Implementation of Action 6 of the California Sustainable Freight Action Plan (CSFAP) Phase 4: Tracking Economic Competitiveness

Final Report Part 2: Economic Impacts of Investment in Public Truck Parking Facilities in California

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A Research Report from the Pacific Southwest Region University Transportation Center

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16. Abstract
The purpose of this research is to examine the macroeconomic impacts of eliminating the statewide truck parking shortage. We compare the costs of constructing and operating the additional spaces with the savings in productivity, emissions, and safety. We estimate the magnitude of the parking shortage for the period of 2025-2035. We estimate a total shortage of about 7,000 spaces by 2035. Total capital costs are $579 million, and the annual operations and maintenance cost is about $15.3 million. We estimate the value of costs avoided by eliminating the parking shortage. The largest savings is in safety, at $3.7 billion in avoided deaths and injuries. Macro-economic impacts are estimated using the REMI- PI+ model. Total impacts on gross state product (GSP) in net present value (NPV) is $964 million, about two thirds of which is due the stimulus from construction. Results depend on assumptions of capital funding sources. We conclude that eliminating the truck parking shortage in California would lead to modest but positive macroeconomic impacts even if some of the funding were taken from existing state programs. It would also result in significant safety impacts.

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The Pacific Southwest Region University Transportation Center (UTC) is the Region 9 University Transportation Center funded under the US Department of Transportation's University Transportation Centers Program. Established in 2016, the Pacific Southwest Region UTC (PSR) is led by the University of Southern California and includes seven partners: Long Beach State University; University of California, Davis; University of California, Irvine; University of California, Los Angeles; University of Hawaii; Northern Arizona University; Pima Community College.

The Pacific Southwest Region UTC conducts an integrated, multidisciplinary program of research, education and technology transfer aimed at *improving the mobility of people and goods throughout the region.* Our program is organized around four themes: 1) technology to address transportation problems and improve mobility; 2) improving mobility for vulnerable populations; 3) Improving resilience and protecting the environment; and 4) managing mobility in high growth areas.

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Disclosure

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Abstract

A recent comprehensive statewide study of truck parking in California sponsored by the California Department of Transportation revealed a scarcity of public parking in many areas of California. Lack of parking leads to lost productivity, risk of non-compliance with federal hours of service laws, and increased safety risk. When parking is not available, drivers must search further for parking, generating additional miles traveled and adding to air pollution emissions and energy consumption. Drivers may have to park on roadsides or other areas to avoid exceeding hours of service requirements. The purpose of this research is to examine the macroeconomic impacts of eliminating the parking shortage. We compare the costs of constructing and operating the additional spaces with the savings in productivity, emissions, and safety.

We estimate the magnitude of the parking shortage for the period of 2025-2035, identify additional space requirements for each of the 10 Caltrans districts expected to have a shortage within the time period and identify approximate locations for constructing new spaces. To the extent possible, we assign additional spaces to existing public truck parking facilities. If existing facilities are not sufficiently available, we identify general locations for new parking facilities. We develop a timeline for construction of spaces over the time period, then estimate the costs of the additional spaces. We estimate a total shortage of about 7,000 spaces by 2035. Total capital costs are $579 million, and the annual operations and maintenance cost is about $15.3 million.

We then estimate the value of costs avoided by eliminating the parking shortage. The largest savings is in safety; we estimate avoiding 2536 truck involved crashes at a savings of $3.7 billion in avoided deaths and injuries. Productivity savings from revenue time savings total $181 million, and savings from avoided air toxic and CO2 emissions total $252 million.

Macro-economic impacts are estimated using the REMI- PI+ model. Crash savings are not included, as they are assumed to not generate indirect or induced economic impacts. Total impacts on gross state product (GSP) in net present value (NPV) is $964 million, about two thirds of which is due the stimulus from construction. The employment impact is 8,668 job years, again with construction accounting for nearly two thirds of the total.

Construction impacts depend on assumptions about funding sources. In our baseline scenario we assume the funds will come from additional sources. We conduct a sensitivity analysis to examine what happens if 25 and 50 percent of the funds respectively displace other existing state funding. GSP impacts fall from $616 million to $338 million and $61 million respectively. Thus macroeconomic impacts depend greatly on where the funding would come from. We conclude that eliminating the truck parking shortage in California would lead to modest but positive macroeconomic impacts even if some of the funding were taken from existing state programs. It would also result in significant safety impacts.

Economic Impacts of Investment in Public Truck Parking Facilities in California

Chapter 1. Introduction

Assembly Bill (AB) 32, also known as The California Global Warming Solutions Act of 2006, was enacted to address the pressing issue of climate change by implementing a comprehensive program aimed at reducing greenhouse gas emissions across California. It was signed into law in 2006 with the objective of integrating economic prosperity and environmental sustainability.

California's transportation system, a crucial driver of economic growth, has been a significant source of greenhouse gas emissions. In response, California has been at the forefront of implementing stringent regulations, particularly in the goods movement sector, resulting in notable reductions in emissions. The state's freight industry plays a vital role in both international trade and domestic commerce, contributing significantly to the state's economy while also being responsible for a substantial portion of transportation sector emissions. To address these challenges, Governor Brown initiated the California Sustainable Freight Action Plan (CSFAP) in 2016. This action plan aims to transition the state's freight transport system toward greater efficiency, environmental sustainability, and economic competitiveness. It includes specific directives for state agencies to develop policies, regulations, and investment programs to facilitate the adoption of clean and zero-emission technologies in the freight sector and promote the overall efficiency of the freight transportation system.

The CSFAP goals were incorporated in the 2020 California Freight Mobility Plan CFMP), the state's first comprehensive freight plan (Caltrans, 2020). The 2023 CFMP includes strategic goals supporting greater efficiency and decarbonization (Caltrans, 2023). In 2021 Governor Newson issued Executive Order N-79-20, which established targets for achieving a zero emission vehicle fleet for passenger cars and trucks by 2035 and for medium and heavy duty trucks by 2045. The California Air Resources Board (CARB) followed with regulations to achieve these targets, the Advanced Clean Truck rule in 2021 and Advanced Clean Fleet rule in 2023.[1]

Comprehensive economic analyses of state climate actions and investment in freight transportation infrastructure are essential to inform policy decisions effectively. Senate Bill 617 requires the evaluation of proposed regulations with significant economic impacts exceeding $50 million through Standardized Regulatory Impacts Assessments. Such studies provide detailed evaluations on the costs and benefits of individual regulatory measures on businesses, which can inform necessary adjustments to state actions and programs to ensure they align

[1] See https://ww2.arb.ca.gov/sites/default/files/2023-06/ACT-1963.pdf, https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-regulation-advisories.

with California's emission reduction targets while avoiding undue burdens on specific business sectors.

The second part of the California Sustainable Freight Action Plan (CSFAP) economic competitiveness provisions requires assessment of the economic impacts of the Action Plan on the freight sector. In this multi-year research funded by Caltrans, we have developed an analytical framework and methods to use the Regional Economic Models, Inc. (REMI) Policy Insight Plus (PI+) Model to analyze the economic impacts of prioritized Action Plan policies/regulations and investment projects, and have applied this analytical tool to one case study: electrification of all cargo handling equipment at POLA/POLB.

In this study, we refine the established analytical tool and apply it to the economic impact analysis of the investment in public truck parking facilities in California. There is a scarcity of public truck parking in many areas of California. Lack of parking leads to lost productivity, risk of non-compliance with federal hours of service laws, and increased safety risk. Additional miles traveled adds to air pollution emissions and energy consumption. The purpose of this research is to examine the macroeconomic impacts of eliminating the parking shortage. We compare the costs of constructing and operating the additional spaces with the savings in productivity, environmental, and safety.

We do not address the parking implications of transition to a zero emissions truck fleet because of both uncertainties and lack of information. Whether long haul trucking is fueled by hydrogen or electricity (or both) is yet to be determined. The two fuels have different implications for distribution and refueling. Battery electric trucks have limited range and require longer fueling times, which could increase parking demand (more frequent stops). Hydrogen fuel cell trucks perform more like conventional diesel and may not affect parking demand. The state is just at the beginning stages of electrification of major corridors, and hydrogen fuel distribution systems planning is even less developed.

The remainder of this report is organized as follows. Chapter 2 provides a brief review of the 2022 California Truck Parking Study that provides the basis for our study. In Chapter 3, we outline the overarching analytical framework for the study, followed by an introduction of the REMI PI+ Model utilized for the economic impact analysis. Chapter 4 begins with an analysis of projected truck parking shortages in California in 2035, followed by a discussion of potential expansion or new construction projects in each Caltrans district to mitigate these shortages. Also in this section, we calculate the direct capital investment costs for both the expansion of existing facilities and new construction projects. Chapter 5 examines various benefits linked to enhanced truck parking infrastructure availability, including safety enhancements, avoidance of revenue-earning miles losses, and environmental benefits. The results of the macroeconomic impact analysis for both the Base Case and two sensitivity cases are presented in Chapter 6. Finally, Chapter 7 concludes the report by summarizing the key research findings of the study.

Chapter 2. Summary of 2022 California Truck Parking Study

The California Truck Parking Study (CTPS, 2022) presents a thorough examination of the state's growing shortage of adequate parking for commercial trucks and drivers. The report estimates that current parking infrastructure meets less than half of the daily demand, with a need for 3,403 additional spaces to meet overnight parking needs, especially along major freight corridors like I-5, I-10, and I-80 in peak hours. This shortage leads to reduced safety, increased driver fatigue, decreased productivity and efficiency, and higher costs for both trucking companies and the state's economy overall. It uses American Transportation Research Institute (ATRI) GPS truck data from 2019 to calculate 24-hour and peak hour demand shortages. The ATRI data were obtained from 174 locations, with data from 164 locations used in the shortage calculations. While truck volumes are projected to rise steadily, the aging truck parking infrastructure has not kept pace, with most built over 50 years ago. Developing additional facilities is constrained by lack of funding and land as well as policy hurdles. The report states that creative solutions and partnerships are urgently required to expand parking capacity through both public and private avenues.

This shortage of parking spaces significantly impacts drivers' ability to rest and comply with federally mandated breaks. Under hours-of-service (HOS) regulations, truck drivers are required to take 30-minute breaks after 8 hours of driving, and they also need 10-hour off-duty breaks after 11 hours of driving. Moreover, they need to find adequate places to park for their mandatory 10-hour daily rest periods. With insufficient parking, drivers are forced to either violate regulations or park in unsafe, unauthorized areas like highway shoulders, exit ramps, or vacant lots. This dramatically increases risks of driver fatigue and accidents.

Beyond safety issues, the lack of parking leads to reduced productivity and efficiency for both drivers and carriers. Drivers waste significant time searching for parking, while carriers deal with congestion, increased fuel consumption, and reduced operating hours for their trucks. As California's freight volumes are projected to grow significantly in coming decades, the parking shortage is likely to worsen. Truck volumes are expected to increase 20% by 2040, further straining limited capacity. Moreover, most current public truck parking facilities were constructed over 50 years ago and are outdated. They lack basic amenities sought by today's truck drivers, like bathrooms, lighting, fencing, security cameras, and wireless internet access. The facilities are often in poor condition due to overuse and inadequate maintenance. Conflicts arise with surrounding communities over issues such as noise, traffic, and other impacts etc.

The development of additional facilities also faces immense challenges. Availability of land parcels large enough for truck lots is limited, and acquisition costs are prohibitive, ranging from $50,000 to $100,000 per space, which are far above the California median price of $10,900 per acre. Construction costs are also high, and securing adequate funding can present a challenge. Local zoning laws and opposition from neighboring residents and businesses often impede the use of many potential sites.

The CSTPS report outlines various potential solutions, such as designating certain public lots or excess park-and-ride spaces for overnight truck use where feasible. Application of new technologies could allow reservations of spaces via mobile apps. Public-private partnerships can attract private investment by offering incentives. Additionally, changes in local land use policies could ease restrictions on commercial parking. Implementing comprehensive statewide strategies and action plans will be helpful in coordinating efforts across various jurisdictions, agencies, and the industry across California.

Chapter 3. Methodology

3.1. Overall Analytical Framework

The impact analysis adopts the analytical framework (see Figure 1) we developed in previous economic impact studies of transportation-related policies. It starts with the establishment of the policy scenario(s) to be evaluated, followed by the estimation of the micro-level impacts of the policy on the regulated industry (or sector). The micro-level analysis results will be used as the inputs in the REMI macro-economic model to analyze the aggregate and sectoral impacts of the policy on the state economy.

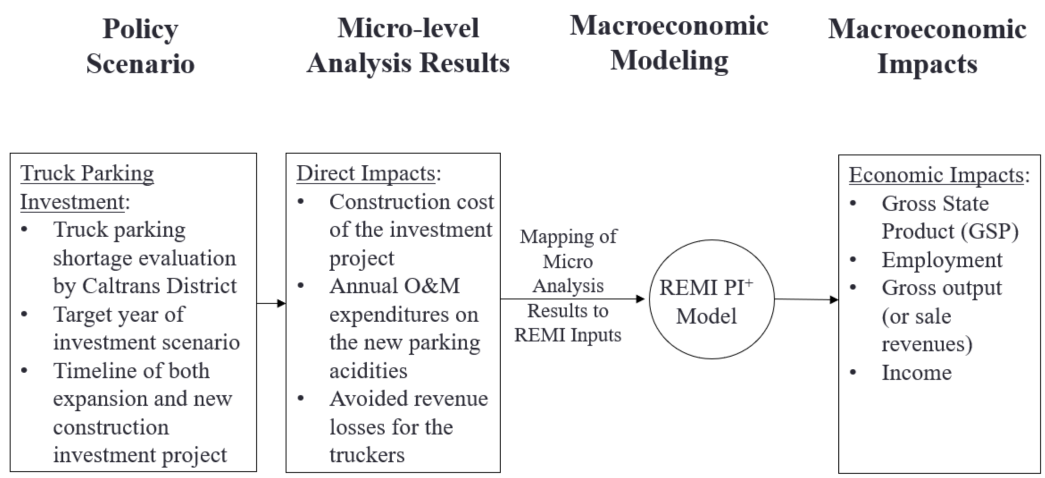


Figure 1. Analytical Framework of Economic Impact of Investment in Truck Parking Facilities

3.2. REMI PI+ Model

The REMI PI+ Model was selected to evaluate the macroeconomic impacts (including gross state product, employment, and personal income) of the various road use charge scenarios. It is the most widely used macro-econometric model to analyze the economic impact of energy and climate policies in the U.S. The REMI Model has evolved over the course of more than 30 years of refinement (see, e.g., Treyz, 1993). It is a packaged program but is built with a combination of national and region-specific data. In addition to the widespread use in the academic community, government agencies in practically every state in the U.S. have used a REMI Model for a variety of purposes. In California, the REMI Model is used by Department of Finance, California Air Resources Board, the South Coast Air Quality Management District, Southern California Association of Governments, Association of Bay Area Governments, and many other government and regional planning agencies to analyze the economic impacts of proposed regulations and regional development policies and initiatives (REMI, 2022).

As a macro-econometric forecasting model, the REMI model covers the entire economy based on macroeconomic aggregate relationships such as consumption and investment. REMI differs somewhat in that it includes some key relationships, such as exports, in a bottom-up approach that allows evaluation of specific sector-based policy options. In fact, it makes use of the finely-grained sectoring detail of an input-output (I-O) model, i.e., it divides the economy into 160 sectors, and thereby depicts important distinctions among them.

The REMI model is able to analyze the quantity of interactions between sectors (ordinary multiplier effects) but with refinements for price changes not found in I-O models. That is, the Model incorporates the responses of producers and consumers to price signals and the changes in other market and regulatory conditions and captures the substitution effects and other price-quantity interactions. The REMI Model also brings into play features of labor and capital markets, as well as trade with other states or countries, including changes in competitiveness. The labor market in the REMI model is linked to a demographic module of population migration. It also includes input substitution between labor and other factors of production, market supply and demand, wage rate determination, and economic geography considerations of labor accessibility of individual industries.

The econometric feature of the REMI Model refers to the fact that the model is based on inferential statistical estimation of key parameters based on pooled time series and cross-regional (panel) data. This gives the Model an additional capability of being able to extrapolate the future course of the economy, a capability that most other types of economic impact models usually lack. A more detailed description of the REMI Model is presented in Appendix C.

The version of the REMI Model used in this study includes two geographical regions: California and rest of U.S. The model divides the whole economy into 160 sectors and is established based on U.S. and California historical data through 2018.

Chapter 4. Estimation of Direct Costs of Truck Parking Investment

4.1. Truck Parking Demand and Supply

Capacity Utilization and Ownership

We use the CSTPS to describe truck parking demand and supply and establish the baseline for our research. The CSTPS (2022) data shows that public truck parking in California has higher utilization rates than commercial parking. For commercial lots, 59% of the facilities are under 70% utilized, while only 35% of public lots meet that threshold. In fact, over half (56%) of public lots are over 90% utilized, indicating over capacity conditions, compared to just 32% of commercial lots. However, commercial entities, including both national chains and other types, own 69% of truck parking locations and 92% of truck parking spaces in the state, dwarfing the state and public owned truck parking facilities in California. The data indicates that while both public and private truck parking face utilization challenges, the issues are more acute for public parking locations as presented in Tables 1 and 2.

Table 1: Truck Parking Facility Utilization

Ownership	*Has Availability (<70% utilization)*	*Near Capacity (70-89% utilization)*	*At or Over Capacity (>90% Utilization)*	*Total*
Commercial	106 (59%)	16 (9%)	58 (32%)	180 (100%)
Public	29 (35%)	8 (10%)	47 (56%)	84 (100%)
Total	**135 (51%)**	**24 (9%)**	**105 (40%)**	**264 (100%)**

Source: CSTPS, p 14

Table 2: Truck Parking Supply by Ownership

Ownership	*# of locations*	*% of locations*	*# of spaces*	*% of spaces*	*Ownership by space*	*Ownership by location*
Public	86	31%	1209	8%	**8%**	**31%**
Commercial: National Chain	60	22%	8496	57%	**92%**	**69%**
Commercial: All other	128	47%	5328	35%		
Total	**274**	100%	**15033**	100%	100%	100%

Source: CSTPS, p 10

The geography of parking facilities and demand is presented in Figures 1 and 2. Figure 1 shows parking spaces by ownership; Figure 2 shows level of demand. Parking facilities are concentrated along the main I-5/SR-99 north/south corridor as well as the main east/west interstate connections. Capacity problems, shown as squares and diamonds on the map, are evident in the Central Valley portion of I-5, I-15, I-10, San Francisco Bay Area, Los Angeles area, and highways leading to the Mexico border.

