

Managed Lanes Implementation Plan

Moving More People in Buses and Carpools
Through HOV Operational Strategies



METROPOLITAN
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Introduction

Bay Area Managed Lanes Network

The San Francisco Bay Area has an extensive existing system of managed lanes, with the majority being High Occupancy Vehicle (HOV) Lanes. As of November 2017, the Bay Area Managed Lanes Network is comprised of over 494 lane-miles of non-tolled HOV and priced Express (Toll) Lanes, which includes 12 HOV lane-miles on bridge approaches and 72 lane-miles of Express Lanes. Bay Area transportation agencies are developing a 550-mile network of Express Lanes that will be completed in 2035. Express Lanes already are open on I-580 in Dublin, Pleasanton, and Livermore; I-680 southbound from Sunol to Milpitas; I-680 in both directions between Alamo and San Ramon; and on SR 237 between Milpitas and San Jose.

Background

The Bay Area is experiencing significant population and employment growth. Rising housing costs are forcing people to commute longer distances to access quality jobs. Many long trips are not well served by transit and access to transit is difficult or services are crowded, so many choose to drive. The result is a transportation network that is stressed beyond capacity. Building new highway capacity is a long, complex, costly process and is in many cases undesirable from an environmental standpoint.

The focus for transportation investment in the highway network is now on how to best make use of the capacity available today. Managed lanes, consisting of both HOV lanes and Express Lanes, have proven to be an effective means to increase the throughput of persons on our highway network. However, as pointed out in the recent Caltrans High Occupancy Vehicle Lane Degradation Determination Report, in the second half of 2016, over half (65%) of the approximately 390 HOV lane miles in the Bay Area were reported to be “Degraded,”

How Managed Lanes Work

- HOV lanes requiring a minimum of two persons per vehicle are described as HOV2+, HOV3+ lanes require a minimum of three persons per vehicle.
- Federal law mandates that the operation of HOV and Express Lanes be monitored to ensure a minimum average speed of 45 mph at least 90% of the time during peak hours over a 180-day period, and changes be made to operating policies when the lanes are degraded.

operating below 45 mph on average during at least 10% of the peak hours.

Of these, 201 miles of HOV lanes were considered either Very Degraded (degradation occurs 50% or more of the time) or Extremely Degraded (degradation occurs 75% or more of the time). Moreover, degradation has worsened: both the extent and severity of degradation have been

Key Elements of the MLIP

- Stakeholder Participation
- Public Outreach/Education
- Data Collection/Analysis
- Management
- Policy Guidance
 - Hours of Operation
 - Occupancy
 - Enforcement
 - Access
 - Exempt Vehicles
- Near Term Improvements
 - System Expansion/Gap Closure Planning
 - Hours of Operation Changes
 - Transit Services/Access
 - Park-Ride Availability and Access
 - Enforcement Technology Pilots

increasing annually. Between 2013 and 2016 the total number of degraded miles has increased by 64 miles (34%) and the number of Very Degraded miles has increased by over 130 miles (225%).

The Purpose of the Managed Lanes Implementation Plan (MLIP)

The Metropolitan Transportation Commission (MTC), in partnership with Caltrans and the California Highway Patrol (CHP), embarked on the Bay Area Managed Lanes Implementation Plan in order to address current problems of degradation on the HOV lane system, review the current practices and policies which govern managed lanes imple-

mentation and operation, and plan for the future expansion of the managed lane network in the nine Bay Area counties. A key aspect of the plan was to recognize the important role that transit and park-ride facilities play in increasing the utilization and effectiveness of managed lanes. The plan addresses policy issues related to the operation of the managed lane network.

Current challenges faced by the existing managed lane system include discontinuity and gaps, as well as inconsistent operating policies that are potentially confusing to the public. There is also a need for guidance as to the appropriate policies and practices to be used throughout the Bay Area for managed lane hours of operation, vehicle occupancy rules, enforcement, access, and exempt vehicles such as Clean Air Vehicles (CAVs). In order to accomplish this, MTC engaged Caltrans, the CHP, each of the county congestion management agencies, and the transit operators using managed lanes in developing the MLIP plan. There was outreach to the public in the form of focus groups and surveys, along with outreach to non-governmental organizations representing the interests of major employers and the traveling public.

During the course of the project it was determined that there was a substantial shortfall in the coverage of the data available to measure managed lane performance, and as a result, the development of the plan included a major regional data collection effort. This has allowed a “data-driven” approach to be adopted for MLIP, crafting findings and recommendations in response to the results of the extensive regional data gathering and evaluation effort.

Table 1 - Managed Lanes Implementation Goals

Degradation (Reliability)	Consistency	Person Throughput (Efficiency)
<p>Causes and Tools</p> <ul style="list-style-type: none"> • Violations and Enforcement • Clean Air Vehicles • Occupancy Policy • Access Restrictions <p>Cover Entire Peak</p> <ul style="list-style-type: none"> • Hours of Operation Policy 	<ul style="list-style-type: none"> • Segments Forming a Network • Policy (When Possible and Appropriate) • Education and Public Outreach • Regional/Local Management and Coordination 	<p>Non-Highway Improvements</p> <ul style="list-style-type: none"> • Improve Access to HOV Options • Park-Rides • Improve Attractiveness of HOV Options • Transit Signal Priority (TSP) on Arterials Connecting to Managed Lanes <p>Encourage All HOV Options</p> <ul style="list-style-type: none"> • Transit • Carpool • Vanpool <p>Network Gap Closures (Connectivity)</p>
Ongoing Activities		
<ul style="list-style-type: none"> • Data Collection • Public Education 		

MLIP Goals

The vision of the MLIP is the creation of an integrated network of:

Managed Lanes – a continuous and connected network of Express Lanes and HOV lanes in all the major travel corridors in the Bay Area including a consistent approach to the setting of hours of operation, occupancy requirements, access controls, the application of enforcement, and the use of the facilities by exempt vehicles such as CAVs.

Transit – an enhanced system of regional and sub-regional express bus service on the managed lanes network (both public and private) including existing services currently provided by the transit operators and new inter-regional express bus service connecting origins and destinations not well served by transit today.

Park-Ride – an expanded system of well-located and managed park-ride facilities to support the use of express bus service and the formation of carpools.

This vision evolved from the consideration of the MLIP goals and objectives with the agency stakeholders and the general public. Specific project goals were also identified as part of this collaborative process:

Degradation (Reliability) – The original motivation for MLIP was to find ways to address the issue of managed lane degradation. With over 65% of the region’s managed lanes being classified as degraded, there is a need to identify the specific causes of degradation and apply the appropriate strategies to address the problems. It is clear from the degradation reports that HOV lanes are

not reliable in terms of delivering consistent time savings. Single Occupant Vehicles (SOVs) using managed lanes in violation of the occupancy rules were found to be a significant problem. These “cheaters” are a major public concern. CAVs also take up capacity that could be used by HOVs and transit vehicles.

Consistency – With 500 miles of managed lanes already operating or in various stages of implementation, it is clear that the system is moving beyond a group of independent highway segments with HOV or Express Lanes to a network with miles of continuous managed lanes. Input from stakeholders and the public makes it clear that there needs to be more consistency in how managed lanes are operated. This involves looking at how and when policies such as vehicle occupancy requirements, hours of operation, enforcement practices, and access management should be consistent.

Person Throughput (Efficiency) – In order to improve the efficiency of the managed lanes network, it is essential to focus on increasing the number of persons (rather than vehicles) using the managed lanes. This is where the integration of managed lanes with transit and park-ride opportunities becomes important. The private sector is also stepping up, providing new types of transit and ride-sharing options.

During the course of the development of the MLIP, it became clear that there is a need for continuing efforts to help fulfill the goals defined in the plan. These include:

Data Collection – A need to continue the types of data collection conducted during the MLIP process to allow for effective monitoring of the managed lanes network’s performance and allow for data driven decisions as to how to best address performance issues and enhance operations.

Public Education – While the public is generally informed about the nature and purpose of HOV lanes, outreach efforts found that there is a basic lack of understanding of the purpose of Express Lanes. There are misconceptions that tend to result in a lack of public support for Express Lanes. This engenders the need for a more comprehensive and focused program of public education regarding Express Lanes – their purpose, function, and use.

The MLIP vision is that of a regional highway system that serves as a multimodal network, embodying:

- A seamless, well managed network of HOV and Express Lanes
 - Clear, consistent messaging and operational practices to enhance public understanding
 - Emphasis on person throughput while minimizing impacts to the general purpose lanes
- Off-highway improvements to make HOV/transit use as easy and accessible as possible
 - TSP on arterials
 - Park-rides
 - Shared mobility hubs for carpool formation
 - First mile/last mile connections to hubs
- Recommended projects, operational improvements, and policy changes needed to complement the existing network as well as new projects being planned/delivered by other agencies
 - Gap closures in congested areas currently lacking managed lanes
 - Off-highway projects to enhance throughput
- Policy changes
 - Make more efficient use of managed lane facilities
 - Enable HOVs and transit to take full advantage of managed lane time savings (violations, occupancy, hours of operation, exempt vehicles)

- Regional consistency
 - Connect the individual county's projects into a seamless, consistent network easily understood by the public
- Best practices going forward
 - Ongoing data collection and monitoring
 - Proactive rather than reactive policy adjustments on a corridor and regional basis

In order to achieve these goals and objectives, MLIP provides the following resources:

Documentation of Existing Conditions – MLIP provides a wealth of data regarding the current operations of managed lanes and managed lane corridors in the Bay Area. The existing managed lane network is identified and currently planned expansions to this network are documented. This includes information about travel speeds, vehicle occupancy, the extent of traffic congestion, transit services and ridership, park-ride locations and usage, managed lane occupancy rule violations, and use of managed lanes by CAVs.

Public Viewpoint – The results of focus groups and telephone surveys provide insight into the public's view of managed lanes in terms of their current level of knowledge and understanding, as well as their opinions relative to key questions such as occupancy rules, enforcement/violations, hours of operation, and CAVs.

Near Term Improvements – MLIP has resulted in the identification of near term improvements as related to:

- **System Expansion/Gap Closure** – Projects proposed by the county congestion management agencies to add new HOV or Express Lanes and close existing gaps in the network.
- **Transit Services/Access** – Improvements to existing express bus service and potential new inter-regional express bus routes.
- **Park-Ride Availability and Access** – Expanded park-ride capacity and measures to more effectively manage park-ride resources.

Guidance on Policies – Research was conducted as part of the MLIP to document current policies and practices relative to managed lanes operations throughout the country as well as specifically in California and the Bay Area. Also, input from stakeholders and the public has helped to provide some guidance on how the following policy issues should be addressed:

- **Hours of Operation** – How should hours of operation for HOV lanes and Express Lanes be set?
- **Occupancy** – Under what conditions should the occupancy rules for managed lanes be changed from HOV2+ to HOV3+?
- **Enforcement** – What can be done to address high levels of observed violations of managed lanes or vehicle occupancy rules?
- **Access** – When should access to HOV or Express Lanes be physically restricted with double painted lines or barriers?
- **Exempt Vehicles** – Given the dramatic increase in the sale of CAVs, what should the policy be for managing their use of managed lanes going forward? How should other exempt vehicles such as two-seater cars, trucks and motorcycles be treated?

Existing Conditions and Network Expansion



Existing Conditions and Network Expansion

Existing Conditions

This chapter documents the existing status, conditions, and performance of the managed lane network in the San Francisco Bay Area. It includes an overview of the existing managed lanes network in terms of the current location of HOV lanes and Express Lanes, and provides a summary of all the currently planned managed lanes projects and their status. The performance of the managed lane network is addressed in this section in terms of the goals and objectives identified for MLIP. In summary, while degradation is a major issue with the managed lane network in the Bay Area, the managed lanes still deliver significant benefits in terms of increased person throughput, higher speeds, and travel time savings as compared to the general purpose (GP) lanes. These benefits could be substantially greater if the issues causing degradation could be effectively addressed.

Existing Bay Area Managed Lanes Network

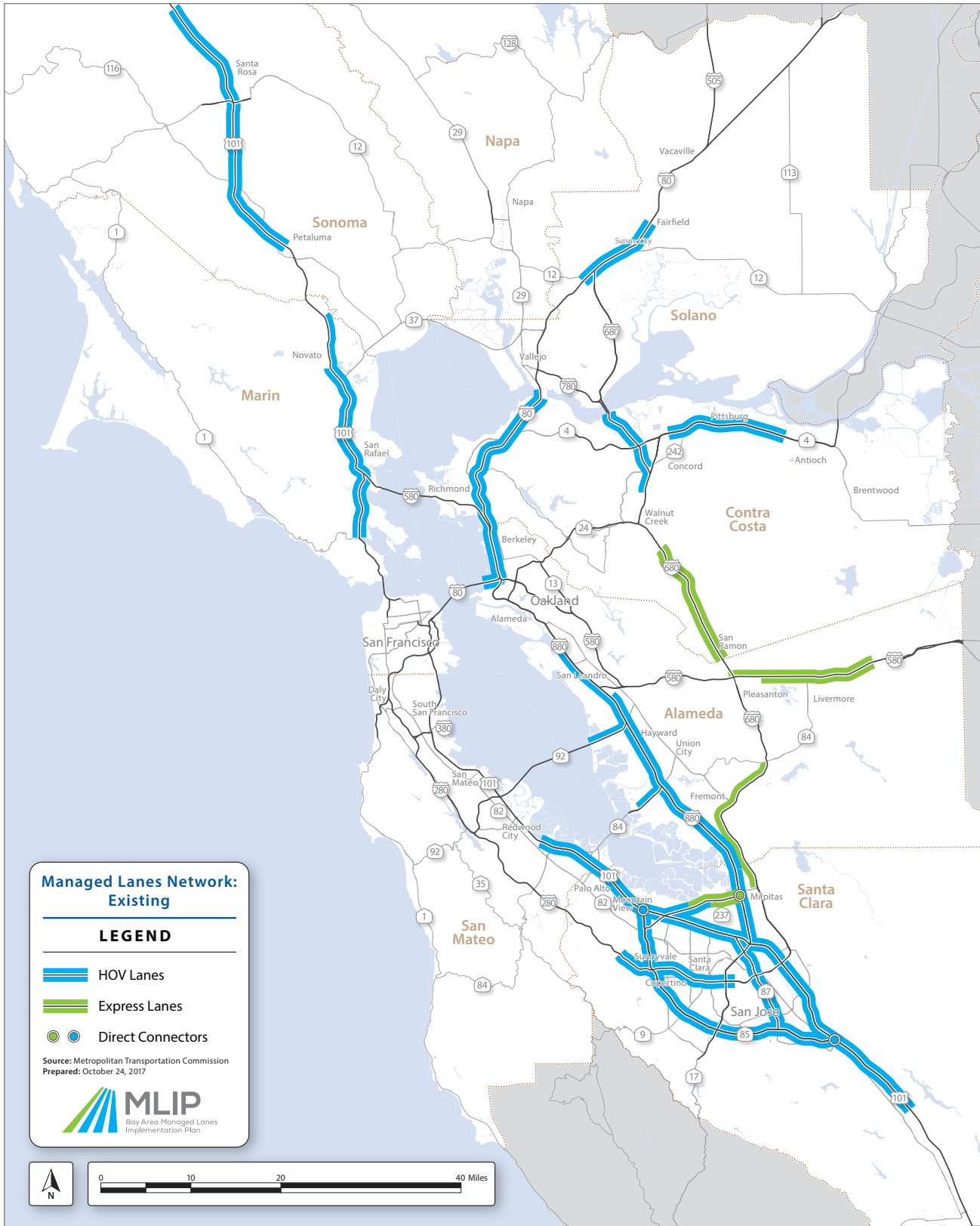
The Bay Area currently has an extensive system of managed lanes, comprised of over 494 lane-miles of non-tolled HOV and tolled Express Lanes, which includes approximately 12 HOV lane-miles on area bridge approaches and approximately 72 lane-miles of Express Lanes. The full network is depicted in [Figure 1 - Existing Managed Lanes Network](#). Today, the best developed portion of the managed lane network is in the South Bay, including Santa Clara County and the southern portions of San Mateo and Alameda Counties. In the remainder of the Bay Area, the managed lane networks tend to be discontinuous, with significant gaps between sections.

Today, the vast majority of the Bay Area's managed lane system is comprised of HOV lanes, but there are many planned Express Lane projects. Currently, there are four active Express Lane segments:

- I-680 Southbound from Pleasanton to Milpitas
- I-680 between Walnut Creek and San Ramon
- SR 237 between Milpitas and San Jose
- I-580 between Livermore and Dublin/Pleasanton

In Santa Clara County, there are three direct highway-to-highway managed lane interchange connectors (direct connectors) that allow motorists using the managed lanes on one highway to directly connect to managed lanes on the other highway. The SR 237 Express Lanes use the direct connector between I-880 and SR 237, and the two other HOV direct connectors link SR 85 and US 101 in Mountain View and South San Jose.

Figure 1 - Existing Managed Lanes Network



Bay Area HOV Degradation

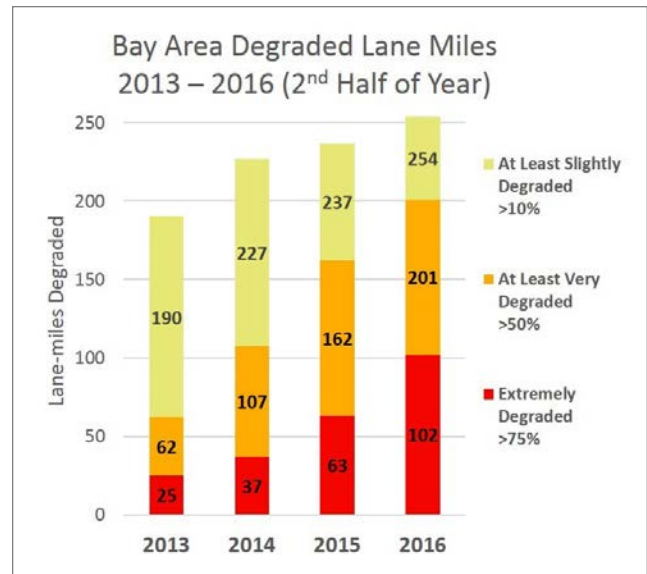
Federal law mandates that the operation of HOV and Express Lanes be monitored to ensure a minimum average speed of 45 mph at least 90% of the time during the peak hour measured over a 180-day period, and that actions be taken to improve operations when the lanes are degraded. These actions can be both physical modifications to the highway as well as operational changes. These standards apply to HOV lanes that allow SOVs, which is the case in California where CAV's are allowed to use managed lanes.

In 2016, speed data was available for 390 miles of the 477 mile Bay Area HOV lane network. 65% of the approximately 390 HOV lane miles (where data was available) were reported by Caltrans per the Federal Highway Administration (FHWA) standards to be "Degraded" in the second half of 2016, operating below 45 mph on average during at least 10% of the peak period hours.

Of these, 201 miles of HOV lanes were considered by Caltrans as either Very Degraded (degradation occurs 50% or more of the time) or Extremely Degraded (degradation occurs 75% or more of the time) as shown in [Figure 2 - Increase in HOV Lane Degradation](#) and [Figure 4 - Bay Area HOV Degradation Summary - Second Half of 2016](#). Moreover, degradation has gotten worse: both the rate and severity of degradation have been increasing annually. Between 2013 and 2016 the total number of degraded miles has increased by 64 miles (34%) and the number of Very Degraded and Extremely Degraded miles increased by over 130 miles (225%).¹

¹ These categories of degradation were defined by Caltrans and are not an FHWA standard.

Figure 2 - Increase in HOV Lane Degradation



Source: Caltrans 2013–2016 HOV Lane Degradation Reports

Every year, Caltrans publishes the California High-Occupancy Vehicle Lane Degradation Action Plan which identifies strategies for addressing degraded HOV lanes. For the Bay Area, Caltrans has largely identified planned projects for different segments, including infrastructure improvements, active traffic management strategies such as ramp metering, and Express Lane conversions on several segments. While these are important projects to address degradation, many of these projects will take years to get funding and be implemented. Much can also be done now to address degradation by operating the existing managed lanes more effectively, which can include operational changes such as access controls and changes in operational policies in terms of which vehicles are eligible to use the lanes.

Figure 3 - Bay Area HOV Degradation Summary – Second Half of 2013

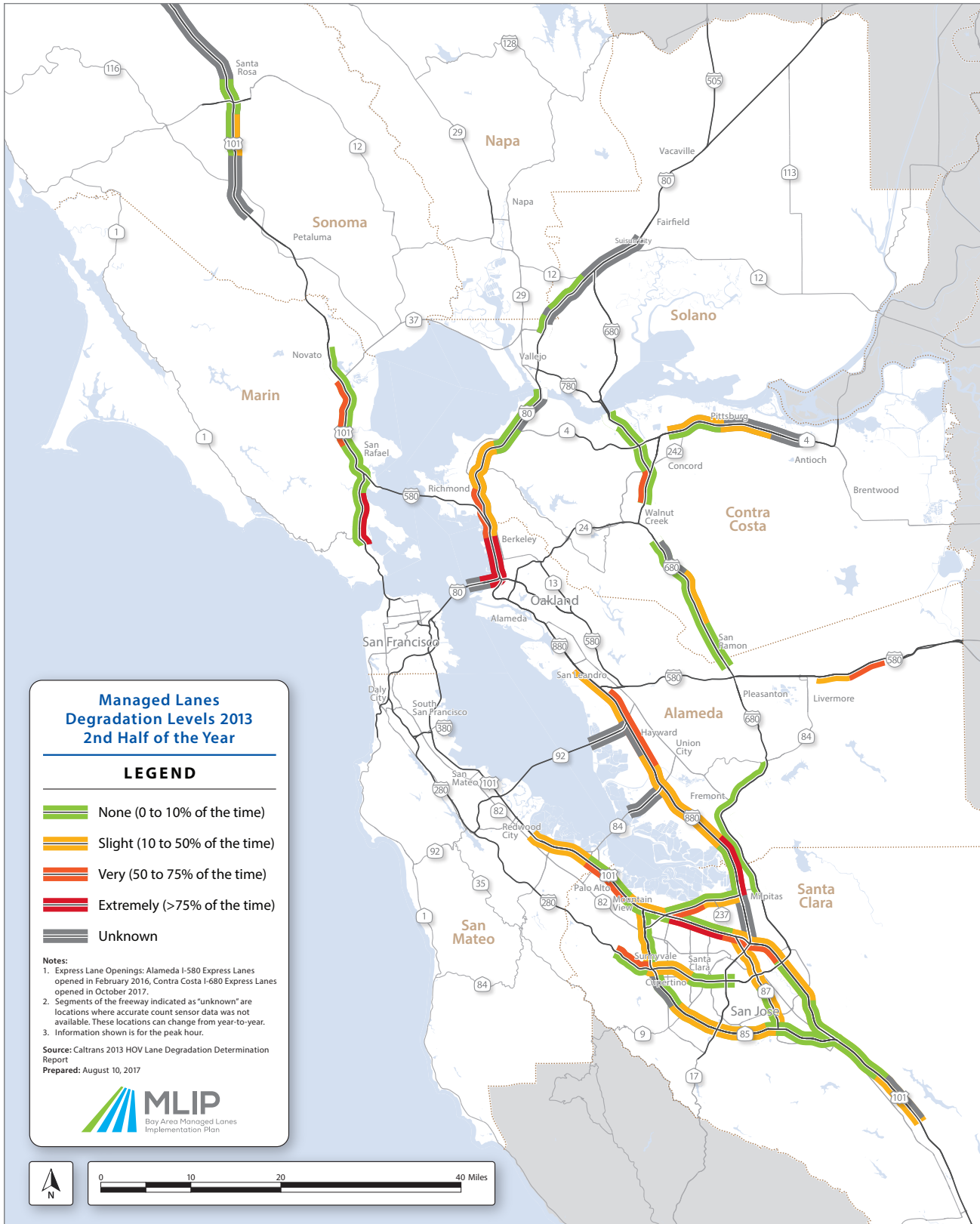


Figure 4 - Bay Area HOV Degradation Summary – Second Half of 2016

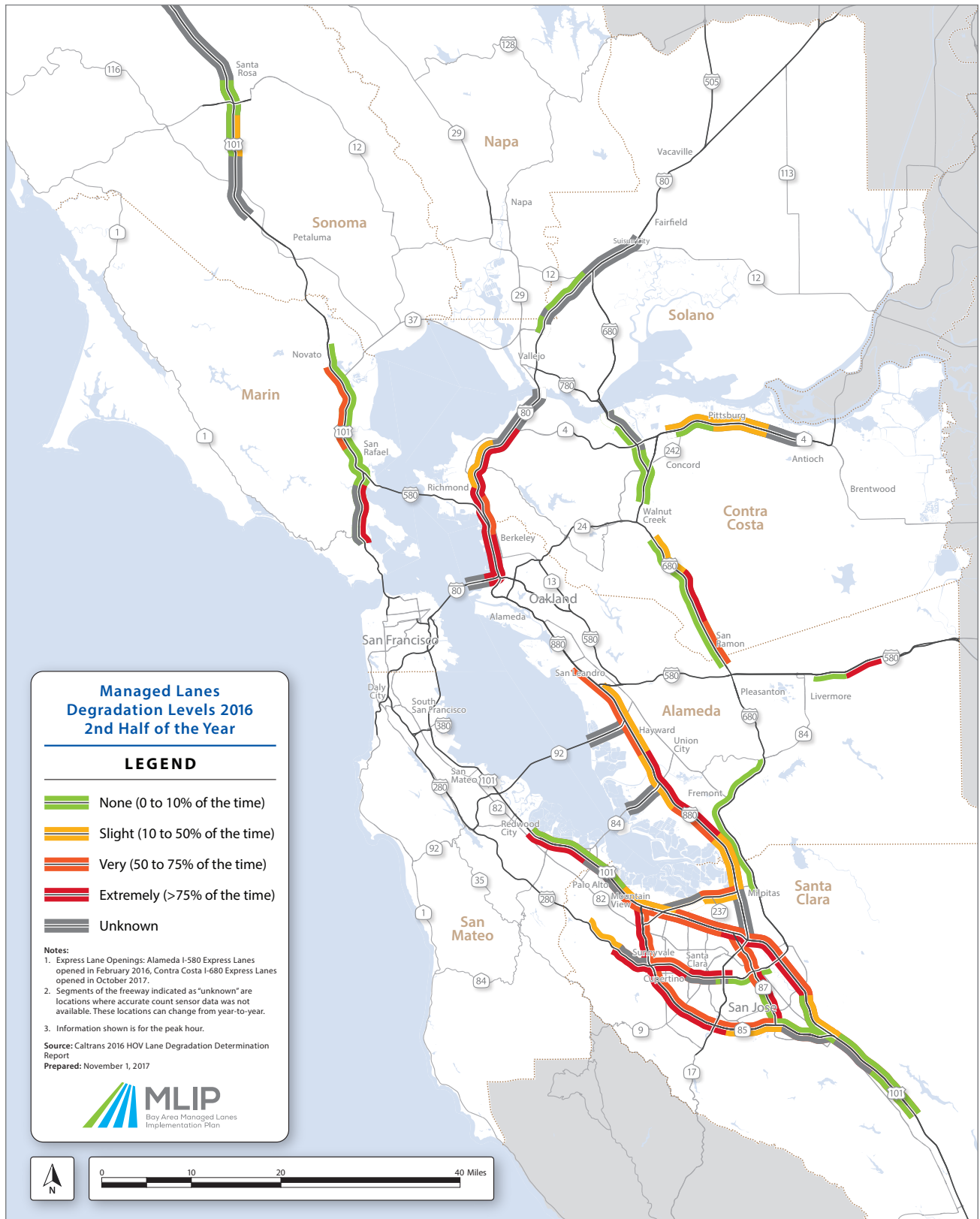
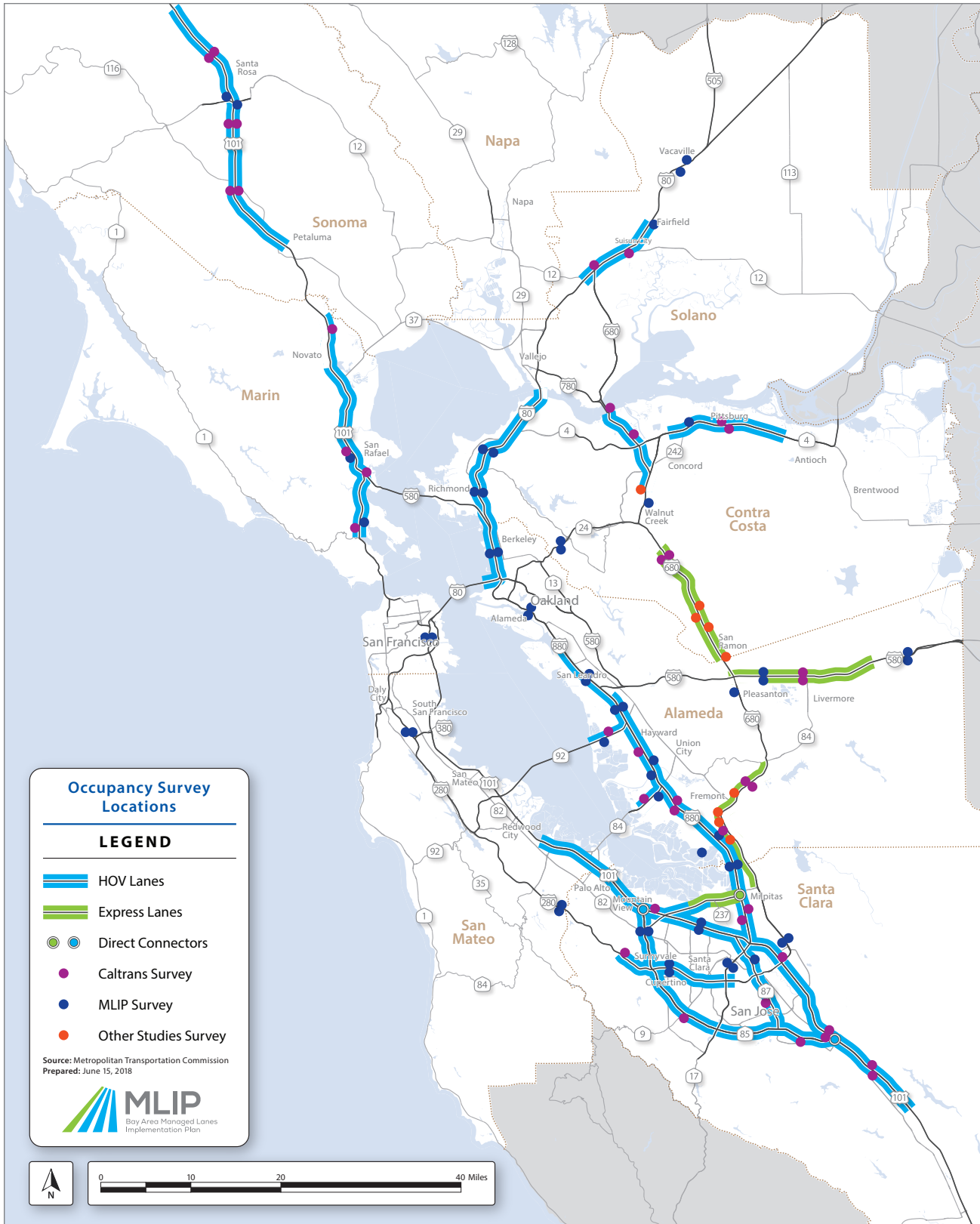


Figure 5 - Occupancy Data Collection Locations



Managed Lane Network Performance

The goals of MLIP are related to three key performance elements:

1. Degradation (Reliability)
2. Consistency
3. Throughput (Efficiency)

The high rate and severity of HOV degradation was a key driver for MLIP. The second goal, consistency, is more of an operational policy issue and is discussed in detail in Chapter 3 on managed lane policies. The focus in this section is on the third goal, the performance of the managed lanes network in terms of throughput. A key goal of MLIP is to maximize the person throughput (the number of persons over a given time-period using the highways) of the regional highway network by increasing the number of persons carried rather than vehicles.

