



SECTION FIVE

HIGH-OCCUPANCY VEHICLE (HOV) SYSTEM ELEMENT

The first expressway high-occupancy vehicle (HOV) lanes opened on San Tomas Expressway in 1982 and the Montague HOV lanes opened one year later. Since then, HOV lanes have been added to Capitol and Lawrence Expressways and HOV queue jump lanes to Central Expressway. Other improvements have included adding electronic signage, moving HOV lanes off the shoulders, and expanding operating hours. Following the County's lead, the state has added a significant number of HOV lane miles on the freeway system, and more are planned. Today, we have 50 miles of expressway HOV lanes and 187 miles of freeway HOV lanes, existing and planned. The total miles of HOV lanes make Santa Clara County the most HOV-friendly county in the San Francisco Bay Area.

The purpose of this element is to take a comprehensive look at the expressway HOV system, including the performance of existing HOV lanes and potential expansion of the HOV system. The goal is to establish an expressway HOV system that is truly effective and functions well with the freeway HOV system.

Table 5-1: Existing Expressway HOV Lanes

Expressway	Expressway HOV Limits	Nearby Freeway
Capitol	Silver Creek Road to Capitol Avenue	US 101, I-680
Central	Bowers Avenue, Scott Boulevard queue jump lanes	N/A
Lawrence	Stevens Creek Boulevard to Arques Avenue	I-280, US 101
	Lakehaven Drive to Tasman Drive	US 101, SR 237
Montague	Mission College Boulevard to McCarthy/O'Toole	US 101, I-880
	Main Street to Milpitas Boulevard	I-880, I-680
San Tomas	Budd Avenue to Walsh Avenue	SR 17, US 101

Expressway HOV System Overview

Table 5-1 lists the existing expressway HOV lanes. Caltrans does not allow the HOV lanes to continue through freeway interchange areas due to concerns about the continuous weaving through the right hand lanes necessary to enter and exit the freeway ramps. For that reason, the HOV lanes usually start and/or end at least one signalized intersection away from the interchange area. This creates gaps in the system for the Lawrence Expressway and San Tomas/Montague Expressway HOV lanes.

Current Plans for Expressway HOV Lanes

Other planning efforts and recommendations that relate to potential changes in the expressway HOV lanes include:

- ❖ The Valley Transportation Plan (VTP) 2020 and the Metropolitan Transportation Commission's (MTC) Regional Transportation Plan (RTP) include adding HOV lanes on Central Expressway from De La Cruz Boulevard to State Route (SR) 237 and a 1990 environmental clearance document includes HOV lanes through to Shoreline Boulevard.
- ❖ San Jose's Evergreen Specific Plan Infrastructure Improvements called for the Capitol Expressway HOV lane to be replaced by light rail service. VTA is currently proceeding with environmental clearance for the light rail extension on Capitol Expressway.

Expressway HOV Lane Operational Characteristics



- ❖ Two or more people per vehicle are required. This is consistent with the freeway HOV lane requirements.
- ❖ Operating periods are 6:00 to 9:00 AM and 3:00 to 7:00 PM. These times are comparable to the freeway HOV lanes, although some freeway lanes start as early 5:00 AM and others end at 10:00 AM.
- ❖ All expressway HOV lanes are bi-directional during peak periods, except San Tomas south of El Camino Real and Montague, where the HOV lanes currently operate only in the peak direction during peak periods. The 8-lane widening projects for San Tomas and Montague Expressways will allow operation of the HOV lanes as bi-directional in each peak period.
- ❖ HOV is in the right lane next to the shoulder. This is to allow transit to access bus stops along the expressway. This location has a secondary advantage of creating acceleration and deceleration lanes for all vehicles entering and exiting the expressway using right turns.
- ❖ Violations are defined as single-occupant vehicles proceeding straight through a signalized intersection rather than turning off the expressway.

