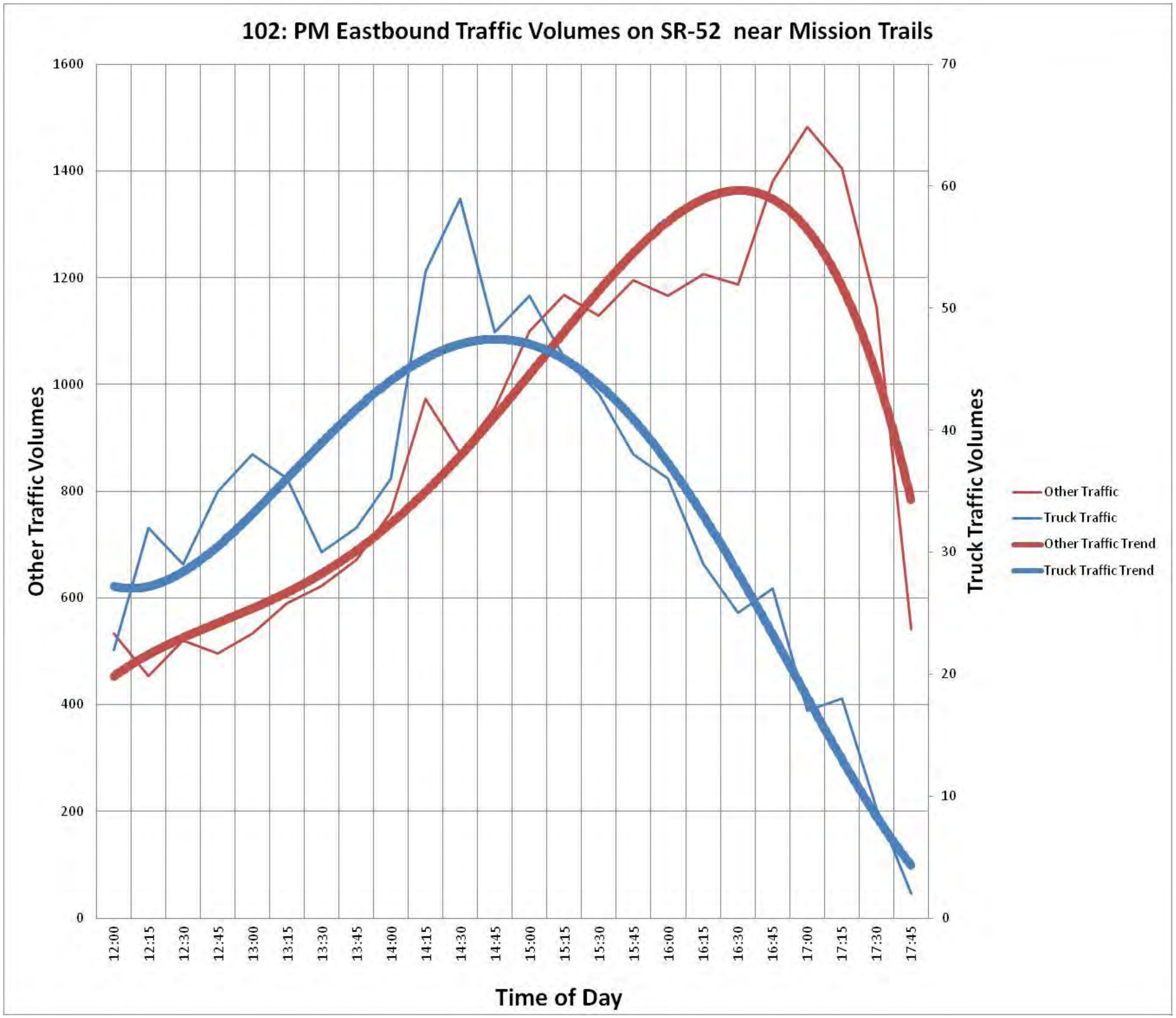

72: AM Westbound Traffic Volumes on SR-78 near Oceanside
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
1400
1200
1000
800
600
400
200
0
70
60
50
40
30
20
10
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



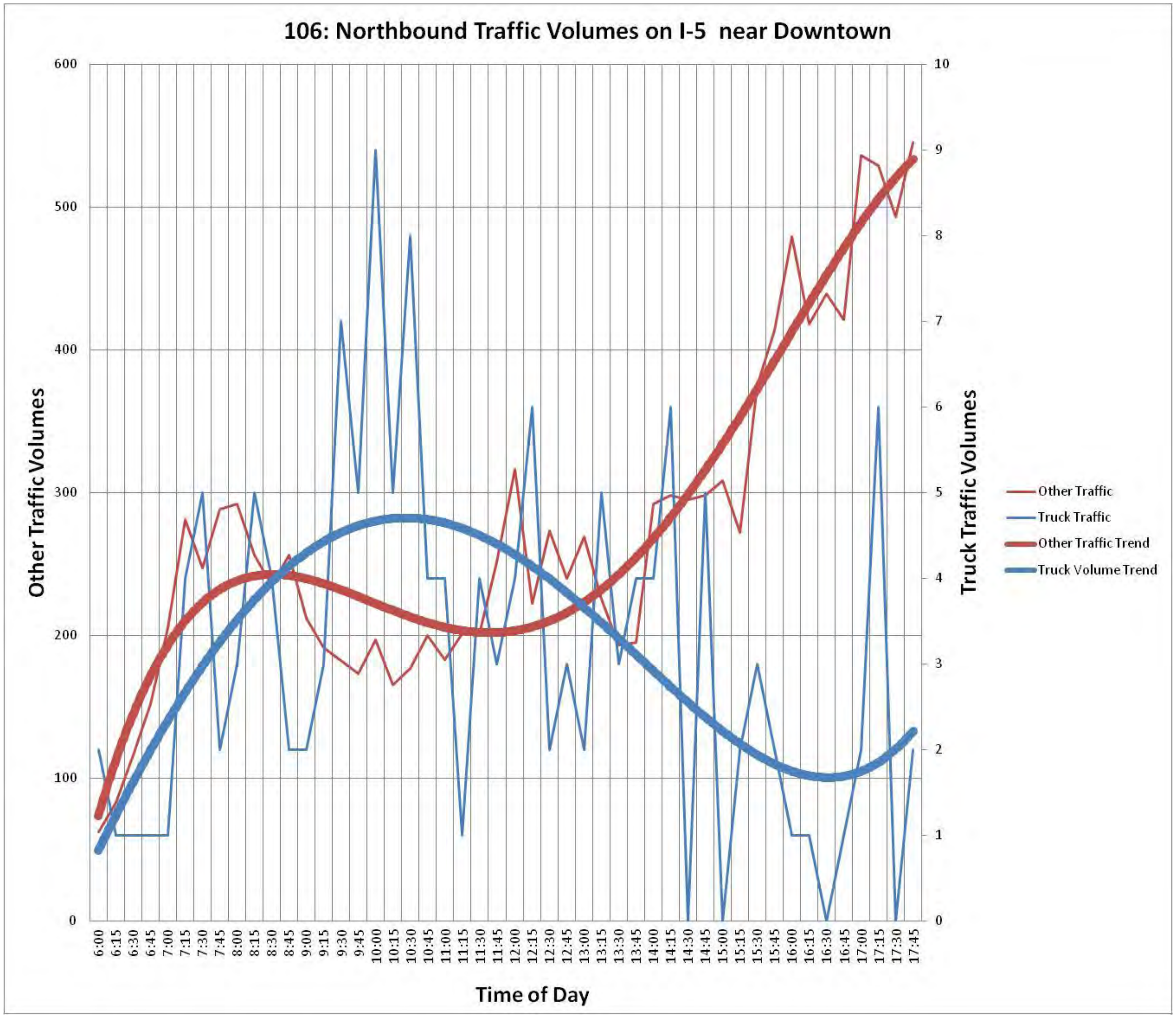
72: PM Eastbound Traffic Volumes on SR-78 near Oceanside
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
1800
1600
1400
1200
1000
800
600
400
200
0
45
40
35
30
25
20
15
10
5
0
12:00
12:15
12:30
12:45
13:00
13:15
13:30
13:45
14:00
14:15
14:30
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



102: AM Westbound Traffic Volumes on SR-52 near Mission Trails
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
1800
1600
1400
1200
1000
800
600
400
200
0
250
200
150
100
50
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



102: PM Eastbound Traffic Volumes on SR-52 near Mission Trails
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
1600
1400
1200
1000
800
600
400
200
0
70
60
50
40
30
20
10
0
12:00
12:15
12:30
12:45
13:00
13:15
13:30
13:45
14:00
14:15
14:30
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


106: Northbound Traffic Volumes on I-5 near Downtown
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Volume Trend
0
100
200
300
400
500
600
0
1
2
3
4
5
6
7
8
9
10
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
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14:45
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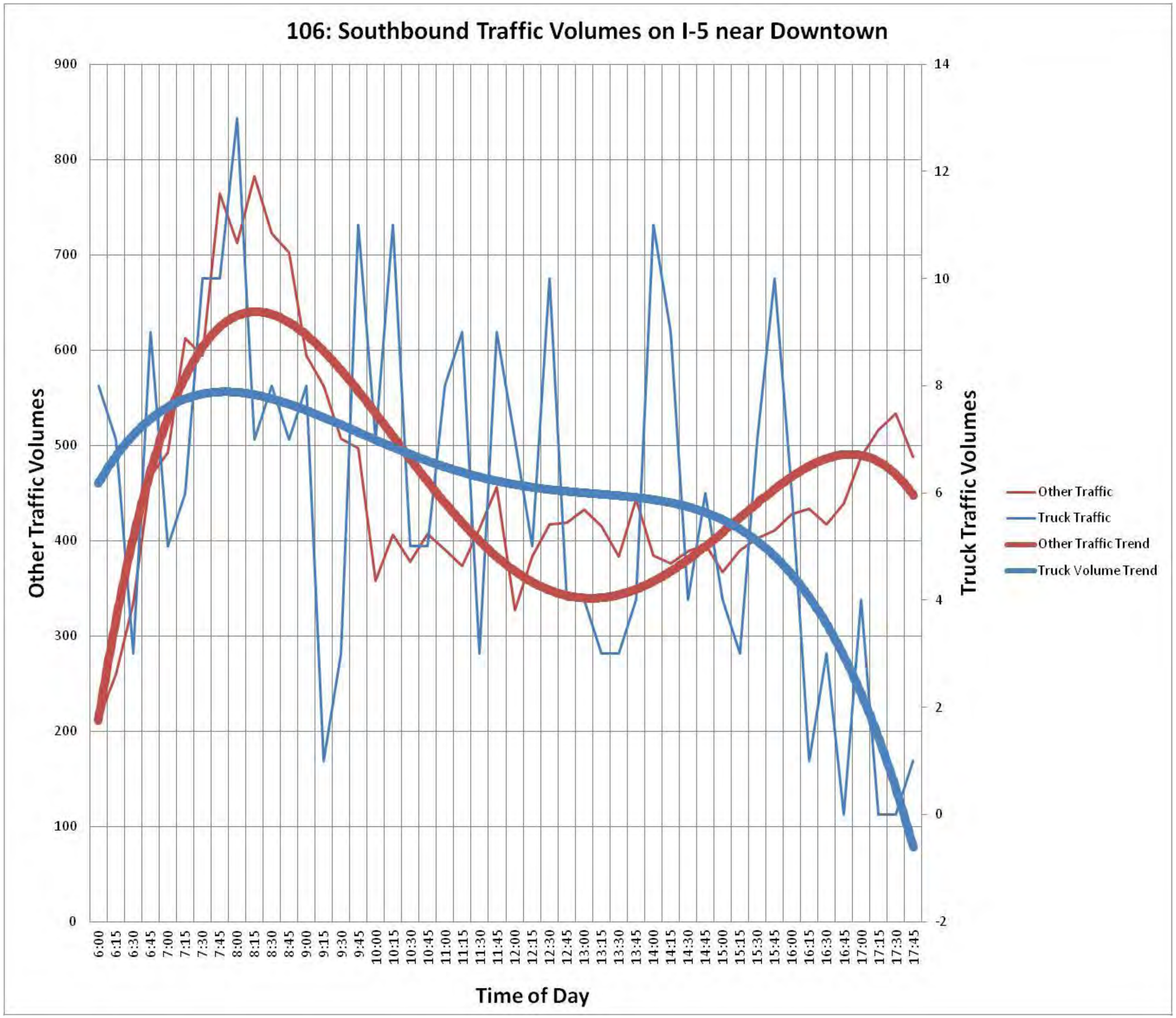
17:15
17:30
17:45



106: Southbound Traffic Volumes on I-5 near Downtown
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Volume Trend
0
100
200
300
400
500
600
700
800
900
-2
0
2
4
6
8
10
12
14
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
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9:00
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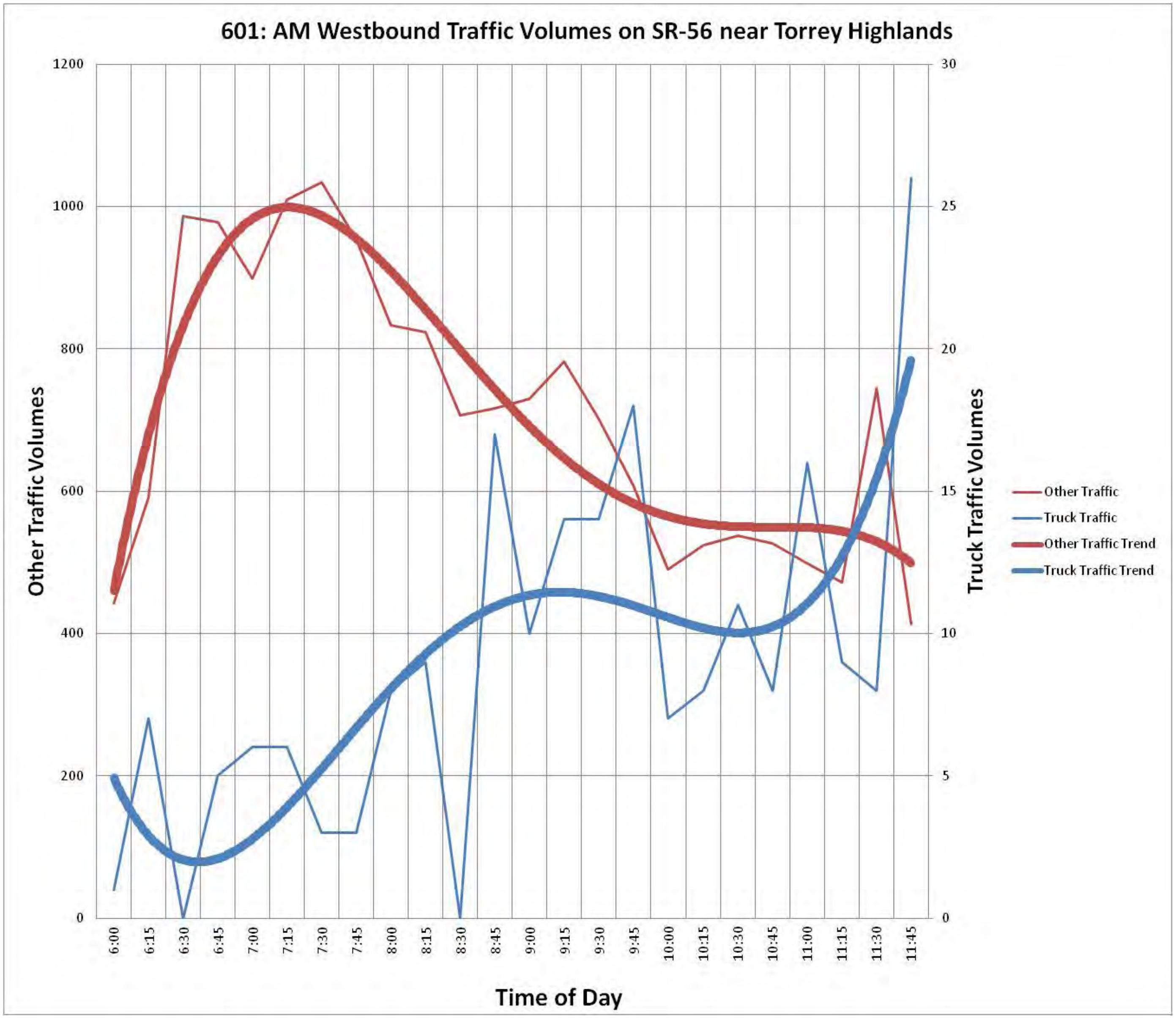
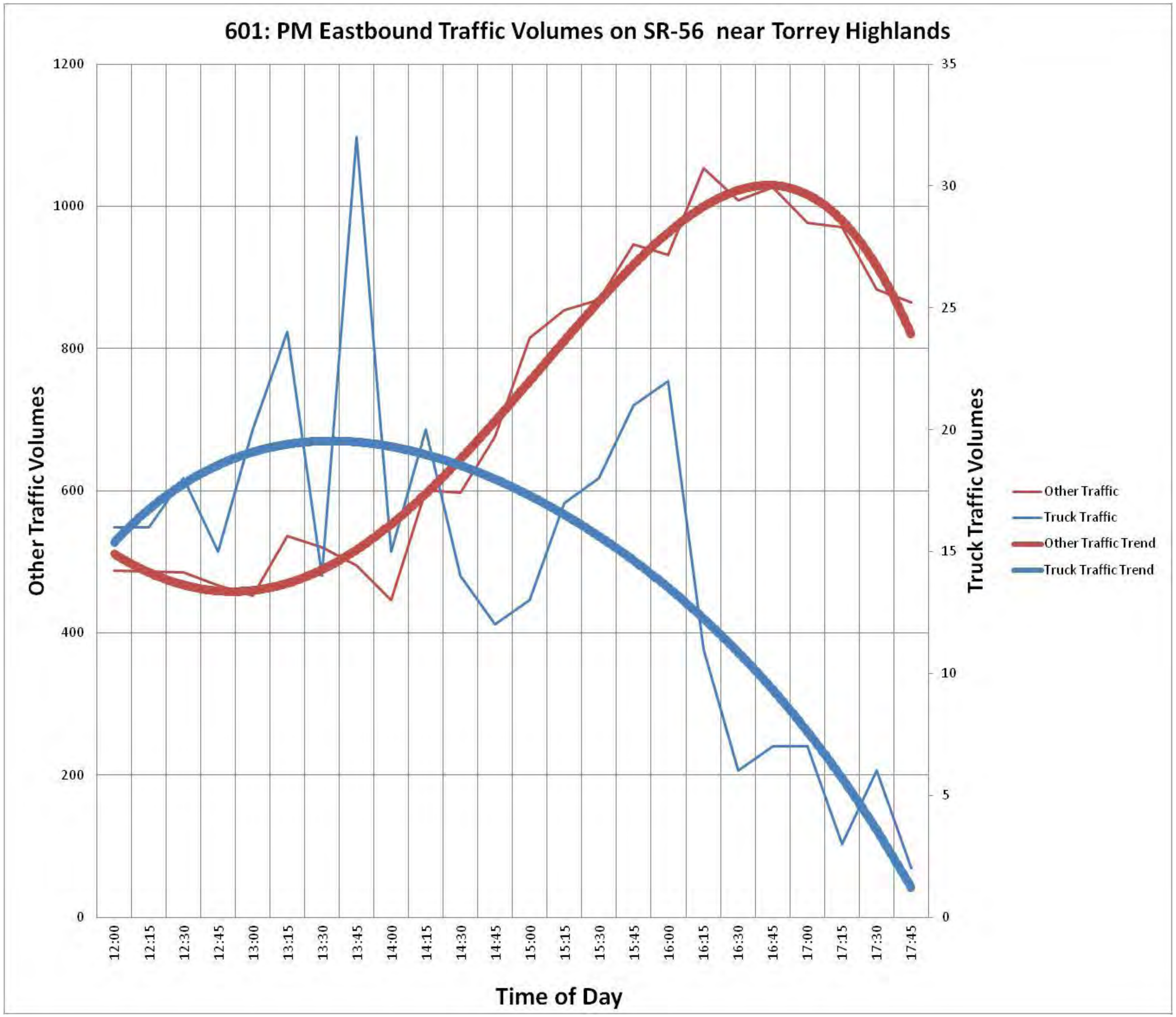
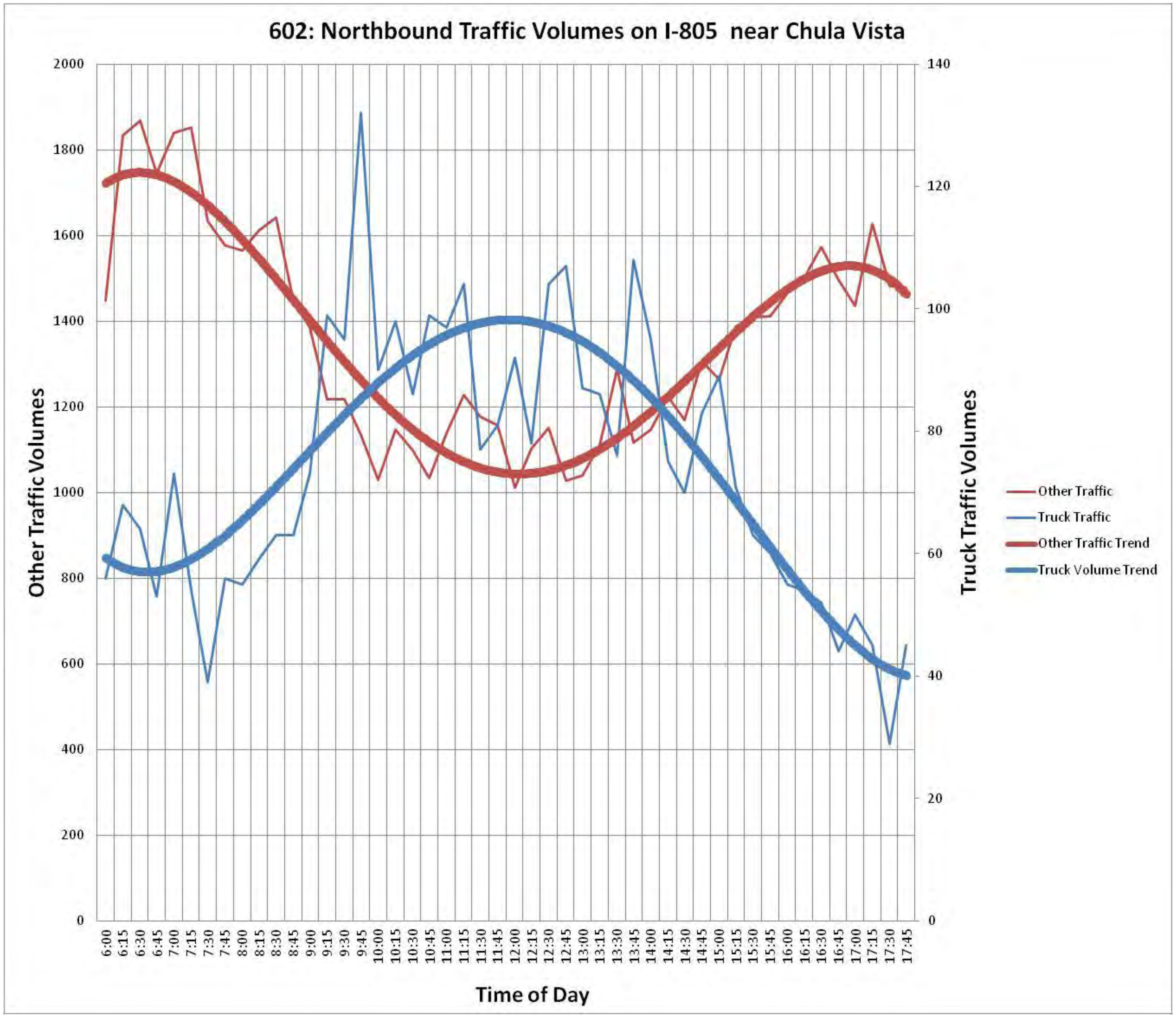
16:45
17:00
17:15
17:30
17:45

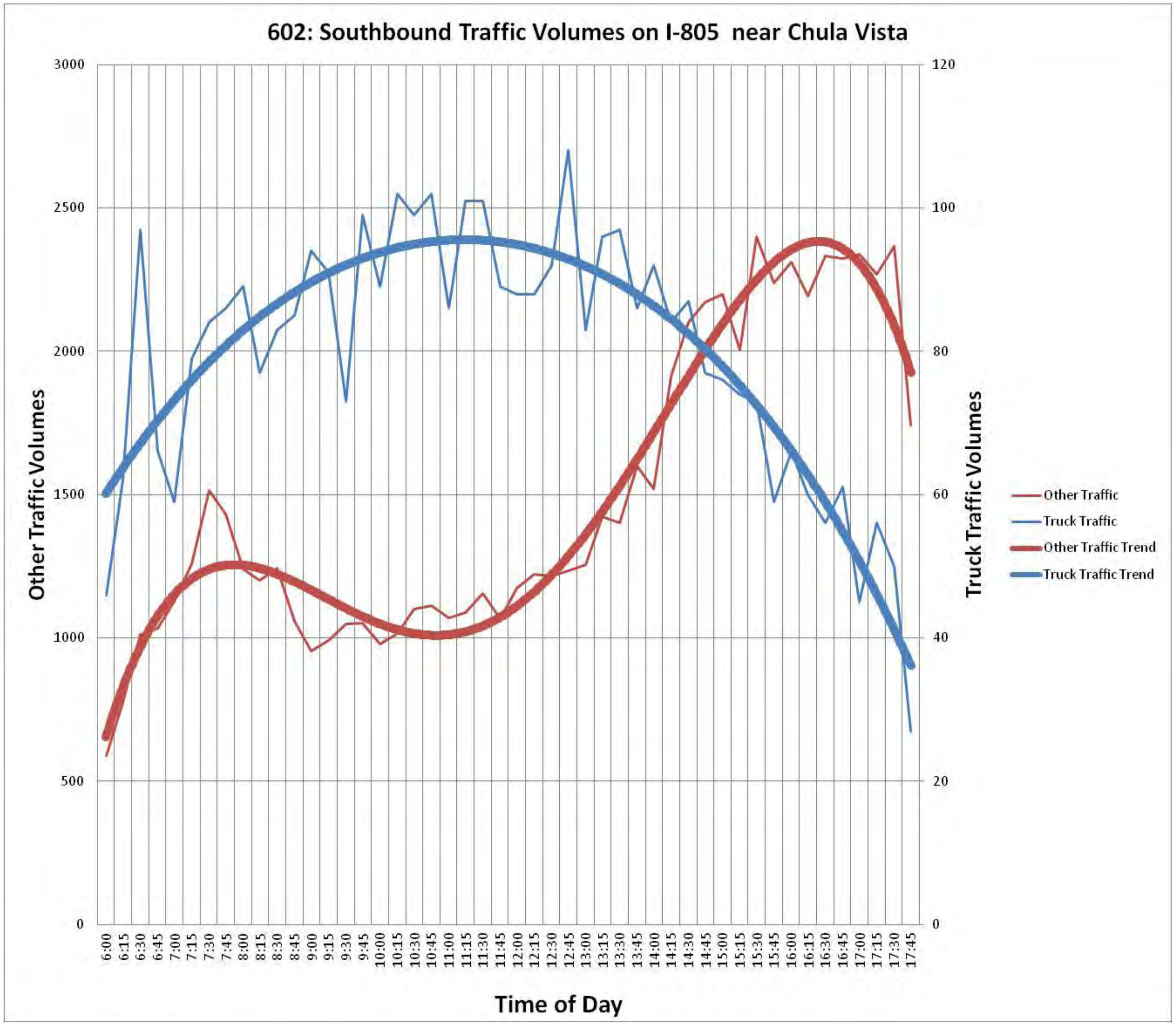


601: AM Westbound Traffic Volumes on SR-56 near Torrey Highlands
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
1200
1000
800
600
400
200
0
30
25
20
15
10
5
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



601: PM Eastbound Traffic Volumes on SR-56 near Torrey Highlands
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


602: Northbound Traffic Volumes on I-805 near Chula Vista
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Volume Trend


602: Southbound Traffic Volumes on I-805 near Chula Vista
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
0
500
1000
1500
2000
2500
3000
20
40
60
80
100
120
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
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10:45
11:00
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11:45
12:00
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14:30
14:45
15:00
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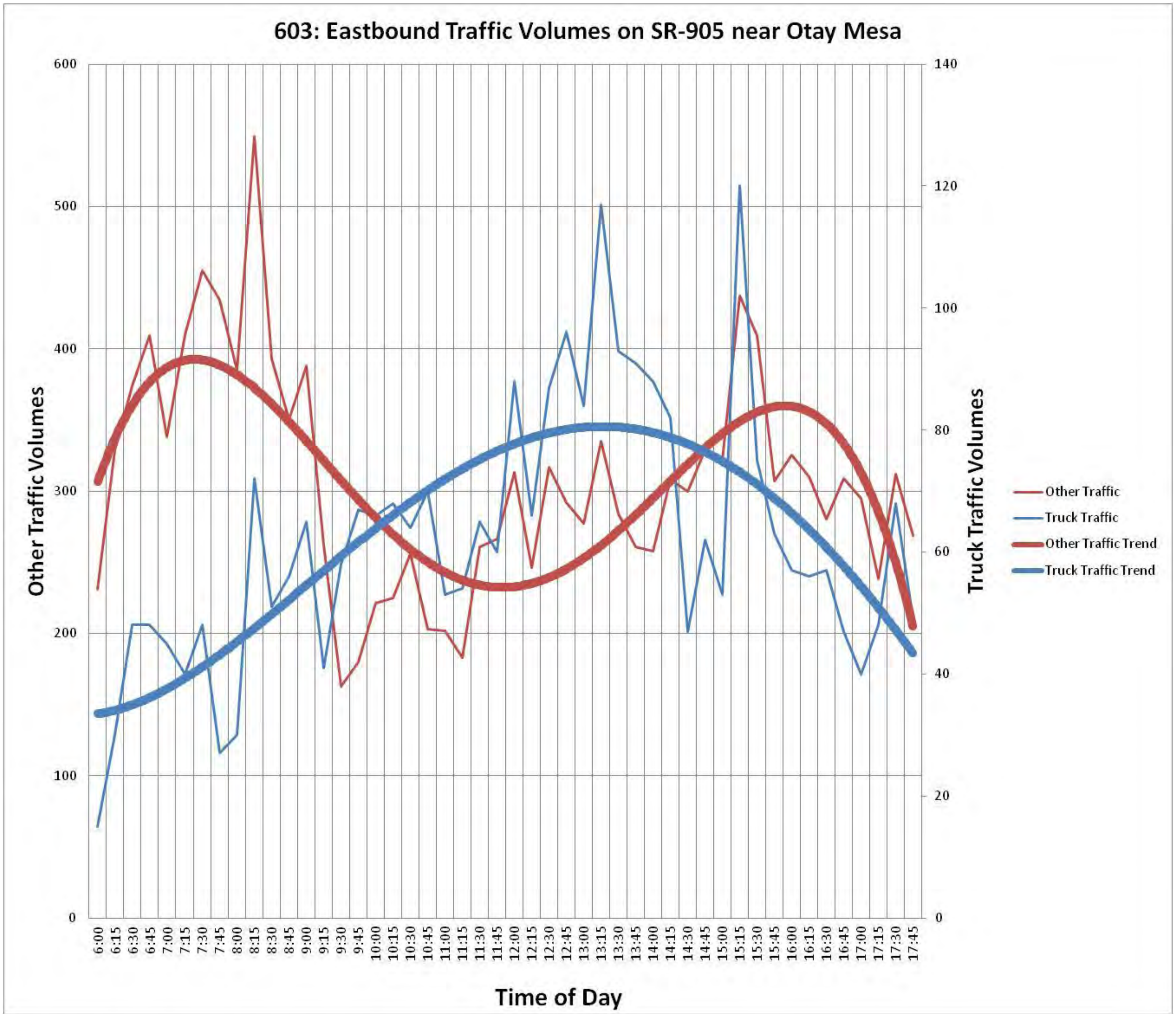
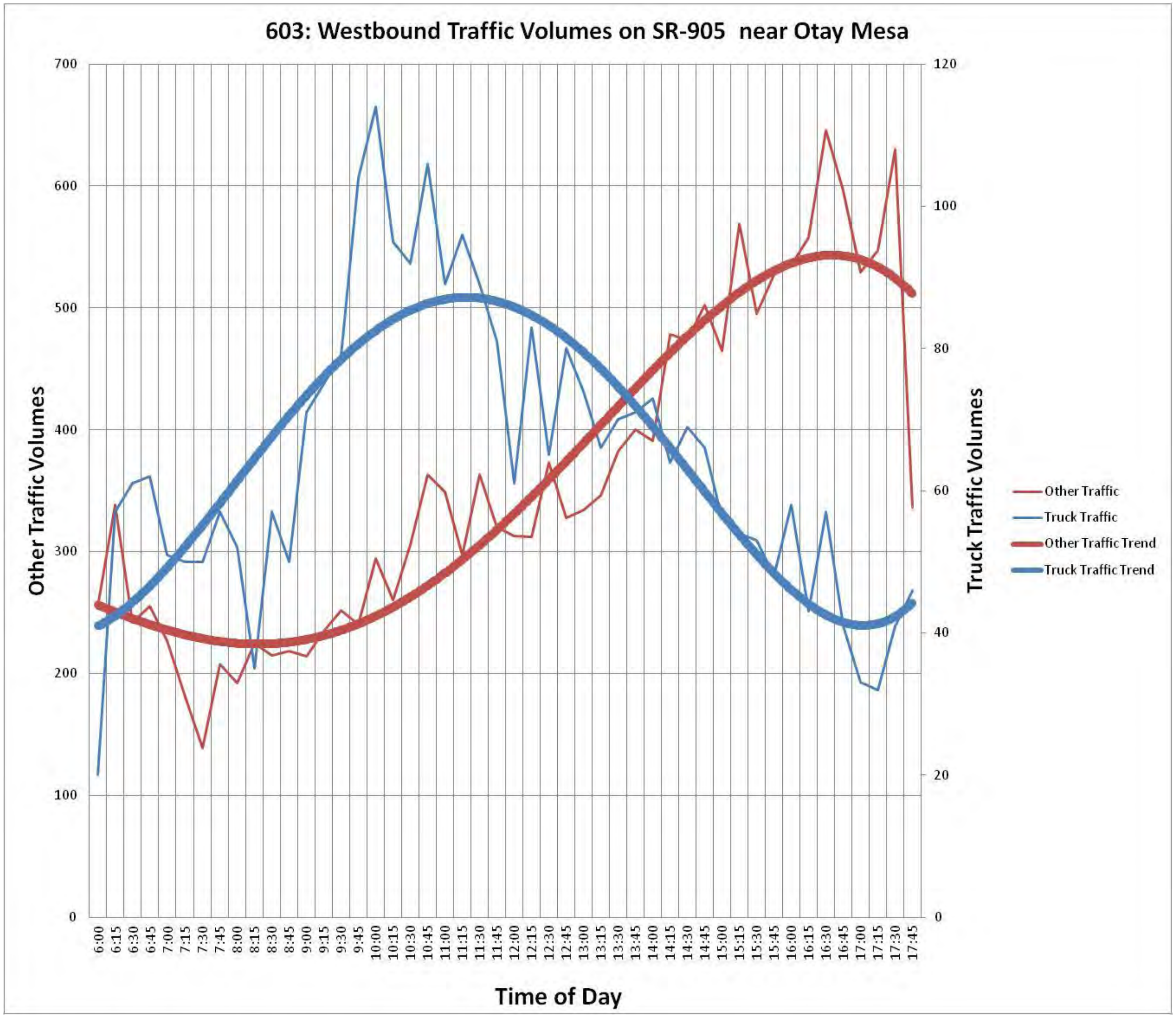
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45



603: Eastbound Traffic Volumes on SR-905 near Otay Mesa
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



603: Westbound Traffic Volumes on SR-905 near Otay Mesa
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
0
100
200
300
400
500
600
700
0
20
40
60
80
100
120
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
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11:00
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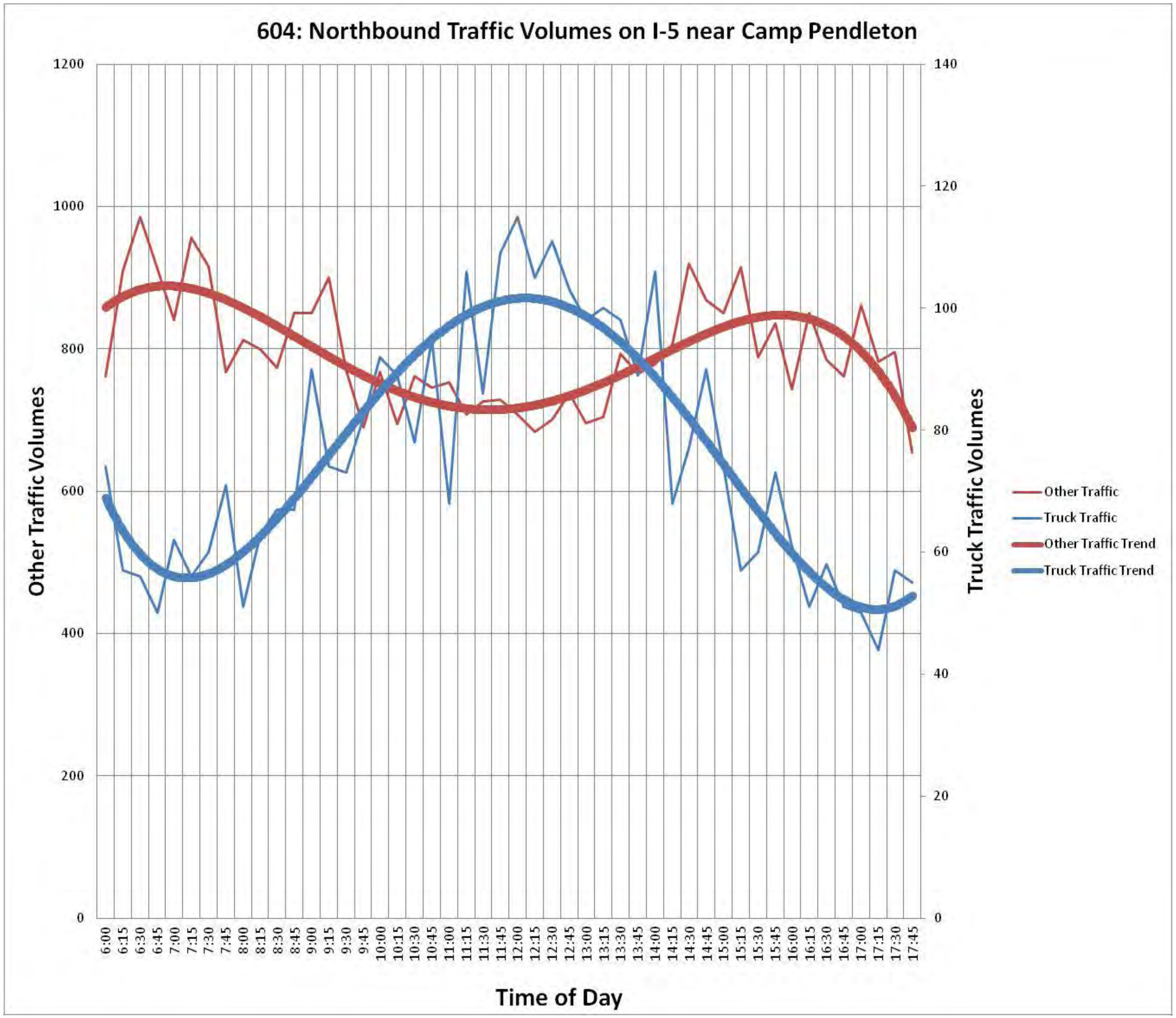
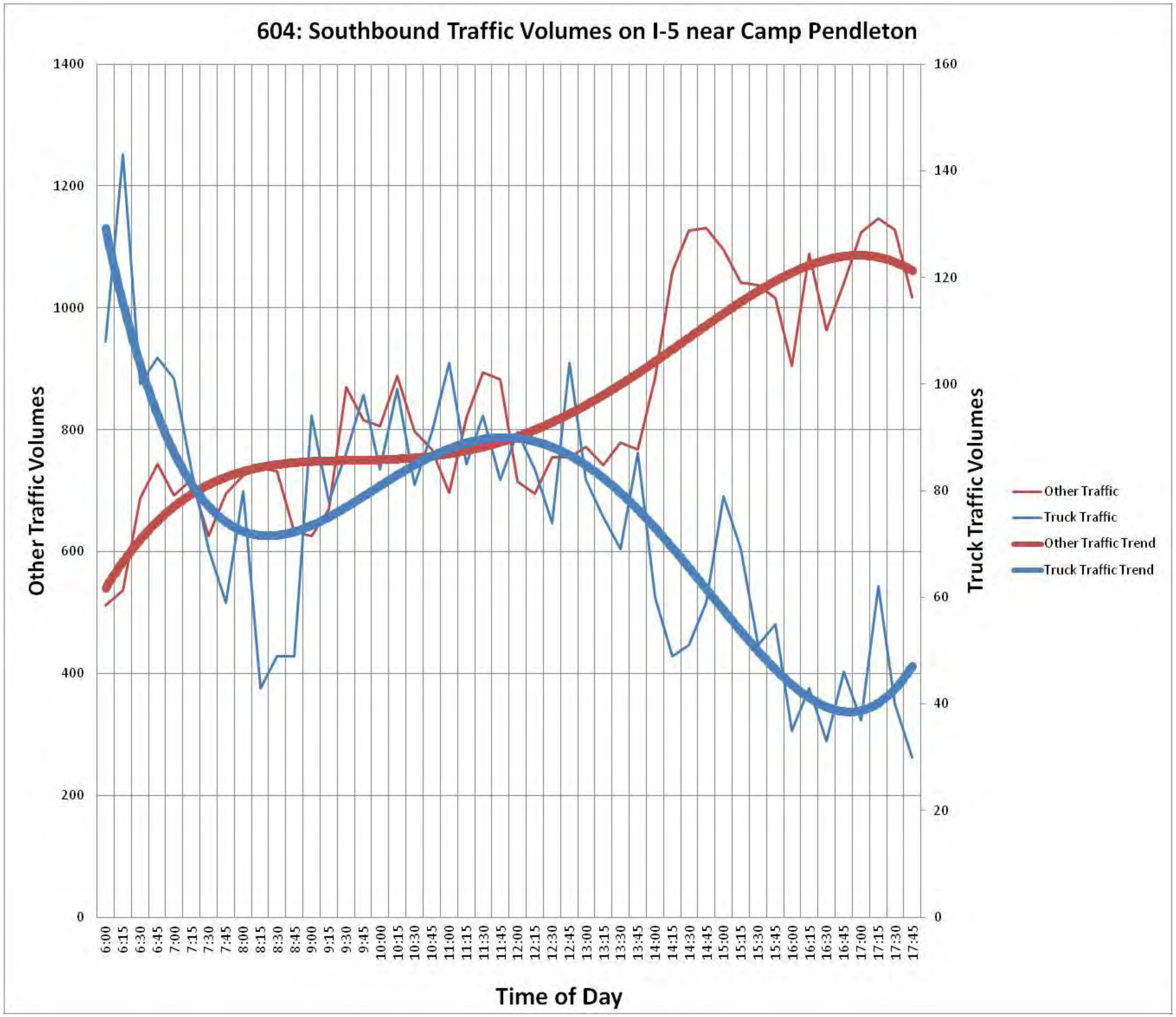
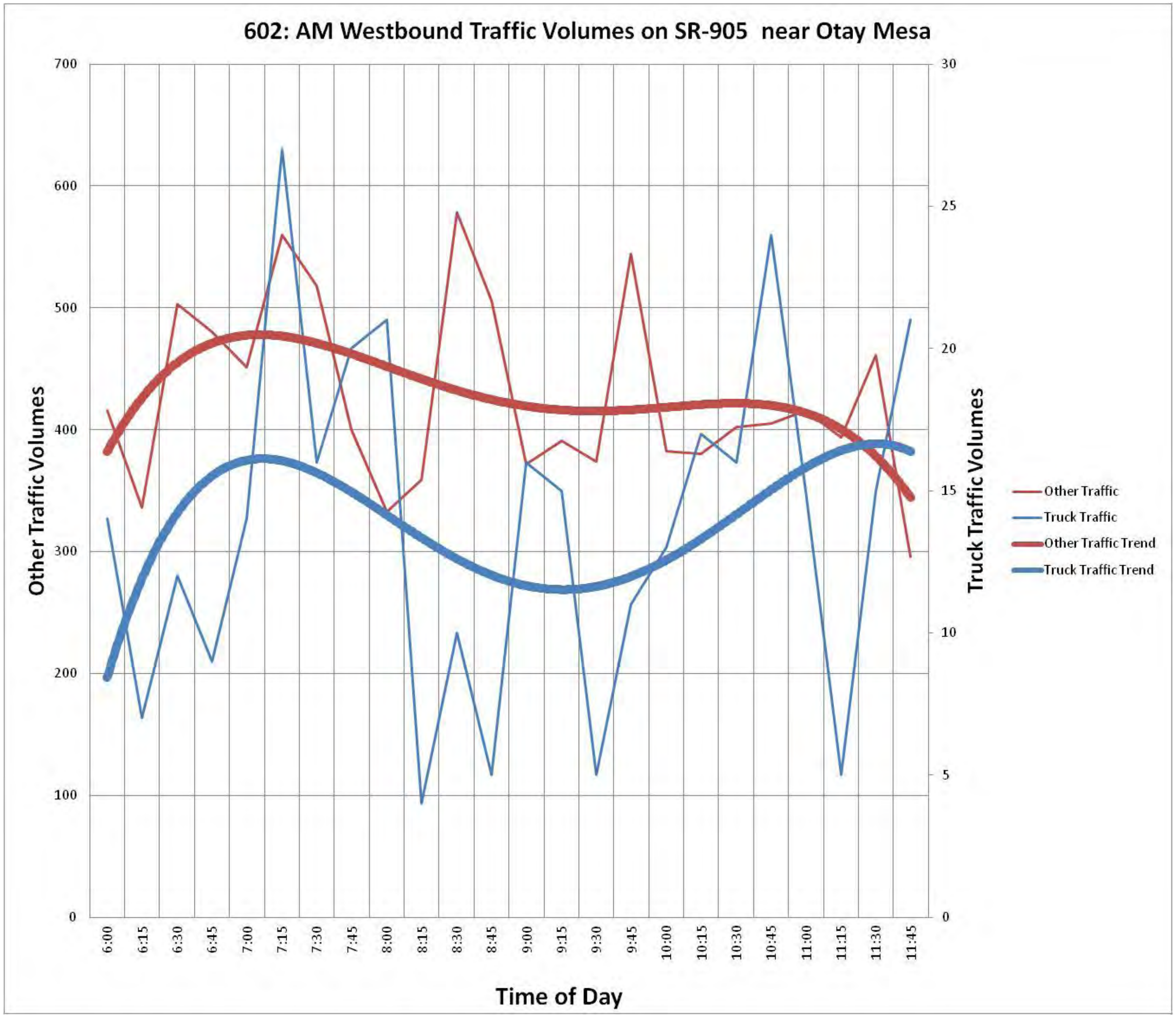
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

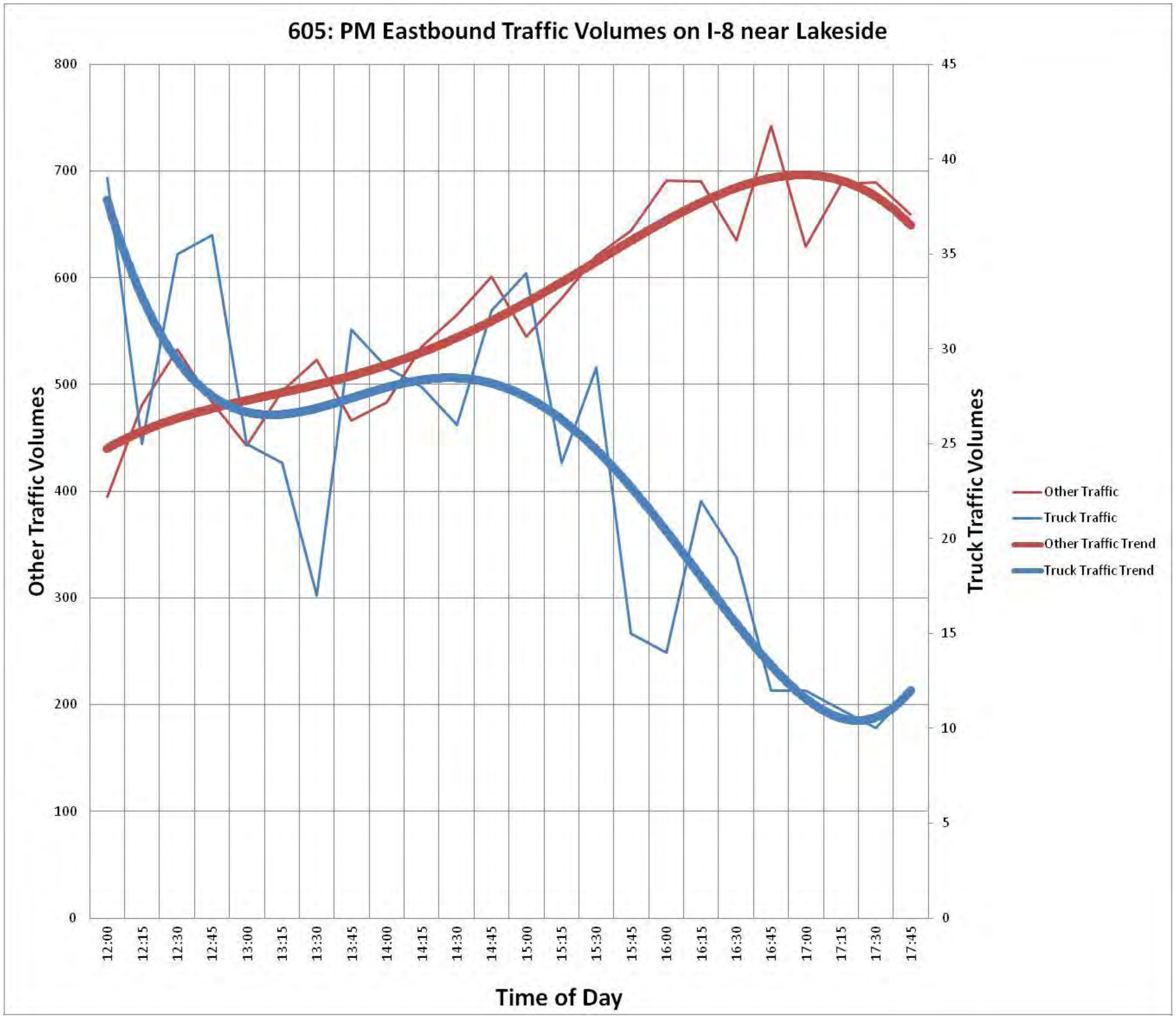

604: Northbound Traffic Volumes on I-5 near Camp Pendleton
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