Existing Throughput

A key element of MLIP was extensive data collection and analysis to understand the performance of the existing managed lanes network. Vehicle occupancy counts were conducted at 83 locations as shown in [Figure 5 - Occupancy Data Collection Locations](#); recent data from Caltrans or other studies are also included. Occupancy was counted in each lane in both directions during both the AM and PM week-day peak periods for two days (counts typically spanned at least 3 hours in the AM peak period and 4 hours in the PM peak period). It was not possible to observe the number of persons in buses and vanpools so default values of 35 persons per bus and 10 persons per vanpool were used, which is standard Caltrans District 4 practice when performing occupancy count analysis.

Figure 6 - Vehicle and Passenger Throughput - US 101 Marin County

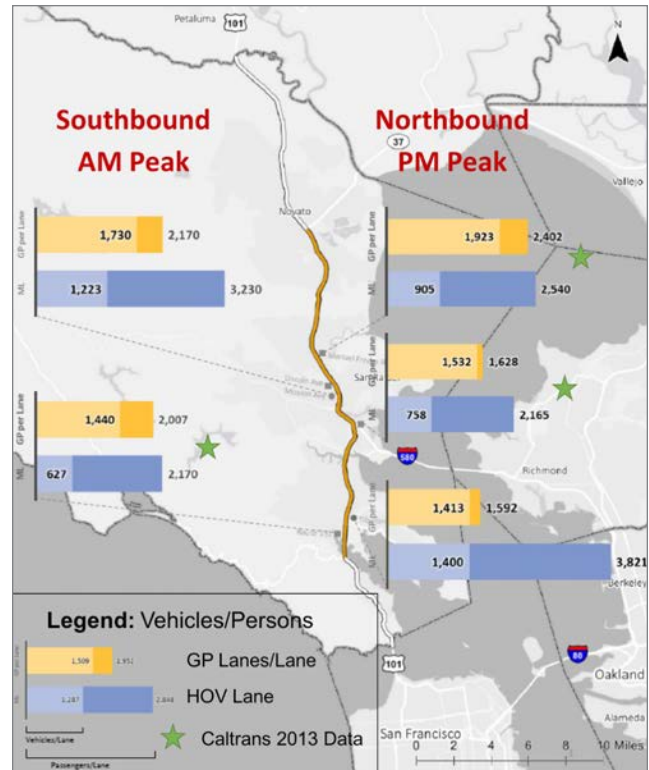
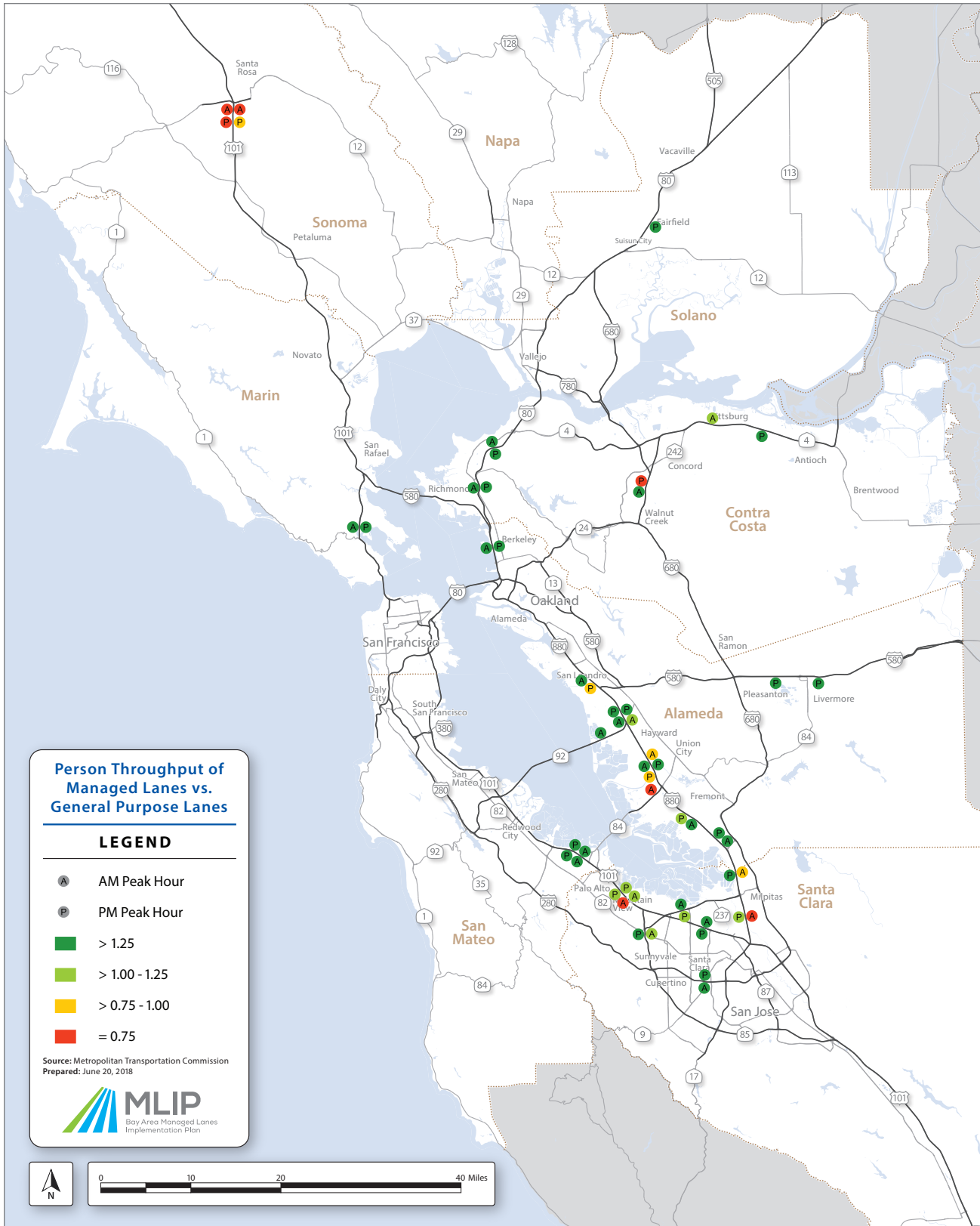


Figure 6 - Vehicular and Passenger Throughput - US 101 Marin County shows the results of occupancy counts collected for MLIP along with counts previously collected by Caltrans at five locations on US 101 in Marin County.

In general, although the number of vehicles in the HOV lane is less than the number of vehicles per lane in the GP lanes, the estimated number of passengers in the HOV lane still exceeds that of the GP lanes. This suggests that the HOV lanes are effective in terms of increasing person throughput. For example, on US 101 in San Rafael just north of Mission Avenue during the AM peak hour, the southbound HOV lane carried 1,223 vehicles and an estimated 3,230 persons. In comparison, the average volume in the GP lanes was 1,730 vehicles, almost 500 more vehicles per hour than the HOV lane, and 2,170 persons, over a 1,000 fewer persons than the HOV lane.

Figure 7 - Person Throughput Ratio - Managed Lanes/GP Lanes



Source: MTC data collection conducted in 2015-2016

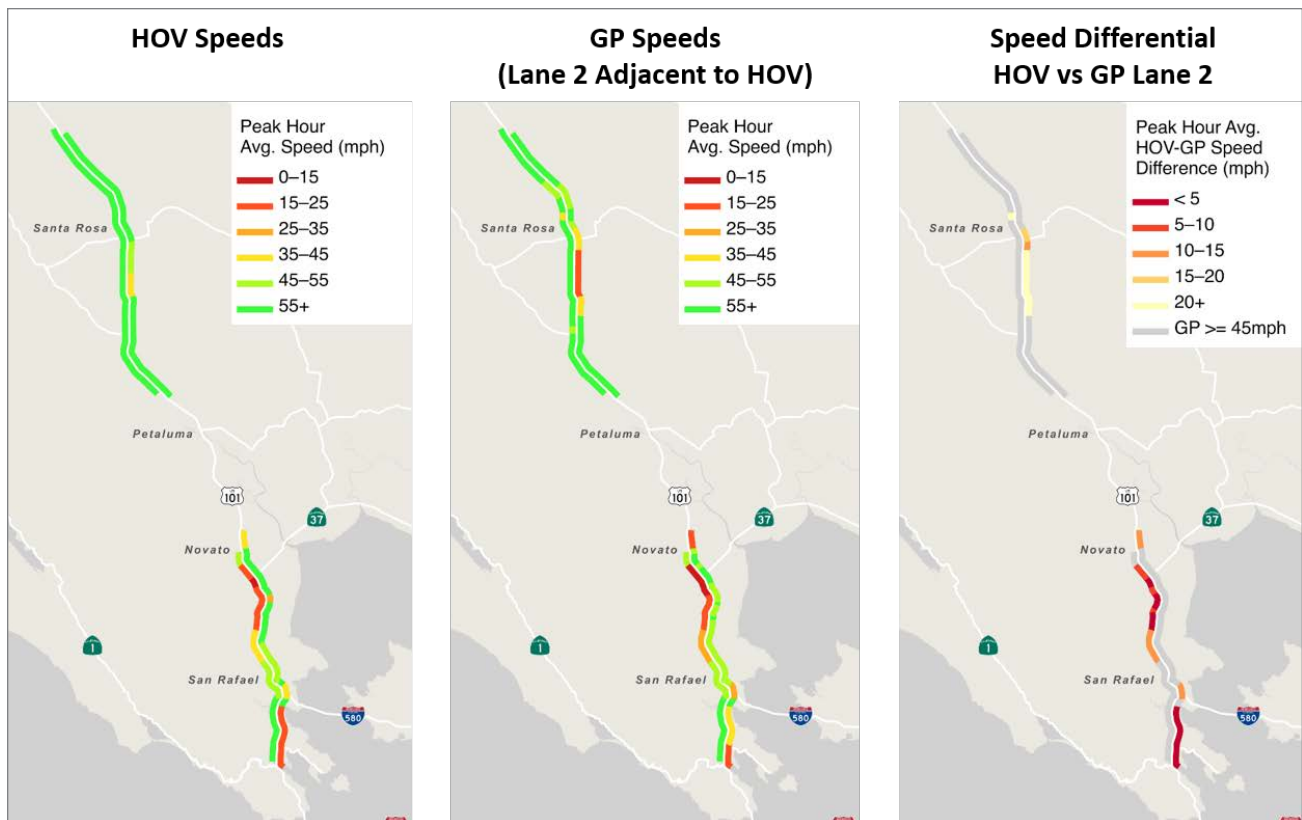
Figure 7 - Person Throughput Ratio - Managed Lanes/GP Lanes shows the ratio of managed lane peak period person flows to GP lane peak person flows on a regional scale. The peak period person flows in the managed lanes exceeds that of the GP lanes in the vast majority of the locations surveyed. Only in a few areas such as Sonoma County are person volumes in the HOV lanes less than those in the adjacent GP lanes. This indicates that currently the managed lanes in the Bay Area are for the most part successful in meeting the objective of increased person throughput.

Existing Speed Differential

Another measure of the efficiency of managed lanes is the ability to deliver higher speeds than the

adjacent GP lanes. When a managed lane corridor is congested, vehicles in the HOV or Express Lane should be moving faster than those in the nearby GP lanes; otherwise there is no incentive to use the managed lane. Figure 8 - Speed/Flow Conditions - HOV Versus GP Lanes - US 101 Marin and Sonoma Counties shows an example of speed conditions on US 101 in Marin and Sonoma Counties. In the congested parts of US 101 in Marin the speeds in the HOV lane (Lane 1) are frequently also under 45 mph and less than 5 mph faster than the speeds in the adjacent GP lane (Lane 2). This means there is little incentive in time savings or reliability for commuters to form carpools or take transit.

Figure 8 - Speed/Flow Conditions - HOV Versus GP Lanes - US 101 Marin and Sonoma Counties



Source: MTC analysis of PEMS observed traffic count data, Tuesday-Thursday, September-October 2016, 7-8 AM Southbound and 5-6 PM Northbound

Figure 9 - Peak Hour Speed/Flow Conditions - HOV Versus GP Lanes - I-80 Alameda and Contra Costa Counties shows a similar situation on the I-80 HOV corridor in Alameda and Contra Costa Counties. In the congested parts of the corridor, the speeds in the HOV lane are frequently also under 45 mph and less than 5 mph faster than the speeds in the adjacent GP lane.

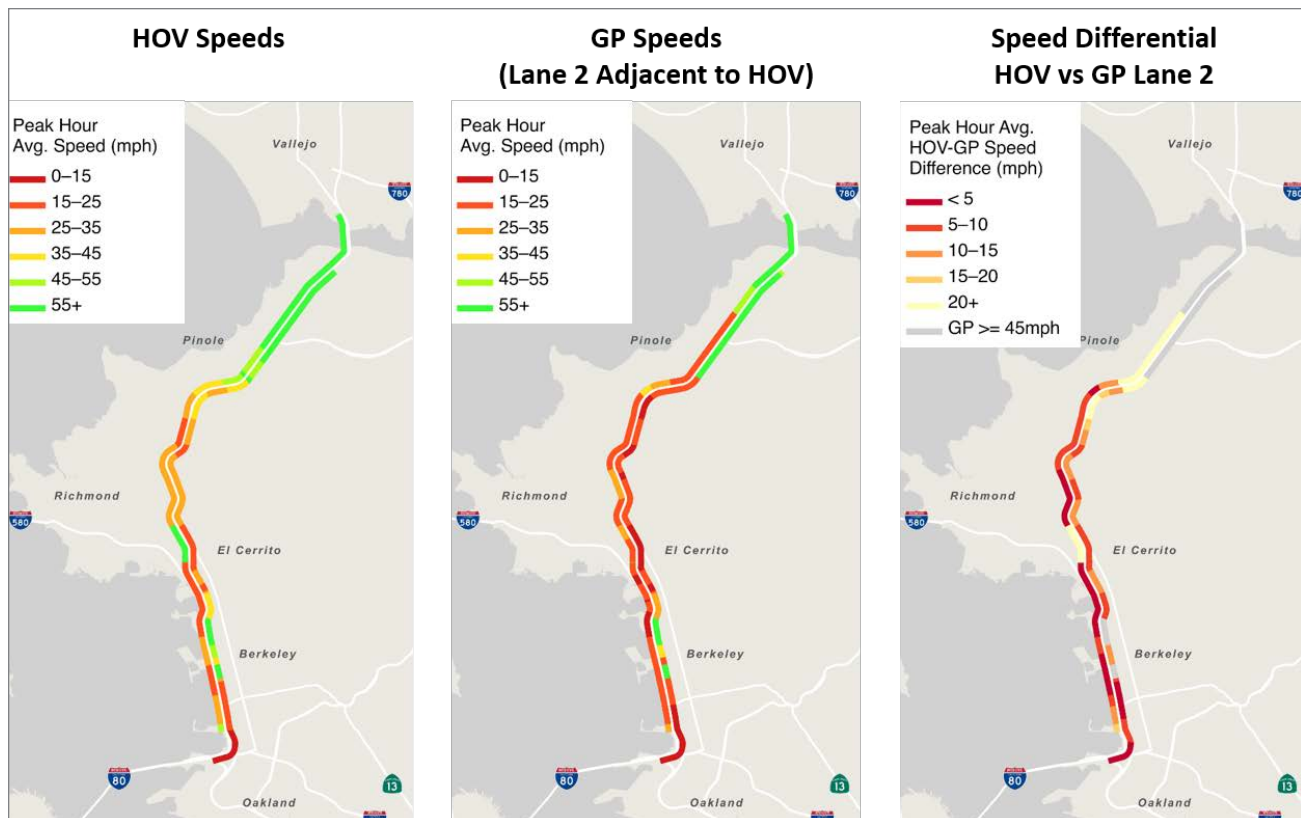
Currently Planned Managed Lanes Projects

Figure 10 - Managed Lanes Under Construction and Environmentally Cleared, Figure 11 - Managed Lanes Under Study but Not Environmentally

Cleared and Figure 12 - Potential Future System Expansion on the following pages summarize the status of currently planned managed lanes projects in the Bay Area. The status is defined in terms of the following categories:

1. Managed lanes projects Under Construction
2. Managed lanes projects that are both Environmentally Cleared and Designed
3. Managed lanes projects that are Environmentally Cleared (but not yet designed)
4. Managed lanes projects that are Under Environmental Review
5. Managed lanes projects that are Under Study or Proposed

Figure 9 - Peak Hour Speed/Flow Conditions - HOV Versus GP Lanes - I-80 Alameda and Contra Costa Counties



Source: MTC analysis of PEMS observed traffic count data, Tuesday-Thursday, September-October 2016, 8-9 AM Southbound and 5-6 PM Northbound

Table 2 - Summary of Planned Managed Lanes Projects

Project	Limits	County
Under Construction		
I-880 HOV to Express Lane Conversion	Milpitas to Oakland	Alameda
SR 4 HOV Lanes	Pittsburg to Antioch	Contra Costa
Environmentally Cleared and Designed		
US 101 HOV Lanes	Marin County Line to Petaluma	Sonoma
SR 237 HOV to Express Lane Conversion	San Jose to Sunnyvale	Santa Clara
Environmentally Cleared		
US 101 HOV Lanes	Novato to Sonoma County Line	Marin
I-80 HOV to Express Lane Conversion	I-680 to Fairfield	Solano
I-80 Express Lane	Fairfield to Vacaville	Solano
I-680 SB HOV to Express Lane Conversion	Martinez to Walnut Creek	Contra Costa
I-680 NB Express Lane	Milpitas to SR 84	Santa Clara/Alameda
I-680 SB Express Lane	Walnut Creek to Alamo	Contra Costa
SR 92 WB HOV to Express Lane Conversion	San Mateo Bridge Approach	Alameda
SR 84 WB HOV to Express Lane Conversion	Dumbarton Bridge Approach	Alameda
US 101 HOV to Express Lane Conversion	Palo Alto to Morgan Hill	Santa Clara
SR 85 HOV to Express Lane Conversion	Mountain View to San Jose	Santa Clara
Under Environmental Review		
US 101 HOV or Express Lanes	Redwood City to I-380	San Mateo
Under Study or Proposed		
I-80 Express Lanes	Vacaville to Yolo County Line	Solano
I-80 Express Lanes	Carquinez Bridge to I-680	Solano
I-680 Express Lanes	I-80 to Martinez	Solano/Contra Costa
I-80 HOV to Express Lane Conversion	Crockett to Bay Bridge	Contra Costa/Alameda
I-680 NB HOV to Express Lane Conversion	Concord to Martinez	Contra Costa
I-680 NB Express Lanes	Walnut Creek to Concord	Contra Costa
SR 4 HOV Lanes	SR 242 to I-680	Contra Costa
I-680 Express Lanes	Dublin to SR 84	Alameda
I-880 North Bound Express Lane	Hayward to Oakland	Alameda
I-580 Express Lanes	Livermore to San Joaquin County Line	Alameda
US 101 HOV or Express Lane	I-380 to San Francisco	San Mateo/San Francisco
SR 84 Express Lanes (on bridge and approaches)	Menlo Park to Newark	San Mateo/Alameda
SR 237 Express Lanes	US 101 to SR 85	Santa Clara
I-680/I-280 Express Lanes	Milpitas to I-880/SR 17	Santa Clara
I-280 HOV to Express Lane Conversion	SR 17 to Los Altos	Santa Clara
I-880/SR 17 Express Lanes	SR 237 to SR 85	Santa Clara
SR 87 HOV to Express Lane Conversion	US 101 to SR 85	Santa Clara
US 101 Express Lanes	Morgan Hill to San Benito County Line (SR 25)	Santa Clara

Table 2 - Summary of Planned Managed Lanes Projects identifies each of the projects in these categories.

There are many projects listed as Under Study or Proposed. Only a few of these projects are under current study. These include the evaluation of US 101 between downtown San Francisco and I-380 which was recently conducted by the San Francisco County Transportation Authority, and the studies of Express Lanes on the Dumbarton Bridge which are part of the ongoing Dumbarton Transportation Corridor project being conducted by the San Mateo County Transit District. Most of the other projects appear in the Regional Transportation Plan or long-range planning documents of the various county agencies and are not being actively developed. However, it is clear that at this time there is already a comprehensive region-wide network of managed lanes in various stages of planning, environmental clearance, design, and implementation in the Bay Area. Several conclusions can be drawn:

Express Lanes – Most of the projects involve either conversion of existing HOV lanes to Express Lanes or the development of new Express Lanes. There is growing acceptance of Express Lanes arising out of a need to address the degradation issues which are common to many of the region's HOV lanes. In addition, Express Lanes provide a way to increase person throughput and assure more reliable travel times. The pricing mechanism inherent to Express Lanes can be used to manage the number of vehicles using the lane, which goes to improve operating conditions. Express Lanes also make better use of lane capacity than HOV lanes as underuti-

lized capacity can be filled with toll paying vehicles. For Very Degraded HOV2+ lanes where increasing occupancy policy to HOV3+ may be necessary, conversion to Express Lanes may be a necessary first step to implementing a policy change. The pricing mechanism can be used to offer HOV2+ vehicles a discounted toll rate to use the Express Lane while also assuring that toll paying SOV's will use available remaining capacity and while maintaining desirable operating conditions. In contrast, converting an existing HOV lane to HOV3+ will typically result in low utilization of the HOV lane, no incentive to form HOV2+ carpools, and degradation of operations in the GP lanes. An existing HOV3+ lane, such as I-80 in Contra Costa and Alameda Counties, could also benefit from conversion to an Express Lane, as pricing could be applied to charge CAVs for using the lane in the same manner as HOV2+ vehicles which pay a discounted toll. Pricing and enforcement technology associated with Express Lanes could also have the benefit of reducing violations by non-eligible vehicles.