Evaluating HOV Lane Performance

In 2002, traffic counts were conducted at select locations for each expressway HOV lane. These locations were selected based on maximum traffic volumes and stopped queues, providing an incentive to carpool. The counts included number and types of vehicles in the HOV lane, number of violations, and number of vehicles in the mixed-flow lanes. In addition, travel time surveys were conducted for the length of each HOV lane.

Performance Measures

To evaluate the performance of the expressway HOV lanes, five performance measures were used. These performance measures were based on similar measures used by Caltrans and MTC to evaluate freeway HOV lanes. The performance measures are described in Table 5-2 including how they were adjusted from freeway to expressway HOV lanes.

Table 5-2: HOV Lane Performance Measures

Performance Measure	Freeway Standard	Expressway Standard	How Expressway Standard Determined
Total vehicles per peak hour	Minimum of 800	Minimum of 400	Converted the freeway standard to take into account the lower capacity on expressways due to slower speeds and signals.
Total persons per peak hour	Minimum of 1,800	Minimum of 880	Based on the average occupancy of 2.2 people per vehicle in the expressway HOV lanes.
Lane Productivity (ratio of people in HOV lane to mixed-flow lane)	No standard set; however, could be considered at least 1.0 ⁽¹⁾	Minimum of 0.80 to 0.90	Around this range of productivity, the impact of converting the HOV lane to mixed flow would lead to no net increase in capacity if a significant number of HOV users return to single-occupant vehicles.
Violation Rates	No higher than 10%	No higher than 15%	A higher violation rate standard was set due to the right lane position of the HOV lane.
Travel Time Savings	At least 1 minute per mile savings over mixed-flow lane	Travel time to be equal or better than mixed-flow lane	Due to differing operating conditions, a minimum travel time savings standard comparable to the freeway standard cannot be established. ⁽²⁾ However, lack of any travel time benefit is indicative of operational problems.

Notes:

- 1) The "Lane Productivity" measure was established by MTC for use in the regional *2002 HOV Lane Master Plan Update*. The report notes that all freeways in the Bay Area, except one, has a productivity ratio of at least 1.0 and several of the freeway HOV lanes have productivity ratios of 2.0 and 3.0 (i.e., double and triple the people in an HOV lane compared to a mixed-flow lane).
- 2) With signals approximately every half mile, the primary benefit of expressway HOV lanes is shorter queues at the signal as opposed to freeway travel where the primary benefit is being able to travel at a faster speed.

Key Findings

Tables 5-3 and 5-4 summarize the performance of the expressway HOV lanes using the performance measures. All measures must be considered to obtain a full view of the lane's performance. Key findings include:

- ❖ Capitol Expressway is the best performing HOV lane and has relatively low violation rates.

- ❖ Lawrence and San Tomas Expressways south of US 101 are performing acceptably. This is likely due to no parallel freeway so these expressways provide the primary central county north-south travel corridors. San Tomas has the most solid and consistent travel time savings.
- ❖ Lawrence north of US 101 performs poorly and has excessively high violation rates. This is due to operational problems created by the early merging of single-occupant vehicles into the lane to prepare for entry onto SR 237.
- ❖ Montague Expressway's performance is marginal to under performing. The area between I-680 and Great Mall Parkway has high violation rates, generally due to the lack of access control along the expressway (i.e., driveways between intersections). Operational problems at the I-880 interchange combined with street connections and driveways immediately east of this interchange slow down travel in the eastbound direction so significantly that the travel time for the Montague HOV lane is higher than in the adjacent mixed-flow lane.
- ❖ Central Expressway's queue jump lanes at Bowers Avenue and Scott Boulevard perform very poorly even though the intersection evaluated operates at level of service (LOS) F. Being closely parallel to the US 101 HOV lane probably accounts for the poor performance.

In summary, the key problems with the under-performing HOV lanes are:

- ❖ Operational problems created by lack of access control and close spacing of intersections/on-ramps leading to weaving conflicts and high violation rates.
- ❖ Parallel freeway HOV lanes that offer more travel time savings and convenience for longer commutes.
- ❖ The right-hand HOV lane concept does not provide an incentive where a large volume of right-turning vehicles must share the lane.