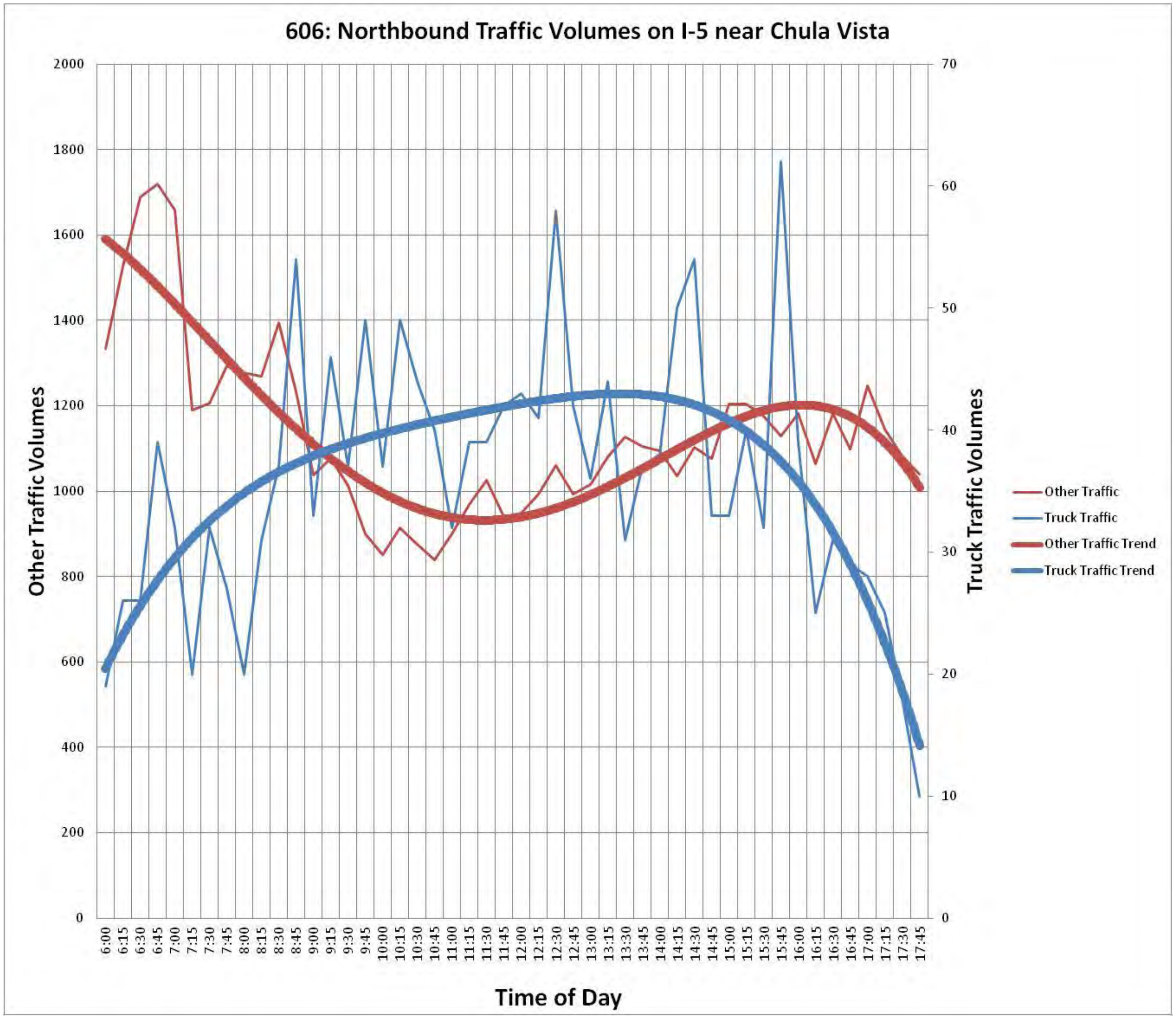
604: Southbound Traffic Volumes on I-5 near Camp Pendleton
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



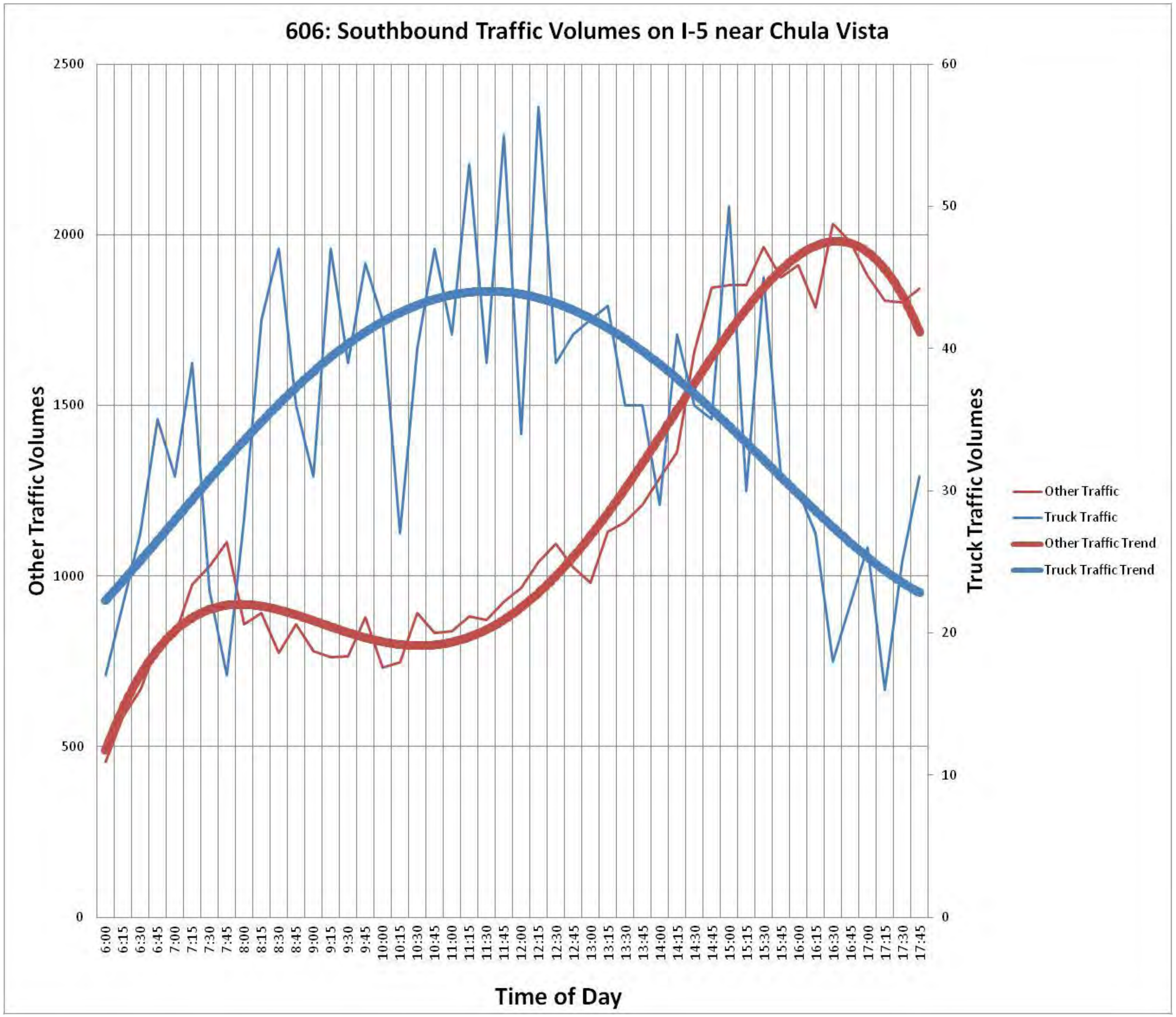
602: AM Westbound Traffic Volumes on SR-905 near Otay Mesa
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



605: PM Eastbound Traffic Volumes on I-8 near Lakeside
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
800
700
600
500
400
300
200
100
0
45
40
35
30
25
20
15
10
5
0
12:00
12:15
12:30
12:45
13:00
13:15
13:30
13:45
14:00
14:15
14:30
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



606: Northbound Traffic Volumes on I-5 near Chula Vista
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


606: Southbound Traffic Volumes on I-5 near Chula Vista
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
2500
2000
1500
1000
500
0
60
50
40
30
20
10
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
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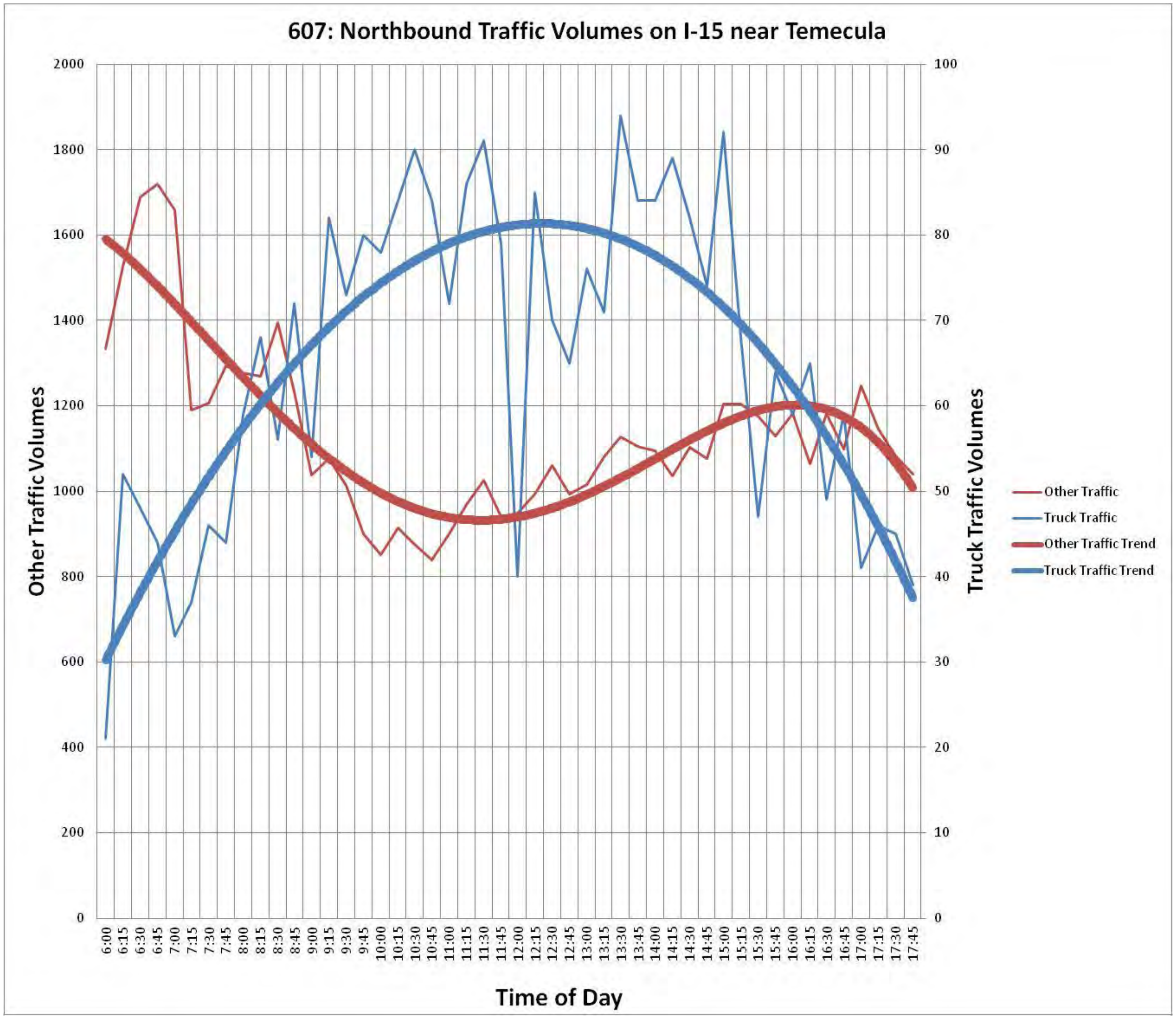
16:45
17:00
17:15
17:30
17:45


607: Northbound Traffic Volumes on I-15 near Temecula
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
0
200
400
600
800
1000
1200
1400
1600
1800
2000
10
20
30
40
50
60
70
80
90
100
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
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14:45
15:00
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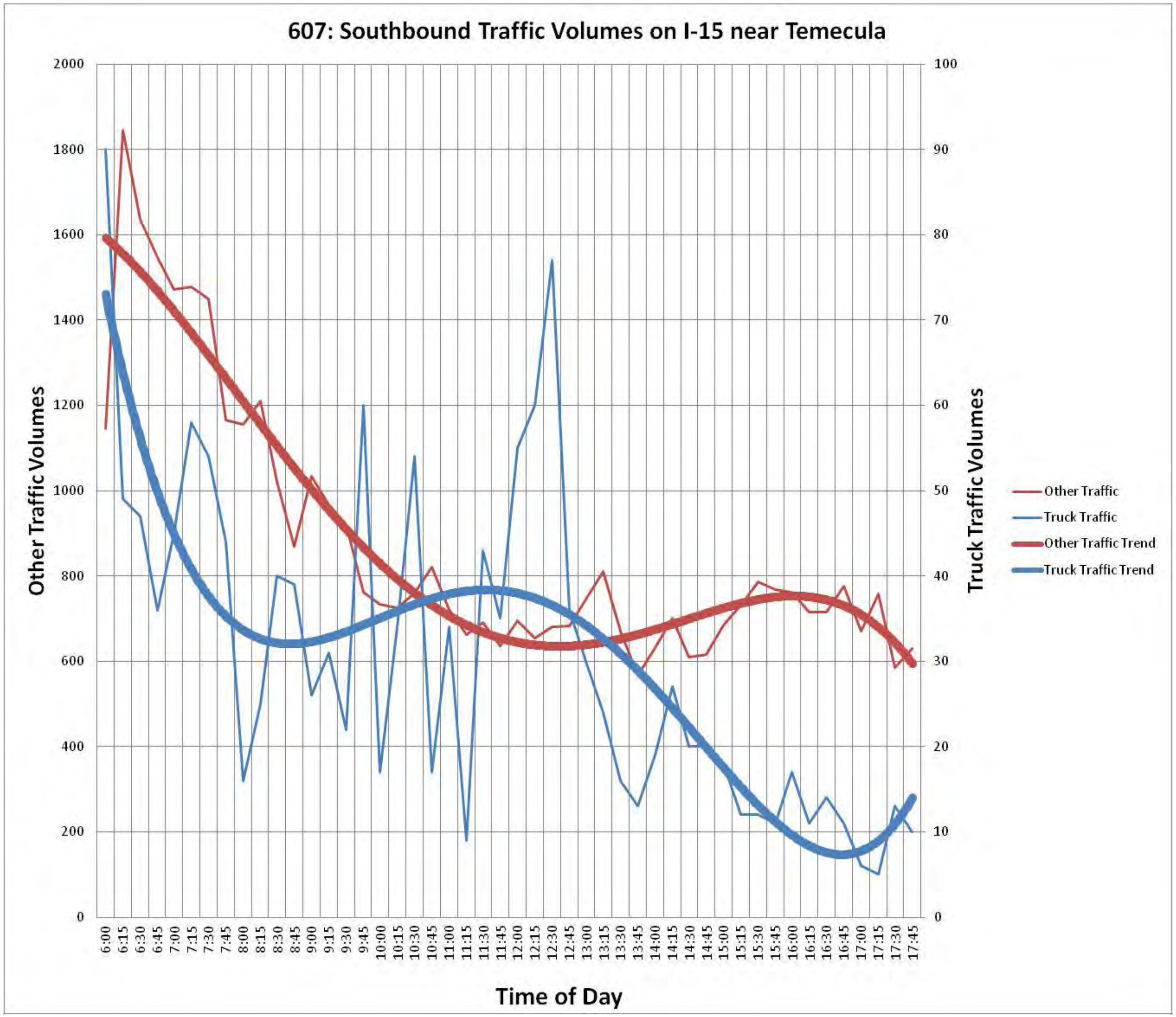
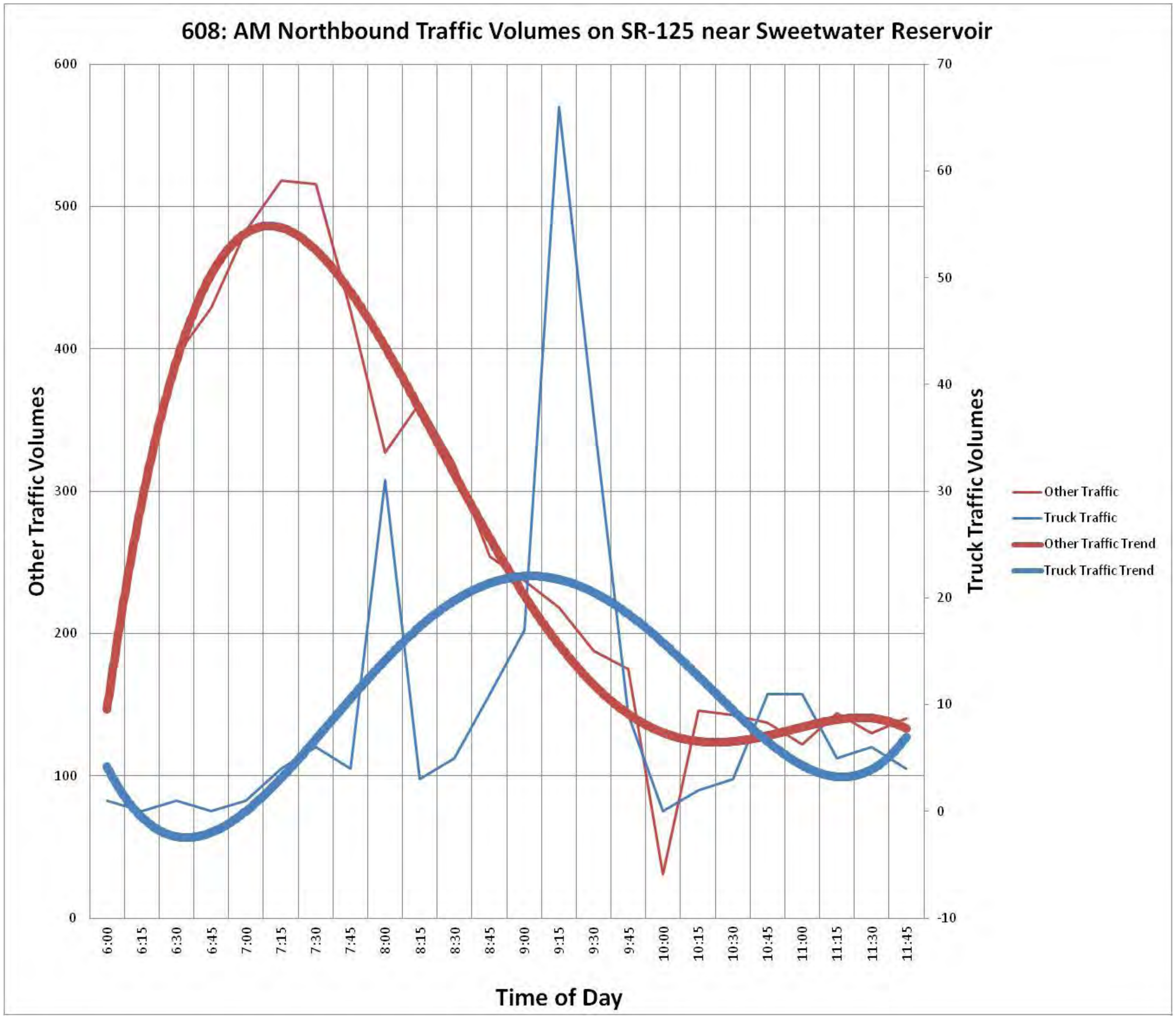
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45



607: Southbound Traffic Volumes on I-15 near Temecula
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



608: AM Northbound Traffic Volumes on SR-125 near Sweetwater Reservoir
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
0
100
200
300
400
500
600
-10
0
10
20
30
40
50
60
70
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
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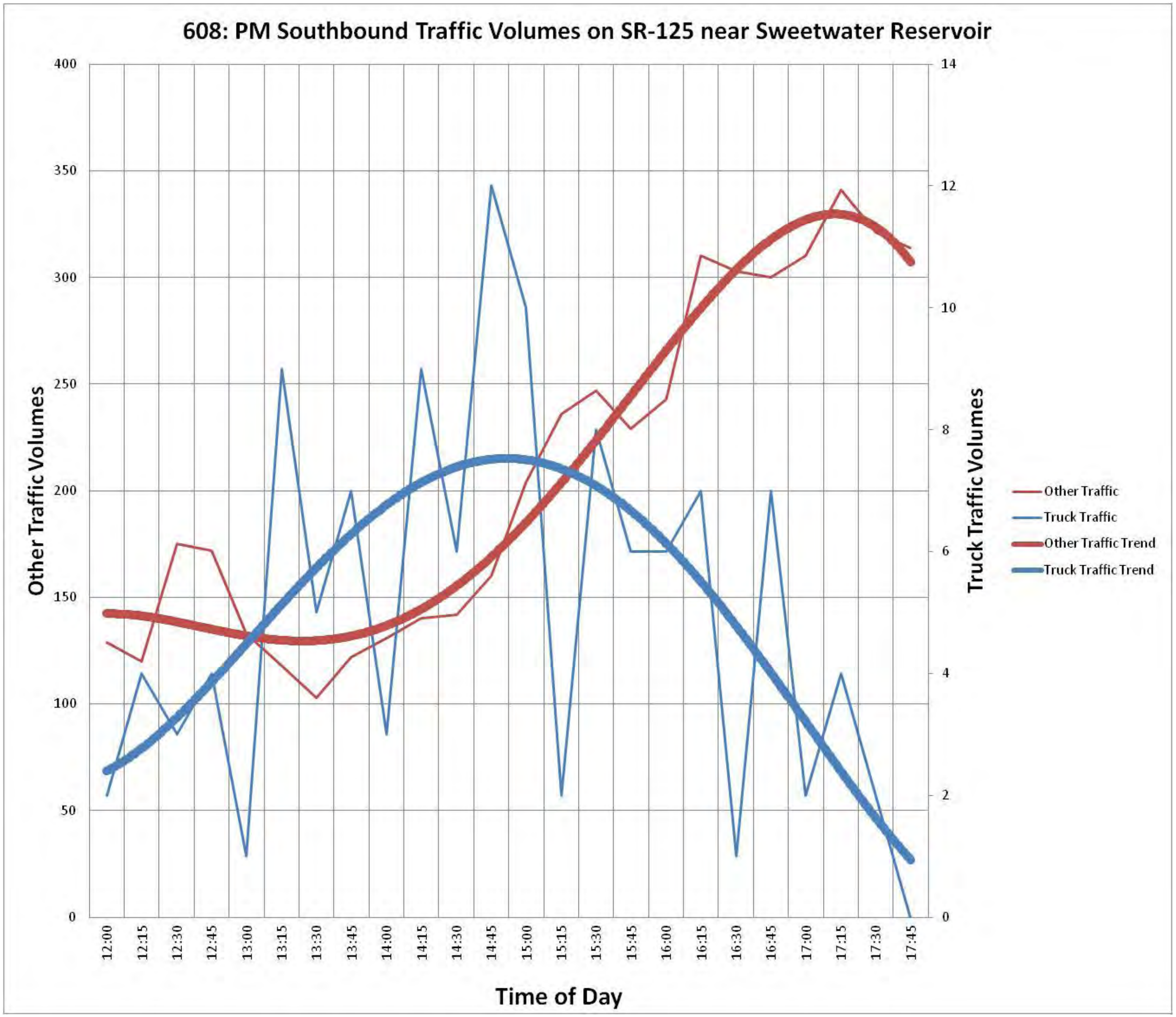
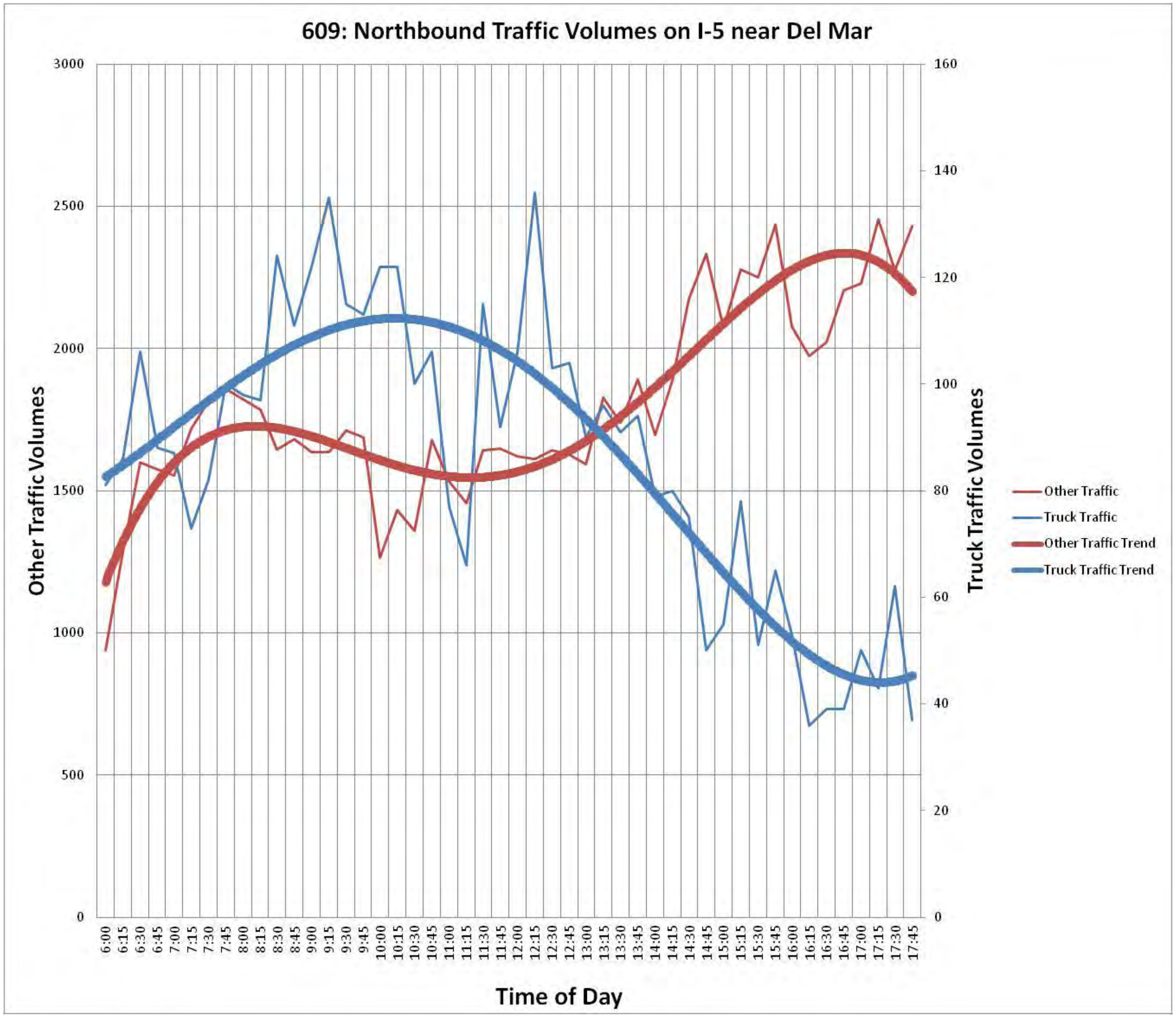
11:15
11:30
11:45


608: PM Southbound Traffic Volumes on SR-125 near Sweetwater Reservoir
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
0
50
100
150
200
250
300
350
400
0
2
4
6
8
10
12
14
12:00
12:15
12:30
12:45
13:00
13:15
13:30
13:45
14:00
14:15
14:30
14:45
15:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45
17:00
17:15
17:30
17:45
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


609: Northbound Traffic Volumes on I-5 near Del Mar
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
3000
2500
2000
1500
1000
500
0
160
140
120
100
80
60
40
20
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
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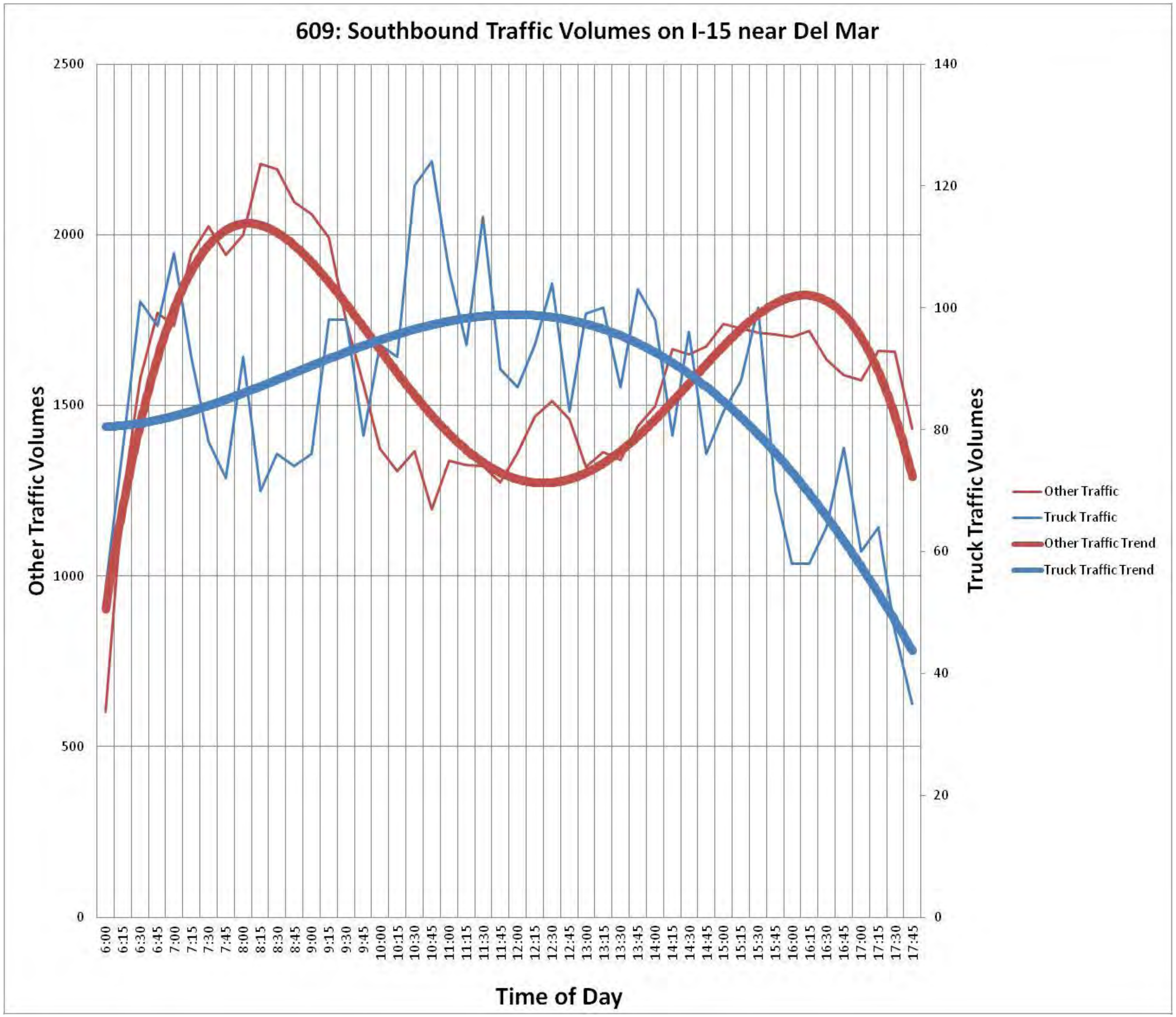
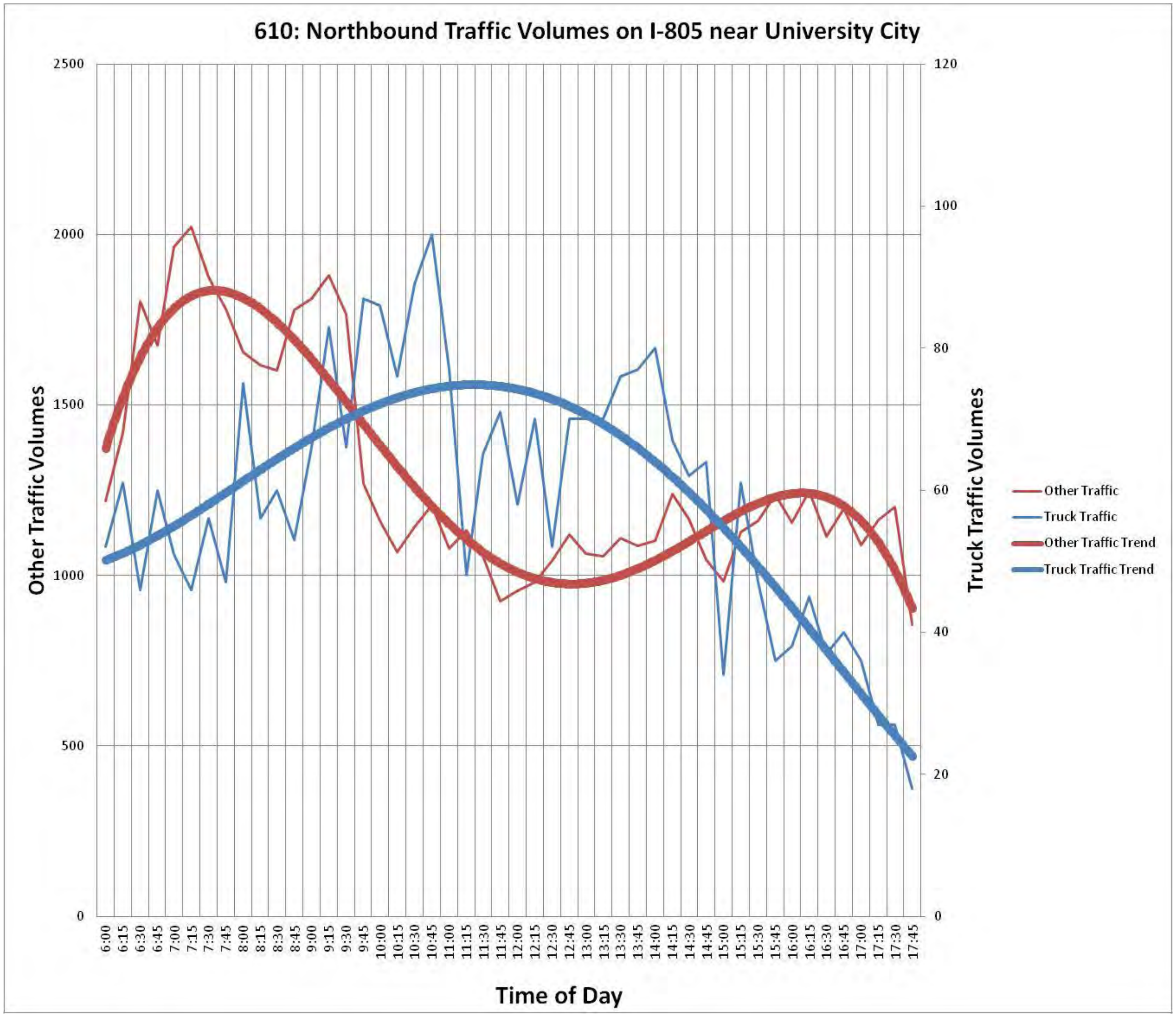
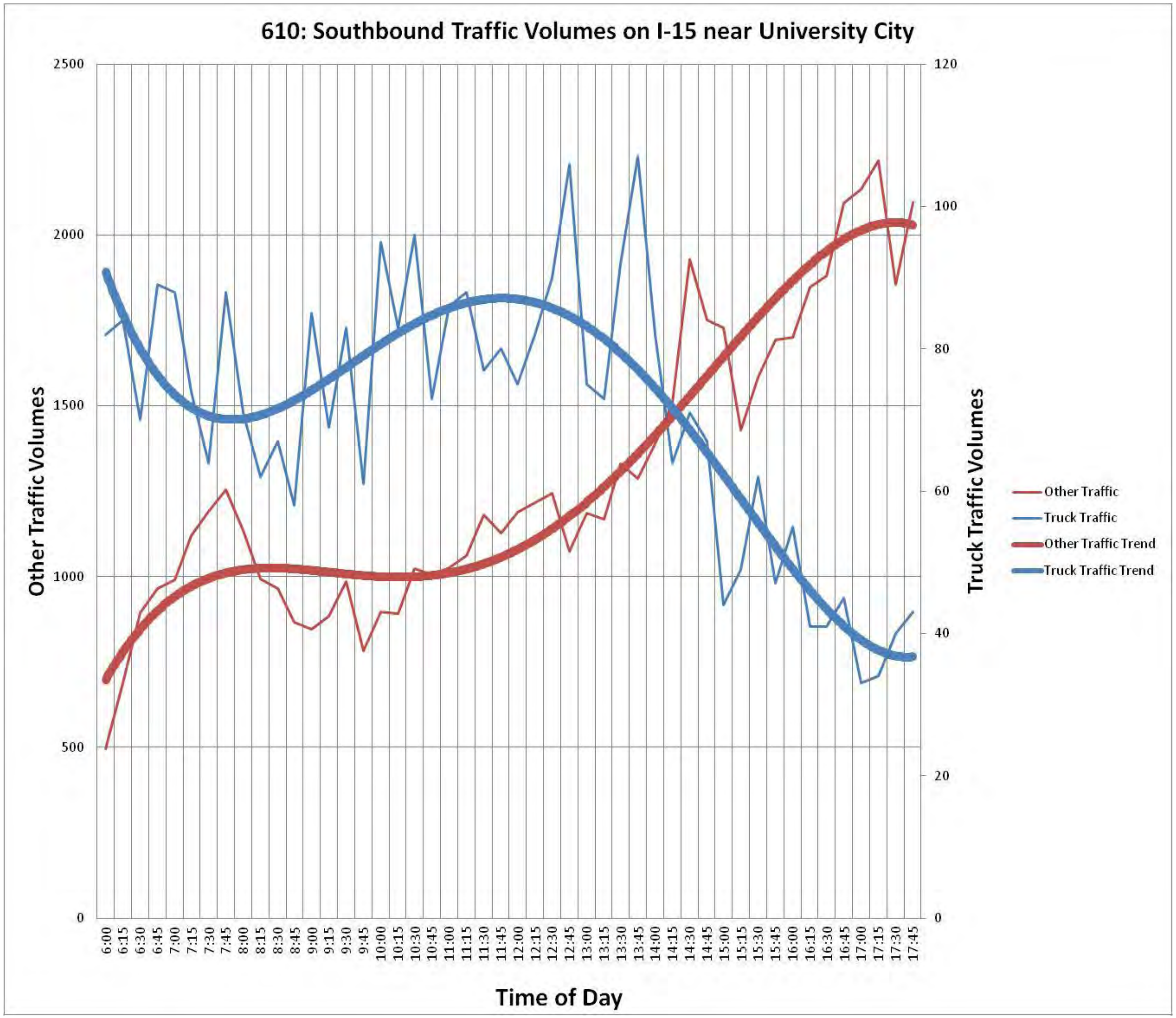
17:15
17:30
17:45



609: Southbound Traffic Volumes on I-15 near Del Mar
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



610: Northbound Traffic Volumes on I-805 near University City
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


610: Southbound Traffic Volumes on I-15 near University City
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
2500
2000
1500
1000
500
0
120
100
80
60
40
20
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
9:00
9:15
9:30
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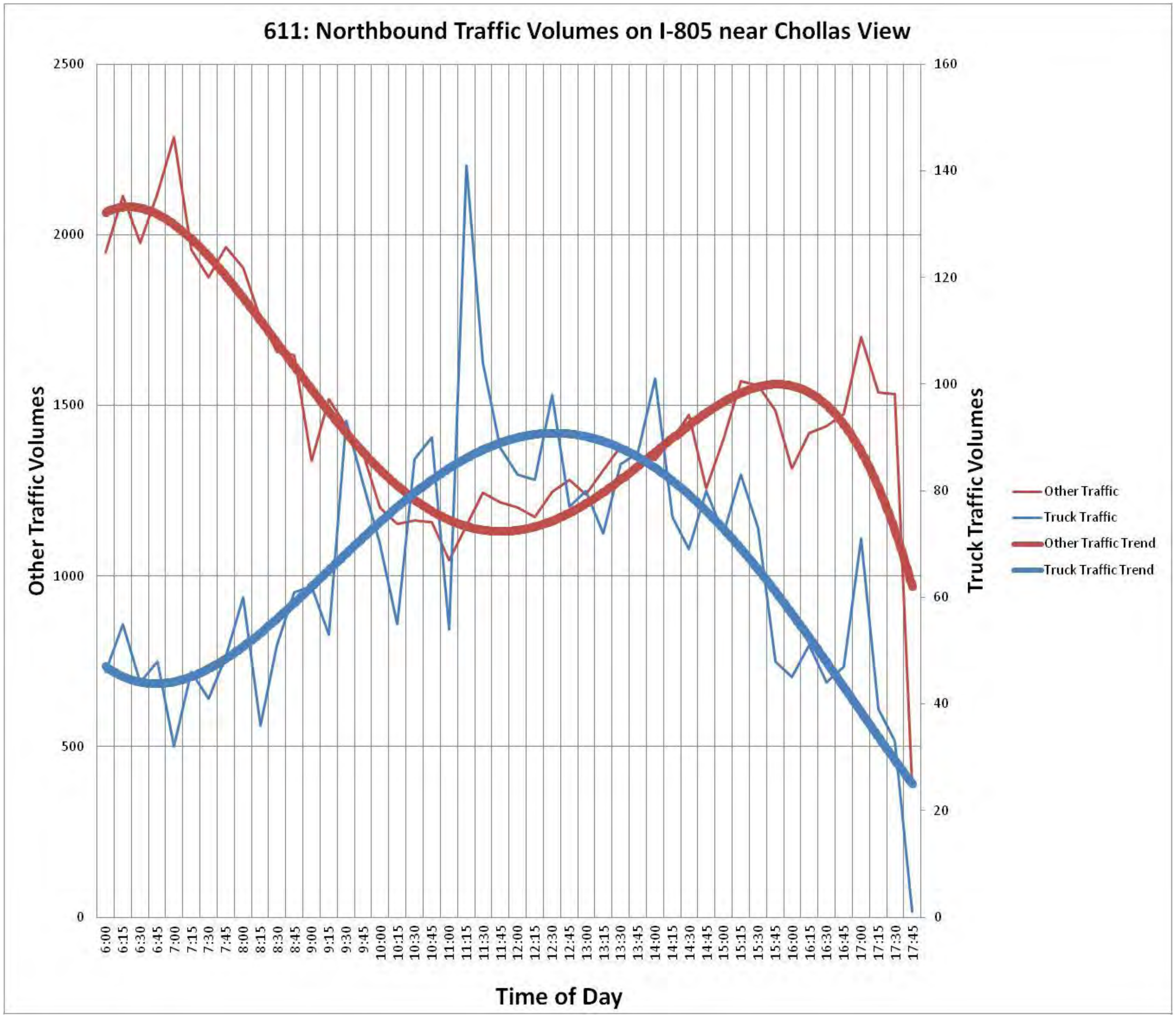
17:15
17:30
17:45


611: Northbound Traffic Volumes on I-805 near Chollas View
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
2500
2000
1500
1000
500
0
160
140
120
100
80
60
40
20
0
6:00
6:15
6:30
6:45
7:00
7:15
7:30
7:45
8:00
8:15
8:30
8:45
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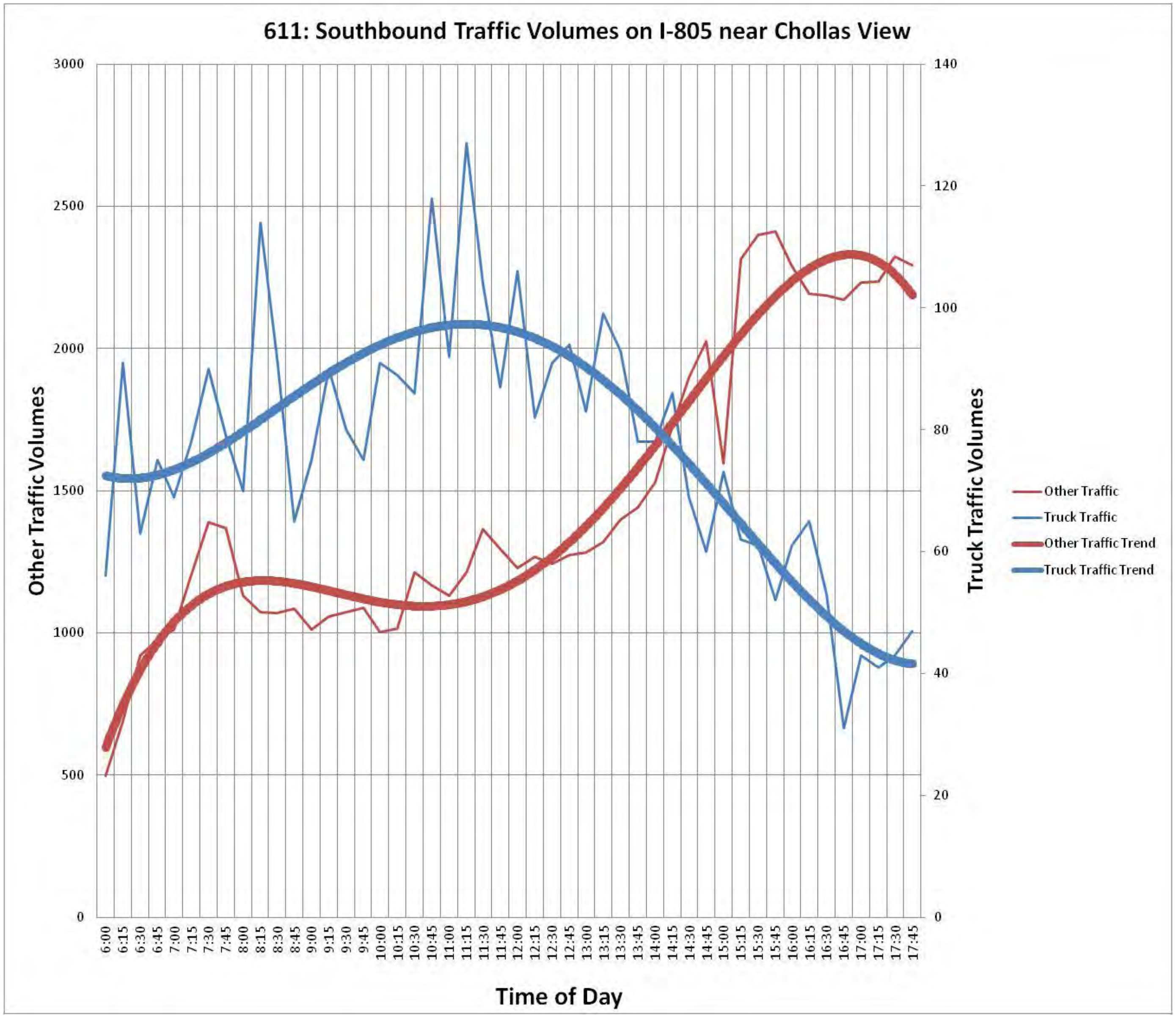
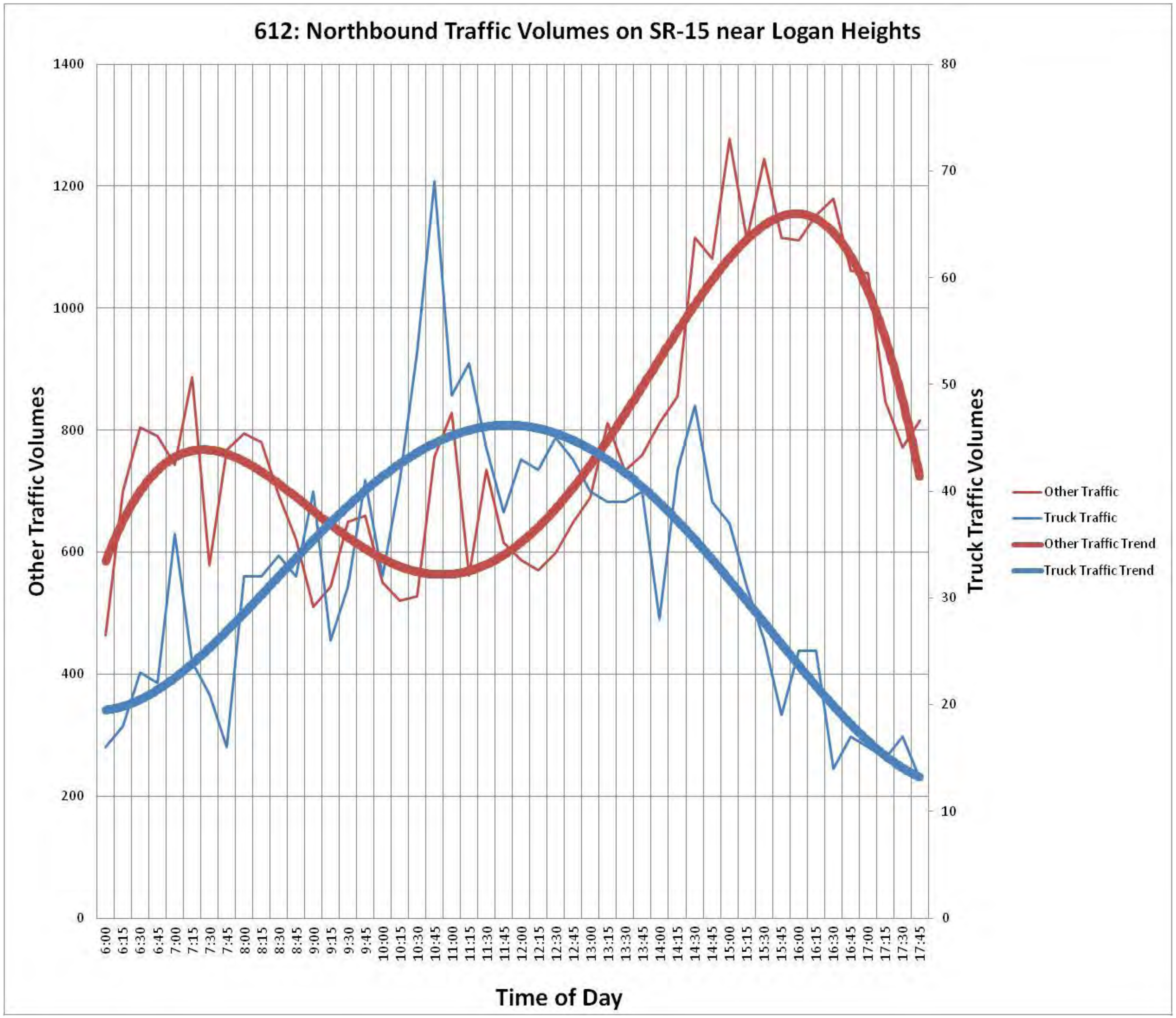
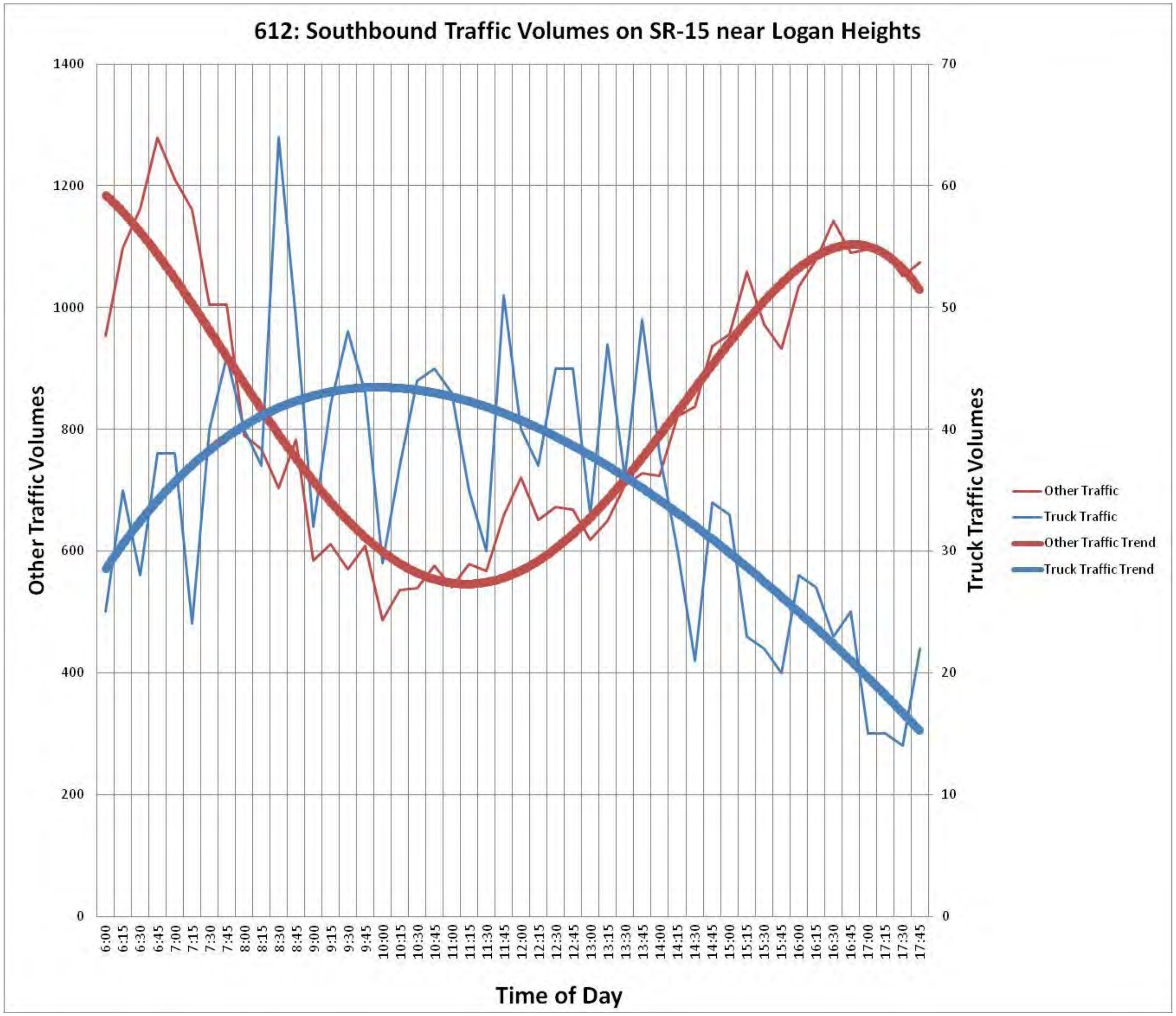
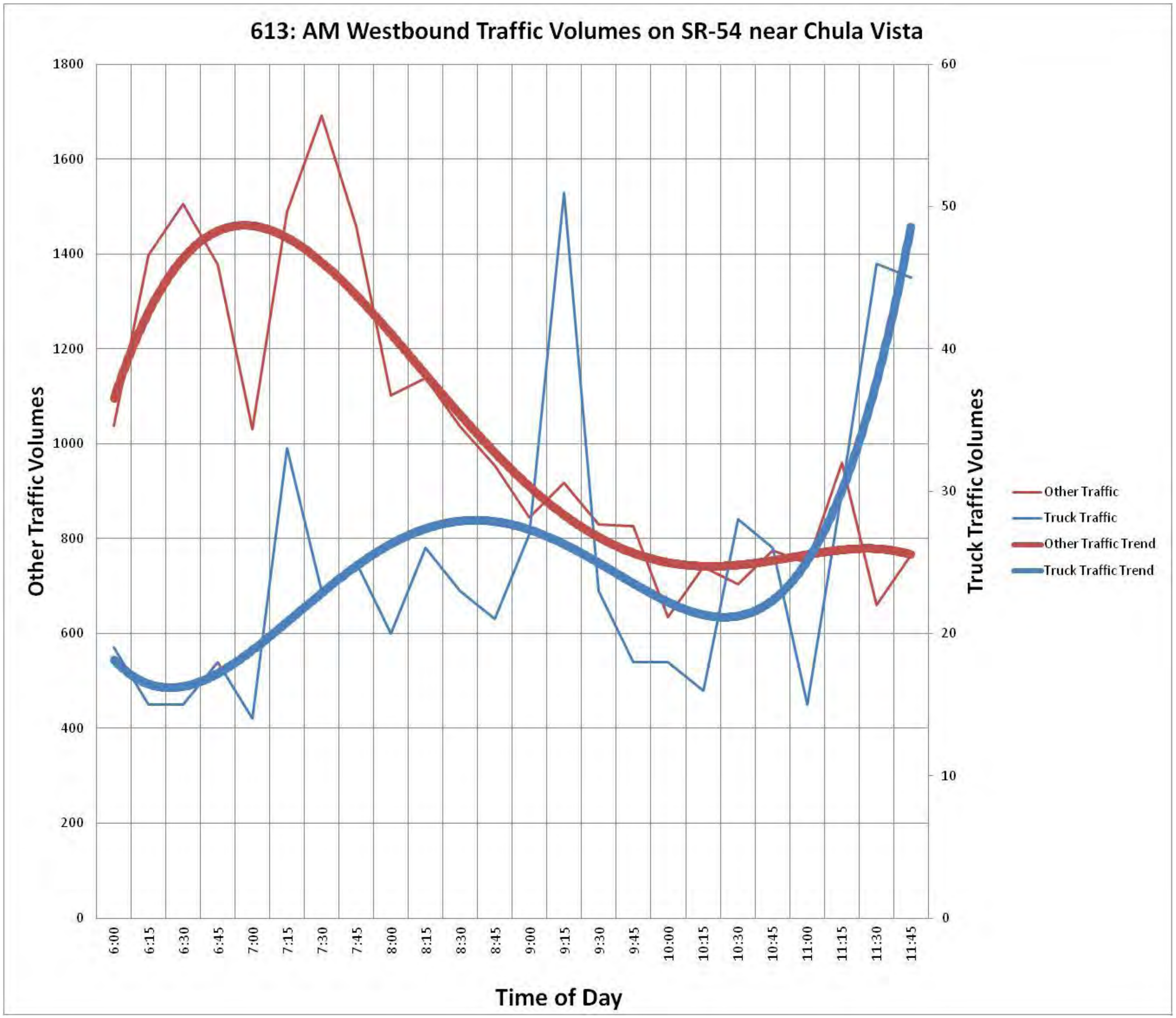