Figure 1: Truck parking facility locations

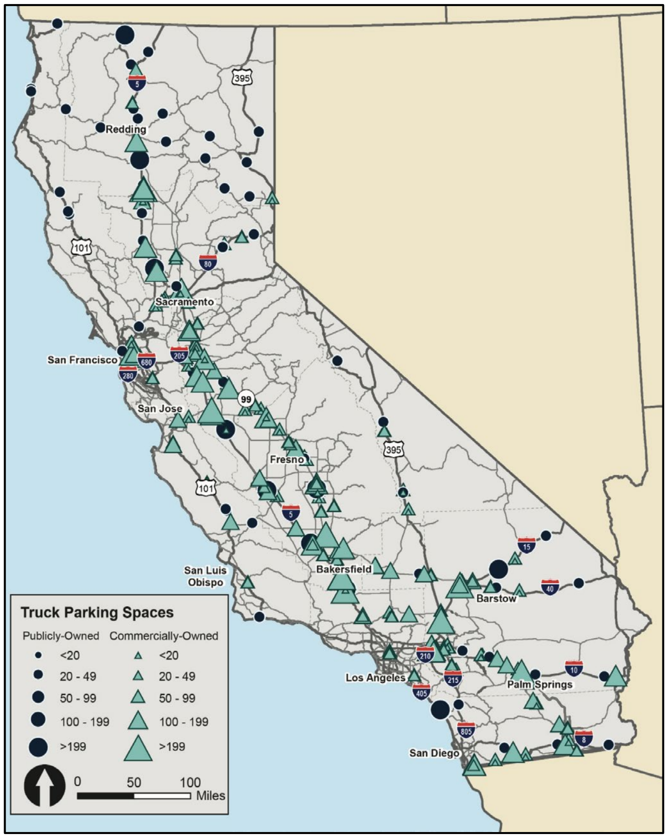
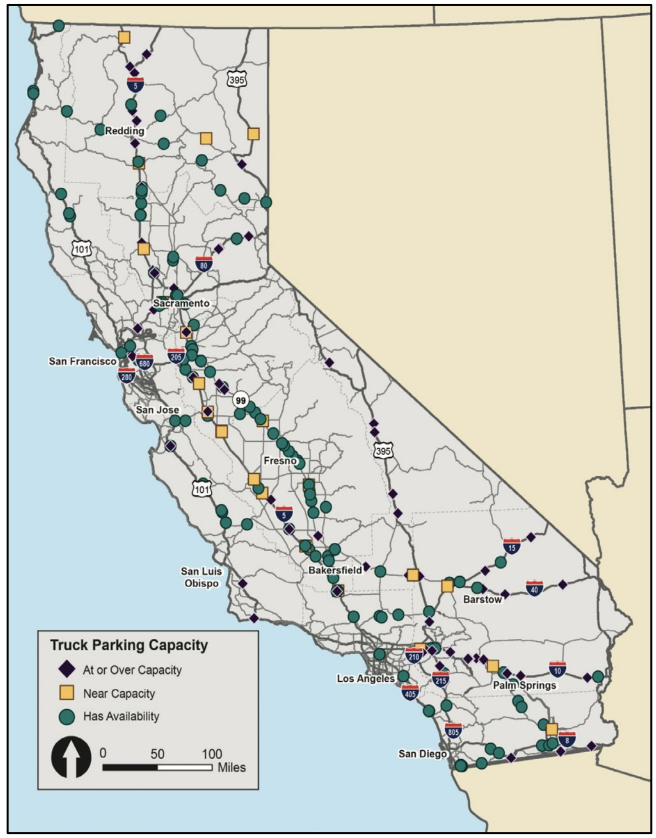


Figure 2: Truck parking demand



Source: CSTPS, App. A Truck Parking Supply and Demand pp. 7 and 13

Current Truck Parking Space Shortages

The CSTPS (2022) estimated truck parking demand using anonymized truck GPS data from the American Transportation Research Institute (ATRI), collected in 2019. However, since the ATRI dataset only captures GPS coordinates of approximately 25 percent of trucks on California roadways, the data were expanded to derive estimates of overall truck parking demand. While the data provide detailed information about stop duration, location, travel time, and travel direction before and after making an extended stop, they tend to underrepresent trucks associated with drayage or with short-haul trips. In total, the study estimated 24-hour demand and peak hour demand at 264 of the 274 truck parking locations across California.

Table 3 shows the total parking supply and demand, as well as peak hour parking shortages in each Caltrans district as of 2022 as reported in the CSTPS. There are a total of 14,925 spaces in the 264 facilities included in the SCTPS. Although the statewide shortage is approximately 3,400 spaces, the existence of a designated parking facility with a surplus capacity may not necessarily align with an area with high demand. For example, if we only focus on the districts that fall short of parking spaces, the total number of shortages is almost 4,300. Therefore, this broad assessment of shortages and surpluses at the State level only provides general indicators of need and likely underestimates the full scope of the truck parking need. The fact that most districts experience shortages indicates that at the busiest time of day there is not enough parking for all the trucks seeking a parking space across much of the State. In some districts, the shortage measured as a percent of the total truck parking supply in a given district exceeds 100 percent (such as District 7 Los Angeles and District 12 Orange County), indicating that the shortage of spaces is even greater than the total number of spaces currently available. Notably, Districts 3, 4, 7, and 8 account for a significant share of the total number of shortages.

Table 3. Truck Parking Shortages as of 2022

District	*Total Parking Supply*	*Total Parking Demand*	*Peak Shortage or Surplus (2022)*	*Shortage or Surplus as a Percentage of Supply*
1. North Coast	87	20	67	77.0%
2. Redding	1,220	1,096	124	10.2%
3. Sacramento	1,032	1,601	-569	-55.1%
4. Bay Area	983	1,491	-508	-51.7%
5. Central Coast	334	371	-37	-11.1%
6. Central Valley	3,249	2,797	452	13.9%
7. Los Angeles	661	1,532	-871	-131.8%
8. Inland Empire	3,671	5,538	-1,867	-50.9%
9. Eastern Sierra	448	476	-28	-6.3%
10. Stockton	2,020	2,310	-290	-14.4%
11. San Diego	1,185	938	247	20.8%
12. Orange County	35	157	-122	-348.6%
Total	**14,925**	**18,327**	**-3,402**	**-22.8%**

Projected Truck Parking Space Shortages in 2035

Without building additional parking infrastructure, the truck parking shortage situation will exacerbate due to the projected economic growth and the associated rise in demand for freight transportation. As truck vehicle miles traveled (VMT) increase, the need for adequate truck parking facilities will increase accordingly. To assess the extent of parking shortages by the end of our study period, we first estimate the demand for truck parking spaces in each Caltrans district by 2035.

We have no information on trends in truck parking demand. To predict demand in 2035, we assume that parking demand will increase linearly with projected growth in truck VMT. We assume a steady 1.5% annual growth rate in VMT through 2035. the nominal growth scenario developed in TRB (2019). We further assume that parking demand grows at the same rate.

In 2022, the statewide peak-hour demand for truck parking is 18,327 spaces. With a 1.5 % annual growth rate, this figure will increase to 21,912 spaces. With current capacity remaining static under a "business as usual" approach, the truck parking space shortage is estimated to spread from the current 8 districts to 10 of the 12 districts by 2035 (Caltrans districts 2 and 6 are projected to go from having a surplus in truck parking to a shortage). Moreover, the total statewide shortage is projected to increase over twofold from 3,402 spaces in 2022 to 7,114 in 2035 as shown in Table 4.

Table 4. Estimated Truck Parking Shortages as of 2035, by district

District	*Total Parking Supply*	*Total Parking Demand*	*Peak Shortage or Surplus (2035)*	*Shortage or Surplus as a Percentage of Supply*
1. North Coast	87	24	63	72.4%
2. Redding	1,220	1,310	-90	-7.4%
3. Sacramento	1,032	1,914	-882	-85.5%
4. Bay Area	983	1,783	-800	-81.4%
5. Central Coast	334	444	-110	-32.9%
6. Central Valley	3,249	3,344	-95	-2.9%
7. Los Angeles	661	1,832	-1171	-177.2%
8. Inland Empire	3,671	6,621	-2,950	-80.4%
9. Eastern Sierra	448	569	-121	-27.0%
10. Stockton	2,020	2,762	-742	-36.7%
11. San Diego	1,185	1121	64	5.4%
12. Orange County	35	188	-153	-437.1%
Total	**14,925**	**21,912**	**-7,114**	**-47.7%**

4.2. Potential Expansion with Projected Demand for 2035

The CSTPS 2022 identified areas in each Caltrans district experiencing high demand per mile and shortages in truck parking. Based on this study, we made preliminary recommendations for the Caltrans districts with current and projected parking shortages to either expand existing public truck parking with high demand per mile of highway or construct new parking lots along high-density demand corridors where truck parking facilities are either unavailable or where both commercial and public truck parking sites are at or over 90% capacity. When we identify existing sites for possible expansion and potential locations for new truck parking lots for each of the eight districts, we also take into consideration the recommendations outlined in the USDOT Federal Highway Administration's Truck Parking Development Handbook[2] (USDOT, 2022). The following considerations are highlighted in the Handbook for building new truck parking lots:

i. Proximity to urban centers
ii. Proximity to ports and highways
iii. Adequate capacity of the highway to support the truck traffic
iv. Sufficient square footage to support efficient operations and
v. Adequate land for tractor trailers to park and move goods

In Appendix A, for each Caltrans district that has been identified as likely experiencing truck parking shortage in the BAU case in 2035, we present the map that shows the locations of the possible sites of expanding current parking facilities and/or possible sites for construction of new truck parks.

To estimate the space that is needed for added parking slots, we collect information on truck parking design standards from the 2022 Truck Parking Development Handbook and 2018 AASHTO Green Book (AASHTO, 2018). The most critical considerations when designing a truck parking facility are the size of vehicles to accommodate, turning radius required, parking stall dimensions, parking slot layout, slot density, and amenities. The standard design vehicle is a 53-foot semi trailer with an 8.5-foot trailer and tractor.[3] This vehicle requires a minimum 44.8 to 46.4 foot diameter to make U-turns. Recommended parking stalls are 12 feet wide, with 8 feet between stalls. Herringbone drive-through (HDT) angled slots at 45 degrees are preferred over straight back-in slots for safety and efficiency, despite slightly lower density. HDT slots should be 20 feet wide to account for truck swept paths. Ideal slot density is 13.5 HDT trucks per acre,

[2] https://ops.fhwa.dot.gov/freight/infrastructure/truck_parking/docs/Truck_Parking_Development_Handbook.pdf

[3] AASHTO's A Policy for the Geometric Design of Highways and Streets (the "Green Book"), Section 2.1.1 General Characteristics, p. 2-5. 2018.

whereas straight slots yield 28.6 trucks per acre but higher collision risks. Access via highway ramps or arterial roads is necessary, along with lighting, security, and amenities like restrooms. Layouts can vary to maximize site utilization. Table 5 provides a summary of the design considerations for standard truck parking areas. Adhering to these standards allows for an optimized balance of safety, efficiency and capacity when designing truck parking facilities.

Table 5: Summary of standard truck parking area design considerations

Design Element	Options	Recommendations
Parking Slot Type	• Straight Back-In (SBI) • Herringbone Drive-Through (HDT)	HDT slots are recommended for truck parking areas to maximize driver efficiency and safety but they are more expensive than SBI.
Swept Paths	• The parking slot needs to be wide enough to allow a truck to avoid hitting trucks parked next to it as it enters or leaves it.	Assuming HDTs with a 60° angle, parking slots need to be 20 feet wide.
Slot Density	• HDT slots with a 30, 40, 45 and 50 degree angle. • SBI slots with a 0° angle.	While the SBI slots can achieve the highest parking density with 28.6 trucks/acre, HDT slots with a 45° angle are recommended (14.4 trucks/acre parking density).
Access, Layout, and Circulation	• Site access point with sufficient spacing from nearby intersections, interchanges and other access points. • HDT Circulation • Turning radius	Different layouts are viable, providing alternative approaches to site utilization and pedestrian circulation. Traffic impact study findings and State access management standards must be considered.
Safety and Security	• Lighting. • Hard and soft controls. • Human trafficking prevention.	Lighting and secure facilities are essential for safety. Assess the surrounding context to determine the amount of additional security measures are appropriate.
Facility Amenities	• Toilet Facilities. • Communication Services. • Open Space.	Inclusion of all these types of facility amenities is recommended for truck parking areas.

Source: Federal Highway Administration, 2021

The CSTPS (2022) design guidelines identified that the minimum area and site dimensions required for basic truck flow safety and efficiency are 5 acres and 200 feet in any direction respectively. The guidelines examine state and other publicly owned properties across Caltrans District 11 (San Diego and Imperial County) and identify seven sites that might be feasible as examples in the Guidelines. The report then uses data from this district to test the truck parking property identification criteria with consultations including Caltrans Owned Parcels in San Diego and Imperial Counties, San Diego Geographic Information Source (SanGIS) Land Use Data, and Property Ownership Data. However, this was based in only one of the 11 Caltrans districts.

Using the seven feasible truck parking sites in Caltrans District-11 (San Diego) as a base case, the average density, defined as the number of trucks that can be parked per gross acre, is 6.51 as presented in Table 6 below. Average gross area for truck parks is 15.94 acres and the average number of slots in each truck park is 111.6.

Table 6: District 11 Land ownership and Truck Park specifications

District -11 Site #	General Location	Primary Owner	Slots	Gross Area (Acres)	Density (Trucks/Acre)
Site 1	North County SW of 1-15/SR 76 junction	Caltrans	61	10	6.1
Site 2	Otay Mesa NE of SR 125/SR 905 junction	Caltrans	42	7.1	5.9
Site 3		State	304	40.6	7.5
Site 4	Kearny Mesa E of 1-805/SR 52 junction, S side	Military Reservations	59	9.5	6.2
Site 5			87	12.9	6.7
Site 6	Central County NW of I-15 /Bernardo Ctr. Dr. Junction	State	38	6.9	5.5
Site 7	Otay Mesa SE of SR 125 / SR 905 junction	Caltrans	190	24.6	7.7
Average			111.57	15.94	**6.51**

Applying the truck parking density factor of 6.51 trucks per acre for new parking facility construction, we estimate that 1,093 acres of new truck parking capacity need to be added by 2035 to meet the projected demand. Taking District 8 San Bernardino/Riverside as an example, this district is estimated to have 2,950 truck parking space shortages during peak hours. Assuming 6.51 trucks can be parked per each gross acre, the district would require 2,950/6.51= 453.15 acres of space. We assume this acreage would be distributed equally among 10 newly built truck parks and the expansion of the 8 existing public truck parks. Thus 453.15/18 = 25.2 acres will need to be constructed or added to each of them. The calculation for each of the identified Caltrans districts is presented in Table 7. Our numbers suggest significant investments into expanding public and private truck parking capacity to meet California's rising freight parking needs between now and 2035.

Tables 7. Construction of New Truck Parks/Existing Site Expansion by Districts (2035)

Caltrans District	Possible new truck parks	Possible Expansion	Projected Shortage in 2035	Spots needed per new or expanded park to fill projected shortage	Spots added in possible new truck parks	Spots added in possible expanded truck parks	Req. size in acres of expansion or new truck parking	Total gross acres req. in district
District 2: Redding	0	1	90	90	0	90	13.82	13.82
District 3: Marysville/Sacramento	3	5	882	110	331	551	16.94	135.48
District 4: Bay Area/Oakland	6	1	800	114	686	114	17.56	122.89
District 5: San Luis Obispo/Santa Barbara	0	1	110	110	0	110	16.90	16.90
District 6: Central Valley Fresno/Bakersfield	0	1	95	95	0	95	14.59	14.59
District 7: Los Angeles/Ventura	10	0	1,171	117	1171	0	17.99	179.88
District 8: Inland Empire San Bernardino/Riverside	10	8	2,950	164	1639	1311	25.18	453.15
District 9: Eastern Sierra/Bishop	0	1	121	121	0	121	18.59	18.59
District 10: Stockton	4	2	742	124	495	247	19.00	113.98
District 12: Orange County	2	0	153	77	153	0	11.75	23.50
Total	**35**	**20**	**7,114**		**4,474**	**2,640**		**1,092.79**

4.3. California Truck Parking Cost Estimates

The District 11 feasibility analysis report (CA DOT, 2022) stated that publicly owned sites were considered the most feasible and least costly to develop. Based on other requirements such as proximity to highways and distance from residential areas, only a few sites met the selection criteria. These seven sites were listed in the report in greater detail for further analysis and breakdown of the layout and development costs. Each site plan used a common set of elements, though not all were used on each plan: 1) Entry Security 2) Exit Security 3) Standard Truck Parking 4) Smaller Truck Parking 5) Oversize Truck Parking 6) Tractor Parking 7) Restrooms 8) Green Space. To support preparation of rough cost estimates, key material quantities of main development components were reported for each site plan:

1. Clear, grub, level, and drainage
2. Low voltage conduit trench for lighting and buildings
3. Substation/switchgear for lighting and buildings
4. High mast light poles
5. Asphalt concrete and base course
6. Manned security booths
7. Chain link boundary fence
8. Green space with picnic facilities, irrigation
9. Striped walkways
10. Water closets
11. Parking striping

The unit costs for these components were developed from Caltrans' Contract Cost Database (sv08data.dot.ca.gov/contractcost/), using recent District 11 values. Given the conceptual nature of each layout, a 20% contingency was applied to the total cost of each site. Although the District 11 report calculates the costs associated with infrastructure and main development components in detail (See Appendix B), it ignores some important cost categories. The first is the cost of land acquisition, because the study assumed that the land will mostly be state owned. Second, the study also did not include costs of permitting, design, environmental mitigation, and construction management. Moreover, the report clearly outlines that "costs shown are rough order of magnitude costs and should not be used for budgetary purposes for any site". (CA DOT, 2022, p.24)

The report estimates give us a much better idea and greater conceptual estimates of the potential development costs associated with constructing truck parking in District-11. It also reconfirms some of the information that we already know. For example, in Section 5.1 CSTPS Draft Appendix, Site Costs (p. 24), the report states that the largest of the seven feasible parking sites have the lowest unit slot costs. Both these sites are rectangular and support efficient site configuration with minimal boundary costs.