**Table 5-3: Summary of HOV Lane Performance by Expressway
Existing Conditions for Peak Direction of Travel**

Expressway	Intersection	Peak Hour	Direction of Travel	Mixed- Flow Thru Lanes	HOV Violation Rate	Persons/Lane		Productivity Ratio ⁽³⁾	HOV Vehicles Peak Hour
						HOV ⁽¹⁾	Mixed Flow ⁽²⁾		
Capitol	Story	AM	Northbound	3	16%	1,060	973	1.09	556
		PM	Southbound	3	17%	1,219	892	1.37	633
Central	Bowers	AM	Westbound	2	38%	205	998	0.21	88
		PM	Eastbound	2	32%	245	947	0.26	94
Lawrence	Monroe	AM	Northbound	3	38%	853	1,323	0.64	376
		PM	Southbound	3	22%	1,070	1,038	1.03	461
	Homestead	AM	Northbound	3	35%	767	961	0.80	340
		PM	Southbound	3	28%	678	1,052	0.64	297
	Tasman	AM	Northbound	3	82%	275	637	0.43	98
		PM	Southbound	3	39%	326	525	0.62	124
Montague	Trade Zone	AM	Westbound	2	61%	427	1,059	0.40	208
		PM	Eastbound	2	64%	315	892	0.35	103
	Zanker	AM	Westbound	2	34%	426	866	0.49	188
		PM	Eastbound	2	22%	557	668	0.83	235
San Tomas	Monroe	AM	Northbound	3	30%	702	1,243	0.56	369
		PM	Southbound	3	15%	903	980	0.92	448

Notes:

HOV = High-Occupancy Vehicle

SOV = Single-Occupancy Vehicle

Performance values shaded are the ones exceeding the following performance measure standards:

Violation Rate < = 15%.

Persons/ HOV Lane > = 880

Productivity Ratio > = 0.80.

HOV vehicles > = 400 vph.

- 1) Based on actual counts conducted by CCS and County (Capitol Expwy.) in 2002. The HOV volume also includes bus and truck volumes observed or estimated.
- 2) The values shown assume that all vehicles on mixed-flow lanes are SOV's.
- 3) Productivity Ratio = (HOV persons) / (avg. mixed-flow persons/lane)

Table 5-4: Expressway HOV Lane Travel Time Comparison ⁽¹⁾

Expressway HOV Lane	Lane Length (miles)	Peak Hour	Peak Direction	Seconds Saved per Mile ⁽²⁾	
				2001	2002
Capitol	3.8	AM	North/Eastbound	19	18
		PM	South/Westbound	0	6
Lawrence	6.1	AM	Northbound	6	7
		PM	Southbound	3	12
Montague ⁽³⁾	5.4	AM	Westbound	3	36
		PM	Eastbound	1	- 7
San Tomas	7.2	AM	Northbound	26	26
		PM	Southbound	3	24

Notes:

- 1) Based on travel time surveys conducted by County Roads and Airports Department.
- 2) The "Seconds Saved per Mile" represents the average over the entire length of each HOV lane. The standard for freeway HOV lanes is a minimum of 1 minute per mile.
- 3) The 2001 data for Montague was collected while various construction projects were underway, which affected overall travel time for all lanes.

Operational Improvement Strategies

Looking more closely at the operational problems experienced by Lawrence north of US 101 and Montague between I-880 and I-680, a preliminary identification and assessment of potential solutions was conducted. As described below, none of the options present encouraging results in terms of effectiveness and general feasibility.

Potential operational improvement strategies include:

- ❖ Remove access/right turn movement – This is the most direct solution, but it has limited application, could result in whole takes of properties lacking alternative access, and does not address freeway connections, a typical problem area. This strategy has application at other locations along the expressway, consistent with the discussion in Section 2 regarding access vs. mobility. It is proposed for several

locations along Lawrence between I-280 and US 101, where HOV lanes are to be maintained.