611: Southbound Traffic Volumes on I-805 near Chollas View
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

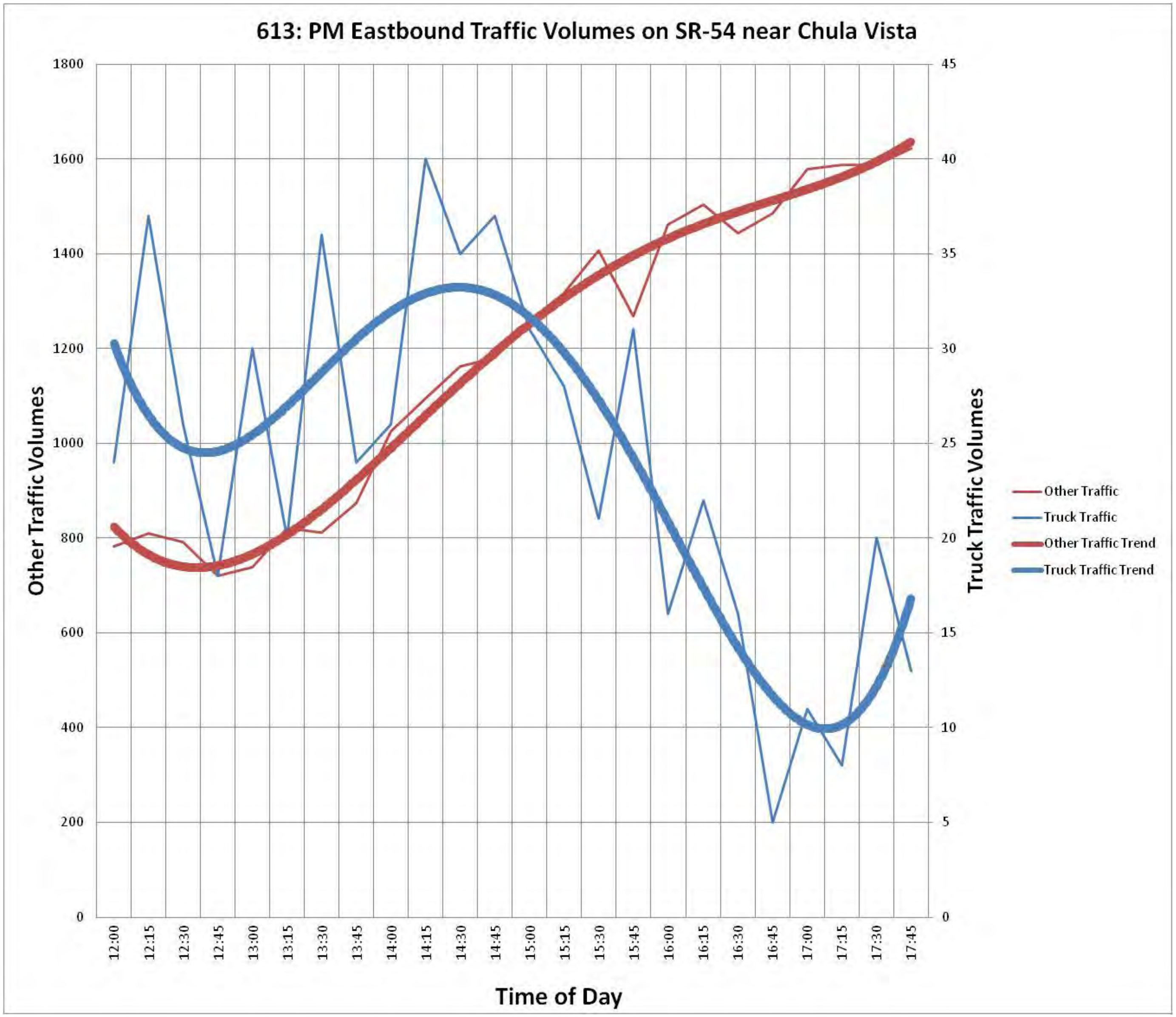

612: Northbound Traffic Volumes on SR-15 near Logan Heights
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



612: Southbound Traffic Volumes on SR-15 near Logan Heights
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend



613: AM Westbound Traffic Volumes on SR-54 near Chula Vista
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


613: PM Eastbound Traffic Volumes on SR-54 near Chula Vista
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
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1600
1800
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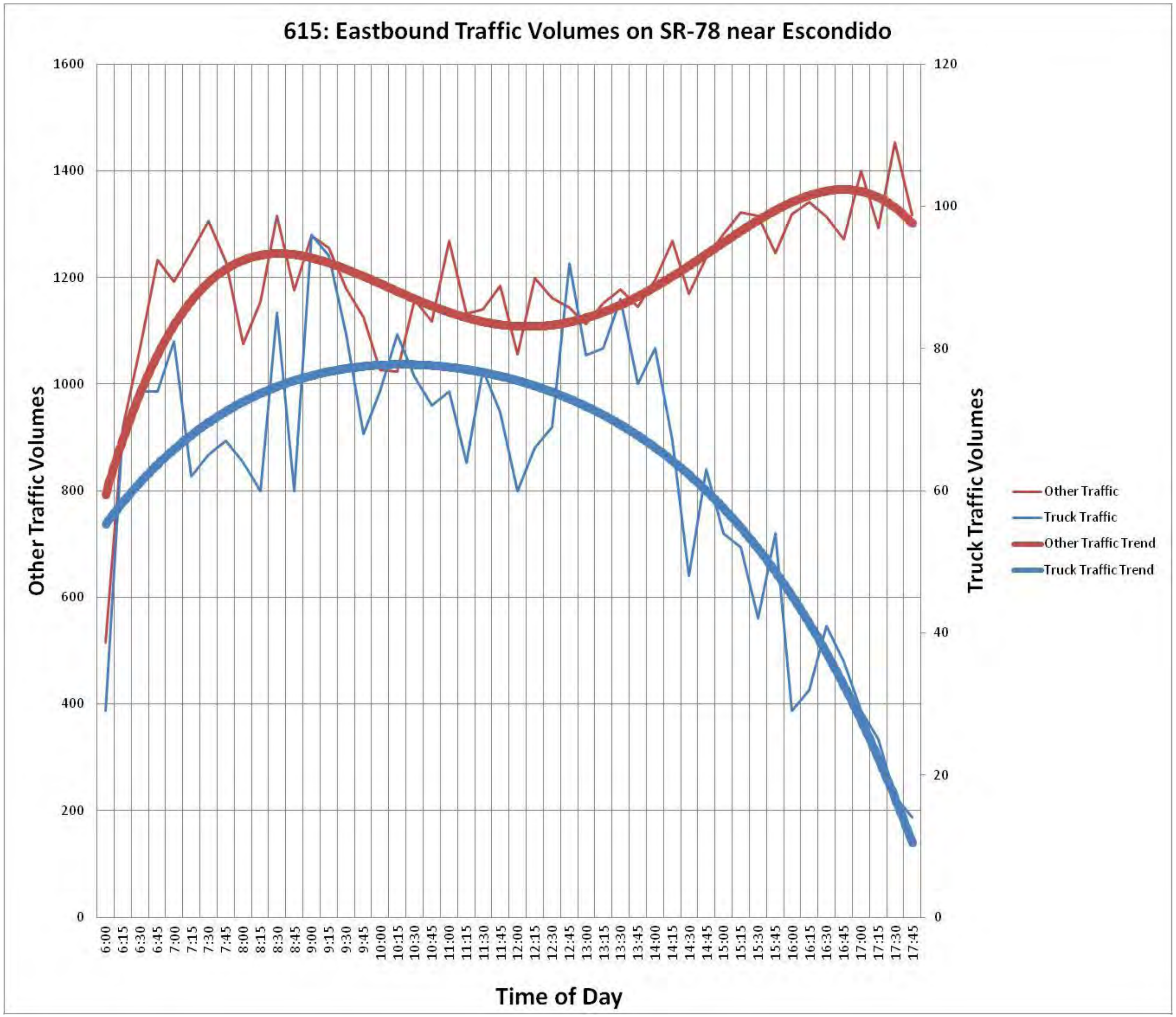
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


615: Eastbound Traffic Volumes on SR-78 near Escondido
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
1600
1400
1200
1000
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600
400
200
0
120
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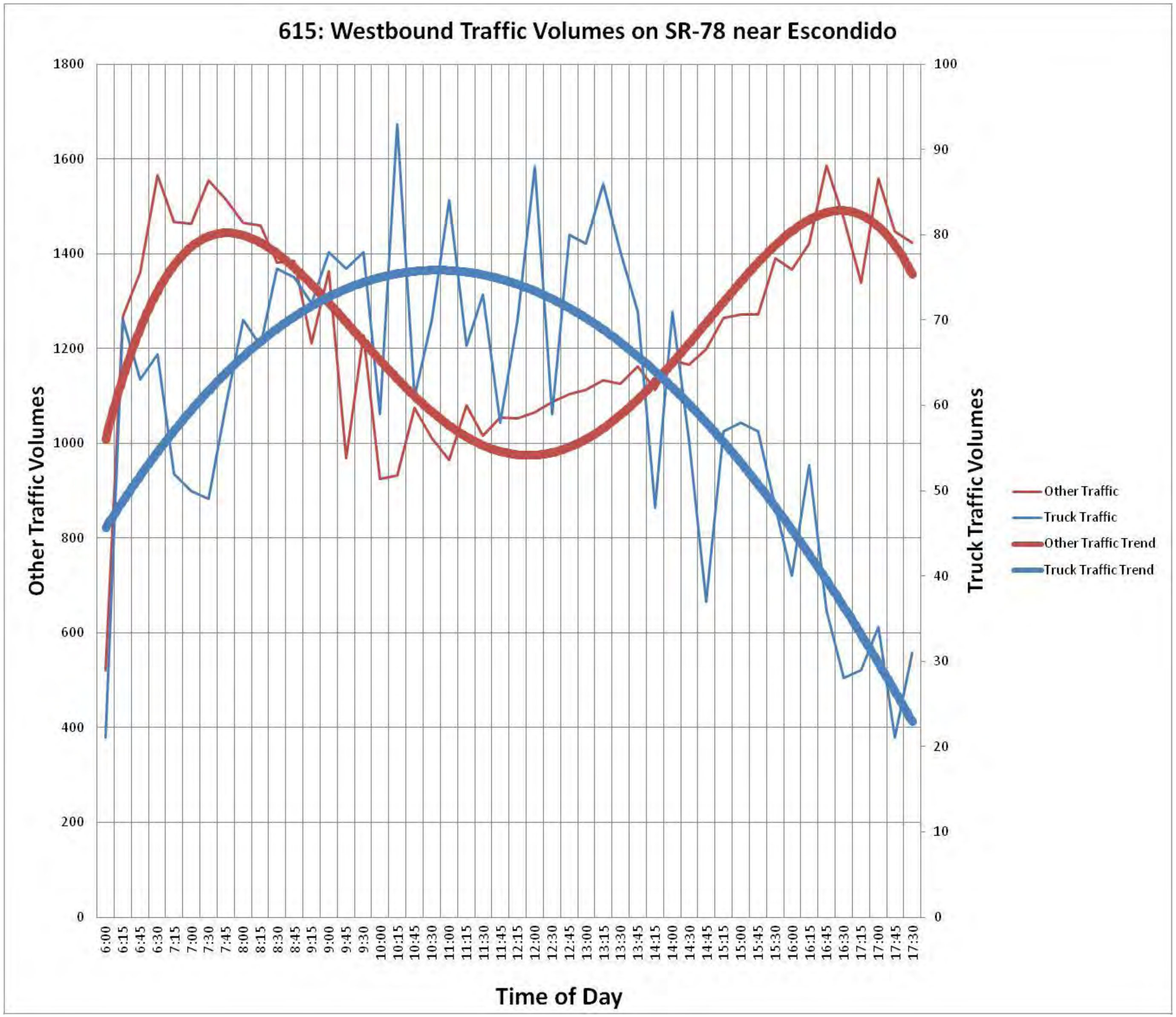

615: Westbound Traffic Volumes on SR-78 near Escondido
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
1800
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400
200
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Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

618: AM Southbound Traffic Volumes on SR-163 near Kearny Mesa
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
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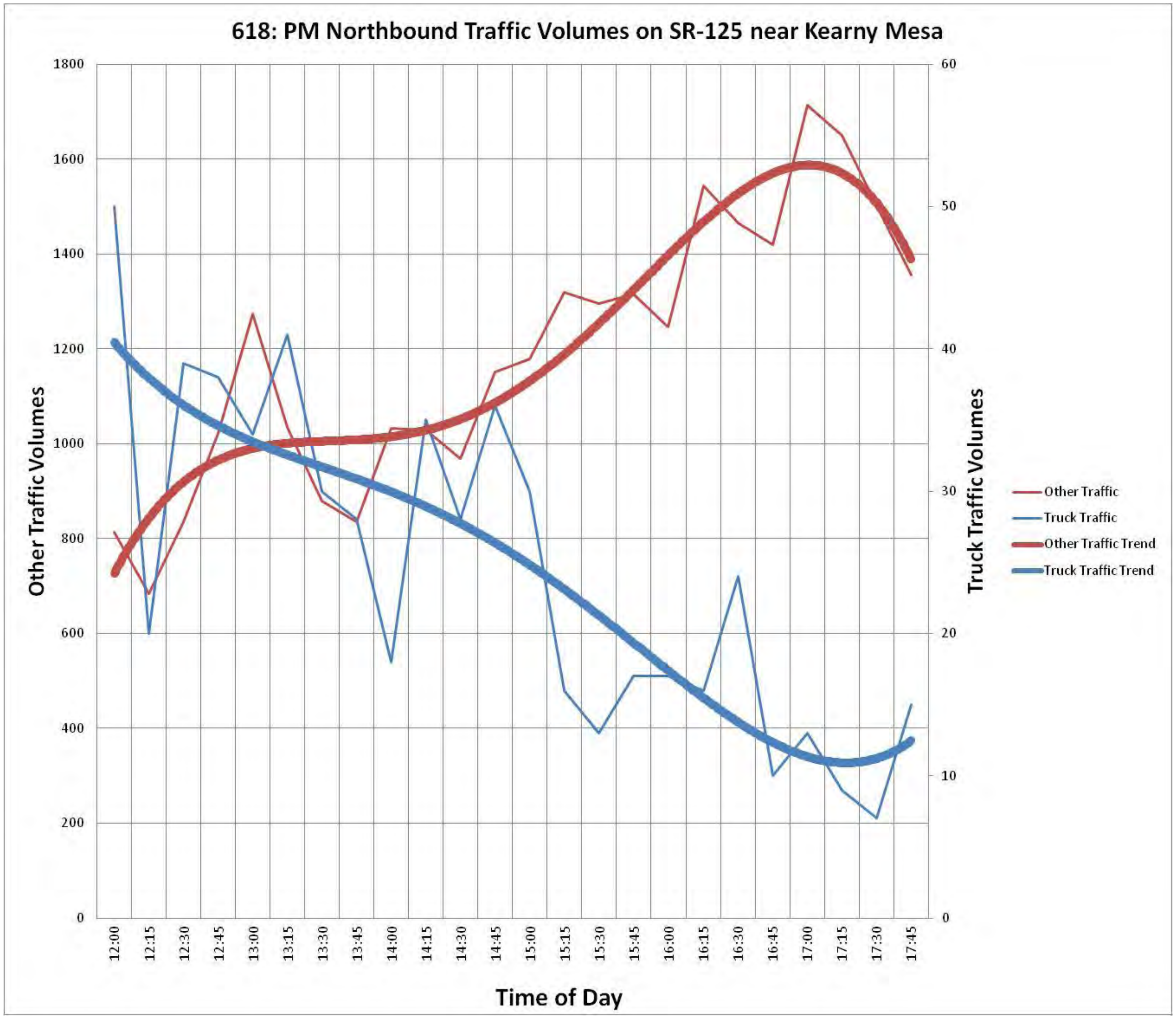
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


618: PM Northbound Traffic Volumes on SR-125 near Kearny Mesa
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
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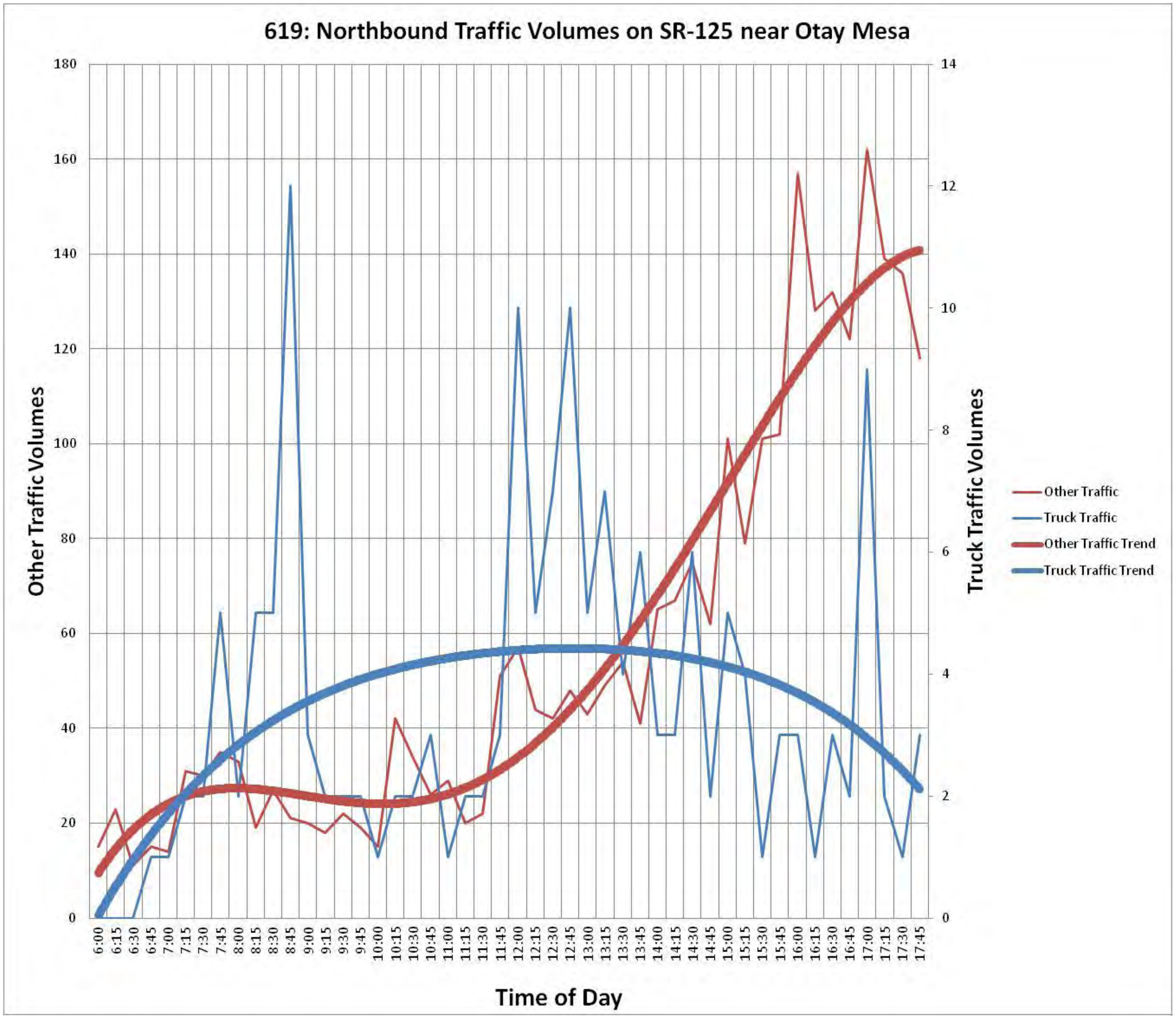
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend


619: Northbound Traffic Volumes on SR-125 near Otay Mesa
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend
180
160
140
120
100
80
60
40
20
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14
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10
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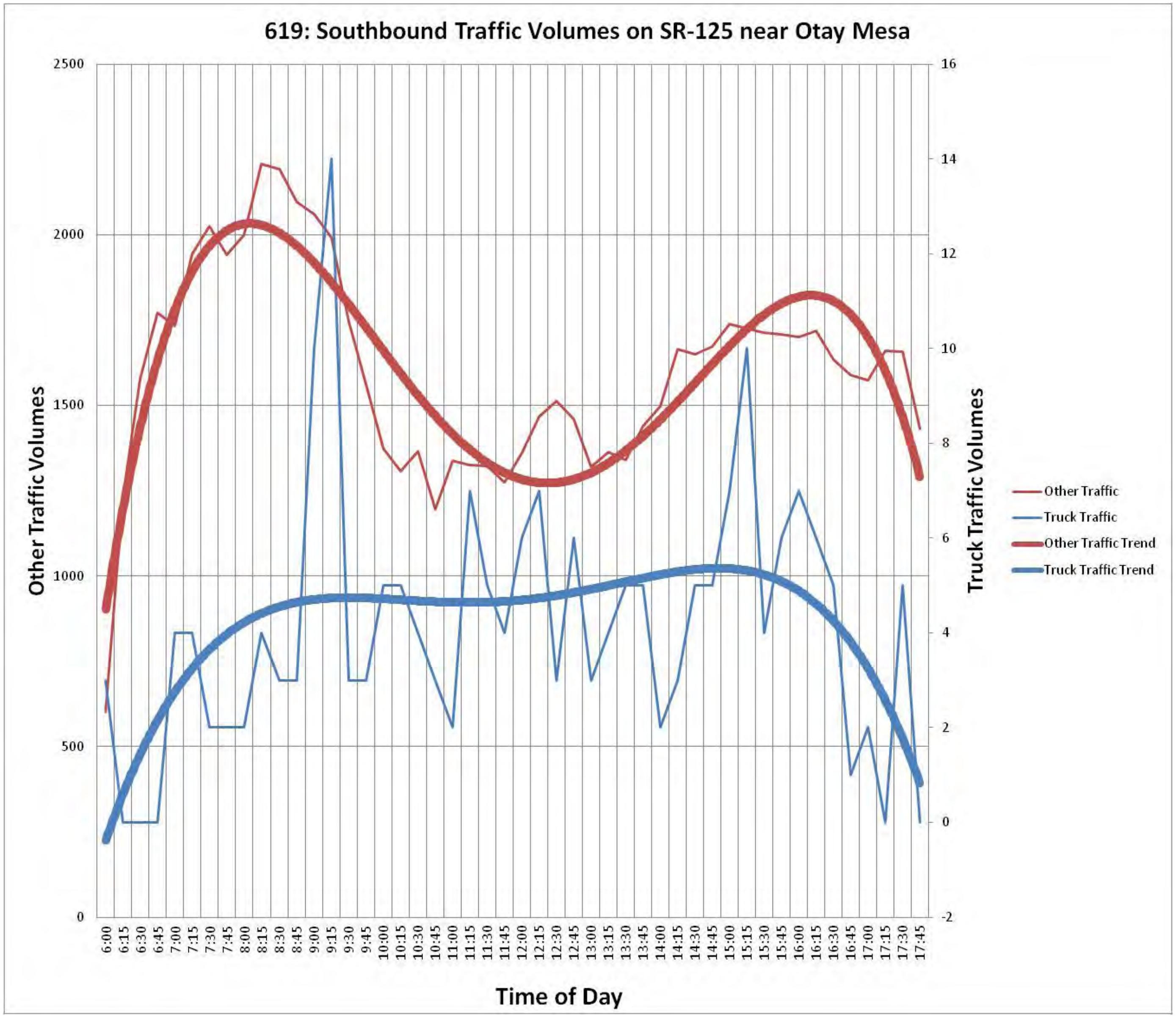

619: Southbound Traffic Volumes on SR-125 near Otay Mesa
Other Traffic Volumes
Truck Traffic Volumes
Time of Day
Other Traffic
Truck Traffic
Other Traffic Trend
Truck Traffic Trend

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Technical Memorandum #5: Strategy Analysis

CH2M HILL, IBI Group, Cheval Research

Draft September 20, 2013; Revised October 10, 2013; Final December 12, 2013

Table of Contents

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Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Technical Memorandum #5: Strategy Analysis

TO: Andrea Hoff and Christina Casgar, SANDAG

FROM: IBI Group, CH2M HILL, Cheval Research

DATE: Draft September 20, 2013; Revised October 10, 2013; Final December 12, 2013

This memorandum is the final technical memorandum for the Trucks on Managed Lanes Study. One additional deliverable will be prepared, which will consist of a White Paper designed to concisely summarize the key findings and recommendations from this Study. This memorandum builds on the previous deliverables prepared for this Study, which included a literature review on freeway truck management strategies (Technical Memorandum #1: Literature Review), a problem statement and issues identification memorandum (Technical Memorandum #2: Issue Identification), a truck management strategy development memorandum (Technical Memorandum #3: Strategy Development), Technical Memorandum #4: Data Collection (which included a review of local truck data and interviews with local trucking industry stakeholders), and a trucking data gaps memorandum. (Technical Memorandum #6: Data Needs Assessment).

The purpose of this memorandum is specifically to assess the strategies identified in Technical Memorandum #3: Strategy Development using the data collected and trucking industry stakeholder feedback collected as part of Technical Memorandum #4: Data Collection. The memorandum is organized as follows:

- **Section 1: Strategy Analysis Methodology Overview:** This section provides a brief summary of the three-tiered process used to assess the truck management strategies. More detailed information and documentation on the methodology are provided in Appendix A.
- **Section 2: Strategy Analysis Findings:** This section includes an assessment of each strategy, including trucking industry feedback and a discussion of the broad range of potential benefits and impacts associated with each strategy in the San Diego region. Key issue areas identified by community and industry stakeholders are included in the discussion.
- **Section 3: Potential Strategy Applicability throughout the Region**: This section provides a high-level description of the potential applicability of the truck management strategies to the region's key trucking corridors and gateways/distribution hubs. Potential timeframes for strategy implementation are also discussed.

- **Section 4: Corridor Scenarios:** This section provides a more detailed look at the potential applicability of the truck management strategies to two specific conceptual corridor locations, which include I-15 (from SR 163 to SR 78) and the Otay Mesa Border Area.
- **Appendix A: Detailed Strategy Analysis Documentation:** Appendix A provides in-depth information on the three-tiered process used to assess the truck management strategies.
- **Appendix B: Additional Industry Interview Feedback:** Appendix B provides documentation of the trucking industry interviews, including direct quotes and comments organized by strategy.
- **Appendix C: San Diego Managed Lane Network:** Appendix C provides a map of the planned managed lane network in the San Diego region through 2050 and provides a discussion of notable findings in relation to the potential for trucks on managed lanes.
- **Appendix D: I-15 DAR Truck Turning Exhibits:** Appendix D shows the results of turning radii tests conducted for standard truck lengths on two sample DARs along the I-15 conceptual corridor (as described in Section 4).

Overall, this memo is intended to serve as a framework for on-going and more detailed future analysis of operational strategies for trucks. The intent is for future corridor, managed lanes, freight, and regional transportation studies and improvement efforts to be able to utilize the results of this Study as background and guidance moving forward.

1. Strategy Analysis Methodology Overview

A three-tiered analysis approach was used to assess the truck management strategies, as described below:

1) Tier 1 - Preliminary Strategy Screening: Fatal Flaw Review
2) Tier 2 - Quantitative Strategy Analysis: Strategy Applicability Review
3) Tier 3 - Final Strategy Analysis: Performance Against Goals

The three tiers included a preliminary strategy screening/fatal flaw review (conducted as part of the strategy identification process), a review of strategy applicability to the San Diego region using local data, and a review of each strategy against the project goals and key issue areas. The three-tiered analysis methodology was developed by the project team with review and feedback from the Project Study Team (PST) and the Freight Stakeholder Working Group (FSWG).

Tier 1 - Preliminary Strategy Screening: Fatal Flaw Review

Tier 1 was the first level of screening and asked the question - were there any strategies that no longer made sense to move forward into the more detailed Tier 2 and Tier 3 analysis steps? Specifically, based on the project team's preliminary research and discussion with industry and stakeholders, were any of the strategies essentially "fatally flawed" for implementation in the San Diego region?

The results of the Tier 1 analysis lead to the following seven truck management strategies being carried forward for further consideration. Each strategy is described in further detail in Section 2: Strategy Analysis Findings.

1. Base Case Scenario (Current Regional Transportation Plan (RTP) Improvements)
2. Traffic Organizational Strategies at Freight Gateways and Distribution Hubs
3. Travel Demand Management (TDM) Strategies to be Developed with Truckers and Shippers/ Receivers
4. Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access)
5. Designated Truck Lanes: Construction of New Lanes on an Existing Facility (e.g. Truck By-pass Lanes, Routes, or Climbing Lanes)
6. Separate Dedicated Truck-Only Facilities (Construction of New Facilities)
7. Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment

Tier 2 - Quantitative Strategy Analysis: Strategy Applicability Review

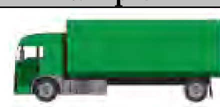
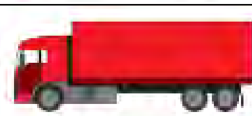
Tier 2 was the second level of screening and was designed to develop the remaining strategies in more detail with information on appropriate implementation timeframes (when), potential locations (where), and the potential truck types and truck trip types (who) that each strategy is best suited to serve. These categories are more fully described below:

- **When (timeframe)**: Is the strategy best suited for implementation in the short-term (0-10 years), medium-term (11 – 20 years), or long-term (21 years through to 2050)?
- **Where (locations):** What types of locations is the strategy best suited for? For example, what location characteristics (e.g. high truck volumes, steep grades, lane configurations, etc) is the strategy best suited to serve?
- **Who (truck characterization):** Who is the strategy best designed to serve (e.g. local, regional, or long-haul truck trips, or light-, medium-, or heavy-duty trucks)? For the purposes of this Study, local, regional, and long-haul trips are defined as follows and illustrated in Figure 1:
  - **Local:** Originates and terminates within San Diego County. (Shown in red.)
  - **Regional:** Originates or terminates in San Diego County, but travels to or from an adjacent location (including all bordering counties, Baja California/Mexico, or Los Angeles County). (Shown in blue.)
  - **Long-haul**: Originates or terminates in San Diego County, but travels outside the region (defined above); or both originates and terminates outside the region, traveling through San Diego County. (Shown in green.)

Figure 1: Local, Regional, and Long-Haul Truck Trips

For the purposes of this Study, truck types (light-, medium-, and heavy-duty) are defined and illustrated in Table 1. Note that this Study defines trucks to include trucks moving freight only; passenger trucks (e.g. pickup trucks) are not included.

Table 1: Truck Types

Category	Example	Description[a]
Light-duty		Smaller and lighter trucks (up to 14,000 lbs), with no more than 2 axles.
Medium-duty		Slightly bigger and heavier trucks (up to 33,000 lbs), with 3 to 4 axles.
Heavy-duty		The largest and heaviest trucks (over 33,000 lbs), with 5 or more axles.

The information gathered in the Tier II analysis was then compared to the results of the local data collection effort to identify the applicability of each strategy to the key trucking corridors and gateways/distribution hubs identified in Technical Memorandum #4: Data Collection (and illustrated in Figures 2 and 3 in Section 3 of this memorandum).

Tier 3 - Final Strategy Analysis: Performance Against Goals

Tier 3 was the final level of strategy analysis and was designed to comprehensively assess the truck management strategies against the goals of the project and key issue areas, as described in the Problem Statement and Technical Memorandum #2: Issues Identification. The analysis area categories included: goods movement, legislative considerations, industry support, broader community support, local economic development, environmental considerations, safety and operations, engineering considerations, and public sector financial considerations. Overall the assessment was conducted as a comparative analysis using qualitative and quantitative information (where available). The methodologies and assessment documentation for each tier of analysis are included in Appendix A. The overall results of the strategy analysis process are described in the Section 2: Strategy Analysis Findings discussion below.

2. Strategy Analysis Findings

This section provides an overview of each of the seven truck management strategies carried forward for more detailed analysis after the Tier 1 Fatal Flaw Review. For each strategy, the following is provided:

- a strategy overview
- key feedback on the strategy from the 17 trucking industry interviews conducted as part of this Study (described further in Technical Memorandum #4: Data Collection)
- a summary of the Tier 2 Analysis findings
- a summary of the Tier 3 Analysis findings, and
- a final overall summary of findings discussion.

Potential strategy applicability (locations and timeframes) throughout the region is provided in Section 3 and potential strategy applicability to the conceptual corridors is described in Section 4.

1. Base Case Scenario (Current RTP Improvements)

Strategy Overview

This scenario reflects what the future looks like for goods mobility in the region if no new actions are taken to address truck mobility (in addition to the improvements already identified in the currently adopted 2050 RTP). The costs and benefits of all other strategies are compared to the base case.

Trucking Industry Interview Perspective

The trucking industry interviewees reported that they continually monitor growth and trends in freight movement and declines in mobility both locally and throughout the larger Southern California region. Increases in international trade are anticipated by the interviewees and effects on seaports, airports, and international border commercial vehicle traffic are acknowledged to be significant. An awareness of the need to mitigate the increases in traffic volumes along the region's major trucking corridors to preserve mobility and control costs were expressed by the interviewees.

Tier 2 and Tier 3 Analysis Results

The base case scenario is unique since the Tier 2 and Tier 3 analyses are designed to compare the truck management strategies to the base case scenario. As such, the Tier 2 and Tier 3 analysis procedures were not applicable to the base case scenario.

Strategy #1 Base Case Scenario (Current RTP Improvements) - Summary of Findings

Truck volumes and truck traffic as a percentage of total traffic are projected to substantially increase through 2050. Multiple growing demands on the region's freeways (combined with limited capacity to shift goods to rail) will impair the efficient movement of trucks in the region. Without additional strategies to assist in maintaining and enhancing long-term truck mobility, the costs to the region of moving necessary goods will likely increase and regional competitiveness will suffer. For these reasons, the truck management strategies identified in this Study should be considered throughout the San Diego region, along freeway corridors and at trucking gateways and distribution hubs, to help facilitate the movement of trucks and ensure reliable goods movement in the coming decades.

2. Traffic Organizational Strategies at Freight Gateways & Distribution Hubs

Strategy Overview

This strategy includes coordinated strategies to optimize truck traffic flow at key locations. The strategies implemented could range from simple to more complex and include:

- Intelligent Transportation Systems (ITS)/communication strategies, such as the use of changeable message signs (CMS) and 511 (or similar) announcements to provide real-time information to truckers and help them avoid congestion and bottlenecks.
- Infrastructure-based strategies, such as dedicated trucks lanes or facilities in key bottleneck locations.

Trucking Industry Interview Perspective

A summary of the key trucking industry feedback is provided below. A compilation of direct quotes and comments from the trucking industry interviewees, in relation to this strategy, are provided in Appendix B.

Connections for truckers from higher volume and busy truck trip generation and termination points in San Diego are an essential part of the overall mobility requirement for industry interviewees. Interviewees indicated that resolving impediments to mobility along arterials and local roads (in key locations such as around the international border crossing, local seaports, the airport, Downtown San Diego, and manufacturing and industrial areas) would assist in maintaining operating efficiency (with respect to drivers and vehicles) and would help address environmental and safety factors. Interviewees expressed a variety of concerns according to the scope of their operations and many included their own ideas about possible solutions for their areas of greatest concern within the provided comments. Below are some examples of specific issues cited by interviewees:

- For truckers crossing the U.S.-Mexico border, local access roads and arterials connecting SR 905 to the northbound and southbound commercial vehicle crossings are congested by queues that form during high volume freight movement periods. Truckers indicated that the major problem for this area is that there are no designated truck routes to and from the border crossings. Truckers appreciate the continued planning to accommodate *future* freight volumes, but are most interested in solving the *existing* routing and infrastructure problems. Additionally, interviewees indicated that they rely on one another for non-recurring traffic incident and exceptional congestion information, but would appreciate a publicly available, timely, and accurate source of information to assist them in making advance routing and dispatch decisions.
- Truckers have mixed feelings about the usefulness of CMSs as a way to convey information on the highway. While some expressed support for this concept, others expressed concern that CMSs can slow traffic since drivers slow down to read the signs. Some interviewees also suggested that 511, radio announcements, dedicated radio stations, smart phone applications (apps) and navigation system messaging could serve as potential alternatives to on-highway signage.

Tier 2 and Tier 3 Analysis Results

The Tier 2 and Tier 3 analysis results for this strategy are described below. This information, combined with the local data collected and documented in Technical Memorandum #4: Data Collection, was used to help inform the high-level findings in Sections 3 and 4 of this memorandum.

Tier 2: Strategy Applicability

- **Timeframe:** Short-term (0 to 10 years); medium-term (11 to 20 years), and long-term (over 20 years). The communication based components of this strategy could be implemented in the short-term. The infrastructure based components of this strategy would best be implemented in the medium- to long-term.
- **Truck Types and Trip Types Best Served:** All. This strategy would serve all types of trucks (light-, medium-, and heavy-duty) and all truck trip types (local, regional, and long haul). While solutions at the border area would primarily serve regional and long haul trucks, solutions at the Port of San Diego, San Diego International Airport, and other industrial areas would also serve local trucks.

- **What Types of Locations are Best Suited for Implementation of this Strategy?** Trucking gateway/distribution hub locations that are experiencing truck queuing and delay, that are projected to grow substantially, and/or that are near sensitive adjacent land uses (e.g. residential neighborhoods). Example locations are provided in Tables 2 and 3 in Section 3: Potential Strategy Applicability throughout the Region.

Tier 3: Final Strategy Analysis

The following is a summary of the Tier 3 Final Strategy Analysis findings for each analysis area for Strategy #2: Traffic Organizational Strategies at Freight Gateways & Distribution Hubs. More detailed information and documentation regarding the final strategy analysis is included in Appendix A.

- **Goods Movement:** This strategy will help to improve truck mobility over the base case scenario, but the benefits would likely be localized to the area of improvement and may not meet longer-term truck mobility goals.
- **Legislative Considerations:** This strategy is consistent with federal, state, and local policies and would not require any legislative changes to be implemented.
- **Industry Support:** This strategy is generally supported by Port and trucking industry representatives. The truck mobility enhancements would likely enhance trucking industry profitability and benefit all truck types and trip types in some capacity, as noted in the Tier 2 discussion above.
- **Broader Community Support:** This strategy is generally expected to be non-controversial and supported by the broader community. Specifically, general acceptance is expected from other facility users (passenger vehicles and transit, etc), partner agencies, community stakeholders, political leaders, and adjacent residential and business owners. Specifically, improved truck routing at gateways and distribution hubs can help reduce neighborhood impacts and improve truck mobility, making this a win-win strategy for multiple stakeholder groups.
- **Local Economic Development:** This strategy is expected to benefit both local and regional economic development due to improvements in goods mobility, both across the border, and at local trucking gateways and distribution hubs.
- **Environmental Considerations:** This strategy should help to reduce criteria air pollutants and greenhouse gas emissions (GHG) due to the expected improvements in truck mobility (which would allow trucks to travel at more fuel-efficient travel speeds and reduce idle times in congestion).
- **Safety and Operations:** This strategy would help to improve safety and operations locally, where implemented, but would not likely address region-wide safety and operational issues, unless implemented in multiple locations across the region. Where implemented, truck travel times, truck travel time reliability, and some improvements to safety and trucking industry liability are expected (due to improved routing and reduced mixing with general traffic).
- **Engineering Considerations:** This strategy is generally implementable from an engineering perspective. While specific design issues would need to be handled on a

case by case basis, there are no major consistent engineering issues associated with the strategy that would be obstacles to implementation.

- **Public Sector Financial Considerations:** While this strategy would not generate revenue, overall the capital and operations and maintenance costs to implement the strategy are anticipated to be comparatively low, with fairly high associated local benefits.

Strategy #2 Traffic Organizational Strategies at Freight Gateways & Distribution Hubs - Summary of Findings

Overall this strategy has multiple benefits and low comparative costs, making it a "win-win" strategy for multiple stakeholders. While the benefits are smaller and more localized than some of the other more capital-intensive truck management strategies reviewed as a part of this Study, this strategy's ability to improve truck mobility, reduce delays, and route trucks more appropriately through the region's trucking gateways and distribution hubs makes it an easy "low-hanging fruit" strategy within the toolbox of truck management strategies available. This strategy is potentially applicable in multiple areas throughout the San Diego region, which is described further in Sections 3 and 4 of this memorandum.

3. Travel Demand Management (TDM) Strategies to be Developed with Truckers and Shippers/ Receivers.

Strategy Overview

This strategy involves working with shippers/receivers to facilitate the shifting of trucks to off-peak travel times through TDM strategies, potentially based on pricing incentives and fees. The focus is on shifting travel patterns rather than on capital investments.

Trucking Industry Interview Perspective

A summary of the key trucking industry feedback is provided below. A compilation of direct quotes and comments from the trucking industry interviewees, in relation to this strategy, are provided in Appendix B.

- Interviewees have unanimously indicated that their hours of operation for their vehicles are almost entirely subject to the operating schedules of the shippers and consignees (receivers) with whom they work. Shippers control when a load is ready to be picked-up. Consignees control when they are willing or able to receive a delivery. The trucker must then operate within these windows to convey the freight from its origin to its destination. However, interviewees also expressed that the complexity is not simply with the coordination of shippers and receivers, but also with regulatory agency compliance and inspection points that must be navigated along the way to the destination. This is a particularly intricate process for those crossing the international border where truckers must operate around the schedules of U.S. and Mexican customs authorities and the hours of operation of other law enforcement and regulatory agencies on both sides of the border.

- Some types of trucking operations already need to operate at night and must contend with municipal or community curfews that constrain loading and delivery times or truck operations along certain routes or within certain neighborhoods. These restrictions are typically an attempt to mitigate noise associated with nighttime warehouse or delivery operations. Interviewees indicated that the trend toward co-location of housing and business and industrial work centers and mixed-use commercial and residential buildings will continue to be a problem for businesses which depend on early morning and late night deliveries of products.
- In the comments included in Appendix B, interviewees also provided examples of where mandates for changes in operating schedules have been successful, but have also created new challenges. Among the challenges are increased costs for shippers and receivers that will require additional labor, supervision, equipment, and energy to extend their operating hours. For truckers, although equipment can be used around the clock, drivers must adhere to hours of service regulations, thus requiring additional drivers for added shifts.

Overall, truckers indicated that mandated changes will most likely be required to implement a travel demand management strategy for trucks.

Tier 2 and Tier 3 Analysis Results

The Tier 2 and Tier 3 analysis results for this strategy are described below. This information, combined with the local data collected and documented in Technical Memorandum #4: Data Collection, was used to help inform the high-level findings in Sections 3 and 4 of this memorandum.

Tier 2: Strategy Applicability

- **Timeframe:** Short-term (0 to 10 years). Due to its low relative cost and high potential benefits, this strategy would best be implemented in the short-term, prior to investing in more costly, complex strategies.
- **Truck Types and Trip Types Best Served**. All. While this strategy would potentially serve all types of trucks (light-, medium-, and heavy-duty) and all truck trip types (local, regional, and long haul), it would best serve local trucks, which are most likely to be making local deliveries and pickups.
- **What Types of Locations are Best Suited for Implementation of this Strategy?** This strategy would best be implemented in trucking gateways or distribution centers that are also near congested freeway corridors. The congested freeway corridors should have auto and truck traffic peaking at the same time and the locations of the shippers/receivers should be associated with the truck-related congestion.

Tier 3: Final Strategy Analysis

The following is a summary of the Tier 3 Final Strategy Analysis findings for each analysis area for Strategy #3: TDM Strategies to be developed with Truckers and Shippers/ Receivers. More detailed information and documentation regarding the final strategy analysis is included in Appendix A.