Conversion of GP Lanes – Historically, all managed lane projects in the Bay Area have involved the construction of new lanes. However, there is now consideration of the idea of converting a GP lane to a managed lane in the studies of US 101 in San Francisco and San Mateo Counties and the Dumbarton Corridor Transportation Study (Dumbarton Bridge). Note that state and federal laws allow converting a GP lane to an HOV lane and converting an HOV lane to an Express Lane, but it prohibits converting a GP lane directly into an Express Lane. New state and federal legislation

Figure 10 – Managed Lanes Under Construction and Environmentally Cleared

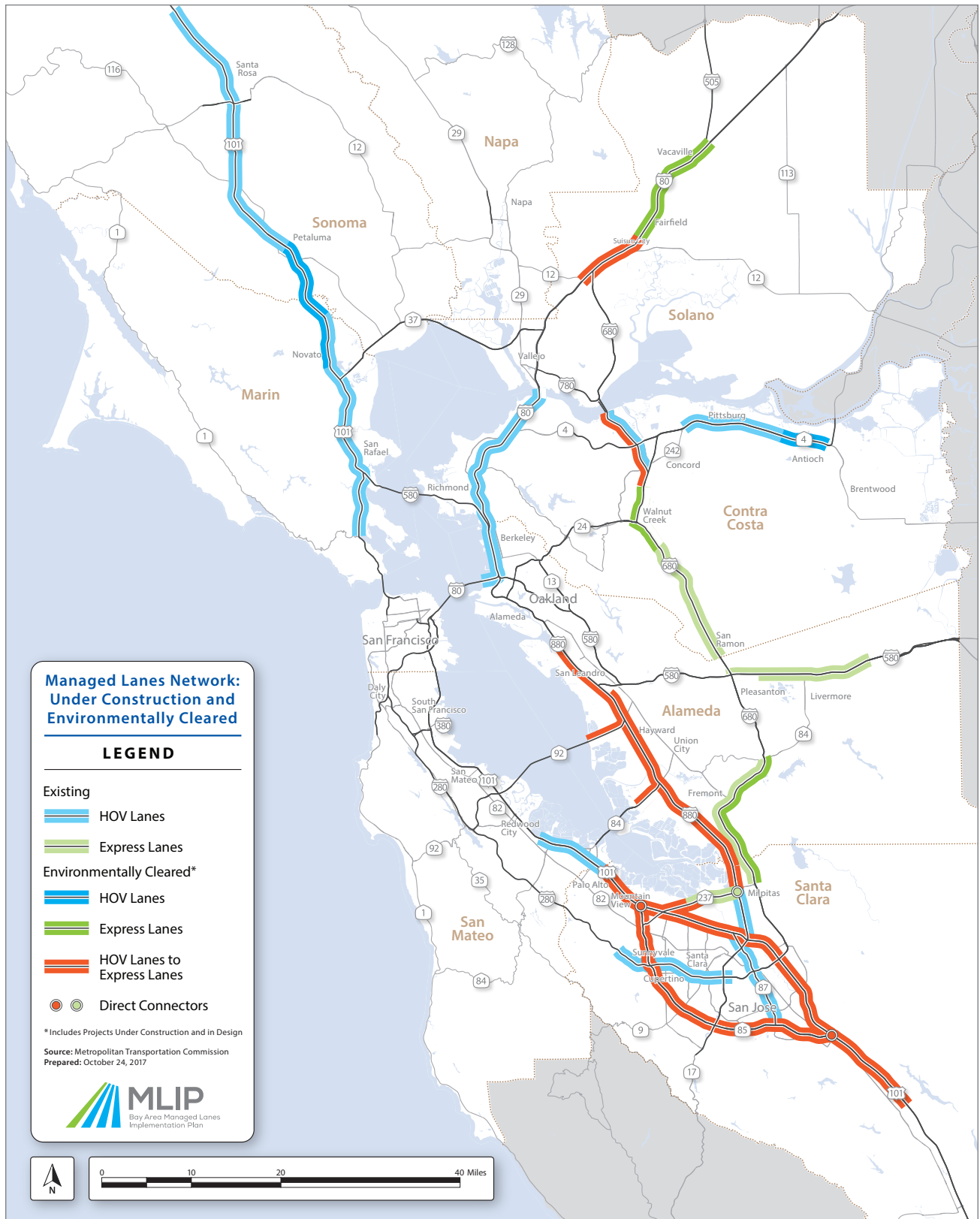
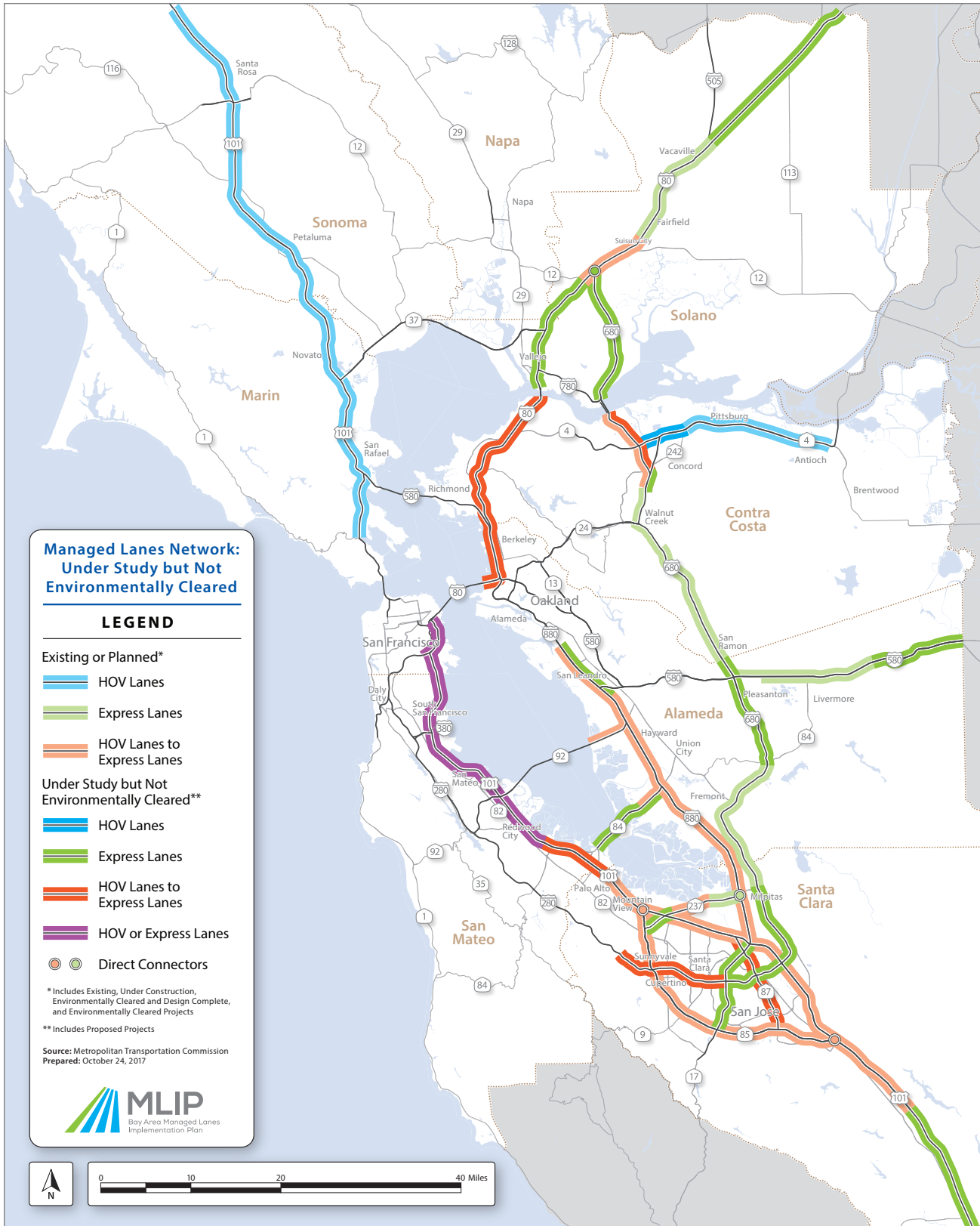


Figure 11 - Managed Lanes Under Study but Not Environmentally Cleared



would be required to change the current prohibition of GP lane conversion to Express Lanes. The need to increase highway person throughput and provide travel time benefits to encourage transit and carpooling in locations where highway widening is largely impractical is the motivation behind these studies.

System Gaps – Even with all the planned and proposed managed lane projects being considered there are still critical gaps in the system. The northern part of I-880 and the western part of I-580/SR 238 are good examples of this. Closing these remaining gaps will be difficult as many of them are in areas with significant physical and environmental constraints which limits the ability to widen the highways in order to add managed lanes. However, it is important to start looking at what would be required to create managed lanes to close these gaps in the network.

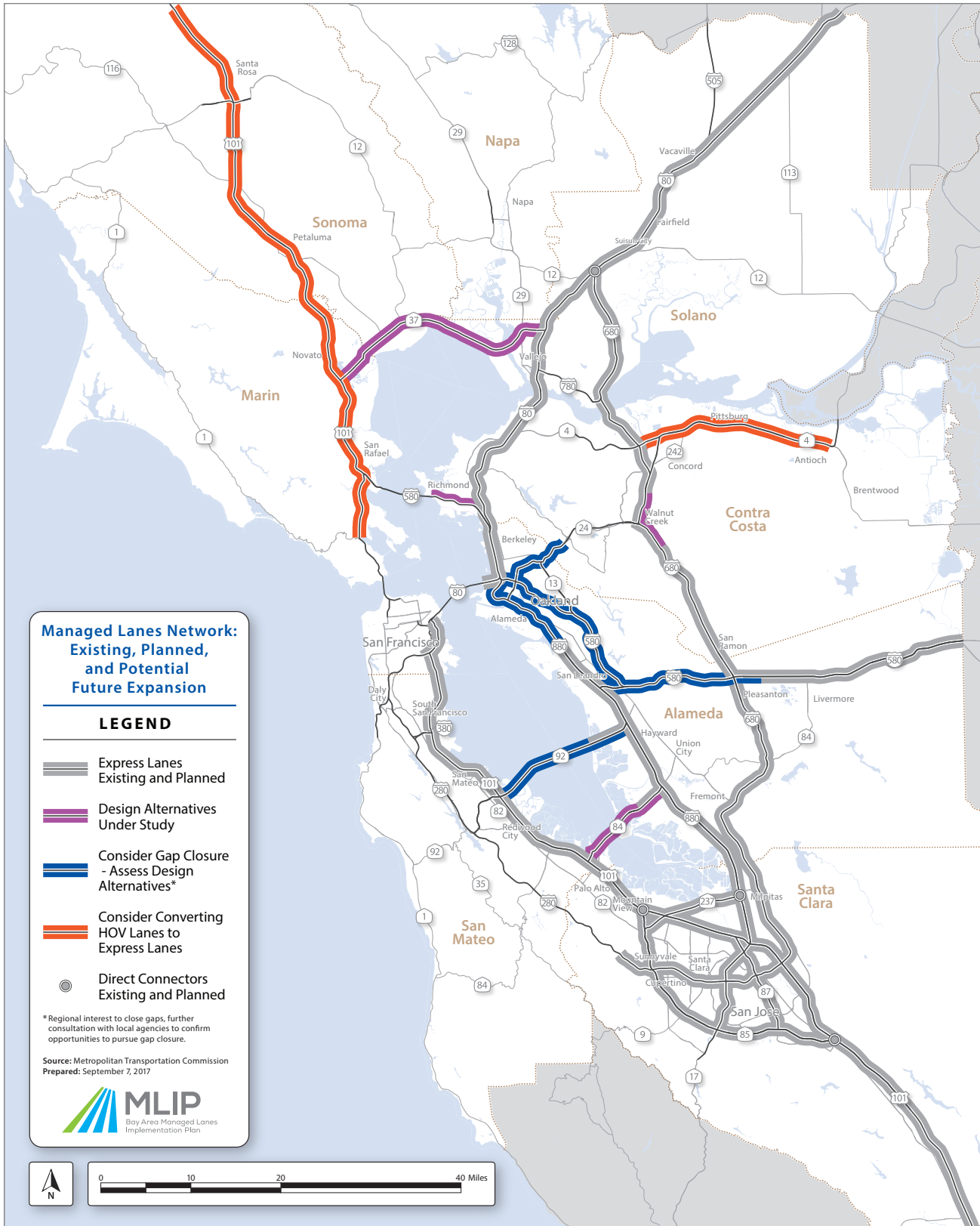
Potential Network Expansion

Figure 12 - Potential Future System Expansion shows projects which have been identified for potential expansion or enhancement of the managed lanes network in the Bay Area. The projects fall into three categories:

Design Alternatives Under Study – These are projects that are currently under study:

- **I-680 Northbound in Contra Costa County** – MTC, in partnership with the Contra Costa Transportation Authority (CCTA), recently completed a Design Alternative Assessment for I-680 northbound from Alamo to Walnut Creek to address the existing I-680 northbound managed lane gap and to improve traffic operations and relieve congestion in central Contra Costa County. Alternatives being recommended for the future project development phase includes GP lane conversion to Express Lane with transit improvements, contra-flow Express Lane, and Express Lane through roadway widening.
- **US 101 in San Francisco and San Mateo Counties** – Caltrans, the San Mateo County Transportation Authority (SMCTA), and City/County Association of Governments of San Mateo County are conducting an environmental review of managed lane options between I-380 and the Santa Clara County line. Both HOV and Express Lane options are being considered in a variety of configurations. The San Francisco County Transportation Authority recently completed a feasibility study of managed lanes on US 101 between downtown San Francisco and I-380. Their work program called for environmental and design studies (Project Initiation Document) to be initiated in 2017. This work is being done in partnership with the SMCTA.

Figure 12 - Potential Future System Expansion



- **Dumbarton Bridge** – The Dumbarton Transportation Corridor project conducted by SamTrans explores the possibility of Express Lanes on the Dumbarton Bridge and its approaches to improve operations for the Dumbarton Express bus service and HOVs. A variety of lane configuration options are being considered.
- **SR 37 in Solano, Sonoma, Napa and Marin Counties** – MTC is working in partnership with the Solano Transportation Authority (STA), the Sonoma County Transportation Authority (SCTA), and Napa Valley Transportation Authority (NVTA) and the Transportation Authority of Marin (TAM) to plan and expedite the delivery of improvements in the SR 37 corridor between I-80 and US 101 to address the threat of sea level rise, traffic congestion, transit options, and recreational activities. A number of near-term operational improvement strategies will be considered, including potentially a contra-flow median lane/Express Lane.
- **I-580 Westbound/Richmond-San Rafael Bridge Corridor in Contra Costa County** – MTC is undertaking an alternative assessment to improve travel reliability and efficiency of buses and HOVs through the Richmond-San Rafael Bridge corridor from Central Avenue to the

bridge toll plaza. A number of strategies will be considered, which would include a consideration to extend the existing HOV lane at the toll plaza eastward towards I-80 through a GP lane conversion. These strategies would also support the I-580 Access Improvement Project that adds a third lane and multi-use path on the bridge.

Gap Closures – Assess Design Alternatives – These are possible projects which would close key gaps in the managed lane network. MTC will look to partner with Caltrans and Congestion Management Agencies to assess the feasibility of a range of managed lane design alternatives for each identified corridor. The corridors under consideration would include:

- **I-580 in Alameda County** – Two corridors would be studied: I-580/SR 238 between I-680 and I-880, and I-580 from Hayward (SR 238) to Oakland.
- **SR 24 in Alameda County** – This corridor would be studied from the eastern county line (Caldecott Tunnel) to I-580 in Oakland.
- **I-880 in Alameda County** – The northern part of I-880 from San Leandro to Oakland (I-80/I-580 Junction) would be studied.

HOV to Express Lane Conversion – These are corridors with existing or planned HOV lanes that should be considered for conversion to Express Lane operations in the future should HOV degradation persist and there is public openness to consider roadway pricing to manage demand. However, before such a conversion is considered it is important that other options such as operational changes to the lane configuration and function be explored. Another important consideration when considering conversions of HOV lanes to Express Lanes is to avoid “trap” situations where vehicles are forced to exit. If an Express Lane directly feeds into an HOV lane, then toll paying SOV vehicles would be forced to exit as they’re prohibited from utilizing the HOV lane.

- **US 101 in Marin and Sonoma Counties** – The HOV lanes in Marin County are severely degraded and solutions to this problem such as increased enforcement, extending the HOV hours of operation,² and lane access configurations should be considered. The PM HOV hours start at 4:30 PM when the corridor is already congested, causing the HOV lane to be immediately degraded. Extending the HOV hours earlier before the congestion has built up could prevent the lane from

opening in a degraded state. If these changes do not prove to be effective or practical, and increasing occupancy policy to HOV3+ is considered inappropriate, then conversion of HOV lanes to Express Lanes should be considered. In Sonoma County, the HOV lanes are underutilized and Express Lanes could be considered as a means of improving utilization. Furthermore, Express Lanes in both counties should be considered as part of the plan to bridge the “Narrows” gap between Novato and Petaluma with managed lanes as more consistent policies through managed lane corridors will be necessary once the corridor is connected.

- **SR-4 in Contra Costa County** – The HOV lanes between Concord and Antioch are nearly complete and there are future plans to extend the HOV lanes west to I-680 in Pacheco. Development of these lanes as Express Lanes should be considered to manage future demand in the corridor, particularly if new housing continues to develop at a rapid pace and to provide consistency with the I-680 Express Lanes.

² When hours of operation are not adjusted periodically to coincide with the duration of the congestion, it becomes very difficult to extend the operational period because now that the congestion exists, the extension of HOV hours may result in degradation of the GP lanes as well as the HOV lane.



Operating Policies

Managed Lane Operating Policies

There are several tools available to address degradation and operate managed lanes more effectively. This section examines the policies of hours of operation, occupancy requirements, violation enforcement, and CAV exemptions, as well as access restrictions, which can impact degradation.

Violations and Enforcement

HOV violations are a growing concern on managed lanes in the Bay Area and are likely the primary cause of degradation on many of the managed lane corridors in the region. Collecting vehicle occupancy and HOV violation data is difficult and labor intensive. However, for MLIP multiple rounds of occupancy and violation data were collected which showed observed rates of HOV violations making up on average 19% (AM) - 24% (PM) of the HOV lane traffic in the region. Given the importance and difficulty of collecting data, MTC, Caltrans, the CHP, and FHWA are discussing ways to improve data collection methods and take advantage of innovative detection technologies.

Because of the high rates of violations and degradation, enforcement is critical to the successful operation of both HOV and Express Lane facilities. An effective enforcement program should help ensure that operating policies such as vehicle occupancy, eligibility, and access enforcement are maintained to preserve the travel time savings, discourage unauthorized vehicles, and maintain a safe operating environment.

HOV lane violations are covered under California Vehicle Code §§21655.5 and a violation ticket is a minimum \$490 fine, but the driver is not assessed a point on their record. The fine may be higher

for repeat offenders and at the discretion of each county's Board of Supervisors. Local counties can assess additional administrative fees.

HOV and Express Lane Enforcement Functions

Enforcement takes many forms in both HOV and Express Lane environments, including:

1. Ensuring that only eligible vehicles with the required occupancy and CAV designation use the lanes
2. Enforcing access restrictions
3. Verifying toll payment for SOV or low-occupant vehicles

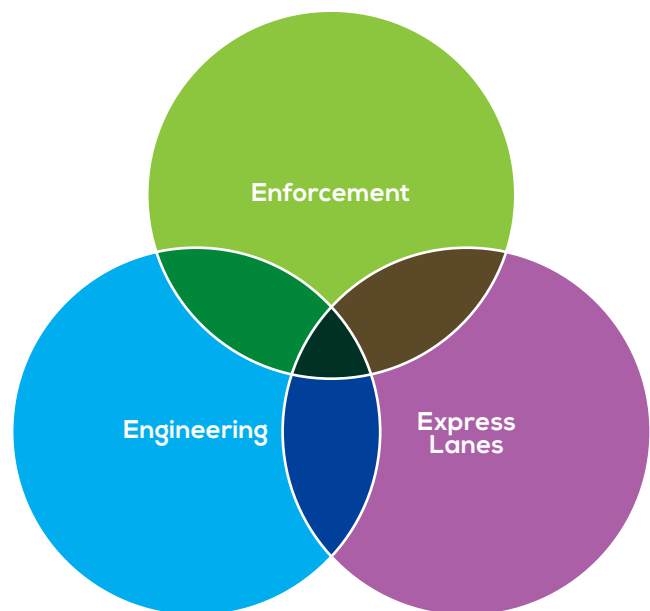
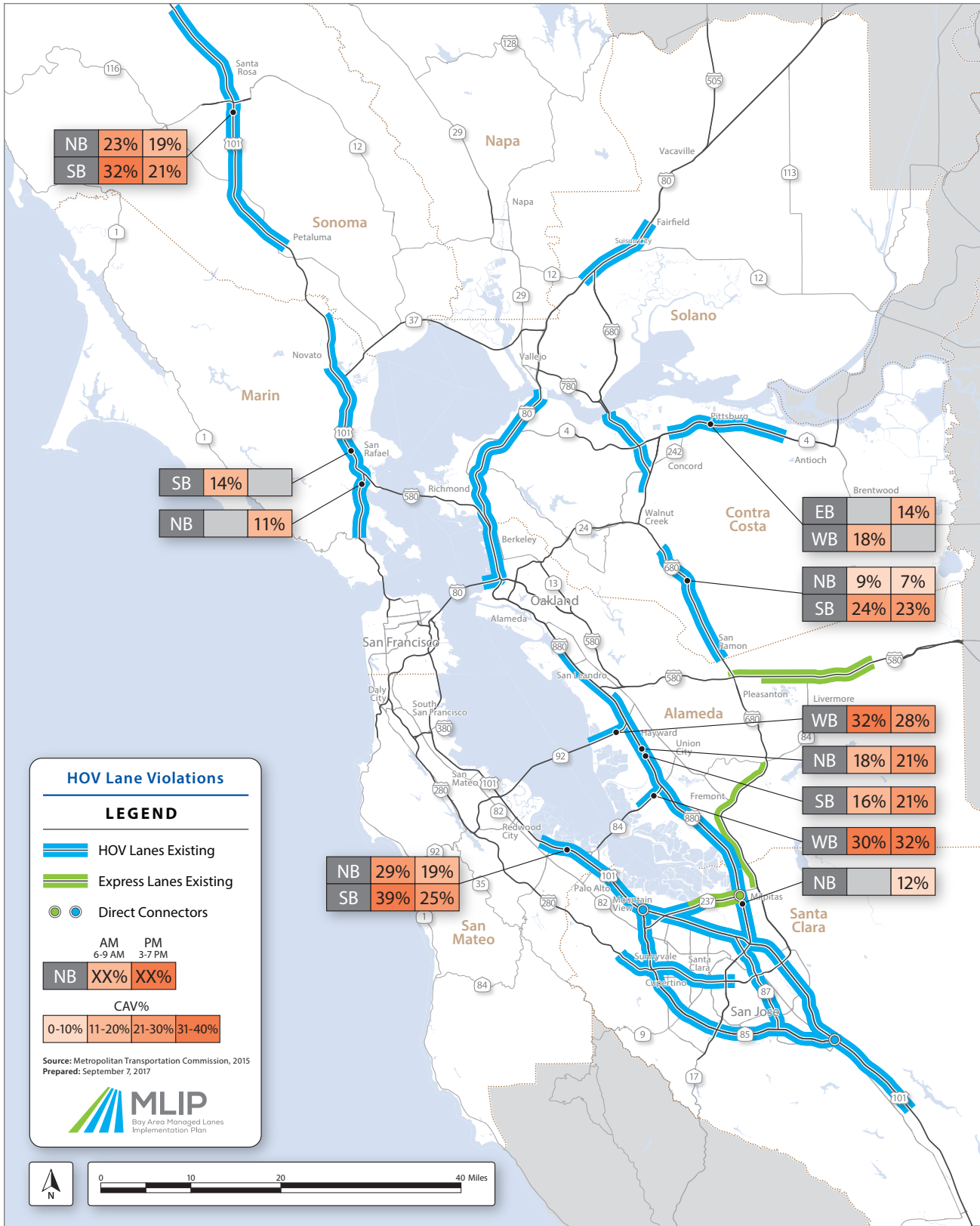


Figure 13 - HOV Lane Violation Data (MTC)



These can be summarized as the “Three Es” of Enforcement, Engineering, and Express Lanes to address degradation and violations.

Enforcement of Vehicle Occupancy and CAV Restrictions

The enforcement strategy and technology implemented must be reliable, highly visible, and equitable. Currently, enforcement of vehicle occupancy and CAV usage of HOV and Express Lanes is performed by CHP officers. Determining the number of occupants in a vehicle is difficult due to limited visibility when observing cars in motion and occasionally results in officers stopping vehicles only to find an additional occupant, such as a child, in the back seat. The prevalence of tinted windows and reduced visibility compounds the officer’s task. While enforcement by the CHP to deter apparent violators may not be the most efficient method to catch violators, it is the most visible to the public, including users of the GP lanes. However, CHP enforcement is expensive as it is labor-intensive and the effects are temporary, with violation rates typically returning to their prior levels shortly after enforcement is suspended.

Enforcing occupancy requirements is the most difficult operational challenge facing officers in both HOV and Express Lanes, as technologies to aide enforcement are in the early stages of development and have not yet achieved the reliability and accuracy required for operational deployment. Cost and privacy concerns associated with the technology also present public acceptance challenges.

CAVs represent an additional enforcement challenge for officers, as they are only identified by the decals affixed to the rear and side bumper of the vehicle. For Express Lanes, officers need to drive alongside the vehicle to identify whether it is an eligible user of the lane, which is inefficient and time-consuming.

Engineering

Facility design influences the types or level of enforcement needed. Barrier or painted buffer separated HOV and Express Lanes can be an effective deterrent to potential HOV violators, but also requires additional space along the facility to monitor, apprehend, and cite violators. Barrier separated facilities generally make apprehension easier, since the violator is confined within the lanes after entry. However, this approach is generally infeasible on congested urban corridors due to limited right of way.

Non-barrier separated HOV and Express Lanes present more challenges to HOV enforcement, as it is easier to enter and exit the lane by changing lanes. Lane delineators such as those in use on SR 91 Express Lanes in Orange County can deter violators, although maintenance and replacement of delineators is expensive and disruptive to traffic.

Enforcement of Access Restrictions

Managed lanes can be designed with access restrictions to improve lane operations and safety. Such restrictions may improve HOV operations by limiting weaving and drivers that use the lane to overtake slower vehicles. Drivers that cross buffer or double white or yellow line-separated managed lanes are subject to moving violations.

Express Lanes

Currently, a substantial proportion of drivers use HOV lanes without the required number of occupants, despite the high minimum fine of \$490. Conversion of an existing HOV lane to an Express Lane could address degradation and violations because Express Lanes provide solo drivers with a legal option to use the lane. In addition, demand for the Express Lanes by non-HOV users is regulated through pricing.

Current Express Lane systems rely on automated toll collection and toll enforcement systems. These include radio-frequency identification (RFID) technology, which enables communication between roadside equipment and a transponder mounted on the windshield, dashboard, or fender of the vehicles. The technology also uses in-pavement equipment, toll readers, and antennas to detect and associate vehicles with the transponder, license plate capture cameras, and back-office accounting systems to verify valid account status and debit the toll assessed from the customer's account. In addition to traditional FasTrak transponders, customers who carpool are offered a specialized transponder (FasTrak Flex) that allows the customer to select the number of occupants in the vehicle in order to be charged the appropriate free or discounted rates. While the electronic tolling technology is highly reliable and accurate, toll collection is susceptible to abuse on facilities that provide toll free or dis-



counted tolls to HOV and CAV vehicles, as drivers can switch their transponders to the HOV mode to evade paying the toll. Thus, manual enforcement by CHP officers to verify occupancy remains an important enforcement strategy for Express Lanes. Beacon lights that indicate the transponder occupancy setting have been installed on the I-580 Express Lanes to aid CHP officers in enforcing vehicle occupancy requirements.



Lights indicate transponder status. Source: WSDOT

Enforcement Policy and Technology Guidelines

Policy and technology options can significantly enhance enforcement of HOV and Express Lanes:

Dedicated Manual Enforcement by Officers -

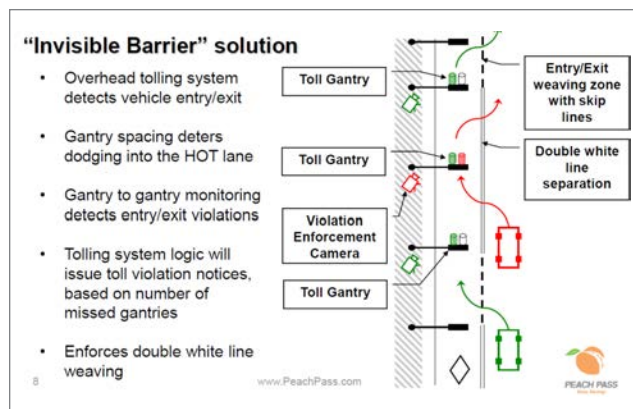
Coupled with a public awareness campaign, can significantly reduce violations. However, the impact is typically transitory if the enforcement is not continued and randomized to ensure potential violators cannot predict and avoid the typical periods when officers are present. It should be noted that the mere presence of an officer can disrupt traffic flow.

FasTrak Transponder or Account - Requiring all users of Express Lane facilities to have a valid transponder or FasTrak account in order to use the lane can deter potential violators. If no transponder or an invalid transponder is detected for a vehicle, and if the license plate is captured on a violation enforcement camera, violation notices can provide a powerful deterrent as they signal to the violator that the lane is actively enforced.

Beacons - Transaction status indicator beacons mounted on toll gantries that is visible to officers downstream of the tolling zone can allow better identification of potential toll violators.

Vehicle Occupancy Detection Systems - Provide continuous enforcement of unauthorized users during the facility's operation. Although early in their development, such systems are showing promise and should be pilot tested to allow refinement of the technology. New automated occupancy detection systems typically rely on overhead and roadside-mounted cameras to identify the vehicle's

Figure 14 - Georgia State Road and Tollway Authority Access Restrictions Enforcement Approach



occupants using facial recognition. While such systems are still improving in accuracy, they could be used to aid officers in identifying repeat violators or to automatically issue warnings rather than citations, with a similar deterrent effect.

Access Restrictions - HOV and Express Lane facilities may benefit from access restrictions at certain locations. While lane delineators can deter vehicles from accessing the lanes or changing lanes within access-restricted sections, they require constant replacement and present a safety issue when the delineators are impacted by vehicles and dislodged, becoming roadway debris. Alternatively, the access restrictions may be enforced using closely spaced gantries with transponder readers to track unauthorized entry/exit. This approach has been used successfully on Express Lanes in Atlanta and is a viable strategy for the Bay Area with similar continuous access HOV lanes, closely-spaced interchanges, and limited available right of way.