- ❖ Add auxiliary lanes – This strategy would widen the expressway to add outside auxiliary lanes in the hopes that this would allow separation of HOV through traffic from right turning traffic, but it would result in an unenforceable center lane operation for the HOV lanes; require costly widening, property acquisition and other impacts; and risk safety impacts associated with unsafe driver lane change movements because of unfamiliarity with this design and the legal restrictions.
- ❖ Construct frontage roads – Frontage roads address some of the safety issues associated with the auxiliary lanes, but adds others by intensifying and concentrating weaving movements at frontage road access points which would be expected to be near signalized cross streets (the worst location from perspective of HOV operation), and would be more costly and have more construction impacts.
- ❖ Construct braided ramps – Braided ramps would apply a freeway design concept to the expressways, with freeway project level costs and impacts. It would require substantial property takes and potentially introduce other environmental impacts (particularly in residential areas as along Lawrence).

New HOV Facilities

No new expressway HOV lanes or extensions to existing lanes are recommended except for a funded project on part of Central Expressway (discussed further below). The expressway segments without HOV lanes all meet at least two of the following conditions which are not supportive of widening the expressway for HOV lanes:

- ❖ The projected traffic congestion levels for the corridor are not high enough to provide incentives to carpool.
- ❖ The local community has other priorities for the right-of-way that would be used for an HOV lane (e.g., bike travel, landscaping, and safety enhancements).
- ❖ There would be operational problems due to lack of access control or intersection/ramp configurations.
- ❖ There are competing parallel freeway HOV lanes existing or planned.

The most significant enhancement that can be made to the expressway HOV system is constructing direct ramp connections from the right-hand expressway HOV lane to the median freeway HOV lane. These would be one-way connectors: from expressway to freeway in the peak direction. The direct connector ramps could provide significant time savings for carpoolers. They would avoid the ramp meter and meter queues and avoid having to cross 2 to 3 lanes of congested freeway to reach the median HOV lane. They would also help resolve existing ramp conflict areas for bicyclists as described in Section 6, “Bicycle Element”. Six locations are recommended for potential HOV direct connector ramps.

Project Recommendations

HOV lane recommendations are illustrated in Figure 5-1 and described below.

Capitol Expressway

- ❖ Retain the HOV lane on Capitol Expressway from Nieman Boulevard to Silver Creek Road pending completion of the US 101 Central Corridor Study. Should the results of the US 101 Central Corridor Study confirm that the HOV lane should be retained after the light rail project is built, consider connecting it to US 101 by constructing an HOV direct connector ramp onto US 101 to encourage carpool use in this highly congested corridor.
- ❖ Removal of the HOV lane between Quimby Road and Capitol Avenue to provide for LRT construction will be the subject of a VTA project environmental analysis.

Central Expressway

- ❖ Complete the currently funded project to build a new HOV lane on Central Expressway from De La Cruz Boulevard to San Tomas Expressway. Operate this HOV lane and the Bowers Avenue queue jump lane on a trial basis for 3 to 5 years with regular monitoring based on the performance measures.
 - If the HOV lane is not successful by the end of the trial period, convert it and the Bowers Avenue queue jump lane to mixed flow to mitigate the LOS F intersections along this section of the expressway.

Figure 5-1: HOV System Recommendations



- If the HOV lane is successful, extend it to Lawrence Expressway when funds allow. If the HOV lane is retained, two interchange projects will be needed to mitigate existing LOS F intersections, adding \$80 to 90 million to the Tier 1B list of projects.
- ❖ Do not construct the HOV lane on Central Expressway from Lawrence Expressway to Shoreline Boulevard for the following reasons:
 - West of Lawrence Expressway, Central Expressway has no existing or projected LOS F intersections and overall traffic congestion is not severe.

- Central Expressway closely parallels a freeway HOV lane.
- Ramp safety improvements are needed between Lawrence Expressway and Mary Avenue in Sunnyvale.
- From Mary Avenue to Shoreline Boulevard in Mountain View, there is local opposition to removing the existing landscaping to construct an HOV lane, especially since there is not a need for the lane based on traffic demand and traffic congestion levels.