- **Goods Movement:** While this strategy has the potential to somewhat enhance truck mobility over the base case scenario, its primary function is to improve mobility for all travelers within a corridor (improving truck mobility is not necessarily the primary function). Truck mobility benefits would be localized to the area where the strategy is being implemented.
- **Legislative Considerations:** While this strategy is generally consistent with federal, state and local policies, some local polices may need to be changed in order to implement the strategy on a case-by-case basis. For example, if working to shift truck travel to different routes or to off-peak travel times that are later at night, any relevant local noise curfews or truck routing restrictions may need to be revised.
- **Industry Support:** This strategy is generally expected to be supported by the trucking industry, though it may be less acceptable to shippers/receivers due to challenges extending their operating hours due to overtime issues for union crews. While truckers may also initially perceive issues with working off-peak hours, benefits related to being able to make more trips with fewer drivers & equipment (due to expanded receiving hours) may offset this issue. If attempting to shift all truck types to later, off-peak hours, parking layover facilities could benefit long-haul trucks.
- **Broader Community Support:** This strategy is expected to be supported by the broader community, including other facility users, since it would help to shift truck-traffic to off-peak travel periods. Some localized opposition could occur if the strategy results in curfews being lifted and trucks are traveling through communities at night (though support for reduced truck volumes on adjacent freeways during peak-hours could help offset this).
- **Local Economic Development:** This strategy is expected to be somewhat neutral in regards to impacts to local economic development. Tradeoffs could occur between cost increases for shippers/receivers and cost savings for truckers. Additionally, changing shipping/receiving hours could affect the hours the border operates, (which would require California Border Patrol hours to change and also potentially mitigate some truck queuing issues).
- **Environmental Considerations:** This strategy is generally expected to reduce GHG emissions and criteria air pollutants. The extent of the benefit will depend upon the extent to which the strategy allows both trucks and passenger vehicles to travel at more fuel-efficient speeds and reduce their idle times in congestion.
- **Safety and Operations:** This strategy is generally expected to have positive operational benefits (improved travel times and travel time reliability for trucks and all facility users). Safety would also be improved to the extent that a greater level of isolation is achieved between passenger vehicles and trucks. However, there would

also be some potential safety risks born by the private industry to the extent that they increase nighttime operations.

- **Engineering Considerations:** This strategy would not involve any physical improvements (other than some potential signage), so engineering considerations are not anticipated to be an issue.
- **Public Sector Financial Considerations:** This strategy would involve very low public sector expenditures, with the potential for medium to high public benefits. The public sector would primarily play a coordination and policy role and minimal, if any, capital investments would be required. Revenue generation potential is minimal, though the strategy could potentially involve fees relating to TDM compliance for shippers/receivers.

Strategy #3 Travel Demand Management (TDM) Strategies to be Developed with Truckers and Shippers/ Receivers - Summary of Findings

While this strategy performs relatively well on many of the Tier 3 analysis categories, the results of the Tier 2 analysis and data collection effort reveals that there are not many locations throughout the San Diego region where the required conditions for implementation are present. Specifically, it was found that locations with trucking distribution hubs and gateways adjacent to congested freeway corridors are not typically experiencing peak truck and auto traffic at the same time (as documented in Technical Memorandum #4: Data Collection). This finding was supported by industry feedback that noted that trucks often already travel during off-peak hours when they can. However, while current conditions do not merit implementation of this strategy in the short-term; it is generally recommended that this strategy remain in the region's truck management strategy toolbox for consideration in the future, if local conditions change.

4. Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access).

Strategy Overview

This strategy would allow trucks on high occupancy vehicle (HOV)/high occupancy toll (HOT) lanes. However, truck access would be restricted to off-peak periods, off-peak directions, assigned to certain lanes, or certain truck types. Options for restricting access include:

- Off-peak use only (restrict truck access to off-peak periods).
- Non-peak direction of travel only (such as away from major employment centers in the AM peak, or towards major employment centers in the PM peak).

- Lane restrictions (trucks restricted to certain lanes in the HOV/HOT system when more than one lane is available). This could potentially involve the use of moveable barriers (such as on I-15) to allow for the use of trucks to use managed lane facilities during peak periods in the peak direction of travel.
- Restrictions by type, size, or weight of truck. For example, certain light-duty trucks could be allowed to use the lanes, while larger trucks remain restricted.

Tolling options could include non-tolled, a flat toll, or a variable toll (based on time-of-day or travel speeds, etc).

Flexible managed lane facilities could be made available with a prioritized hierarchy that reflects regional, state, and/or federal policy. As examples:

- Designating managed lanes for exclusive use by trucks may be too limiting at certain times and in certain locations, where flexible applications would yield greater overall benefits.
- During off-peak or non-commuting periods, pricing policies might allow or encourage lane availability to trucks (possibly at no charge) to induce truck traffic away from less desirable routes.
- Fees for truck access could be charged if there is a travel time advantage over other travel lanes and there are no attractive alternate routes.

Trucking Industry Interview Perspective

A summary of the key trucking industry feedback is provided below. A compilation of direct quotes and comments from the trucking industry interviewees, in relation to this strategy, are provided in Appendix B.

- Interviewees had both positive and negative reactions to this strategy depending on the type of trucking operation they represented and their personal experience with HOV/HOT facilities. Primary concerns included the method of access to the HOV lanes, mixing of trucks and passenger vehicles, the size of the trucks acceptable for travel in the lanes, and the number of lanes that would be available on the facility.
- Many interviewees indicated that they did not want their larger trucks crossing many lanes of traffic to enter or exit the HOV lanes. This concern was primarily directed toward tractor-trailers (5-axle articulated vehicles). There was also concern about roadway geometry at entrances and exits, and HOV/HOT facility termination at the number one (left most) lane of the freeway, where larger trucks would have to contend with a lengthy merge back to the right hand lane.
- Interviewees also expressed concerns about the speed differential between faster passenger vehicles and slower large trucks, particularly on steep grades where climbing trucks slow down even further. Interviewees typically agreed that small and medium sized "bobtail" trucks would be good candidates for HOV/HOT lane use under existing and currently envisioned future facility configurations.
- Finally, some interviewees expressed concerns about possible increase in cost of operations for either a second driver or tolls. However, one interviewee,

representing a major parcel carrier, indicated that they would much rather pay a toll for a reliable travel time than risk a service failure. Overall, interviewees indicated that benefits may accrue if there are improvements in mobility during peak hours of operation and if safety concerns are addressed.

Tier 2 and Tier 3 Analysis Results

The Tier 2 and Tier 3 analysis results for this strategy are described below. This information, combined with the local data collected and documented in Technical Memorandum #4: Data Collection, was used to help inform the high-level findings in Sections 3 and 4 of this memorandum.

Tier 2: Strategy Applicability

- **Timeframe:** Medium-term (11 to 20 years) to long-term (over 20 years). Due to the high cost and phasing requirements of constructing the planned network of managed lanes throughout the region, this strategy is best designed to alleviate truck-related congestion in the medium- to long-term.
- **Truck Types and Trip Types Best Served**: All. However, light- and medium-duty trucks are likely to benefit more than heavy-duty trucks. Benefits to different truck types would depend on the specific restrictions implemented. Long stretches of managed lanes could also benefit regional and long-haul truck trip types.
- **What Types of Locations are Best Suited for Implementation of this Strategy?** This strategy would best be implemented along freeway corridors with two or more managed lanes per direction and Direct Access Ramps (DARs). Corridors in close proximity to airports, seaports, and other trucking gateways and distribution hubs are also good candidates. Example locations are provided in Tables 2 and 3 in Section 3: Potential Strategy Applicability throughout the Region.

Tier 3: Final Strategy Analysis

The following is a summary of the Tier 3 Final Strategy Analysis findings for each analysis area for Strategy #4: Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access). More detailed information and documentation regarding the final strategy analysis is included in Appendix A.

- **Goods Movement:** This strategy has the potential to directly improve truck mobility over the base case scenario by permitting certain types of trucks to use the managed lanes. Truck mobility benefits will vary depending upon the types of restrictions in place.
- **Legislative Considerations:** Currently, trucks with three or more axles are restricted to speed limits of 55 mph and the right most freeway lanes (Sections 21645 and 22406 of the California Vehicle Code). Additionally, the California Highway Patrol prohibits HOT lanes from being used by vehicles restricted to a 55 MPH speed limit. This legislative framework means that various legislative changes would be required to implement this strategy, depending upon the restrictions in place. The least amount of legislative change would be required to permit light-duty trucks to use the managed lanes. Since trucks with two axles are not restricted to 55 mph and are

already permitted to use the managed lanes, the only change that would be required would be to remove the occupancy restrictions to allow light-duty trucks to use the lanes without having two or more occupants or paying a toll. A more robust level of legislative change would be required to allow medium- and/or heavy-duty trucks onto the managed lanes. Specifically, the California Vehicle Code would need to be amended to permit trucks with three or more axles to use the lanes. Currently, Section 21655 of the California Vehicle Code (CVC) specifies that any vehicle subject to the provisions of Section 22406 "shall be driven in the right-hand lane for traffic or as close as practicable to the right edge or curb . . . (when a specific lane or lanes have not been designated)". This latter phrase indicates that there may be room for interpretation within the existing CVC to allow medium- and/or heavy-duty trucks onto managed lanes, if they are designated for such use. Federal legislation that guides the use and operation of HOV/HOT lanes is currently silent on the issue of trucks. However, U.S.C. Title 23, Section 166 requires state agencies to monitor HOV lane performance if high occupancy toll vehicles or low emission vehicles are allowed to use the lanes and to take action to improve lane operations if the average operating speed falls below minimum requirements[1]. Further study and legal consultation would be required to determine the feasibility of implementing this strategy from a legislative standpoint.

- **Industry Support:** The trucking industry is generally supportive of this concept due to the improved mobility benefits, though safety concerns related to ingress/egress and merging/weaving were expressed during the trucking industry interviews. The level of trucking industry acceptance is highest for options that are un-tolled.
- **Broader Community Support:** This strategy is anticipated to receive broader community support than allowing trucks full, un-restricted access to the managed lanes. However, some concerns will remain and are anticipated to include safety and operational flow concerns from other facility users (due to ingress/egress and merging/weaving issues), as well as potential concerns related to increases in truck traffic near DARs from surrounding communities.
- **Local Economic Development:** This strategy would enhance local economic development due to the associated improvements to truck mobility, both locally, regionally, and for freeway corridors that connect to the border.
- **Environmental Considerations:** This strategy is expected to generally reduce GHG emissions and criteria air pollutants by allowing both trucks and passenger vehicles to travel at more fuel-efficient speeds (45 to 55 mph) and by reducing idling in congested conditions. While improved traffic flow could potentially induce additional travel over time and offset some of the emission reductions, strategies that improve traffic flow are typically considered to provide net overall positive GHG benefits, particularly those that improve travel times through improved system operational efficiency rather than capacity expansion[2]. However, the question of induced demand is complex and further study would be needed to assess impacts to short- and long-term emissions reductions from the strategy.

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[1] U.S.C. Title 23, Section 166 – HOV Facilities

[2] Transportation's Role in Reducing U.S. Greenhouse Gas Emissions – Volume 1: Synthesis Report", Report to Congress, US Department of Transportation, April 2010.

- **Safety and Operations:** Safety issues associated with this strategy are related to concerns with trucks accessing the managed lanes. To minimize the need for merging across multiple lanes, medium- and heavy-duty trucks should enter and exit the managed lanes via the DARs only. Light-duty trucks with two axles that are not restricted to the 55 mph speed limit would be the only types of trucks allowed to access the managed lanes via the Intermediate Access Points (IAPs). Traffic flow is generally expected to improve, due to a greater degree of isolation between trucks and passenger vehicles in the general purpose lanes. Traffic flow in the managed lanes is generally expected to remain consistent (with minimal to no difficulty in maintaining the required speed of 45 mph), so long as trucks are permitted on managed lanes only in locations where there are two or more managed lanes in each direction. This will allow for passing and emergency access, as needed.
- **Engineering Considerations:** This strategy is generally implementable from an engineering perspective, though the number of managed lanes, presence of shoulders, and presence of DARs will determine feasibility on a case-by-case basis. Additional considerations include the pavement index of the managed lanes and the turning radii of the existing DARs.
- **Public Sector Financial Considerations:** Since the region's managed lane network is already programmed, the capital and operations and maintenance costs of this strategy are likely to be primarily related to signage, truck routing to and from the DARs, and public education. The strategy is likely to be cost effective since these costs will likely be off-set by the benefits to mobility that would accrue. Additionally, while potentially unpopular with the trucking industry, revenue potential could exist if SOV trucks are tolled similarly to SOV passenger vehicles. However, this would be a regional policy decision and would need to take into consideration regional priorities and the options available to both freight and passengers for switching to other modes of travel.

Strategy #4 Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access) - Summary of Findings

This strategy has the potential to capitalize on the region's investment in a managed lanes network by allowing trucks to utilize the managed lanes under certain conditions. This is prudent for the region to consider given the projected increase in truck volumes, the critical role trucks play in goods movement and the regional economy, and the limited potential to shift goods movement to rail and other non-freeway based modes.

To be effective, this strategy is recommended only along corridors with two managed lanes in each direction (to allow for passing), and only light-duty trucks with no more than two axles should be allowed to access the lanes via the IAPs. Trucks with three or more axles should be required to use the DARs to address safety and traffic operational concerns related to truck merging/weaving across multiple lanes of traffic.

Additional options for implementation include removing occupancy restrictions for trucks in the managed lanes and either providing a reduced toll or eliminating the toll to use the lanes. Options to allow trucks to use the lanes during certain times of day or in certain directions also exist. Engineering considerations should be considered on a case-by-case basis, but generally include pavement index considerations and the ability of trucks to make turns onto the DARs. This strategy was considered on the I-15 corridor to determine how it would function in a real world scenario. A full description of this case study can be found in Section 4: Corridor Scenarios.

5. Designated Truck Lanes: Construction of New Lanes on an Existing Facility (e.g. Truck By-pass Lanes, Routes, or Climbing Lanes).

Strategy Overview

This strategy would include the construction of new lanes designated for trucks on an existing facility. Trucks would be required to use the designated lanes; autos could either be permitted or restricted from using the lanes. Tolling options could include non-tolled, a flat toll, or a variable toll. If tolled, the use of the lanes could be made voluntary by continuing to allow trucks non-tolled access to the general purpose lanes.

Designated truck lanes may be separated by barriers or rumble strips to improve safety, and can be built to withstand greater vehicle weights. The intent of designated truck lanes is to attract the trucking industry to use them because the value proposition for the tolls would more than offset safety and productivity gains from using the lanes (due to reduced travel times, increased travel time reliability, reduced accident risk, and the potential for more lenient weight and length restrictions).

Trucking Industry Interview Perspective

A summary of the key trucking industry feedback is provided below. A compilation of direct quotes and comments from the trucking industry interviewees, in relation to this strategy, are provided in Appendix B.

- During discussions with interviewees, a designated lane or lanes was commonly suggested to assist with:
  - mobility along congested corridors,
  - transitions through freeway junctions, intersections and on/off ramps,
  - peak-hour congestion on arterials, and
  - separate truck traffic on steep grades.

  Interviewees indicated that the most benefit would be realized by designating a lane or lanes for truck travel during peak traffic hours.
- Climbing lanes were mentioned for many key locations around San Diego that include steep grades, such as those coming out of Mission Valley on all north/south

interstate freeways. Potential climbing lanes for grades on I-5, I-15 and others were also mentioned throughout the interview process. Interviewees expressed concerns about cost and access, but viewed the strategy as favorable overall.

- Some interviewees indicated that a designated lane, such as the second or third lane from the right, specifically for through trucks may be helpful. In this scenario, interviewees envisioned trucks in a lane that did not subject them to the merging traffic along stretches of freeway where there were numerous on/off ramps.

A list of congestion spots, steep grades, and problematic intersections and freeway interchanges mentioned by interviewees is included in Technical Memorandum #4: Data Collection.

Tier 2 and Tier 3 Analysis Results

The Tier 2 and Tier 3 analysis results for this strategy are described below. This information, combined with the local data collected and documented in Technical Memorandum #4: Data Collection, was used to help inform the high-level findings in Sections 3 and 4 of this memorandum.

Tier 2: Strategy Applicability

- **Timeframe:** Medium-term (11 to 20 years) to long-term (over 20 years). Due to the time to plan and construct such facilities, this strategy is best suited for medium-term (smaller projects) to longer-term implementation (larger projects).
- **Truck Types and Trip Types Best Served:** All. This strategy would benefit all types of trucks and truck trip types. If ingress/egress from the lanes is restricted or less frequent, or if tolls are implemented, the strategy may benefit regional and long-haul truck trips more than local truck trips.
- **What Types of Locations are Best Suited for Implementation of this Strategy?** Example locations in the San Diego Region where this strategy could be implemented include locations with substantial grades, congested locations with high truck volumes and low levels of service, and corridors with missing trucking links or bottlenecks. Additional considerations include the proximity of potential corridors to airports, seaports, and other trucking gateways and distribution hubs. Example locations are provided in Tables 2 and 3 in Section 3: Potential Strategy Applicability throughout the Region.

Tier 3: Final Strategy Analysis

The following is a summary of the Tier 3 Final Strategy Analysis findings for each analysis area for Strategy #5: Designated Truck Lanes. More detailed information and documentation regarding the final strategy analysis is included in Appendix A.

- **Goods Movement:** This strategy would enhance truck mobility over the base case scenario, but the benefits for shorter segments, such as truck by-pass lanes, would be localized near the location of investment.
- **Legislative Considerations:** Any strategy that adds lane capacity could potentially be challenging from a legislative perspective. Existing federal regulations for transportation management areas in non-attainment areas prohibit the use of federal

funds for projects that will result in a significant carrying capacity increase for SOVs (unless the project addresses safety improvements, bottleneck elimination, or is addressed through a congestion management process that prioritizes TDM and operational management strategies prior to capacity expansion)[3]. While adding short segments of lane capacity for the purpose of facilitating goods movement (and not SOV capacity expansion) should be less challenging, such a project would also need to be consistent with local policy documents, including General Plans and the Regional Transportation Plan, prior to implementation.

- **Industry Support:** The trucking industry is generally very supportive of this strategy since travel times, travel-time reliability and the profitability of a majority of trucking stakeholders would likely improve.
- **Broader Community Support:** This strategy is expected to be somewhat controversial. While other facility users are likely to enjoy the higher degree of isolation this strategy creates, they may argue that the money could be better spent on a new general purpose lane for all users instead. Additionally, any new lane capacity has the potential to be controversial due to concerns related to increases in criteria air pollutants and GHG emissions and potential impacts to neighborhoods if new right-of-way (ROW) is required. Close coordination with local jurisdictions and outreach to stakeholders would be needed from the early stages of the planning and implementation process to ensure all concerns and potential issues related with this strategy are addressed.
- **Local Economic Development:** The improvements to truck mobility as a result of this strategy would somewhat enhance local and regional economic productivity. To the extent that improvements are also connected to the border region, goods movement across the border would also be enhanced.
- **Environmental Considerations:** Temporary releases of criteria air pollutants and GHG emissions from construction of the facility would be offset by greater long-term mobility improvements (due to the ability of trucks to by-pass congestion and travel at more fuel-efficient travel speeds). However, the improvements could also induce additional truck trips within the shipper/receiver window of operations, so the overall net environmental benefit could potentially be neutral. This issue is complex and further study would be needed to assess trade-offs on a case-by-case basis.
- **Safety and Operations:** This strategy performs well from a safety and operations perspective. In general, the greater level of isolation between trucks and passenger vehicles means less mixing of traffic and merging/weaving conflicts. This reduces accident rates, reduces trucking industry liability, and generally improves travel times and travel time reliability for all facility users.
- **Engineering Considerations:** While the construction of a truck route, climbing lane, or by-pass lane is certainly feasible from an engineering perspective, the need for additional ROW could be a challenge in areas that are already built out and would need to be assessed on a case-by-case basis.

[3] CFR § 450.320

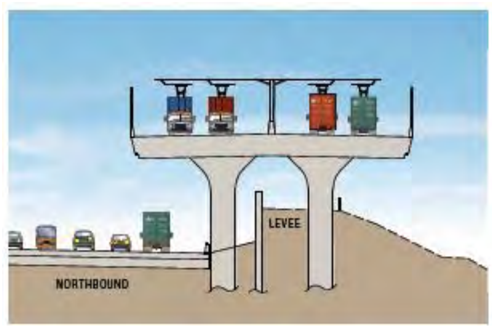
- **Public Sector Financial Considerations:** This strategy is cost-intensive as it involves capital improvements, requires maintenance, and is not likely to generate revenue. While high benefits are also a potential, it would be necessary to verify that the anticipated benefits are equal to or greater than the costs required to build and maintain the facility.

Strategy #5 Designated Truck Lanes: Construction of New Lanes on an Existing Facility - Summary of Findings

In general, projected truck volumes in the San Diego region do not reach the thresholds required to merit the construction of designated truck lanes (>20,000 two-way truck average daily traffic (ADT) for at least 10 miles[4]). However, some higher truck volume bottlenecks could potentially benefit from truck by-pass lanes over the long-term (e.g. the SR 905/I-805 Interchange). Additional potential applicability within the region could be the use of truck-climbing lanes in areas with steeper than average grades. Overall, due to the high costs and the potential ROW and legislative issues, this strategy is only recommended for consideration in bottleneck locations where the truck volumes and local conditions warrant such an improvement. While there are currently few locations within the San Diego region where these criteria are met, changing conditions could make this strategy more relevant in the future.

6. Separate Dedicated Truck-Only Facilities (Construction of New Facilities).

Strategy Overview



Similar to strategy #5, this strategy would involve developing a system of dedicated truck-only facilities/roadways. However, this system would be separate facilities, as opposed to new lanes on existing facilities. Trucks would be required to use the facilities, and autos would not be permitted. There is potential for the allowance of longer-combination vehicles (LCVs) with appropriate legislative changes. Tolling options could include non-tolled, a flat toll, or a variable toll. If tolled, the use of the lanes could be made voluntary by continuing to allow trucks non-tolled access to the general purpose lanes.

Dedicated truck lanes would separate trucks from other mixed-flow traffic to enhance safety and/or stabilize traffic flow. Priority and/or dedicated lanes for trucks can help to improve truck speeds and reduce truck/auto crashes as well as the associated long-term lane closures that can increase congestion-related GHG emissions. There are a few dedicated truck lanes in the United States, although they are rare (more are being studied). Of those that do exist, it is common to require trucks to use the dedicated truck lanes, while not expressly prohibiting their use by other vehicles as well.

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4 Source: NCHRP Report 649 / NCFRP Report 3, as shown in Table A-4 in Appendix A and described in Technical Memorandum #1 – Literature Review (page 23 and Table 3).

Trucking Industry Interview Perspective

A summary of the key trucking industry feedback is provided below. A compilation of direct quotes and comments from the trucking industry interviewees, in relation to this strategy, are provided in Appendix B.

- The idea of a facility that isolates trucks completely from passenger car traffic was well received by interviewees from a safety and efficiency perspective. The benefits to mobility were clearly envisioned.
- Industry interviewees' primary concern with a dedicated facility would be cost and how that would translate to increases in their operating costs.
- Many interviewees also expressed their concern regarding the need for this type of investment in San Diego County based on truck traffic volumes as compared with those in the Los Angeles area.

Tier 2 and Tier 3 Analysis Results

The Tier 2 and Tier 3 analysis results for this strategy are described below. This information, combined with the local data collected and documented in Technical Memorandum #4: Data Collection, was used to help inform the high-level findings in Sections 3 and 4 of this memorandum.

Tier 2: Strategy Applicability

- **Timeframe:** Long-term (over 20 years). This strategy would best be implemented in the long-term due to high cost and construction time required to design and construct the facility.
- **Truck Types and Trip Types Best Served:** The truck types best served include medium- and heavy-duty trucks and the trip types best served include regional and long haul truck trips. Since the construction of a new dedicated truck-only facility would likely have very limited ingress/egress, it would most likely best serve regional and long-haul truck trips. However, shorter facilities near key ports/freight gateways could also serve local truck trips.
- **What Types of Locations are Best Suited for Implementation of this Strategy?** Example locations where this strategy could be implemented include corridors with high truck volumes and poor operational performance, and corridors with high truck-related accident rates. Additional considerations include corridors with close proximity to airports, seaports, and other trucking gateways and distribution hubs. However, due to the factors discussed in the Strategy #6 Summary of Findings section below, there are no example locations in the San Diego region where this strategy is recommended for implementation.

Tier 3: Final Strategy Analysis

The following is a summary of the Tier 3 Final Strategy Analysis findings for each analysis area for Strategy #6: Separate Dedicated Truck-Only Facilities. More detailed information and documentation regarding the final strategy analysis is included in Appendix A.

- **Goods Movement:** This strategy would greatly enhance truck mobility over the base case scenario by completely separating trucks from general traffic. The benefits would accrue to the areas where the improvements are made.
- **Legislative Considerations:** Any strategy that adds lane capacity could potentially be challenging from a legislative perspective. Existing federal regulations for transportation management areas in non-attainment areas prohibit the use of federal funds for projects that will result in a significant carrying capacity increase for SOVs (unless the project addresses safety improvements, bottleneck elimination, or is addressed through a congestion management process that prioritizes TDM and operational management strategies prior to capacity expansion)[5]. While building a dedicated truck-only facility for the purpose of facilitating goods movement (and not expanding SOV capacity) should be less challenging, such a project would also need to be consistent with local policy documents, including General Plans and the Regional Transportation Plan, prior to implementation**.** An additional legislative consideration for this strategy is the potential to allow larger and longer-combination vehicles on a dedicated truck-only facility. While such vehicles are currently prohibited in California, they are popular among the trucking industry and the potential to allow them on a dedicated truck-only facility (where safety concerns related to mixing with passenger vehicles is less of an issue) could be re-visited.
- **Industry Support:** This strategy is likely to be supported by the trucking industry, if truck volumes warrant the level of public expenditure required. However, this level of investment would very likely involve requiring trucks to use the truck-only facility and also tolling, which would be controversial. The tolls would be nominal and set up to ensure the facility can be managed to guarantee that travel times, travel time reliability, and private sector profitability benefits accrue to the trucking industry. However, tolls are politically unpopular and a substantial amount of outreach would be required to ensure the strategy is amenable to the industry it is designed to serve. Another possible factor that would increase the attractiveness of this strategy to the trucking industry is the potential to allow larger and longer-combination vehicles on the dedicated truck-only facility. While legislative barriers would need to be addressed (as described above), this would allow truckers to increase their profitability by carrying more goods per trip.
- **Broader Community Support:** This strategy is expected to be fairly controversial. While other facility users are likely to enjoy the higher degree of isolation this strategy creates, they may argue that the money could be better spent in other ways. Additionally, a new truck-only facility would undoubtedly be controversial due to concerns related to increases in criteria air pollutants and GHG emissions and potential impacts to neighborhoods for the new ROW required. Close coordination with local jurisdictions and outreach to stakeholders would be needed from the early stages of the planning and implementation process to ensure all concerns and potential issues related with this strategy are addressed.
- **Local Economic Development:** The improvements to truck mobility as a result of this strategy would help to enhance local and regional economic productivity. To the

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[5] CFR § 450.320

extent that improvements connect to the border region, goods movement across the border would also be enhanced.

- **Environmental Considerations:** Temporary releases of criteria air pollutants and GHG emissions from construction of the facility would be offset by greater long-term mobility improvements (due to the ability of trucks to by-pass congestion and travel at more fuel-efficient travel speeds). However, the improvements could also induce additional truck trips within the shipper/receiver window of operations, so the overall net environmental benefit could potentially be neutral or even negative. This issue is complex and further study would be needed to assess trade-offs on a case-by-case basis.
- **Safety and Operations:** This strategy performs very well from a safety and operations perspective. In general, the complete isolation of trucks from passenger vehicles would eliminate the mixing of traffic and merging/weaving conflicts between trucks and autos. This would reduce accident rates, reduce trucking industry liability, and generally improve travel times and travel time reliability for all facility users.
- **Engineering Considerations:** While the construction of a truck-only facility is certainly feasible from an engineering perspective, the need for additional ROW for such a facility would be enormously challenging in areas that are already built out.
- **Public Sector Financial Considerations:** The capital costs associated with the strategy would be very high and operations and maintenance of the facility would also be required. However, this strategy would have the potential to generate at least some revenue due to the collection of tolls. While this strategy can be cost-effective under the correct circumstances, the truck volumes are not high enough in the San Diego region for the benefits to warrant the high level of public investment that would be required for implementation.

Strategy #6 Separate Dedicated Truck-Only Facilities (Construction of New Facilities) - Summary of Findings

In general, projected truck volumes in the San Diego region do not reach the levels required to merit implementation of this strategy. For example, the projected truck volumes along I-710 near the Port of Long Beach (where this strategy is being considered) reach as high as 74,400 (two-way truck ADT), and the truck percentage of total traffic reaches as high as 63 percent on some segments. Overall, due to the high costs and the potential ROW and legislative issues, this strategy is not recommended for implementation in the San Diego region, now or in the future, given currently projected traffic and truck conditions and volumes.

7. Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment.

Strategy Overview

This strategy uses ITS and ATM technologies (both external and in-vehicle) to improve truck mobility and safety. This strategy actually represents a number of potential freeway operations strategies that combine broader ITS implementation and operations techniques with truck focused information and management strategies.

In general these strategies fall into three basic categories:

- **Variable Speed Limits and Control:** Under this strategy variable speed limits are applied to all lanes of traffic. The goal is to decrease the potential speed disparities between higher and lower speed traffic, particularly in situations where traffic patterns are starting to accordion or breakdown as volumes start to reach capacities. Speed limits could be displayed per lane either on overhead gantries and/or in-vehicles and adjusted by roadway segment, time of day, and near-real time projected traffic conditions. Section 22355 of the California Vehicle Code specifically authorizes variable speed limits[6].

- **Flexible Truck Lane Assignments**: Under this approach, lanes designated as allowed for trucks or passing trucks could be highlighted. During certain conditions and on certain facilities this would possibly allow for trucks in more lanes than the far two right lanes, particularly when truck volumes are higher and overall volumes are lower.

- **Designated Truck Lane Preferences**: This strategy would clearly identify and reinforce particular lane(s) as truck preferred lanes. The concept is to enhance overall isolation between trucks and cars by:
    - Clearly designating lanes as preferred truck lanes,
    - Allowing autos to pass through these lanes with the understanding that they are preferred truck lanes, and
    - Designating truck lanes outside of the far right lane where there is substantial merging and weaving of traffic, such as at closely spaced interchanges or where auxiliary lanes are serving high auto volumes but are not utilized significantly by trucks.

Each of these strategies could match or integrate well with the regional role out of Integrated Corridor Management (ICM) system elements. The I-15 corridor between SR 163 and SR 78 has already been implemented as an initial ICM corridor in the region. This strategy would simply overlay and supplement the ICM strategy by integrating truck operations strategies. This would be a logical enhancement of the ICM rollout concept across the region given the impact that trucks can have on overall freeway operations.

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[6] CVC Section 22355 Variable Speed Limits http://www.dmv.ca.gov/pubs/vctop/d11/vc22355.htm

Trucking Industry Interview Perspective

A summary of the key trucking industry feedback is provided below. A compilation of direct quotes and comments from the trucking industry interviewees, in relation to this strategy, are provided in Appendix B.

- Trucking interviewees (including owners, managers, and drivers) are currently users of a variety of communications and fleet management technologies. Interviewees indicated that technology has to have a clear benefit to rationalize the investment (e.g. efficiency and/or safety have to be improved to justify the use of any technology on the road, in the office, or in the vehicle).
- Overall, industry interviewees are progressive with regard to implementation of back office and in-vehicle technologies to support their operations. The size of the interviewee's company did not necessarily indicate whether and to what extent technology has been integrated into their operations. For some interviewees, once technology investments are made, they are not likely to be updated or upgraded until fully depreciated or until additional benefits from the upgrade or update investment outweigh the cost. Some companies use very sophisticated fleet management and monitoring solutions that allow real-time or near real-time tracking of vehicles, drivers, and freight. Among the interviewees, Xata, Inc. products were commonly used fleet and vehicle management solutions. Any fleet management solution requires a significant investment and is also often a proprietary or customized Commercial-Off-The-Shelf (COTS) application combined with in-vehicle monitoring and communications devices.
- Cell phones and smart phones are dominant in communications technologies used, and apps have been suggested by some interviewees to provide additional traffic and traveler information. Interviewees indicated that communication with their drivers was very important.
- Public investment in roadside or on-highway communications technology is viewed as helpful most of the time and by many interviewees. Some interviewees are concerned about distraction by CMSs or other on-highway signage and suggested that heads-up displays may be a safer option. Signage around truck trip generation points, such as the airport or seaports, was indicated as helpful, especially for long-haul truckers. CMSs are viewed as less helpful for local truckers that are familiar with their routes.
- Dynamic speed limit implementation via electronic signage was viewed as very helpful by most interviewees. Many consider normalization of speed between passenger vehicle traffic and larger trucks and tractor-trailers as a means of enhancing safety and easing congestion resulting from stop and go traffic.
- Using electronic signage or possibly other in-vehicle messaging for dynamic lane assignment was viewed favorably.
- Willingness to pay for technology services is low, due to the numerous free services and information currently available from the private sector through trucker's communication technology providers (such as internet service providers and cellular phone service providers).

Tier 2 and Tier 3 Analysis Results

The Tier 2 and Tier 3 analysis results for this strategy are described below. This information, combined with the local data collected and documented in Technical Memorandum #4: Data Collection, was used to help inform the high-level findings in Sections 3 and 4 of this memorandum.

Tier 2: Strategy Applicability

- **Timeframe:** Short-term (0 to 10 years) to medium-term (11 to 20 years).
- **Truck Types and Trip Types Best Served:** All.
- **What Types of Locations are Best Suited for Implementation of this Strategy?** Example locations in the San Diego Region where this strategy could be implemented include corridors with high truck volumes and percentages, corridors with a high proportion of truck-related accidents, and locations where operational characteristics support enhanced flexibility. Example locations are provided in Tables 2 and 3 in Section 3: Potential Strategy Applicability throughout the Region.

Tier 3: Final Strategy Analysis

The following is a summary of the Tier 3 Final Strategy Analysis findings for each analysis area for Strategy #7: Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment. More detailed information and documentation regarding the final strategy analysis is included in Appendix A.

- **Goods Movement:** This strategy would improve truck mobility on the region's freeways over the base case scenario by improving traffic flow and optimizing the use of existing freeway capacity.
- **Legislative Considerations:** This strategy is generally consistent with federal, state and local policy. Certain ITS strategies, such as variable speed limits and dynamic lane assignment could require some buy-in from local and state policymakers. Additionally, the existing CVC restriction of trucks with three or more axles to speed limits of 55 mph and the right most freeway lanes would need to be addressed (Sections 21645 and 22406 of the CVC). However, the provision in these regulations specifying that the restrictions apply only "when a specific lane or lanes have not been designated" should facilitate addressing any legislative issues associated with this strategy.
- **Industry Support:** This strategy is generally supported by the trucking industry. The industry would enjoy the benefits of improved truck mobility and profitability (though the latter could be somewhat offset by the costs of any on-vehicle truck equipment required to implement the strategy).
- **Broader Community Support:** While this strategy is generally expected to be supported by the broader community, some education and stakeholder outreach would be needed to address concerns over new technologies. For example, variable speed limits and dynamic lane assignment (that allow trucks in new lanes) could potentially raise concerns and questions among other facility users. Additionally, partner agencies could have some concerns/questions about the legislative issues

described above. Overall, ITS is widely acknowledged as a strategy with multiple benefits for a wide-array of stakeholders and it is unlikely that community opposition would serve as a barrier to implementation. However, some education and additional enforcement may be necessary to ensure compliance with the new technologies (for example with adherence to variable speed limits).

- **Local Economic Development:** The improvements to truck mobility as a result of this strategy would help to enhance local and regional economic productivity. To the extent that improvements connect to the border region, goods movement across the border would also be enhanced.
- **Environmental Considerations:** Overall, the wide deployment of this strategy would improve traffic flow and allow all facility users to travel at more fuel-efficient travel speeds. This would have a high potential to reduce criteria air pollutant and GHG emissions (though this could be offset somewhat by potential increases in VMT from induced and/or latent demand).
- **Safety and Operations:** This strategy performs well from a safety and operations perspective. In general, the strength of ITS and ATM technologies is the increased ability to actively manage existing freeway capacity so that throughput is optimized. The benefits include improved traffic flow, travel speeds, and travel time reliability for all users (passenger vehicles as well as trucks), in addition to improved safety and incident management.
- **Engineering Considerations:** While ITS and ATM technologies are generally feasible from an engineering standpoint, implementation of this strategy could be somewhat challenging if the required infrastructure (e.g. gantries, conduit, etc) have not already been included in freeway corridor designs. This issue is being addressed in the concurrent Caltrans HOV/Managed Lane Planning and Design Guidance study.
- **Public Sector Financial Considerations:** Public sector costs would be required to install and maintain ITS equipment, though the costs are not anticipated to be cost-prohibitive. While the strategy is unlikely to generate revenue (in relation to truck management), the strategy is expected to be generally cost-effective with medium costs and high levels of benefits.

Strategy #7 Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment - Summary of Findings

This strategy has the potential to optimize the use of existing freeway capacity and improve travel times and travel time reliability for all users (both passenger vehicles and trucks). The strategy is anticipated to be cost-effective and is likely aligned with improvements already planned and underway as part of the programmed HOV/Managed Lanes network throughout the region. As such, this strategy is considered a “win-win” approach for San Diego and represents another “low-hanging fruit” option for improving truck mobility throughout the region. Numerous freeway corridors throughout the region have been identified as potential candidates for this strategy and are described further in the following section.

3. Potential Strategy Applicability throughout the Region

As part of the Tier 2 Quantitative Strategy Analysis process, the project team reviewed the results of the local data collection effort to identify the applicability of each strategy to the key trucking corridors and gateways/distribution hubs in the San Diego region. Specifically, the results presented in the remainder of this section are based on a review of the following:

- Trucking industry interview feedback on problem areas throughout the San Diego region.
- Local data on current and projected freeway conditions, including truck volumes, truck percentages, and proximity to gateways/distribution hubs, and
- Information on thresholds/guidelines from the literature review regarding the truck volumes and truck percentages that typically merit certain strategies, such as dedicated truck-only lanes (described in Appendix A).

Since this is a high-level; long-range planning study, the information presented in this section is not intended as recommendations (much more detailed project-level studies would be required to confirm appropriate truck management strategies for each location). Rather, the information presented in this section is intended to be the first step – that is, to identify, at a high-level, the areas in the San Diego region where truck management strategies may be warranted, and which strategies should be considered for further study in each location. The results of this review are summarized for both freeway corridors/interchanges and trucking gateways/distribution hubs in the remainder of this section. As would be expected, there is some overlap between the freeway corridors and gateways/distribution hubs, which is noted throughout, where applicable.

Freeway Corridors/Interchanges – Summary of Issues and Potential Strategy Applicability

For the purposes of this assessment, the major freeway corridors and interchanges were divided into segments, as shown in Figure 2. The issues and potential truck management strategy solutions for each segment are described below. This is followed by a summary matrix, which provides a snapshot of the applicability of each strategy for the freeway corridor segments and interchanges, as shown in Table 2.

- **C1: SR 905** (also part of the G1: Border Area)
  - **Issues:** Issues associated with this location include high current and projected truck volumes and truck percentages due to border-related truck traffic
  - **Potential strategies:** Truck Management Strategy #2: Traffic Organizational Strategies and Truck Management Strategy #7: ITS could work together to help better utilize existing capacity and smooth operational flow once SR 11 and the new border crossing are constructed. This concept is further described in the Corridor Scenarios section of this memorandum.

Figure 2: Trucking Freeway Corridors: Potential Truck Management Strategy Application

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- **C2: SR 905/I-805 Interchange** (also part of the G1: Border Area)
  - **Issue:** Issues associated with this location include high current and projected truck volumes and truck percentages due to border-related truck traffic. This is also a key trucking interchange that will only become more important as cross-border trade increases.
  - **Potential Strategies:** Truck Management Strategy #5: Dedicated Truck Lanes could help trucks bypass local traffic at the interchange and improve safety and overall operations. This concept is further described in the Corridor Scenarios section of this memorandum.
- **C3: SR 125**
  - **Issues:** When tolls are removed from SR 125 in the 2035 to 2050 timeframe, higher truck volumes are projected to occur along this freeway. There are also steeper than average grades along the SR 125 corridor.
  - **Potential Strategies:** Truck Management Strategy #5: Dedicated Truck Lanes, specifically truck climbing lanes, could be implemented in the future if truck volumes warrant and SR 125 becomes a more popular trucking corridor and link to the US/Mexico Border. Truck Management Strategy #7: ITS could also be a means of designating a truck lane through dynamic lane assignment.
- **C4: I-8 (east of SR 67)**
  - **Issues:** High winds, ice and snow occur along I-8 near Alpine and can affect the safety of trucks moving along this corridor.
  - **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies and Truck Management Strategy #7: ITS could possibly be implemented together in the El Cajon/Santee and Alpine areas to provide earlier notification to truckers related to weather issues, allowing them to plan their trip routes and timing accordingly and avoid long weather-related delays.
- **C5: SR 52 (east of I-805)** (also part of the G6: El Cajon/Santee Area)
  - **Issues:** Issues associated with this location include high projected truck percentages combined with a falling level of service over time.
  - **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could possibly be implemented to provide routing information to assist truckers in getting to their connecting north/west corridors more easily and Truck Management Strategy #7: ITS could assist with truck throughput via dynamic lane assignment and all lanes running techniques. The current and projected truck volumes along SR 52 are not high enough to merit consideration of Truck Management Strategy #5: Dedicated Truck Lanes at this time.
- **C6: I-805 (SR 905 to I-5)**
  - **Issues:** I-805 from SR 905 to I-5 is already a key trucking corridor and is projected to have heavier truck volumes and lower levels of service by 2050.

- Potential strategies: Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access could be considered to help improve truck throughput and truck travel time reliability. For a two managed lanes configuration (one managed lane in each direction), removing the occupancy restriction for light-duty commercial trucks (no more than 2 axles) could be a first step. This would allow light-duty commercial trucks to enter the managed lanes via the IAPs. Once the managed lanes go to a four managed lanes configuration (two lanes in each direction) medium-duty trucks (3 to 4 axles) that meet length requirements could potentially access the managed lanes through any available DARs, though the number of planned DARs in this stretch is fairly minimal (as shown in Figure C-1 in Appendix C). Additionally, Truck Management Strategy #7: ITS could facilitate truck mobility for heavy-duty trucks in general purpose lanes through dynamic lane assignment and improved traveler information for truckers.

- **C7: I-15 (south of SR 163)**
  - **Issues:** The SR 15 corridor in the Mid-City area has been heavily impacted by the completion of SR 15 and truck traffic should be discouraged in this already congested area. Additionally, safety improvements in the SR 94, SR 15, and I-805 interchange could improve operations.
  - **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies, Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access and Truck Management Strategy #7: ITS could be implemented together to encourage northbound trucks to bypass the I-805/SR 15 Interchange by continuing to travel north on I-805 and then use SR 163 to cut back over to northbound I-15 to access the I-15 managed lanes. Potential techniques to do this include signing as a preferred truck route (#2), providing a possible managed lanes connection (#4), and dynamic lane assignment (#7).
- **C8: I-15 (SR 163 to SR 78)** (also part of the G10: Rancho Bernardo Distribution Hub)
  - **Issues:** I-15 from SR 163 to SR 78 is projected to experience high increases in truck volumes in both directions.
  - **Potential Strategies:** Truck Management Strategy #3: TDM could be considered for shifting trucks to off-peak travel times, since this corridor is adjacent to the Rancho Bernardo Distribution Hub. Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access could be considered since this corridor has a fully built-out system of 4 managed lanes (two in each direction). Truck Management Strategy #7: ITS could be considered to help improve traffic operations throughout the corridor. These concepts are discussed further in the Corridor Scenarios section of this memorandum.
- **C9: SR 78/I-15 Interchange** (also part of the G10 Palomar Airport Road/SR 78 Corridor Distribution Hub)
  - **Issues:** Trucking industry interviewees frequently expressed safety concerns and frustration with delays at this interchange. Additionally, the interchange is an important freight corridor connector, with projected increases in truck percentages and volumes, and also has a moderately steep grade.

- **Potential Strategies:** Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access could benefit truck mobility in this location for light-duty trucks as the network of managed lanes is built out. SR 78 is designated for 2 managed lanes (one in each direction) by 2050 and a managed lane to managed lane connector is planned for north to west & east to south on the interchange (as shown in Figure C-1 in Appendix C).

- **C10: I-15 (SR 78 to the County line)**
  - **Issues:** I-15 from SR 78 to the San Diego County line has substantial grades and is planned to have four toll lanes (two in each direction) which would require all vehicles (not just single-occupancy vehicles), to pay a toll to use them. The corridor is also projected to have an LOS of F in 2050 for northbound traffic.
  - **Potential Strategies:** Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access could potentially improve truck mobility in this corridor by allowing trucks in the toll lanes for a discounted price. Truck Management Strategy #5: Dedicated Truck Lanes could potentially enhance mobility by providing truck climbing lanes and a greater degree of separation between passenger vehicles and trucks, if future truck volumes warrant such an investment. Truck Management Strategy #7: ITS could also improve overall corridor operations through dynamic lane assignment and the possible implementation of variable speed limits.
- **C11: I-5 (I-5/I-805 Interchange to SR 78)**
  - **Issues:** I-5 from the I-805 Interchange to SR 78 is a key trucking corridor and is projected to experience a high increase in truck volumes and truck percentages by 2050 and levels of service are projected to range between LOS D and F.
  - **Potential Strategies:** Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access could be considered to help improve truck throughput and truck travel time reliability. Even though four managed lanes (two in each direction) are planned, since there is only one DAR planned (as shown in Figure C-1 in Appendix C) , it would likely be best to consider only removing the occupancy restriction for light-duty commercial trucks (no more than 2 axles), which would then be able to access the managed lanes via the IAPs. Since medium-duty trucks (3 to 4 axles) should only access the managed lanes through DARs (for safety and operational reasons), medium-duty trucks would likely not be allowed to access the I-5 managed lanes. Truck Management Strategy #7: ITS could facilitate truck mobility for medium-duty and heavy-duty trucks in the general purpose lanes through dynamic lane assignment and improved traveler information for truckers.
- **C12: I-5/SR 78 Interchange (**also part of the G10 Palomar Airport Road/SR 78 Corridor Distribution Hub)
  - **Issues:** Trucking industry interviewees frequently expressed safety concerns and frustration with delays at this interchange. Currently the interchange is a constrained connection for truckers; however improvements are planned, including a managed lane to managed lane connector by 2050, as shown in Figure C-1 in Appendix C.
  - **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could complement the planned interchange improvements through

arterial management strategies for adjacent arterials. Truck Management Strategy #7: ITS could facilitate truck mobility through all lanes running on the westbound to northbound shoulder.

- **C13: I-5 (SR 78 to the County line)**
  - **Issues:** I-5 from SR 78 to the San Diego County line has substantial grades and is planned to have four toll lanes (two in each direction) which would require all vehicles (not just single-occupancy vehicles), to pay a toll to use them. The corridor is also projected to experience large increases in truck volumes and percentages through 2050 and levels of service are projected to fall to LOS D in both directions.
  - **Potential Strategies:** Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access could potentially improve truck mobility in this corridor by allowing trucks in the toll lanes for a discounted price. Truck Management Strategy #5: Dedicated Truck Lanes could potentially enhance mobility by providing truck climbing lanes and a greater degree of separation between passenger vehicles and trucks, if future truck volumes warrant such an investment. Truck Management Strategy #7: ITS could improve overall corridor operations through dynamic lane assignment and the possible implementation of variable speed limits.

Table 2: Potential Strategy Applicability to Freeway Corridors in the San Diego Region

Corridors/ Interchanges	Time-frame	#1 Base Case	#2 Commun-ication Strategies	#3 TDM	#4 Trucks on ML (Restricted)	#5 Dedicated Truck Lanes	#6 Dedicated Truck Facility	#7 ITS
C1: SR 905	Short		X					
	Med							X
	Long							
C2: SR 905/ I-805 Interchange	Short							
	Med							
	Long					X		
C3: SR 125	Short							
	Med							X
	Long					X		
C4: I-8 (east of SR 67)	Short		X					
	Med							X
	Long							
C5: SR 52 (east of I-805)	Short		X					
	Med							X
	Long							
C6: I-805 (SR 905 to I-5)	Short							
	Med				X			X
	Long							
C7: I-15 (south of SR 163)	Short		X					
	Med				X			X
	Long							
C8: I-15 (SR 163 to SR 78)	Short							
	Med			X	X			X
	Long							
C9: I-15 & SR 78 Interchange	Short							
	Med				X			
	Long							
C10: I-15 (SR 78 to County line)	Short							
	Med				X			X
	Long					X		
C11: I-5 (I-805 to SR 78)	Short							
	Med				X			X
	Long							
C12: I-5 & SR 78 Interchange	Short		X					
	Med							X
	Long							
C13: I-5 (SR 78 to County line)	Short							
	Med				X			X
	Long					X		

Trucking Gateways/Distribution Hubs – Summary of Issues and Potential Strategy Applicability

The trucking gateways and distribution hubs identified in Technical Memorandum#4: Data Collection were used for this assessment, and are shown in Figure 3. The issues and potential truck management strategy solutions for each trucking gateway/distribution hub are described below. This is followed by Table 3, which provides a summary of the applicability of each strategy to the region's trucking gateways and distribution hubs.

- **G1: Border Area** (includes C1: SR 905 and C2: SR 905/I-805 Interchange)
  - **Issues:** Trucking industry interviewees expressed multiple concerns regarding truck mobility and delay at the Otay Mesa Border area. Additionally, SR 905 at the Border contains the highest percentage of truck traffic in the region.
  - **Potential Strategies**: Truck Management Strategy #2: Traffic Organizational Strategies could help improve truck routing and provide services for truckers along La Media Road and Siempre Viva Road. Truck Management Strategy #5: Dedicated Truck Lanes could help trucks bypass local traffic at the SR 905/I-805 Interchange and improve safety and overall operations. Truck Management Strategy #7: ITS could help better utilize existing capacity and smooth operational flow along SR 905 once SR 11 and the new border crossing are constructed. These concepts are further described in the Corridor Scenarios section of this memorandum.
- **G2: National City Marine Terminal and National Distribution Center**
  - **Issues:** This location is a key trucking gateway and experiences a high degree of intermodal freight activity. Challenges at this location include truck queuing down Bay Marina Parkway when ships come in, constrained truck access to I-5 due to neighborhood development, and the potential for recreational development in the area which may create additional opposition to truck queuing.
  - **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could alleviate truck queuing by improving truck routing and time of travel through improved travel information for truckers.
- **G3: 10th Avenue Marine Terminal and 32nd Street Naval Station**
  - **Issues:** This location is a key trucking gateway. Challenges at this location include out-of-direction travel for trucks to avoid the Barrio Logan neighborhood and competing uses for Harbor Drive (bikes, passenger vehicles, etc).
  - **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could alleviate truck queuing by improving truck routing and time of travel through improved travel information for truckers. Truck Management Strategy #7: ITS could address issues along Harbor Drive through lane designation.