Our cost estimates for the 10 Caltrans districts that were identified to have peak hour truck parking shortages by 2035 rely heavily on assumptions and calculations used in draft appendices of the CSTPS regarding development costs.

The full list of assumptions and calculation method used in the cost estimation is as follows:

1. *Clear Grub Level:* Acre times unit price of $21,569
2. *Low Voltage Conduit:* These cost estimates use "the unit costs for development from the Caltrans's Contract Cost Database (from sv08data.dot.ca.gov/contractcost/, using recent District 11 values and quantities from Table 4.1 in CSTPS Draft Appendix). The 250LF/acre estimate for Low Voltage Conduit for example, is calculated from site quantities across all 7

sites; in site 1, 2, 3, 7, and 6, for 10 acres bringing per acre lin ft to 237.6, (237.6*10*122= $289,872). We average this process for Sites 1, 3, and 7 as they represent the different sizes of sites, 10, 40 and 24 acres (and other sites on occasion) respectively, to yield an estimated average 250LF/acre of Low Voltage Conduit. Please note that like most other categories of development costs, the total cost increases at a decreasing rate with the increase in lot size.

3. *Substation Megavolt Ampere:* The MVA unit cost of $250k with one substation per site is a reasonable assumption. We assume that this will require 1 or 2 substations for each new site (2 for bigger ones) but not for existing truck parks that can be expanded (although more substations might be needed for substantial expansion). However, these numbers were calculated to include two substation/ new site and that 50% of the existing sites to be expanded will add one more substation.
4. *HM Pole 0.5M Lumens:* Given this measure varies a lot, we used a simple average estimation based on Table 4.1 in CSTPS Draft Appendix (*see Appendix B)*. The 11 sites use 73 *0.5M Lumens* across 111.6 acre of land for the feasible sites in the district; meaning 0.654 of 0.5M Lumens are used per acre of land. This estimate has been used in our calculation.
5. *AC Pavement for Container:* This measure also varies across sites based on surrounding luminescence condition so we use the simple average estimation based on the data for the District 11's seven sites. According to Tables 4.1 *and 4.2* of the report, AC Pavement for Container accounts for at least 90% of total lot space in acres; so we calculated 90% of the lot size in acres, multiplying this value by the unit cost of $136,480.
6. *Manned Booth Lane:* We reviewed some private and public truck parking maps in California and there are at least 2 to 4 manned booths for moderately sized truck parks; so we used the same approach as used for MVA. We assumed at least 2 manned booths for newly built truck parks and that 50% of the existing sites to be expanded will add one more booth (since they likely have booths) to calculate estimates.
7. *Chain Link Boundary Fence:* Based on Table 4.1 from CSTPS Draft Appendix, the average chain link boundary fence used for the feasible seven sites in District 11 is 227.5 feet/acre of land, which is used in our cost estimates.
8. *Green Space:* This typically accounts for 6-8% of total parking lot space in acres according to District 11's 7 site estimates. So we assumed 7% as the average green space for the proposed new truck parks for each district. Since existing parks might have green space already, we assumed that half of these existing parks (4 among 8 to be expanded in District 8 for example) will increase the green space. For the District 8 example, 5 (new) + 4 (of 8 to be expanded)*22.06 (Req. size in acres or new truck parking)=198.54*0.07=13.8978 acres of new green space.
9. *Walkway:* Average walkway required for the 7 sites in District 11 is estimated to be 278.75 LF/acre. This is used but only for newly constructed sites because existing ones likely have walkways already. So for District 8, since it will have 5 new sites, 5*22.06 (Req. size in acres of expansion or new truck parking)*278.75*$1
10. *Water Closet:* Based on the seven sites in Caltrans District-11, the average number of water closet required is 55.27/acre of land; But since existing truck parks likely have this, we just added this for the new truck parks to be constructed. So for the District 8 example: 55.27*22.06 (space required per each new truck park)*5(new truck parks proposed)*$352

11. *Park Striping:* Based on Table 4.1 of CSTPS, cost for park striping is $0.6 lf per acre of land and requires 500 ln ft/acre on average across the 7 feasible sites of district 11; So for District 8, 0.6*500*286.79= $86k
12. *Freeway Ramp:* We also include cost of constructing two lane ramps for freeway access to newly built truck parks, which cost $140,150 in 2013 according to the North Carolina DOT[4]. Adjusted for inflation this equals $185,721 in 2023, which is used in the estimates.
13. *Contingency Cost:* Similar to the CSTPS Draft Appendix, a 20% contingency is used, added to the base cost.
14. *O&M Cost:* Similar to the Oregon Truck Study, the average annual O&M cost is estimated to be 2.67% of the total construction base cost of each truck slot
15. *Soft Costs:* Soft costs of permitting, design, environmental mitigation, and construction management generally range from 30-40% of the total construction hard costs according to Shoup (2016), so the average 35% is used.
16. Costs of land acquisition were not included in District11 study, so we used $10,900/acre of land, which is the median price for an acre of California land.

Given that the specific timelines for the truck parking infrastructure investment plan across individual Caltrans districts are not the primary focus of this study, we have established some general assumptions. First, for parks with potential for expansion, we assume that the expansion project will commence in 2025 and conclude in 2029. Second, recognizing the additional time required for permitting, engineering design, environmental assessment, and site preparation for new park locations, we assume that the construction of these new parking facilities will occur between 2030 and 2035. Table 8 provides cost estimates for both expansion and new construction projects, factoring in a 3% annual increase in unit costs based on the 2023 cost estimates. For expansion projects, the estimated unit costs for 2025 are utilized, while estimated unit costs for 2030 are applied to new construction projects. The table indicates construction costs of $158 million for truck parking expansion projects across 20 locations and $407 million for the construction of 35 new truck parks, totaling $564 million. Additionally, the estimated land acquisition cost is approximately $14.3 million. Thus total capital costs are $579 million. The annual operations and maintenance cost is about $15.3 million. The detailed cost estimates for individual Caltrans districts are presented in Appendix D. These are the direct costs to be used in the REMI model analysis.

[4] https://connect.ncdot.gov/resources/safety/ITS%20and%20Signals%20Resources/Cost%20Estimates%20Ramp%20Metering%20Feasibility%20Study%20for%20Durham%20and%20Wake%20Counties.pdf ;

Table 8. Cost Estimation of Truck Parking Expansion and New Construction Investment

	Description	Unit	Unit Cost in 2025	For Truck Park Expansions	Unit Cost in 2030	For New Truck Parks	Total Cost (or Average Cost)
Development Cost	Clear Grub - Level	Acre	$23,569	$9,557,808	$27,323	$18,777,870	$28,363,000
	Low Voltage Conduit	LF	$133	$13,515,376	$155	$26,553,156	$40,068,686
	Substation for 2 to 8 MVA	LS	$273,182	$2,731,818	$316,693	$22,168,476	$25,216,986
	HM Pole .5M Lumens	LS	$36,677	$9,727,308	$42,519	$19,110,881	$28,880,709
	AC Pavement for Container	Acre	$149,135	$54,430,185	$172,889	$106,936,959	$161,540,033
	Manned Booth Lane (2-6)	LS	$208,806	$2,088,059	$242,063	$16,944,431	$19,274,553
	Chain Link Boundary Fence	LF	$34	$3,125,703	$39	$6,140,953	$9,266,695
	Green Space	Acre	$154,045	$2,186,413	$178,580	$8,591,130	$10,956,124
	Walkway	LF	$1.1	$0	$1.3	$242,678	$242,680
	Water Closet	SF	$385	$0	$446	$16,937,466	$16,937,912
	Parking Striping	LF/Acre	$0.7	$132,938	$0.8	$261,179	$394,117
	Freeway Ramp Access	2 lane	$202,942	$0	$235,266	$8,234,303	$8,469,569
Base Development Cost		$		$97,495,609		$250,899,482	$348,395,090
Soft Cost (35% of Base Construction Cost)		$		$34,123,463		$87,814,819	$121,938,282
20% Contingency/Escalation Cost		$		$26,323,814		$67,742,860	$94,066,674
Total Construction Cost		**$**		**$157,942,886**		**$406,457,160**	**$564,400,046**
Land Cost	Land Acquisition Cost	$ / Acre	$11,911	$4,830,085	$13,808	$9,489,489	$14,333,381
Total Cost (Land + Construction)				**$162,772,971**		**$415,946,649**	**$578,719,620**
Area required		Acres		406		687	1,093
Cost / Acre		$ / Acre		$401,389		$605,228	$529,585
Total truck Slots (Based on projected demand shortage for 2035)		#		2,640		4,474	7,114
Cost / Slot		$ / Slot		$61,657		$92,969	$81,349
Total Expanded or New Truck Parks				20		35	55
Annual O&M Cost / Slot			2.67%	$1,646	2.67%	$2,482	$2,172
Total Annual O&M Cost				**$4,194,609**		**$11,105,776**	**$15,300,385**

Chapter 5. Benefits of Increased Truck Parking Infrastructure

In this section, we evaluate various categories of benefits associated with the increased availability of truck parking infrastructure to address parking shortage issues in California by 2035. Our analysis is focused on three main areas of benefits:

1. Safety improvements, including avoided crashes associated with truck parking in undesignated areas, and the economic values of the prevented property damages, fatalities, and injuries.
2. Cost savings in revenue-earning miles for truck drivers, considering the time saved from not having to search for parking at the required time and location, and the associated increase in revenues.
3. Environmental benefits, specifically cost savings resulting from reduced emissions of NOx, PM2.5, and CO2 associated with the avoidance of truck miles traveled during the search for parking space.

5.1. Mitigation of Parking Shortage

To quantify the annual benefits, we begin by estimating the yearly parking shortages that can be mitigated from 2025 to 2035 through the expansion and new construction projects detailed in the previous section. Due to the lack of specific timelines for these projects in individual Caltrans districts, we make a simplified assumption. Between 2025 and 2029, we assume that 528 out of the total 2,640 expanded parking slots in existing facilities will become available each year. Similarly, between 2030 and 2035, we assume that 745 out of the total 4,474 slots in newly constructed parking facilities will become available annually.

In a baseline scenario, assuming the current truck parking supply remains constant throughout the study period, parking shortages are estimated for each year from 2025 to 2035. This estimation assumes a 1.5% annual increase in parking space demand. The calculation involves determining the difference between the parking supply (assumed to remain static at current capacity) and the projected parking demand in each district for each year between 2025 and 2035. The results are presented in the first numerical column of Table 9, with the second column indicating the added truck parking slots each year. The last column shows the percentage of parking shortages that can be addressed.

Table 9. Mitigation in Parking Shortage 2025-2035

Year	Parking Shortages	Truck Parking Slots Added	Mitigation in Parking Shortage
2025	4,698	528	11.2%
2026	4,908	1,056	21.5%
2027	5,119	1,584	30.9%
2028	5,334	2,112	39.6%
2029	5,551	2,640	47.6%
2030	5,772	3,386	58.7%
2031	6,013	4,132	68.7%
2032	6,258	4,878	77.9%
2033	6,507	5,624	86.4%
2034	6,807	6,369	93.6%
2035	7,114	7,114	100.0%

5.2. Safety Improvement

A potentially significant benefit of reducing the parking shortage is reduced costs of crashes and associated deaths and injuries. In this section we estimate the potential benefit savings of reduced crashes. Reduced crashes do not have direct economic effects, and therefore are not included in our modeling analysis.

We use data from the California Statewide Integrated Traffic Records System (SWITRS) which is available through the Transportation Injury Mapping System (TIMS).[5] We use data from 2015, 2019 and 2021. 2015 is the most recent year without major extreme weather events or other factors to affect the data; 2019 is the last full year of data prior to COVD, and 2021 is the most recent year of data available. The SWITRS data has a code that indicates whether a truck is involved in the crash; we use this variable to select the crashes. Our interest is in truck-involved crashes that take place when the truck is stopped. Ideally we would like to identify only those crashes that take place when a truck is parked outside of a legal parking space, but such data are not available. We approximate by including crashes in which the truck is reported as parked or in parking maneuver. We call these "parked crashes."

[5] TIMS is available at https://tims.berkeley.edu/.

From the parking shortage data in Chapter 5, we observe that 8 of the 12 Caltrans Districts have a parking shortage in 2022, and 10 of 12 are projected to have a parking shortage in 2035. We use the 10 districts to generate baseline crash data. Table 10 gives total truck involved crashes, total parked crashes, and the share of parked crashes for the 10 Caltrans Districts. The bottom row gives the average. Crashes increase from 2015 - 2021, likely reflecting the overall growth in truck traffic over the period. At about 9%, parked crashes constitute a relatively small share of all reported truck involved crashes.

Table 10. Total truck involved crashes and total parked crashes by year

Year	Total Truck Involved Crashes	Total Parked Crashes	% of Share Parked Crashes
2015	4,119	368	8.93%
2019	4,839	455	9.40%
2021	5,334	509	9.54%
Average	**4,764**	**444**	**9.32%**

The next step is to identify parked crashes by severity so that we can assign a monetary value to the avoided crash. The SWITRS data categorizes victim injuries into 8 categories, ranging from fatality to no injury. The most recent estimates of medium and heavy duty truck crash costs are from Zaloshnja and Miller (2007). They estimate crash costs per victim in 2005 USD and use the Model Minimum Uniform Crash Criteria (MCUCC) injury codes, which are termed KABCO codes. The FHWA provides a crosswalk for each state's coding system; we use this crosswalk to convert the injury codes in SWITRS to the KABCO codes as shown in Table 11

Table 11. Conversion of SWITRS codes to KABCO codes

SWITRS codes	KABCO codes
1 = Killed	K = killed
2 = Severe injury, 5 = suspected serious injury	A = incapacitating injury
3 = other visible injury, 6 = suspected minor injury	B = non-incapacitating injury
4 complaint of pain, 7 = possible injury	C = possible injury, complaint of pain
0 = no injury	O = no injury

[Source for mapping of SWITRS codes to KABCO codes for CA – https://safety.fhwa.dot.gov/hsip/spm/conversion_tbl/pdfs/kabco_ctable_by_state.pdf. }

Crashes may have one or more victims and each victim may have a different level of injury. We calculate the average number of victims per crash by KABCO injury category. Table 13 gives the number of victims by year and KABCO injury category. As with crashes, the number of victims is generally inversely related to frequency. There are relatively few no injury victims, likely because no injury crashes are less likely to be reported. However, as the data stands, over 87% of parked crashes involving a truck resulted in injury or death.

Table 12 Victims by KABCO injury category, parked crashes

Year	Deaths [Type K]	Incapacitating Injury [Type A]	Non-incapacitating Injury [Type B]	Possible injury [Type C]	No injury [Type O]
2015	29	35	195	256	134
2019	34	102	203	298	71
2021	33	93	263	287	32
Totals	**96**	**230**	**661**	**841**	**237**

Dividing the number of victims by the number of crashes that occurred in the respective year yields the victims per crash ratio in Table 13 used to calculate the predicted victims due to parking shortages presented later.

Table 13: Three year average victim per crash ratios by KABCO category

Category	Deaths	Incapacitating injury	non-incapacitating injury	possible injury	no injury
Victims per crash ratio	0.0721	0.1727	0.4962	0.6314	0.1779

In selecting all parked crashes, we are assuming that all parked crashes are due to the shortage of parking spaces. This is in effect an upper bound assumption, as some parking crashes likely take place in legal parking areas or have nothing to do with a shortage of parking. The lower bound estimate would be that no crashes are attributable to the parking shortage, which is quite unlikely. For the purpose of this research, we provide a middle estimate; we assume that half of the parking crashes are attributable to the parking shortage. We further assume that the distribution of these crashes across severity categories is the same as for all parked crashes.

We also conducted a check on crash location. It is possible that some of these crashes took place far from a state highway. If so, we would be over-estimating the number of crashes attributable to the parking shortage. We created a 5 mile buffer around all state highway routes and located all of the truck involved crashes; 98% were within the 5 mile buffer. We conclude that assumption that half of the crashes are attributable to the parking shortage is reasonable.

We assume that truck crashes will increase proportionately to the shortage in parking spots and not vehicle miles or total number of trucks in operation. We use the shortage because escalating parking shortages exacerbate the need to search for available parking and increase the likelihood of parking on freeway off-ramps, city streets, and roadside shoulders, which cause hazards not only to the truck driver but also other vehicles using these roads and adjacent properties.

To estimate crashes in future years we calculate the baseline ratio of average crashes (444) to the net statewide parking shortage (3402) and divide by 2 to get a rate of 0.065 crashes per shortage space. We use the ratios in Table 13 to predict the number of crashes and victims by KABCO type for each year from 2025 to 2035, with and without the parking supply intervention. Details are given in Appendix E.

The next step is to estimate crash costs. We used inflation-adjusted figures calculated in a USDOT report (USDOT , 2023) describing the per victim cost of those involved in crashes with medium- and heavy-duty trucks. According to the USDOT report, the values result from multiplying the KABCO-level accident's associated Maximum Abbreviated Injury Scale (MAIS)-level probabilities by the recommended unit Value of Injuries for each MAIS level, and then summing the products. The MAIS categorizes injuries along a six-point scale from Minor to Not Survivable, while the KABCO scale is shown in Table 11. These values are similar to the per victim costs presented by Zaloshnja and Miller (2007) which were defined based on injury severity and accounted for personal medical and injury remediation costs (including cost of fatalities), increased insurance payout and premium costs, lost time opportunity costs, estimated property damage and costs incurred through emergency services. The costs in the USDOT report are in 2022 dollars. We inflate the costs to 2024 dollars using the US Bureau of Labor Statistics Consumer Price Index in April 2024 (US Bureau of Labor Statistics, 2024).