Lawrence Expressway

- ❖ Convert the Lawrence Expressway HOV lane north of US 101 between Lakehaven Drive to Tasman Drive to mixed-flow lanes due to poor performance and operational problems, and to mitigate projected traffic conditions.

Montague Expressway

- ❖ Convert the existing Montague Expressway HOV lanes between Main Street and Milpitas Boulevard (i.e., between I-880 and I-680) to mixed-flow lanes, after the appropriate environmental review and revisions to the Regional Transportation Plan (RTP). The conversion is due to poor performance and operational problems. It will also mitigate LOS F conditions.
- ❖ When the 4th lane in each direction is added, designate it as an HOV lane on a trial basis for 3 to 5 years with regular monitoring based on the performance measures. The design of the 4th lane should address the operational problems to the greatest extent feasible. The 680 – 880 Cross-Connector Study should include funding for correcting the operational problems should Montague be designated the primary HOV connector.
 - If the HOV lane is not successful after the trial period and continues to experience significant operational problems, convert it to mixed flow.
 - If the HOV lane is retained, an interchange project at Great Mall/Capitol Avenue may be needed to mitigate an existing LOS F, adding \$42 million to the Tier 1B list of projects.

HOV Direct Connector Ramps

- ❖ Candidate locations for expressway to freeway HOV direct connector ramps are as follows:
 - Capitol Expressway and US 101 (subject to 101 Central Corridor Study)
 - Lawrence Expressway and I-280 (would be part of the overall interchange reconfiguration for Lawrence Expressway/Stevens Creek Boulevard/I-280)
 - Lawrence Expressway and US 101
 - Montague Expressway and I-880
 - San Tomas Expressway and I-280 (would be a stand-alone connection without an interchange)
 - San Tomas Expressway/Montague Expressway and US 101

Costs and Project Delivery

- ❖ Converting HOV lanes to mixed flow – Funding is required for environmental review and for removing signage and pavement markings. These costs are estimated at \$0.1 million per conversion project. Tier 1A of the Capacity and Operational Improvement Projects includes three expressway conversions for a total of \$0.3 million. Once funds are available, these projects could be completed in about one year.
- ❖ Fixed Guideway Funds – VTA receives federal Fixed Guideway Funds for operating buses in HOV lanes. Converting HOV lanes will result in lost operating revenue for VTA, estimated at \$40,000 per year for the Lawrence HOV lane north of US 101 and \$220,000 per year for the Montague HOV lane between I-880 and I-680.
- ❖ HOV direct connector ramps – The estimated cost is \$20 – 30 million for each location assuming a one-way connection from the expressway to the freeway based on the peak flow of traffic. The Lawrence Expressway/280 direct connector is included in the Tier 3 project to reconfigure the entire interchange area. Another \$100-150 million has been allocated to Tier 3 for the remaining five locations

recommended. Once funds become available, these projects will take approximately 8 to 10 years to deliver.

Operational Recommendations

- ❖ Continue the regular monitoring program for the expressway HOV lanes to determine performance using the performance measures. If not performing up to standards, take appropriate corrective action. Some guidelines for corrective action include:
 - High violation rates – If the violation rate is over 15% and less than 50%, enforcement should be increased. Violation rates over 50% typically indicate a problem with the usability of the lane. The operational problem should be identified and, if feasible, eliminated. If it cannot be eliminated, consideration should be given to converting the HOV lane to mixed flow.
 - Under-performing – If there is an incentive to use the HOV lanes due to high levels of congestion and LOS F intersections, focus should be on what more can be done to encourage carpool use. If the performance cannot be improved and corridor level of service is poor, consideration should be given to converting the HOV lane to mixed flow to relieve the congestion problems.
- ❖ Work with Caltrans to determine what is needed to continue the expressway HOV lanes across the freeways, especially for the San Tomas Expressway/Montague Expressway/US 101 interchange.
- ❖ Continue to coordinate with Caltrans for consistency on operational policies for the freeway and expressway HOV lanes