Figure 3: Trucking Gateways/Distribution Hubs: Potential Truck Management Strategy Application

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- **G4: San Diego International Airport**
    - **Issues:** Issues at this key trucking gateway include access issues for trucks coming in and out of the cargo area and the current cruise ship staging area. Additionally, parcel delivery trucks experience challenges accessing the San Diego International Airport from southbound SR 163 during the afternoon peak period. These deliveries need to arrive at the airport in the late afternoon to meet plane departure schedules and traffic merging and mixing along SR 163 between Friars Road and I-8 results in frequent traffic bottlenecks and creates delays resulting in service failures for trucks[7]. Parcel carriers have diverted some shipments out of the area to other airports (such as Orange County) to avoid future service failures for their air cargo. Additionally, over the long-term, the growing importance of small parcel shipping due to the increase in online shopping needs to be further studied to understand future implications and local effects.
    - **Potential strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could have the potential to improve truck routing to the cargo area, along Harbor Drive, and from southbound SR 163. Additionally, Truck Management Strategy #7: ITS could provide real-time airport travel times along SR 163. However, further study is needed to better understand existing and projected truck traffic at the San Diego International Airport.
- **G5: Mid-City**
    - **Issues:** Mid-City is a dense, urban area that is projected to grow and also experience an increase in truck trips over time. El Cajon Boulevard, in particular, could potentially experience an increase in light-duty trucks due to localized growth and the associated growth in delivery demands.
    - **Potential Solutions:** Truck Management Strategy #2: Traffic Organizational Strategies could have the potential to improve truck routing through this dense, urban neighborhood. This could include the use of urban freight consolidation centers to downsize package deliveries and allow for smaller trucks to deliver them to their local destinations.
- **G6: El Cajon/Santee** (includes C5: SR 52 east of I-805)
    - **Issues:** The primary issue with this distribution hub is its distance to major freight corridors, such as I-15 and I-805. Over time, truck volumes and percentages are projected to increase along SR 52 and levels of service are expected to decline.
    - **Potential Strategies:** Truck Management Strategy #7: ITS could improve overall mobility along SR 52 through technologies such as dynamic lane assignment, variable speed limits, and improved traveler information systems.

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[7] While the San Diego International Airport is currently planning numerous cargo access and traffic circulation improvements, including modifications to Washington Street between Kettner Boulevard and San Diego Avenue (as documented in the August 2011 San Diego International Airport Master Plan Supplemental EIR), the improvements will not likely affect truck access issues as far east as the I-8, SR 163 and Friars Road area mentioned by the interviewees.

- **G7: Kearny Mesa**
  - **Issues:** Truck access to SR 163, I-805 and I-15 can be challenging. Because this area is built-out truck routing through residential neighborhoods can be a challenge.
  - **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could facilitate the routing of trucks to freeways, while avoiding residential areas. Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access on adjacent I-15 and I-805 could also benefit truck mobility in the Kearny Mesa region.
- **G8: Miramar / Mira Mesa / Sorrento Valley**
  - **Issues:** This is generally a high growth area and example issues include congestion at the I-5 and I-805 Interchange and along Mira Mesa Boulevard and Miramar Road.
  - **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could facilitate the routing of trucks to freeways, while avoiding residential areas. Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access on adjacent I-5, I-805, and I-15 could also benefit truck mobility in this area. Truck Management Strategy #5: Dedicated Truck Lanes in the form of truck by-pass lanes could be considered at the I-5 and I-805 merge to address stakeholder concerns in this area. Additionally, Truck Management Strategy #7: ITS could facilitate overall trucking mobility in this area through technologies such as dynamic lane assignment, variable speed limits and improved traveler information.
- **G9: Poway**
  - **Issues:** This trucking distribution hub is projected to experience low growth; however, there are issues with truck routing through neighborhoods near Scripps Poway Parkway.
  - **Potential strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could be used to facilitate the routing of trucks to avoid sensitive residential areas.
- **G10: Rancho Bernardo** (also a part of C8: I-15 from SR 163 to SR 78)
  - **Issues:** The Rancho Bernardo trucking distribution hub is projected to experience some growth through 2050 and is also adjacent to the I-15 which is projected to experience high truck volumes and percentages in both directions.
  - **Potential Strategies:** Truck Management Strategy #3: TDM could help to shift trucks to off-peak travel times if trucks are travelling during the auto peak periods. Additionally, Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access could benefit truck mobility in this area.
- **G11: Palomar Airport Road / SR 78 Corridor** (also a part of C9: SR 78/I-15 Interchange and C12: I-5/SR 78 Interchange)

- **Issues:** Issues in this area include truck access and congestion along SR 78 and at the interchanges of SR 78 with I-5 and I-15, which causes trucks to use San Marcos Boulevard, Mission Road and South Santa Fe Avenue as alternative routes[8].
- **Potential Strategies:** Truck Management Strategy #2: Traffic Organizational Strategies could help facilitate truck routing to avoid sensitive neighborhood areas. Truck Management Strategy #7: ITS along SR 78 could help improve truck mobility by utilizing dynamic lane assignment and shoulder running, when necessary.

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[8] SANDAG and Caltrans are currently developing a Project Study Report for improvements to the SR 78 corridor included in the 2050 RTP. Improvements identified in the RTP include two managed lanes (one in each direction) and operational improvements along SR 78 from I-5 to I-15, HOV connectors at the I-5/SR 78 Interchange and I-15/SR 78 Interchange, and freeway connectors at the I-5/SR 78 Interchange.

Table 3: Potential Strategy Applicability to Trucking Gateways/Distribution Hubs throughout the San Diego Region

Gateways/ Distribution Hubs	Time-frame	#1 Base Case	#2 Communication Strategies	#3 TDM	#4 Trucks on ML (Restricted)	#5 Dedicated Truck Lanes	#6 Dedicated Truck Facility	#7 ITS
G1: Border	Short		X					
	Med							X
	Long					X		
G2: National Marine Terminal and Distribution Center	Short		X					
	Med							
	Long							
G3: 10th Ave. Terminal & 32nd	Short		X					
	Med							X
	Long							
G4: Airport	Short		X					
	Med							X
	Long							
G5: Mid City	Short		X					
	Med							
	Long							
G6: El Cajon/Santee	Short							
	Med							X
	Long							
G7: Kearny Mesa	Short		X					
	Med				X			
	Long							
G8: Miramar / Mira Mesa / Sorrento Valley	Short		X					
	Med				X			X
	Long					X		
G9: Poway	Short		X					
	Med							
	Long							
G10: Rancho Bernardo	Short			X				
	Med				X			
	Long							
G11: Palomar Airport Road / SR 78 Corridor	Short		X					
	Med							X
	Long							

4. Conceptual Corridor Scenarios

To test whether the strategies would be compatible if integrated together in a conceptual "real corridor" case study scenario, the project team identified two locations for more detailed consideration. To select the conceptual corridors, the project team looked for locations with heavy truck volumes that could serve to demonstrate a variety of the truck management strategies, if implemented, and allow lessons learned to be applied elsewhere in the region. The locations selected are shown in Figure 4 and include the I-15 corridor from SR 78 to SR 163 (Corridor/Interchange "C8"in Section 3 of this memo) and the Border Area, which includes SR 905 and the SR 905/I-805 Interchange (Gateway/Distribution Hub "G1" in Section 3 of this memo). The remainder of this section describes these locations in more detail, including the issues they face and the options for truck management strategy implementation.

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Figure 4: Conceptual Corridor Locations

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Conceptual Corridor #1: Otay Mesa Border Area

Trucking industry interviewees repeatedly expressed safety concerns and frustration with delays at the Otay Mesa Border area. They also called for solutions in locations experiencing high truck delay and needing fixing "sooner than later." This area experiences a high percentage of truck traffic into and out of Mexico along SR 905, La Media Road and key arterials. Challenges include long, unmanaged queues along these roadways during peak commercial vehicle traffic hours, a lack of services for drivers (e.g. restrooms, water, and trash receptacles) and conflicts with local access to businesses and side streets.

The potential strategies identified for this area include Truck Management Strategy #2: Traffic Organizational Strategies, Truck Management Strategy #5: Dedicated Truck Lanes, and Truck Management Strategy #7: ITS. These concepts are illustrated in Figure 5 and further described below.

Truck Management Strategy #2 – Communication Based Strategies

To address the existing problems with truck back-ups, blocked-drive-ways and queuing off of Siempre Viva Road and the northern end of La Media Road, the following truck routing strategies could be considered:

- Complement the existing Otay Mesa POE Truck Route Improvements underway[9] by the City of San Diego by incorporating static and dynamic signing to facilitate the routing of trucks to the new route.
- Consider creating truck queuing waiting areas/lots for southbound trucks waiting to cross the border. The lots could have services for truckers (restrooms, shade structures, water, etc) to create a more enjoyable crossing experience. This strategy would require some sort of organizational/enforcement strategy to implement, such as taking ticket numbers and crossing the border only when your number is called, etc. Trucks would need to be routed to the lots through communication strategies, including static signage and dynamic messaging (based off of current congestion levels at the border).

Truck Management Strategy #5 – Truck Routes/Bypass Lane

To address high truck volumes and percentages at the SR 905 and I-805 Interchange, consider the following:

- For northbound traffic, add a dedicated truck lane on the ramp from westbound SR 905 to northbound I-805.
- For southbound traffic, convert an existing lane to a dedicated truck lane on the flyover from southbound I-805 to eastbound SR-905. The merge would need to be adjusted to ensure operational flow with merging passenger vehicles.

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[9] The first phase of improvements (completed in May 2011) included adding an emergency vehicle lane to the truck-only road between Drucker Lane and the inspection facilities at the POE. The second phase of the project will extend Britannia Boulevard to the south, add one truck lane and emergency lane, and extend the truck road parallel to the border between Britannia Boulevard and La Media Road. It also will add a second lane to the truck route between La Media Road and Drucker Lane. Construction of the second phase is scheduled to be complete in FY 2016.

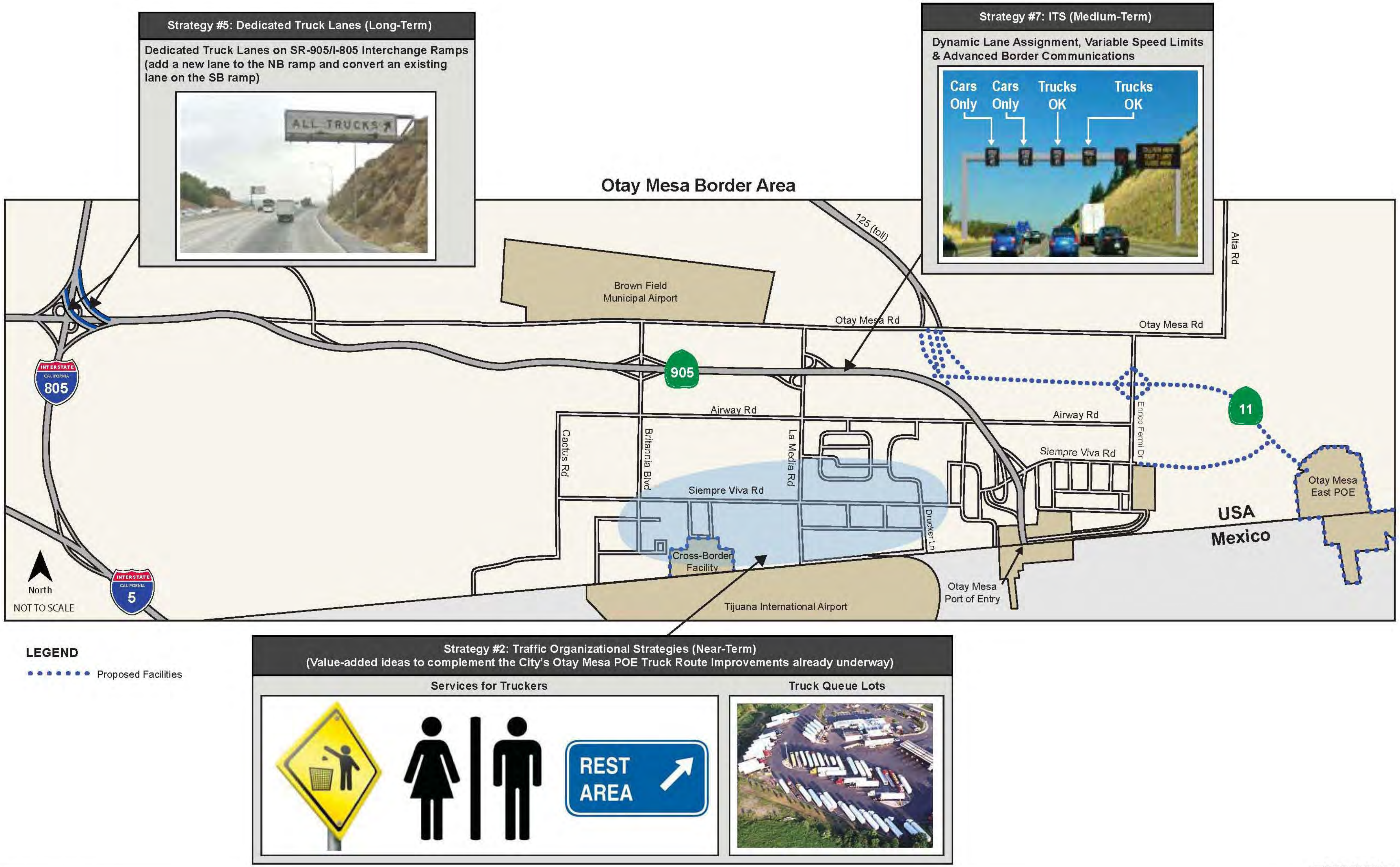
Issues with ROW constraints, costs, and steep slopes, would need to be addressed for both options prior to implementation.

Truck Management Strategy # 7 - ITS

To improve traffic flow along SR 905 for trucks coming to/from the U.S./Mexico border, consider the following:

- Dynamic lane assignment: This would enable the allowance of trucks on all lanes on SR 905. This would require a gantry with dynamic message signs indicating when trucks are allowed in each lane (e.g. “trucks ok”, “passenger vehicles only”). To improve traffic flow, southbound trucks heading toward the existing border could be assigned to the right two lanes and through trucks or trucks heading to the new border crossing could be assigned to the left two lanes. The pavement profile for the left lanes on SR 905 approaching SR 11 and the Otay Mesa East POE would be able to support the weight of trucks. Caltrans is already seeking an exemption for SR 11 to allow trucks in the left hand lane, so implementing this strategy could be well-timed.
- Automated notification system: This could notify truckers in advance of congestion issues at the border and suggest alternate routes/time of day, etc so truckers can make their travel decisions based on complete information. This could be implemented in conjunction with southbound border wait time systems currently under consideration by Caltrans and SANDAG. Notification could occur through CMS signs located along SR 905, as well as on key surface streets. A future Caltrans CMS is planned for SR 905 at Britannia Boulevard eastbound. Also, information could be broadcast as part of a broader border wait time and information system through regional 511 and related information outlets. Local CMS and/or simple static signage with dynamic wait time elements could be deployed on La Media Road and Britannia Boulevard to inform local trucking traffic of delays and provide opportunities to access services before joining a lengthy border crossing line.

Figure 5: Trucks on Managed Lanes: Potential Strategy Applicability in the Otay Mesa Border Truck Gateway



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Conceptual Corridor #2: I-15 (from SR 163 to SR 78)

I-15 from SR 163 to SR 78 currently has four managed lanes (two in each direction) with five DARs throughout the corridor. The project team looked for freeway corridors with plans for four managed lanes (two each way) and DARs to allow for the testing of Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access. The corridor is also projected to experience an increase in truck volumes between now and 2050 in both directions, though the percentage of traffic that is composed of trucks is expected to increase only a little (in the northbound direction). Daily level of service is expected to fall from LOS A (existing conditions) to between LOS D to F in 2050. In addition, several areas along I-15 were identified as problem areas by the trucking industry stakeholder interviewees, including the segment of the corridor that goes through Rancho Bernardo and the I-15/SR 78 Interchange.

The potential strategies identified for this corridor include Truck Management Strategy #3: TDM, Truck Management Strategy #4: Trucks on Managed Lanes - Restricted Access, and Truck Management Strategy #7: ITS. These concepts are illustrated in Figure 6 and further described below.

Truck Management Strategy #3: Truck Travel Demand Management

To address high projected truck volumes on I-15, the project team considered TDM strategies with shippers/receivers in the adjacent Rancho Bernardo Trucking Distribution Hub. However, the project team found that truck and auto traffic on I-15 are not peaking at the same time[10], so a TDM strategy to shift trucks to off-peak travel times does not appear to be needed. However, a TDM strategy could make sense in the future, if peak spreading occurs and/or auto and truck traffic begin to peak at the same time.

Truck Management Strategy #4: Trucks on Managed Lanes – Restricted Access

To address high truck volumes, improve truck mobility, improve truck travel time reliability, and to test the feasibility of allowing trucks on the region's planned network of managed lanes, consider the following:

Level 1: Remove the Existing Occupancy Restrictions for 2-Axle Commercial Trucks: Two-axle trucks are already allowed in the managed lanes; however they must have two or more passengers to use the lanes for free or pay the toll. Since commercial trucks do not often have more than one driver, removing the occupancy restrictions would allow commercial two-axle trucks to access the lanes for free, similar to a carpool. Since 2-axle trucks are currently allowed, this would serve as a good first step to "test" whether or not having access to the managed lane system benefits light-duty truck drivers and to see how the change in occupancy requirements affects the capacity of the managed lanes. The 2-axle commercial trucks could access the managed lanes from either the IAPs or the DARs. FasTrak transponders would be required (which would help ensure non-commercial 2-axle trucks (e.g. pick-up trucks) with a single occupant could not try to use the managed lanes for free).

[10] Identified based on the San Diego Region Occupancy and Classification Study, Vehicle Class Count Site #44, as shown in Technical Memorandum #4: Data Collection, Appendix D pages 165 and 166.

Level 2: Allow Medium-Duty Trucks (3 to 4 Axles) that Meet Maximum Length Restrictions to Access the Managed Lanes via the DARs: Occupancy requirements would be removed for these trucks, but a toll would likely be charged (so Caltrans could remain operational control over the lanes). This would allow a tolled option for trucks in the managed lanes that offers improved travel times and reliability, while still allowing trucks free access in the general purpose lanes. Several issue areas were considered related to this concept, including pavement index, truck turning radii on the existing I-15 DARs, and the existing capacity of the express lanes. Each of these issue areas are addressed below.

Pavement Index: Pavement structural sections were compared between the general purpose lanes and HOV/managed lanes on six sample projects in the region (three on I-15 and three on I-805 as shown in Appendix B). While pavement structural sections for managed lanes can be recommended using the minimum pavement index required, in practice, managed lanes and general purpose lanes are frequently designed and built to the same standard. The results showed that, as built, the HOV/managed lanes have the same or even stronger pavement structural sections compared to the existing general purpose lanes.

Table 4: HOV/Managed Lanes & Existing General Purpose Lanes Pavement Structural Sections

#	Route	Location	Post mile	ADT (Design Year)	Truck Percent-age	GP Mainline Lane**	HOV/Managed Lanes*
1	I-805	SR 54 to SR 94	PM 9.4 – PM 13.8	160,000 (2030)	<5%	0.65' PCC 0.45' CTB 0.90' AS	0.80' JPCP 0.25' HMA-A 0.55' CL2 AB
2	I-805	Palomar Street to SR 54	PM 5.5 – PM 9.4	160,000 (2030)	<5%	0.65' PCC 0.45' CTB 0.90' AS	0.80' JPCP 0.25' HMA-A 0.55' CL2 AB
3	I-15	SR 163 to Carmel Mountain Road	PM R10.4 – PM M21.2	300,000 (2020)	7%	0.75' PCC 0.42' TPB 0.60' AS	0.74' PCC 0.39' HMA-A 0.54' CL2 AB
4	I-15	9th Avenue to SR 78	PM R30.0 – PM R31.5	380,000 (2020)	7%	0.65' PCC 0.45' CTB 0.90' AS	0.89' PCC 0.49' ACB (Type A) 0.64' CL2 AB
5	I-15	Camino Del Norte to Rancho Bernardo Road	PM M22.0 – PM M24.1	NA	-	0.65' PCC 0.55' ACB 1.50' AS	0.75' PCC (UTJ) 0.39' ACB (Type A) 0.54' CL2 AB
6	I-805	Soledad Canyon Bridge to Carmel Mountain Road	PM 26.5 – PM 28.9	202,000 (2030)	8%	0.65' PCC 0.45' CTB 0.50' AS	0.79' JPCP 0.39' HMA-A 0.54' CL2 AB

Source: (Caltrans Advanced Planning Field Counts – April 2013)

* The I-15 HOV/Managed Lane examples have already been built; The I-805 HOV/Managed Lane examples are under construction.

** PCC = Portland Cement Concrete, CTB = Cement Treated Base, AS = Aggregate Sub-base, JPCP = Jointed Plain Concrete Pavement, HMA-A = Hot Mixed Asphalt (Type A), CL2 AB = Class 2 Aggregate, ACB (Type A) = Asphalt Concrete Base

DAR Truck Turning Radii: While some of the DARs on the region's planned network of managed lanes have yet to be built, the DARs along the I-15 study corridor have already been constructed, and many of the DARs along I-805 are currently under construction. As such, turning radii were tested for standard truck lengths in the light-, medium-, and heavy-duty truck categories for two sample DARs along the I-15 corridor (the Del Lago DAR and the Mira Mesa DAR). For these DARs, it was determined that overall, light-duty and medium-duty trucks (with lengths up to the measurements included in Table 5) could likely make the turns onto these two I-15 DARs, while most heavy-duty trucks would experience challenges (as shown in the Appendix C exhibits). The lengths described in Table 5 are based on AASHTO's 2011 standard truck classifications as presented in the software program, AutoTurn. While communication and enforcement regarding truck length restrictions on the DARs could potentially be a challenge, one solution could be to include truck length as a factor when providing trucks with their FasTrak transponders. Further study would be needed to determine the turning radii for the other DARs along I-15 (although the Del Lago DAR was selected because it has one of the tightest turning radii of the DARs along the study corridor). Additional further study should include consideration of signing and truck routing onto and off of the I-15 DARs to avoid impacts to neighborhoods, as well as how to route medium-duty trucks back to the freeway once they are required to exit the managed lanes at the last DAR.

Table 5: Trucks on Managed Lanes Study – Truck Classification Chart

Truck Type	Examples of California Legal Truck Types	Number of Axles*	Example Length Measurements (for Standard Trucks)	Corresponding FHWA Vehicle Class
Light-duty		2	**Non-Articulated Truck** Wheelbase: 20 ft	5 (goods movement trucks only)
Medium-duty	 	3 - 4	**Non-Articulated Truck** Wheelbase: 25 ft **Articulated Truck** Kingpin to rear axle: 25.5 ft Steering axle to rear axle: 38 ft	6, 7, and 8
Heavy-duty	 	5 +	**Articulated Truck** Kingpin to rear axle: 41 ft Steering pin to rear axle: 60.5 ft	9 and 10

* Legal axle weights are assumed for all vehicles

I-15 Express Lane Capacity: The capacity of the I-15 express lanes was also examined to assess the effects of allowing trucks in the managed lanes. Specifically, the project team looked at the current utilization of the lanes in terms of vehicles per hour and mode-split. While the data are somewhat limited along the corridor, Table 6 shows the current volumes and occupancies by mode for the I-15 Express Lanes at Hale Avenue from a count taken by Caltrans in April 2013. The AM and PM peaks occur over a period of three hours, so the vehicles per hour are fairly low (just over 1,200) in the peak directions. The I-15 managed lanes have two lanes in each direction and an overall approximate capacity of about 4,000 vehicles per hour, so the current level of service is quite high. The I-15 express lanes also have the capability of increasing peak direction capacity with the reversible lane moveable barrier if necessary in the future. While Table 6 only shows existing volumes and mode-split at one location (additional locations and forecasts are not available), it reveals that the I-15 Express Lanes currently have the capacity for additional vehicles, and that carpools/vanpools and transit make up only 30 percent of AM peak traffic and 52 percent of PM peak traffic. In the future, if managed lane capacity is an issue, one policy option could be allowing carpools, transit, and trucks in the managed lanes, and no longer allowing single occupancy vehicles, depending on how the region wants to prioritize the use of the managed lane infrastructure.

Table 6: Volumes and Occupancy on the I-15 Express Lanes at Hale Avenue

Direction	Peak Period (3 hrs)	Total Volume	Mode Split*				
			SOV	HOV-2	HOV-3	Motorcycle	Vanpool/Bus
NB	AM Peak	441	27%	56%	9%	7%	1%
	PM Peak	3754	43%	45%	4%	4%	3%
SB	AM Peak	3738	68%	26%	2%	4%	2%
	PM Peak	1065	36%	53%	6%	4%	1%

Source: (Caltrans Advanced Planning Field Counts – April 2013)

* Totals do not all equal 100% due to rounding

Truck Management Strategy #7: ITS

To improve overall operational flow & safety on the general purpose lanes for all users (including heavy-duty trucks), consider the following external and internal ITS technologies:

- External Technologies:
  - Variable speed limits in conjunction with dynamic lane assignment could help maximize truck throughput along I-15 and reduce speed differentials between passenger vehicles and trucks.
  - Dynamic truck routing in conjunction with the existing Integrated Corridor Management (ICM) program (based on real-time response to incidents and congestion levels) could optimize the use of existing corridor capacity and improve truck travel times along the corridor.
  - Dynamic signage could be used to provide information on when trucks are permitted or prohibited on the managed lanes. In addition, a length detection & warning system for trucks accessing the managed lanes via the DARs could be

helpful (this could initially be in the form of a static sign and then become a dynamic sign in the future).

- Internal Technologies:
  - Driver notification systems could be installed in trucks to notify truck drivers of real-time traffic conditions and recommended routing.
  - Lane-keeping technologies could be installed in trucks to notify truck drivers when driving patterns indicate drowsiness. This could help improve safety and reduce crashes.

Additional information on the potential implementation of a trucks on managed lanes pilot project along I-15 is discussed in the final White Paper produced for this Study.

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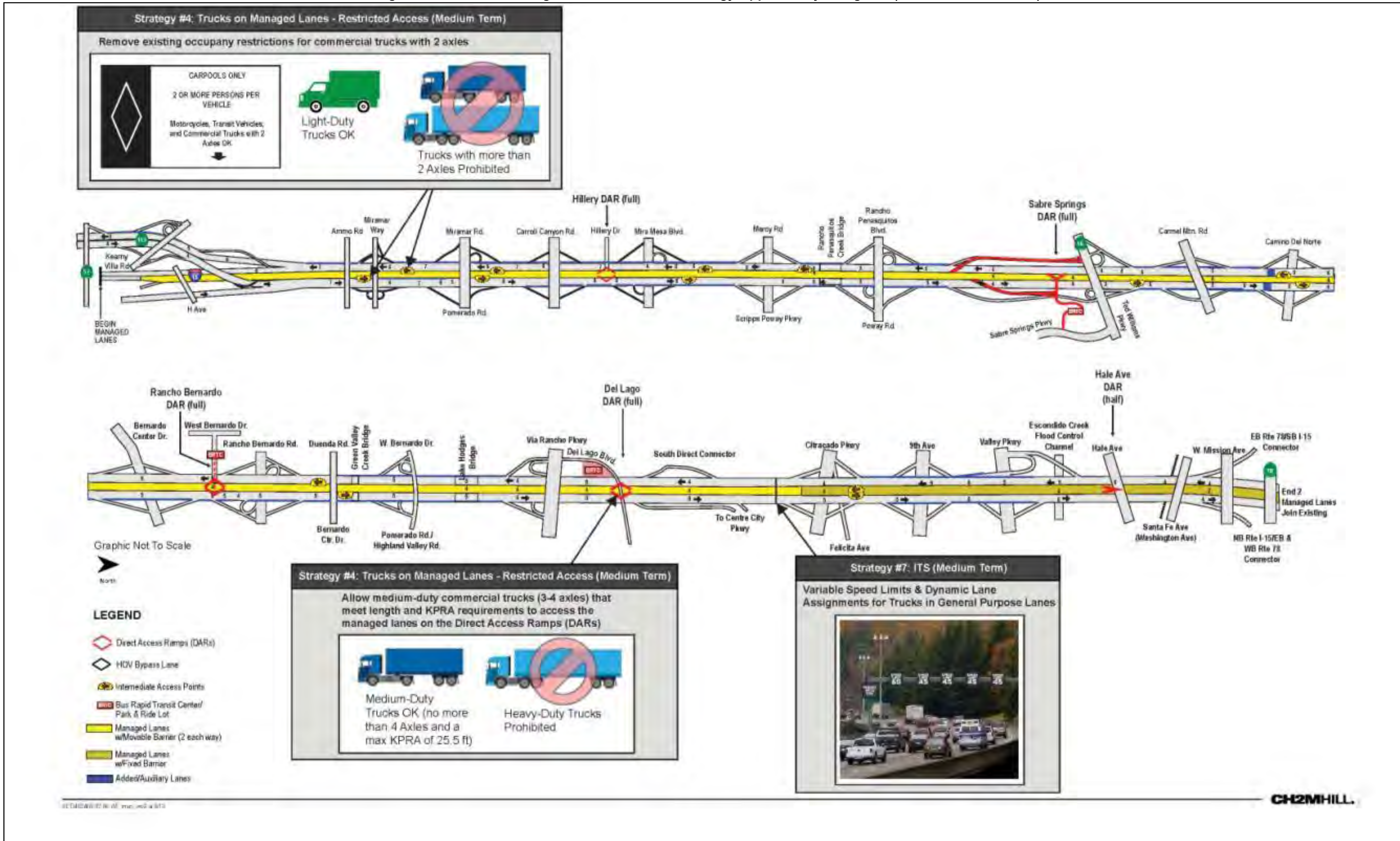
Figure 6: Trucks on Managed Lanes: Potential Strategy Applicability along I-15 (from SR 163 to SR 78)



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Appendix A: Detailed Strategy Analysis Documentation

Tier 1 - Preliminary Strategy Screening: Fatal Flaw Review

Based on preliminary stakeholder feedback, the first tier of analysis was developed to screen the strategies at a high level to identify fatal flaws prior to moving forward with the more detailed Tier 2 quantitative and Tier 3 final strategy assessments. The Tier 1 analysis categories, rating scale, and the results of the Tier 1 assessment are described in the following section.

Tier 1 Analysis Categories, Rating Scale, and Results

The analysis categories for the Tier 1 assessment were developed to help determine whether each strategy is appropriate for implementation in the San Diego region. The list is not intended to be comprehensive, but rather reflects a "first cut" at the "universe" of strategies that were initially identified in Technical Memorandum #3: Strategy Development. The strategies were assessed qualitatively using a "consumer reports" style constructed scale, as described in Table A-1.

Table A-1: Rating Scale

●	The strategy provides the highest level of benefits compared to the base case scenario.
◕	The strategy provides some level of benefit compared to the base case scenario.
◑	The strategy is neutral/performs the same as base case scenario.
◔	The strategy is expected to somewhat worsen conditions, compared to the base case scenario.
○	The strategy is expected to substantially worsen conditions, compared to the base case scenario.

The strategies are generally assessed based on how well they compare to the base case scenario. Specifically, a full circle generally equates to an improvement in conditions over the base case, an empty circle generally equates to a worsening of conditions, and a half circle generally equates to staying "about the same".

A detailed description of each Tier 1 analysis category and an overview of the rating scale are provided in Table A-2. The results of the Tier 1 analysis are included in Table A-3.

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Table A-2: Tier 1 Preliminary Strategy Analysis Categories

Analysis Category	Topic	Description	Scale
Goods Movement	Truck Mobility	Does the strategy improve truck mobility?	● Strategy clearly improves truck mobility compared to the base case scenario. ◕ Strategy could improve truck mobility compared to the base case scenario. ◑ Truck mobility expected to be the same as under the base case scenario. ◔ Strategy would not likely improve truck mobility compared to the base case scenario. ○ Strategy expected to worsen truck mobility compared to the base case scenario.
Legislative Considerations	Consistency with Federal, State, and Local Policy	Would the strategy require changes to existing federal, state, or local legislation?	● No changes to existing legislation are required to implement the strategy. ◕ Potential for minor changes/political buy-in required to implement the strategy. ◑ Minor changes to existing legislation are required to implement the strategy. ◔ Moderate changes to existing legislation are required to implement the strategy. ○ Major changes to existing legislation are required to implement the strategy.
Industry Support	Trucking Industry Acceptance	Is the strategy likely to be supported by trucking industry stakeholders?	● The strategy is expected to be highly supported by the trucking industry. ◕ The majority of trucking industry stakeholders are expected to support the strategy; though some may oppose. ◑ The trucking industry is expected to be neutral (neither actively support nor oppose the strategy). ◔ The majority of trucking industry stakeholders are expected to oppose the strategy; though some may support. ○ The strategy is expected to be controversial and unpopular with the trucking industry.
Broader Community Support	Other Facility User Acceptance (Passenger Vehicle Drivers, Transit, Etc)	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?	● The strategy is expected to be highly supported by other facility users. ◕ The majority of other facility users are expected to support the strategy; though some may oppose. ◑ Other facility users are expected to be neutral (neither actively support nor oppose the strategy). ◔ The majority of other facility users are expected to oppose the strategy; though some may support. ○ The strategy is expected to be controversial and unpopular with other facility users.

Table A-2: Tier 1 Preliminary Strategy Analysis Categories

Analysis Category	Topic	Description	Scale
Broader Community Support (cont.)	Partner Agencies, Non-Profit Stakeholders, Political Leaders, etc	Is the strategy likely to be supported by partner agencies, community stakeholders, and political leaders?	● The strategy is expected to be championed by partner agencies, nonprofit stakeholders, and political leaders. ◕ The strategy is expected to be somewhat supported by partner agencies, nonprofit stakeholders, and political leaders. ◑ Partner agencies, nonprofit stakeholders, and political leaders are expected to be neutral and/or disinterested in the strategy. ◔ The strategy is expected to be somewhat controversial and unpopular with partner agencies, nonprofit stakeholders, and political leaders. ○ The strategy is expected to be actively opposed by partner agencies, nonprofit stakeholders, and political leaders.
Safety and Operations	Traffic Flow	Is the strategy expected to improve overall operations and/or safety for facility users (trucks, vehicles, and transit)?	● The strategy is expected to improve safety and overall traffic flow for all users. ◕ The strategy is expected to improve safety and overall traffic flow for one or more user groups, without detracting from the traffic flow experienced by other user groups. ◑ Safety and overall traffic flow are expected to remain unchanged when compared to the base case scenario. ◔ The strategy is expected to worsen safety and overall traffic flow conditions experienced by at least one, but not all facility user groups. ○ The strategy is expected to worsen safety and overall traffic flow conditions experienced by all facility user groups.
Financial Considerations	Overall Cost-Effectiveness (Public-Sector Perspective)	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?	● The relative benefits of the strategy are expected to outweigh the costs over the strategy life cycle. ◕ The relative benefits of the strategy are expected to slightly outweigh the costs over the strategy life cycle. ◑ The relative benefits of the strategy are expected to break even with the costs over the strategy life cycle. ◔ The relative benefits of the strategy are expected to be somewhat less that the costs over the strategy life cycle. ○ The relative benefits of the strategy are not expected to outweigh the costs over the strategy life cycle.

Table A-3: Tier 1 Strategy Analysis Results

#	Strategy ○◔◑◕●		Goods Movement	Legislative Consideration	Industry Support	Broader Community Support		Safety and Operations	Financial Considerations	Fatal Flaw Results ○ = 0 - .125, ◔ = .126 - .375 ◑ = .376 - .625 ◕ = .626 - .875 ● = .876 - 1		
		Analysis Category:	Goods Movement	Legislative Consideration	Industry Support	Broader Community Support		Safety and Operations	Financial Considerations			
		Topic:	Truck Mobility	Consistency with Federal, State and Local Policy	Trucking Industry Acceptance	Other facility user acceptance (passenger vehicles drivers, transit, etc)	Partner agencies, nonprofits, political leader support	Traffic flow	General cost-effectiveness			
		Descrip-tion:	Does the strategy meet the desired improvements in truck mobility over short, medium, and long term planning horizons?	Is the strategy consistent with federal, state, and local Policy?	Is the strategy acceptable to trucking industry stakeholders?	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?	Is the strategy acceptable to partner agencies, community stakeholders, and political leaders?	Is the strategy expected to improve overall traffic flow for facility users (trucks, vehicles, and transit)?	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?			
1	**Base Case Scenario**		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	**Traffic Organizational Strategies at Freight Gateways & Distribution Hubs**		◑	●	●	◑	◕	◑	●	◕	21/28	0.75
			The benefits are likely to be localized and may not meet longer term freight mobility goals.	No legislative changes would be required.	Port and industry stakeholders already noted clear support.	Other facility users are expected to be neutral (neither strong support nor opposition is expected).	Some local neighborhoods could have concerns; however others may be supportive.	Strategy would have localized safety/traffic flow improvements; however broader issues may remain.	The strategy would have low costs with high, localized benefits.			
3	**Travel Demand Management Strategies to be Developed with Truckers and Shippers/ Receivers**		◔	◑	◔	●	◕	◑	◕	◑	16/28	0.57
			This is a useful strategy, though not great for enhancing truck mobility.	Local policy programs would likely be required to implement this strategy.	Likely acceptable to truckers (in urban areas); may be less acceptable to shippers/receivers. Truckers may initially perceive issues with working off hours, though benefits related to making more trips with fewer drivers & equipment (due to expanded receiving hours) may offset this issue.	Other facility users are expected to support this strategy since it would shift trucks to off-peak travel times.	This strategy is expected to be generally liked by the community, though some neighborhoods could oppose increases in nighttime truck traffic.	There would be potential risks born by the private industry with an increase in nighttime operations.	This strategy has low public costs with the potential for high benefits. However private sector costs could increase (costs to shippers/receivers).			

Table A-3: Tier 1 Strategy Analysis Results

#	Strategy ○◔◑◕●		Goods Movement	Legislative Consideration	Industry Support	Broader Community Support		Safety and Operations	Financial Considerations	Fatal Flaw Results ○ = 0 - .125, ◔ = .126 - .375 ◑ = .376 - .625 ◕ = .626 - .875 ● = .876 - 1		
		Analysis Category:	Goods Movement	Legislative Consideration	Industry Support	Broader Community Support		Safety and Operations	Financial Considerations			
		Topic:	Truck Mobility	Consistency with Federal, State and Local Policy	Trucking Industry Acceptance	Other facility user acceptance (passenger vehicles drivers, transit, etc)	Partner agencies, nonprofits, political leader support	Traffic flow	General cost-effectiveness			
		Descrip-tion:	Does the strategy meet the desired improvements in truck mobility over short, medium, and long term planning horizons?	Is the strategy consistent with federal, state, and local Policy?	Is the strategy acceptable to trucking industry stakeholders?	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?	Is the strategy acceptable to partner agencies, community stakeholders, and political leaders?	Is the strategy expected to improve overall traffic flow for facility users (trucks, vehicles, and transit)?	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?			
4	**Trucks on the Planned Network of HOV/HOT Managed Lanes (Full-Shared Access)**		◑	○	○	○	○	○	◑	◔	4/28	0.14
			Truck mobility expected to be enhanced for some trucks only.	Legislative changes would be required to implement this strategy.	Multiple concerns related to access and safety are anticipated.	Other facility users are expected to have multiple concerns related to this strategy.	Multiple concerns related to access and safety are anticipated.	Multiple concerns related to access and safety will impact traffic flow.	The system is already planned for construction and there are possible pavement issues to consider.			
5	**Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access)**		◕	○	◑	◔	◑	◑	◑	◑	12/28	0.43
			There are potential benefits for certain truck types.	Legislative changes would be required to implement and would vary depending on the types of restrictions.	The greater level of isolation for trucks would reduce concerns.	The restrictions would help to make this strategy more acceptable than full access.	The greater level of isolation for trucks would reduce concerns.	The greater level of isolation for trucks would reduce concerns.	The increased cost of signage would likely be offset by the increased benefits of the strategy.			
6	**Designated Truck Lanes (Conversion of General Purpose Lanes)**		◔	●	○	○	○	○	○	◔	6/28	0.21
			It would be challenging to isolate trucks and disallow autos - mobility benefits may be marginal. No improvement over the base case.	Major legislative changes are not anticipated.	Industry support would depend on the specifics (e.g. mandatory usage? Passing lane?)	Converting GP lanes is typically controversial. Vehicle drivers would experience less capacity.	Converting GP lanes is typically controversial. Vehicle drivers would experience less capacity.	Issues could come up due to merging /weaving.	The benefits of the strategy are not expected to merit the costs of implementation.			

Table A-3: Tier 1 Strategy Analysis Results

#	Strategy ○◔◑◕●		Goods Movement	Legislative Consideration	Industry Support	Broader Community Support		Safety and Operations	Financial Considerations	Fatal Flaw Results ○ = 0 - .125, ◔ = .126 - .375 ◑ = .376 - .625 ◕ = .626 - .875 ● = .876 - 1		
		Analysis Category:	**Goods Movement**	**Legislative Consideration**	**Industry Support**	**Broader Community Support**		**Safety and Operations**	**Financial Considerations**			
		Topic:	**Truck Mobility**	**Consistency with Federal, State and Local Policy**	**Trucking Industry Acceptance**	**Other facility user acceptance (passenger vehicles drivers, transit, etc)**	**Partner agencies, nonprofits, political leader support**	**Traffic flow**	**General cost-effectiveness**			
		Descrip-tion:	Does the strategy meet the desired improvements in truck mobility over short, medium, and long term planning horizons?	Is the strategy consistent with federal, state, and local Policy?	Is the strategy acceptable to trucking industry stakeholders?	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?	Is the strategy acceptable to partner agencies, community stakeholders, and political leaders?	Is the strategy expected to improve overall traffic flow for facility users (trucks, vehicles, and transit)?	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?			
7	**Designated Truck Lanes (Construction of New Lanes on Existing Facilities - e.g. Truck By-Pass lanes, routes, or climbing lanes)**		◕	◕	●	◔	◔	●	◑	◕	18/28	0.64
			The mobility improvements will be localized.	Consistent with federal and state policy, may not be consistent with local policy.	The trucking industry is expected to be very supportive of this concept.	Passenger vehicle drivers would like the higher degree of separation, but may argue for a new GP lane for all users instead.	New capacity is likely to be controversial (SCS); some support & some opposition expected; could improve air and GHG emissions.	The good degree of isolation would benefit traffic flow.	This strategy is expected to have both high costs and high benefits.			
8	**Separate Dedicated Truck-Only Facilities (Construction of New Facilities)**		●	◑	◕	◔	○	●	○	◑	14/28	0.50
			This strategy would greatly enhance truck mobility by removing trucks from general traffic.	This strategy is expected to be somewhat inconsistent with local policy.	This strategy is likely to be acceptable to the trucking industry; however, this level of investment would very likely require tolling, which may be controversial.	Passenger vehicle drivers would like the higher degree of separation, but may argue for a new GP lane for all users instead.	Building new ROW in developed areas would be unpopular; unlikely that truck volumes will warrant this level of investment.	The higher degree of isolation would improve traffic flow.	The benefits of this strategy in San Diego are unlikely to warrant the costs.			

Table A-3: Tier 1 Strategy Analysis Results

#	Strategy ○◔◑◕●		Goods Movement	Legislative Consideration	Industry Support	Broader Community Support		Safety and Operations	Financial Considerations	Fatal Flaw Results ○ = 0 - .125, ◔ = .126 - .375 ◑ = .376 - .625 ◕ = .626 - .875 ● = .876 - 1		
		Analysis Category:	Goods Movement	Legislative Consideration	Industry Support	Broader Community Support		Safety and Operations	Financial Considerations			
		Topic:	Truck Mobility	Consistency with Federal, State and Local Policy	Trucking Industry Acceptance	Other facility user acceptance (passenger vehicles drivers, transit, etc)	Partner agencies, nonprofits, political leader support	Traffic flow	General cost-effectiveness			
		Descrip-tion:	Does the strategy meet the desired improvements in truck mobility over short, medium, and long term planning horizons?	Is the strategy consistent with federal, state, and local Policy?	Is the strategy acceptable to trucking industry stakeholders?	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?	Is the strategy acceptable to partner agencies, community stakeholders, and political leaders?	Is the strategy expected to improve overall traffic flow for facility users (trucks, vehicles, and transit)?	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?			
9	**Tolling Strategies for Trucks in General Purpose Lanes (Based on Traffic Conditions or Time of Day)**		○	○	○	◔	◑	◔	○	◔	4/28	0.14
			This strategy would do nothing to enhance truck mobility – it is designed to optimize traffic flow for passenger vehicles.	Legislative changes would be needed to toll existing GP lanes.	This strategy is expected to be highly controversial and opposed by the trucking industry.	This strategy may be unpopular due to local arterial impacts.	Potential general support is expected, though some economic and neighborhood impact concerns could arise (due to shifting trucks to local arterials).	This strategy improves conditions in some locations and for some users; however it worsens conditions in other locations.	This strategy has low benefits with high implementation costs.			
10	**Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment**		◕	◕	●	◔	◕	◑	◑	◕	18/28	0.64
			This strategy has the potential to improve conditions over the base case.	This strategy could require some buy-in from policymakers.	The trucking industry would enjoy the potential for increased truck throughput.	Lane assignments that allow trucks in new lanes could be controversial.	Some mild interest/support is expected.	Improvements are expected overall, though the degree to which improvements are experienced by trucks and passenger vehicles could vary.	This strategy is expected to have medium costs with high benefits.			

Tier 1 Analysis – Summary of Findings

As reported in Technical Memorandum #3: Strategy Development, the project team and PST discussed and analyzed all ten strategies and it was determined that three strategies were either redundant as stand-alone strategies or inappropriate for further analysis. These strategies are described below:

- **Strategy # 4: Trucks on the Planned Network of HOV/HOT Managed Lanes (Full, Unrestricted Access).** The project team heard multiple concerns from both trucking industry and broader community stakeholders related to access, operations, and safety related to the allowance of full, unrestricted access for trucks on the planned network of HOV/HOT lanes. Additionally, current legislation would need to be revised to allow trucks of all sizes in the HOV/HOT lanes and there are no solid successful examples of this strategy operating elsewhere in the United States.

- **Strategy #6: Designated Truck Lanes (Conversion of General Purpose Lanes).** Designating a lane for trucks can be accomplished under the ITS Strategy through dynamic lane assignment. Also, converting an existing general purpose lane to a truck-only lane would be challenging. If lanes were designated truck-only on the left hand side of the freeway, DAR access may be required. If the lanes were on the right hand side, weaving issues with passenger vehicles could occur (and this would not provide much benefit over the current right lane restrictions in California). Additionally, converting a general purpose lane from auto to truck would be highly controversial and the potential to then manage the truck lane with tolls would require a change to existing legislation.

- **Strategy # 9: Variable Tolling Strategies for Trucks in General Purpose Lanes (Based on Traffic Conditions or Time of Day).** Tolling strategies for trucks in general purpose lanes does little to meet the problem statement goal of enhancing truck mobility. While mobility for passenger vehicles may be somewhat improved by shifting truck traffic to alternate times of day or routes, the toll would be punitive in that it would not offer the trucking industry any tangible benefits in the form of improved travel times or travel time reliability, or a non-tolled option. Also, tolls can cause diversion of trucks to alternate routes that are not designed to accommodate trucks. Strong opposition and litigation would be expected from the trucking industry, negative impacts could occur within local communities due the diversion of trucks onto local arterials, and it would also be legislatively difficult to implement since tolling existing general purpose lanes is currently not allowed under existing legislation.

Due to the reasons described above, the project team and PST agreed to narrow the strategy list from the initial list of ten, to the seven strategies listed below:

1. **Base Case Scenario (Current RTP Improvements):** Consider what the future looks like for goods mobility in the region if no new actions are taken to address truck mobility (in addition to the improvements already identified in the currently adopted 2050 RTP).

2. **Traffic Organizational Strategies at Freight Gateways & Distribution Hubs:** Coordinated strategies to optimize truck traffic flow at key locations. The strategies

implemented could range from simple to more complex and include ITS/communication strategies (such as the use of variable message signs and 511 announcements to provide real-time information to truckers to help them avoid congestion and bottlenecks) and infrastructure-based strategies (such as dedicated trucks lanes or facilities in key bottleneck locations).

3. **Travel Demand Management (TDM) Strategies to be Developed with Truckers and Shippers/ Receivers:** Facilitate the shifting of trucks to off-peak travel times, based on pricing incentives and fees.

4. **Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access):** Allow trucks restricted access to the network of managed lanes, for example during off-peak periods, for off-peak directions, assign trucks to certain lanes and/or restrict access to certain truck types.

5. **Designated Truck Lanes:** The construction of new lanes on existing facilities, such as truck bypass lanes, truck routes, or climbing lanes.

6. **Separate Dedicated Truck-Only Facilities:** The construction of new facilities dedicated for trucks.

7. **Intelligent Transportation Systems/Active Traffic Management and Lane Assignment:** Use technologies (both external and in-vehicle) to improve truck mobility and safety. Optimize the operational flexibility of the freeway through lane assignment, active speed management, and/or dynamic signage.

These seven truck management strategies were moved forward into the more comprehensive Tier 2 and Tier 3 analyses.

Tier 2 - Quantitative Strategy Analysis: Strategy Applicability Review

The Tier 2 Quantitative Strategy Analysis was designed to determine the applicability of the seven truck management strategies to the San Diego region. The Tier 2 assessment process consisted of the following steps:

1. Further developing the remaining seven truck management strategies to determine when, where, and for whom each strategy is most applicable (described in the body of this memorandum in Section 2).
2. Gathering local data and interviewing industry stakeholders to identify key trucking corridors and gateways/distribution hubs throughout the region (completed as part of Technical Memorandum #4: Data Collection).
3. Assessing the seven strategies to determine the potential for each strategy to improve the current and projected truck mobility needs in the San Diego region. This involved comparing what is known about truck volume and percentage thresholds that merit certain strategies (as identified in the literature review) to the findings from the local

data collection. These thresholds and guidelines are described in the following section. The results of this process are documented in the body of this memorandum in Section 3.

Tier 2 - Strategy Thresholds and Guidelines

Table A-4 includes example thresholds and guidelines for both truck-only lanes and the conversion of general purpose lanes to truck lanes identified from the literature review. These thresholds are examples of the types of conditions that may merit implementation of the referenced strategy.

Table A-4. Example Strategy Thresholds and Guidelines

Truck-Only Lane Thresholds	
ADT (two-way)	> 100,000 - 120,000 OR at least 15,000 per lane
Peak total traffic volumes	> 1,800 vehicle per hour per lane (vphpl)
Off-peak total traffic volumes	> 1,200 vphpl
Truck Volumes (two- way ADT)	> 20,000 for 10 miles
Truck percentages	> 25% - 30% of total traffic
LOS	"E" for urban areas; "F" for rural areas
Lane configuration	At least 2 general purpose lanes and the potential for 2 truck-only lanes in each direction
Corridor location	Proximity to major freight generators or termini
Conversion of general purpose lane to truck lane	
Truck Volumes	> 12 %

Sources: NCHRP Report 649/NCFRP Report 3, 2010; Burke, 2005

Table A-5 includes information on the types of existing and projected truck volumes and percentages on three of the facilities that were included as case studies in Technical Memorandum # 1: Literature Review.

Table A-5: Example Strategy Thresholds and Guidelines from Case Studies

Case Study	Year	Average daily truck volumes (two-way)	Percent Truck Volumes of Total	Percent of Accidents Involving Trucks
I- 710 DEIS – Dedicated Truck Facility	2008	10,300 - 42,100	9 - 50%	29 - 36% (from 2004 - 2007)
	2035	20,100 - 74,400	11 - 63%	N/A
I-70 Dedicated Truck Lanes	2009	10,207 - 16,869	18 - 34%	26%
	2045	21,911 - 35,222	20 - 35%	59%
I-81 Virginia (Variable Tolls)	2005	N/A	20 - 40%	N/A

In general, the projected truck volumes and truck percentages on San Diego freeways through 2050 are not high enough to merit the capital-intensive levels of investment required for the construction of dedicated truck lanes or separate truck-only facilities (Truck Management Strategies # 5 and #6). However, truck lanes may still be appropriate for consideration in certain key locations, such as for an interchange by-pass, or where climbing lanes may be merited.