Our estimates come with three caveats. First, we are constrained by what is available in the TIMS data. TIMS focuses on injuries to persons, and the primary crash data source from which TIMS is drawn does not consistently report property damage. Therefore, our estimates are only for costs associated with personal injuries. Second, we use the USDOT value of life. We know that the value of life is quite subjective and there are many interpretations and estimates on what this value should be. The USDOT estimate is within the bounds of widely accepted estimates and we therefore consider it best available. Lastly, our estimates reflect damage caused by the first-order impacts of the lack of parking. Other impacts, such as driver fatigue or working over the HOS limit are not considered.

Table 14 gives the estimated average cost per victim for each category of crash in 2024 dollars. Costs decline as severity of injury decreases. Fatal injuries are by far the most costly because of the high value of a lost life.

Table 14. Cost per victim by injury type, $2024

Category	Deaths	Incapacitating injury	Non-incapacitating injury	Possible injury	No injury
Cost per victim	$13,942,903	$1,325,357	$260,789	$124,594	$5,578

We estimate the crash-related savings as the value of the number of crashes avoided relative to the baseline (no increase in parking spaces, accounting for industry growth through 2035). Table 15 gives predicted total business as usual crashes and the number of crashes avoided for each year. (See Appendix D for a table with crashes by type). We use the three-year average number of crashes by severity category as our baseline. With no intervention, we expect crashes to increase by about 51 percent. Based on the TIMS data and our projections, there is the potential to eliminate 38.5 percent of all parked truck-related crashes in the state by strategically building more truck parking across the state (based on the assumption that half of parked truck crashes are due to a shortage of truck parking).

Table 15. Predicted total of crashes and costs avoided per year (in 2024 US $M)

Year	Predicted crashes, baseline	Predicted crashes with mitigation	Crashes avoided	Percent crashes avoided
2025	307	272	35	11.4%
2026	320	251	69	21.6%
2027	334	231	103	30.8%
2028	348	210	138	39.7%
2029	362	190	172	47.5%
2030	377	156	221	58.6%
2031	392	123	269	68.6%
2032	408	90	318	77.9%
2033	425	58	367	86.4%
2034	444	29	415	93.5%
2035	464	0	464	100.0%
Total	**4,182**	**1,609**	**2536**	**61.5%**

Our last step is to calculate the value of the avoided crashes. Results are given in Table 16. The value of avoided crashes increases each year, reaching $670 million by 2035. This would be the annual savings as long as parking shortages do not reappear. Total savings over the 10 year period is $3.712 billion. Our estimate suggests large annual savings due to reduced truck-involved crashes and therefore significant safety and economic benefits for the state.

Table 16. Costs avoided for injuries and fatalities, 2025 - 2035 (in 2024 US $M)

Year	Fatal injury crashes [Type K]	Incapacitating injury [Type A]	Non-incapacit-ating injury [Type B]	Possible injury [Type C]	No Injury Reported [Type O]	Total Costs Avoided per Year
2025	34.62	7.89	4.46	2.71	0.03	49.71
2026	69.25	15.77	8.92	5.42	0.07	99.42
2027	103.87	23.66	13.38	8.13	0.10	149.14
2028	138.49	31.54	17.84	10.84	0.14	198.85
2029	173.12	39.43	22.30	13.55	0.17	248.56
2030	222.04	50.57	28.60	17.38	0.22	318.80
2031	270.96	61.71	34.90	21.21	0.27	389.04
2032	319.88	72.85	41.20	25.04	0.32	459.28
2033	368.79	83.99	47.50	28.87	0.36	529.51
2034	417.65	95.11	53.79	32.69	0.41	599.66
2035	466.50	106.24	60.08	36.52	0.46	669.80
Total	**2,585.17**	**588.74**	**332.93**	**202.38**	**2.55**	**3,711.77**

5.3. Time and Revenue Savings

A study conducted by ATRI assessed the lost revenue time experienced by drivers who park earlier than necessary or spend time searching due to parking shortages (Borris and Brewster, 2016).The research indicates that drivers sacrifice an average of 56 minutes of revenue earning time per day. This results in a reduction of an individual driver's productivity by 9,300 revenue-earning miles annually, translating to lost revenues of $4,600 each year. Assuming that each additional new parking space can effectively prevent the revenue losses of one truck driver searching for parking, the calculated revenue-earning time and miles savings, along with the total revenue savings, are presented in Table 17 for each year from 2025 to 2035. By 2035, if all truck parking shortages can be addressed, it is expected that more than 2.4 million revenue-earning hours, which are equivalent to nearly 66.2 million miles of revenue-earning miles can be saved annually. This translates to a total of $32.7 million revenue savings on a yearly basis.

Table 17. Time and Revenue Savings with Reduced Parking Shortages

	Truck Parking Slots Added	Revenue-Earning Time Savings (hours)	Revenue-Earning Miles Savings (miles)	Revenue Savings ($)
2025	528	179,872	4,910,400	2,428,800
2026	1,056	359,744	9,820,800	4,857,600
2027	1,584	539,616	14,731,200	7,286,400
2028	2,112	719,488	19,641,600	9,715,200
2029	2,640	899,360	24,552,000	12,144,000
2030	3,386	1,153,497	31,489,800	15,575,600
2031	4,132	1,407,635	38,427,600	19,007,200
2032	4,878	1,661,772	45,365,400	22,438,800
2033	5,624	1,915,909	52,303,200	25,870,400
2034	6,369	2,169,706	59,231,700	29,297,400
2035	7,114	2,423,503	66,160,200	32,724,400

5.4. Environmental Benefits

The expansion and construction of truck parks across California, as outlined in this report, are expected to yield significant environmental benefits through reduced emissions. With 7,114 new truck parks planned for construction in phases from 2025 to 2035, the emission reduction calculations using the CARB's EMFAC database estimate substantial savings in terms of reduced NOx, PM2.5, and CO2 emissions. The emission factors for Class 8 truck fleet are calculated as 4.7249 g/mile for NOx, 0.7679 g/mile for PM2.5, and 2,541.8 g/mile for CO2 based on the EMFAC database. Additionally, the EPA offers insights into the benefits per ton of emission reductions by sector, with estimates standing at $10,700/ton for NOx and $166,000/ton for PM2.5 for internal combustion engines. The social cost of carbon is estimated to be $200/ton. Given that addressing parking challenges for each truck can save 9,300 revenue-earning miles, it is estimated that the environmental benefits associated with each additional parking space amount to $470 for NOx emission reduction, $1,186 for PM2.5 emission reduction, and $4,728 for CO2 emissions reduction.

Table 18 presents the estimated environmental benefits for each year over the study period. By 2035, it is estimated that over $3.3 million would be saved from reduced NOx emissions, $8.4 million from reduced PM2.5 emissions, and a massive $33 million from reduced CO2 emissions. These savings are calculated based on the average emission rates of T7 Class 8 vehicles, the revenue-earning miles lost per year, and the corresponding monetary benefits per ton of emission reduction. The construction of these truck parks will provide additional capacity and space for trucks, thereby reducing idling time and associated emissions. The substantial environmental benefits and cost savings from emission reduction showcase the positive impact this project will have on air quality and climate change mitigation efforts in California.

Table 18. Environmental Benefits of Addressing Truck Parking Shortages (2025-2035)

Year	Truck Parking Slots Added	NOx Reduction ($M)	PM2.5 Reduction ($M)	CO2 Reduction ($M)	Total Environmental Benefits ($M)
2025	528	$0.25	$0.63	$2.50	$3.37
2026	1,056	$0.50	$1.25	$4.99	$6.74
2027	1,584	$0.74	$1.88	$7.49	$10.11
2028	2,112	$0.99	$2.50	$9.99	$13.48
2029	2,640	$1.24	$3.13	$12.48	$16.85
2030	3,386	$1.59	$4.02	$16.01	$21.62
2031	4,132	$1.94	$4.90	$19.54	$26.38
2032	4,878	$2.29	$5.79	$23.06	$31.14
2033	5,624	$2.64	$6.67	$26.59	$35.90
2034	6,369	$2.99	$7.55	$30.11	$40.66
2035	7,114	$3.34	$8.44	$33.63	$45.42

Chapter 6. Macroeconomic Impact Analysis Results

6.1. Application of the REMI Model

Before undertaking the economic simulations in the REMI Model, the direct impact data (capital and operating costs, revenue savings, environmental benefits) are prepared for utilization in the model. Benefits of avoided crashes are not used in the REMI model, because the benefits are only direct. This step involves the selection of appropriate variables and determination of the proper economic sectors in REMI to simulate the investment projects. Table 19 illustrates how the direct impacts of the truck parking investment are translated into REMI economic variable inputs.

The second column of Table 19 shows different types of direct impacts (or “drivers”) of investment in additional truck parking facilities. The third column presents the corresponding economic variables in the REMI PI+ Model and indicates their position within the Model (i.e., in which one of the five major model blocks in REMI described in Appendix C that the policy variables can be found).

Table 19. Linkages between Direct Impacts and REMI Simulation Inputs

Linkage	Direct Impact	Policy Variable Selection in REMI
1	Construction expenditures on new truck parking facilities	Output and Demand Block → Industrial Sales of Construction sector → Increase Output and Demand Block → Industrial Sales of Architectural, Engineering, and Related Services sector → Increase
2	Increased O&M spending	Output and Demand Block → Industrial Sales of Construction sector → Increase
3	Avoided revenue losses from saved time/miles searching for parking	Output and Demand Block → Industrial Sales of Truck Transportation sector → Increase
4	Offsetting effect: Reduced government spending elsewhere	Output and Demand Block →State and Local Government Spending →Decrease

6.2. Aggregate Economic Impacts

Economic Impacts of the Construction of Additional Truck Parking Facilities

The aggregate economic impacts of expanding existing truck parks and developing new parking spaces are presented in Tables 20a and 20b for each year between 2025 and 2035 for the following indicators: employment, gross state product (GSP), output (sale revenues), and personal income. The Net Present Value (NPV) computed by adopting a 3% rate of discount over the entire study period is also presented for GSP, output, and personal income impacts in the last column. The upper panel of Table 20a presents the impacts in levels relative to baseline and the lower panel presents the impacts in terms of percentage changes with respect to the California economy. Table 20b presents the same information for 2031 through 2035.

The last column of Table 20b gives total job impacts and total GSP, output, and personal income in NPV. Results are positive for all measures. The NPV of the increased GSP over the entire study period is estimated to be $615.6 million. The highest impact will occur in 2030 associated with the assumed start year of the construction of new truck parking facilities across the

Caltrans districts. The average annual employment created is estimated to be 505 job-years[6] over the entire study period. The total employment impacts are estimated to be 5,553 job-years between 2025 and 2035. The increase in gross output (or sale revenues) is estimated to be $1.1 billion in NPV. The increase in personal income is projected to be about $391.7 million in NPV. Although some of the aggregate impacts are relatively large in terms of absolute levels, they remain small in percentage terms because of the size of the state economy.[7]

Table 20a. Aggregate Macroeconomic Impacts of Development of New or Expanded Truck Parking Facilities – Impacts of Construction Activities, 2025 - 2030

Variable	Units	2025	2026	2027	2028	2029	2030
Changes in Major Macroeconomic Indicators from Baseline							
Total Employment	Job-year	393	362	355	339	321	702
GSP	M 2023$	49.30	45.82	45.82	44.21	42.35	94.59
Output	M 2023$	87.64	81.66	81.42	78.68	75.57	168.54
Personal Income	M 2023$	32.83	25.90	27.27	27.08	26.77	62.15
Percent Change from Baseline Level							
Total Employment	Job-year	0.0015%	0.0014%	0.0014%	0.0013%	0.0012%	0.0027%
GSP	M 2023$	0.0013%	0.0011%	0.0011%	0.0011%	0.0010%	0.0022%
Output	M 2023$	0.0013%	0.0012%	0.0012%	0.0011%	0.0011%	0.0023%
Personal Income	M 2023$	0.0010%	0.0008%	0.0008%	0.0008%	0.0008%	0.0018%

[6] One job-year refers to a worker working full time for one year. Results presented for a given year represent the jobs in place that year whether they are new jobs or carryovers from past years.
[7] In 2022, the GSP of California was $3.64 trillion and the total employment was over 18 million.

Table 20b. Aggregate Macroeconomic Impacts of Development of New or Expanded Truck Parking Facilities – Impacts of Construction Activities, 2031 - 2035

Variable	Units	2031	2032	2033	2034	2035	NPV (or Total Person-Year Jobs)
Changes in Major Macroeconomic Indicators from Baseline							
Total Employment	Job-year	656	641	616	594	574	5,553
GSP	M 2023$	89.03	87.99	85.44	83.06	80.96	615.64
Output	M 2023$	159.94	158.56	154.64	150.93	147.62	1,105.50
Personal Income	M 2023$	54.13	55.67	55.44	55.21	54.91	391.65
Percent Change from Baseline Level							
Total Employment	Job-year	0.0025%	0.0024%	0.0023%	0.0022%	0.0021%	
GSP	M 2023$	0.0020%	0.0019%	0.0018%	0.0017%	0.0017%	
Output	M 2023$	0.0021%	0.0020%	0.0020%	0.0019%	0.0018%	
Personal Income	M 2023$	0.0015%	0.0015%	0.0015%	0.0014%	0.0014%	

Economic Impacts of Operation and Maintenance of the Expanded or New Truck Parking Facilities

After the completion of the expansion and new parking facility construction projects, spending will incur on an annual basis for the operation and regular maintenance of these facilities. Tables 21a and 21b presents the total economic impacts associated with the O&M expenditures. As a growing number of additional expanded or new parking spaces become available, the economic impact of the O&M expenditure will increase from supporting 10 jobs and generating $1.22 million GSP in 2025 to 133 jobs and $18.54 million GSP by 2035. Different from the economic impacts resulting from the construction activities, which represent one-time stimulus to the state economy, the jobs supported and GSP and income generated by the operation and maintenance activities will be recurring over the entire service lifespan of these new facilities.

Table 21a. Aggregate Macroeconomic Impacts of Operation and Maintenance of New or Expanded Truck Parking Facilities, 2025 - 2030

Variable	Units	2025	2026	2027	2028	2029	2030
Changes in Major Macroeconomic Indicators from Baseline							
Total Employment	Job-year	10	19	27	35	43	60
GSP	M 2023$	1.22	2.35	3.45	4.52	5.55	7.93
Output	M 2023$	2.23	4.28	6.29	8.25	10.15	14.55
Personal Income	M 2023$	0.80	1.42	2.06	2.70	3.34	4.87
Percent Change from Baseline Level							
Total Employment	Job-year	0.00004%	0.00007%	0.00011%	0.00014%	0.00016%	0.00023%
GSP	M 2023$	0.00003%	0.00006%	0.00008%	0.00011%	0.00013%	0.00018%
Output	M 2023$	0.00003%	0.00006%	0.00009%	0.00012%	0.00014%	0.00020%
Personal Income	M 2023$	0.00003%	0.00004%	0.00006%	0.00008%	0.00010%	0.00014%

Table 21b. Aggregate Macroeconomic Impacts of Operation and Maintenance of New or Expanded Truck Parking Facilities, 2031 - 2035

Variable	Units	2031	2032	2033	2034	2035	NPV (or Total Person-Year Jobs)
Changes in Major Macroeconomic Indicators from Baseline							
Total Employment	Job-year	76	91	106	120	133	720
GSP	M 2023$	10.15	12.34	14.46	16.53	18.54	76.77
Output	M 2023$	18.75	22.85	26.88	30.84	34.71	142.12
Personal Income	M 2023$	6.20	7.56	8.92	10.28	11.62	47.23
Percent Change from Baseline Level							
Total Employment	Job-year	0.00029%	0.00034%	0.00040%	0.00045%	0.00049%	
GSP	M 2023$	0.00023%	0.00027%	0.00031%	0.00035%	0.00038%	
Output	M 2023$	0.00025%	0.00029%	0.00034%	0.00038%	0.00042%	
Personal Income	M 2023$	0.00017%	0.00020%	0.00023%	0.00026%	0.00029%	

Economic Impacts of Avoided Revenue Losses from Saved Revenue-Earning VMT

In Section 5.3, we estimate the lost revenues that can be avoided if the truck drivers can save the time and miles searching for parking space by having a space available at the time and location as needed. Tables 22a and 22b present the annual economic impacts associated with the avoided revenue losses. With the construction of additional truck parking spaces over the 10-year study period, the economic impact of avoided revenue losses will increase from supporting 36 jobs and generating nearly $8 million GSP in 2025 to about 400 jobs and $111.8 million GSP by 2035. In addition, these economic benefits will be recurring over the entire service lifetime of these new parking facilities.

