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

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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).

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...

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

Source: 2050 SANDAG RTP
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)
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 County2 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.

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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).

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

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

Source: FHWA, 2011
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:

- 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.”

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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 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.

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).

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. 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.

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

**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).

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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).

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

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).

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

FIGURE 10: CROSS SECTIONS PROPOSED FOR I-710 UNDER ALTERNATIVES 6B AND 6C
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 Corridor Along SR 60](source: SCAG 2012 – 2035 RTP)

![Figure 12: Benefits of an East-West Corridor Strategy](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.

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

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

Source: FHWA, 2011
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 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**

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Source: Transport Canada, 2011
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.


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

<table>
<thead>
<tr>
<th>Expected Advantages</th>
<th>Disadvantages &amp; Cautions</th>
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| **Safety** | • Some analyses pointing to little safety improvement (T,C,S)  
| • 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) |
| **Goods & People Mobility** | • Unutilization of truck lane capacity can be problematic, both in real terms and in public perceptions, if passenger car lanes are congested (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,D) |
| **Infrastructure Cost** | • 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** | • 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)  
| • 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) |
| **Revenue Generation** | • Tolls not projected to close construction costs of SR-38 (S)  
| • I-81 corridor in Virginia received opposition from trucking industry as a result of tolls (S) |
| **Land Use/Accessibility** | • Little, if any, accessibility improvement for households (C)  
| • 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 |
| **Social/Environmental** | • Diversion of trucks to new corridors would involve diversion of emissions, noise, and vibration (S)  
| • More shift from intermodal rail to truck may occur as a result of improved truck lane reliability, leading to increased emissions and fuel consumption (S)  
| • 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) |

Source: Transport Canada, 2011


This report contains a vast amount of information about implementing Commercial Motor Vehicle (CMV)-only lanes\textsuperscript{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.

\textsuperscript{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)

• 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)

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):
  o $5.8 billion for adding additional mixed-flow lanes
  o $10.5 billion for truck-only lanes
  o $11.2 billion for truck-only lanes that include LCV operations

• Total baseline costs for urban corridor alternatives (2008 dollars):
  o $800 million for mixed-flow lanes
  o $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.


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](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).

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

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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.  


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

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 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

<table>
<thead>
<tr>
<th>Key Finding</th>
<th>Study</th>
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<tbody>
<tr>
<td><strong>General Benefits and Costs</strong></td>
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<tr>
<td>Truck use of separate truck-only lanes could result in the following benefits:</td>
<td></td>
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<tr>
<td>• A reduction in truck travel times, improving freight movement efficiency</td>
<td>Poe, 2010</td>
</tr>
<tr>
<td>• More predictable travel times, allowing expansion of just-in-time delivery options</td>
<td></td>
</tr>
<tr>
<td>• An improvement in domestic and international competitiveness</td>
<td></td>
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<tr>
<td>• The maintenance of consumer goods pricing</td>
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<tr>
<td>• A reduction in truck idle time in congestion, which also reduces fuel consumption and improves air quality</td>
<td></td>
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<tr>
<td>• An improvement in facility capacity by removing many trucks from the general purpose lanes and making better use of toll or managed lanes</td>
<td></td>
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<tr>
<td>• A reduction in crashes and incident impacts (fewer lanes blocked, easier to access and clear) by concentrating trucks to a designated lane</td>
<td></td>
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<tr>
<td>• A more comfortable driving environment for those intimidated by driving near trucks</td>
<td></td>
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<tr>
<td>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.</td>
<td>Bucklew, 2012</td>
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<tr>
<td><strong>Planning</strong></td>
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<tr>
<td>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.</td>
<td>AASHTO, 2007</td>
</tr>
<tr>
<td>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.</td>
<td>USGAO, 2008</td>
</tr>
<tr>
<td>Stakeholders, in particular the trucking industry, should be involved in planning truck-only lanes (especially in regards to issues such as tolling).</td>
<td>NCHRP Report 649/NCFRP Report 3, 2010</td>
</tr>
<tr>
<td>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.</td>
<td>Sisiopiku &amp; Cavusoglu, 2011</td>
</tr>
<tr>
<td>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.</td>
<td>NCHRP Report 649/NCFRP Report 3</td>
</tr>
<tr>
<td>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).</td>
<td>NCHRP Report 649/NCFRP Report 3</td>
</tr>
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</table>

**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

| 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 |
Results consistently indicate that truck-only lanes in urban corridors have higher safety benefits compared to mixed-flow lanes.

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.

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.

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.

### 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.

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)

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.

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.

| NCHRP Report 649/NCFRP Report 3 | Liu & Garber, 2007 |
| Liu & Garber, 2007 | Adelakun & Cherry, 2009 |
| Fuha, 2009 | Burke, 2005 |
| Fuha, 2009 | Burke, 2005 |
| Sisiopiku & Cavusoglu, 2011 | ODOT, 2009 |
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

**Timing/Criteria**

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

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

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

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Poe, 2010

NCHRP Report 649/NCFRP Report 3, 2010

FDOT, 2002

Burke, 2005
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.

The following thresholds for implementing truck-only lanes are cited in the report:

<table>
<thead>
<tr>
<th>Mainline Volumes</th>
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<tbody>
<tr>
<td>Peak hour &gt; 1,800 vehicles per hour per lane (vphpl) (Janson)</td>
</tr>
<tr>
<td>Off-peak hour &gt; 1,200 vphpl (Janson)</td>
</tr>
<tr>
<td>Two-way average daily traffic (ADT) &gt; 120,000 OR at least 15,000 per lane (Douglas)</td>
</tr>
<tr>
<td>ADT &gt; 100,000 (Battelle)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Heavy Truck Volumes</th>
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</thead>
<tbody>
<tr>
<td>Two-way average daily truck traffic (ADT) &gt; 20,000 for 10 miles OR the corridor should provide access to major freight generators at the termini (Douglas)</td>
</tr>
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<table>
<thead>
<tr>
<th>Heavy Vehicle Percentage</th>
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<tr>
<td>&gt; 30 percent (Janson)</td>
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<tr>
<td>25 percent trucks (Battelle)</td>
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<tr>
<th>Lane configuration</th>
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<tr>
<td>At least two general purpose lanes and two truck-only lanes in each direction (Douglas)</td>
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<tr>
<th>Tolling</th>
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<tr>
<td>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.</td>
</tr>
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</table>

| 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... |
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 | Transport Canada, 2011 |

| 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. | NCHRP Report 649/NCFRP Report 3, 2010 |

| 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 |

<p>| 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 |</p>
<table>
<thead>
<tr>
<th>Funding</th>
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<tbody>
<tr>
<td>Traditional funding mechanisms can be inadequate for new large truck-only lane projects, and public-private partnerships should be considered.</td>
<td>Bucklew, 2012</td>
</tr>
</tbody>
</table>


Liu, Q., & Garber, N. J. U.S. Department of Transportation, Office of University Programs, Research Innovation and Technology Administration. (2007). *Identifying the impact of truck-lane restriction strategies on traffic flow and safety using simulation* (UVACTS-14-5-103)


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