Tier 2 Analysis – Summary of Findings

No strategies were screened out as a result of the Tier 2 Quantitative Analysis; however, the project team came away with a much better understanding of how each strategy might potentially apply to locations throughout the San Diego region. This information is fully documented in the body of this memorandum in Section 3. While some strategies apply multiple times (e.g. Strategy #7: ITS) and others not at all (e.g. Strategy #6: Separate Dedicated Truck-Only Facilities), all of the strategies were carried forward into the Tier 3 Final Strategy Analysis, so that a complete understanding of the issues associated with each strategy could be documented for future reference.

Tier 3 - Final Strategy Analysis: Performance Against Goals

Tier 3 Analysis Categories, Rating Scale, and Results

The Tier 3 Final Strategy Analysis process was designed to screen the truck management strategies against the project issue areas and goals. The analysis categories for the Tier 3 assessment are based on the content of the Problem Statement and Technical Memorandum #2: Issues Identification, and represent a more fully developed and comprehensive version of the Tier 1 Fatal Flaw analysis categories. The same rating scale (consumer reports style) used for the Tier 1 assessment was used for Tier 3, and is shown in Table A-6 below.

Table A-6: Rating Scale

●	The strategy provides the highest level of benefits compared to the base case scenario.
◕	The strategy provides some level of benefit compared to the base case scenario.
◑	The strategy is neutral/performs the same as base case scenario.
◔	The strategy is expected to somewhat worsen conditions, compared to the base case scenario.
○	The strategy is expected to substantially worsen conditions, compared to the base case scenario.

The strategies were generally analyzed based on how well they compared to the base case scenario. Specifically, a full circle generally equated to an improvement in conditions over the base case, an empty circle generally equated to a worsening of conditions, and a half circle generally equated to staying "about the same".

A detailed description of the strategy analysis categories are provided in Table A-7, and the results of the Tier 3 Final Strategy Analysis are provided in Tables A-8.1 to A-8.3. The analysis categories and topics that were also a part of the Tier 1 Fatal Flaw Review are shown in gray in Table A-7 and are also starred in Tables A-8.1 to A-8.3. The analysis categories and topics that were previously assessed in Tier 1 were reviewed again and updated as needed in the Tier 3 Final Strategy Analysis. The results of the Tier 3 Analysis are described in the body of this memorandum in Section 2.

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Table A-7: Tier 3 Final Strategy Analysis Categories[11]

Analysis Category	Topic	Description	Scale
Goods Movement	Truck Mobility	Does the strategy improve truck mobility?	● Strategy clearly improves truck mobility compared to the base case scenario. ◕ Strategy could improve truck mobility compared to the base case scenario. ◑ Truck mobility expected to be the same as under the base case scenario. ◔ Strategy would not likely improve truck mobility compared to the base case scenario. ○ Strategy expected to worsen truck mobility compared to the base case scenario.
Legislative Considerations	Consistency with Federal, State, and Local Policy	Would the strategy require changes to existing federal, state, or local legislation?	● No changes to existing legislation are required to implement the strategy. ◕ Potential for minor changes/political buy-in required to implement the strategy. ◑ Minor changes to existing legislation are required to implement the strategy. ◔ Moderate changes to existing legislation are required to implement the strategy. ○ Major changes to existing legislation are required to implement the strategy.
Industry Support	Trucking Industry Acceptance	Is the strategy likely to be supported by trucking industry stakeholders?	● The strategy is expected to be highly supported by the trucking industry. ◕ Many trucking industry stakeholders are expected to support the strategy; though some may oppose. ◑ The trucking industry is expected to be neutral (neither actively support nor oppose the strategy). ◔ Many trucking industry stakeholders are expected to oppose the strategy; though some may support. ○ The strategy is expected to be controversial and unpopular with the trucking industry.
	Private Sector Profitability	Is the strategy expected to enhance or reduce profitability for the trucking industry?	● The strategy is expected to enhance profitability for all trucking industry stakeholders. ◕ The strategy is expected to enhance profitability for the majority of trucking industry stakeholders. ◑ The strategy is neutral in regards to trucking industry profitability. ◔ The strategy is expected to reduce profitability for the majority of trucking industry stakeholders. ○ The strategy is expected to substantially reduce profitability for all trucking industry stakeholders.
	Truck Types and Truck Trip Types	Is the strategy likely to benefit all types of trucks and truck trip types?	● The strategy is expected to benefit all types of trucks and truck trip types. ◕ The strategy is expected to benefit many types of trucks and truck trip types, but not all. ◑ The strategy is expected to benefit some types of trucks and truck trip types. ◔ The strategy is expected to benefit a few types of trucks or truck trip types. ○ The strategy is not expected to benefit trucks.

[11] Shaded rows were also included as part of the Tier 1 Analysis.

Table A-7: Tier 3 Final Strategy Analysis Categories[11]

Analysis Category	Topic	Description	Scale
Broader Community Support	Other Facility User Acceptance (Passenger Vehicle Drivers, Transit, Etc)	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?	● The strategy is expected to be highly supported by other facility users. ◕ The majority of other facility users are expected to support the strategy; though some may oppose. ◑ Other facility users are expected to be neutral (neither actively support nor oppose the strategy). ◔ The majority of other facility users are expected to oppose the strategy; though some may support. ○ The strategy is expected to be controversial and unpopular with other facility users.
	Partner Agencies, Non-Profit Stakeholders, Political Leaders, etc	Is the strategy likely to be supported by partner agencies, community stakeholders, and political leaders?	● The strategy is expected to be championed by partner agencies, nonprofit stakeholders, and political leaders. ◕ The strategy is expected to be somewhat supported by partner agencies, nonprofit stakeholders, and political leaders. ◑ Partner agencies, nonprofit stakeholders, and political leaders are expected to be neutral and/or disinterested in the strategy. ◔ The strategy is expected to be somewhat controversial and unpopular with partner agencies, nonprofit stakeholders, and political leaders. ○ The strategy is expected to be actively opposed by partner agencies, nonprofit stakeholders, and political leaders.
	Adjacent Neighborhood Support/Environmental Justice Issues	Is the strategy likely to be supported by residents and business owners immediately adjacent to the corridor?	● The strategy is expected to be championed by residents and business owners immediately adjacent to the corridor. ◕ The strategy is expected to be somewhat supported by residents and business owners immediately adjacent to the corridor. ◑ Residents and business owners immediately adjacent to the corridor are expected to be neutral and/or disinterested in the strategy. ◔ The strategy is expected to be somewhat controversial and unpopular with residents and business owners immediately adjacent to the corridor. ○ The strategy is expected to be actively opposed by residents and business owners immediately adjacent to the corridor.
Local Economic Development	Local & Regional Economic Prosperity	Is the strategy expected to enhance local & regional economic prosperity?	● The strategy is expected to substantially enhance the local & regional economy. ◕ The strategy is expected to somewhat enhance the local & regional economy. ◑ The strategy is not expected to affect the local & regional economy. ◔ The strategy is expected to somewhat negatively affect the local & regional economy. ○ The strategy is expected to strongly negatively affect the local & regional economy.

Table A-7: Tier 3 Final Strategy Analysis Categories[11]

Analysis Category	Topic	Description	Scale
	Border Issues	Is the strategy expected to enhance goods movement across the Border?	● The strategy is expected to substantially enhance goods movement across the Border. ◕ The strategy is expected to somewhat enhance goods movement across the Border. ◑ The strategy is not expected to affect goods movement across the Border. ◔ The strategy is expected to somewhat negatively impact goods movement across the Border. ○ The strategy is expected to strongly negatively impact goods movement across the Border.
Environmental Considerations	Air and Greenhouse Gas Emissions	Is the strategy expected to help reduce criteria air pollutants and greenhouse gas emissions?	● The strategy is expected to substantially reduce criteria air pollutants and greenhouse gas emissions. ◕ The strategy is expected to somewhat reduce criteria air pollutants and greenhouse gas emissions. ◑ The strategy is not expected to reduce criteria air pollutants and greenhouse gas emissions. ◔ The strategy is expected to somewhat increase criteria air pollutants and greenhouse gas emissions. ○ The strategy is expected to substantially increase criteria air pollutants and greenhouse gas emissions.
Safety and Operations	Traffic Flow	Is the strategy expected to improve overall operations and/or safety for facility users (trucks, vehicles, and transit)?	● The strategy is expected to improve safety and overall traffic flow for all users. ◕ The strategy is expected to improve safety and overall traffic flow for one or more user groups, without detracting from the traffic flow experienced by other user groups. ◑ Safety and overall traffic flow are expected to remain unchanged when compared to the base case scenario. ◔ The strategy is expected to worsen safety and overall traffic flow conditions experienced by at least one, but not all facility user groups. ○ The strategy is expected to worsen safety and overall traffic flow conditions experienced by all facility user groups.
	Travel Time Reliability	Is the strategy expected to improve travel time reliability for facility users (trucks, vehicles, and transit)?	● The strategy is expected to improve travel time reliability for all users. ◕ The strategy is expected to improve travel time reliability for one or more user groups, without detracting from the travel time reliability experienced by other user groups. ◑ Travel time reliability is expected to remain unchanged for all users when compared to the base case scenario. ◔ The strategy is expected to worsen the travel time reliability experienced by at least one, but not all facility user groups. ○ The strategy is expected to worsen the travel time reliability experienced by all facility user groups.

Table A-7: Tier 3 Final Strategy Analysis Categories[11]

Analysis Category	Topic	Description	Scale
	Safety/Accident Rates	Is the strategy expected to improve safety for facility users (trucks, vehicles, and transit)?	● The strategy is expected to improve safety for all users. ◕ The strategy is expected to improve safety for one or more user groups, without detracting from the safety of other user groups. ◑ Safety is expected to remain unchanged for all users when compared to the base case scenario. ◔ The strategy is expected to worsen safety for at least one, but not all facility user groups. ○ The strategy is expected to reduce safety for all facility user groups.
	Trucking Industry Liability	Is the strategy expected to reduce trucking industry liability?	● The strategy is expected to substantially reduce trucking industry liability. ◕ The strategy is expected to somewhat reduce trucking industry liability. ◑ Trucking industry liability is expected to remain unchanged by the strategy. ◔ The strategy is expected to somewhat increase trucking industry liability. ○ The strategy is expected to substantially increase trucking industry liability.
	Incident Management	Is the strategy expected to improve incident management?	● The strategy is expected to greatly improve incident management. ◕ The strategy is expected to somewhat improve incident management. ◑ Incident management is expected to remain unchanged by the strategy. ◔ The strategy is expected to somewhat negatively impact incident management. ○ The strategy is expected to substantially negatively impact incident management.
Engineering Considerations	Engineering Feasibility	Is the strategy generally implementable from an engineering perspective? For example, are issues such as ROW constraints, ingress/egress or pavement design anticipated to be consistent obstacles to implementation?	● The strategy is expected to be easily implementable from an engineering perspective, in the majority of cases. ◕ The strategy is expected to be generally implementable from an engineering perspective, in many cases. ◑ The strategy is expected to be implementable from an engineering perspective in about half of the cases. ◔ The strategy is expected to not be implementable from an engineering perspective, in most cases. ○ The strategy is expected to not be implementable from an engineering perspective, in all cases.

Table A-7: Tier 3 Final Strategy Analysis Categories[11]

Analysis Category	Topic	Description	Scale
Public Sector Financial Considerations	Capital and O&M costs	Are the capital and operations and maintenance costs expected to be cost prohibitive?	● The capital and operating and maintenance costs are expected to minimally increase public expenditure on freight and goods movement. ◕ The capital and operating and maintenance costs are expected to modestly increase public expenditure on freight and goods movement. ◑ The capital and operating and maintenance costs are expected to somewhat increase public expenditure on freight and goods movement. ◔ The capital and operating and maintenance costs are expected to substantially increase public expenditure on freight and goods movement. ○ The capital and operating and maintenance costs are expected to greatly increase public expenditure on freight and goods movement.
	Revenue Generation Potential	Does the strategy have the potential to generate revenue?	● The strategy will generate a large amount of revenue. ◕ The strategy will generate a moderate amount of revenue. ◑ The strategy will generate some revenue. ◔ The strategy may generate revenue, but it is uncertain. ○ The strategy will not generate revenue.
	Overall Cost-Effectiveness (Public-Sector Perspective)	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?	● The relative benefits of the strategy are expected to outweigh the costs over the strategy life cycle. ◕ The relative benefits of the strategy are expected to slightly outweigh the costs over the strategy life cycle. ◑ The relative benefits of the strategy are expected to break even with the costs over the strategy life cycle. ◔ The relative benefits of the strategy are expected to be somewhat less that the costs over the strategy life cycle. ○ The relative benefits of the strategy are not expected to outweigh the costs over the strategy life cycle.

Table A-8.1: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●	Analysis Category:	Goods Movement	Legislative Consideration	Industry Support			Broader Community Support
		Topic:	Truck Mobility*	Consistency with Federal, State and Local Policy *	Trucking Industry Acceptance*	Private Sector Profitability	Truck Types and Truck Trip Types	Other Facility User Acceptance* (passenger vehicles drivers, transit, etc)
		Description:	Description: Does the strategy meet the desired improvements in truck mobility over short, medium, and long term planning horizons?	Is the strategy consistent with federal, state, and local policy?	Is the strategy acceptable to trucking industry stakeholders?	Is the strategy expected to clearly enhance profitability for the trucking industry?	Is the strategy likely to benefit all types of trucks and truck trip types?	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?
1	**Base Case Scenario (Current RTP Improvements)**		N/A	N/A	N/A	N/A	N/A	N/A
2	**Traffic Organizational Strategies at Freight Gateways & Distribution Hubs**		◑	●	●	◕	◕	◑
			Benefits will likely be localized and may not meet longer term freight mobility goals.	No legislative changes would be required.	Port and industry representatives have already noted clear support.	The mobility enhancements related to this strategy would likely enhance trucking industry profitability.	Benefits will accrue to all types of trucks; though solutions at the border will primarily serve regional and long-haul truck trips, while solution at the Port and local gateways and distribution hubs will also serve local trucks.	Other facility users are expected to be neutral (neither strong support nor opposition is expected).
3	**Travel Demand Management Strategies to be Developed with Truckers and Shippers/ Receivers**		◔	◑	◕	◑	◑	●
			While this strategy has the potential to somewhat enhance truck mobility, its primary function is to improve mobility for all travelers within a corridor.	Local policies/programs would likely be required for implementation. Some local policies/programs may need to change (e.g. noise curfews or truck routing).	Likely acceptable to truckers (in urban areas); may be less acceptable to shippers/receivers. Truckers may initially perceive issues with working off hours, though benefits related to being able to make more trips with fewer drivers & equipment (due to expanded receiving hours) may offset this issue.	Could increase costs for shippers/manufacturers due to overtime for union crews. However, trucking industry impacts are likely neutral.	Local and regional trips may benefit more; however long-haul trips may experience challenges since the region lacks parking layover facilities.	Other facility users are expected to support this strategy since it would shift trucks to off-peak travel times.

Table A-8.1: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●							
		Analysis Category:	Goods Movement	Legislative Consideration	Industry Support			Broader Community Support
		Topic:	Truck Mobility*	Consistency with Federal, State and Local Policy *	Trucking Industry Acceptance*	Private Sector Profitability	Truck Types and Truck Trip Types	Other Facility User Acceptance* (passenger vehicles drivers, transit, etc)
		Description:	Description: Does the strategy meet the desired improvements in truck mobility over short, medium, and long term planning horizons?	Is the strategy consistent with federal, state, and local policy?	Is the strategy acceptable to trucking industry stakeholders?	Is the strategy expected to clearly enhance profitability for the trucking industry?	Is the strategy likely to benefit all types of trucks and truck trip types?	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?
4	**Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access)**		◕	○	◑	◕	◕	◔
			There are potential benefits for certain truck types - depending on the types of restrictions implemented.	Legislative changes would be required to implement and would vary depending on the types of restrictions.	The greater level of isolation for trucks would reduce industry safety concerns (e.g. due to speed disparity).	The majority of trucking industry stakeholders would likely benefit in terms of profitability; however trade-offs would need to be assessed in relation to tolling scenarios.	Light- and medium-duty trucks are likely to benefit more than heavy duty trucks. Benefits to different truck types would depend on the specific restrictions implemented. Long stretches could also benefit regional and long-haul truck trip types.	Restrictions will help to make the use of managed lanes more acceptable to other users than allowing trucks full access to the managed lanes. User acceptance will depend on the types of restrictions implemented. Other facility user acceptance is not expected to be high, but the restrictions will make the strategy more palatable.
5	**Designated Truck Lanes (Construction of New Lanes on Existing Facilities - e.g. Truck By-Pass lanes, routes, or climbing lanes)**		◕	◑	●	◕	●	◔
			The mobility improvements associated with this strategy would be localized near the location of investment.	Consideration needed of federal air quality policy that requires a 'congestion management process' in order to add lane capacity to freeways using federal funds.** Also, need for strategy to be consistent with existing local policy documents (e.g. General Plans and regional transportation plan).	The trucking industry is very supportive of this concept if volumes warrant the investment.	This strategy would likely benefit the profitability of a majority of trucking industry stakeholders. Smaller trucks may not benefit as much if all trucks are required to be in a designated lane.	Heavy-duty trucks likely to benefit the most, though small and medium-duty trucks would also benefit.	Passenger vehicle drivers would like the higher degree of isolation this strategy creates, though they may argue for a new GP lane for all users instead.

Table A-8.1: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●		Goods Movement	Legislative Consideration	Industry Support			Broader Community Support
		Analysis Category:	Goods Movement	Legislative Consideration	Industry Support			Broader Community Support
		Topic:	Truck Mobility*	Consistency with Federal, State and Local Policy *	Trucking Industry Acceptance*	Private Sector Profitability	Truck Types and Truck Trip Types	Other Facility User Acceptance* (passenger vehicles drivers, transit, etc)
		Description:	Description: Does the strategy meet the desired improvements in truck mobility over short, medium, and long term planning horizons?	Is the strategy consistent with federal, state, and local policy?	Is the strategy acceptable to trucking industry stakeholders?	Is the strategy expected to clearly enhance profitability for the trucking industry?	Is the strategy likely to benefit all types of trucks and truck trip types?	Is the strategy acceptable to drivers of passenger vehicles and transit vehicles?
6	**Separate Dedicated Truck-Only Facilities (Construction of New Facilities)**		●	◔	◕	◕	●	◔
			This strategy would greatly enhance truck mobility by removing trucks from general traffic.	Consideration needed of federal air quality policy that requires a 'congestion management process' in order to add lane capacity to freeways using federal funds.** Also, need for strategy to be consistent with existing local policy documents (e.g. General Plans and regional transportation plan).	Concept is likely to be supported by the trucking industry, if volumes warrant expenditure. However, this level of investment would very likely require tolling, which may be controversial.	This strategy would be tolled (likely an amount where benefits would still accrue to some trucking industry stakeholders) depending on the implementation.	Heavy-duty trucks likely to benefit the most, though light- and medium-duty trucks would also benefit.	Passenger vehicle drivers would like the higher degree of isolation this strategy creates, though they may argue for a new GP lane for all users instead.
7	**Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment**		◕	◕	●	◑	●	◔
			This strategy has the potential to improve conditions over the base case scenario.	Could require some buy-in from policymakers for improvements such as variable speed limits and dynamic truck lane assignment.	The trucking industry would enjoy the potential for increased truck throughput.	Mobility, safety, and operational improvements could help profitability; however this could be offset by on-vehicle equipment costs.	Benefits would accrue to all truck types and truck trip types.	Dynamic lane assignment that allows trucks in new lanes could potentially be controversial.

* Topic also assessed as part of the Tier 1 analysis. The scores in this section were updated for these topics, as needed, to reflect the more complete set of information available to the project team.

Table A-8.2: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●	Analysis Category:	Broader Community Support		Local Economic Development		Environmental Considerations	Safety and Operations	
		Topic:	**Partner Agencies, Nonprofits, Political Leader Support***	**Adjacent Community Support/Environmental Justice Issues**	**Local & Regional Economic Prosperity**	**Border Issues**	**Air and Greenhouse Gas Emissions**	**Traffic Flow***	**Travel Time Reliability**
		Descrip-tion:	Is the strategy acceptable to partner agencies, community stakeholders, and political leaders?	Is the strategy likely to be supported by residents and business owners immediately adjacent to the corridor?	Is the strategy expected to enhance local & regional economic prosperity?	Is the strategy expected to enhance goods movement across the border?	Is the strategy expected to help reduce criteria air pollutants and greenhouse gas emissions?	Is the strategy expected to improve overall traffic flow for facility users (trucks, vehicles, and transit)?	Is the strategy expected to improve travel time reliability for facility users (trucks, vehicles, and transit)?
1	**Base Case Scenario (Current RTP Improvements)**		N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	**Traffic Organizational Strategies at Freight Gateways & Distribution Hubs**		◕	◕	◕	●	◕	◑	◕
			Improved flow of trucks at gateways could potentially reduce neighborhood routing.	Improved flow of trucks at gateways could potentially reduce neighborhood routing. Industrial areas, such as the border, are also likely to support.	Mobility benefits would somewhat enhance local and regional economic productivity.	This strategy could substantially help improve goods movement across the border.	Improvements to truck mobility will generally reduce GHG and criteria air pollutants if trucks can travel at more fuel-efficient speeds and reduce idle times, in congestion.	Would have localized safety/traffic flow improvements, but broader issues may remain	Travel time reliability for trucks would improve, while not negatively impacting other users.
3	**Travel Demand Management Strategies to be Developed with Truckers and Shippers/ Receivers**		◕	◑	◑	◑	◕	◑	●
			Strategy expected to be generally liked by the community, though some neighborhoods could oppose increases in nighttime truck traffic.	Some opposition could be expected if curfews are lifted and trucks are traveling through communities at night; however support for reduced truck volumes on freeways during peak-hours could off-set this.	Tradeoffs could occur between impacts to shippers/receivers and truckers.	Changing shipping/receiving hours could affect the hours the border operates, which would require CBP hours to change (potentially mitigating queuing issues).	Improvements to truck mobility will generally reduce GHG and criteria air pollutants if trucks can travel at more fuel-efficient speeds and reduce idle times, in congestion.	There are potential risks born by private industry with nighttime operations.	Though hours of travel could be restricted, reliability would be improved for all users.

Table A-8.2: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●	Broader Community Support		Local Economic Development		Environmental Considerations	Safety and Operations	
	Topic:	Partner Agencies, Nonprofits, Political Leader Support*	Adjacent Community Support/Environmental Justice Issues	Local & Regional Economic Prosperity	Border Issues	Air and Greenhouse Gas Emissions	Traffic Flow*	Travel Time Reliability
	Descrip-tion:	Is the strategy acceptable to partner agencies, community stakeholders, and political leaders?	Is the strategy likely to be supported by residents and business owners immediately adjacent to the corridor?	Is the strategy expected to enhance local & regional economic prosperity?	Is the strategy expected to enhance goods movement across the border?	Is the strategy expected to help reduce criteria air pollutants and greenhouse gas emissions?	Is the strategy expected to improve overall traffic flow for facility users (trucks, vehicles, and transit)?	Is the strategy expected to improve travel time reliability for facility users (trucks, vehicles, and transit)?
4	**Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access)**	◑	◑	◕	◕	◕	◑	◕
		A greater level of isolation for trucks would reduce safety concerns (e.g. due to speed disparity).	Increases in truck traffic near DARs could create some opposition in surrounding communities.	Mobility benefits would somewhat enhance local and regional economic productivity.	The benefit of this strategy is based on mobility improvements to truck corridors that tie to the border.	Improvements to truck mobility will generally reduce GHG and criteria air pollutants if trucks can travel at more fuel-efficient speeds and reduce idle times, in congestion. This strategy should also help passenger vehicles travel at more fuel-efficient speeds (approx 45 - 55 mph). However, improved traffic flow could potentially induce additional travel over time and offset some of the emission reductions. Further study would be needed to assess impacts to short- and long-term emissions reductions from specific projects.	Greater levels of isolation between trucks and passenger vehicles would reduce concerns.	If well managed, travel time reliability should improve for trucks and not be reduced for other users.
5	**Designated Truck Lanes (Construction of New Lanes on Existing Facilities - e.g. Truck By-Pass lanes, routes, or climbing lanes)**	◔	○	◕	◕	◑	●	●
		New capacity is likely to be controversial due to potential for increased GHG. Some support & some opposition would be expected. Close coordination with local jurisdictions and outreach to stakeholders would be needed from the early stages of the planning and implementation process.	Some local properties may be negatively impacted if new ROW is required.	Mobility benefits would somewhat enhance local and regional economic productivity.	The benefit is based on mobility improvements to truck corridors that tie to the border. If the improvement connects directly to the border, goods movement across the border would be enhanced.	Construction impacts would be offset by greater long-term mobility improvements (due to the associated improvements to fuel-efficiency from smoother traffic flow). However, the improvements could induce additional truck trips within the shipper/receiver window of operations, so the overall net GHG benefit is likely to be neutral. The issue is complex and further study would help to assess these trade-offs.	The higher levels of isolation between autos and trucks would improve traffic flow.	The strategy would improve reliability for all users.

Table A-8.2: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●								
		Analysis Category:	**Broader Community Support**		**Local Economic Development**		**Environmental Considerations**	**Safety and Operations**	
		Topic:	**Partner Agencies, Nonprofits, Political Leader Support***	**Adjacent Community Support/Environmental Justice Issues**	**Local & Regional Economic Prosperity**	**Border Issues**	**Air and Greenhouse Gas Emissions**	**Traffic Flow***	**Travel Time Reliability**
		Descrip-tion:	Is the strategy acceptable to partner agencies, community stakeholders, and political leaders?	Is the strategy likely to be supported by residents and business owners immediately adjacent to the corridor?	Is the strategy expected to enhance local & regional economic prosperity?	Is the strategy expected to enhance goods movement across the border?	Is the strategy expected to help reduce criteria air pollutants and greenhouse gas emissions?	Is the strategy expected to improve overall traffic flow for facility users (trucks, vehicles, and transit)?	Is the strategy expected to improve travel time reliability for facility users (trucks, vehicles, and transit)?
6	**Separate Dedicated Truck-Only Facilities (Construction of New Facilities)**		○	○	◕	◕	◑	●	●
			Building new ROW in developed areas would be very unpopular. It is unlikely that truck volumes warrant this level of investment.	Some local properties may be negatively impacted since new ROW would likely be required.	Mobility benefits would somewhat enhance local and regional economic productivity.	The benefit would be based on mobility improvements to truck corridors that tie to the border. If the improvement connects directly to the border, goods movement across the border would be greatly enhanced.	Construction impacts would be offset by greater long-term mobility improvements (due to the associated improvements to fuel-efficiency from smoother traffic flow). However, the improvements could induce additional truck trips within the shipper/receiver window of operations, so the overall net GHG benefit is likely to be neutral. The issue is complex and further study would help to assess these trade-offs.	The higher degree of isolation would improve traffic flow.	The strategy would improve reliability for all users.
7	**Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment**		◕	◑	◕	◕	●	◕	●
			Some mild interest/support would be expected.	Adjacent residents and/or business owners would likely be neutral and/or disinterested; though some concerns could arise related to new signage.	Mobility benefits would somewhat enhance local and regional economic productivity.	The benefit is based on mobility improvements to truck corridors that tie to the border. If the improvement connects directly to the border, goods movement across the border would be greatly enhanced.	Wide deployment and traffic flow improvements for all freeway travelers would have a high potential to reduce GHGs and air pollutants (could be offset by some VMT increase due to induced demand related to improved travel times and travel time reliability).	Traffic flow is likely to be smoothed out and improved overall - though the degree to which improvements are experienced by trucks and passenger vehicles could vary.	The strategy would improve reliability for all users.

* Topic also assessed as part of the Tier 1 analysis. The scores in this section were updated for these topics, as needed, to reflect the more complete set of information available to the project team.

Table A-8.3: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●	Safety and Operations			Engineering Considerations	Public Sector Financial Considerations		
	Analysis Category:	**Safety and Operations**			**Engineering Considerations**	**Public Sector Financial Considerations**		
	Topic:	**Safety/Accident Rates**	**Trucking Industry Liability**	**Incident Management**	**Ease of Implementation (Construction)**	**Public Sector Capital and O&M costs**	**Public Sector Revenue Generation Potential**	**Public Sector General Cost-Effectiveness***
	Descrip-tion:	Is the strategy expected to improve safety for facility users (trucks, vehicles, and transit)?	Is the strategy expected to reduce trucking industry liability?	Is the strategy expected to improve incident management?	Is the strategy generally implementable from an engineering perspective? For example, are issues such as ROW constraints, ingress/egress or pavement design anticipated to be consistent obstacles to implementation?	Are the capital and operations and maintenance costs expected to be cost prohibitive?	Does the strategy have the potential to generate revenue?	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?
1	**Base Case Scenario (Current RTP Improvements)**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	**Traffic Organizational Strategies at Freight Gateways & Distribution Hubs**	◕ Safety for trucks would improve, while safety for others would either improve or not be negatively impacted.	◕ Some improvements could reduce liability (e.g. truck local access routes), while others would improve traffic flow, but not necessarily reduce liability.	◑ Affects on incident management would depend on the types of improvements and the specifics of implementation; however, the affects are generally considered to be neutral.	◕ This strategy is generally implementable from an engineering perspective, in the majority of cases. Specific issues could be handled on a case by case basis.	◑ The capital and O&M costs for this strategy would be relatively low.	○ This strategy would not have the potential to generate revenue.	● This strategy is expected to have low costs and high, localized, benefits.
3	**Travel Demand Management Strategies to be Developed with Truckers and Shippers/ Receivers**	◑ There would be safety consideration with trucks traveling at night - though this is likely not a change compared to the base case.	◑ Would depend on whether trucks are traveling during the day or at night. The increased risk would primarily be experienced by shippers, rather than trucking industry.	◑ This strategy would not be expected to affect incident management.	N/A TDM does not involve physical improvements.	● This strategy would involve very low public sector expenditures. The public sector would primarily play a coordination and policy role - minimal, if any, capital investments would be required.	◔ This strategy could involve potential fees relating to TDM compliance for shippers/receivers.	◕ This strategy would have low costs for the public sector, with the potential for high benefits. However, private sector costs could increase (costs to shippers/receivers).

Table A-8.3: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●	Analysis Category:	Safety and Operations			Engineering Considerations	Public Sector Financial Considerations		
		Topic:	Safety/Accident Rates	Trucking Industry Liability	Incident Management	Ease of Implementation (Construction)	Public Sector Capital and O&M costs	Public Sector Revenue Generation Potential	Public Sector General Cost-Effectiveness*
		Descrip-tion:	Is the strategy expected to improve safety for facility users (trucks, vehicles, and transit)?	Is the strategy expected to reduce trucking industry liability?	Is the strategy expected to improve incident management?	Is the strategy generally implementable from an engineering perspective? For example, are issues such as ROW constraints, ingress/egress or pavement design anticipated to be consistent obstacles to implementation?	Are the capital and operations and maintenance costs expected to be cost prohibitive?	Does the strategy have the potential to generate revenue?	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?
4	**Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access)**		◑	◑	◔	◑	◑	◑	◑
			Further study is needed on a corridor basis to determine actual impacts to safety. Greater isolation between trucks and autos on the GP lanes would improve safety; while mixing trucks and autos on managed lanes could pose concerns.	Further study is needed on a corridor basis to determine actual impacts to safety. Where safety is improved, liability will be reduced.	Affects will depend on the corridor, number of managed lanes, presence of shoulders, and presence of DARs.	This strategy is generally implementable from an engineering perspective, in about half of the cases. Will depend on the corridor, number of managed lanes, presence of shoulders, and presence of DARs.	Capital and O&M costs would likely be primarily related to signage and public education	SOV trucks could potentially need to pay a fee if SOV passenger vehicles must pay a fee – this would be a policy consideration.	Any increased costs due to signage, etc, would likely be offset by the overall benefits.
5	**Designated Truck Lanes (Construction of New Lanes on Existing Facilities - e.g. Truck By-Pass lanes, routes, or climbing lanes)**		◕	◕	◕	◔	◔	○	◑
			The greater level of isolation would reduce accidents due to safety issues related to mixing trucks and autos.	The greater level of isolation would reduce accidents due to safety issues related to mixing trucks and autos.	The increased isolation and capacity could facilitate incident management.	The construction of new truck routes or by-pass lanes could be challenging in terms of ROW. Many freeway cross-sections are likely already fully built-out.	This strategy is cost-intensive as it involves capital improvements and will require maintenance.	Truck by-pass lanes and routes would likely be non-revenue generating facilities.	This strategy is expected to have both high costs and high benefits.

Table A-8.3: Tier 3 Final Strategy Analysis Results

#	Strategy ○◔◑◕●								
		Analysis Category:	Safety and Operations			Engineering Considerations	Public Sector Financial Considerations		
		Topic:	Safety/Accident Rates	Trucking Industry Liability	Incident Management	Ease of Implementation (Construction)	Public Sector Capital and O&M costs	Public Sector Revenue Generation Potential	Public Sector General Cost-Effectiveness*
		Descrip-tion:	Is the strategy expected to improve safety for facility users (trucks, vehicles, and transit)?	Is the strategy expected to reduce trucking industry liability?	Is the strategy expected to improve incident management?	Is the strategy generally implementable from an engineering perspective? For example, are issues such as ROW constraints, ingress/egress or pavement design anticipated to be consistent obstacles to implementation?	Are the capital and operations and maintenance costs expected to be cost prohibitive?	Does the strategy have the potential to generate revenue?	Are the relative benefits of the strategy expected to outweigh the costs of implementation over the life cycle of the strategy?
6	**Separate Dedicated Truck-Only Facilities (Construction of New Facilities)**		●	●	●	○	○	◕	○
			This strategy provides the highest degree of isolation and therefore the highest reduction in truck/auto conflicts.	This strategy provides the highest degree of isolation and therefore the highest reduction in truck/auto conflicts.	The increased isolation and capacity could facilitate incident management.	The construction of brand new facilities could be extremely challenging in terms of ROW.	The capital costs associated with this strategy are expected to be very high.	While this strategy has the greatest revenue potential, the truck volumes in San Diego will not likely be high enough to warrant the strategy.	The benefits are unlikely to warrant the cost in the San Diego region.
7	**Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment**		◕	◑	●	◕	◕	○	◑
			Safety would likely be improved due the potential of the strategy to reduce speed differentials, improve wayfinding, and minimize weaving.	Could be safer from an operational viewpoint, but without buffers that enhance isolation, liability could remain or increase (increased reliance on commercial vehicle operators).	Incident management would improve due to the ability to dynamically change traffic speeds and lanes & provide information to travelers in real-time in response to incidences.	This strategy could be somewhat challenging if gantries, conduit, etc haven't already been included in the corridor design. In-vehicle technology components are N/A.	Both the costs and benefits of this strategy would be evenly distributed amongst users. The costs are not anticipated to be cost-prohibitive.	Strategy is unlikely to generate revenue. Also, 511 is currently free and unlikely to be a pay service in the future.	This strategy is expected to have medium costs with high benefits overall.

* Topic also assessed as part of the Tier 1 analysis. The scores in this section were updated for these topics, as needed, to reflect the more complete set of information available to the project team.

Tier 3 Analysis – Summary of Findings

The results of the Tier 3 Final Strategy Analysis are described in the body of this memorandum in Section 2. Overall, the intent of the Tier 3 analysis was not to screen out any strategies, but to provide an overall understanding of the pros and cons of each strategy as they relate to the project goals and objectives for improving truck mobility throughout the San Diego region. This information is fully captured in the description of each strategy in Section 2 and was also used to inform the strategies discussed in the two conceptual corridor scenarios. Strategies that did not perform well in the Tier 3 Final Strategy Analysis were not recommended for consideration in the two conceptual corridor locations.

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Appendix B: Additional Industry Interview Feedback

Direct quotes and comments from industry interviewees are organized by strategy below. This is followed by additional comments and thoughts on other important changes needed that were captured during the trucking industry interviews.

Strategy #2: Traffic Organizational Strategies at Freight Gateways & Distribution Hubs

The following are direct quotes and comments from industry interviewees regarding Strategy #2: Traffic Organizational Strategies at Freight Gateways & Distribution Hubs:

- "For the [Otay Mesa] border area, La Media Road is a problem, but there is a bigger issue - the fact that there isn't a dedicated truck route into and out of the border area. Siempre Viva and Airway are used by trucks, but it is not designated for them. Proposed routing into and out of San Diego international border area via SR 125 and SR 52 to I-15 or I-5 will cost more in terms of miles traveled, grades, and fuel, etc."
- "Trucks mixing with passenger cars once leaving CHP compound [at U.S. – Mexico border crossing at Otay Mesa] causes problems now and will increase as a problem with additional truck traffic in the future. Islands and barriers near CHP compound also are not configured properly for truck turns; potholes on Siempre Viva are very bad."
- "[For trucks traveling to and from the Los Angeles area ports from the U.S. - Mexico border] SR 52 is not a viable option in the AM due to congestion at Golden Triangle; need a designated truck lane here, especially to mitigate traffic congestion starting at 4:30 PM on weekdays."
- "When there are [traffic] problems [in the border area], industry informs each other, can't depend on government agencies."
- "To fix border, we need to fix infrastructure on entire corridor. Need 3 lanes into Mexico. Need Customs open 24/7 providing a service to the country to facilitate trade. Need the entire Customs crossing under one organization. Infrastructure on both sides of border needs improvement - streets and roads. Looking for 30-45 min predictable crossing time. "
- "Traffic signs would be a benefit [around the airport]. Are there statistics indicating the accidents per lane? Does the safety aspect outweigh the movement of the goods?"
- "Signage around airport [would be helpful]."
- "Also need access and egress to the airport via commuter terminal and keep the trucks off Harbor Drive. UPS and FedEx work off of east side of runway, so very little volume that goes in and out of the airport freight terminal anymore. Most cargo has moved to FedEx and UPS."
- "Any type of communication [with truckers] is good. Changeable Message Signs and Amber alert messages are good communication tools. Onboard communication system allows information to be sent immediately to the driver."

- “Most interested in getting information to companies far enough in advance to make decisions. For instance, if the Grapevine [mountain pass north of Los Angeles on I-5] is closed for snow, [it is] not helpful to receive this information at base of the mountain. There really is no one stop shop for this right now.”
- “We don’t do a great job of knowing what’s going on in San Diego. With onboard communications systems, we can send out a broadcast message out to entire team with information like wild fires in San Diego.”
- “CMS is [the] biggest waste of money. Traffic slows down to read CMS; if SANDAG is projecting increase in volume of SD traffic - CMS will slow down traffic. People want to read it. Need to look at how traffic patterns and speeds changed when CMS was installed. GPS and Navigation system will tell them this. Would rather see messages on Navigation system.”
- “Alerting drivers with signs or radio announcements is viable.”
- “Don’t think [signs are] a good idea. If there is any kind of sign that people think they should read, it slows traffic down all together. By the time the travel times on the CMS catch up with reality, the signs haven’t always reflected the real drive time. If there is anything going on, they are so far behind. Causes more congestion. Radio announcements are great, but could they have a dedicated channel just for traffic. And the dedicated channel for traffic should tell you frequently what the [travel] time is right now.”
- “Need to know what’s happening on the freeways ahead of time from the arterials. Options at Pomerado Road to skip over congested I- 15 NB or SB, or 67 SB in the afternoon. Need to know traffic conditions at [signal] light at Wild Cat Canyon Road to Barona where it gets backed up.”
- “An example of well organized urban delivery facility is in downtown Los Angeles at Lower Grand. All deliveries go off of Lower Grand and all loading docks and service roads are located down there.[This street is located] off of SR 101 at Figueroa (the men’s Central jail exit).”
- “Yellow yield left turns - left turns that turn to a flashing yellow and yield when left turn light is not green. Would save a lot idling. Check on Oregon policy.”
- “Need to use 511 or some kind of radio announcements. Some guys have their own personal devices for traffic conditions. Would like “weather radio” type announcements for traffic.”
- “Would be helpful to have method to know what is the clearest route to Los Angeles and the Inland Empire, possibly using signage or an app.”
- “We know the area, 90percent of the time it is the same driver on the route. The driver is accustomed to changes in traffic patterns. Might help more with over the road guys, than local drivers that know the area. Messages would be redundant knowledge for local or regional guys. This is noise to be managed.”

Strategy #3: Travel Demand Management (TDM) Strategies to be Developed with Truckers and Shippers/ Receivers

The following are direct quotes and comments from industry interviewees regarding Strategy #3: TDM Strategies to be Developed with Truckers and Shippers/ Receivers:

- "Night time only travel would cause grocery stores not to get their milk deliveries and McDonalds not to get their tomatoes [for that day's requirements]. You would be changing a whole culture."
- "Only mandates will compel shippers and receivers to change their behavior beyond what is economically advantageous for them."
- "In order to use any infrastructure at night [i.e., change travel behavior], the whole world has to change – customs, agriculture, shipper, consignee. There has to be great economic benefit to the stakeholders to do this."
- "Only a law put in place by the state of California that says trucks must travel between 6 PM and 6 AM will get shippers to change their hours of operation."
- "Shippers want deliveries completed to be able to invoice. Need to stay on the JIT [Just-In-Time delivery] system."
- "During the '84 Olympics in LA, there were staggered schedules that worked really well. [Staggered schedules] can be done, but both shippers and receivers have to be willing to do it."
- "[There is] no reason why we shouldn't be able to cross the border at night. However CBP probably won't have 24/7 operation due to expense."
- "Changing hours of shipping/receiving - culture of shipping and receiving is not easy to be changed. Currently, if a load is not delivered at the time that receiver designates, then they require trucker to take it to a yard [and hold the freight, tying up the trailer and incurring storage charges for the trucker], and then additionally penalize the trucker $200. A change in the government agency regulations is the only thing that might help."
- "[Delivery schedules are] driven by shipper/consignee. [Shippers and receivers indicate to truckers that] If you want to deal with us, these are hours for pickup and delivery. This is particularly true of Costco and other high volume customers. For example, a customer needs their new freezers, but only between midnight and 4 AM."
- "There are already some types of loads with travel time restrictions. For instance, on over width loads there is curfew on I-5 6 AM - 8 AM Chula Vista to Gilman, and 4 PM -6 PM. Our company does 10 loads per month."
- "Need to incentivize receivers; transportation operations are operationally dependent and customer dependent."
- "Immediate reaction is that this is a good plan – but challenges with this are immense. Need to be used or managed in San Diego to handle congestion, need to assess what business needs really are and have an exception process. Business needs are not all the same. Can be routed and done as counter flow to traffic. Part of business that would this would add significant expense. Multiple use companies would have to buy more vehicles or hire more people to work within delivery time frame. Adds complexity to

routing and adds costs. Risk of eliminating or forcing more carrier shipments that may not be in the best interest of safety. Not all shipments are created equal in terms of when they need to be there. This may not be a good thing for [our local distribution company]."

- "[It would be a] steep uphill battle to get businesses to change to night time operating hours. Now we would have to have more management and nighttime pay differential for employees. Truckers are not going to let their trucks sit around during the day; they will want to keep the rolling stock rolling, in San Diego or elsewhere. May not effectively lower the truck traffic, and might increase the truck traffic."
- "Increase hours of operation [for CBP and other agencies] at the U.S. - Mexico border."
- "129 out of 285 [of our] Southern California stores are in curfew delivery areas (hours vary by community, shopping center, or municipality). Currently curfew stores are routed together or placed as last stop on route."
- "We have some latitude to some degree [to move freight at alternative hours]. Shipment of the [our freight] happens at night. Planes leave between 6- 9 pm. There is some opportunity; but it is difficult to make that kind of adjustment. Have to deliver [our product] in the daylight. Safety issues that come with delivery at night are numerous – dogs, etc. We conducted an experiment to have trucks leave at 5 AM and that didn't work due to dependence on airlines and inter-district transfer."
- "[Our organization is] bound to shipper/receiver schedules. All [of our] customers want their deliveries by noon, except one restaurant supplier who wants their deliveries after 2 PM. Also constrained by ABC regulations that do not allow deliveries on Sunday after 8 PM."
- "If SANDAG or other authority mandates [loading or delivery in off-peak hours] with the shippers, then trucking companies will hide behind the new requirement and [indicate that they] need to comply with the regulations to get trucks off of the peaks."
- "Need to get our customers to be part of this. If every customer could give a key to let [our delivery drivers] in at off hours that would make it easy. Need [the] cooperation of all players. Need coordinated delivery system for areas. Kind of like putting in a curfew that deliveries could only be made at certain times. However, we need more than a four hour window to make all of our deliveries."
- "A major problem is that [developers] are putting living quarters above[commercial use property] and trucks are allowed to make deliveries only after 7AM, but the deliveries really need to be made at 4 AM; so this continues to be dilemma for mixed use environments."
- "If a contractor delivers to us [the receiver] during off hours, they have to wait. This is uncontrollable."
- "Don't like this strategy; Makes cost of doing business less predictable. Costs or fees to the shipper will end up in the mix down the road."
- "Changing shipper/receiver times - Long Beach is an example: They moved all the day traffic to night, and now truck traffic congestion is at night. It takes 3 hours to get a container at night. Most trans-loading gets done in Inland Empire or Ports. There are

more raw materials than finished goods. 50percent of what comes out of Long Beach goes back empty. Long Beach trucks went from 17,000 trucks to 9,000 trucks [after daytime movement penalties were imposed]; small truckers went away, and rates went up."

- "Prefer to deliver in off peak hours."
- "Have most trucks off the road during daylight hours (off peak delivery only); as with Los Angeles during the '84 Olympics per Mayor Bradley."
- "70-80 percent of customers [in the San Diego area] would have to be willing to change their hours in order for trucking to change their hours to off peak. All parties would have to change - Customs, Agriculture, Shipper, Consignee, etc."

Strategy #4: Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access).

The following are direct quotes and comments from industry interviewees regarding Strategy #4: Trucks on the Planned Network of HOV/HOT Managed Lanes (Restricted Access):

- "Some bobtails are currently using HOV lanes now when there are two people in the truck; but it is not feasible to always have two people in the truck."
- "[Our company] would rather pay toll and understand the balance sheet, than not know costs due to variable traffic problems. From [this company's] perspective it makes sense to remove restrictions to allow 3 axle trucks on managed lanes."
- "Don't like the idea of putting trucks [i.e., eighteen wheelers] over lanes to the left of 4th and 5th lanes. Other states (like Texas) allow trucks in all lanes. Definitely putting trucks in HOV lanes is not a good idea. Trucks belong in the right two lanes."
- "Cost of adding extra person [in the vehicle to use the HOV lane] doesn't work out. Hours of operation might be limited and could use transponder and software. Safety would be big consideration. Can you put a motor home in lane?"
- "Cost of second driver precludes use of lanes now. Best advantage [for trucks to use the HOV lanes would be] at peak times during heavy congestion. [We also have] safety concerns and access concerns."
- "If [the HOV lane] was trucks only [this strategy] would be ok, provided that there were enough off ramps to reduce out and around mileage. Not good if sharing with personal vehicles. Accidents are mostly around merging and mixing with cars. Speed disparity is also an issue. Just trucks would be ok. May be beneficial in non peak to separate trucks – only hesitancy is safety related at the interchanges. What about access? Crossing lanes is an issue."
- "If trucks are permitted in carpool lanes, the State needs to change truck speed limit to match cars in carpool lane. However, I don't want trucker doing 80 behind me when I'm in my car; not in constricted environment like one or two lane HOV lane."
- "We have safety concerns unless they will be restricting the size and weight of the vehicle, or restricting to exclusive use for trucks only. We favor larger heavier trucks for efficiency and profitability."

- “The idea of a truck going to a managed lane is not logical under today's rules - ingress and egress are the majors concerns; unless clearly available for trucks, particularly for merging right out of lanes. How many off/on ramps can be built for trucks on current HOV lane?”
- “Possibly dedicate a truck only lane; particularly for I-5 and I-15. May be frustrating if faster smaller trucks are required to travel with larger slower trucks.”
- “Off peak doesn’t work for [our small parcel delivery organization]. Charge businesses for the use of the lane; we would like to have access for the large trucks on the HOV lane. If it saved money, it would be desirable. Allowing trucks into HOV lanes would benefit all. There is some value to having a truck only lane for safety, reduce traffic mixing. We would be happy to pay for that opportunity. We wish there were more carpool lanes.”
- “There is an overabundance of underutilized carpool lanes; however, merging through traffic to get to carpool lanes with a truck is a problem.”
- “I really like this one, but should be restricted to bobtails. I’m worried about access, but would be willing to pay a fee to use it with single drivers. I think this should be a short term strategy on existing facilities.”
- “Like the idea of putting trucks in HOV lane if there are enough lanes. There is no benefit to traveling in HOV during off-peak, and transitions to high lane not acceptable. Off peak would be more of a safety thing.”
- “If they had their own lane this could work. In other words, one of the lanes was for trucks, and other lane was for cars. Merging would be a problem across traffic, but dedicated access ramps would work.”
- “Need incentives for access to HOV and HOT lanes when using green (alternative fuel) vehicles.”
- “[For trucks potentially using the I-15 HOV lanes, the] off ramps before 78 are likely to be a problem [due to their location adjacent to the No. 1 lane].”

Strategy #5: Designated Truck Lanes: Construction of New Lanes on an Existing Facility (e.g. Truck By-pass Lanes, Routes, or Climbing Lanes).

The following are direct quotes and comments from industry interviewees regarding Strategy #5: Designated Truck Lanes: Construction of New Lanes on an Existing Facility (e.g. Truck By-pass Lanes, Routes, or Climbing Lanes):

- “Make number 3 lane (the lane adjacent to the right-most lane) a through truck only lane (restrict passenger car traffic in that lane).”
- “Don’t think designated truck lanes would work here. Probably better in LA. Not needed in San Diego now.”
- “Focus on areas that have enough lanes, but benefit trucks.”
- “Trending toward CNG vehicles; more incentives for green trucks are needed. Another trend is to switch from smaller trucks and deliver with 53 [foot trailers] to larger chain stores.”

- "Good idea. I have seen those in a variety of places in country. However, anywhere that puts a truck in situation where truck has to cross 3-4 lanes is not desirable. Possible location would be NB I-15 at Rainbow for a climbing lane."
- "Possibly dedicate a truck only lane; particularly for I-5 and I-15. May be frustrating if faster smaller trucks are required to travel with larger slower trucks."
- "Grades up to Gilman Drive are also a problem; climbing lane needed here."
- "This is a good strategy."
- "This is an ideal strategy that serves industry best but concerned about cost. Best for longer segments of freeway (30+ miles). Potential locations: I-5 Corridor; I-15 Rancho Bernardo to San Diego; I-8 (certain times of day). Most of our stores are off of I-8. Interchanges at I-805/I-8, and I-805/I-5."
- "Pay for use is ok."
- "By-pass lanes are needed at I-5 southbound near 78. Climbing lane is needed up hill on 805 South from I-8. Dedicated lane is needed for commercial vehicle traffic along Miramar Road"
- "Really like the idea of having dedicated or designated truck only lane on Miramar Road and other congested areas in order to separate truck traffic and expedite onto freeway. Don't think dedicated facility is realistic due to cost."
- "Need plenty of time, prior warning and space to change lanes."
- "On I-15 on the way to Las Vegas, near Baker (near Bun Boy), there is a truck-only lane on the right that is an example of a dedicated lane."
- "Places where a truck only facility would help – I-5 and I-8 (Taylor Street), Miramar SR 163/I-15 merge – right lanes quickly end and trucks have to merge across a few lanes fairly quickly. This is something that needs to be addressed. Why not make one of these lanes a truck lane?"