Table 22a. Aggregate Macroeconomic Impacts of Avoided Revenue Losses from Saved Revenue-Earning Miles, 2025 - 2030

Variable	Units	2025	2026	2027	2028	2029	2030
Changes in Major Macroeconomic Indicators from Baseline							
Total Employment	Job-year	36	72	107	141	173	215
GSP	M 2023$	4.43	9.07	13.89	18.74	23.46	29.72
Output	M 2023$	7.98	16.32	24.99	33.75	42.36	53.80
Personal Income	M 2023$	4.86	9.38	14.11	18.93	23.79	30.54
Percent Change from Baseline Level							
Total Employment	Job-year	0.00014%	0.00028%	0.00042%	0.00055%	0.00067%	0.00082%
GSP	M 2023$	0.00011%	0.00023%	0.00034%	0.00045%	0.00055%	0.00068%
Output	M 2023$	0.00012%	0.00024%	0.00036%	0.00048%	0.00059%	0.00073%
Personal Income	M 2023$	0.00015%	0.00029%	0.00043%	0.00056%	0.00069%	0.00086%

Table 22b. Aggregate Macroeconomic Impacts of Avoided Revenue Losses from Saved Revenue-Earning Miles, 2031- 2035

Variable	Units	2031	2032	2033	2034	2035	NPV (or Total Person-Year Jobs)
Changes in Major Macroeconomic Indicators from Baseline							
Total Employment	Job-year	256	294	331	367	401	2,394
GSP	M 2023$	35.98	42.18	48.34	54.52	60.63	271.30
Output	M 2023$	65.51	76.98	88.58	100.25	111.81	494.87
Personal Income	M 2023$	37.29	43.96	50.83	57.73	64.62	283.00
Percent Change from Baseline Level							
Total Employment	Job-year	0.00097%	0.00111%	0.00124%	0.00136%	0.00148%	
GSP	M 2023$	0.00080%	0.00092%	0.00103%	0.00114%	0.00125%	
Output	M 2023$	0.00087%	0.00099%	0.00112%	0.00124%	0.00135%	
Personal Income	M 2023$	0.00102%	0.00118%	0.00133%	0.00148%	0.00162%	

Summary of Macroeconomic Impacts

Table 23 presents a summary of the economic impacts related to the construction investment and O&M expenditures of the additional truck parking facilities, along with the savings resulting from the avoidance of revenue-earning miles losses once the identified parking shortage challenges are addressed. The results are presented for the period from 2025 to 2035. During this 10-year study period, total employment impact is estimated to be 8,668 job-years. Additionally, the increases in GSP, gross output, and personal income, measured in NPV, are estimated to be $964 million, $1,742 million, and $722 million, respectively.

Table 23. Summary of the Economic Impacts Associated with Truck Parking Investment

Impact Category	Employment Impact (total Job-Years)	NPV of GSP Impact ($M)	NPV of Output Impact ($M)	NPV of Personal Income Impact ($M)
Construction Activities	5,553	616	1,106	392
O&M Expenditures	720	77	142	47
Savings from Avoidance of Revenue-Earning Miles Losses	2,394	271	495	283
Total	**8,668**	**964**	**1,742**	**722**

6.3. Sensitivity Analysis

In the Base Case analysis we assume that federal funding and existing state transportation funding will be the source of funding for the public truck parking investment project, which will not result in displacement of state government spending in other areas. However, given the various competing areas requiring transportation infrastructure investment, it is likely that investment in truck parking facilities will result in shifts of state and local funding from other government expenditures.

To assess how offsetting of other government expenditures will affect the overall macroeconomic impacts of the truck parking facility investment, two sensitivity cases are simulated. In the first sensitivity case, it is assumed that 25% of the project investment will be offset by a reduction in government spending in other similar areas. In the second sensitivity case, this offsetting percentage is increased to 50%.

Table 24 displays the total impacts on employment, GSP, and output over the entire study period for these two sensitivity cases. The results for the Base Case are also presented in the first row of the table for easy comparison. The analysis only focuses on the impacts of construction expenditures because the economic impacts related to annual O&M and potential avoided revenue-earning miles losses after the completion of additional parking construction projects would be the same as in the Base Case.

The findings suggest that if investing in additional truck parking capacity leads to a displacement of state government expenditures elsewhere, the stimulus effects seen in the Base Case will diminish. Specifically, if this investment results in a reduction in other government expenditures equal to 25% of the investment amount, the total employment impact will decrease from 5,553 job-years to 3,183 job-years, and the NPV of the GSP impact will decrease from $616 million to $338 million. This represents approximately 55% to 57% of the overall stimulus effects estimated for the Base Case. In the scenario where the displacement effect is 50%, the total employment impact will decrease to just 813 job-years, and the NPV of the GSP impact will decrease to $61 million, representing an 85% to 90% reduction in stimulus effects compared to the Base Case.

Table 24. Total Economic Impacts of Construction Expenditures for Sensitivity Cases (2025-2035)

Scenarios	Employment Impact (total Job-Years)	NPV of GSP Impact ($M)	NPV of Output Impact ($M)	NPV of Personal Income Impact ($M)
Base Case – no displacement of other government spending	5,553	616	1,106	392
Sensitivity Case 1. 25% displacement of other government spending	3,183	338	634	213
Sensitivity Case 2. 50% displacement of other government spending	813	61	163	35

Chapter 7. Conclusions

This report has examined the costs and benefits of addressing California's truck parking shortage. Based on the comprehensive 2022 statewide truck parking study and expected growth in trucking, we estimate a shortage of about 7,000 public spaces by 2035. Lack of parking leads to lost productivity; drivers may park before the hours of service (HOS) limit is reached or may have to drive extra miles in searching for parking. The shortage adds safety risks, as drivers may park in undesignated areas, or even exceed the HOS limit. Searching for parking adds to truck VMT and associated air toxic and CO2 emissions.

7.1 Summary of findings

We have conducted a macroeconomic impact analysis of eliminating the parking shortage. We compare the costs of constructing and operating the additional spaces with the savings in productivity, emissions, and safety. We estimated the magnitude of the parking shortage for the period of 2025-2035 and identified additional space requirements for each of the 10 Caltrans districts expected to have a shortage within the time period. We identified approximate locations for constructing new spaces and estimated construction and operating costs based on the best information available from Caltrans, AASHTO and FHWA. We developed a timeline for construction of spaces over the time period, then estimated the costs of the additional spaces. We estimated a total shortage of about 7,000 spaces by 2035. Total capital costs are $579 million, and the annual operations and maintenance cost is about $15.3 million.

Eliminating the parking shortage generates safety, labor productivity and environmental benefits. We estimated these benefits in the form of avoided costs. The largest savings is in safety; we estimate avoiding 2536 truck involved parking crashes at a savings of $3.7 billion in avoided deaths and injuries. Productivity savings from revenue time savings total $181 million, and savings from avoided air toxic and CO2 emissions total #252 million.

We used the REMI- PI+ model to estimate macroeconomic impacts. Crash savings are not included, as they are assumed to not generate indirect or induced economic impacts. Total impacts on gross state product (GSP) in net present value (NPV) is $964 million, about two thirds of which is due the stimulus from construction. The employment impact is 8,668 job years, again with construction accounting for nearly two thirds of the total.

Construction impacts depend on assumptions about funding sources. In our baseline scenario we assume the funds will come from additional sources. We conducted a sensitivity analysis to examine what happens if 25 and 50 percent of the funds respectively displace other existing state funding. GSP impacts fall from $616 million to $338 and $61 respectively. Thus, macroeconomic impacts depend greatly on where the funding would come from. We conclude that eliminating the truck parking shortage in California would lead to modest but positive macroeconomic impacts even if some of the funding were taken from existing state programs. Macro-economic benefits, as well as other direct benefits, are dwarfed by the potential safety benefits.

7.2 Limitations

Our study has the following limitations. First, we assume that all the needed parking can be built within the districts where needed. The districts with the greatest shortages – 8, 7, 3 and 4 – are also among the most heavily urbanized and therefore most challenging for finding suitable locations. Our use of an average value for land acquisition likely underestimates land prices in these districts, but overestimates for less intensively urbanized districts. Second, we use the best available data for construction costs, but the data are based on a handful of examples. There is likely significant uncertainty associated with our cost estimates.

A third limitation is our assumption regarding truck involved parking crashes. The TIMS data is not sufficient to definitively determine whether a given crash is directly related to a parking shortage. We used a mid-range estimate that half of all parked crashes are related to parking problems. Because avoided human death and injury costs are by far the greatest benefit, this assumption greatly affects overall results.

Fourth, we have not considered the private truck parking market. We have assumed that all of the shortage would be made up by public facilities. It is possible that commercial facilities will increase or expand. This could affect the construction, operations and maintenance calculations and economic impacts, but should not affect safety, time savings, or environmental benefits.

Finally, we have not considered the costs or demands for electric charging or hydrogen fueling facilities. The Advanced Clean Fleet and Advanced Clean Truck regulations require a fully zero-emission drayage truck fleet by 2035 and fully zero-emission statewide truck fleet by 2042. At this time there is limited information and great uncertainty on how the long haul truck fleet will evolve, whether battery electric, hydrogen fuel cell, or both. This research presents a first step in identifying parking demand. It may be helpful in planning for the deployment of the new energy infrastructure. A logical next step in this research would be to extend the analysis to providing the anticipated fueling and energy systems.

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Data Management Plan

Products of Research

Our research is primarily based on the data provided in the California Department of Transportation (2022) California Statewide Truck Parking Study report and appendices. Crash data were collected from the TIMS website hosted at UC Berkeley. Victim cost data were drawn from a USDOT FMCSA report. The data on PM2.5 emission factor of Class 8 trucks are estimated based on data collected from the California Air Resources Board's (CARB's) Emission Factor (EMFAC) 2021 database. All of these data sources are available to the public and listed in the reference list.

Data Format and Content

All of the datasets compiled for this research are stored in Excel format.

Data Access and Sharing

Data sources are presented in the report and in the reference list. Links are provided in the reference list.

Reuse and Redistribution

Data cited or produced in this research have no restrictions on reuse and redistribution.

Appendix A. Possible Locations for Public Truck Park Expansions and New Truck Park Constructions

Table 7: District-2 Redding	
Projected Shortage for 2035	90
Public Truck Parks near capacity	6
1 Possible Expansion of Existing Site	0 Possible New location for Truck Parks

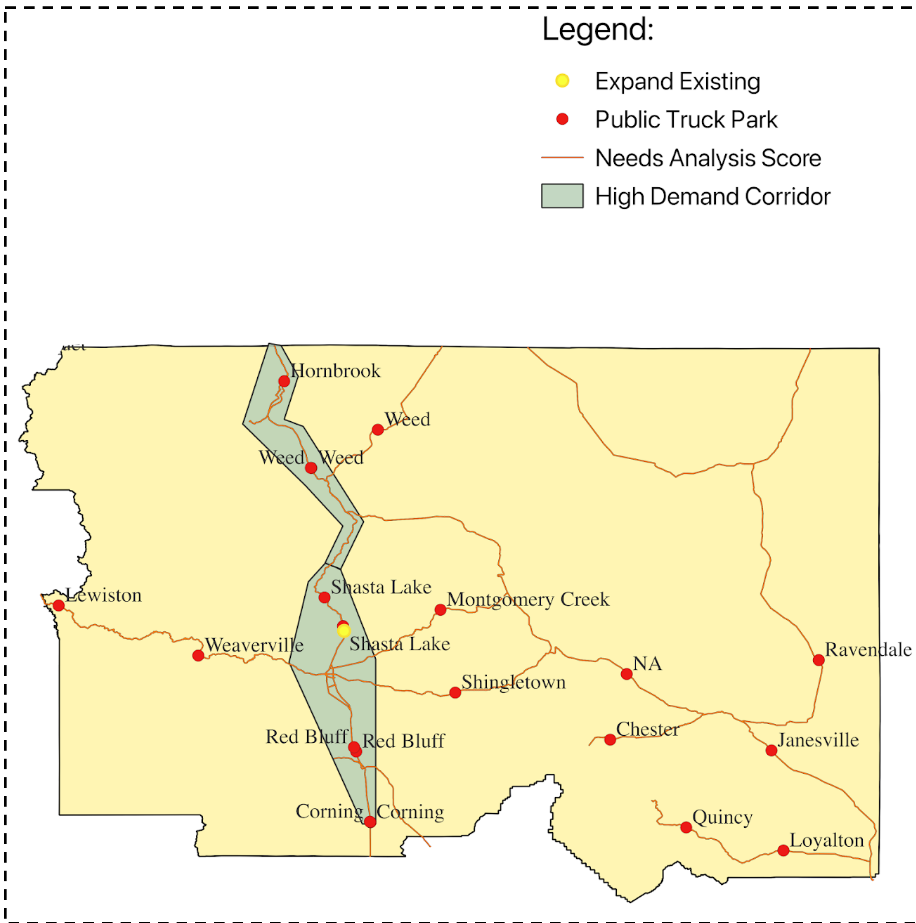


Table 8: District-3 Marysville/Sacramento	
Projected Shortage for 2035	882
Public Truck Parks near capacity	5
5 Possible Expansion of Existing Sites	3 Possible New location for Truck Parks

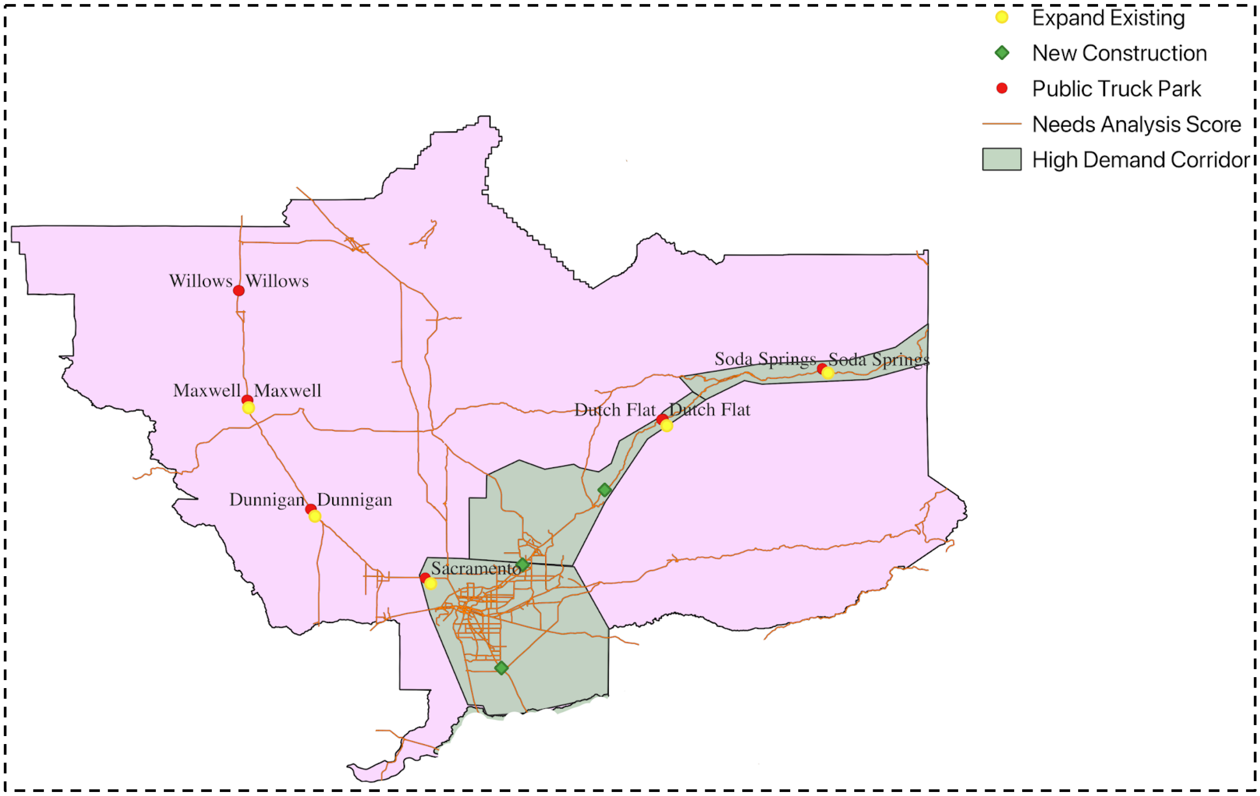


Table 9: District 4-Bay Area/Oakland	
Total Shortage of Spaces	**800**
Public Truck Parks near capacity	**1**
1 Possible Expansion of Existing Site	6 Possible New locations for Truck Parks

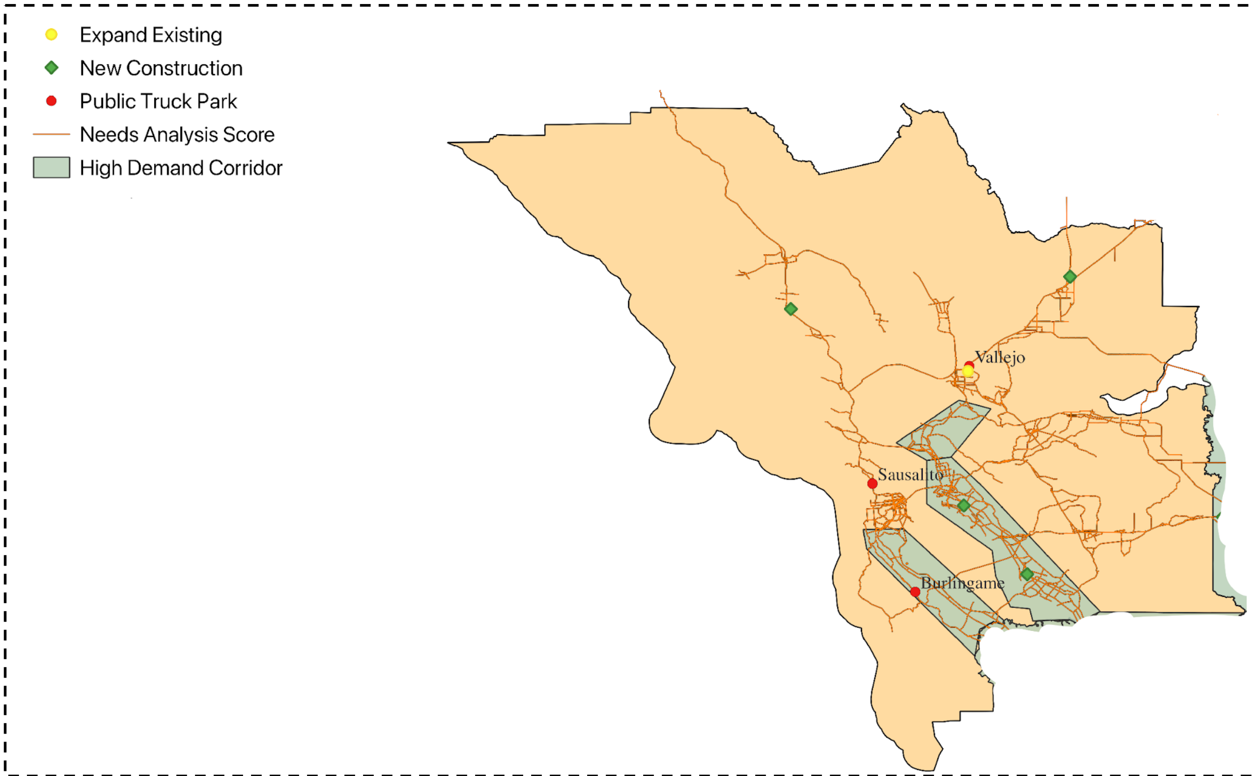


Table 10 : District 5-San Luis Obispo/Santa Barbara	
Projected Shortage for 2035	110
Public Truck Parks near capacity	2
1 Possible Expansion of Existing Sites	0 Possible New locations for Truck Parks