MLIP Recommendations and Next Steps for Violation Detection and Enforcement

- Pilot and evaluate dedicated managed lanes violation enforcement
- Pilot and evaluate emerging technologies to assist in analyzing violation rates and supporting enforcement
- Perform regular data collection and monitoring to understand impacts on degradation

Exempt Vehicles

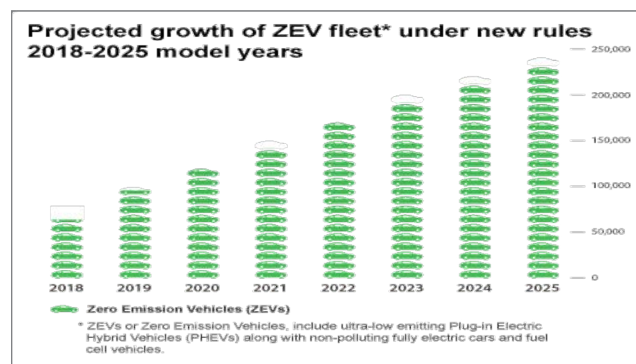
State law permits motorcycles (with up to three wheels) to use HOV lanes. In the Bay Area specifically, two-seater vehicles with two occupants are permitted to use the HOV 3+ lanes, except at the Golden Gate Bridge toll plaza. In addition, designated CAVs are permitted to use the HOV lanes regardless of the number of occupants. Since 2005, the state has been providing this market incentive for CAVs to promote the CAV market and achieve air quality improvement goals. Owners of qualifying CAVs such as plug-in hybrid and electric vehicles are able to apply for decals that permit them to use the HOV lanes without a restriction on vehicle occupancy.

Clean Air Vehicles

The use of HOV and Express Lanes by exempt vehicles (primarily CAVs) has grown significantly since the state's designation of qualifying CAVs as eligible users of the HOV and Express Lanes, regardless of vehicle occupancy. As of October 2017 there are over 111,000 CAVs registered in the Bay Area, up 354% in less than 4 years, and over 289,000 across California. As of April 2017, CAVs comprised approximately 1.8% of two-axle vehicles in the Bay Area, with Santa Clara County leading at 2.9%. In the rest of California, excluding the Bay Area, CAVs comprised 0.8% of two-axle vehicles.

Continued explosive growth in CAVs is anticipated. The California Air Resources Board estimates that zero emission vehicles will comprise over 15% of new vehicle sales across the state by 2025.

Figure 15 - Projected Growth of Zero Emissions Vehicle (ZEV) Fleet



Source: California Air Resources Board

Figure 16 - HOV Lane Clean Air Vehicle Decal Data (MTC, 2015)

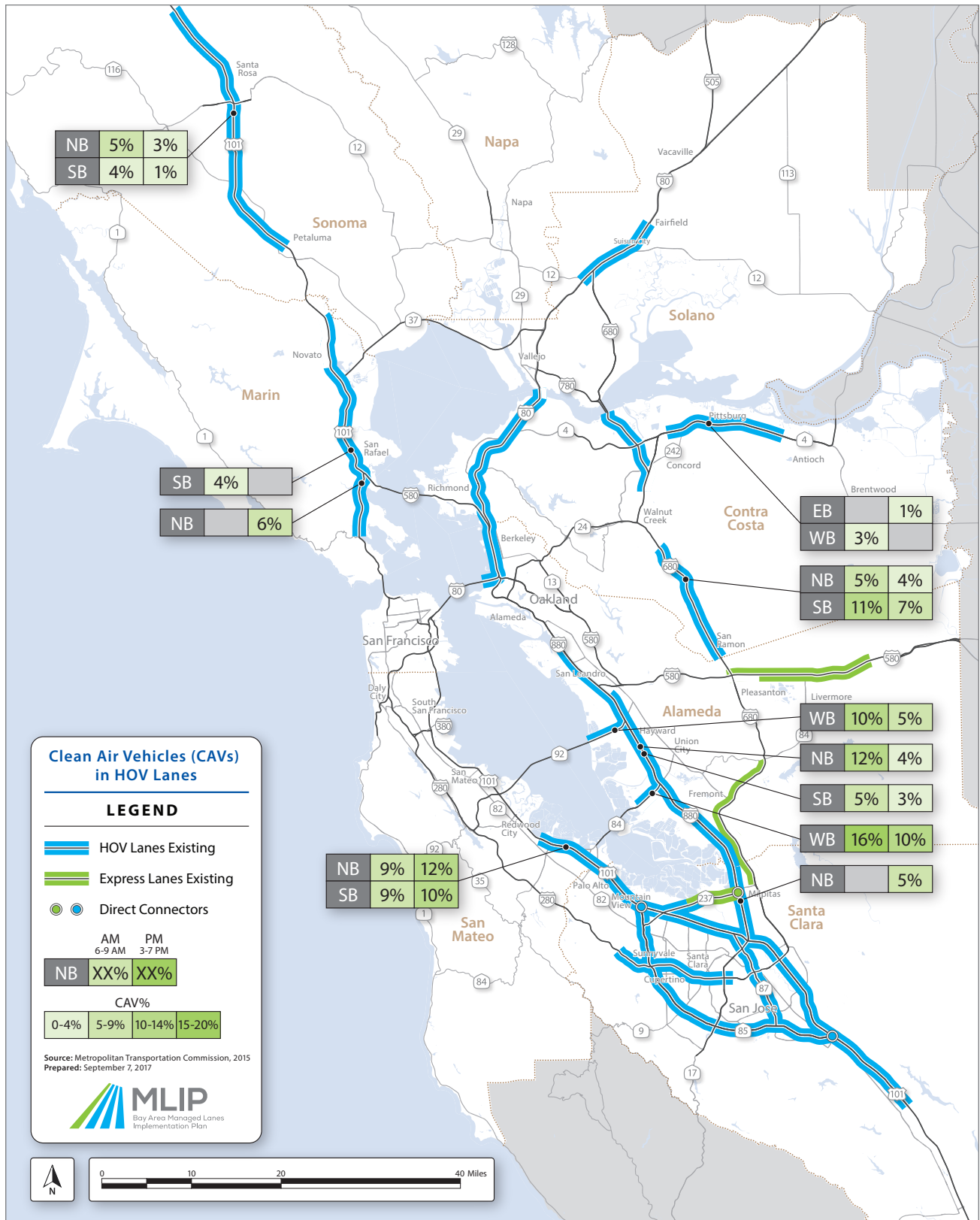
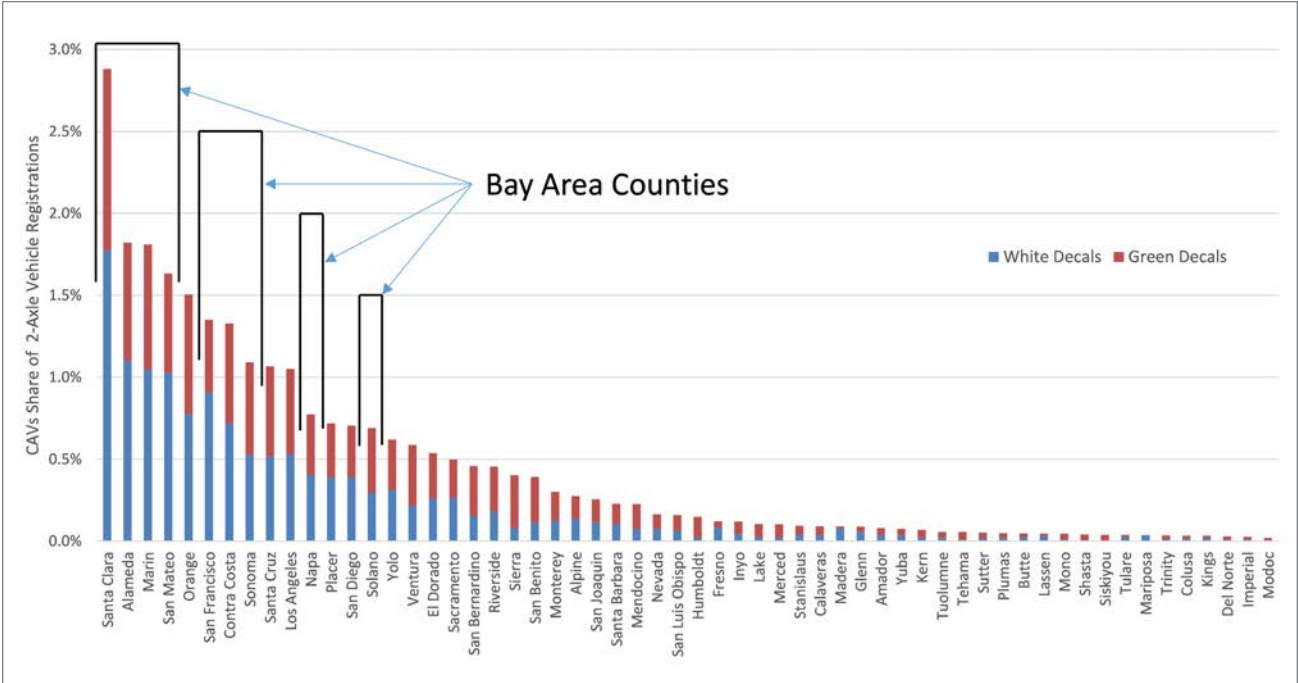


Table 3 - Clean Air Vehicle Growth in Bay Area Counties (Green + White Decals Registered)						
County	Dec 2013	Dec 2014	Dec 2015	Dec 2016	Oct 2017	Oct 2017 vs Dec 2013
Alameda	4,549	9,000	14,199	17,618	23,934	+426%
Contra Costa	2,621	4,787	7,447	9,134	12,179	+365%
Marin	959	1,819	2,652	3,275	4,171	+335%
Napa	193	359	508	647	858	+345%
San Francisco	2,197	3,133	4,347	5,140	6,535	+197%
San Mateo	2,838	5,004	7,431	9,112	11,457	+304%
Santa Clara	9,746	18,543	28,188	35,523	45,702	+369%
Solano	655	1,085	1,511	1,766	2,233	+241%
Sonoma	801	1,800	2,718	3,306	4,550	+468%
Bay Area Total	24,559	45,530	69,001	85,521	111,619	+354%

Figure 17 - Clean Air Vehicles Share of Registered 2-Axle Vehicles by County (April 2017)



Source: CAVs as a Share of All 2-Axle Vehicle Registrations (MTC)

Owners of eligible CAVs can apply for decals that permit them to use HOV and Express Lanes for a discounted toll (currently free) as a solo driver. Two types of decals are issued, white decals for Inherently Low Emission Vehicles (ILEVs) and green decals for Transitional Zero Emission Vehicles (TZEVs). Both programs expired January 1, 2019, with no cap on eligible vehicles under current legislation. Federal law allows TZEVs to continue to use HOV and Express Lanes until September 30, 2025, and ILEVs which expired September 30, 2019.

While the CAV share of vehicle registrations is small (1.8% in the Bay Area in April 2017), their prevalence in managed lanes is much greater: region-wide, 2015 data collection indicated that CAVs averaged 6% to 8% of HOV lane users, with higher concentrations in the South Bay, and CAV decal registrations have since grown by over 60%. While this represents a small proportion of HOV usage, the impact on degradation could be much greater. On the SR 237 Express Lane, Santa Clara Valley Transportation Authority (VTA) observed that in the 1st half of 2017, CAVs made up 38% of westbound AM traffic in the Express Lane and 30% eastbound PM. While CAVs are currently exempt from tolls on Express Lanes, state law requires only a reduced toll. Thus, they may also be charged a discounted toll if management of their usage of the lanes is necessary.

Two-Seater Vehicles

A second, but smaller category of exempt vehicles are two-seater vehicles. Unique to the Bay Area since 1995, state law permits two-seater vehicles with two occupants to use HOV lanes that require three or more occupants. This includes some, but not all, vans, trucks, and sports cars. The enabling legislation, AB 210, also grants toll-free or discounted toll rates to such vehicles on toll bridges and Express Lanes in the Bay Area. With the exception of the Golden Gate Bridge, all HOV3+ lanes and bridge approaches allow two-seater vehicles to use the lane and receive the carpool discount.

Guidelines for Exempt Vehicle Use of HOV and Express Lanes

Exempt vehicle use of HOV and Express Lanes is expected to increase significantly with the projected continued growth in the sale of CAVs. This is likely to accelerate as lower cost fully electric vehicles proliferate. The impacts to HOV lane operation and degradation are likely to be appreciable with this market shift, and changes to the eligibility of lane use and toll exemptions will likely be required to maintain HOV lane time savings.

As HOV lanes are converted to Express Lanes, changes to vehicle exemptions and discounted tolling of CAVs should be considered.

MLIP Recommendations and Next Steps for Exempt Vehicles

- Regular data collection on scale of CAVs using managed lanes is necessary
- On degraded Express Lane corridors consider tolling CAVs at discounted rates

Vehicle Occupancy

The minimum occupancy requirement for vehicles allowed to use an HOV facility is an effective but imprecise policy option for addressing degradation. Because of the magnitude of its impact, increasing vehicle occupancy should be one of the final policy options considered in addressing degradation. Ideally, violation enforcement and CAV exemptions should be considered first as they do not contribute to managed lanes' primary purpose of increasing passenger throughput. The occupancy requirement should be set to achieve effective utilization of the lanes and encourage use of bus transit, carpooling, and vanpooling. However, if the occupancy requirement is so low and creates so much demand that it makes the HOV facility congested, it will reduce the travel time savings and reliability that attract people to transit or carpooling. Over time, as overall traffic demand and congestion in the corridor increases, usage of the HOV lane typically increases to a point that requires adjustment of the vehicle occupancy policy to restore the travel time benefits to HOVs.

Establishing Vehicle Occupancy Guidelines

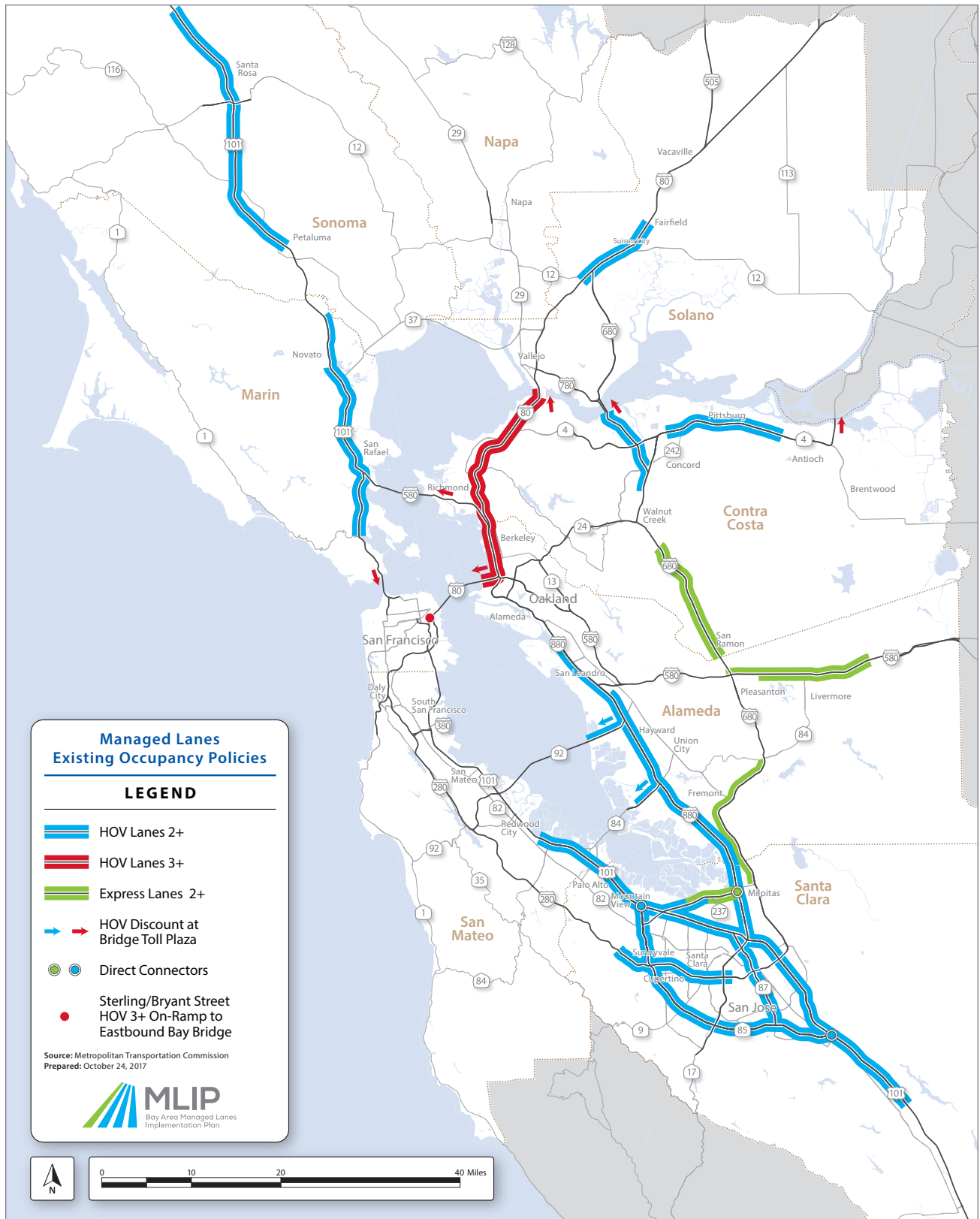
Federal statutes specify that public authorities with jurisdiction over the operation of an HOV facility have the authority to establish the occupancy requirements of vehicles on the facility with a minimum of two occupants except for specific vehicles:

1. Motorcycles
2. Public transportation vehicles and over-the-road buses
3. Tolloed, single or low-occupancy vehicles; and,
4. Low emission and energy-efficient vehicles. The latter two categories are permitted subject to meeting the minimum operating standards for HOV facilities.

Caltrans provides the following considerations in setting occupancy requirements:

- Maximizing person throughput
- Allowing for HOV growth and increased usage of the HOV facility
- Maintaining a free-flow condition, preferably Level of Service C
- Conforming to the occupancy requirements of the region, particularly connecting HOV routes
- Completion of a region's HOV system or adjacent HOV facilities could redistribute the HOV traffic, thereby making occupancy adjustments unnecessary
- Adjusting occupancy requirements to avoid the perception of lane underutilization

Figure 18 - Bay Area Occupancy Rules



Current Bay Area HOV Lane Occupancy Requirements

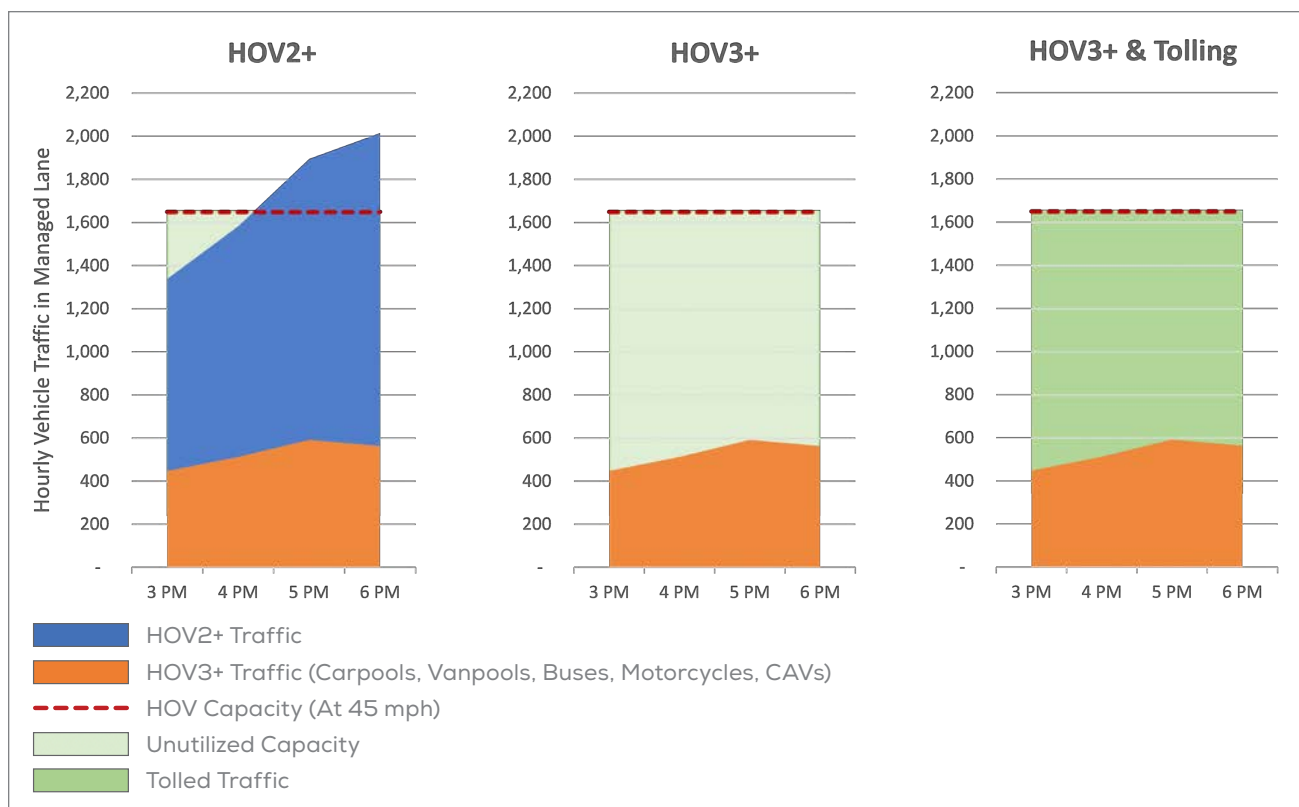
As shown in Table 3 - Clean Air Vehicle Growth in Bay Area Counties and Figure 18 - Bay Area Occupancy Rules, mainline HOV lanes in the Bay Area typically require a minimum of two occupants per vehicle (HOV 2+), with bridges generally requiring a minimum of three persons to use the HOV lanes (HOV 3+). Notable exceptions are the HOV lanes on I-80 in Contra Costa and Alameda counties which requires three occupants and the San Mateo and Dumbarton bridges which only require two occupants.

Vehicle Occupancy Policy Options

HOV lanes provide the potential flexibility to alter the vehicle occupancy levels in response to changing demands. Requirements may be lowered to encourage use, or increased in response to HOV lane congestion, and may be set by time of day. For example, the I-10 Express Lanes in Los Angeles are HOV3+ during peak periods, but HOV2+ all other times of the day.

Increasing the occupancy requirement for congested HOV lanes may be the logical solution if prohibiting other vehicles or adding additional HOV

Figure 19 - Vehicle Throughput and Capacity Utilization for HOV and Express Lanes



lanes are infeasible. However, changing minimum occupancy requirements from two to three occupants can significantly reduce the number of vehicles eligible to use the HOV lanes. Such adjustments may be severe if only a 10% to 20% reduction in demand is necessary to maintain non-degraded conditions. In addition, increasing the HOV lane occupancy requirement from two to three occupants may further deteriorate operation of the GP lanes. In such situations where increasing the occupancy requirement is necessary to address degradation, conversion of the HOV lanes to Express Lanes in conjunction with a change in occupancy requirements is a more viable option as it does not involve prohibiting any vehicles from utilizing the managed lane. This approach may involve a combination of:

Changes to Occupancy Requirements

- Increasing the minimum number of occupants from two to three, with discounted toll rates for HOV2+'s.

Changes to CAV Requirements

- Starting to toll CAVs at discounted toll rate

Use by SOVs

- Toll-paying SOVs may be permitted to use the HOV lanes as long as the lanes operate at or above the minimum operating standard
- Usage of the Express Lanes by SOVs is regulated by varying the toll rate and excluding SOVs during peak HOV demand periods

Motorcycles, transit buses, and vanpools would continue to use the Express Lanes toll-free.

Guidelines for Vehicle Occupancy Changes

Public Acceptance - It is important to consider public acceptance when making changes to HOV lane occupancy requirements and in HOV to Express Lane conversions. HOV lanes are popular among those who use them, and less popular with non-users due to perceptions of underutilization and inequity.

Changes to Carpool Policies Must be Made

Carefully - Two-person carpools make up the majority of vehicles on HOV2+ lanes and the formation of three-person carpools is known to be more difficult for commuters.

HOV to Express Lane Conversions - For HOV to Express Lane conversions, users may assume that they will maintain access to the lane. Maintaining public acceptance in conversion of HOV to Express Lanes, combined with an increase in occupancy requirements is a challenge, recognizing that some users may be negatively affected. Therefore, changes to HOV lane occupancy requirements should be considered as a last resort, after other operational policy changes have been exhausted. In order to increase the occupancy requirement on an HOV lane, it is recommended to first convert to an Express Lane. However, the opposite is not true, converting an HOV lane to an Express Lane does not necessarily require increasing the occupancy requirement.

Connecting and Intersecting Corridors - In addition, as with other operational policies, existing HOV and Express Lane occupancy requirements on connecting or intersecting routes should be considered when establishing vehicle occupancy policies. This is particularly important when direct ramps and connectors exist or are planned to minimize unnecessary weaving and HOV and Express Lane entry and exit movements that may also impact the GP lanes.

MLIP Recommendations and Next Steps for Vehicle Occupancy Changes

- Express Lanes provide a better opportunity to increase occupancy requirements than HOV lanes
- Begin tolling CAVs at a discounted rate
- Review HOV2+ occupancy requirement exceptions on bridges
 - San Mateo Bridge
 - Dumbarton Bridge
- Review HOV2+ occupancy requirement on degraded Express Lanes
 - SR 237 Express Lane
 - I-880 Express Lane
 - US 101 Express Lane
- Support strategies necessary to successfully increase to HOV3+
 - Park-Rides
 - Express Bus Service
 - Carpool Facilitation

Hours of Operation

The hours of operation of managed lanes is a critical operational policy component. Considerations for hours of operation on an HOV lane are different from an Express Lane and they will be discussed separately when appropriate.

Current Bay Area HOV Hours of Operation Characteristics

HOV Lane Hours of Operation

The HOV lanes in the Bay Area have historically provided part-time operation during commute travel peaks within an individual corridor and allow all vehicles to access the lanes during all other times to provide additional capacity. [Table 4 - Bay Area Managed Lanes Characteristics](#), [Figure 20 - Bay Area Managed Lane Hours of Operation](#), and [Figure 21 - Bay Area Managed Lane Hours of Operation Duration](#) illustrate the existing variability in hours of operation and duration of managed lanes across the Bay Area. In general, Bay Area HOV lanes operate during the peak travel periods, typically from 5:00 to 9:00 AM and 3:00 to 7:00 PM, with significantly shorter hours of operation in Marin and Sonoma counties.

The HOV approaches to the seven state-owned bridges and the HOV lanes along I-80 in Alameda, Contra Costa and Solano counties operate an additional hour longer to 10:00 AM during the morning peak period. The state-owned bridges provide a HOV toll discount during the HOV operating hours, while the toll plaza HOV lane and toll discount at the Golden Gate Bridge are only in effect for two hours in the afternoon.

Express Lane Hours of Operation

The I-580, I-680 Sunol, and Contra Costa I-680 Express Lanes currently operate from 5:00 AM to 8:00 PM. The SR 237 Express Lanes are the only Express Lanes currently operating during peak periods similar to the HOV lanes regionally (i.e.

5:00 to 10:00 AM and 3:00 to 7:00 PM). However, with SR 237 Phase 2 Express Lanes expected to open in 2019, VTA has proposed extending the hours of operation to make the 5:00 AM and 8:00 PM hours consistent with all other Express Lanes in the Bay Area.

Table 4 - Bay Area Managed Lane Characteristics

County-Route	Direction	Facility Type	HOV Occupancy Requirement	Existing Hours	
				AM	PM
Seven State Bridges	One Way	HOV	2+ and 3+	5-10	3-7
Golden Gate Bridge	Southbound	HOV	3+	5-9	4-6
Alameda/Contra Costa I-80	Both	HOV	3+	5-10	3-7
Alameda I-580	Both	Express Lane	2+	5 AM-8 PM	
Alameda/Santa Clara I-680	Southbound	Express Lane	2+	5 AM-8 PM	
Alameda/Santa Clara I-880	Both	HOV	2+	5-9	3-7
Contra Costa SR 4	Westbound	HOV	2+	5-9	-
Contra Costa SR 4	Eastbound	HOV	2+	-	3-7
Contra Costa I-680	Both	HOV	2+	5-9	3-7
Contra Costa I-680	Both	Express Lane	2+	5 AM-8 PM	
Marin US 101	Southbound	HOV	2+	6:30-8:30	-
Marin US 101	Northbound	HOV	2+	-	4:30-7
Santa Clara SR 85	Both	HOV	2+	5-9	3-7
Santa Clara SR 87	Both	HOV	2+	5-9	3-7
Santa Clara US 101	Both	HOV	2+	5-9	3-7
Santa Clara SR 237	Both	HOV	2+	5-9	3-7
Santa Clara SR 237	Westbound	Express Lane	2+	5 AM-8 PM	
Santa Clara SR 237	Eastbound	Express Lane	2+	5-9	3-7
Santa Clara I-280	Both	HOV	2+	5-9	3-7
San Francisco Sterling/ Bryant Ramp	Eastbound	HOV	3+	-	3:30-7
San Mateo US 101	Both	HOV	2+	5-9	3-7
Solano I-80	Both	HOV	2+	5-10	3-7
Sonoma US 101	Both	HOV	2+	7-9	3-6:30

Note: The seven state-owned bridges include the Antioch, Benicia-Martinez, Carquinez, Dumbarton, Richmond-San Rafael, San Francisco-Oakland and San Mateo-Hayward bridges.