Strategy #6: Separate Dedicated Truck-Only Facilities (Construction of New Facilities).

The following are direct quotes and comments from industry interviewees regarding Strategy #6: Separate Dedicated Truck-Only Facilities (Construction of New Facilities):

- "Strategies that separate autos from trucks help from a safety perspective as well as efficiency. Would rather pay a toll and understand the balance sheet than sacrifice reliability and incur costs due to service failures."
- "This strategy seems enormously expensive. Need to determine if there are complaints about too much truck traffic in San Diego and determine if something like this is really needed."
- "Have this in Europe; limited to 5 days a week. Here, general cargo shuts down on Friday night. Majority of cargo really moves over the weekend, Friday – Monday morning. "
- "First step would be to dedicate a lane, and then an entire facility based on volume."

- "Great ideas. Routing could get a little bit off. Safety elements offset some of the out and around on miles. Personally love the idea of separating big rigs from personal vehicles from the safety perspective."
- "This is a good strategy."
- "Possibly dedicate a truck only lane; particularly for I-5 and I-15. May be frustrating if faster smaller trucks are required to travel with larger slower trucks."
- "Need more access - possibly a way for San Diego to LA."
- "Nobel Drive on-ramp is underutilized (1 car per green); opportunity to add a lane just for trucks to 805 South. Maybe a truck-only lane here."
- "Really like the idea of having dedicated or designated truck only lane on Miramar Road and other congested areas in order to separate truck traffic and expedite onto freeway. Don't think dedicated facility is realistic due to cost."
- "Just south of base you have National City Port – that whole area would be a candidate truck-only facility. 32nd Street has its own truck entrance (not well designed or located) but is still for trucks only."
- "Like the dedicated truck facility idea but put monorail for commuters instead of trucks."

Strategy #7: Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment.

The following are direct quotes and comments from industry interviewees regarding Strategy ##7: Intelligent Transportation Systems (ITS)/Active Traffic Management (ATM) and Lane Assignment:

- "Wouldn't want to see any signage too high. Once you take drivers eyes off the road there are problems. Our drivers use the Smith system - look out 15 seconds behind next vehicle; stopping time can cause accidents. Would like to have something that would flash right in front of the driver on the windshield; a heads-up display. Trucks follow closely, so they can't be distracted by looking away."
- "Traffic signs would be a benefit [around the airport]. Are there statistics indicating the accidents per lane? Does the safety aspect outweigh the movement of the goods? Also access and egress airport via commuter terminal and keeps the trucks off Harbor Drive."
- "Most bang for the buck – transmitting to smart phone, traffic conditions, and availability of other lane. Saves money and is more efficient. Reduce transit times, HOS [hours of service], fuel consumption. DOT [Department of Transportation] HOS must be compliant no matter what."
- "I report back to my office based on what I'm seeing in my personal travel. If there was an app with continuous status of traffic that would be helpful."
- "Could really reduce or shift the amount of trucking that would be allowed. Like this idea better than strategies that would restrict travel. The ideas that don't cost a lot. Restricting out of the merge lane and moving lanes over (luke warm). Little bit of

reservation about being used in the way that was originally intended with planners down the road."

- "Dynamic speed management – are we sure? Do we have an opportunity to see if speed changes would make a difference? Not against this, if proven viable."
- "This is a good strategy. Like this for certain stretches of freeway and at interchanges. Needs to be dynamic bollard system to segregate lanes dynamically. As industry becomes more skittish about coming driver shortage, there are not a lot of young kids coming into industry. Who will be coming in? Will they be English speakers? Need icon driven [signage and messaging]; such as a green light for go, or picture of truck on sign for lane assignment. In the truck, using EOBR that will have messaging. A quick visual with red or green arrows would make more sense than text. Limit the reading; keep it symbols and icon driven."
- "Now using driver management system via Xata and participate in PrePass. Newer equipment will have LDWS [lane departure warning system], and anti-rollover system. Our company is not a front runner with any particular technologies."
- "Assigning 3rd lane for trucks may cause more congestion. On CMS, should also have something on the signs related to traffic - travel times are great on the signs."
- "Possibility to send messages/broadcasts on XATA system when there are unusual traffic conditions. Broadcasts are currently text display only on XATA screen."
- "Speed normalization would be best. When traffic is heavy, 45 [MPH] for all trucks is better than 25 [MPH] stop and go."
- "Have we looked at having the same speed limit for trucks and cars (such as in Arizona)? All vehicles on the road are going the same speed."
- "Controlling the speed of the vehicles could make sense. Controlling speed for all traffic in certain lanes. Should have two lanes big horsepower and slow truck lanes."
- "Some places you can tune to radio and get traffic information (Disneyworld, Grand Canyon)."
- Need Amber alerts to all with cell phones. Anything we can do for all commercial truckers, not just mine, would be helpful."
- "All drivers have [our company proprietary] handhelds. They communicate via personal cell phones. Write their orders in their handheld. Looking at more sophisticated technologies for route efficiencies, fuel efficiencies, etc."
- "Communicating with drivers is important. Also, there are applications on phones to provide info on how traffic is moving - currently. This will be the biggest source of information."
- "Would be helpful to have method to know what is the clearest route to LA and Inland Empire (possibly using signage or an app)."
- "We know the area, 90 percent of the time it is the same driver on the route. The driver is accustomed to changes in traffic patterns. Might help more with over the road guys,

than local drivers that know the area. Messages would be redundant knowledge for local or regional guys. Noise to be managed."

Additional Comments

The following represent additional comments provided by interviewees either during the interview process or during project meetings. This information is being provided to provide additional important context around the trucking industry's perspective.

- "For U.S. - Mexico freight, volume of raw materials to finished goods is 2 to 1; raw materials come into Mexico in a variety of ways, not all truck loads."
- "Only produce trucks can regularly cross the border with product and go to LA [then come back empty] because load revenue covers empty backhaul."
- "Very little volume that goes in and out of the airport freight terminal. Most cargo has moved to FedEx and UPS."
- "There is less scrutiny [for air freight at the cargo terminals] than on passenger plane belly freight."
- "A lot of air freight goes to Los Angeles because wide bodies are all on LAX planes; and only narrow bodies are used in SAN."
- "3PLs [Third Party Logistics service providers] are not airline employees; benefit of caring whether freight is on/off goes away."
- "Major focus of this project should be I-5 corridor. North/south travel is the biggest concern for border crossers."
- "Speed of cars and trucks being different is the first problem; the second problem is multiple inspection points on routes. Need to resolve current problems before continuing with solutions for future problems. Any time you stop a truck and restart it, you lose time."
- "How many containers end in Tijuana? We have been dealing for so many years with both Mexican and U.S. governments; but we still haven't resolved current problems."
- "At the border, there are only two officers assigned by SDPD for commercial police - need more personnel. There are cultural differences between drivers from each country."
- "Some raw materials come in on rail, steamship lines, etc."
- "Viability of Mexican trucks to move beyond 25 mile commercial zone is dependent on the load (i.e., commodity), truck licensing, driver immigration status, and other economic factors; cannot expect to run with empty backhaul for long trips into the interior of the U.S. - not a viable option. Trips for Mexican trucks to LA are viable because cost of empty return can be covered by the total cost of moving the freight."
- "Mexican laws are changing and eventually will restrict the age of the tractor; this is not an emissions based regulation. Ideally, would like to move a truck between the border and Los Angeles non-stop."

- "Wish other government agencies would have similar meetings to this one [referring to project focus group]."
- "When considering 3000 current cross-border trucks, this includes only truck actually crossing the border, doesn't include trucks that are also servicing the border area. Also considering growth in the Otay area, it will not just be the growth to 6,000 - 8,000 trucks [from the current 3000], it will be a lot more."
- "There are times when the Mexican government reacts almost the same way as the U.S. government does regarding border wait times; Tit for tat waits on northbound and southbound sides of the border. If the US side slows things down crossing Northbound, then there are hung lines going southbound that same evening. Same with holidays, if there is a holiday in the US there will be a holiday in Mexico. It seems like there are holiday wars. We need a holiday moratorium."
- "First [border] crossers are coming back across the border (southbound) at 11AM with the heaviest traffic in the afternoon. We have appointments for most loads with the rail yard; the quicker you can bet them inside Tijuana loading the quicker you can get them back."
- "Truckers will utilize Saturdays for empty moves. This is a better time to move empties; less congestion."
- "There are also pushes for local governments to concentrate people in the future; this may force people onto the rail system or buses. May be more like New York or Chicago with more of transit system."
- "Good idea to communicate to public that there is a plan to address regional congestion."
- "Performance measured by OTR [over the road trucks] by the number deliveries; for local trucks by the number of dollars that they are delivering. We need to cube out our OTR trucks to maximize efficiency. Twenty years from now should be doing fewer deliveries to be more efficient."
- "One of the things that could help would be if the state would reconsider the length laws. More efficient if carrying more product per unit (e.g.57′ and 59′ trailers). Would be good if state did this as a larger strategy instead of infrastructure."
- "Increasing length reduces number of trucks on road, but increases safety concerns, and possibly wear and tear on infrastructure."
- "Like the dedicated truck facility idea but put monorail for commuters instead of trucks."
- "Parking - always on the street, particularly downtown. Our trucks are getting 5 double parking tickets per month. We need 75 feet to park the truck and make deliveries."
- "Need to stay in contact with Federal government, DOT, CARB, and state regulators during planning to make sure that you don't build massive infrastructure and then trucks are disallowed on a particular corridor. Predict that diesel will be phased out; in 50 years diesel trucks will not be something that will be seen in the state of California."

Other Important Changes Needed

Additionally, the set of direct quotes and comments from interviewees below represents ideas for important changes needed in infrastructure or agency operations to assist in improving truck mobility along major corridors or surrounding important gateways and hubs.

- "Our company is a clean fleet that uses LNG, low sulfur diesel, and HFC engines. Incentives for alternative fuel trucks are imperative."
- "Customs, immigration, and CHP - seems like there should be one process to make border crossing more efficient."
- "Customs needs more hours in the early morning. Not starting at 9 AM; trucks are lined up at 6 AM. No reason trucks can't be in Tijuana getting processed."
- "Need more coordination between U.S. and Mexico. Federal Government issue. Current Customs hours creates a bottleneck every day. One of the carriers has a yard in Tijuana to stage empties to mitigate this problem. Cost and security are issues for some carriers so only bigger carriers will have yards."
- "I-805 both directions is a problem, so open up SR 125 as a freeway (non-tolled). We need a truck by-pass lane around the 805/5 merge in either direction. Get rid of crisscrossing freeway exits/entrances such as 163 Friars. I-8 East in the afternoon is also a problem; SR 52 is solid in the afternoon from Kearny Mesa to SR 125."
- "Need the ability to cube out OTR [over the road] trucks to reduce number of deliveries (need regulatory change to address size and weight of vehicle(s))"
- "What is really needed is better mass transit to get cars off of the road. Need more user friendly mass transit with more options, faster lines, better connections so there is less wait time between connections, and fewer connections for longer corridors. Significantly longer transit times compared with car travel times discourage use of mass transit."
- "Drivers complain about I-805 climbing hill to go to the landfill, going north out of Mission Valley. Also going South [on I-805] there is a steep grade and merging I-8 traffic all at the same time."
- "Strategies that separate autos and trucks help from a safety perspectives as well as efficiency."
- "Border mobility could be improved via changes in CBP operations… staggered lunches, more staffing when lines are long and less staffing when lines are short; not currently working this way. Need to look at causes of congestion related to border CBP staffing. "

Appendix C: San Diego Managed Lane Network

Figure C-1 displays a map of the planned managed lanes, high-occupancy vehicle, and toll lanes network in the San Diego region. The map reflects the 2050 RTP ultimate potential managed lanes network. The types of facilities highlighted include:

- Transit Only Lanes – where only transit vehicles would be allowed to travel without carpool or single occupant tolled vehicles.
- 2 Managed Lanes – where the ultimate configuration will be one managed lane in each direction permitting carpools, transit vehicles, and single occupant tolled vehicles.
- 4 Managed Lanes – where the ultimate configuration is similar, but with two managed lanes in each direction.
- Toll Lanes – where new capacity would be added with toll lanes open to all traffic.
- DARs – where vehicles can access the managed lanes directly from nearby surface streets without using traditional freeway on-ramps and merging across to IAPs for the managed lanes.
- HOV/ML Connectors – where managed lane and/or HOV facilities on different freeways are directly connected allowing continuous travel along the managed lane/HOV network without having to merge into or across the general purpose lanes.

Figure C-1 is derived from information from the Caltrans/SANDAG Managed Lanes Design Guidelines Study. Additional information is available about the planned implementation timelines of each segment of the managed lanes. For example, some facilities may initially be built as two managed lanes or HOV lanes (one in each direction) and then expanded to four managed lanes by the 2050 horizon displayed in the figure.

An overview of the map indicates the following notable findings in relation to the potential for trucks on managed lanes:

- SR 125 may no longer be a toll facility by 2050.
- DARs are much more prevalent along I-15.
- There are no DARs currently anticipated along the northern portions of I-5.
- The restriction of two transit lanes (only) on the segment of I-15 between I-805 and I-8 means that fluid truck movements along managed lanes to I-15 would have to stem elsewhere (e.g. perhaps along I-805 to SR163).
- I-805, I-5 (north of I-805), and I-15 are the only facilities that are currently planned to have four managed lanes. Four managed lanes (two in each direction) are considered more appropriate for truck travel so that a passing lane is provided for other traffic, if needed.
- The potential for four tolled lanes along the northernmost sections of I-5 and I-15 may represent an opportunity for the inclusion of trucks.

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Figure C-1: 2050 HOV/Managed Lane Network

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Appendix D: I-15 DAR Truck Turning Exhibits

While some of the DARs on the region's planned network of managed lanes have yet to be built, the DARs along the I-15 study corridor have already been constructed, and many of the DARs along I-805 are currently under construction. As such, turning radii were tested for standard truck lengths in the light-, medium-, and heavy-duty truck categories for two sample DARs along the I-15 conceptual corridor (the Del Lago DAR and the Mira Mesa DAR). The results are shown in the following exhibits. For these DARs, it was determined that overall, light-duty and medium-duty trucks (with lengths up to the measurements included in Table 5 in Section 4 of this memorandum) could likely make the turns onto these two I-15 DARs, while most heavy-duty trucks would experience challenges.

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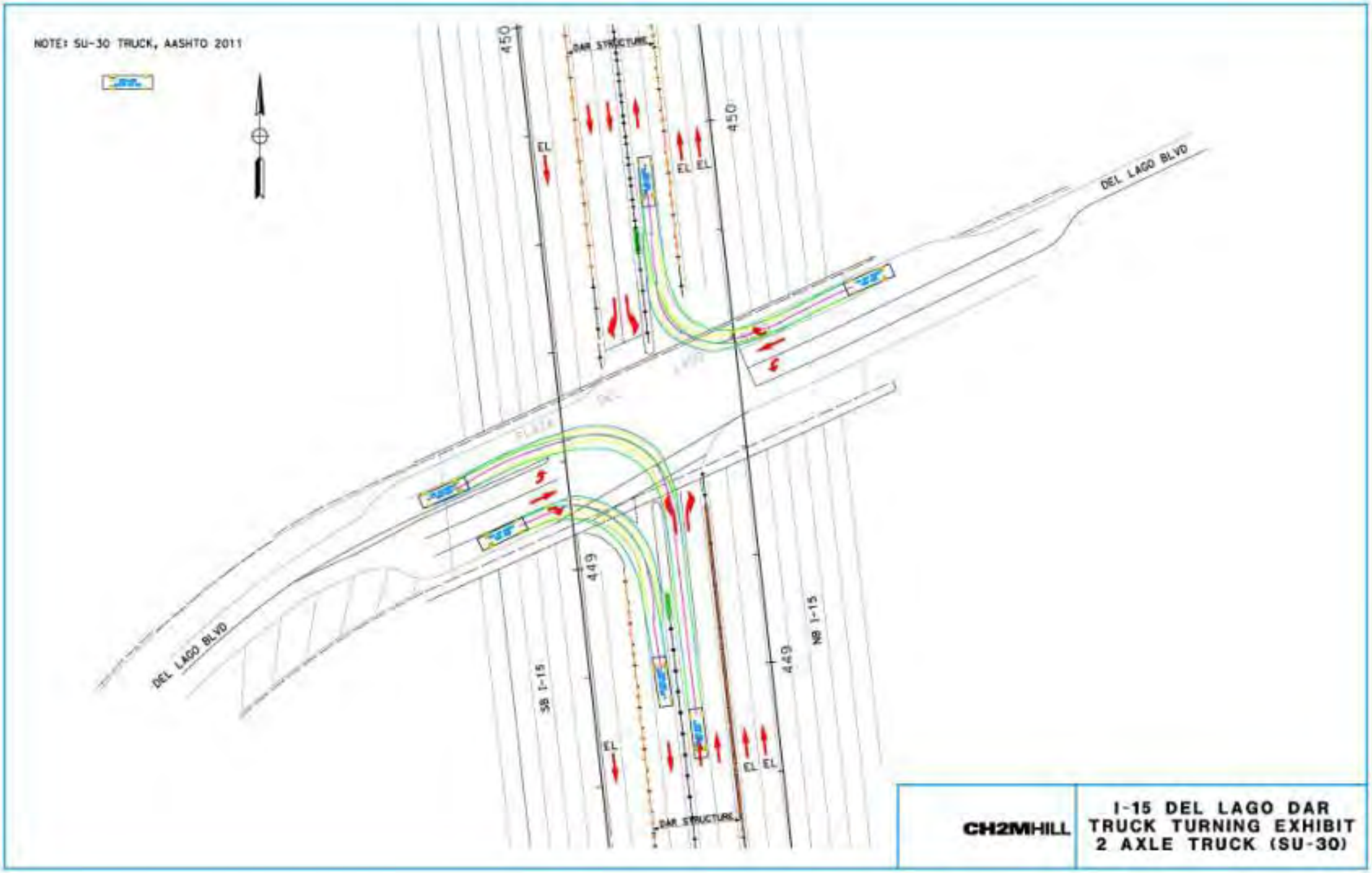
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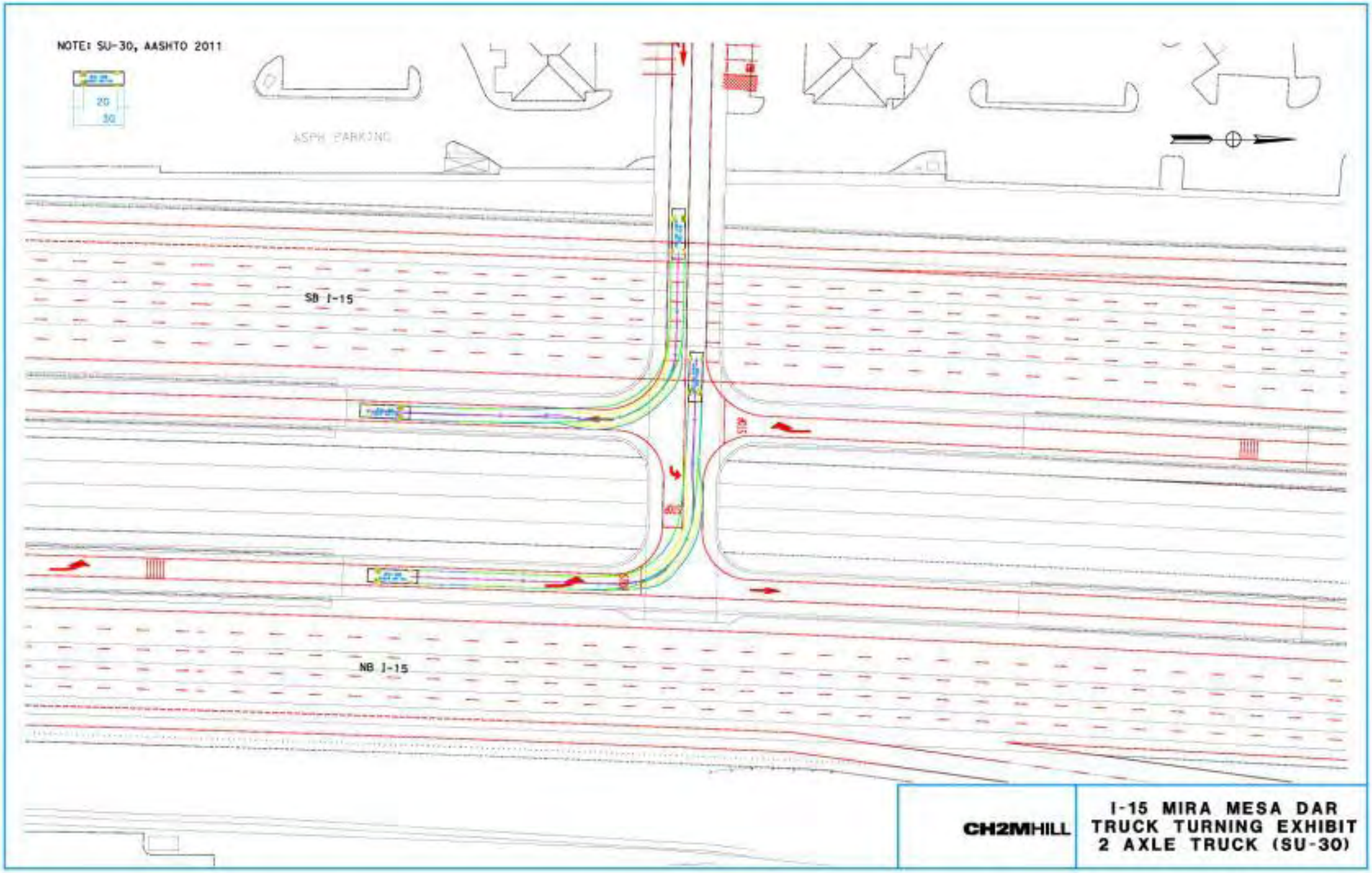
DAR STRUCTURE
DEL LAGO BLVD
DEL LAGO BLVD
SB I-15
NB I-15
CH2MHILL
I-15 DEL LAGO DAR
TRUCK TURNING EXHIBIT
2 AXLE TRUCK (SU-30)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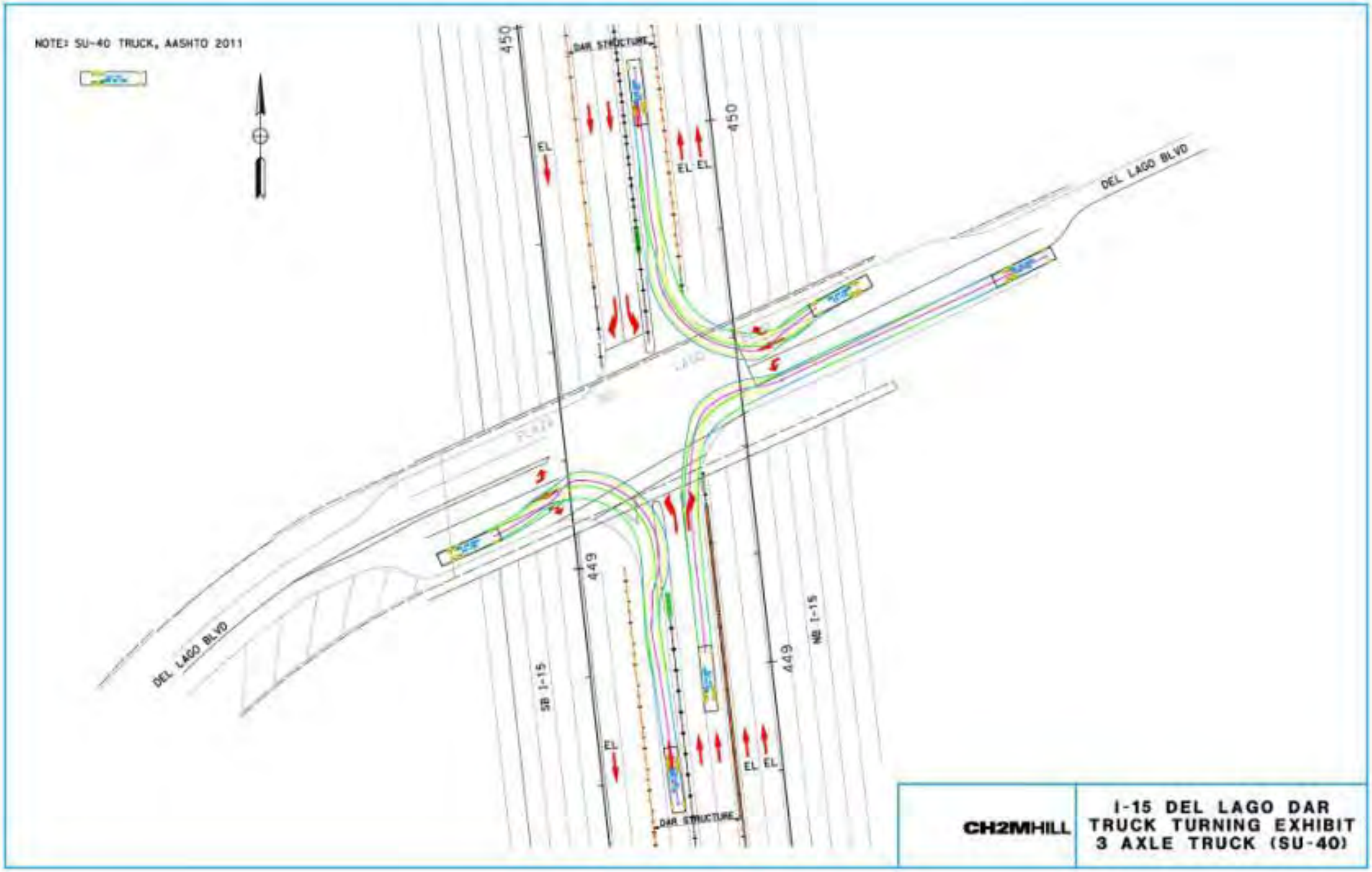
20
30
ASPH PARKING
SB I-15
NB I-15
CH2MHILL
I-15 MIRA MESA DAR
TRUCK TURNING EXHIBIT
2 AXLE TRUCK (SU-30)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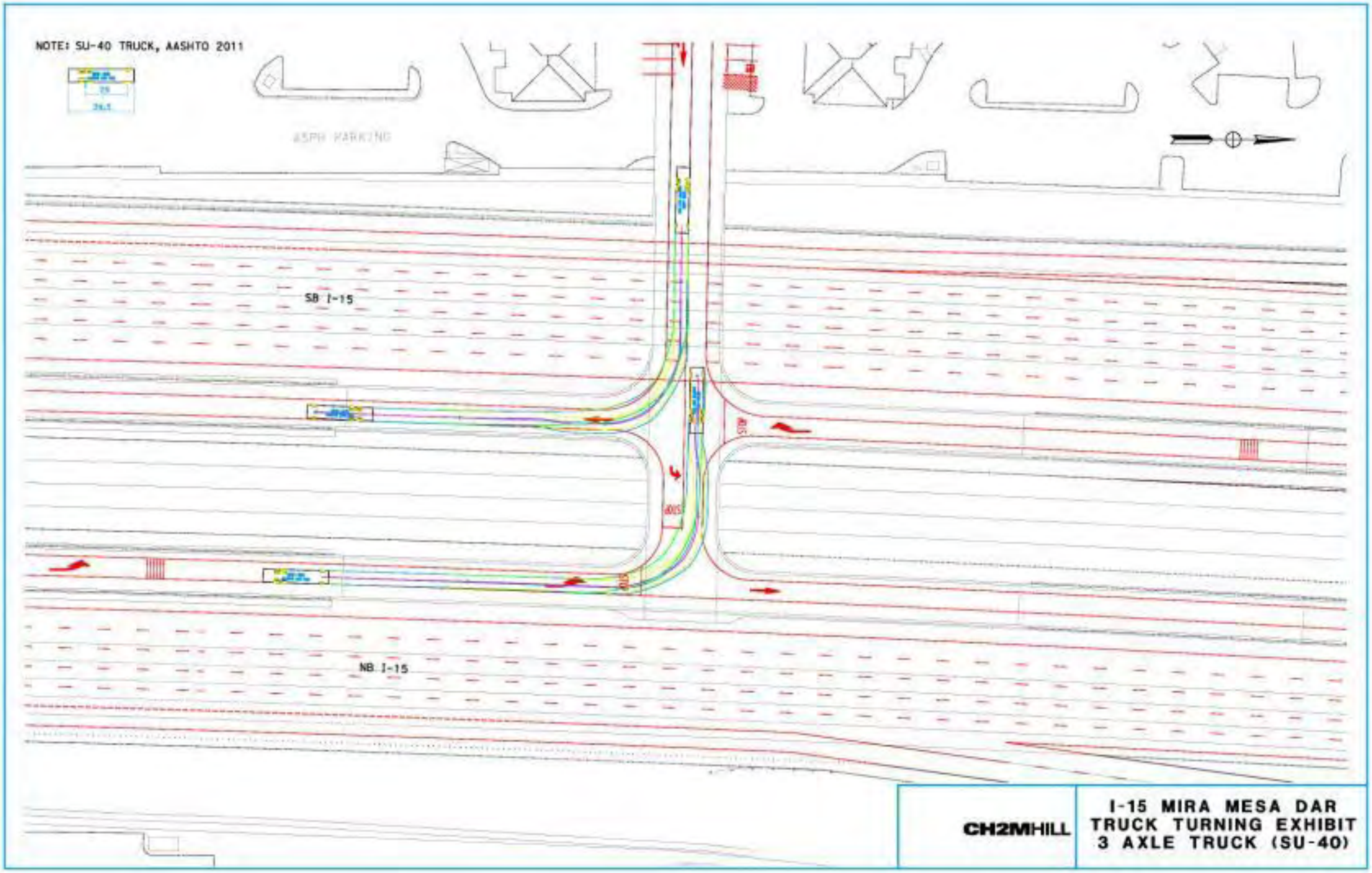
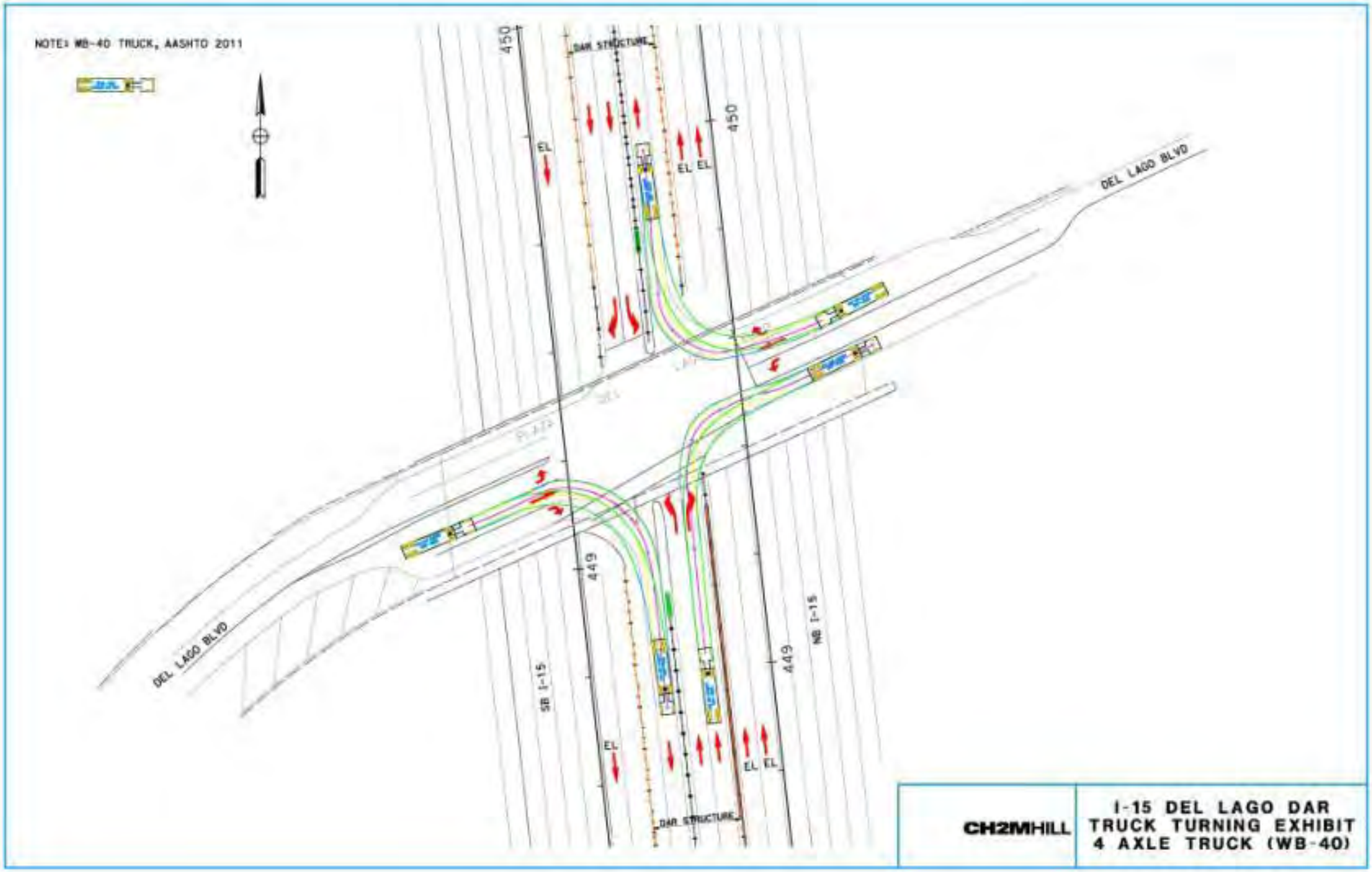
DAR STRUCTURE
450
449
EL
DEL LAGO BLVD
SB I-15
NB I-15
CH2MHILL
I-15 DEL LAGO DAR
TRUCK TURNING EXHIBIT
3 AXLE TRUCK (SU-40)



NOTE: SU-40 TRUCK, AASHTO 2011
ASPH PARKING
SB I-15
NB I-15
CH2MHILL
I-15 MIRA MESA DAR
TRUCK TURNING EXHIBIT
3 AXLE TRUCK (SU-40)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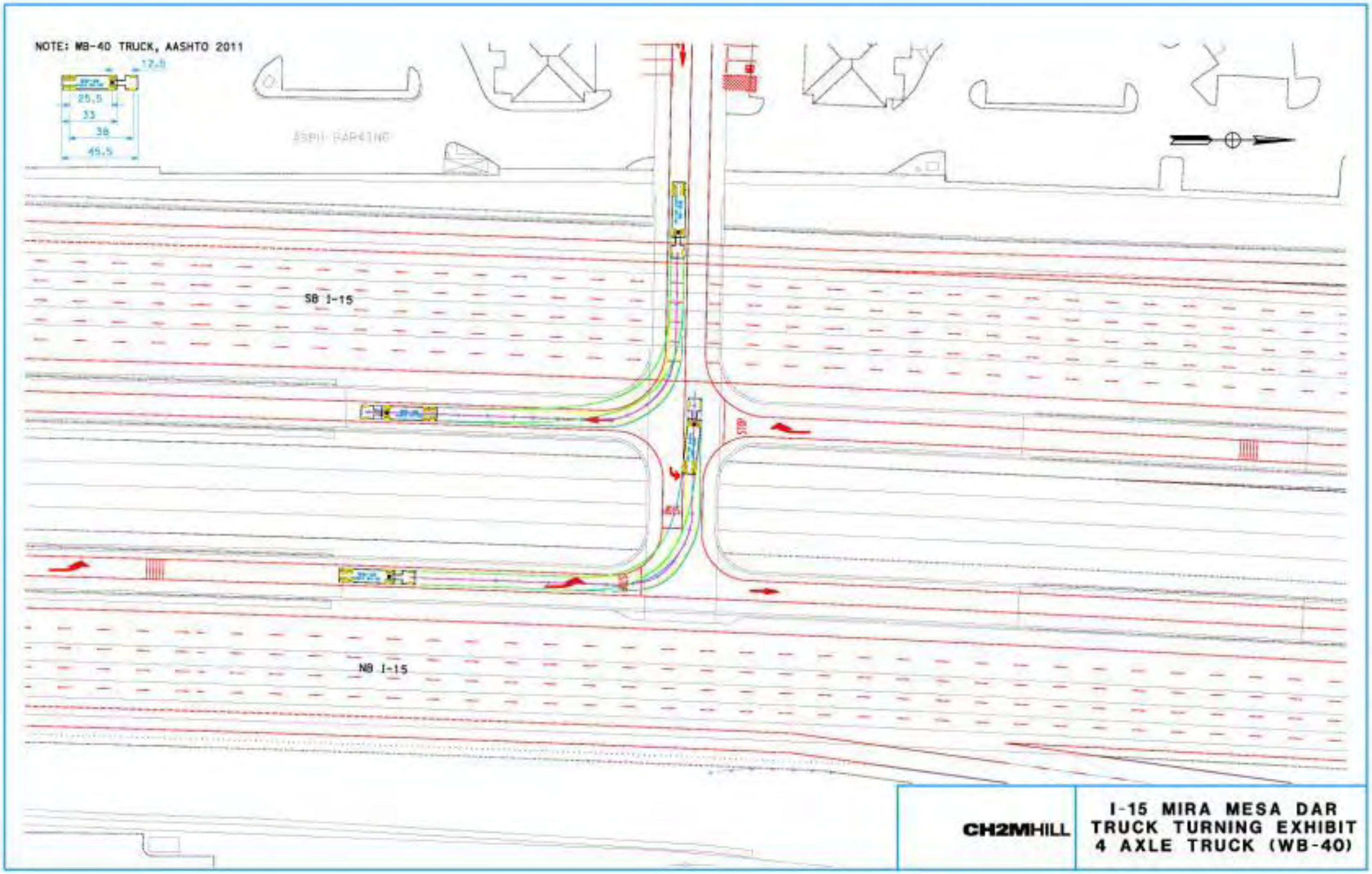
DEL LAGO BLVD
DEL LAGO BLVD
SB I-15
NB I-15
DAR STRUCTURE
DAR STRUCTURE
450
450
449
449
CH2MHILL
I-15 DEL LAGO DAR
TRUCK TURNING EXHIBIT
4 AXLE TRUCK (WB-40)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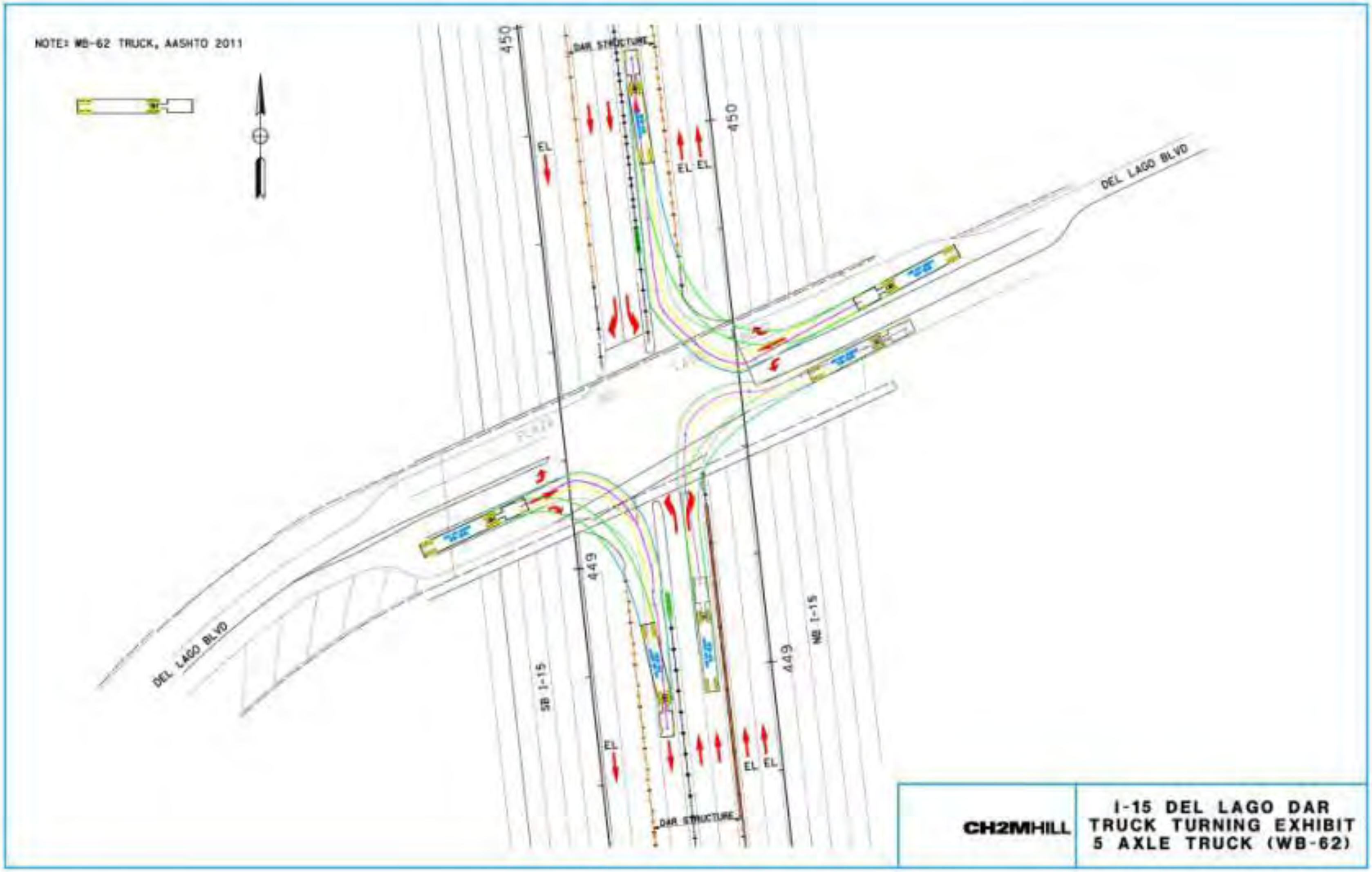
12.5
25.5
33
38
45.5
SB I-15
NB I-15
CH2MHILL
I-15 MIRA MESA DAR
TRUCK TURNING EXHIBIT
4 AXLE TRUCK (WB-40)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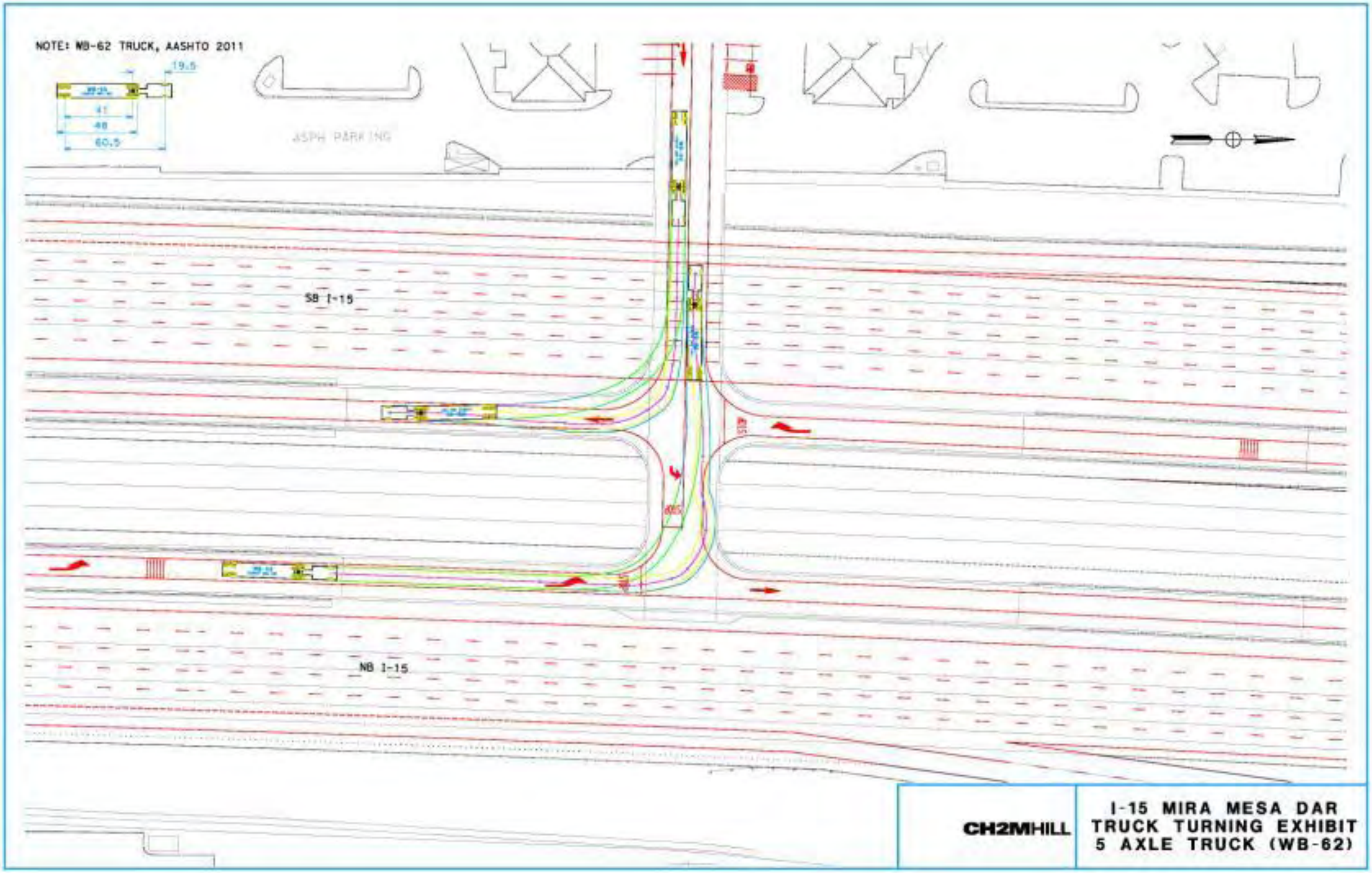
DAR STRUCTURE
450
450
EL
EL EL
DEL LAGO BLVD
DEL LAGO BLVD
449
449
SB I-15
NB I-15
EL
EL EL
DAR STRUCTURE
CH2MHILL
I-15 DEL LAGO DAR
TRUCK TURNING EXHIBIT
5 AXLE TRUCK (WB-62)


NOTE: WB-62 TRUCK, AASHTO 2011
19.5
41
48
60.5
ASPH PARKING
SB I-15
NB I-15
CH2MHILL
I-15 MIRA MESA DAR
TRUCK TURNING EXHIBIT
5 AXLE TRUCK (WB-62)

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Technical Memorandum #6: Data Needs Assessment

TO: Andrea Hoff and Christina Casgar, SANDAG

FROM: CH2M HILL, IBI Group, Cheval Research

DATE: Revised December 11, 2013

The Analysis of Freeway Operational Strategies for Trucks Study (Study) represents an opportunity to consider the available data on truck movements and mobility in the San Diego region. Through the data collection efforts conducted in Task 4 of this Study, it was possible to assess what data was available through existing sources, as well as what data was desired but not yet available.

This memo summarizes key truck data gaps, evaluates alternatives for enhancing detection to fill some of these gaps, and provides a high-level concept for collecting and reporting this data on an on-going basis.

Summary of Existing Data

A significant amount of data was collected on existing and forecast truck volumes and mobility conditions through the efforts in Task 4. This data is generally limited to:

- Subset of Weigh-in-Motion (WIM) Sites – There are a handful of existing WIM sites in the County that are currently the only means of collecting on-going and continuous vehicle classification data and axle counts that can be translated into vehicle classifications and truck counts.

- Manual Observations/Data Collection Efforts – Gaps in truck volumes and classification data is supplemented through a series of manual observations conducted throughout the County. While this information was timely for purposes of development of the heavy duty truck model and related Average Vehicle Occupancy (AVO) data needs, it cannot be continued at regular intervals as the necessary resources and funding do not exist.

- Surveys – Commercial employer/employee surveys were conducted by SANDAG to provide key inputs to regional and truck model development needs. These surveys provide origin-destination, trip purpose, and trip detail information for the period during which they are conducted. These surveys are useful snapshots, but do not provide data over time.

- Heavy Duty Truck Model Forecasts – SANDAG has developed a Heavy Duty Truck Model, which provides forecast volumes for light, medium, and heavy truck traffic throughout the County up to the Regional Transportation Plan (RTP) horizon of 2050.

- Accident Data – Summaries of truck accident data from the statewide aggregated SWITRS database were collected. Accidents involving trucks are noted, but details are not generally available on the type of collision. Inconsistencies also exist in type of information recorded.

- Industry Interviews – Numerous industry interviews were conducted as a part of this Study. Details are provided in Technical Memos #4 and #5. This information was useful for assessing strategies and identifying areas of concern, but does not represent a comparative long-term data source for truck information.

Methodology for Identifying Data Gaps and Addressing Gaps

The methodology for identifying data gaps and identifying options for addressing those gaps was relatively straightforward and included:

- Agency Stakeholder Discussions – Three key meetings were held specific to truck data gaps:
    - Meeting with SANDAG modeling and GIS staff (June 2013) – A meeting was held with SANDAG staff responsible for modeling, including the Heavy Duty Truck Model, as well as with GIS staff experienced with goods movement and truck data collection issues.
    - Meeting with SANDAG Integrated Corridor Management (ICM) Team (July 2013) – This meeting was held with the SANDAG ICM Program Manager to assess what data is currently being collected for the I-15 ICM corridor, and how supplemental vehicle classification data could be incorporated into and support the regional ICM efforts.
    - Meeting with Caltrans Ramp Metering Group (August 2013) – A technical meeting was held with the Caltrans Ramp Metering Group to determine which Caltrans D11 Vehicle Detection Sites (VDS) were:
        - Activated as double-loops per lane in a speed trap configuration
        - Deployed as side-fire radar units with some classification capabilities

      This meeting also provided background on current truck classification and radar site configurations for vehicle classification data as handled by the Caltrans Ramp Metering Information System (RMIS).

- Review of Data Collection Results – The team reviewed vehicle classification data available from existing vehicle classification sites and collected through manual data collection efforts. Areas where additional truck data was desired for this Study were also assessed.

- Follow-up Discussions – Follow-up one-on-one discussions occurred with Caltrans Traffic, Ramp Metering, and GIS/Planning staff on available data for current and planned detection sites. In addition, follow-up discussions were held with SANDAG staff on potential methods for collecting and making vehicle classification data available.

- Preliminary Vehicle Classification Site Selection – A strategy for collecting additional vehicle classification and truck data was reviewed. Sites were selected for collecting truck volumes and classifications including some existing Caltrans VDS sites and proposed new sites.