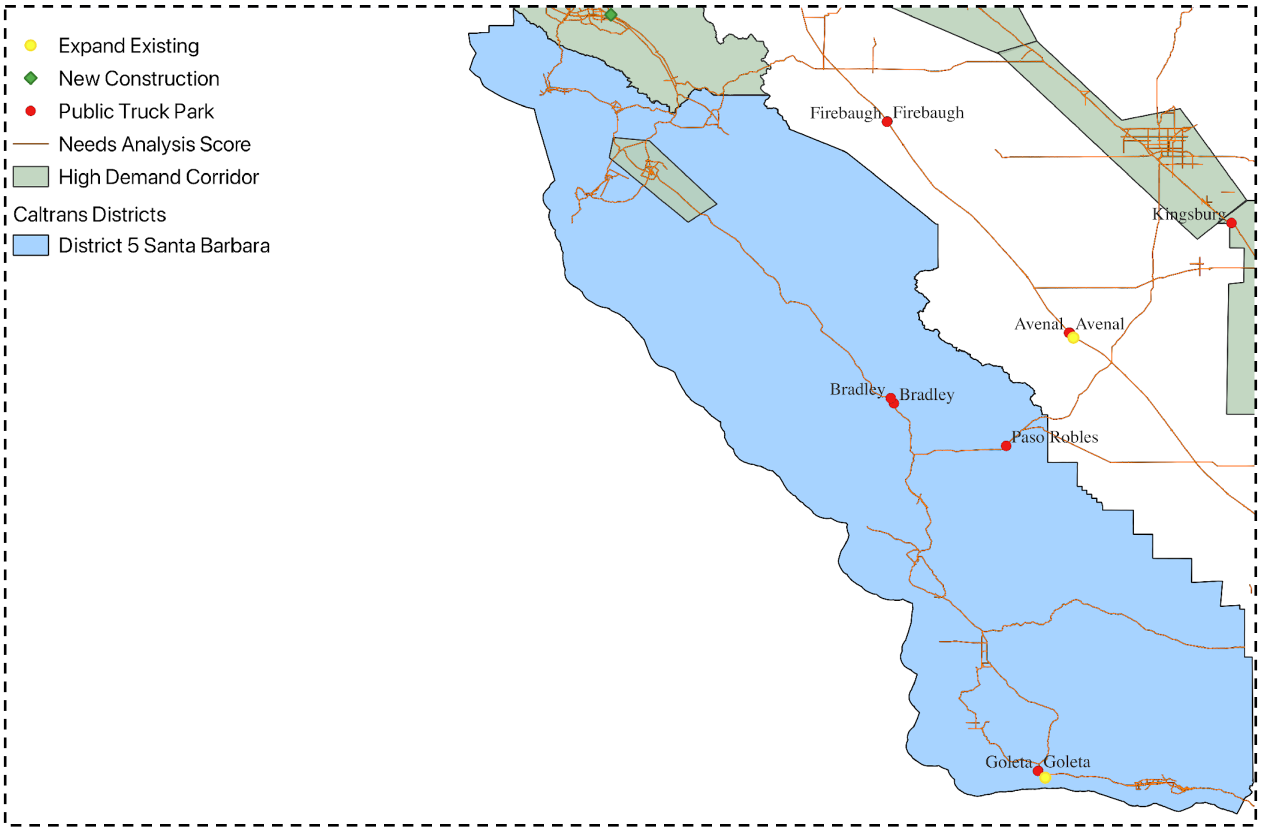


Table 11 : District 6-Fresno/Bakersfield	
Projected Shortage for 2035	**95**
Public Truck Parks near capacity	**2**
1 Possible Expansion of Existing Sites	0 Possible New locations for Truck Parks

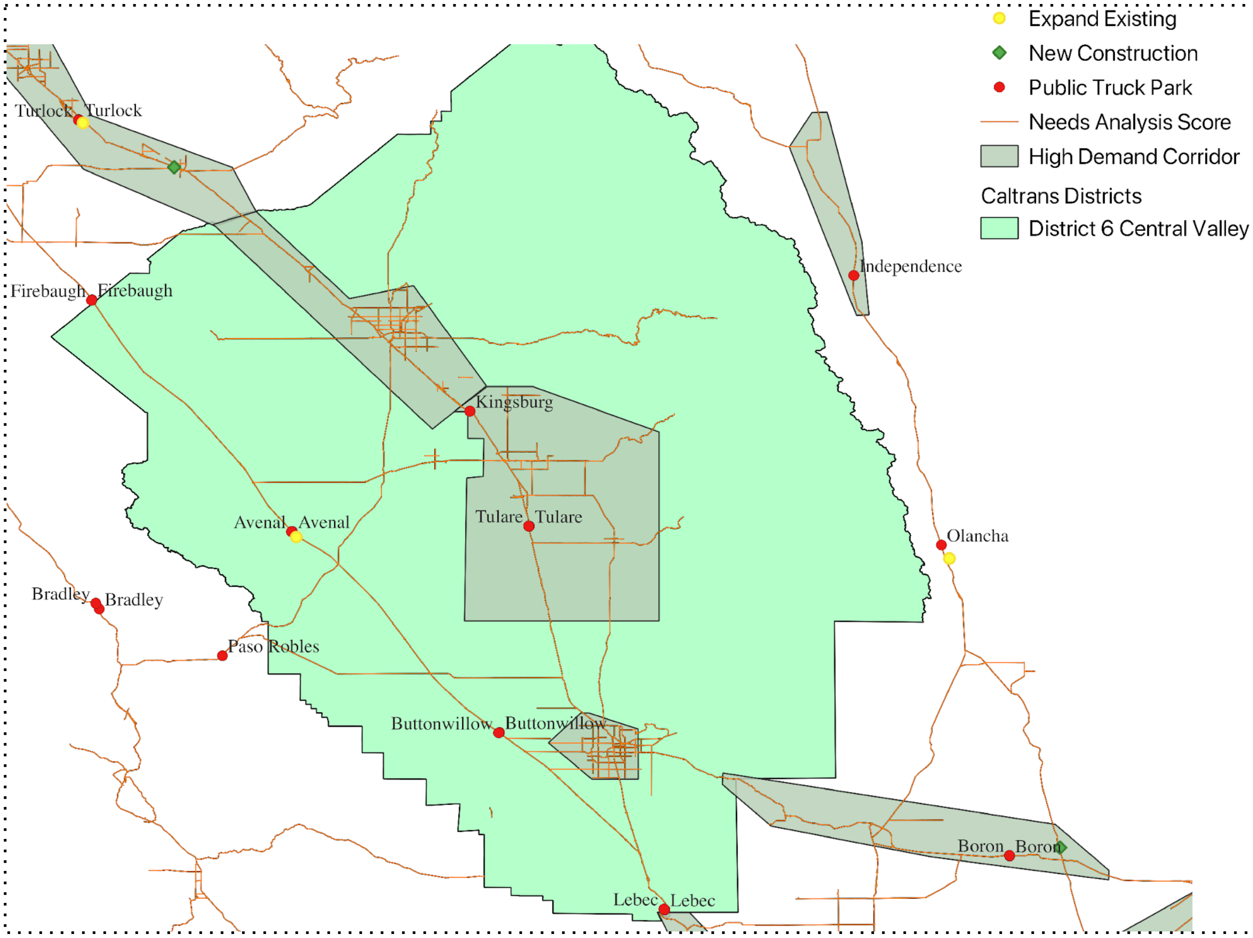


Table 12: District 7-Los Angeles/Ventura	
Projected Shortage for 2035	1171
Public Truck Parks near capacity	0
0 Possible Expansion of Existing Sites	10 Possible New locations for Truck Parks

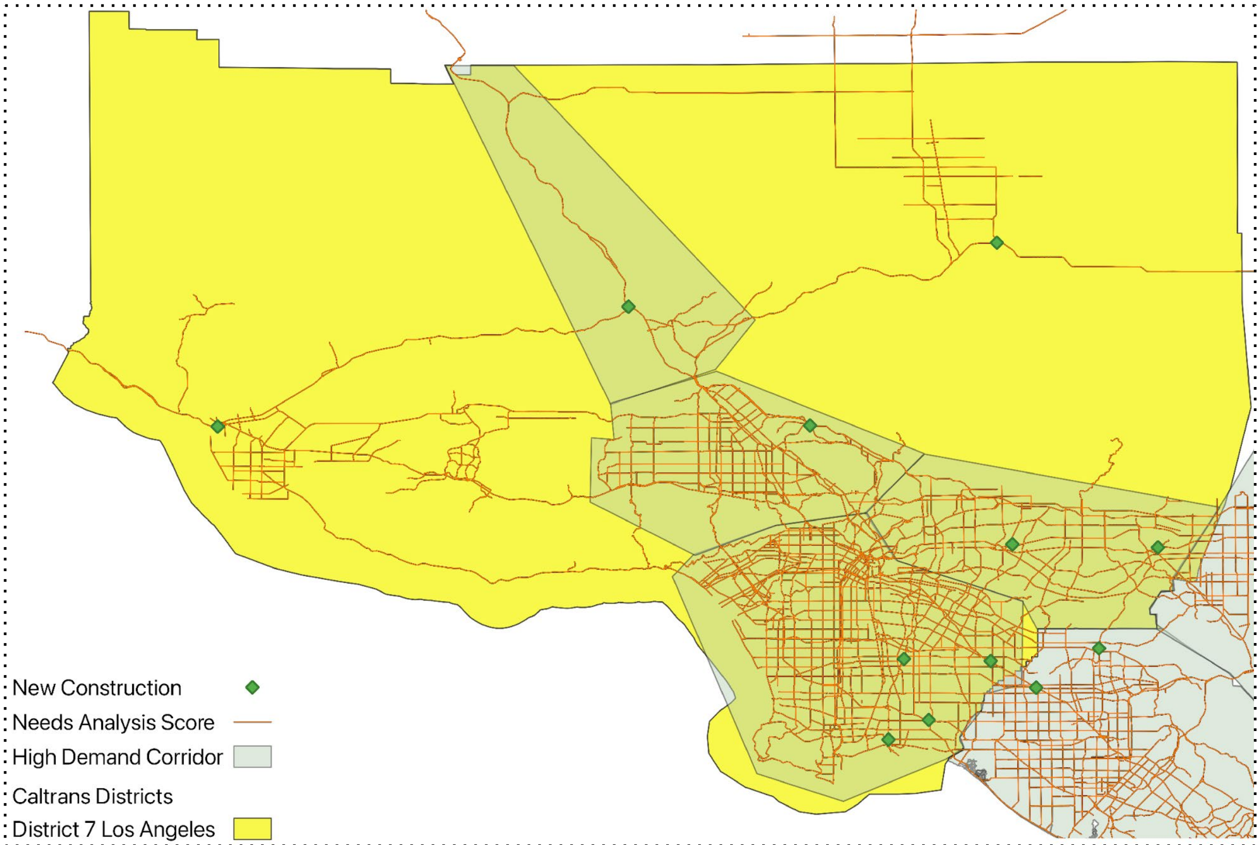


Table 13: District 8-San Bernardino/Riverside	
Total Shortage of Spaces	**2950**
Public Truck Parks near capacity	**8**
8 Possible Expansion of Existing Sites	10 Possible New locations for Truck Parks

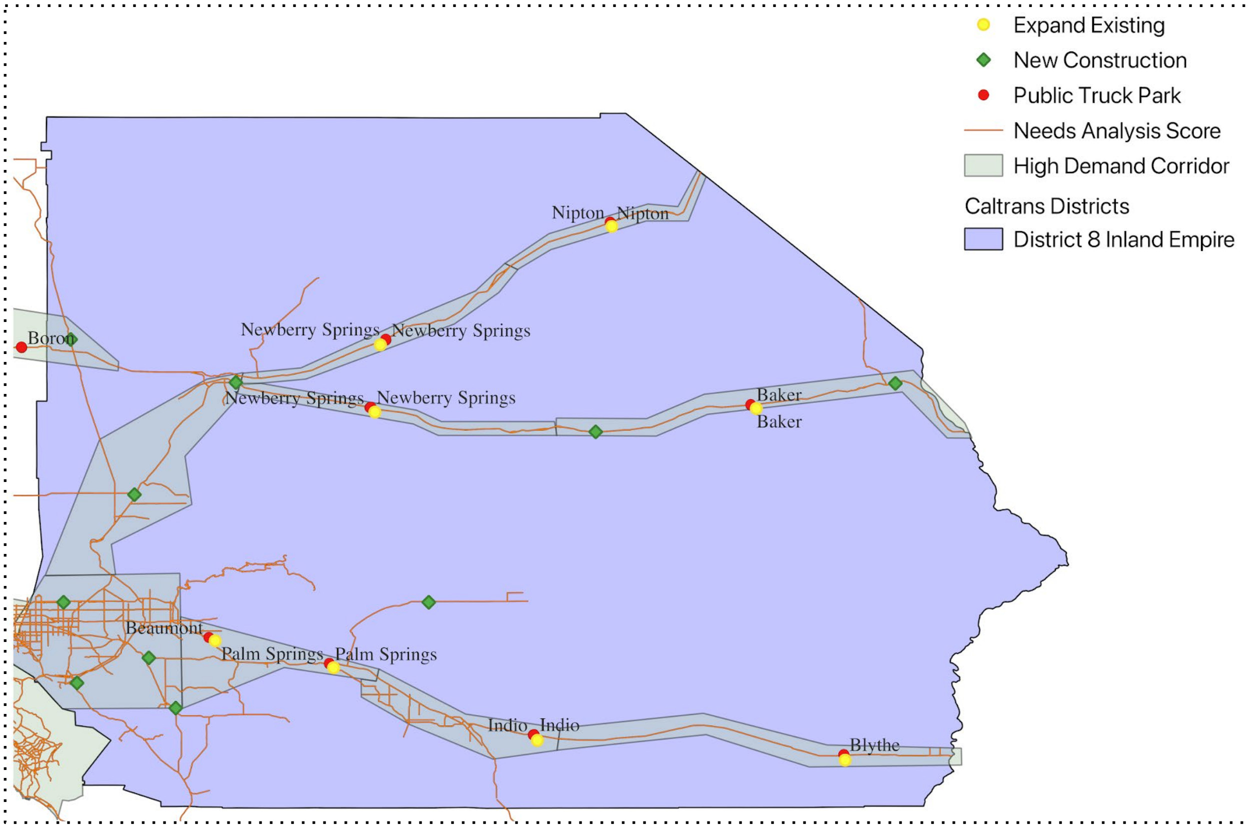


Table 14: District 9-Eastern Sierra/Bishop	
Projected Shortage for 2035	121
Public Truck Parks near capacity	3
1 Possible Expansion of Existing Sites: X	0 Possible New locations for Truck Parks: O

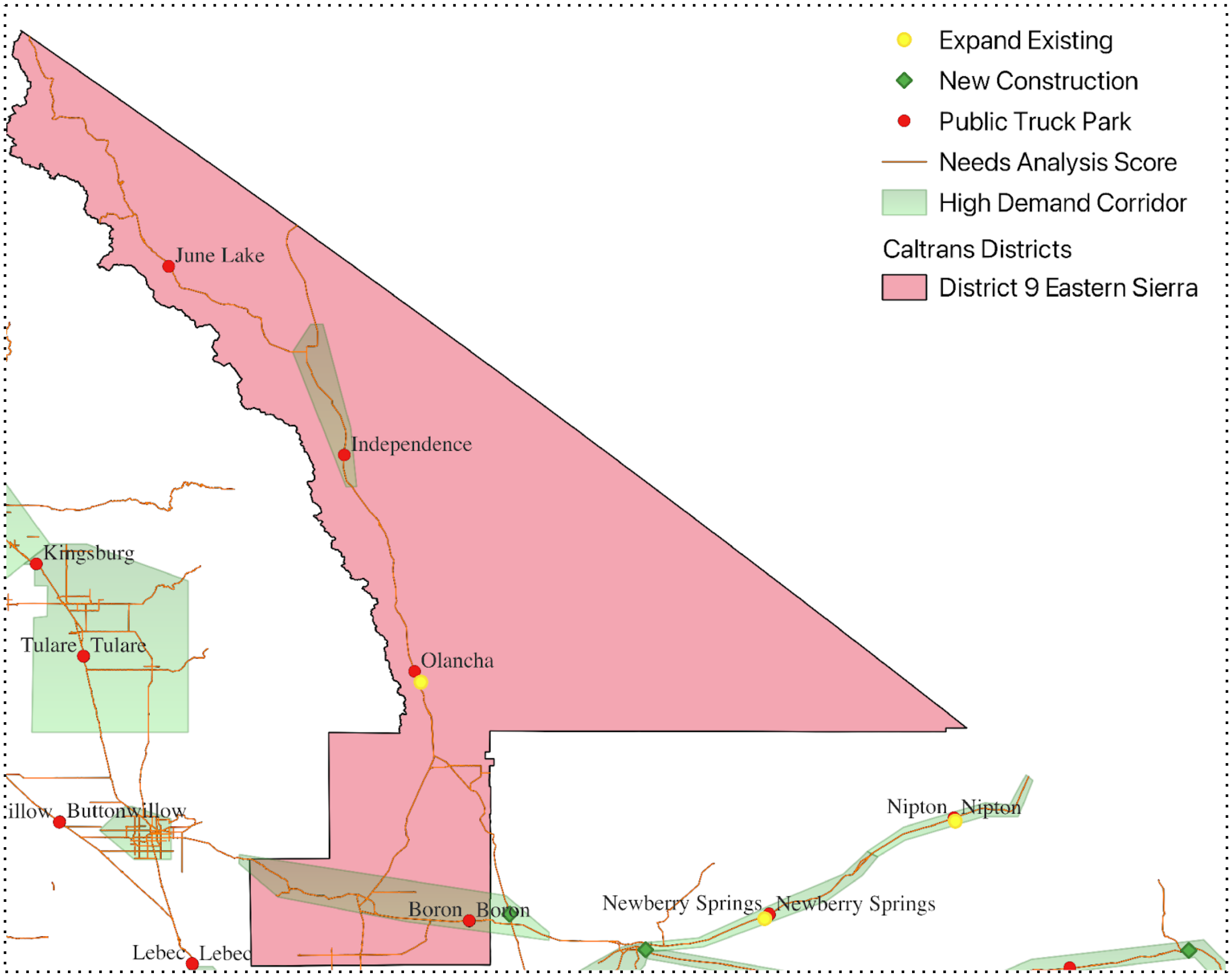


Table 15: District 10-Stockton	
Projected Shortage for 2035	742
Public Truck Parks near capacity	2
4 Possible Expansion of Existing Sites: X	2 Possible New locations for Truck Parks: O