Express Lane

Hours Shorter Than 5:00 to 10:00 AM or 3:00 to 7:00 PM

Express Lane and Hours Shorter Than 5:00 to 10:00 AM or 3:00 to 7:00 PM

Figure 20 - Bay Area Managed Lane Hours of Operation

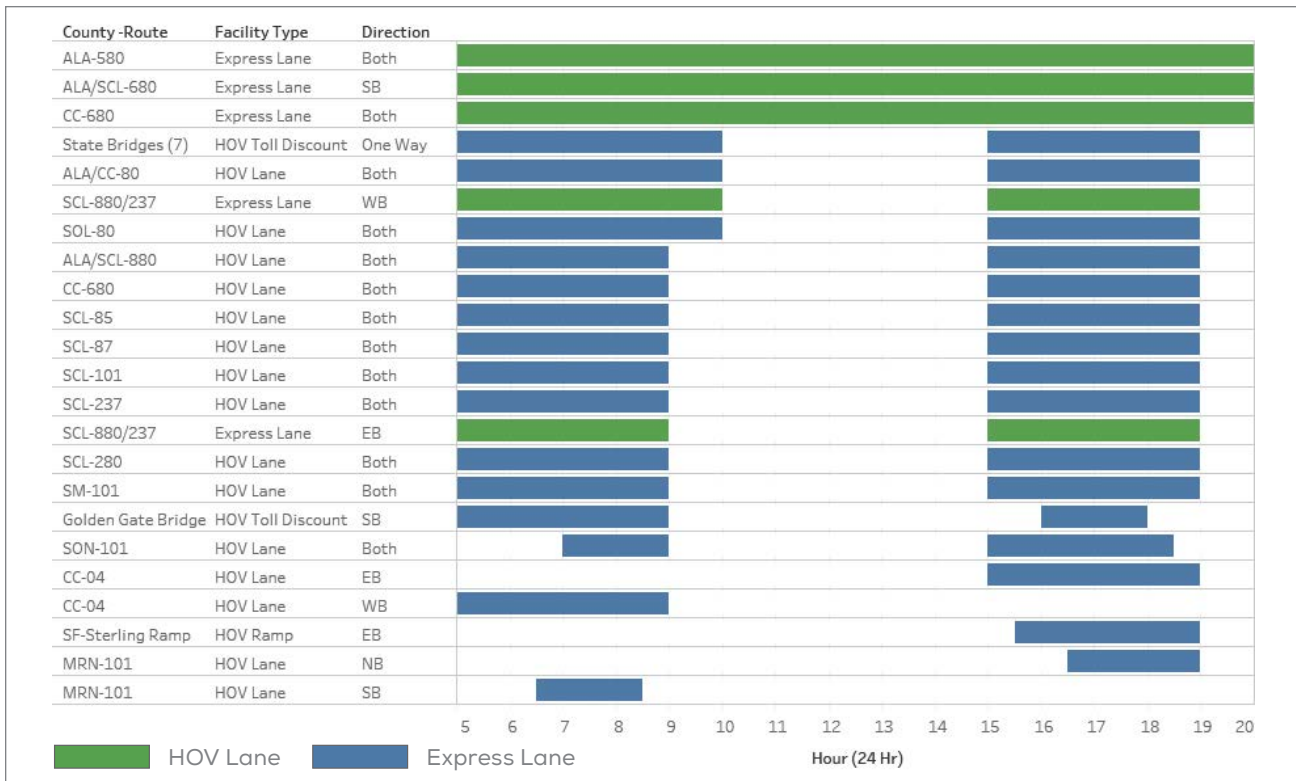


Figure 21 - Bay Area Managed Lane Hours of Operation Duration

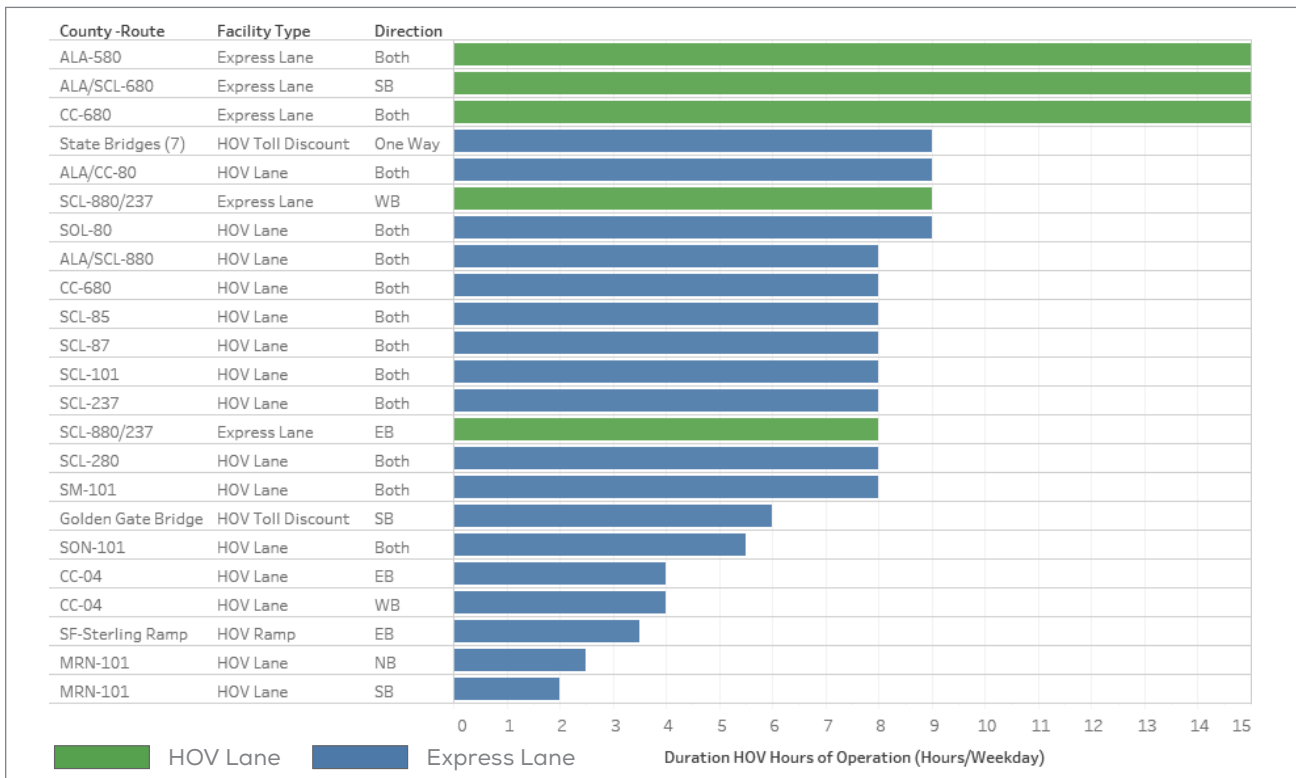
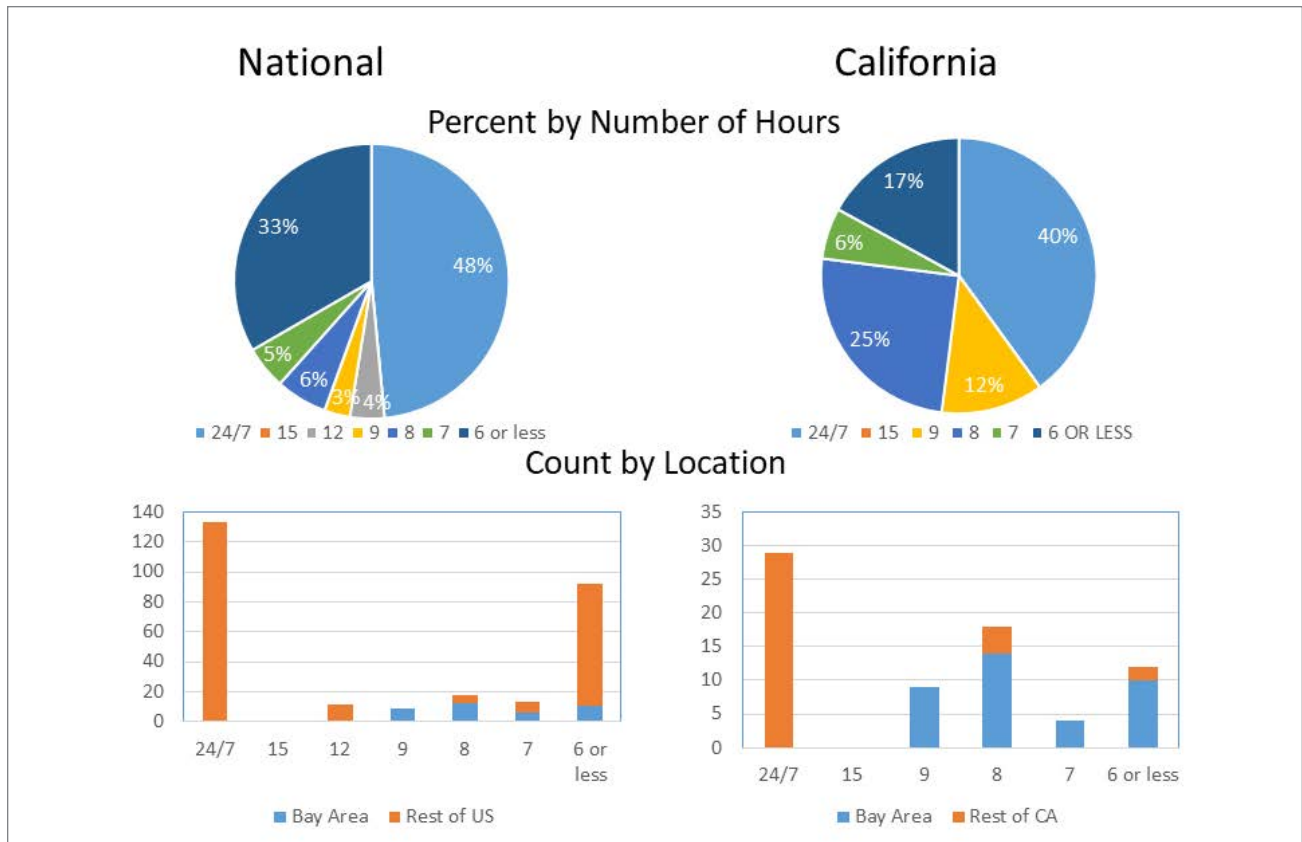


Figure 22 - National and Regional HOV Lane Hours of Operation

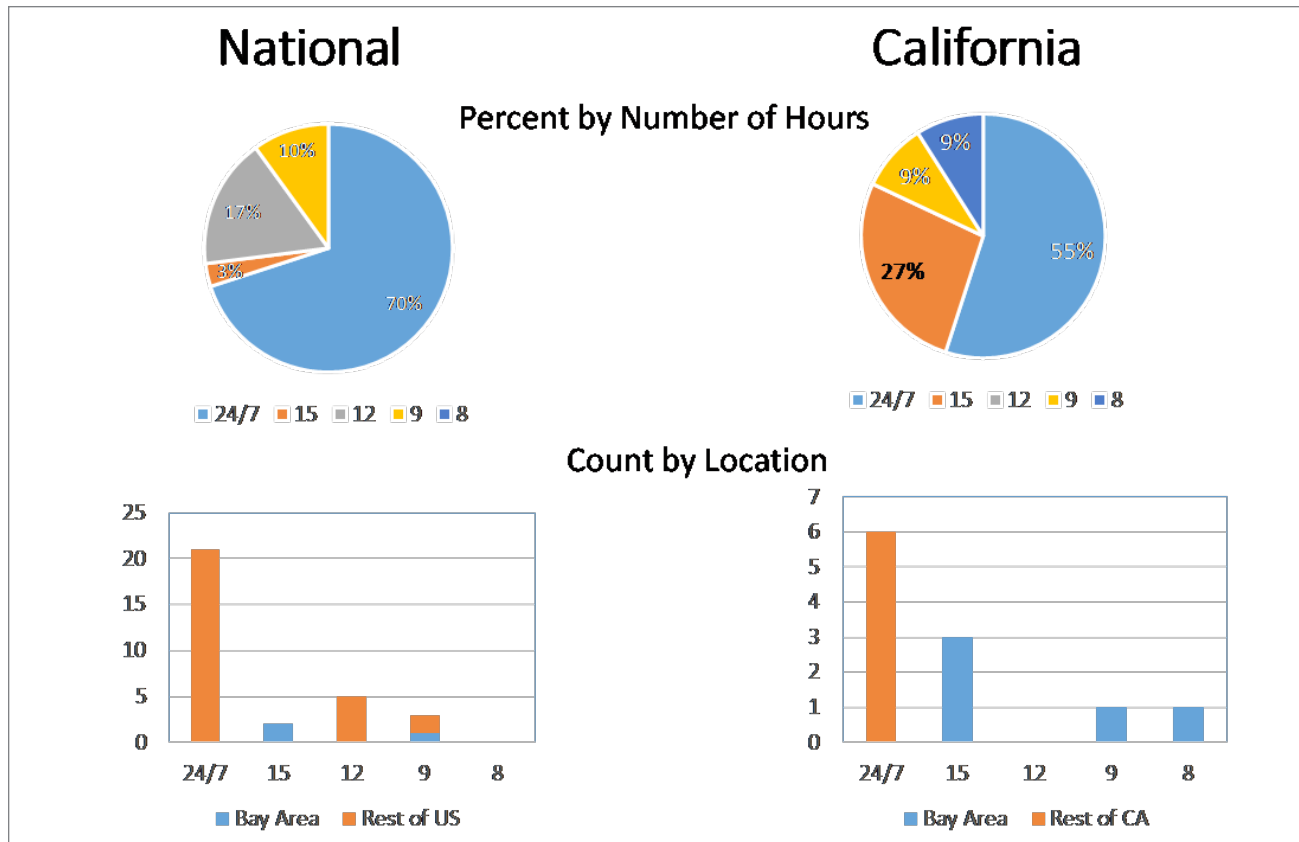


Statewide and National HOV Hours of Operation Characteristics

The Bay Area managed lane hours of operation characteristics contrast with national and statewide practice, as shown in Figure 22 - National and Regional HOV Lane Hours of Operation. The majority of HOV lanes across the country currently operate continuously (24/7) with shorter hours of operation being typical in areas that experience concentrated peak period HOV demand. The HOV

hours of operation vary significantly within California, with HOV lanes in Southern California primarily providing continuous, 24/7 operation, while the Bay Area HOV lane hours of operation are established on an individual corridor basis. This difference in hours of operation is likely related to the access configuration: in the Bay Area most HOV lanes are open access, allowing users to enter and exit the lane as needed; whereas in Southern California, access is limited typically by double white striping with openings only at certain locations.

Figure 23 - National and Regional Express Lane Hours of Operation



Statewide and National Express Lane Hours of Operation Characteristics

The existing hours of operation for Express Lanes across the nation and in California are illustrated in Figure 23 - National and Regional Express Lane Hours of Operation. Express Lanes in Southern California operate on a continuous, 24/7, basis similar to the regional HOV lanes characteristics.

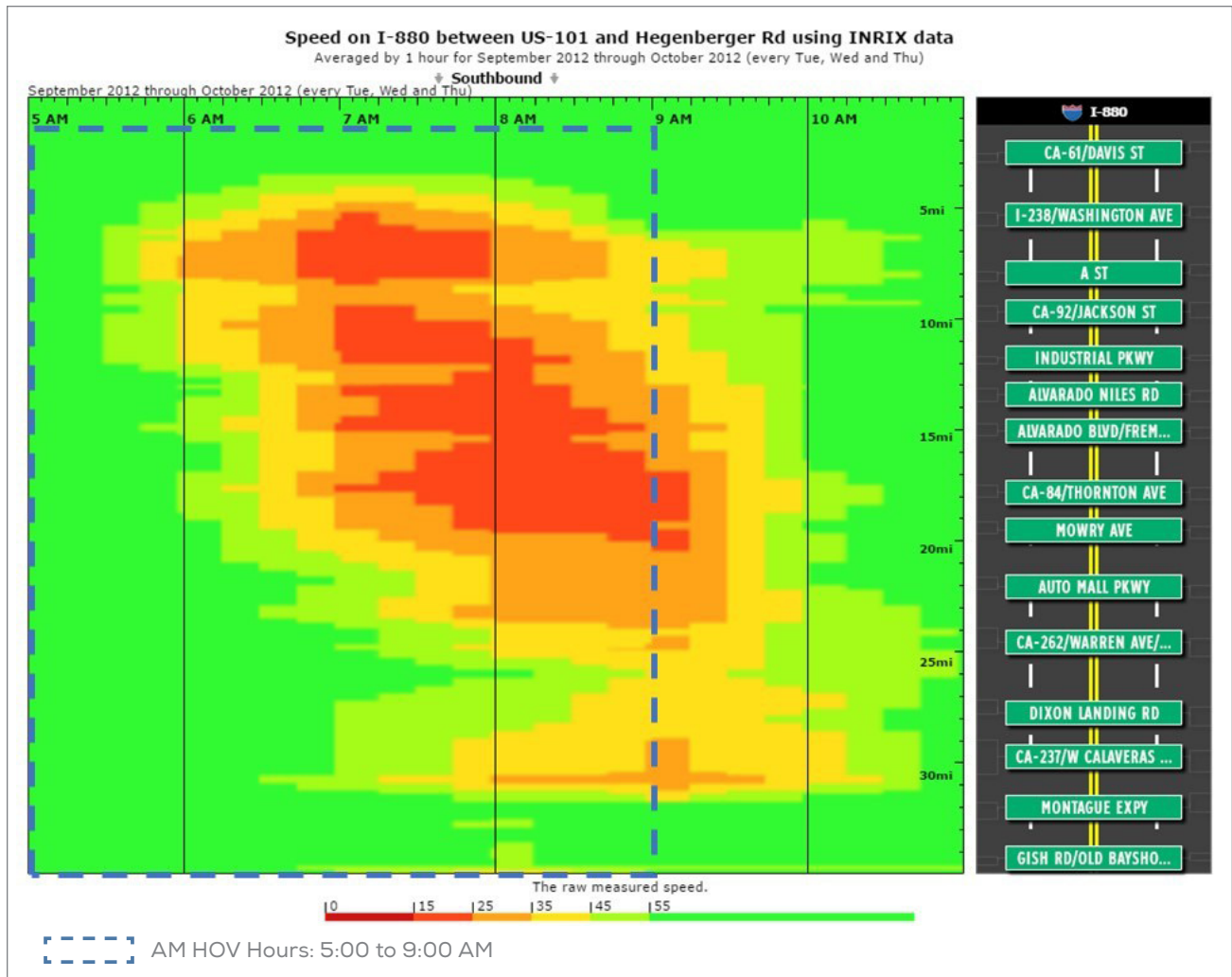
Impacts of Traffic Congestion on Managed Lane Hours of Operation

As the Bay Area has grown, traffic demand has outpaced highway capacity expansions, resulting in more congested roadways and longer peak periods. Over a three-year period, from 2012 to 2015,

congestion deterioration along several highways within the Bay Area have seen their peak periods expanding by an additional hour or more. Figure 24 - I-880 Southbound Congestion Scans - 2012 September-October Weekday AM Peak Hours presents weekday (Tuesday-Thursday) traffic congestion profiles for southbound I-880 in Alameda and Santa Clara counties for average weekday traffic speeds for September-October in 2012 and 2015 during the AM peak period.

Congestion has Grown - The heaviest traffic congestion period, representing speeds below 25 mph, has expanded from 6:30 to 9:15 AM in 2012 to 6:00 to 10:00 AM in 2015, thus lasting more than an hour longer.

Figure 24 - I-880 Southbound Congestion Scans – 2012 September–October Weekday AM Peak Hours



HOV Hours do not Match Congestion Patterns -

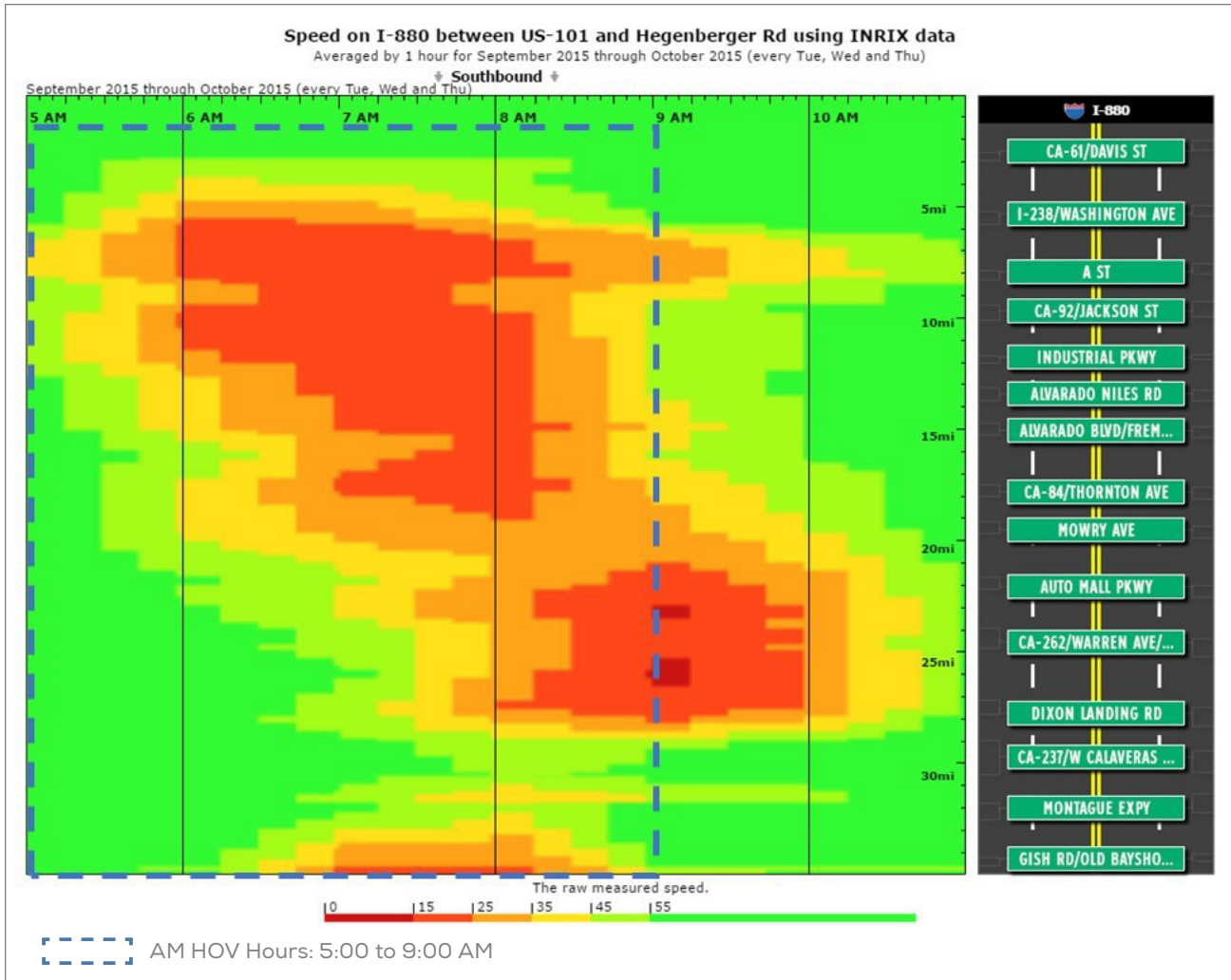
The HOV lane hours of operation (5:00 - 9:00 AM) no longer fully cover the observed peak period, as it has grown to extend beyond 9:00 AM.

Less Incentive to Carpool or Take Transit - Buses and HOV lane users are impacted by the additional GP lane congestion and growing use and degradation of HOV lane during the hours of operation. This leads to longer and less reliable travel times for

carpoolers and reduces the incentive to carpool or take transit instead of driving alone.

These trends suggest that the hours of operation of the most congested managed lanes corridors in the Bay Area need to be re-examined to ensure that the travel time incentives for more efficient travel modes such as transit and carpooling are at least preserved, if not improved.

Figure 25 - I-880 Southbound Congestion Scans – 2015 September–October Weekday AM Peak Hours



Policy Options for Establishing Hours of Operation

Statewide Hours of Operation Guidelines

Caltrans' existing guidance for determining HOV lane hours of operation is primarily based on traffic congestion and the duration of peak and off-peak periods.

Additional considerations include traffic safety, public acceptance, air quality impacts, enforcement challenges, and existing travel patterns. The Caltrans guidelines also stress "the need to maintain consistent and uniform operation on a corridor by corridor basis is required as well as an ultimate region-wide basis to avoid motorist confusion."³ While uniform hours of operation are desirable to minimize driver confusion, these variations arise from the challenge of balancing corridor operations with public acceptance, consistency, and other factors.

³ California Department of Transportation, *High-Occupancy Vehicle Guidelines*, 2003 Edition.

Several additional factors should be considered in assessing possible changes in HOV hours of operation. These considerations also vary for HOV and Express Lanes. Key factors to consider include:

- Demonstrated use of the HOV lane during other times of the day
- Level of congestion in the HOV and adjacent GP lanes
- Eligibility and access type of the HOV facilities
- Person and vehicle throughput characteristics
- Magnitude of bus operations and potential to expand bus services if extending hours of operation
- Network connectivity to other managed lanes
- Quantification of the benefits
- Perception of changes in HOV hours by users, non-users, and policy makers

HOV and Express Lane Hours of Operation Policies

HOV lanes are typically designed to address regularly occurring peak period congestion. However, Express Lanes can also address infrequent and irregular congestion through pricing such as seasonal or extended Friday afternoon traffic. In HOV corridors, drivers in the GP lanes can be frustrated by an underutilized empty HOV lane since they are prohibited from using it, but Express Lanes are an available option to all passenger vehicles. Express Lanes and their ability to use demand-responsive pricing to manage utilization of the lanes lend themselves to longer hours of operation than HOV lanes as they can always reduce toll rates when traffic is lighter.

Bay Area Hours of Operation

The HOV lane hours of operation in the Bay Area are established through the HOV Lane Committee, which serves as an ad-hoc group chaired by Caltrans with participation by MTC and the CHP.

Hours of Operation Scenarios

Typical scenario options for consideration when adjusting the HOV lane hours of operation include:

Incremental Extension of Peak-Period Weekday

Operations - Extending the peak-period HOV operation is typically considered in response to changes in travel patterns, increased HOV lane congestion at the start and or end of the current operating hours, if expanded bus service is planned or contemplated beyond the existing hours of operation, and or in conjunction with plans to achieve regional connectivity through expansions or capacity enhancements.

Midday Weekday Expansion - Expanded daytime HOV operation covers a major portion, but not all, of the entire day. This scenario covers many irregularly occurring high demand periods during the late mornings and early afternoons, as well as guards against the eventual demand increases in the shoulder hours of the peak periods.

Table 5 - HOV Hours of Operation Policy Options

Policy Scenario	Advantages	Limitations
Customized Peak-Period Hours e.g. 5:00 to 9:00 AM, 3:00 to 7:00 PM	<ul style="list-style-type: none"> • Consistent with existing practice • Hours can be expanded based on demand • Provides incentives for shoulder hours • Reduces public concerns • Allows GP lane congestion to dissipate faster at the end of peak periods 	<ul style="list-style-type: none"> • Does not address midday congestion • Complicates signage • Does not address congestion beyond hours of operation • Need regular review to address changing congestion
Expand to Daytime e.g. 5:00 AM to 8:00 PM	<ul style="list-style-type: none"> • Covers most high-demand periods • Guards against future demand 	<ul style="list-style-type: none"> • Significant change from existing policy • Complicates signage • Not always sufficient demand to fill lane in off-peak • May impact GP lane operation
Expand to Weekend e.g. 5:00 AM to 8:00 PM, 7 days/week	<ul style="list-style-type: none"> • Address growing weekend congestion, particularly recreational travel corridors • Can encourage and support new weekend transit service 	<ul style="list-style-type: none"> • Longer distance travelers • Many already in eligible carpools • Minimal existing weekend bus services • Weekend and weekday peak periods of congestion are inconsistent and would require 5 AM to 8 PM hours of operation • May impact GP lane operation

Weekend Operation - Expanding HOV or Express Lane operations to weekends may warrant consideration on heavily trafficked recreational corridors. However, there are a different set of challenges to consider on the weekend as travelers are making different types of trips, traveling longer distances, and many are already in carpools. There is also minimal bus service available for those unable to carpool.