Data Gaps Identification

The limitations of the collected data are described in Technical Memorandum #4. The key limitations of the main data sources are:

- Lack of Vehicle Classification Data – With limited active WIM sites, the region lacks historic and on-going truck volumes on key corridors throughout the County. Some of these gaps have been temporarily mitigated by manual data collection efforts, but these efforts occur infrequently, are severely resource constrained, and represent narrow snapshots in time. This data would be helpful for both near-term traffic conditions estimation through Integrated Corridor Mangement (ICM) efforts, long-range modeling, as well as various traffic operations, corridor level, and goods movement studies.

- Lack of Solid Origin/Destination Data for Trucks – Truck and freight goods movement travel patterns are not generally well understood, particularly for internal to internal truck trips (within the San Diego region). SANDAG has conducted commercial employment surveys, but these do not provide comprehensive information in this area. This data shortfall stems from goods movement trips only representing a subset of overall commercial trips. SANDAG has been working to supplement this data with other sources, but the results of these efforts have not been fully determined. In addition, some trucking companies would view this data as proprietary and often this information is made anonymous when collected. This data would be highly useful for goods movement studies, as well as future modeling efforts.

- Lack of Trip Purpose Data for Trucks – While there is some limited truck classification and count data, there is no real information on the purpose of truck trips (empty, laden, distribution, long-haul, etc.) other than that available from the subset of the commercial survey data. This data is extremely difficult to collect, but would be useful for goods movement studies and modeling efforts.

- Gaps in Accident Data Summaries and Lack of Detail – Accident summary information available from SWITRS and even TASIS is often lacking in some detail. The data available for entry is often impacted by what information was originally entered by the responding law enforcement agency. Increasing basic latitude/longitude information is available for many but not all accidents. It would be useful to know more details about the type of accident (sideswipe, rear-end, etc.) as well as the role of the truck in the accident if known (was the truck struck or cut-off, jack-knifed, etc.). Unfortunately, this data is very difficult to obtain beyond anecdotal information from very significant or impactful accidents.

Enhancing Regional Vehicle Classification Data

Several key areas of truck data gaps were identified as part of developing the information for this memo. The most prevalent gap identified was the general lack of vehicle classification data and truck volumes data. The lack of data in this area impacts multiple areas, including: modeling (long-range and near-real time), goods movement studies, traffic operations analyses, and regional transportation performance metrics monitoring.

There have been efforts in the past to implement vehicle classification systems, but treating vehicle classification data and truck count data as a separate system responsible to a separate group has not proven viable. Long-term resources are difficult to obtain and maintain, so previous efforts have seen maintenance and reliability drop over time.

Fortunately, timing seems fortuitous for addressing the truck count and vehicle classification data gap given demands for the data by different groups at Caltrans and SANDAG, as well as on-going enhancements to the Performance Measurement System (PeMS) to support vehicle classification data which can act as a collection, processing, and dissemination resource for the region. This section of the memo discusses the proposed approach for dealing with gaps in current truck count and vehicle classification data in the region.

<u>High-Level Concept for Vehicle Classification Data</u>

Figure 1 displays the high-level architecture concept for enhancing regional vehicle and truck classification and count data. This approach is based on enhancements to the field sensor network, routing of data back through RMIS/Caltrans, and sse of PeMS for data collection and dissemination. Each of these areas is described below:

- *Enhancement to Field Sensor Network*: Three levels of improvements to the field sensor network are proposed:

    - Update, Calibration, and Maintenance of Existing WIM Sites – Some of the WIM sites are not fully operational or are providing sporadic data. These sites are generally sited in important locations, and the data they can provide is still highly useful. The sites should be checked, and repaired as necessary.

    - Calibration and Use of Side-Fire Radar Sites for Supplement Vehicle Classification – It is possible to utilize some of the existing Caltrans VDS to provide supplemental classification data. VDS in D11 generally consist of three types of devices:

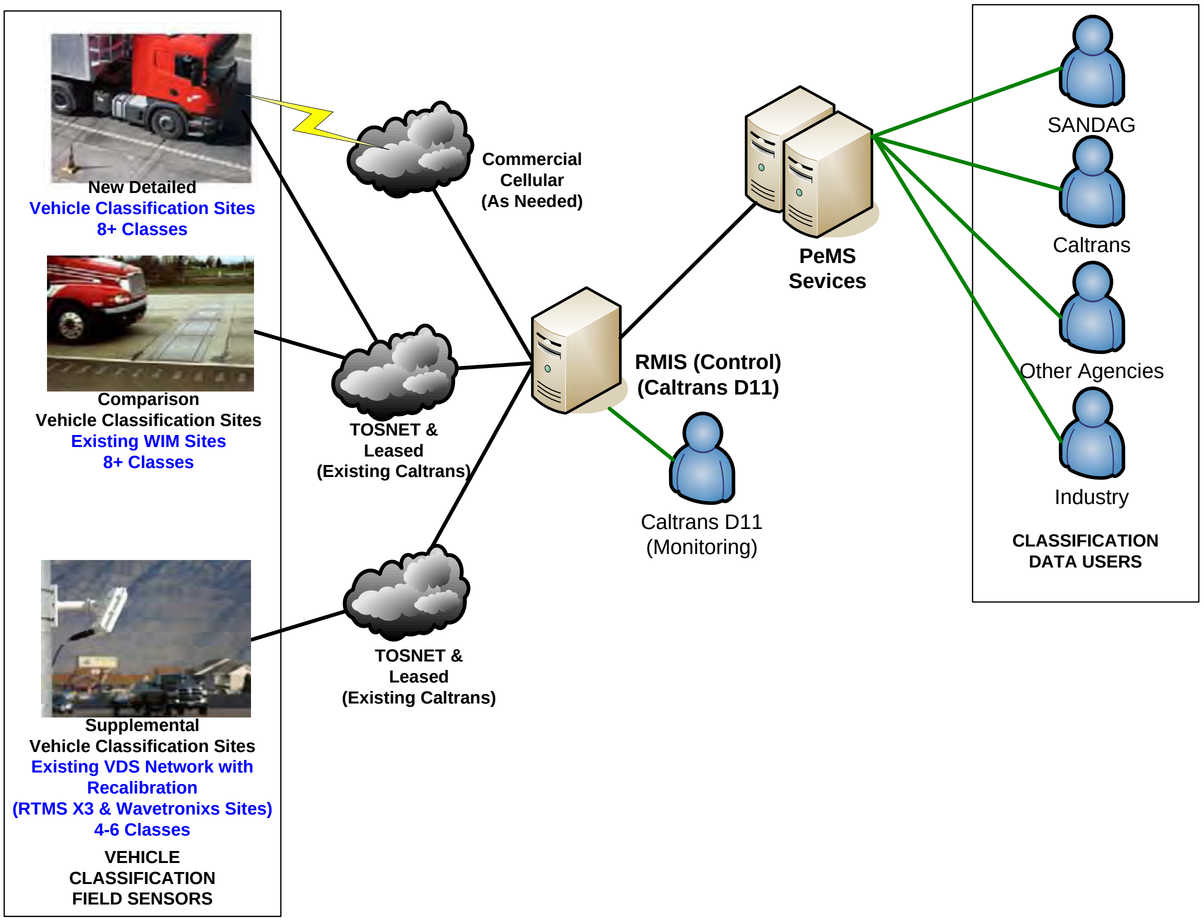


Figure 1 - Overall Concept for Truck Counts and Classification Data Gaps

- Loop based VDS – Generally these exist with two loops in each lane of traffic along many freeways and highways in the region. If implemented with both loops active they can provide relatively accurate classification data. Discussions with Caltrans indicate that currently the majority of loop VDS only have one set of loops active. This means they are using preset average vehicle lengths for calculating speeds. Caltrans is working to update the sites over time and make all dual-loop setups active, however the recommendation by Caltrans for the near-term was to focus supplemental vehicle classification data collection on radar-based sites.

- Caltrans Radar (RTMS x3 and Wavetronix) Sites – Radar-based VDS sites have been deployed along substantial segments of the freeway network. They consist of two different devices, RTMS x3 and Wavetronics 125 with slightly different configurations and capabilities which are discussed later in this section.

- Nokia Radar Sites – There are a number of VDS that are not controlled by Caltrans, but provide data to Caltrans and regional information systems. These sites are not considered as part of a vehicle classification approach as there is no agency control over configuration, maintenance, and management. While it might be possible to reach an agreement with Nokia on providing the data, it is unclear how the necessary adjustments and calibrations would be reimbursed.

- Deployment of a Subset of Detailed Vehicle Classification Sites – Both SANDAG and Caltrans indicated a desire to obtain the most detailed vehicle classification data possible. In general this is viewed as being able to group trucks and vehicles into 8-10 classification bins at minimum with high levels of accuracy. Due to the issues with the existing WIM sites, both in terms of reliability and coverage, additional detailed truck classification sites should be deployed to provide better reliability, accuracy, and coverage. The deployment of new sites must strike a balance between the costs of deployment and maintenance with the need for additional data. Several potential technologies and sites for these sites are discussed later in this section.

- *Routing of Data Back Through RMIS/Caltrans*: As many of the sites already are connected to Caltrans field communications networks and are routed through the Caltrans D11 TMC, it should be possible to largely utilize existing infrastructure and systems to support the existing, supplemental, and detailed vehicle classification sites. Some modifications may be required to RMIS and related interfaces to support the detailed vehicle classification sites. This approach would mean that basic monitoring and maintenance of the vehicle classifications sites would rest with Caltrans.

- *Use of PeMS as a Data Collection and Dissemination Resource*: Based on discussions with Caltrans and SANDAG, it seems that PeMS is already able to support the desired classification data. PeMS is an excellent resource for collecting this data and making it available, however it is generally used to look at individual sites and the data would have to be placed into other tools to look at regional patterns and trends. PeMS should be accessible by all potential data users including Caltrans, SANDAG, industry, etc.

<u>Existing Vehicle Detection Sites and Weigh-in-Motion Sites</u>

Figure 2 displays approximate locations for all Caltrans VDS and WIM sites in the region. Sites locations shown are sometimes only for a single direction and specific locations are approximate. As seen in Figure 2, there is extensive VDS coverage on all of the major freeway corridors in the urban areas of the region. Loop-based VDS sites are distinguished from radar-based VDS sites in the figure. Radar-based sites are concentrated along I-5, I-805, and I-15.

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

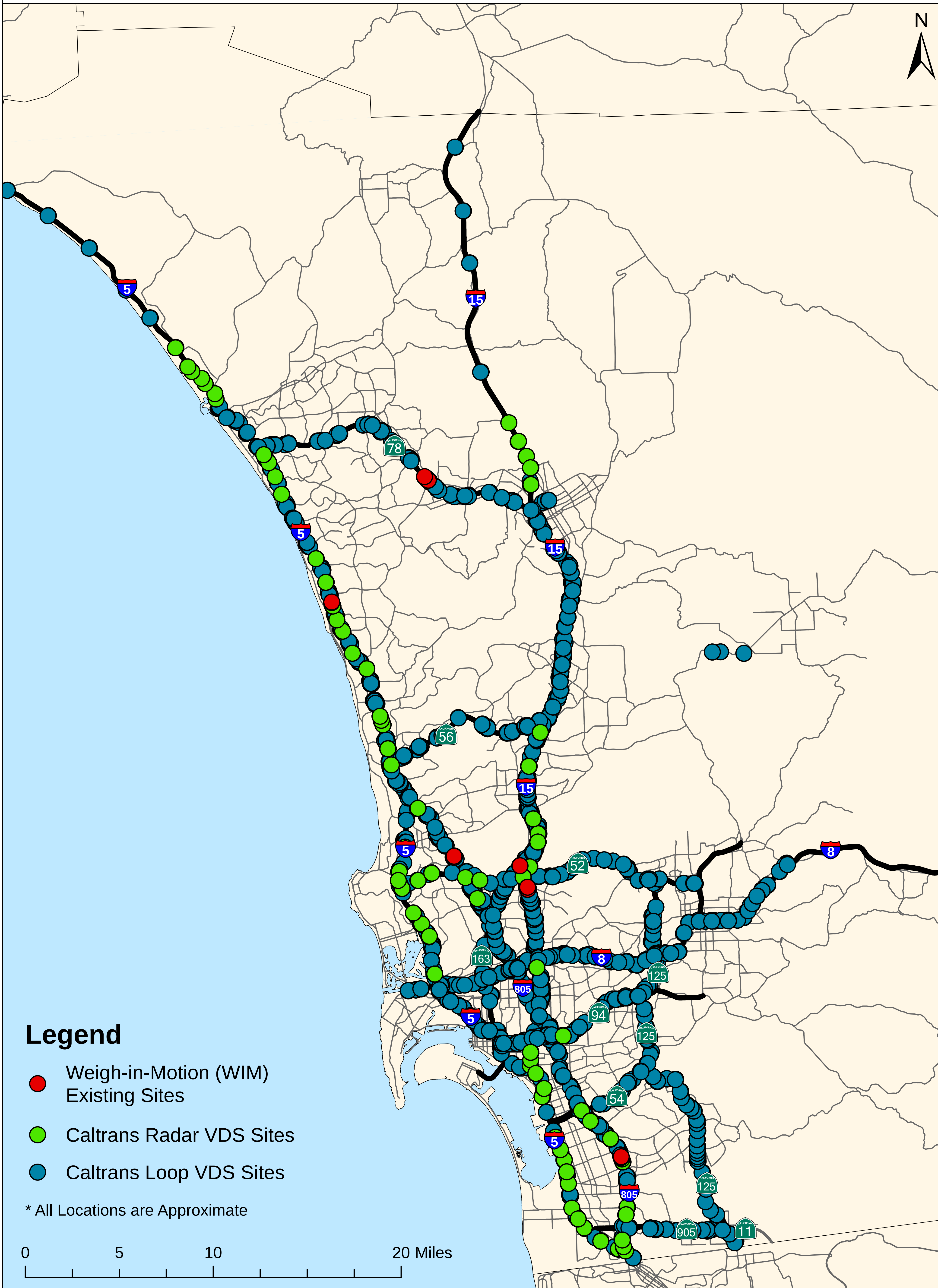


Figure 2: WIM & Caltrans VDS Locations (All Directions)
Source: Caltrans

Date: 9/20/13

Potential Supplemental Radar Sites

Figures 3 and 4 display WIM and Radar VDS locations in the northbound/westbound and southbound/eastbound directions respectively. These figures distinguish between RTMS x3 and Wavetronix 125 radar sites as the type of device impacts its classification capabilities. In general, Wavetronix devices are suggested as supplemental vehicle classification sites, with a couple exceptions, for reasons discussed later in this section. It is feasible for many of the sites indicated in these figures to provide classification data. In fact, the sites currently provide unconfigured classification data to RMIS. However, to be effective and reliable each site to be utilized for classification purposes should be recalibrated and configured to support the desired classification bins by length. Sites where speeds consistently drop below 15mph are not recommended for vehicle classification.

It is possible that dual-loop sites may serve as additional supplemental sites, particularly along corridors where side-fire locations are not readily available. While there are a number of new dual-loop sites active in the region, Caltrans confirmed that the controller software cannot currently directly calculate vehicle classifications. There are broader efforts that might expand these capabilities over time, but for the near-term the use of side-fire radar sites seem the best path and is consistent with Caltrans District 11 suggestions.

Potential Vehicle Classification Technology Options

There are a number of vehicle classification technologies currently available on the open market from a number of different vendors. Table 1 summarizes the different technologies available, as well as their potential uses, advantages, disadvantages, etc.

As noted in the overall concept discussion, the intent is to maximize the use of the existing WIM and potential supplemental side-fire radar sites. This means that the technology assessment is most applicable to new detailed vehicle classification sites suggested for deployment. Of all the technologies review, the most viable in terms of collecting the desired detailed classification data in a field environment are:

- Piezoelectric Sensors
- Laser Radar
- Video

Microwave, magnetic, and loop sensors generally cannot provide the more detailed classifications desired, and/or are already available as supplemental sensors.

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

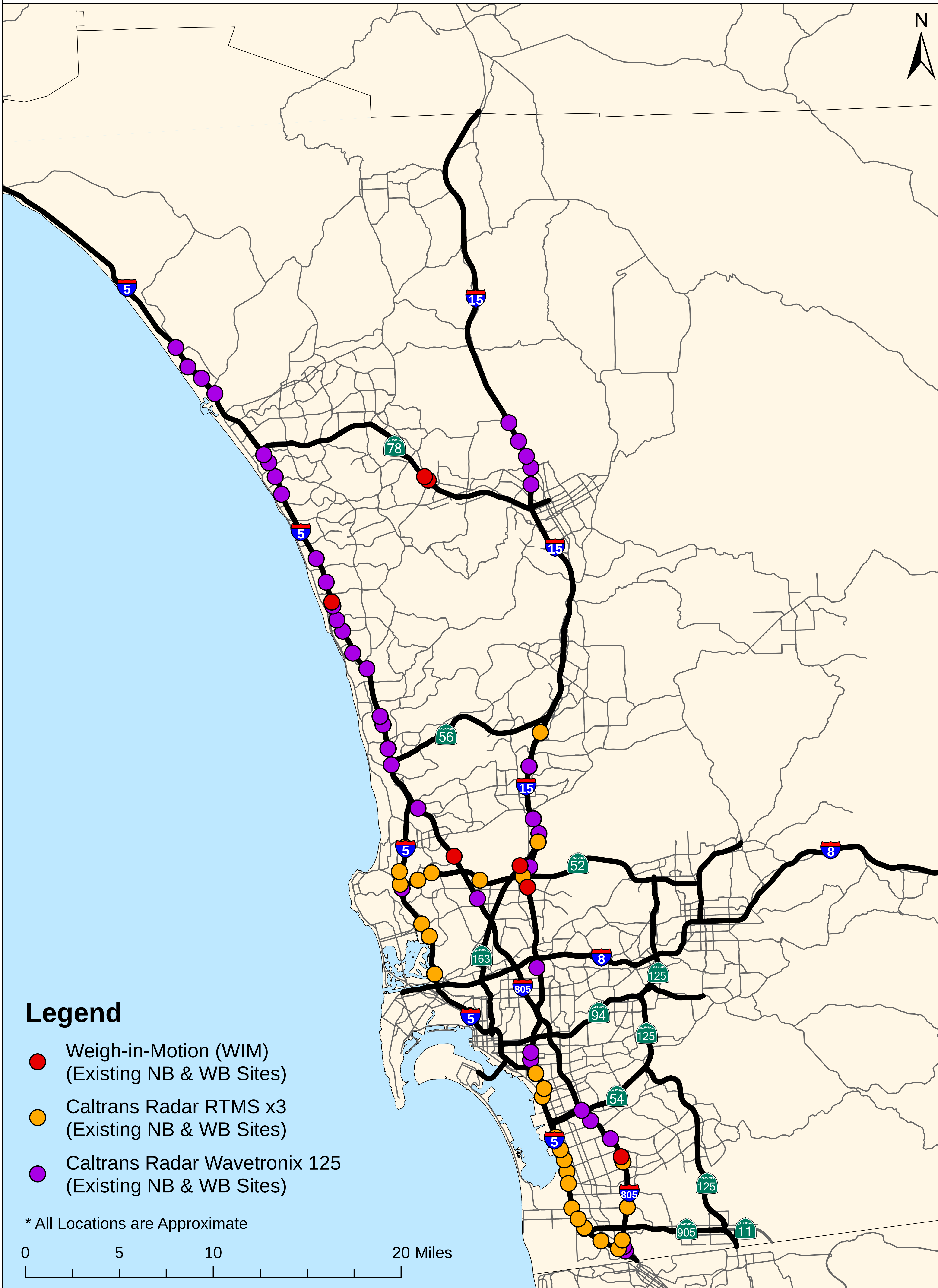


Figure 3: WIM & Caltrans Radar VDS Locations
(Northbound & Westbound)

Source: Caltrans

Date: 9/20/13

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

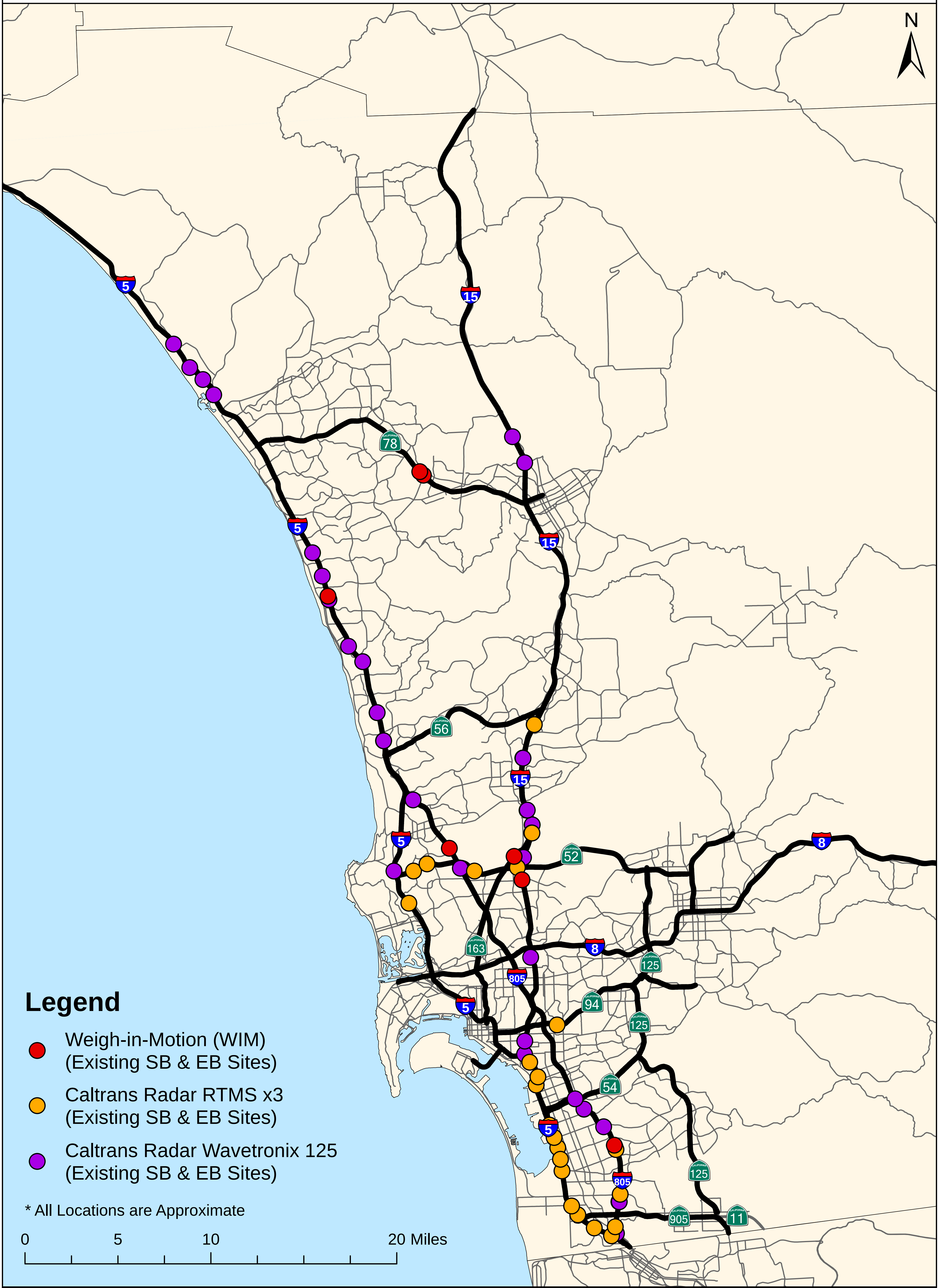


Figure 4: WIM & Caltrans Radar VDS Locations (Southbound & Eastbound)

Source: Caltrans

Date: 9/20/13

Table 1: Vehicle Classification Technology Option Comparisons

Technology Type	Category	Principles of Operation for Vehicle Classification	Installation Configuration	Applications and Uses	Advantages	Disadvantages	Costs (Sensors Only – Not Installed)
Pneumatic Road Tube	On top of Roadway	Sends a burst of air pressure along a rubber tube when a vehicle's tires pass over the tube	Installed perpendicular to the traffic flow direction	• Short-term traffic counting • Vehicle classification by axle count and spacing	• Portable • Quick installation • Low power usage • Sensor manufacturers often supply software packages to assist with data analysis	• Inaccurate axle counting when truck and bus volumes are high • Temperature sensitivity of the air switch • Cut tubes from vandalism and truck tire wear	• Low cost • Easy maintenance
Inductive Loop Detectors	In-Roadway Sensor Technology	Electronics units that excite the wire loop at the higher frequencies that identify specific metal portions under the vehicle	Saw cut into pavement in 6-ft by 6-ft square, 6-ft diameter round, or rectangular configurations	• Vehicle passage • Presence • Count • Occupancy • Two-loop speed trap • Vehicle classification by specific metal portions under the vehicle	• Mature technology • Large experience base • Provide basic traffic parameters • Suitable for a large variety of applications • Insensitive to inclement weather such as rain, fog, and snow	• Installation requires pavement cut • Decreases pavement life • Disruption of traffic for installation and repair • Failures associated with installations in poor road surfaces • Subject to the stresses of traffic and temperature	• Low cost ($500 to $800) • Installation and maintenance costs significantly increase the life-cycle cost
Magnetic Sensors	In-Roadway Sensor Technology	Passive devices that indicate the presence of a metallic object by detecting the perturbation magnetic anomaly in the Earth's magnetic field created by the object	Installed in the center of traveled path, coring, or boring under the roadway	• Identify stopped and moving vehicles • Magnetic signature of a vehicle • Vehicle classification by vehicle length derived from occupancy	• Less susceptible than loops to stresses of traffic • Insensitive to inclement weather such as snow, rain, and fog	• Installation requires pavement cutting, coring, or boring under the roadway • Decreases pavement life • Installation and maintenance require lane closure • Models with small detection zones require multiple units for full lane detection	• Moderate ($900 to $6,300)
Piezoelectric Sensors	In-Roadway Sensor Technology	Piezoelectric materials generate a voltage when subjected to mechanical impact or vibration	Installed perpendicular to the traffic flow direction in pavement along with appropriate Resin-based grout or Epoxy	• Classify vehicles by axle count and axle spacing • Which measures vehicle weight and speed	• Differentiate individual axles with high precision • Speed accuracy • Determine the classification of the vehicle based on weight and axle spacing • Capability to determine and monitor the weights of vehicles	• Installation requires pavement cut • Decreases pavement life • Disruption of traffic for installation and repair • Failures associated with installations in poor road surfaces • Subject to the stresses of traffic and temperature • Multiple detectors are required to instrument a location	• Low cost ($500 to $800) • Only marginally more expensive than an inductive loop

Technology Type	Category	Principles of Operation for Vehicle Classification	Installation Configuration	Applications and Uses	Advantages	Disadvantages	Costs (Sensors Only – Not Installed)
Weigh-in-Motion (WIM)	In-Roadway Sensor Technology	Plates with strain gauges bonded to the underside and calculate the dynamic load	Installed in the center of traveled path, under each tire	• Estimating the gross vehicle weight of a vehicle and the portion of this weight carried by each wheel assembly (half-axle with one or more tires), axle, and axle group on the vehicle • Heavy Vehicle traffic volume, speed, vehicle classification based on number and spacing of axles, and the equivalent single axle loading (ESAL)	• Quartz sensors do not generally age or fatigue • Temperature effects are negligible • Rapid changes in temperature do not cause a drift in output signal	• Used at low speed ranges (2 mph to 25 mph) • Monitor up to four lanes	• Moderate to high ($4,500 to $34,000) • Lasts longer, reducing life cycle maintenance costs and increasing reliability
Microwave Radar	Over-Roadway Sensor Technology	Sensors transmit energy toward an area of the roadway from an overhead antenna and a portion of the transmitted energy is reflected back towards the antenna	Mounted over the middle of a lane to measure approaching or departing traffic flow parameters in a single lane, or at the side of a roadway to measure traffic parameters across several lanes	• Volume • Speed • Occupancy • Calculated length of vehicle • Vehicle classification by vehicle length derived from occupancy	• Typically insensitive to inclement weather at the relatively short ranges encountered in traffic management applications. • Multiple lane operation available	• CW Doppler sensors cannot detect stopped vehicles	• Low to moderate ($700 to $3,300)
Active Infrared (Laser radar)	Over-Roadway Sensor Technology	Illuminate detection zones with low power infrared energy supplied by laser diodes operating in the near infrared region of the electromagnetic spectrum	Mounts 19.7ft to 23ft above the road surface with a forward tilt	• Vehicle presence at traffic signals • Volume • Speed measurement • Length assessment • Queue measurement • Vehicle classification by two- and three-dimensional images of vehicles	• Transmits multiple beams for accurate measurement of vehicle position, speed, and class • Multiple lane operation available	• Operation may be affected by fog when visibility is less than 20ft (6m) or blowing snow is present • Installation and maintenance o Periodic lens cleaning o Require lane closure	• Moderate to high ($6,500 to $14,000)

Technology Type	Category	Principles of Operation for Vehicle Classification	Installation Configuration	Applications and Uses	Advantages	Disadvantages	Costs (Sensors Only – Not Installed)
Video Image Processor	Over-Roadway Sensor Technology	Video image processor systems detect vehicles by analyzing the imagery from a traffic scene to determine changes between successive frames	Side of a roadway mounting height: 30ft to 50ft Centralized location over the middle of the roadway mounting height: 20ft	• Vehicles classification by length • Vehicle presence • Flow rate • Occupancy • Speed	• Monitors multiple lanes and multiple detection zones/lane • Easy to add and modify detection zones • Rich array of data available • Provides wide-area detection when information gathered at one camera location can be linked to another	• Installation and maintenance o Periodic lens cleaning o Lane closure when camera is mounted over roadway • Performance affected by: o Inclement weather such as fog, rain, and snow o Vehicle shadows o Vehicle projection into adjacent lanes o Day-to-night transition o Vehicle/road contrast o Water, salt grime, icicles, and cobwebs on camera lens • Requires 30ft - to 50ft (9m to 15m) camera mounting height (in a side-mounting configuration) for optimum presence detection and speed measurement • Some models susceptible to camera motion caused by strong winds or vibration of camera mounting structure • Detection zones need to be within the field-of-view of the camera • Reliable nighttime signal actuation requires street lighting	• Moderate to high ($5,000 to $26,000)

Given likely mounting limitations and the need to avoid the cost and complexity of overhead mounting and gantries, as well as provide full coverage for the freeway, piezoelectric sensors seem the most viable near-term option. In addition, they are commonly deployed for truck vehicle classification and axle counting. It should be noted that any in-ground sensor (eg piezoelectric included) can create difficulty in terms of maintenance and eventual replacement, particularly where traffic volumes are high. That said, the cost and complexity of in-ground sensors must be considered against the design and installation costs for overhead vehicle classification sensor options, particularly where readily available mounting options and structures do not exist.

<u>Overall Proposed Vehicle Classification Data Sites</u>

Figures 5 and 6 list the existing, supplemental, and proposed vehicle classification sites for the region in the northbound/westbound and southbound/eastbound directions respectively. WIM sites continue to be part of the vehicle classification network. A series of supplemental radar based sites are suggested as well. A number of sites are noted in "clumps" where one of several sites in this area could be checked, calibrated, and configured as desired to provide supplemental vehicle classification data.

<u>Consideration of Non-Freeway Sites</u>

While the initial sites noted in this memo focus on the freeway and highway network, it should be noted that there are substantial gaps in vehicle classification and truck volume data on major arterials, rural routes frequented by trucks, and marine terminal and land Port of Entry (POE) access routes. Project stakeholders noted additional needs for vehicle classification sites along rural portions of SR78, SR79, SR67, and SR94. They also indicated that once more reliable data is available for freeway and highway corridors, that enhanced data would be very useful for key truck access routes. Some of the more substantial truck trip production areas and access routes are discussed in Technical Memos #4 and #5 of this Study.

<u>Supplemental Radar Site Details</u>

There are some differences in capabilities and configurations between the two side-fire radar detectors commonly used by Caltrans in the region. Key elements of each device are discussed below. In general, the Wavetronix device offers a slightly greater number of classification bins, but both use vehicle lengths for classification purposes. While many or all sites are currently providing classification data, this data should be ignored for sites that have not been specifically checked, calibrated, and configured to the desired bins (vehicle length categories). It is recommended for both detectors that the potential number of classification bins be limited to one less than the total bins possible.

Analysis of Freeway Operational Strategies Related to the Use of Managed Lanes by Trucks

Figure 5: Existing and Proposed Vehicle Classification Sites (Northbound & Westbound)

Source: IBI Group

Date: 9/20/13

Analysis of Freeway Operational Strategies
Related to the Use of Managed Lanes by Trucks

Figure 6: Existing and Proposed Vehicle Classification Sites
(Southbound & Eastbound)

Source: IBI Group

Date: 9/20/13

- RTMS X3

  - Number of Classification - RTMS X3 can classify vehicle length in increments of 2 classifications, up to 6 vehicle length classification groupings.
  - Factory Defaults - There are no factory default settings for vehicle classification groupings. Vendor recommended configuration for vehicle length classifications at initial startup are 0-26, 26-39, 39-49, 49-66, 66-79, and 79 feet or longer.

  - Accuracy - The accuracy depends upon free flowing traffic. Vendor recommends vehicle speeds above 15 MPH for data accuracy. Though RTMS currently has a newer generation of the sensor, G4, with higher resolution radar and improved detection processing, better lane-by-lane count accuracy and better performance at lower speeds than the X3 product. While generally these improvements to X3 would improve the vehicle length classification, there has not been a side-by-side comparison of the two products, X3 and G4, to verify the improvement. Figure 7 shows how a radar sensor can detect multiple lanes of traffic in a side-fire configuration. This strategy applies to both unit types deployed in the region.

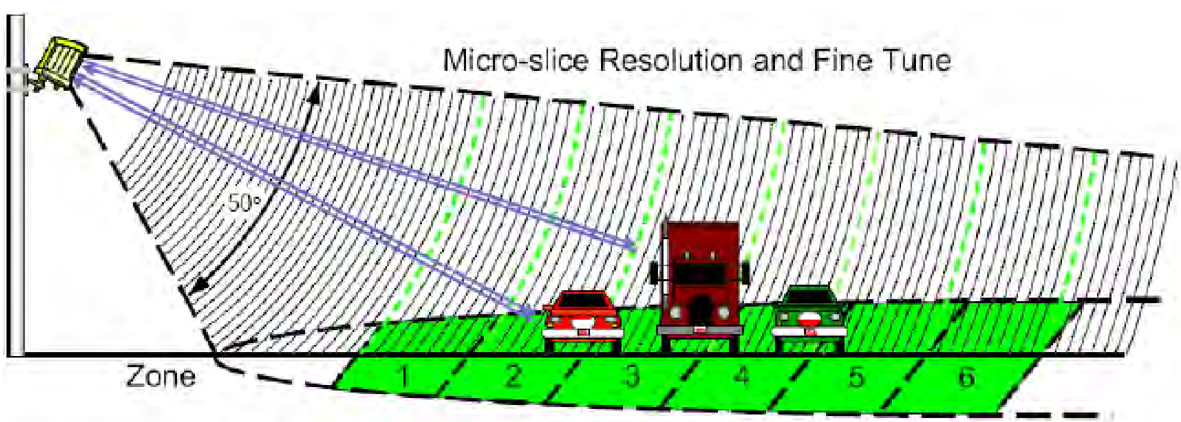


Figure 7: Radar Microwave and Beam Footprint

  - Limitations - The software wizards used at startup and recalibration are different between the RTMS sensor generations. The latest startup wizard is more intuitive with more software options available, whereas the RTMS X3 recalibration software has a few updated versions since the sensor first became available on the market. Updating the sensor with latest software and recalibration is necessary to accurately collect detector data. When lanes shift due to construction, restriping, or new lanes were added, the sensor must be recalibrated using the latest software. It is also possible to collect inaccurate data if the pole that the RTMS is mounted on moves or rotates from its original position.

- Implementation - Initial startup and recalibration can be completed through the software wizard. After the initial setup, the sensor will continually learn the background, making a background threshold blanket to use to detect passing vehicles. Additionally, as temperatures changes, the microwave constantly adapts to maintain frequency stabilization.

- Wavetronix 125

  - Number of Classification - Wavetronix 125 can classify vehicle length in any increments, in up to 8 vehicle length classification bins.
  - Factory Defaults - There are no factory default settings for vehicle classification bins. Vendor recommended configuration for vehicle length classifications at initial startup are 0-10, 10-19, 19-24, 24-54, 54-109 and 109 feet or longer.
  - Accuracy - Vendor recommends a minimum vehicle speed of 5 MPH must be maintained in order to achieve 90-95% accuracy.
  - Limitations - The sensor has to be recalibrated if the traveled lanes shift or change directions. After the initial startup when the lanes are 'locked in' to the sensor, the sensor will only detect vehicles within the lane boundaries to which it was configured.
  - Implementation - Figure 8 displays the typical side-fire configuration used for all radar sites in the region. Initial startup and recalibration can be done

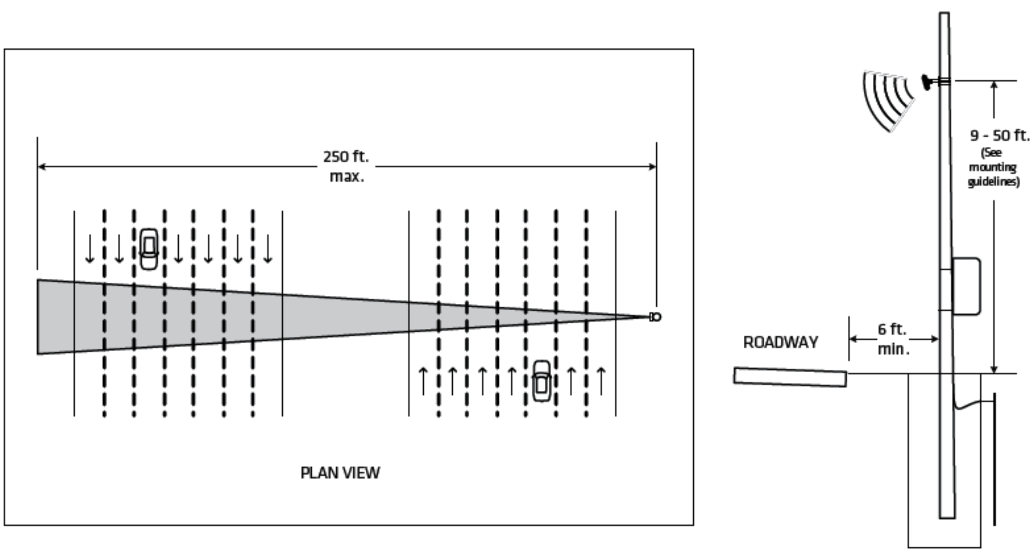


Figure 8: Placement of Radar Detector in Side-Fire Setup

through the free software on the Wavetronix website. One of the options to recalibrate the sensor is to adjust the countdown timer length. The timer is adjusted when the large vehicles are not getting detected accurately. By lengthening the timer, the sensor will detect one large vehicle instead of multiple vehicles.

- Summary of Side-Fire Radar Detectors - Both the RTMS and Wavetronix units have a long history of implementation, and strong support and development from the manufacturers. The main difference between the products is that the Wavetronix unit has more flexibility in choosing the number of vehicle length classification bins and vendor recommended minimum speed to collect accurate that data can be as low as 5 MPH. Neither of the products needs additional equipment installation to collect data for vehicle length classification. The flexibility and accuracy of the data makes the Wavetronix unit the recommended product for classifying vehicle length in a side-fire configuration for initial deployment where the option between the two devices exist. It should be noted that both vendors offer upgraded and more advanced units, but these two devices represent those units currently deployed for Caltrans use in the region.

<u>Preliminary Programmatic Cost Estimate for Truck Count & Vehicle Classification Concept</u>

Table 2 summarizes the planning level cost estimate for the deployment of the concept discussed in this memo. All costs are preliminary and are intended for planning and programming purposes only. Costs assume that PeMS will be used as the backoffice data collection and reporting system with data passed through RMIS/Control at the Caltrans TMC. The pilot site implementation assumes the steps discussed later in this document, and the hourly rate is estimated at $140 per hour whether Caltrans or contractor staff is assumed.

program. Several of these binders should be prepared and distributed to Caltrans and SANDAG staff in appropriate departments.

5. Remaining Site Roll-Outs: Once the pilot has been successfully completed and all configuration and bin settings are understood and agreed upon, the remaining sites can be rolled out over time. This will require a cooperative effort between Caltrans and SANDAG, with involvement from contractors and/or vendors as appropriate. It should be possible to roll out the entire vehicle classification network in the region in a 12-month period assuming funding is in place.
   a. *Detailed Sites*: There are five bi-directional (or 10 single direction) detailed classification site locations suggested in this memo (as shown in Figures 5 & 6).
      i. Design – All detailed sites will require design, but plan sheets should be relatively simple and the layout of sensors within the roadway should be typical.
      ii. Construction – Construction can be conducted under the Job Order Contract process with the same contractor(s) as the pilot if that has proven successful.
      iii. Activation, Calibration, and Validation – All sites will need to be installed, calibrated, and validated with brief observational periods. Communications will have to be established either through existing Caltrans communications or wireless.
   b. *Supplemental Sites*: Supplemental sites are already in place and only require proper review, adjustment, and calibration. Even if configuration can occur remotely, it is strongly suggested that each site be reviewed and checked on-site. For each location where detailed sites are deployed in proximity to supplemental sites, a comparison of that data for a select period should be conducted.
6. PeMS Reporting Integration, Connectivity, and Validation – As noted throughout this memo, the assumed resource for collecting and reporting vehicle classification data for the region is PeMS. PeMS is the logical choice given that it already exists as a data collection and performance monitoring resource in the region, but it is important to note that PeMS is only as useful and/or accurate as the underlying sensor network. SANDAG and Caltrans should confirm that PeMS data is accurately representing the pilot and roll-out sensor data for each of the sites. Once this is established, then appropriate post-processing and/or reporting techniques can be determined. It may be possible to streamline access to certain truck data sets by working with PeMS staff.

7. On-Going Maintenance and Monitoring – A major failing of previous vehicle classification and data collection sites is that proper regular maintenance has not always been available, resourced, or required. Once a number of sites fail to report or fail to report complete data, trust in the data collection network is lost and not

would be possible to deploy a significantly less costly solution if the detailed sites are done at a later date, and the supplemental sites become the focus of the implementation. Under this scenario, costs could be reduced to approximately $275,000 with an additional $20,000 to check and repair WIM sites.

Options for Dealing with Other Truck Data Gaps

While the significant gaps in the truck count and vehicle classification system were the primary focus of improvements in this memo, it is important to note that several other data gaps were discussed and some options exist for dealing with these areas.

- Origin/Destination and Trip Purpose: As noted previously, consistent data is not currently available for truck origins/destinations and trip purposes. The primary method for collecting this data today is manual surveys. There are some possible methods to supplement or support these data needs.

    - American Transportation Research Institute (ATRI) – SANDAG has had some preliminary discussions with ATRI about providing basic truck origin/destination data for planning and modeling support purposes. This approach seems reasonable, but is most likely to draw upon regional or long-haul trip data sets and miss many smaller fleet or local internal truck trips. There are other sources of GPS truck fleet data (eg Omnitracs) that would more likely reflect smaller fleet activity; however data confidentiality will be a concern for the industry. This option could be researched further to assess what might be possible.

    - Mobile Smartphone Application and 511 Tie-In – SANDAG is currently planning upgrades to their 511 and regional traveler information solutions. This includes some mobile smartphone applications that relate to 511 functions for TDM purposes. It may be possible to piggy-back some survey functions to highlight trip purpose and connect origin and destination for a subset of participants. This approach would require additional research.

- Detailed Accident Data: Comprehensive accident data would not be possible to obtain without significant manual efforts and follow-ups. SWITRS and TASIS would continue to be reasonable sources of summary information. However, it might be useful to speak with the Caltrans Traffic Operations staff at the TMC. Major accidents that generate significant traffic delays and lane closures are usually entered into the Caltrans ATMS software. This software feeds regional data fusion systems and eventually 511. It may be possible to obtain on-going incident report summaries involving trucks. These summaries may contain additional data from a traffic impacts perspective that is not available through accident reports.

- USDOT Truck Travel Time Data – Through a national USDOT program, travel time data will be available in monthly summaries for major segments along significant interstates. Data for trucks will be available based on information provided through ATRI. This data is available to SANDAG and Caltrans for planning and performance monitoring purposes. While it does not provide origin/destination or trip purpose information, it may prove useful for understanding when truck travel times are most impacted by overall traffic conditions.

Next Steps for Truck/Vehicle Classification Implementation

The opportunity is timely to move towards an enhanced truck and vehicle classification data collection network in the region. The following steps illustrate one possible method for moving forward with the implementation of that network.

1. Site Location Confirmation – Using this memo as a starting point, the specific desired sites for detailed and supporting vehicle classification should be confirmed with involved stakeholders. It is important to note that the number of sites selected will need to be limited, particularly at first, in order to maintain a reasonable and cost effective roll-out plan for truck and vehicle classification data. It is recommended that the total number of sites selected not exceed the number of locations highlighted in this memo by more than 10%. It is important to note that multiple supplemental sensor sites are highlighted in a general area, and it is anticipated that only one of those sites would be activated in conjunction with an approximate detailed vehicle classification site. Refer to Figures 5 & 6 in this memo for suggested sites.

2. Determine Vehicle Classification Bins and Comparative Data Across Sensor Types – The existing WIM sites, suggested detailed vehicle classification sites, and supplemental sites represent different sensor sites with separate data collection methods. WIM sites are weight and largely axle count based, whereas supplemental sites are vehicle-length based. Piezoelectric (if selected for the detailed sites) are largely axle and axle-space based methods which infer vehicle length. This memo provides some background on vendor suggested vehicle length bins for supplement sensor settings, but it is important that the comparative data and bins be aligned to match regional needs. This should generally be consistent with FHWA truck classifications discussed more broadly in this Trucks on Managed Lanes Study, but it should be noted that overlap exists between several of the classifications. It is recommended that the total number of bins for supplemental sites not exceed six (6), and the total number of bins for detailed sites not exceed eight (8) or nine (9). This will help to focus data sets on the types of truck traffic that are: A) most common; and B) fall within the realm of reasonable freeway operational analysis.

3. Follow-Up Discussions with PeMS Resources – PeMS is already being prepared to provide vehicle classification data. In addition, the side-fire radar sites, whether identified as supplemental vehicle classification sites or not, provide vehicle classification data. It is suggested that the possibility of identifying calibrated and confirmed truck and vehicle classification sites be discussed with PeMS support staff so that accurate sites that are part of the vehicle classification data collection network in the region can be distinguished from sites that have not been reviewed, calibrated, and/or validated. In addition, SANDAG and Caltrans may like to discuss the format and extent of the data exports available from PeMS. It may be possible and prudent to develop a common regional truck data summary export that requires less post-download processing and adjustment.

4. Pilot Site(s) Selection for Vehicle Classification Sites – In order to confirm the effectiveness of the supplemental vehicle classification sites, as well as determine effective settings, calibration, and placement of the detailed vehicle classification sites, a pilot deployment and test effort is recommended. The pilot site should be selected based on the relatively proximity of supplemental vehicle classifications sites and proposed detailed vehicle classification sites where truck volumes and classification data would be consistent.

    a. *Design and Construct Pilot Site* – The detailed vehicle classification site will have to be designed to include the selected sensors, appropriate traffic control, supporting power and cabinets, possible maintenance pads, and ties to either the Caltrans TOSNET or wireless communications. The site could then be contracted out through SANDAG's Job Order Contract process to speed deployment.

    b. *Site Calibration and Validation* – Once deployed, the site should be calibrated, and it is recommended that the selected sensor vendor be involved in this process for the pilot. Data should be collected over three separate periods in time and manual or video observations should be compared with the results from the detailed site sensors.

       It may be possible to deploy the pilot in proximity to an existing WIM site and confirm the WIM site is providing valid data as another form of validation. Also, a temporary setup could be placed to allowed video collection and recording of the data for validation purposes.

    c. *Calibration and Adjustment of Supplemental Classification Sites* – The selected supplemental sensor sites should be checked, calibrated, and adjusted to reflect the desired vehicle length classifications and bins. The pilot should not be conducted without this step included. The primary goal will be to confirm proper operation of all the sensors and determine what adjustment and calibration activities are needed to ensure accurate vehicle classification data collection.

    d. *Comparison of Data* – Once the pilot period is complete (a minimum of 2 weeks is suggested), the data from each of the sensors in the pilot should be compared to assess the comparative classification bin assignments and accuracy of the devices. Lessons learned from the pilot deployment and this comparison can be applied to the design, deployment, and calibration of the remaining sites/locations.

    e. *Guidelines for Remaining Classification Sites Roll-Out* – Often times the lessons learned from initial deployments and pilots are lost over time. The vehicle classification network in the region is intended to operate over an extended period of time and provide on-going accurate information for several years. It is strongly recommended that a guidelines binder be put together that combines vendor manuals, site design details, calibration and configuration settings for each location, lessons learned for field deployment, and lessons learned through on-going monitoring and maintenance from the pilot program. Several of these binders should be prepared and distributed to Caltrans and SANDAG staff in appropriate departments.

5. Remaining Site Roll-Outs: Once the pilot has been successfully completed and all configuration and bin settings are understood and agreed upon, the remaining sites can be rolled out over time. This will require a cooperative effort between Caltrans and SANDAG, with involvement from contractors and/or vendors as appropriate. It should be possible to roll out the entire vehicle classification network in the region in a 12-month period assuming funding is in place.
    a. *Detailed Sites*: There are five bi-directional (or 10 single direction) detailed classification site locations suggested in this memo (as shown in Figures 5 & 6).
        i. Design – All detailed sites will require design, but plan sheets should be relatively simple and the layout of sensors within the roadway should be typical.
        ii. Construction – Construction can be conducted under the Job Order Contract process with the same contractor(s) as the pilot if that has proven successful.
        iii. Activation, Calibration, and Validation – All sites will need to be installed, calibrated, and validated with brief observational periods. Communications will have to be established either through existing Caltrans communications or wireless.
    b. *Supplemental Sites*: Supplemental sites are already in place and only require proper review, adjustment, and calibration. Even if configuration can occur remotely, it is suggested that each site be reviewed and checked on-site. For each location where detailed sites are deployed in proximity to supplemental sites, a comparison of that data for a select period should be conducted.
6. PeMS Reporting Integration, Connectivity, and Validation – As noted throughout this memo, the assumed resource for collecting and reporting vehicle classification data for the region is PeMS. PeMS is the logical choice given that it already exists as a data collection and performance monitoring resource in the region, but it is important to note that PeMS is only as useful and/or accurate as the underlying sensor network. SANDAG and Caltrans should confirm that PeMS data is accurately representing the pilot and roll-out sensor data for each of the sites. Once this is established, then appropriate post-processing and/or reporting techniques can be determined. It may be possible to streamline access to certain truck data sets by working with PeMS staff.

7. On-Going Maintenance and Monitoring – A major failing of previous vehicle classification and data collection sites is that proper regular maintenance has not always been available, resourced, or required. Once a number of sites fail to report or fail to report complete data, trust in the data collection network is lost and not

easily regained. The deployment of a vehicle classification network is a substantial undertaking, and it is important that on-going maintenance resources be identified and followed up. It is suggested that Caltrans is in the best position to maintain the detailed and supplement vehicle classification sites, however regional interagency MOUs may be required to ensure funds, maintenance timelines, regular maintenance and calibration, etc.