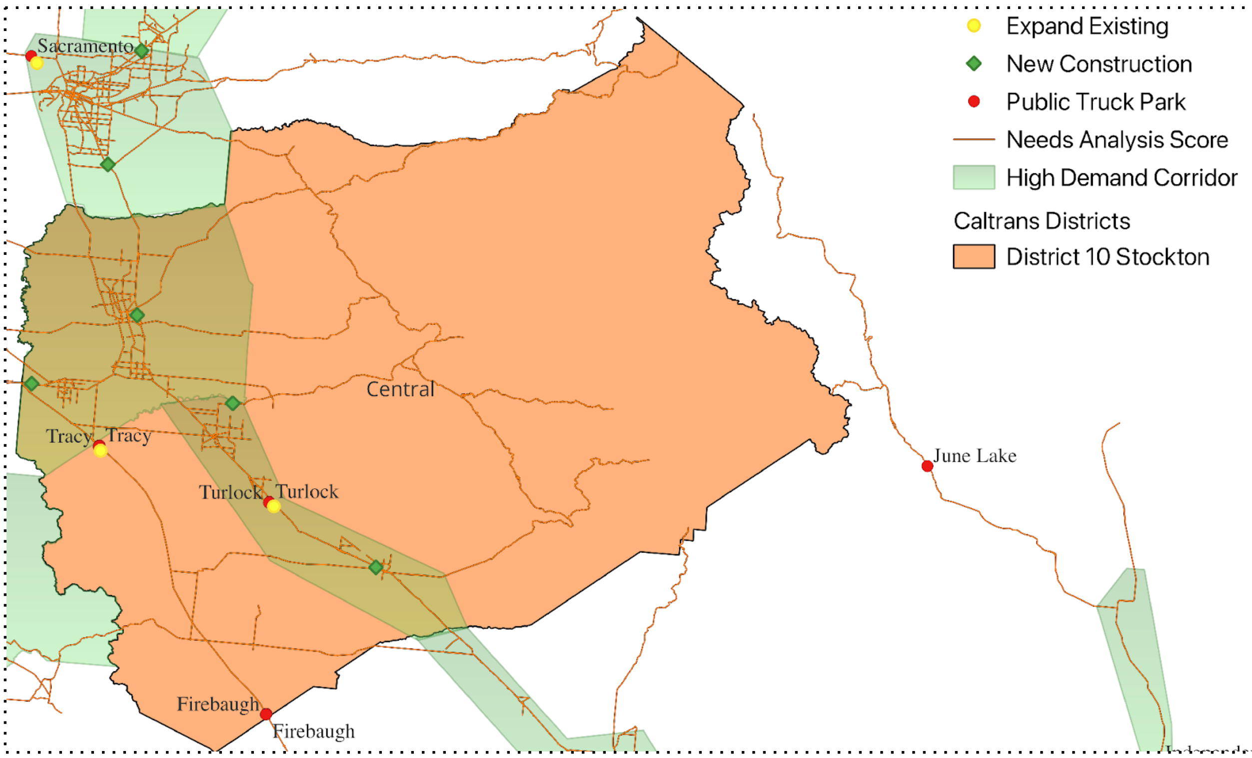
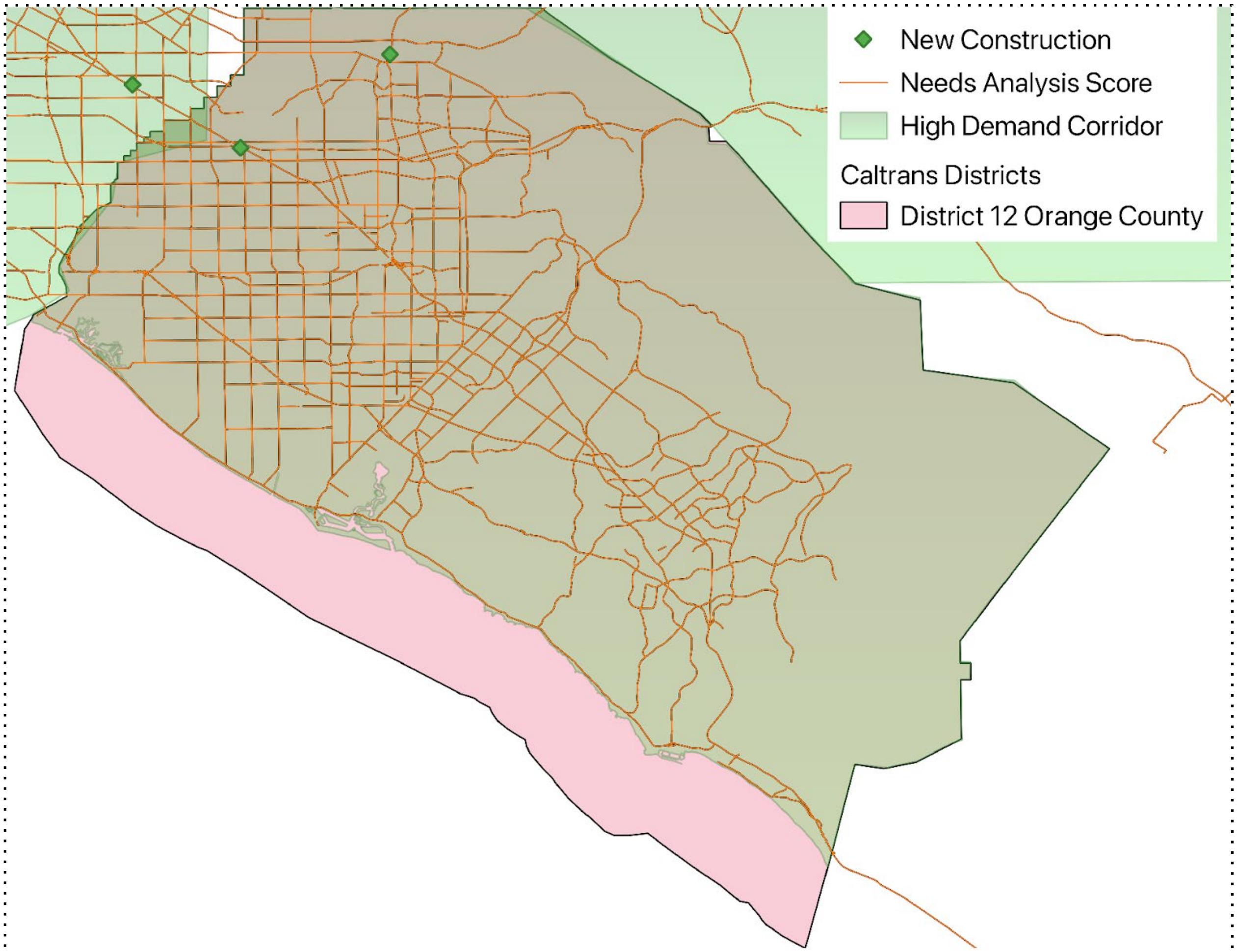


Table 16: District 12-Orange County	
Projected Shortage for 2035	153
Public Truck Parks near capacity	0
0 Possible Expansion of Existing Sites: X	2 Possible New location for Truck Parks: O



Appendix B. Model Costs for District-11

Table 4-1 - Site Quantities

Description	Units	A1	A2	A3	A4	A5	A6	A7
Clear - Grub - Level	Acre	10.0	7.1	40.4	9.5	12.6	6.9	24.6
Low Voltage Conduit	Lin Ft	2,376	2,175	9,027	2,926	3,462	2,174	3,254
Substn for 2 to 5 MVA	Lump Sum	1	1	1	1	1	1	1
HM Pole .5M Lumens	Lump Sum	8	7	27	9	12	1	9
AC for Container	Acre	9.4	6.5	38.3	8.5	11.4	6.6	22.2
Manned Booth Lane	Lump Sum	2	2	4	2	2	0	2
Chain Link Boundary Fence	Lin Ft	2,884	2,645	6,990	3,314	3,359	2,067	4,270
Green Space	Acre	0.6	0.6	2.0	1.0	1.0	0.4	1.9
Walkway	Lin Ft	2,258	1,676	13,228	2,103	3,097	1,784	6,963
Water Closet	Sq Ft	792	624	1,920	624	624	624	960
Parking Striping	Lin Ft	5,100	3,450	24,000	4,950	6,975	3,075	15,075

Table 5-1 - Rough Site Construction Costs (“k” = thousands)

Description	Unit	Unit Price	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Clear - Grub - Level	Acre	$21,569	$216 k	$153 k	$871 k	$205 k	$272 k	$149 k	$531 k
Low Voltage Conduit	LF	$122	$290 k	$265 k	$1,101 k	$357 k	$422 k	$265 k	$397 k
Substation for 2 to 5 MVA	LS	$250,000	$250 k	$250 k	$250 k	$250 k	$250 k	$250 k	$250 k
HM Pole .5M Lumens	LS	$33,565	$269 k	$235 k	$906 k	$302 k	$403 k	$34 k	$302 k
AC Pavement for Container	Acre	$136,480	$1,283 k	$887 k	$5,233 k	$1,160 k	$1,556 k	$901 k	$3,030 k
Manned Booth Lane	LS	$191,087	$382 k	$382 k	$764 k	$382 k	$382 k	$0 k	$382 k
Chain Link Boundary Fence	LF	$31	$90 k	$83 k	$218 k	$103 k	$105 k	$65 k	$133 k
Green Space[1]	Acre	$140,973	$85 k	$85 k	$282 k	$141 k	$141 k	$57 k	$268 k
Walkway	LF	$1	$2 k	$1 k	$9 k	$1 k	$2 k	$1 k	$5 k
Water Closet	SF	$352	$279 k	$220 k	$676 k	$220 k	$220 k	$220 k	$338 k
Parking Striping	LF	$1	$3 k	$2 k	$16 k	$3 k	$5 k	$2 k	$10 k
Base Cost	$		$3,148 k	$2,563 k	$10,328 k	$3,125 k	$3,758 k	$1,943 k	$5,646 k
Total Cost	**$**		**$3,777 k**	**$3,076 k**	**$12,393 k**	**$3,751 k**	**$4,509 k**	**$2,331 k**	**$6,776 k**
Area	Acres		10.0	7.1	40.6	9.5	12.9	6.9	24.6
Cost/ Acre	$/Acre		$378 k	$433 k	$307 k	$395 k	$358 k	$338 k	$275 k
Truck Slots	#		61	42	304	59	87	38	190
Cost / Slot	$/Slot		$6,192	$10,315	$1,009	$6,691	$4,113	$8,891	$1,450

1. Unit cost for Green Space varies a bit from site to site

Source: CA DOT, 2022, p. 24-25

Appendix C. Description of the REMI PI+ Model

REMI PI$^+$ is a structural economic forecasting and policy analysis model. It integrates input-output, computable general equilibrium, econometric and economic geography methodologies. The model is dynamic, with forecasts and simulations generated on an annual basis and behavioral responses to wage, price, and other economic factors.

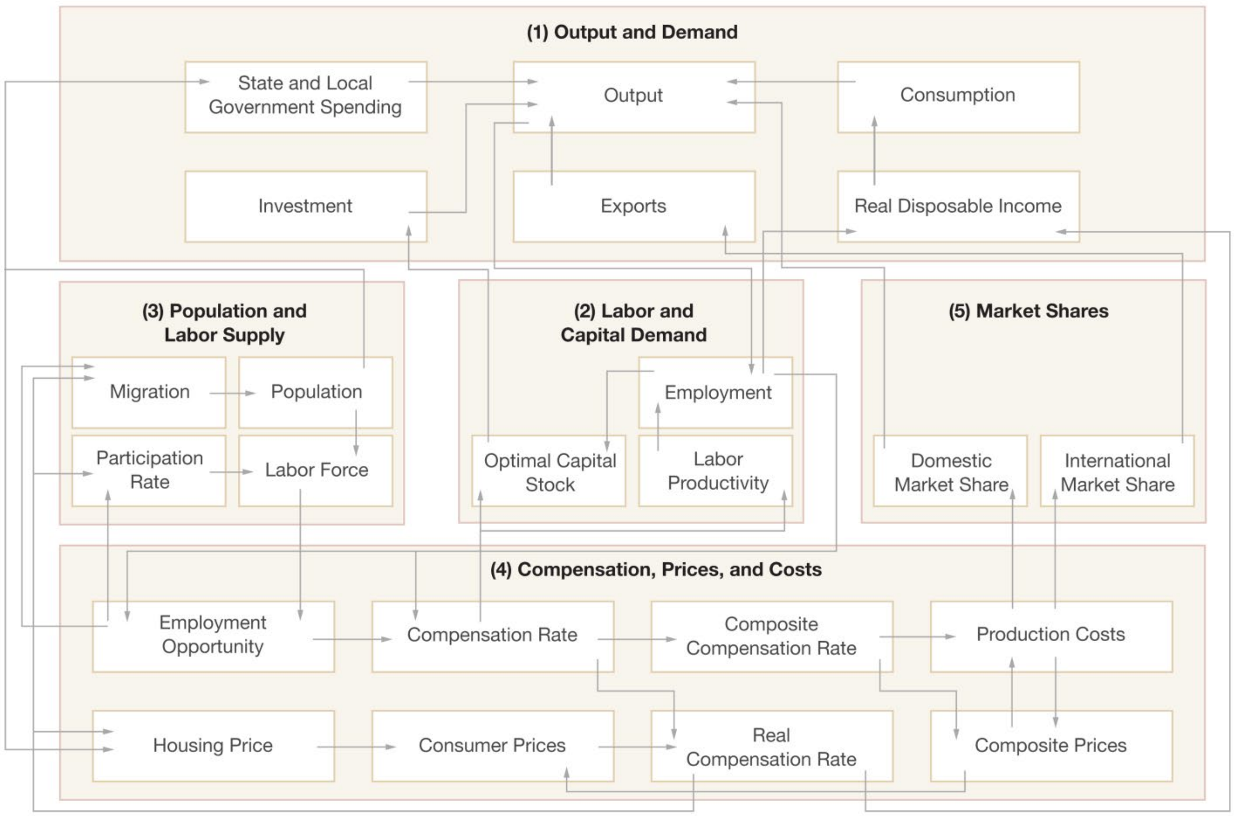
The REMI model consists of thousands of simultaneous equations with a structure that is relatively straightforward. The exact number of equations used varies depending on the extent of industry, demographic, demand, and other detail in the model. The overall structure of the model can be summarized in five major blocks: (1) Output and Demand, (2) Labor and Capital Demand, (3) Population and Labor Supply, (4) Compensation, Prices, and Costs, and (5) Market Shares. The blocks and their key interactions are shown in Figures C1 and C2.

The Output and Demand block includes output, demand, consumption, investment, government spending, import, product access, and export concepts. Output for each industry is determined by industry demand in a given region and its trade with the US market, and international imports and exports. For each industry, demand is determined by the amount of output, consumption, investment, and capital demand on that industry. Consumption depends on real disposable income per capita, relative prices, differential income elasticities and population. Input productivity depends on access to inputs because the larger the choice set of inputs, the more likely that the input with the specific characteristics required for the job will be formed. In the capital stock adjustment process, investment occurs to fill the difference between optimal and actual capital stock for residential, non-residential, and equipment investment. Government spending changes are determined by changes in the population.

The Labor and Capital Demand block includes the determination of labor productivity, labor intensity and the optimal capital stocks. Industry-specific labor productivity depends on the availability of workers with differentiated skills for the occupations used in each industry. The occupational labor supply and commuting costs determine firms' access to a specialized labor force.

Labor intensity is determined by the cost of labor relative to the other factor inputs, capital and fuel. Demand for capital is driven by the optimal capital stock equation for both non-residential capital and equipment. Optimal capital stock for each industry depends on the relative cost of labor and capital, and the employment weighted by capital use for each industry. Employment in private industries is determined by the value added and employment per unit of value added in each industry.

The Population and Labor Supply block includes detailed demographic information about the region. Population data is given for age and gender, with birth and survival rates for each group. The size and labor force participation rate of each group determines the labor supply. These participation rates respond to changes in employment relative to the potential labor force and to changes in the real after tax compensation rate. Migration includes retirement, military, international and economic migration. Economic migration is determined by the relative real after tax compensation rate, relative employment opportunity and consumer access to variety.



Source: REMI (2023).

Figure C1. REMI Model Linkages (Excluding Economic Geography Linkages)

The Compensation, Prices, and Costs block includes delivered prices, production costs, equipment cost, the consumption deflator, consumer prices, the price of housing, and the wage equation. Economic geography concepts account for the productivity and price effects of access to specialized labor, goods and services.