24/7 Operation - 24/7 hours of operation are common on buffer-separated limited-access HOV and Express Lanes in other regions of California and other states, but are not well suited for the Bay Area’s network of open access managed lanes.

Table 5 - HOV Hours of Operation Policy Options summarizes several key advantages and limitations of the various policy scenarios for HOV lane hours of operation.

Guidelines for Reviewing HOV Hours of Operation

The following guidelines are provided as considerations for modifying the hours of operation of the managed lanes within the Bay Area:

HOV vs Express Lanes - Considerations of hours of operation are different for HOV lanes and Express Lanes. Extending hours of operation for HOV lanes into periods with low HOV demand can result in noticeable negative impacts on GP lane operations. This is less the case for Express Lanes, as the pricing mechanism can be adjusted to allow and encourage low occupancy vehicle use of the Express Lanes during periods of low HOV demand.

Periodic Review - HOV lane hours of operation should be periodically reviewed to see if changes in the duration and intensity of congestion warrant changes in the hours.

Based on Existing Traffic Characteristics - HOV lane hours of operation should be based primarily on existing traffic characteristics, including traffic congestion, duration of peak periods, demand for the lanes, travel patterns, and in support of existing and proposed transit service.

Consistent within Corridor - The hours of operation of the HOV lanes should be consistent within a corridor, regardless of agency or county jurisdiction, to eliminate motorist confusion and minimize disruption to both HOV lane and GP lane traffic that is likely to arise otherwise. Consistent hours of operation will improve awareness which will help in the CHP enforcement of many facilities within the region.

Intersecting Corridors - In addition, the hours of operation of existing managed lanes along intersecting routes should be considered when modifying the hours of operation along the corridor under study, and especially when direct highway-to-highway HOV and Express Lane connections exist or are planned.

Transit Services - The ability of transit service to utilize the HOV lanes, capture the travel time savings benefits, and increase person throughput should be explicitly considered when modifying the hours of operation.

Complement Other Policies - As one of several tools available for managing traffic, a consistent policy for managed lane hours of operation should complement other operational policies such as vehicle occupancy, access treatments, vehicle eligibility, and pricing.

Implement with Public Outreach - Expansions of the hours of operation will require more effective public outreach to educate the public on the managed lane basics, different types of lanes, benefits and rationale for their implementation and the typical operational benefits the public is likely to experience from the utilization of the managed lanes.

Consistent Hours for Express Lanes - As Express Lanes are implemented the current approach of expanding hours of operation to consistent 5:00 AM to 8:00 PM weekday hours will ensure time savings and reliability benefits throughout a greater portion of the day.

MLIP Recommendations and Next Steps for Modifying HOV Hours of Operation

- Finalize focused analysis and determine if changes to the HOV hours are warranted
 - Marin US 101
 - Sterling/Bryant St I-80 On-ramp – PM
 - South Bay HOV Corridors – AM
 - I-280
 - I-880
 - SR 85
 - SR 87
 - SR 237
 - US 101
 - Bay Bridge Toll Plaza (Midday and Weekend)
- Identify supportive strategies necessary to efficiently utilize HOV lane capacity when extending HOV hours of operation
 - Park-Rides
 - Express Bus Service
 - Carpool Facilitation
- Identify and analyze additional corridors with extended congestion
- Continue proactive monitoring of HOV operations

Access

The type of access provided for HOV and Express Lanes influences the demand for the lanes and affects the operational performance, design, and cost of implementation. The tolling strategy, locations, and enforcement mechanism are all dependent on the type of access provided.

HOV lanes in Northern California have historically operated as open access or continuous access facilities, while those in Southern California oper-

ate as limited or restricted access facilities. While experience has shown that HOV lanes can operate equally well under both open or limited access, recent national practice has been to restrict access when the lanes are converted to Express Lanes to facilitate toll collection and violation enforcement.

This norm has recently been reconsidered as agencies have faced dual challenges of maintaining access to communities along the corridors and constrained right of way in dense urban corridors. The initial Bay Area Express Lanes were implemented as limited-access lanes (I-680 Sunol and SR 237). More recent Express Lanes, such as those implemented on I-580 in Alameda County and I-680 in Contra Costa County, are operated as open access lanes with restrictions only in specific, highly congested sections.

A recent six-month pilot project conducted by Santa Clara County converted approximately 4,100 feet of the westbound SR 237 Express Lane between Zanker Road and North First Street in San Jose from limited to open access to allow eligible carpoolers from Milpitas to gain access to the carpool lane at an earlier entry point and paying Express Lane users to exit at an earlier exit point. A safety and operations study conducted for the pilot project indicated an improvement in operation and the open access has been maintained since.

Which Type of Access is Appropriate?

Caltrans permits either open or limited access managed (HOV and Express Lanes) under Traffic Operations Policy Directive 11-02, with the type of access to be determined based on engineering studies comprised of traffic operations and safety analyses.

Table 6 - Limited Access

Criteria	Pros of Limited Access	Cons of Limited Access
Operations/Safety	<ul style="list-style-type: none"> • Smoother flow, higher speeds which support transit and carpool • Encourages use for longer trips • Can be used to restrict lane changing at high traffic locations • Easier to close for maintenance/incidents 	<ul style="list-style-type: none"> • Drivers unable to access when needed • Could induce lane violations • Need to monitor access point operations • Concentrates demand at specific locations • More difficult to access ramps • May restrict transit access
Enforcement	<ul style="list-style-type: none"> • Potentially lower toll evasion and occupancy violation • Easier to enforce 	
Costs/Implementation		<ul style="list-style-type: none"> • May require more roadway width for buffer and access points • Closely spaced interchanges limit access locations • Additional pavement marking and signing

Table 7 - Open Access

Criteria	Pros of Open Access	Cons of Open Access
Operations/Safety	<ul style="list-style-type: none"> • Allows easy driver access • Less complex driver decision-making • Easier access to ramps • Distributes managed lane demand 	<ul style="list-style-type: none"> • Potential for unexpected vehicle entry and exit, especially with heavy GP traffic • May reduce managed lane speeds and decrease incentive for transit and carpool • Allows last minute lane changes to access highway ramps
Enforcement		<ul style="list-style-type: none"> • May result in higher toll evasion and occupancy violations
Costs/Implementation	<ul style="list-style-type: none"> • Lower cost of design and construction 	<ul style="list-style-type: none"> • Increased cost of Express Lane toll collection • More frequent toll readers and violation cameras

Both open and limited access HOV and Express Lanes entail tradeoffs in accessibility, operational flexibility, enforcement, and customer satisfaction. The majority of HOV lanes in the Bay Area operate alongside the GP lanes, with little or no separation between them.

Managed lane access to the lanes is governed by operations and safety considerations, enforcement needs, transit access, tolling requirements, and cost. The tradeoffs among these considerations is illustrated by the following:

Caltrans research on open and limited access HOV lanes indicated no noticeable difference in safety and operational performance of the two approaches. While site-specific differences were observed, both access approaches provided generally comparable operational and safety performance.

The State of Washington recently completed a pilot study that converted the SR 167 Express Lanes from limited to open access for the 10-mile corridor. The pilot study indicated significant public support for open access and improved perceptions of convenience from the public and transit bus operators. While insufficient data was available to make conclusions on the safety impacts, a modest increase in collisions was observed, although the severity of collisions did not indicate a significant change due to the conversion to open access. Increases in travel times and a drop in the reliability of both the HOT and GP lanes were observed after conversion.

Guidelines for HOV and Express Access

Based on available research, both open and limited access HOV and Express Lane operations appear to be viable options. Consequently, recommendations on access include the following:

Evaluate Open and Limited Access - Both open and limited access options should be evaluated when designing new HOV or Express Lanes, including restrictions on access for specific roadway sections that present operational challenges.

Limit Access for Operations and Safety - Where operational problems due to merging or diverging traffic cause degradation on open access managed lanes, short sections of limited access should be considered as a solution similar to those on the I-580 Express Lanes near I-680 and those planned for the I-880 Express Lanes near SR 92. Engineering studies, including traffic operations and safety assessments, should be conducted for individual corridors as the impact of the type of access is often dependent on the traffic demand, trip characteristics, roadway configuration, and geometry.

Access for HOV to Express Lane Conversions - Driver experience and familiarity with existing open access HOV lane operation in the Bay Area is a significant factor to consider in determining the type of access selected for HOV to Express Lane conversions.

Consistency - Consistency in the type of access is more important within a specific corridor, than across the region. While regional consistency in the selection of HOV and Express Lane facilities access is desirable, clear roadway signage and pavement marking can largely address driver expectations and guidance needs among corridors with varying access applications.

MLIP Recommendations for Access Restrictions

In specific managed lane locations where the existing access configuration causes safety or operational issues, consider piloting access restriction changes.

Express Bus/ Park-Ride Network



MLIP

Bay Area Managed Lanes
Implementation Plan

Express Bus/ Park-Ride Network

Overview

A discussion of HOV lanes and Express Lanes is not complete without also discussing the high occupancy vehicles themselves. While managed lanes that offer travel time savings and reliability can provide great incentive for travelers to carpool or take transit, without transit services in place or convenient locations to access transit or form carpools, the full potential of managed lanes to move more people may not be realized.

To improve the efficiency of the managed lanes network, the focus must be on increasing the number of persons, rather than vehicles, using managed lanes. Transit is critical to achieve the third goal of the MLIP: Person Throughput (Efficiency). Buses can move large numbers of people, greatly increasing the person-carrying ability of managed lanes. HOV and Express Lanes, when managed well, can offer the benefits of travel time savings and improved reliability for transit riders and reduced operating costs for transit providers, which may allow services to expand without additional resources.

The other element to this relationship between transit and managed lanes is providing first and last-mile options to allow commuters to access these express bus services. While there are many first and last-mile solutions, park-rides remain an important first-mile solution to provide access to higher-occupancy vehicles, especially in lower-density areas. They serve as a node where people can gather to board transit vehicles or use ride-sharing.

The integration of managed lanes with transit and park-ride opportunities is important to provide well-managed lanes that offer travel time savings, express buses to take advantage of the travel time



Integrated Managed Lanes, Express Bus, and Park-Ride Network

savings offered by these lanes, and park-rides to access these services. Park-rides may also speed up express bus services by making fewer stops, thus saving passengers more time. New park-ride facilities and express bus stops should take into the consideration the need to integrate with the needs and plans of the surrounding community. Safety and security must also be considered, as well as bicycle and pedestrian access. With any operational changes to managed lanes or new managed lanes

projects, transit and park-ride improvements should be coordinated to improve or create options for commuters to take transit or carpool. The private sector is also playing a growing role, providing new types of transit and ride-sharing options, first and last-mile options, and tools to manage park-ride assets more effectively. MLIP envisions an integrated regional network of non-degraded managed lanes, express bus services, and park-ride facilities.

In particular, express bus service which use the managed lane network will:

Improve Efficiency - Increase the person throughput of the regional managed lanes network without building new highway capacity. In turn, more efficient managed lanes will improve the productivity of transit through improved travel times which will lead to increased ridership and reduced operating costs or more service for the same amount of funds. Increased ridership will also lead to improved fare-box recovery, which also reduces operating costs.

Improve Connectivity - Close gaps in the long distance regional transit network between origins and destinations that are not well served directly by transit today.

Enhance Reliability - Provide transit riders with consistent peak period travel times, allowing them to better plan their trips and make more effective use of their time, thus making transit a more viable option.





National Experience

In the Bay Area, as in other parts of the country, the first HOV facilities opened as bus-only lanes. To avoid underutilizing the facilities, they were later changed to allow carpools. As the Bay Area and other regions around the country are employing strategies to manage these lanes even more effectively, the opportunities for transit grows as buses can take advantage of greater time savings and reliability.

Transit has played a prominent role in the development of managed lanes in other areas of the country. In fact, the first highway HOV facility in California started as a busway. The El Monte Busway (I-10/San Bernardino Highway) in Los Angeles was initially only available for buses when it opened in 1973. Three-person carpools were allowed to use the bus lane for three months in 1974 during a strike by bus operators, and thereafter it was converted to an HOV3+ lane in 1976. It is one of the most efficient HOV facilities in North America, carrying over 18,000 daily bus riders. It has since allowed HOV2+ during off-peak hours and has been converted into a high-occupancy toll lane to allow low-occupancy vehicles to utilize excess capacity on the lane.

In San Diego, the I-15 managed lanes were the nation's first Express Lanes to use dynamic pricing. From their inception, Express Lane revenues were dedicated to corridor transit and park-ride improvements. The managed lanes are now served by three high-frequency, long distance express bus *Rapid* routes. Direct access ramps provide

Figure 26 - National Examples of Managed Lane Express Bus Concepts

Bus Toll Lanes, Tampa	Metro Express Lanes, Houston	I-15 Managed Lanes, San Diego	US-36 Managed Lanes Denver
 <p>New Lanes in Limited-Access Highway in Existing Right of Way</p> <ul style="list-style-type: none"> • Uses transit to add new capacity on price-managed lanes • Lanes are owned by and dedicated first to transit • Price management = free flow operations • Guaranteed capacity, level of service • Schedule reliability and lower fares for BRT and express bus 	 <ul style="list-style-type: none"> • Metro, the regional transit operator, manages 85 miles of Express Lanes • Buses are viewed as the priority user of the lanes • Pricing is used to ensure reliable operations 	 <ul style="list-style-type: none"> • <i>Rapid</i> transit service: This high-frequency, limited stop transit system connects communities in the I-15 corridor to regional destinations through upgraded transit stations • Three <i>Rapid</i> routes are funded from toll revenues • Includes Direct Access Ramps (DARs) and transit stations 	 <ul style="list-style-type: none"> • Concession agreement with the private operator includes a transit service quality threshold, which when exceeded, triggers conversion from HOV2+ to HOV3+ • The Flatiron Flyer BRT service offers service every 4 to 15 minutes during peak hours and every 15 minutes off-peak, Monday through Friday

for access to and from the Express Lanes without having to weave across the GP lanes and highway transit stations provide convenient transit access opportunities and connections to other local and regional services.

In Houston, Texas, the Metro transit system is the owner of the regional Express Lane network. These were mostly HOV lanes that were converted to Express Lanes with the objectives of enhancing the regional transit network and increasing transit ridership.

In Tampa, Florida, the Tampa-Hillsborough Expressway Authority is working to implement a bus toll lane concept where toll lanes will be added with the

primary function of supporting a regional express bus-on-freeway program. The revenues from the Express Lanes would be used to fund the transit services as well as to support the financing of the Express Lane project.

In Denver, Colorado, the concession agreement for the privatization of the US 36 Express Lanes included express bus travel times as a trigger point or threshold for converting operations to HOV3+. This clearly indicated strong policy support for maintaining acceptable travel speeds for express buses and encouraged express bus use of the corridor.

Bay Area Experience

Existing Transit Services

Several Bay Area transit operators provide express bus service that use the managed lanes network as shown in [Figure 27 - Existing Express Bus Service](#). Golden Gate Transit, AC Transit, WestCAT, and SamTrans provide express bus service for commuters to and from San Francisco. Other agencies such as Soltrans and FAST provide express bus routes that connect to BART. AC Transit also operates services connecting the East Bay across the San Mateo-Hayward and Dumbarton Bridges.

Express bus service on highways using managed lanes can have a substantial impact on the person throughput of the highway. For example, on US 101 northbound near the Tiburon interchange during the two-hour PM peak period, 85 buses, representing 3% of the vehicles in the HOV lane, carried an estimated 2,465 persons. This is 37% of the persons traveling in the HOV lane and 15% of the persons traveling on the highway in that time period. These 85 buses represent 1,230 two-person carpools. The HOV lane would not be able to accommodate this many additional carpools.

The various transit agencies each have their own funding sources, service areas, and goals. Because of this, the operation of service beyond an agency's jurisdictional boundaries are usually limited, even though potential transit riders would often like to

see services crossing these boundaries. There is a high level of service provided to and from San Francisco, but the amount of service to the major job centers outside of San Francisco, and particularly to Silicon Valley job centers, is much lower. There are rail options, but many employment sites are not located within walking distance of train stations and may not have connecting shuttle or transit service.

With these gaps in express bus service, many private employers and private shuttle operators have rushed in to fill these gaps. In recent years, the number of long-distance commuter bus shuttles provided by private employers has grown dramatically, with ridership growing by over a million boardings each year, or about 4,000 average weekday boardings from 2012 to 2014.⁴

However, transit operators, both public and private, face the challenges of operating service in a managed lane network that does not function as well as it could. HOV lane degradation, limited hours of HOV lane operation that do not cover peak transit periods of service, and gaps in the HOV network all contribute to limited time savings and service unreliability, as well as increased transit operating costs. With HOV degradation, some bus drivers do not take advantage of existing HOV lanes because of the level of degradation or the difficulty of navigating in and out of the lanes. In recent years, operators have had to adjust their express bus schedules to account for increased travel time and declining reliability of managed lanes.

4 Bay Area Council and MTC 2016 Bay Area Shuttle Census

Figure 27 - Existing Express Bus Service



- Golden Gate Transit operates service from Sonoma and Marin counties to and from San Francisco, with an estimated 10,200 boardings on 350 weekday bus trips in the US 101 corridor.
- Soltrans and FAST provide express bus service on I-80/I-680 that connects to BART stations, with an estimated 1,100 boardings on 69 weekday bus trips.
- SamTrans dramatically scaled back express bus service between San Mateo County and San Francisco due to the last recession, but major employers now operate 280 private shuttles on US 101 in the PM peak period.
- AC Transit operates Transbay bus services on three bridges (Bay Bridge, San Mateo-Hayward Bridge, and Dumbarton Bridge) with 12,700 average weekday boardings using 350 weekday bus trips.
- VTA has an express bus network that primarily operates within Santa Clara County, with a few lines that connect to BART.
- WestCAT provides its Lynx express bus service from Hercules to San Francisco via I-80 with 925 boardings in 40 weekday bus trips.

Figure 27 - Existing Express Bus Services illustrates that beyond San Francisco and a few other destinations, most express bus service remains within the jurisdiction of the transit agency. Key features of existing express bus services include the following:

Figure 28 - Daily Express Bus Trips

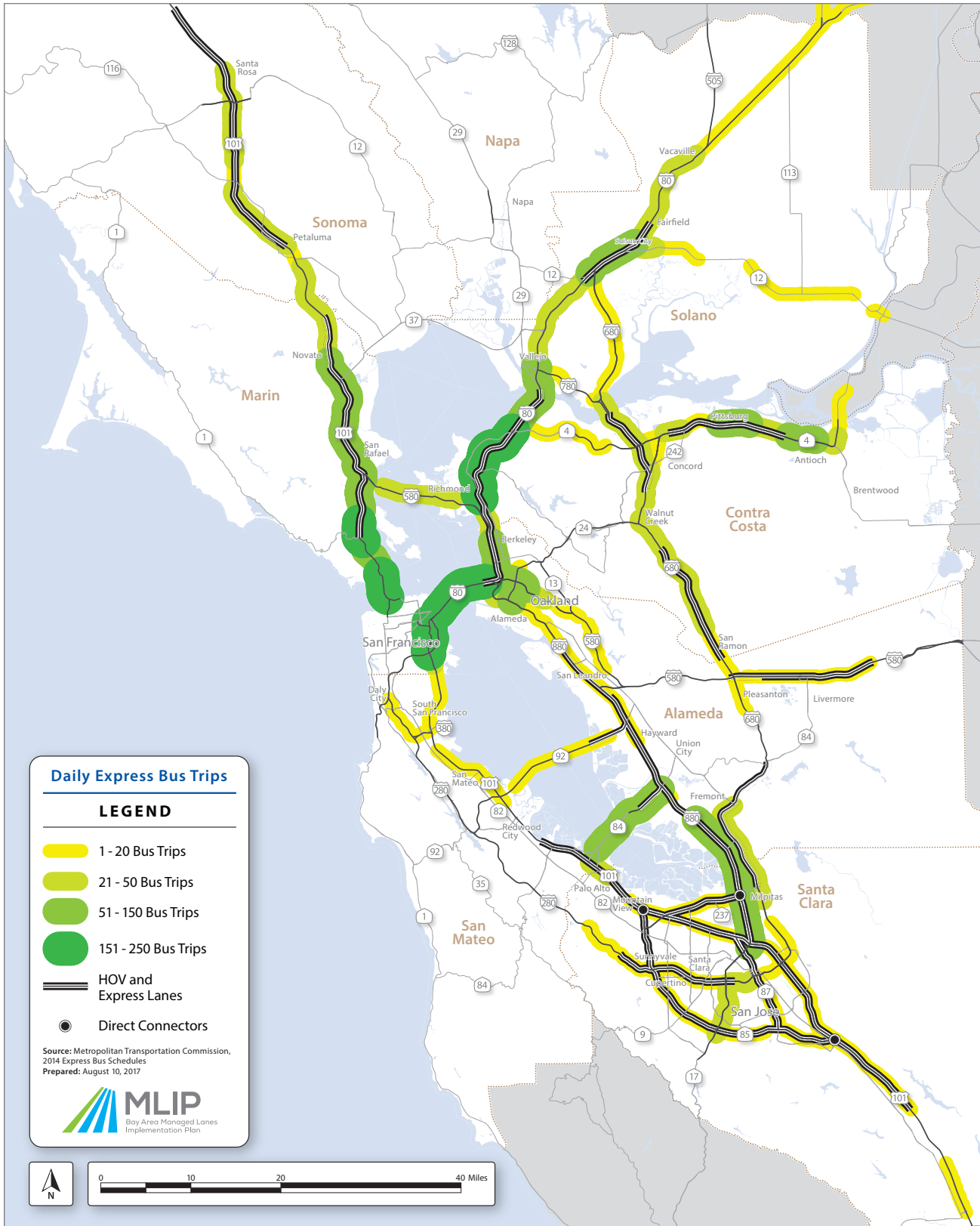


Figure 29 - Existing Weekday Public Transit Ridership - US 101 Sonoma-Marin



Figure 30 - Existing Weekday Public Transit Ridership - I-80 Contra Costa-Alameda

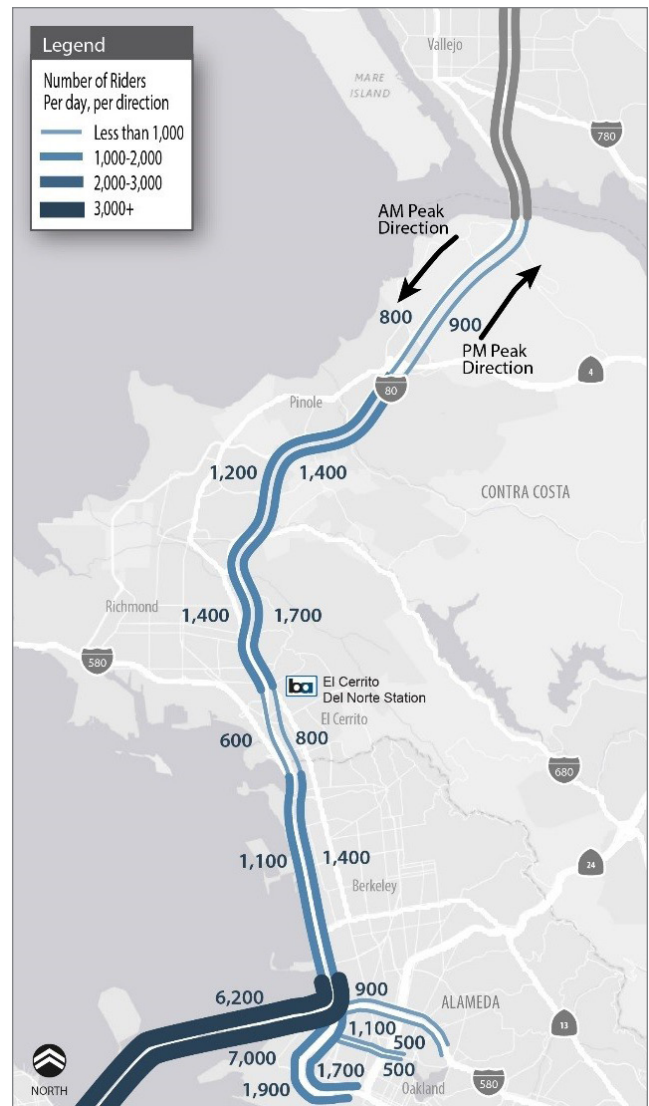
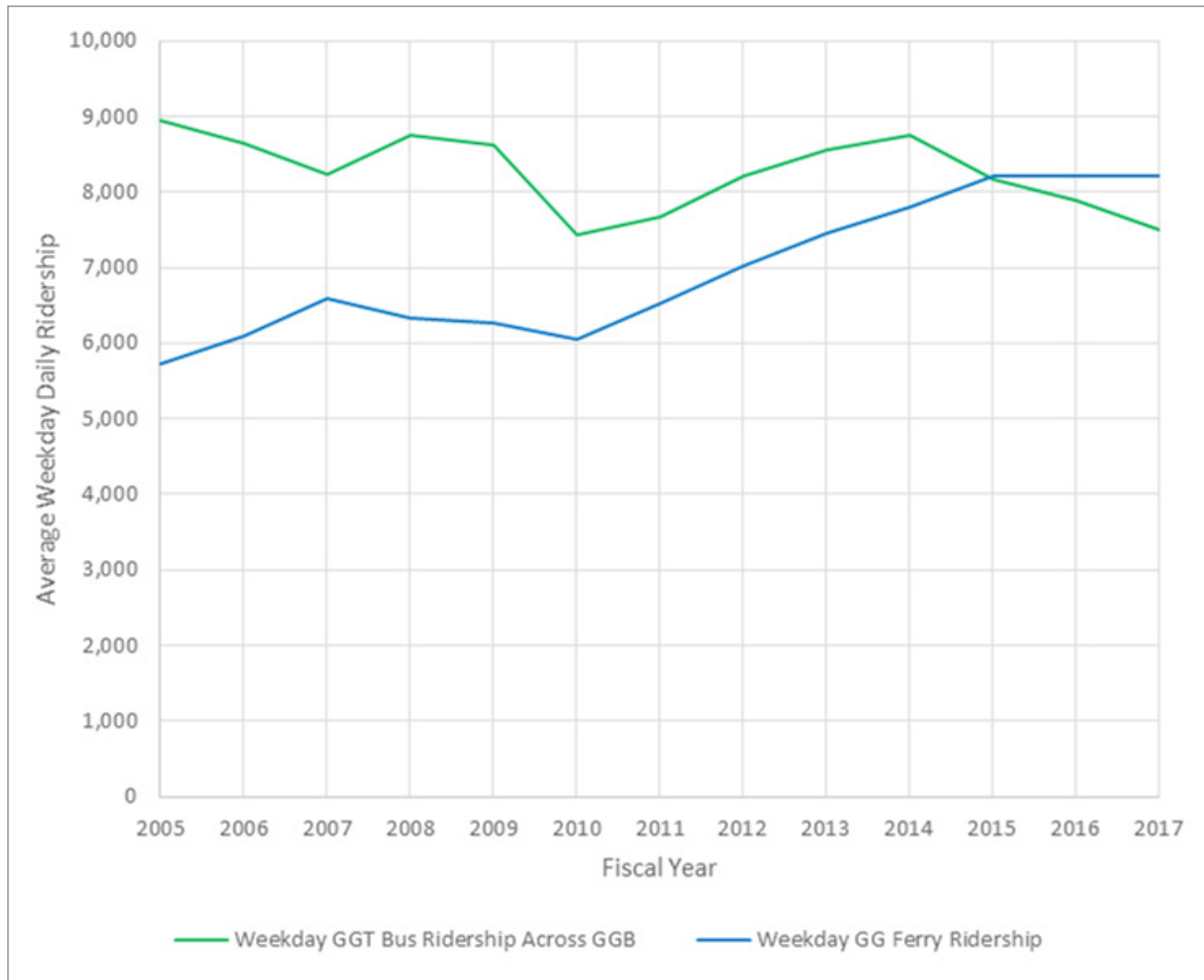


Figure 31 - Historical Golden Gate Transit Express Bus and Golden Gate Ferry Ridership Between the North Bay and San Francisco



Transit Ridership

The existing express bus service in the Bay Area carries a significant number of transit riders. The two most heavily used corridors are I-80 in West Contra Costa and Alameda Counties and US 101 in Sonoma and Marin Counties. [Figure 29 - Existing Weekday Public Transit Ridership - US 101 Sonoma-Marin](#) and [Figure 30 - Existing Weekday Public Transit Ridership - I-80 Contra Costa-Alameda](#)

show estimated current weekday transit ridership accommodated by public transit services in these two corridors. The highest estimated volume of express bus transit ridership occurs on the Bay Bridge with 13,200 weekday riders. In southern Marin County, transit volumes are also quite large, with an estimated 9,900 weekday riders. There may also be a substantial number of transit riders using US 101 in the San Francisco-San Mateo-Santa Clara corridor; however, the bulk of transit services

using this corridor consist of employer shuttles and private transit services to San Francisco International Airport. Ridership information was not available for these services.