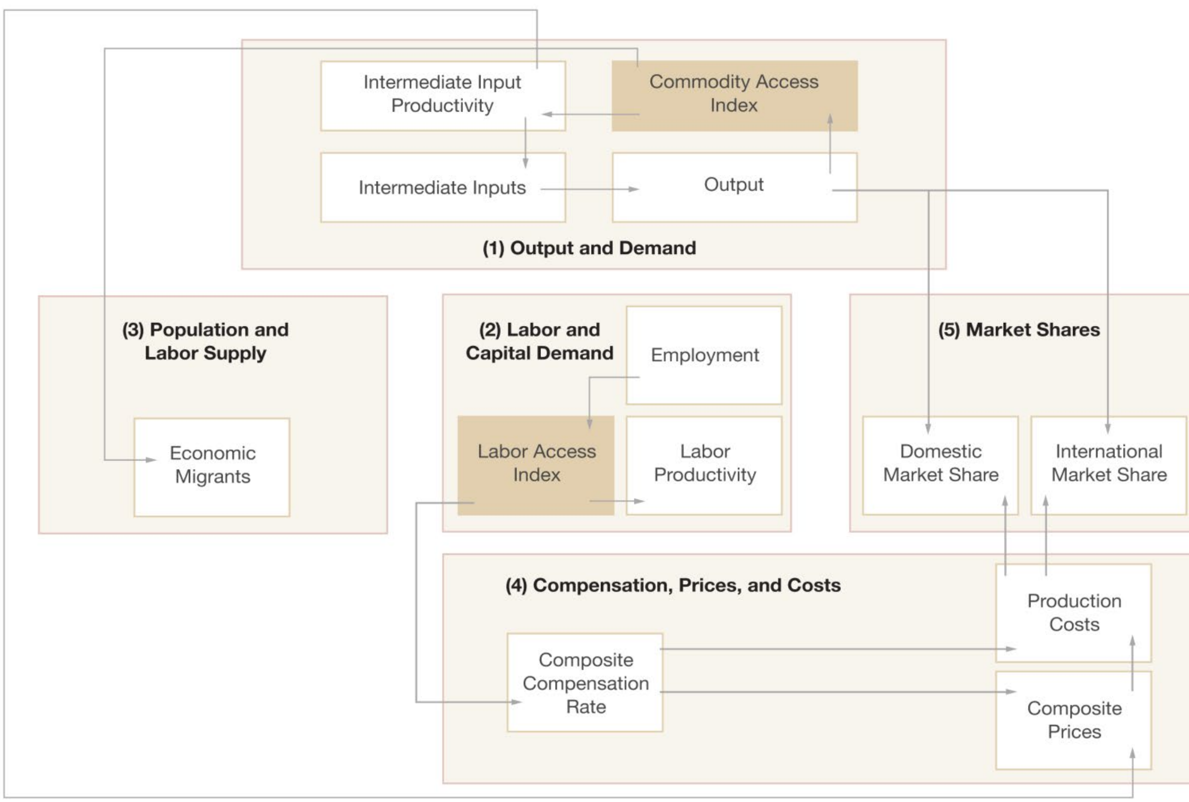
These prices measure the value of the industry output, taking into account the access to production locations. This access is important due to the specialization of production that takes place within each industry, and because transportation and transaction costs associated with distance are significant. Composite prices for each industry are then calculated based on the production costs of supplying regions, the effective distance to these regions, and the index of access to the variety of output in the industry relative to the access by other uses of the product.

The cost of production for each industry is determined by cost of labor, capital, fuel and intermediate inputs. Labor costs reflect a productivity adjustment to account for access to specialized labor, as well as underlying compensation rates. Capital costs include costs of non-residential structures and equipment, while fuel costs incorporate electricity, natural gas and residual fuels.

The consumption deflator converts industry prices to prices for consumption commodities. For potential migrants, the consumer price is additionally calculated to include housing prices. Housing price changes from their initial level depend on changes in income and population density. Regional employee compensation changes are due to changes in labor demand and supply conditions, and changes in the national compensation rate. Changes in employment opportunities relative to the labor force and occupational demand change determine compensation rates by industry.

The Market Shares equations measure the proportion of local and export markets that are captured by each industry. These depend on relative production costs, the estimated price elasticity of demand, and effective distance between the home region and each of the other regions. The change in share of a specific area in any region depends on changes in its delivered price and the quantity it produces compared with the same factors for competitors in that market. The share of local and external markets then drives the exports from and imports to the home economy.

As shown in Figure C2, the Labor and Capital Demand block includes labor intensity and productivity, as well as demand for labor and capital. Labor force participation rate and migration equations are in the Population and Labor Supply block. The Compensation, Prices, and Costs block includes composite prices, determinants of production costs, the consumption price deflator, housing prices, and the wage equations. The proportion of local, interregional and international markets captured by each region is included in the Market Shares block.



Source: REMI (2023).

Figure C2. Economic Geography Linkages

Appendix D. Truck Parking Expansion and New Construction Investment Cost by Caltrans District

Table D1. Cost Estimation of Truck Parking Expansion Investment

	Description	Unit	Unit Cost in 2025	District 2	District 3	District 4	District 5	District 6
Development Cost	Clear Grub - Level	Acre	$23,569	$325,724	$1,995,708	$413,771	$398,317	$343,872
	Low Voltage Conduit	LF	$133	$460,595	$2,822,063	$585,100	$563,246	$486,258
	Substation for 2 to 8 MVA	LS	$273,182	$136,591	$682,954	$136,591	$136,591	$136,591
	HM Pole .5M Lumens	LS	$36,677	$331,500	$2,031,100	$421,109	$405,380	$349,970
	AC Pavement for Container	Acre	$149,135	$1,854,946	$11,365,235	$2,356,360	$2,268,349	$1,958,297
	Manned Booth Lane (2-6)	LS	$208,806	$104,403	$522,015	$104,403	$104,403	$104,403
	Chain Link Boundary Fence	LF	$34	$106,522	$652,659	$135,316	$130,262	$112,457
	Green Space	Acre	$154,045	$74,512	$456,532	$94,653	$91,118	$78,663
	Walkway	LF	$1.1	$0	$0	$0	$0	$0
	Water Closet	SF	$385	$0	$0	$0	$0	$0
	Parking Striping	LF/Acre	$0.7	$4,530	$27,758	$5,755	$5,540	$4,783
	Freeway Ramp Access	2 lane	$202,942	$0	$0	$0	$0	$0
Base Development Cost		$		$3,399,323	$20,556,023	$4,253,058	$4,103,206	$3,575,294
Soft Cost (35% of Base Construction Cost)		$		$1,189,763	$7,194,608	$1,488,570	$1,436,122	$1,251,353
20% Contingency/Escalation Cost		$		$917,817	$5,550,126	$1,148,326	$1,107,866	$965,329
Total Construction Cost		**$**		**$5,506,904**	**$33,300,757**	**$6,889,955**	**$6,647,194**	**$5,791,976**
Land Cost	Land Acquisition Cost	$ / Acre	$11,911	$164,606	$1,008,541	$209,101	$201,291	$173,777
Total Cost (Land + Construction)				**$5,671,510**	**$34,309,298**	**$7,099,056**	**$6,848,485**	**$5,965,754**
Area required		Acres		13.82	17.56	16.90	14.59	14.59
Cost / Acre		$ / Acre		$410,384	$405,188	$404,373	$405,236	$408,893
Total truck Slots (Based on projected demand shortage for 2035)		#		90	551	114	110	95
Cost / Slot		$ / Slot		$63,017	$62,239	$62,117	$62,259	$62,797
Total Expanded or New Truck Parks				1	5	1	1	1
Annual O&M Cost / Slot			2.67%	$1,683	$1,662	$1,659	$1,662	$1,677

Total Annual O&M Cost			**$151,429**	**$916,058**	**$189,545**	**$182,855**	**$159,286**

Table D1. Cost Estimation of Truck Parking Expansion Investment (cont'd)

	Description	Unit	Unit Cost in 2025	District 7	District 8	District 9	District 10	District 12
Development Cost	Clear Grub - Level	Acre	$23,569	$0	$4,746,802	$438,148	$895,466	$0
	Low Voltage Conduit	LF	$133	$0	$6,712,294	$619,571	$1,266,248	$0
	Substation for 2 to 8 MVA	LS	$273,182	$0	$1,092,727	$136,591	$273,182	$0
	HM Pole .5M Lumens	LS	$36,677	$0	$4,830,983	$445,918	$911,346	$0
	AC Pavement for Container	Acre	$149,135	$0	$27,032,279	$2,495,184	$5,099,535	$0
	Manned Booth Lane (2-6)	LS	$208,806	$0	$835,224	$104,403	$208,806	$0
	Chain Link Boundary Fence	LF	$34	$0	$1,552,353	$143,288	$292,845	$0
	Green Space	Acre	$154,045	$0	$1,085,863	$100,229	$204,844	$0
	Walkway	LF	$1.1	$0	$0	$0	$0	$0
	Water Closet	SF	$385	$0	$0	$0	$0	$0
	Parking Striping	LF/Acre	$0.7	$0	$66,023	$6,094	$12,455	$0
	Freeway Ramp Access	2 lane	$202,942	$0	$0	$0	$0	$0
Base Development Cost		$		$0	$47,954,549	$4,489,427	$9,164,728	$0
Soft Cost (35% of Base Construction Cost)		$		$0	$16,784,092	$1,571,299	$3,207,655	$0
20% Contingency/Escalation Cost		$		$0	$12,947,728	$1,212,145	$2,474,477	$0
Total Construction Cost		**$**		**$0**	**$77,686,369**	**$7,272,872**	**$14,846,859**	**$0**
Land Cost	Land Acquisition Cost	$ / Acre	$11,911	$0	$2,398,820	$221,420	$452,528	$0
Total Cost (Land + Construction)				**$0**	**$80,085,189**	**$7,494,292**	**$15,299,387**	**$0**
Area required		Acres		0.00	201.40	18.59	37.99	0.00
Cost / Acre		$ / Acre		$0	$397,642	$403,136	$402,686	$0
Total truck Slots (Based on projected demand shortage for 2035)		#		0	1,311	121	247	0
Cost / Slot		$ / Slot		$0	$61,082	$61,936	$61,857	$0
Total Expanded or New Truck Parks				0	8	1	2	0
Annual O&M Cost / Slot			2.67%	$0	$1,631	$1,654	$1,652	$0
Total Annual O&M Cost				**$0**	**$2,138,275**	**$200,098**	**$408,494**	**$0**

Table D2. Cost Estimation of Investment in New Truck Parking

	Description	Unit	Unit Cost in 2030	District 2	District 3	District 4	District 5	District 6
Development Cost	Clear Grub - Level	Acre	$27,323	$0	$1,388,143	$2,878,045	$0	$0
	Low Voltage Conduit	LF	$155	$0	$1,962,927	$4,069,747	$0	$0
	Substation for 2 to 8 MVA	LS	$316,693	$0	$1,900,155	$3,800,310	$0	$0
	HM Pole .5M Lumens	LS	$42,519	$0	$1,412,761	$2,929,085	$0	$0
	AC Pavement for Container	Acre	$172,889	$0	$7,905,253	$16,390,005	$0	$0
	Manned Booth Lane (2-6)	LS	$242,063	$0	$1,452,380	$2,904,760	$0	$0
	Chain Link Boundary Fence	LF	$39	$0	$453,966	$941,211	$0	$0
	Green Space	Acre	$178,580	$0	$635,094	$1,316,745	$0	$0
	Walkway	LF	$1.3	$0	$17,940	$37,195	$0	$0
	Water Closet	SF	$446	$0	$1,252,092	$2,595,970	$0	$0
	Parking Striping	LF/Acre	$0.8	$0	$19,307	$40,030	$0	$0
	Freeway Ramp Access	2 lane	$235,266	$0	$705,797	$1,411,595	$0	$0
Base Development Cost		$		$0	$19,105,817	$39,314,697	$0	$0
Soft Cost (35% of Base Construction Cost)		$		$0	$6,687,036	$13,760,144	$0	$0
20% Contingency/Escalation Cost		$		$0	$5,158,570	$10,614,968	$0	$0
Total Construction Cost		**$**		**$0**	**$30,951,423**	**$63,689,808**	**$0**	**$0**
Land Cost	Land Acquisition Cost	$ / Acre	$13,808	$0	$701,505	$1,454,434	$0	$0
Total Cost (Land + Construction)				**$0**	**$31,652,928**	**$65,144,242**	**$0**	**$0**
Area required		Acres		0.00	50.81	105.33	0.00	0.00
Cost / Acre		$ / Acre		$0	$623,028	$618,452	$0	$0
Total truck Slots (Based on projected demand shortage for 2035)		#		0	331	686	0	0
Cost / Slot		$ / Slot		$0	$95,700	$95,002	$0	$0
Total Expanded or New Truck Parks				0	3	6	0	0
Annual O&M Cost / Slot			2.67%	$0	$2,555	$2,537	$0	$0
Total Annual O&M Cost				**$0**	**$845,133**	**$1,739,351**	**$0**	**$0**

Table D2. Cost Estimation of Investment in New Truck Parking (cont'd)

	Description	Unit	Unit Cost in 2030	District 7	District 8	District 9	District 10	District 12
Development Cost	Clear Grub - Level	Acre	$27,323	$4,914,855	$6,878,556	$0	$2,076,181	$642,090
	Low Voltage Conduit	LF	$155	$6,949,931	$9,726,736	$0	$2,935,858	$907,957
	Substation for 2 to 8 MVA	LS	$316,693	$6,333,850	$6,333,850	$0	$2,533,540	$1,266,770
	HM Pole .5M Lumens	LS	$42,519	$5,002,016	$7,000,542	$0	$2,113,000	$653,477
	AC Pavement for Container	Acre	$172,889	$27,989,310	$39,172,275	$0	$11,823,518	$3,656,598
	Manned Booth Lane (2-6)	LS	$242,063	$4,841,266	$4,841,266	$0	$1,936,506	$968,253
	Chain Link Boundary Fence	LF	$39	$1,607,312	$2,249,504	$0	$678,976	$209,983
	Green Space	Acre	$178,580	$2,248,613	$3,147,033	$0	$949,881	$293,765
	Walkway	LF	$1.3	$63,518	$88,896	$0	$26,832	$8,298
	Water Closet	SF	$446	$4,433,154	$6,204,395	$0	$1,872,696	$579,159
	Parking Striping	LF/Acre	$0.8	$68,360	$95,673	$0	$28,877	$8,931
	Freeway Ramp Access	2 lane	$235,266	$2,352,658	$2,352,658	$0	$941,063	$470,532
Base Development Cost		$		$66,804,843	$88,091,384	$0	$27,916,930	$9,665,812
Soft Cost (35% of Base Construction Cost)		$		$23,381,695	$30,831,984	$0	$9,770,925	$3,383,034
20% Contingency/Escalation Cost		$		$18,037,308	$23,784,674	$0	$7,537,571	$2,609,769
Total Construction Cost		**$**		**$108,223,846**	**$142,708,042**	**$0**	**$45,225,426**	**$15,658,616**
Land Cost	Land Acquisition Cost	$ / Acre	$13,808	$2,483,746	$3,476,112	$0	$1,049,208	$324,483
Total Cost (Land + Construction)				$110,707,592	$146,184,154	$0	$46,274,634	$15,983,099
Area required		Acres		179.88	251.75	0.00	75.99	23.50
Cost / Acre		$ / Acre		$615,452	$580,672	$0	$608,984	$680,132
Total truck Slots (Based on projected demand shortage for 2035)		#		1,171	1,639	0	495	153
Cost / Slot		$ / Slot		$94,541	$89,197	$0	$93,547	$104,465
Total Expanded or New Truck Parks				10	10	0	4	2
Annual O&M Cost / Slot			2.67%	$2,524	$2,382	$0	$2,498	$2,789
Total Annual O&M Cost				$2,955,893	$3,903,117	$0	$1,235,533	$426,749

Pacific Southwest Region UTC
University Transportation Center

Appendix E. Parking-Related Crashes and Victims Calculation

Table E-1 Predicted parking crashes and victims by year, baseline (no build)

Year	Parking Shortage	Predicted crashes	Predicted victims					
			Death	Incapacitating injury	Non-incapacitating injury	Possible injury	No injury	**Total (by year)**
2025	4,698	307	22	53	152	194	55	**475**
2026	4,908	320	23	55	159	202	57	**497**
2027	5,119	334	24	58	166	211	59	**518**
2028	5,334	348	25	60	173	220	62	**540**
2029	5,551	362	26	63	180	229	64	**562**
2030	5,772	377	27	65	187	238	67	**584**
2031	6,013	392	28	68	195	248	70	**608**
2032	6,258	408	29	71	203	258	73	**633**
2033	6,507	425	31	73	211	268	76	**658**
2034	6,807	444	32	77	220	280	79	**689**
2035	7,114	464	33	80	230	293	83	**720**
Total (by category)		**4,182**	**301**	**722**	**2,075**	**2,640**	**744**	**6,483**

Table E-2 Avoided predicted crashes and victims by year, mitigation

Year	Avoided parking space shortage	Avoided crashes	Avoided victims					
			Death	Incapacitating injury	Non-incapacitating injury	Possible injury	No injury	**Total (by year)**
2025	4,698	34	2	6	17	22	6	**53**
2026	4,908	69	5	12	34	44	12	**107**
2027	5,119	103	7	18	51	65	18	**159**
2028	5,334	138	10	24	68	87	25	**214**
2029	5,551	172	12	30	85	109	31	**267**
2030	5,772	221	16	38	110	140	39	**343**
2031	6,013	270	19	47	134	170	48	**418**
2032	6,258	318	23	55	158	201	57	**494**
2033	6,507	367	26	63	182	232	65	**568**
2034	6,807	416	30	72	206	262	74	**644**
2035	7,114	464	33	80	230	293	83	**719**
Total (by category)		**2,573**	**183**	**445**	**1,275**	**1,625**	**458**	**3,986**