Some corridors have multiple transit mode options such as between Marin County and downtown San Francisco, which are served by Golden Gate Transit express bus and the Golden Gate Ferry. [Figure 31 - Historical Golden Gate Transit Express Bus and Golden Gate Ferry Ridership Between the North Bay and San Francisco](#) shows that in the 12 years between 2005 and 2017, ferry ridership increased by 43% while Golden Gate Transit express bus ridership to and from San Francisco decreased by 16%. Overall, combined express bus and ferry ridership to and from San Francisco increased by 7% over the same period. There are likely multiple factors that led to these changes but one critical reason is that congestion on US 101 has increased express bus travel times while ferry travel times have not been impacted.

In summary, while today Bay Area transit operators are providing significant levels of express bus service that use portions of the managed lane network, there are issues which are hampering the use of these services and the ability of the operators to expand their services. These issues relate to:

- Degradation of the HOV lanes which increase travel times and reduce reliability
- HOV lane hours of operation that fail to cover the full peak travel period transit schedules
- Inability to offer service that cross county or transit service area lines due to institutional and funding issues

Express Bus Planning

This effort focused on two basic elements:

Enhancing Existing Express Bus Service – MTC collaborated with key transit operators to identify improvements to services and facilities that would address current and near-term future needs.

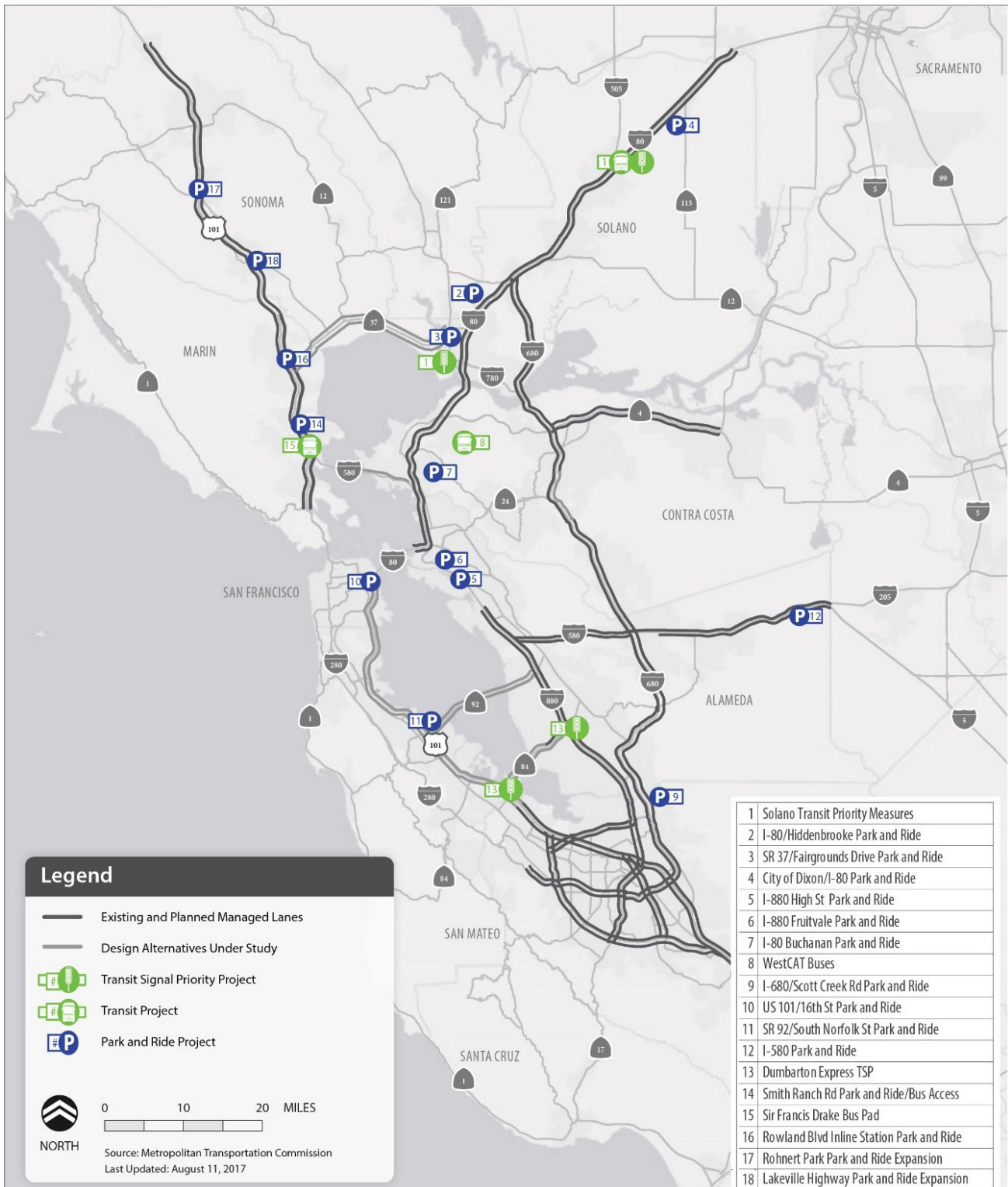
Conceptualizing New Express Bus Service – Utilize the existing and expanded managed lanes network.

Potential Transit Improvements

To improve transit service using managed lanes, MTC collaborated with the transit agencies that provide express bus service to identify potential improvements to transit and park-ride infrastructure and services. As with other improvements identified for network expansion, these improvements are focused on the near-term, 5-10 year timeframe, with relatively low cost. There are other major projects that are higher priorities for transit or local agencies, but these projects are not included due to their higher cost and longer timeline or because they did not have a direct relationship to the usage of managed lanes. [Figure 32 - Potential Transit and Park-Ride Projects](#) provides the location and the nature of each of the projects. The proposed improvements are focused in four corridors:

US 101 – Marin-Sonoma – Golden Gate Transit proposed a number of park-ride and bus stop improvements. These include expanding an existing park-ride, reconfiguring an existing park-ride for improved bus circulation, establishing an inline station, and establishing a bus stop to provide regional connections to the ferry terminal and SMART train station.

Figure 32 - Potential Transit and Park-Ride Projects



These projects would enable Golden Gate Transit to make improvements to service by realigning routes, reducing travel times, and improving connections to other services.

I-80/I-680 – Solano – Solano Transportation Authority, through its Transit Corridor Study, identified priority locations for park-rides and transit priority measures.

I-80 – Contra Costa–Alameda – With WestCAT’s Lynx service between Hercules and San Francisco at capacity, WestCAT proposed double decker vehicles to increase capacity on its existing service. Additionally, MTC is planning a commuter parking lot at I-80 and Buchanan in Albany using Caltrans right-of-way under the freeway. The project will establish a bus stop and passenger loading area near the lot so that buses and carpools can stop to pick up passengers. The double-decker buses and the commuter parking lot have been funded through Bay Bridge Forward.

SR 84 (Dumbarton Bridge) – Alameda–San Mateo – Transit Signal Priority improvements would be made on key streets connecting to the bridge corridor to reduce transit travel times.

Other Park-Ride Opportunities – MTC has been working with Caltrans and the Alameda County Transportation Commission to identify potential park-ride opportunities along I-880, I-680, and I-580.

Bay Bridge Forward

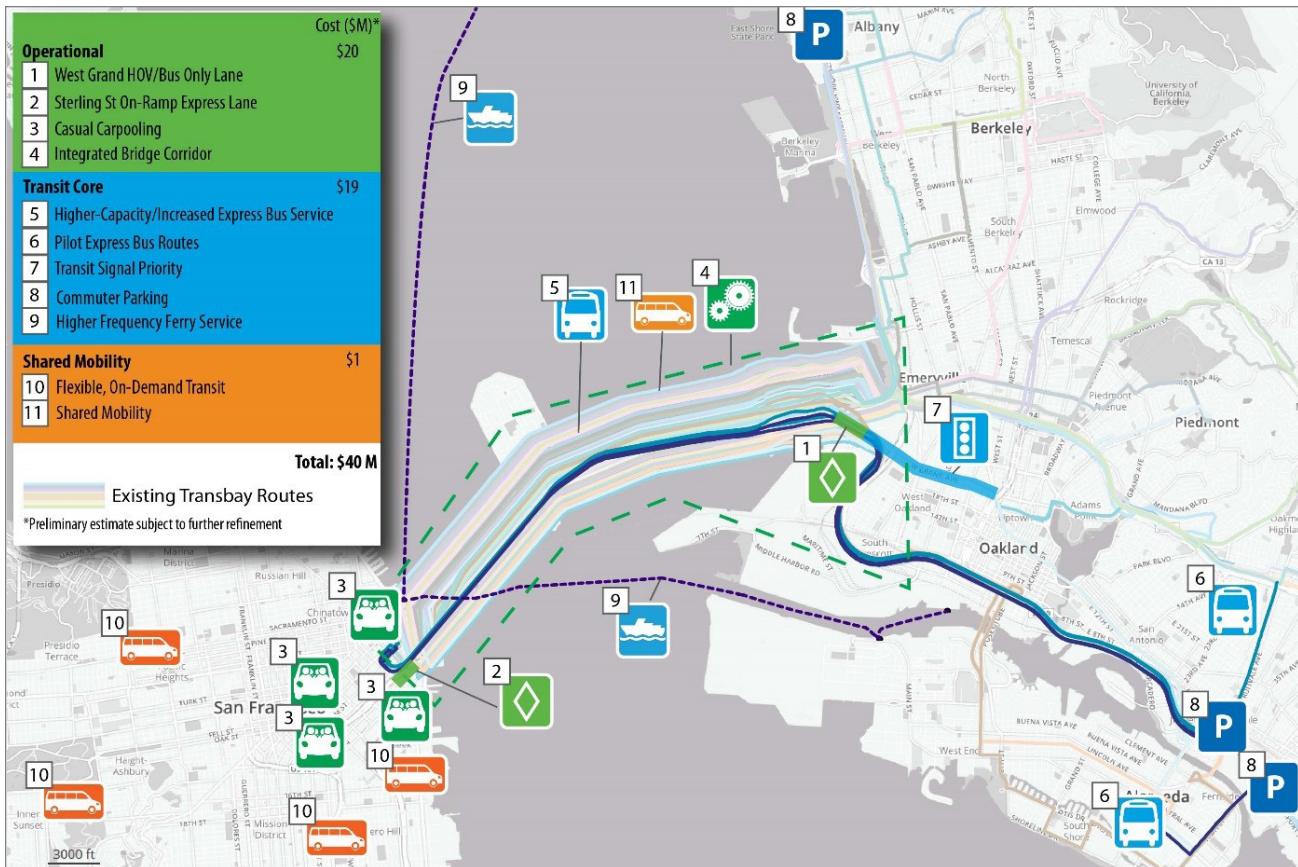
Bay Bridge Forward is a suite of near-term projects with \$40 million in funding to improve person throughput along the Bay Bridge corridor. Several project concepts were born out of MLIP and have been mentioned in this report. Some projects will improve travel options on the managed lanes leading to the Bay Bridge and some concepts could be applied to other corridors. The projects are shown in [Figure 33 – Bay Bridge Forward](#) and a few are highlighted below:

West Grand HOV/Bus Only Lane – This project extends an existing HOV lane farther east by converting the existing shoulder to a bus lane that will be open to HOVs during the peak periods. The project is intended to allow buses and HOVs to access the lane earlier and avoid the congestion that often occurs on the ramp.

Enforcement – As part of improvements to the Sterling St/Bryant St on-ramp in San Francisco, there will be a pilot of vehicle occupancy detection technology at the HOV on-ramp, which currently experiences high HOV violation rates and degradation. In conjunction, MTC will also pilot CHP enforcement strategies, including at the Sterling St/Bryant St on-ramp, to test which enforcement strategies will improve performance of HOV lanes.

Increased Express Bus Service – Bay Bridge Forward helps fund the refurbishment of buses and increased service for the most productive AC Transit Transbay bus routes, most of which are in the North Oakland/Berkeley area and use the I-80 highway.

Figure 33 - Bay Bridge Forward



Double-Decker Buses - Double-decker buses for WestCAT’s Lynx service as well as for AC Transit to increase capacity on their most productive routes.

Casual Carpooling - MTC is pursuing options to improve stop locations or casual carpool information on the I-80 corridor.

Commuter Parking - These lots are located in areas that would conveniently serve commuters to San Francisco, and there is some interest from employers in using these facilities to serve their employees heading to the Peninsula and South Bay.

New Regional Express Bus Service

Managed lanes represent a great opportunity to enhance existing express bus service or provide new ones. With improved operations of managed lanes or new managed lanes, the travel time savings and reliability offered could increase demand for existing service or create a demand for services that currently do not exist.

Service Expansion

Golden Gate Transit identified two of their express routes which travel through Sonoma and Marin counties to downtown San Francisco, the 72x and 101x, as strong candidates for service expansion, particularly if managed lanes operations improve. If weekend HOV hours were to be piloted on I-80, WestCAT is interested in piloting Saturday service between Hercules and San Francisco, given it's frequently requested among surveyed customers. With the future I-80/Buchanan Street commuter parking lot, AC Transit's Transbay Route L could easily be modified to add a stop at the new lot; however, because it is currently running near capacity, additional service would likely be needed to serve passengers at the lot.

Pilot Services

New express bus service using managed lanes can make transit a viable option for existing auto travelers. Concepts were developed for potential near- and mid-term express bus routes that would serve intercounty commute trips that are currently made on congested highway corridors.

With the planned I-880/Fruitvale Avenue and I-880/High Street commuter parking lots, AC Transit is interested in piloting service to San Francisco that would pick up at these lots. The MLIP project team proposed pilot service from western Contra Costa County to the San Francisco Civic Center or hospital campuses with dense employment outside of downtown San Francisco and currently not well-served by transit.

Regional Express Bus Concept

Process

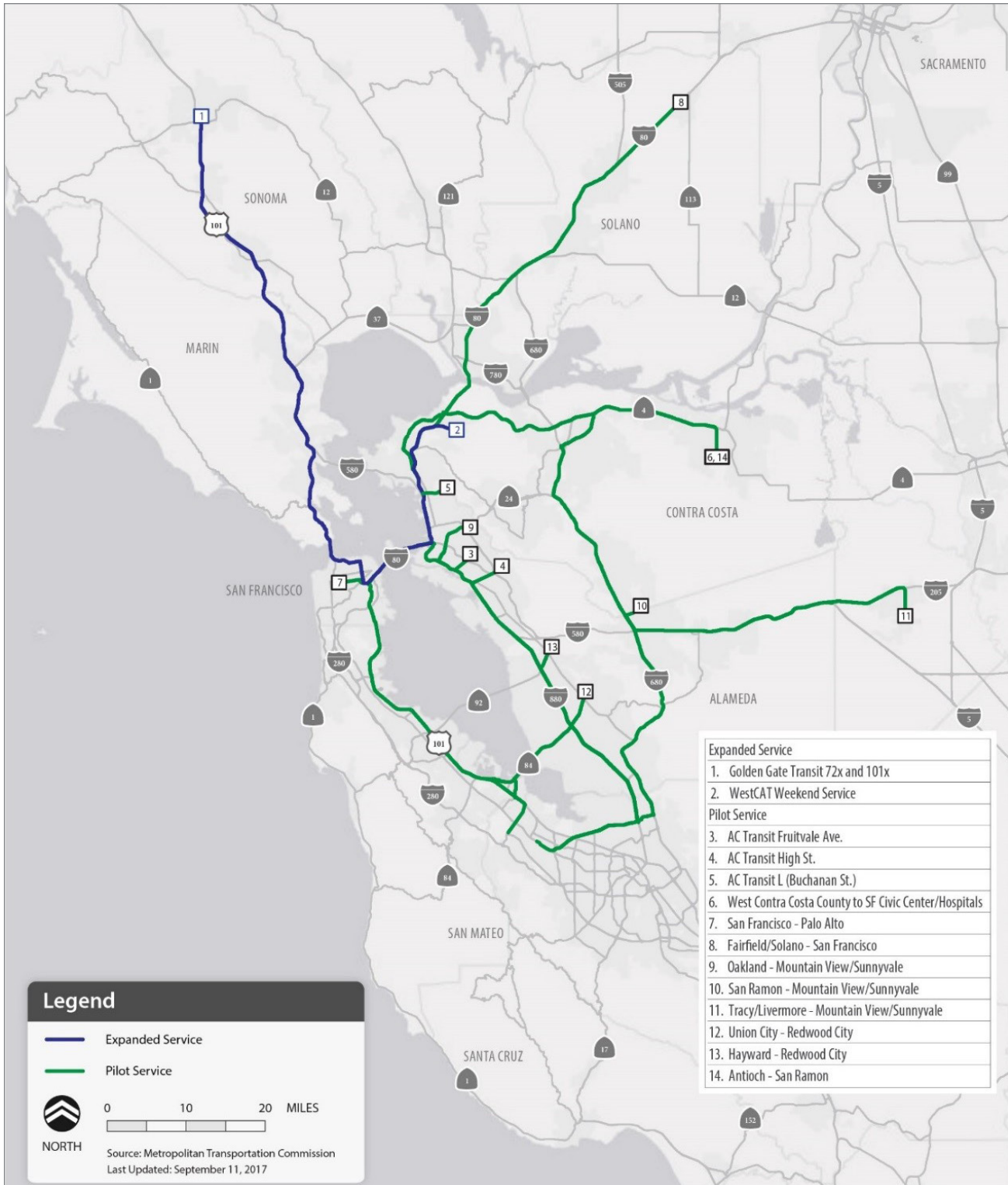
1. Coordinate with on-going planning efforts
2. Identify key origin-destination pairs
 - Not well served by transit today
 - Able to make use of existing and planned managed lanes
 - Home to work travel demand of over 1,000 daily trips
 - Trip lengths between 30 - 75 miles, long enough to be competitive with driving
3. Define transit routes
4. Measure potential benefits

To determine the potential travel markets for the employment destinations, Longitudinal Employer-Household Dynamics (LEHD) data from the 2013 Census was analyzed to determine the cities from which a significant number of work trips are originating. No ridership forecasts for regional express bus service were generated in this study. However, the LEHD data provides an estimate of what the overall travel market is between home origins and employment destinations.

Pilot Express Bus Concepts

Near-term routes were identified that focused on using existing managed lanes or those that are in the process of being implemented to maximize time savings and reliability. The team also identified other express bus routes that would take advantage of the next round of managed lanes development and focus on origin-destination pairs that showed

Figure 34 - Proposed Enhanced and New Express Bus Services



good potential. Figure 34 - Proposed Enhanced and New Express Bus Services shows the express bus route concepts that were identified using this process. While the Fairfield/Vallejo route traveling directly to San Francisco may duplicate existing routes that connect to BART, providing a one-seat express bus ride using Express Lanes could be an attractive alternative to BART trains that are at capacity during peak hours. Additionally, Silicon Valley is a big destination for commuters from the Tri-Valley and San Joaquin County.

Park-Ride System Management

There are over 150 park-ride facilities serving the highway network in the Bay Area. While many of these facilities experience high levels of use and some are over capacity, there are also substantial park-ride resources that are underutilized. The most heavily used park-ride facilities tend to be those that are well served by transit and have good access to and from the highway network, especially in the morning peak direction. Park-ride lots that are further removed from the highway with little or no transit service are typically lightly used. For example, several lots in the southbound direction on US 101 in southern Marin County and in the westbound direction on I-80 in Solano and Contra Costa County (see Figure 35 - Existing Park-Ride Facilities - US 101 - Sonoma/Marin) are often filled to capacity while nearby park-ride lots without transit service are underutilized.



Real-Time Parking Information Display

A relatively new dynamic in park-ride use is the advent of employer provided commute shuttles that use existing publicly-operated park-ride lots as well as privately leased lots as gathering points for their employees. In some cases, there is competition between public and private transit uses for park-ride space. For example, the popular Ardenwood Park-Ride facility next to SR 84 in Fremont is served by the Dumbarton Express buses as well as a number of private shuttles.

Caltrans owns approximately 50 park-ride lots and there are also a number that are owned by local cities or transit operators. In a few cases, the transit providers operate facilities which are owned by Caltrans.

Figure 35 - Existing Park-Ride Facilities – US 101 – Sonoma/Marin

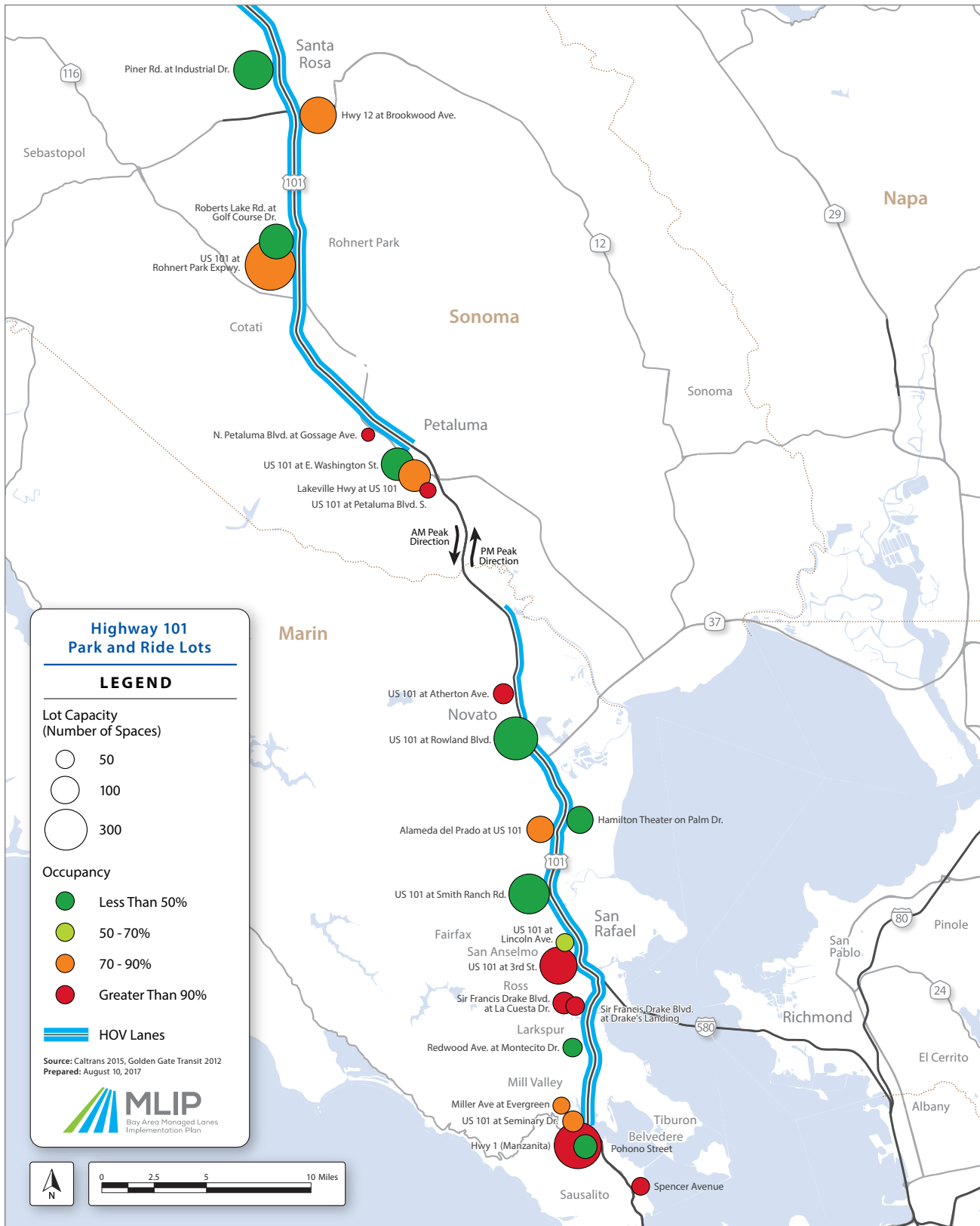
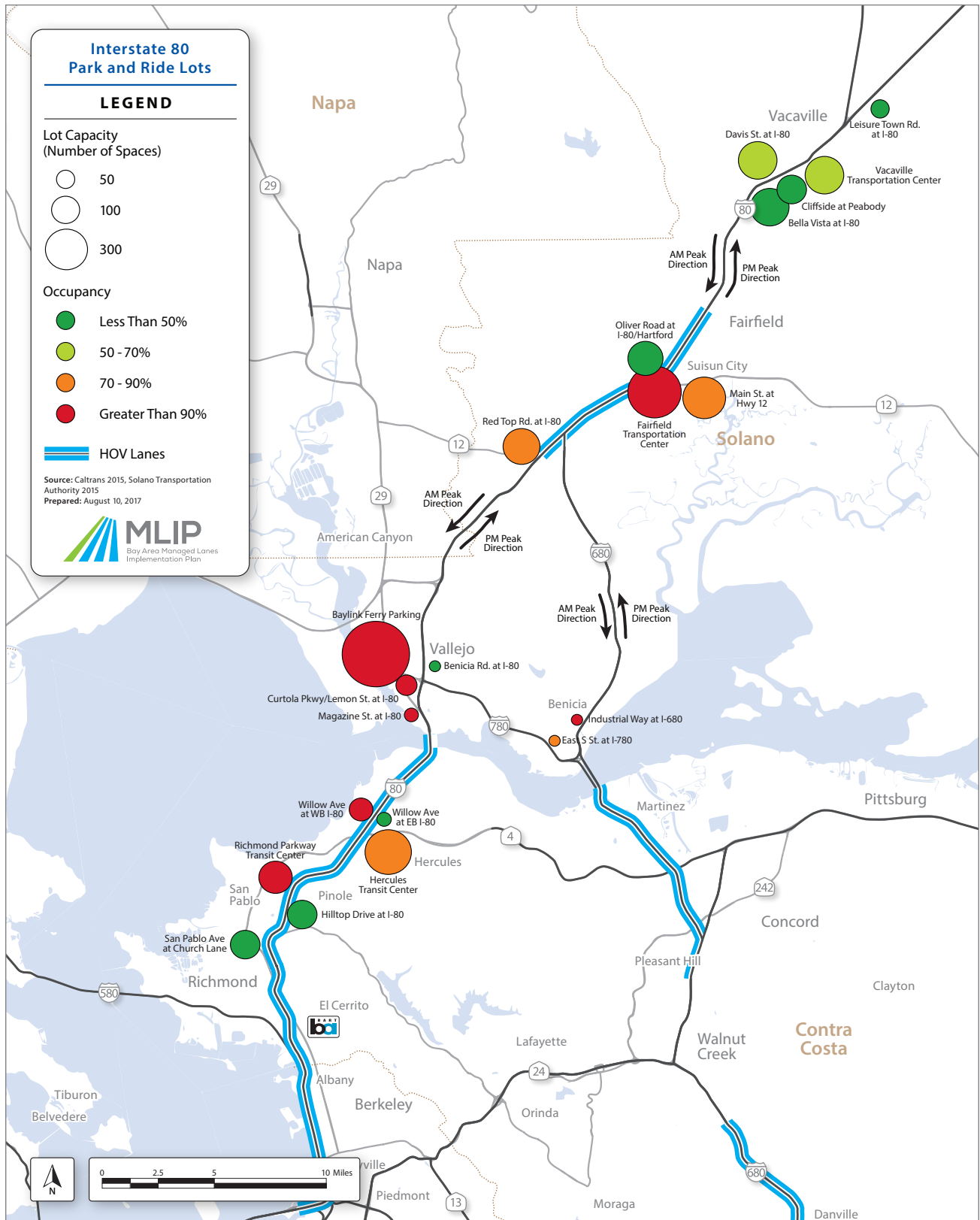


Figure 36 - Existing Park-Ride Facilities – I-80/I-680 – Solano/Contra Costa



There are many opportunities to improve the utility of the region's park-ride resources:

Parking Information – The 511.org website has a map of 182 park-ride locations with an inventory of spaces and amenities such as bike parking and lighting. The individual transit operators also provide some information for their service areas. However, there is limited to no information on parking availability. Although BART parking is limited to BART patrons, as an example of parking availability information, BART provides on its website the approximate time when a station's parking facilities fill-up. With continuing improvements in parking occupancy technology and decreases in cost, such information could become more viable for park-ride lots in the future.

Parking Operations/Management – Most of the facilities are open on a first-come first-serve basis to the public and there is no attempt to manage who uses the facility or how it is used. Many facilities are not maintained on a regular basis and no security is provided. Security is an issue at many park-ride facilities, as vandalism of vehicles is quite common. Parking pricing can enable agencies to afford regular maintenance and an attendant or security.

Parking Pricing – Pricing is a powerful tool that can be used to manage the utilization of parking. Golden Gate Transit implemented parking fees at their Larkspur Ferry Terminal lot to help ensure that their patrons, rather than customers of local businesses, were using their lot. Revenue generated by pricing can be used to cover operations and maintenance costs and to increase the services and amenities available at the park-ride facilities. AC Transit added security when they implemented a



Example of a Shared Use Commuter/ Commercial Parking Lot in Pleasanton, CA.

parking fee at their highly-utilized Richmond Parkway Transit Center. By pricing park-ride lots with high utilization, drivers can be encouraged to park at other nearby underutilized sites that are free. Reserved parking can also be provided, as is the case at the Ardenwood Park-Ride lot, where AC Transit offers monthly reserved parking for a fee for a limited number of spaces. Reserved parking or free/discounted parking can also be made available to carpoolers that drive to the parking lot to encourage carpooling for park-ride users.

Shared Parking – In many cases, the opportunities to develop new park-ride facilities or expand existing ones are limited due to lack of land availability and the high cost of land acquisition and construction. Shared parking arrangements offer an opportunity to make use of parking that is underutilized during the normal business day. Church parking and commercial retail parking often falls in this category. This type of parking is needed for evenings and weekends, but often goes largely unused during the weekday business hours. Anecdotally, many private employers in the region make shared parking arrangements with churches or retailers to create park-ride for their employees.

Table 8 - Park-Ride Management Program Elements and Potential Solutions

Program	Objective	Technology and Management Solutions
Parking Information	Provide parking location and real-time availability information	<ul style="list-style-type: none"> • Electronic signs on freeways and at large park-ride sites • Parking and map apps • 511.org/transit websites • Interface with GPS driving aids • Real-time transit information displays at the park-ride site
Parking Operations/ Management	Provide coordinated/ strategic oversight of park-ride resources in each travel corridor	<ul style="list-style-type: none"> • Regional/corridor level parking management plans • Use of private parking operators • Integrate park-ride programs with carpooling services and transit providers • Coordinate with causal carpooling websites or carpool programs/apps • Encourage carpooling at locations not well served by transit • Enforcement of parking regulations • Security provisions and services • Facility maintenance • Bicycle/pedestrian access • Secure bicycle parking • Valet, tandem or stacked parking • LED lighting
Parking Pricing	Improve utilization of park-ride assets by using pricing to manage demand	<ul style="list-style-type: none"> • Differential pricing by location • Clipper card and/or FasTrak payment options • Onsite payment systems • Pay by phone • Reserved/premium parking • Demand or congestion based pricing
Shared Parking	Facilitate the use of existing underutilized parking for park-ride	<ul style="list-style-type: none"> • Parking lease programs • Encourage cities to require park-ride use of commercial parking near freeways/transit stops

Potential Programs and Solutions

Caltrans has several parcels underneath or near highways that are vacant or underutilized. MTC has worked with Caltrans to identify viable locations that can be converted into park-ride lots. Additionally, Golden Gate Transit has identified several improvements or expansions to existing Caltrans park-ride lots.

Caltrans has established agreements with SolTrans and AC Transit to allow them to use three different lots and charge parking fees to pay for operating and maintaining those lots. Aside from these three lots, all other Caltrans lots are free of charge. Lots that are at capacity present an opportunity to price, manage, and provide amenities. Pricing also presents an opportunity for a regional or corridor-level approach to managing park-rides. Parking fees at one highly utilized lot may be able to cover not only operation and maintenance expenses for that lot, but for another less-utilized but free lot in the same corridor, which could help attract more users.

Corridor plans conducted by the transit providers or county congestion management agencies will allow fine-tuning of the park-ride management strategies best suited to the needs of the users and characteristics of transit services and managed lane facilities along the travel route. [Table 8 - Park-Ride Management Program Elements and Potential Solutions](#) identifies the type of programs and solutions that can be used to implement the parking management program.

Summary

Transit plays a major role in the operation and development of the Bay Area's managed lane network. Key findings include:

- Bay Area transit operators already provide a significant amount of express bus transit service on a few existing managed lane corridors.
- The success of these services is impaired due to the large portion of the managed lane network that is degraded as well as the numerous gaps that exist in the managed lanes network.
- Conversion of HOV lanes to Express Lanes and/or changing operating policies could help to increase express bus ridership. Introduction of new express lanes and closing gaps in the managed lanes network could also help these services.
- Other major metropolitan areas have embraced the concept that transit should be a priority when it comes to managed lanes and that pricing (and the resulting revenues) can be used to improve transit service quality resulting in increased ridership.
- A regional concept for new express bus services that are designed to take advantage of the travel time savings and reliability of managed lanes, and particularly Express Lanes, appear to offer substantial benefits.
- Increasing park-ride capacity and better park-ride management of facilities supports express bus service and increases carpooling.

Stakeholder and Public Outreach



Stakeholder and Public Outreach

Purpose

As part of the work being performed for development of the MLIP, focus groups and a web-based public opinion survey were conducted to obtain input from Bay Area leaders, commuters, and the general public in order to provide qualitative and quantitative information on key questions and issues being addressed in the MLIP and to provide a top-down and bottom-up perspective of key stakeholder and public attitudes about awareness, development, and operation of managed lanes.

Approach

Stakeholder outreach began with a roundtable comprised of key stakeholders to ascertain what perspectives, concerns, and opinions they would like to see addressed during development of the MLIP and what opinions and issues they believe the public has regarding managed lanes.

These interviews built the foundation for the seven public outreach focus groups. Participants included solo drivers, carpoolers, and transit users. The focus groups shed light on understanding the public's views on the current and possible future managed lanes network.

Focus Group Research

During the month of June in 2016, seven focus groups were held in the Bay Area to identify and address the opinions, concerns, and acceptance issues key stakeholders and the public may have with developing and operating the Bay Area managed lanes network. Participants came from a

variety of ages, locations,⁵ and ethnicities. While participants were not selected based on household income, a wide range of occupations, employment status, and educational backgrounds were represented. Solo drivers, carpoolers, and transit users were represented, as well as those working in both public and private sectors.

Participant comments and questions during the focus groups were recorded to identify their concerns about current and future managed lane facilities. Concerns are forerunners of fears, and fears provide insight into what participants are most interested in.

The information gathered from this qualitative exercise was subsequently used to develop a survey to provide a quantitative assessment of the issues uncovered. An additional group discussion was held on June 30th with the Bay Area Council, a business-sponsored, public policy advocacy organization. This group was hand-selected and therefore the feedback is not summarized here.

⁵ For a complete list of focus group locations and recruitment areas see MLIP Focus Group Report, August 2016.

Focus Group Insights

- Participants expressed confusion about the definition of an Express Lane and some were not aware what HOV stands for. The term “Express” evoked speed, tolls, and restricted access.
- The perceived benefits of Express Lanes are higher speed, lower congestion, time savings, convenience, and carpooling advantages.
- The main negatives about Express Lanes include concerns about violators, the cost of using the Express Lanes, social justice, fear that they won’t solve congestion problems but may actually add to it, and impacts to carpoolers.
- Having the choice to use the Express Lanes could lessen opposition to them and should be emphasized in outreach messaging.

When participants were provided a description of Express Lanes, they better understood the intended goals of providing a reliable option that moves traffic faster and decreases congestion.

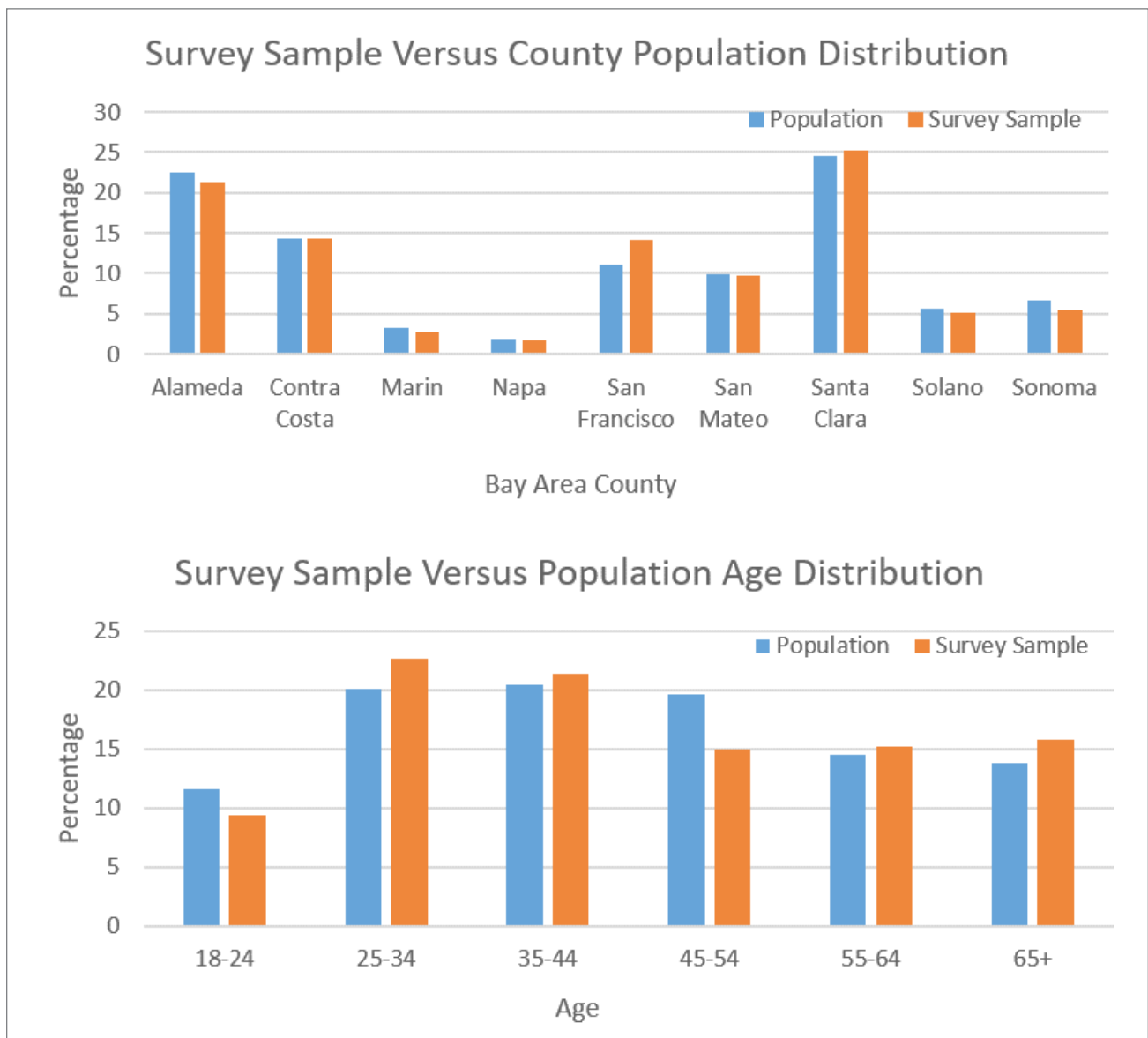
- Participants were split on environmental impact. Some viewed Express Lanes as a disincentive for solo drivers to carpool, while others believed that allowing solo drivers to use them would reduce congestion.
- Of seven statements of concern participants rated on a 0-10 scale, no concern averaged higher than a seven among all groups. The top four of these issues of moderate concern were equity, violations, taking away a free lane, and effectiveness.
- All participants had noticed carpool violators. In one group, half of them admitted violating the carpool lane themselves.
- Express Lane violation concerns centered on solo drivers using the lanes without paying, insufficient enforcement, and unreliable technology.
- Most were not aware of the new FasTrak Flex transponders; those who were doubted their efficacy because drivers could “forget” to put the transponder in the right mode and not get caught.
- A hypothetical proposal to convert a GP lane to an Express Lane rated lower than converting an HOV lane to an Express Lane.
- The solution is to frame the discussion of Express Lanes in terms of choice – that Express Lane users are not being unfair to others; they are simply making their best choice. As one put it “Let them pay to get out of my way.”

Opinion Survey

The focus groups provided an opportunity to obtain qualitative insights which were then investigated through quantitative research in the form of an online survey. The survey was used to explore the awareness, fears, opinions, attitudes, and perceptions of managed lanes in the Bay Area. It was

After discussing Express Lanes, participants wanted information on the cost of tolls, how revenue would be used, enforcement issues, future plans, congestion, and the basic definitions.

Figure 37 - MLIP Survey Sample Distribution



also used to determine the extent to which themes uncovered in the qualitative research were held by the general public and provided statistically valid data for further investigation of HOV and Express Lane policy issues.

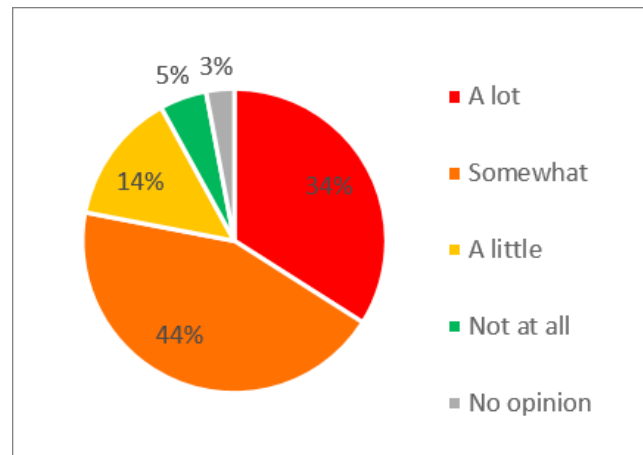
Survey Methodology

An online survey about HOV and Express Lanes conducted over a ten-day period in October 2016 obtained the opinions of 1,208 Bay Area residents. The survey provided respondents the option to take the survey in English, Spanish, and Chinese and was designed to be a representative sample of the Bay Area, both geographically and by age category. [Figure 37 - MLIP Survey Sample Distribution](#) illustrates the distribution of the survey sample.

Awareness and Satisfaction with HOV and Express Lanes

- The survey revealed that Bay Area residents were more aware of HOV lanes than Express Lanes
 - 92% of respondents are aware of HOV lanes, but only 46% had heard of Express Lanes
- Bay Area residents are not happy with the current HOV system
 - 2% of respondents were concerned at least a little by the failure to meet the 45 mph standard
 - The perception is that the HOV lanes aren't working

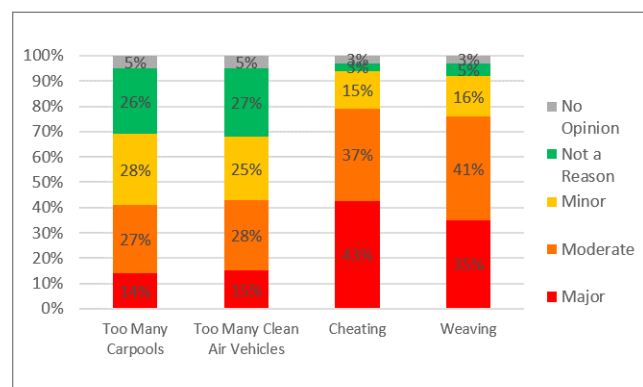
Figure 38 - Commuters Bothered by HOV Lane Congestion



Causes of HOV Lane Congestion

- Cheating (80%) and weaving (76%) are perceived as the primary cause of HOV lane congestion, followed by the number of CAVs (43%) and car-pool vehicles (41%).

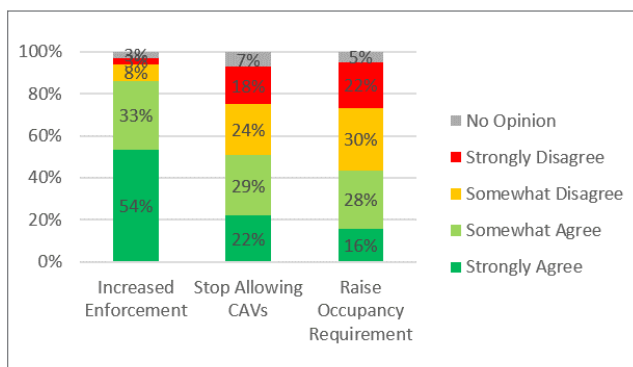
Figure 39 - Causes of HOV Lane Congestion



Enforcement is the Perceived Solution to Improve HOV Lane Performance

- 87% believe increased enforcement will make carpool lanes faster
- 78% believe that CHP officers should be dedicated to carpool lane enforcement

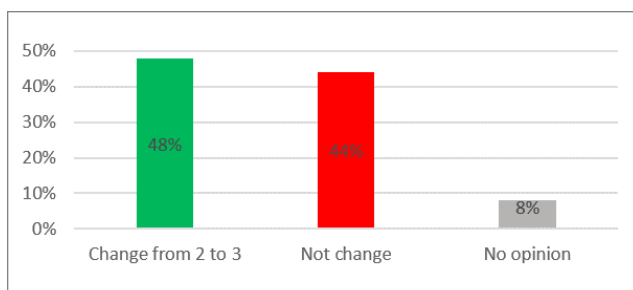
Figure 40 - Support for Solutions to Improve HOV Lane Performance



Support for Changing HOV Lane Occupancy Requirements

- A plurality of respondents (48%) support changing occupancy requirements for congested HOV lanes

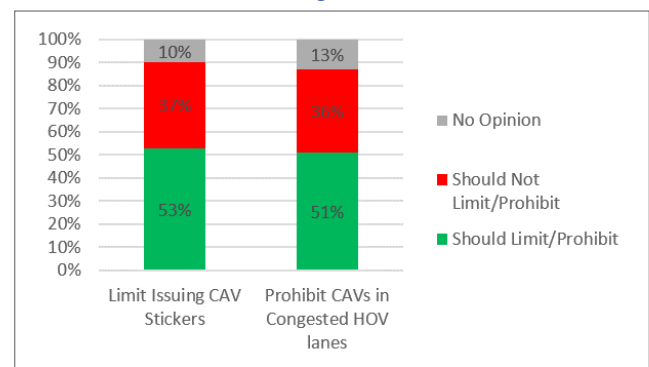
Figure 41 - Support for Changing HOV Occupancy Requirements



Support for Restricting CAV Use of HOV Lanes

- 53% support limiting CAV stickers to reduce their usage of HOV lanes
- 51% support prohibiting CAVs in the most congested HOV lanes

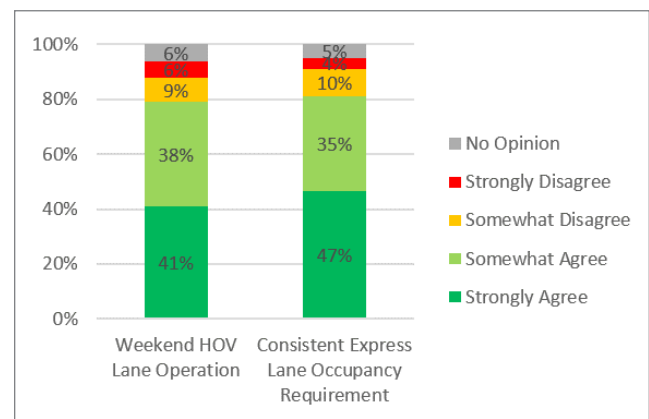
Figure 42 - Support for Limiting Issuance of CAV Stickers or Prohibiting CAVs in HOV Lanes



Other Solutions for Making HOV Lanes Faster

- 79% support weekend HOV lane operation where needed
- 89% support consistent, region-wide HOV lane occupancy requirements

Figure 43 - Support for Weekend HOV Hours or Consistent Occupancy Requirements



Support for CAV Tolls in Express Lanes

- 30% support maintaining CAV toll-free use of Express Lanes
- 66% support discounted and full tolls for CAVs in Express Lanes

Support for New HOV Lanes – Build New or Convert Existing Lane

- 41% support converting congested mixed-flow lane to HOV as opposed to waiting to build a new lane with no with no additional explanation
- Of the 59% who initially supported waiting to build new lanes or had no opinion, 36% (21% of full sample) support converting a lane to HOV if it can save 5-10 years and be done at a lower cost

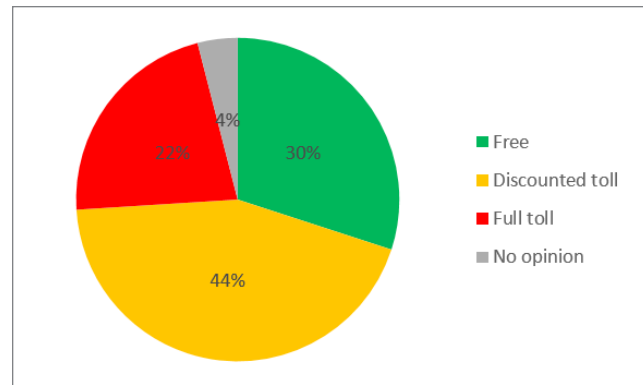
Figure 46 - Combined Support for New HOV Lane - Build New or Convert Existing Lane shows the responses to the following questions:

On a very congested freeway without a carpool or Express Lane, would you prefer to wait to build new carpool lane when there's funding OR convert existing freeway lane into an Express Lane now with express buses and build new lane later when funding is available?

Would you prefer building a new carpool lane in 10-15 years at a high cost OR converting an existing freeway lane to an Express Lane in five years at a lower cost?

These questions combined show that 62% of respondents support converting a GP lane to a HOV if it can save 5-10 years and be done at lower cost than building new lanes

Figure 44 - Support for CAV Tolls in Express Lanes



Findings of the Stakeholder and Public Outreach

Bay Area Residents are More Aware of HOV Lanes Than Express Lanes

Both in the focus groups and survey, Bay Area residents reported higher awareness of HOV as compared to Express Lanes. According to the survey, 92% were aware of HOV lanes, but only 46% had heard of Express Lanes.

Bay Area Residents are not Happy with the Current HOV System

Users expressed frustration with the current HOV system, citing increasing congestion and slow carpool lanes. The general perception among the audiences reached is that these lanes aren't working which is causing frustration during travel.

Cheating is Perceived as the Main Reason for Lack of Faith in the System

80% of respondents believe cheating is a moderate or major reason for congestion in the current managed lanes. 76% of respondents believe weaving is a moderate or major cause for congestion.

Figure 45 - Support for New HOV Lane - Build New or Convert Existing Lane

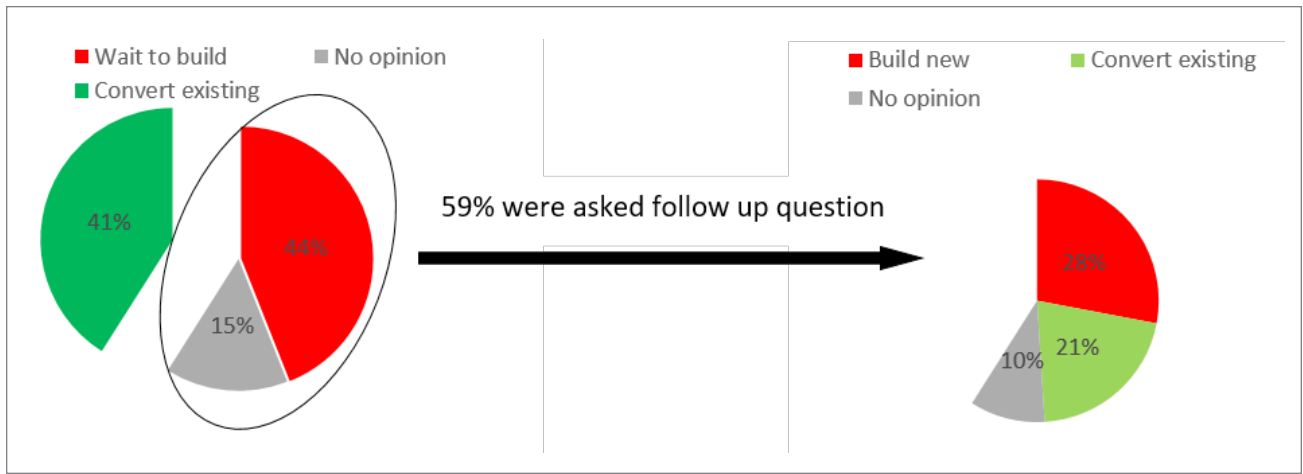
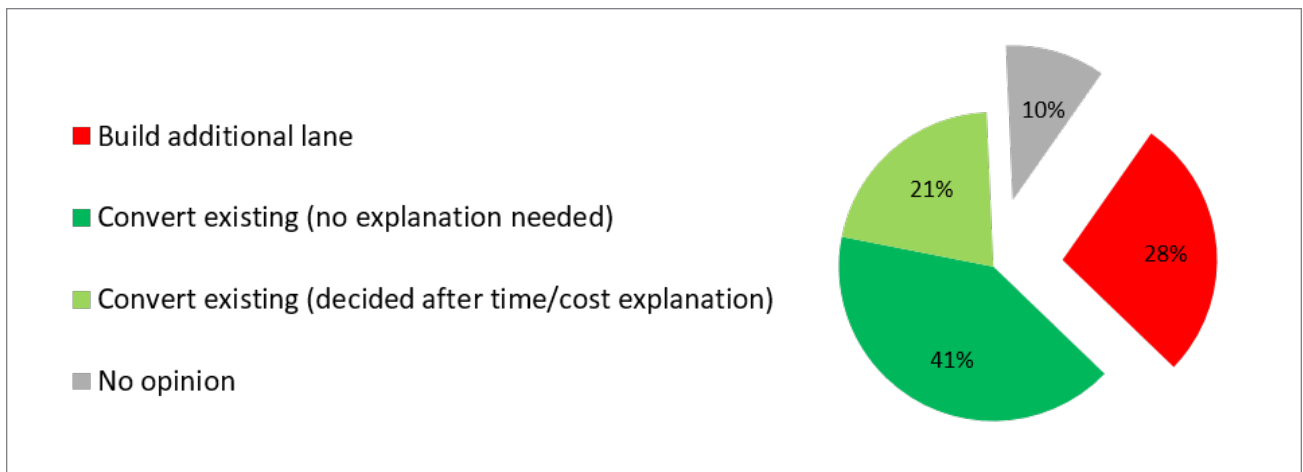


Figure 46 - Combined Support for New HOV Lane - Build New or Convert Existing Lane



Enforcement is the Perceived Solution

87% of survey respondents believe increasing enforcement will make carpool lanes faster. This opinion was also held by the focus group participants. These findings align with the belief that cheating is the main reason for congestion. Additionally, 78% believe highway patrol officers should be specifically assigned to issuing tickets for carpool violations. While this solution may not be practical, it illustrates how much the public is frustrated with cheaters.

They Will Use it if it Works

Almost three out of every four people surveyed said they would carpool and use HOV lanes if it saved them 5 to 10 minutes.

How to Restore Faith in the Managed Lane System

The focus groups and survey demonstrated that customers are savvy commuters who understand issues related to commuting and congestion, but additional education is needed related to Express Lanes. Based on feedback from the public, the best path to rebuild confidence in the managed lane system should emphasize the following:

- Acknowledge problems with current system
- Demonstrate clear direction to address issues
- Increase enforcement efforts
- Maintain consistency of rules across Express Lane network
- Adjust hours of operation as needed
- Show proof solution is working





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