



# **Technical Study for High Occupancy Vehicle Lanes on State Highways in the San Joaquin Valley**

## **FINAL**

### **The State of California Department of Transportation Districts 6 and 10**

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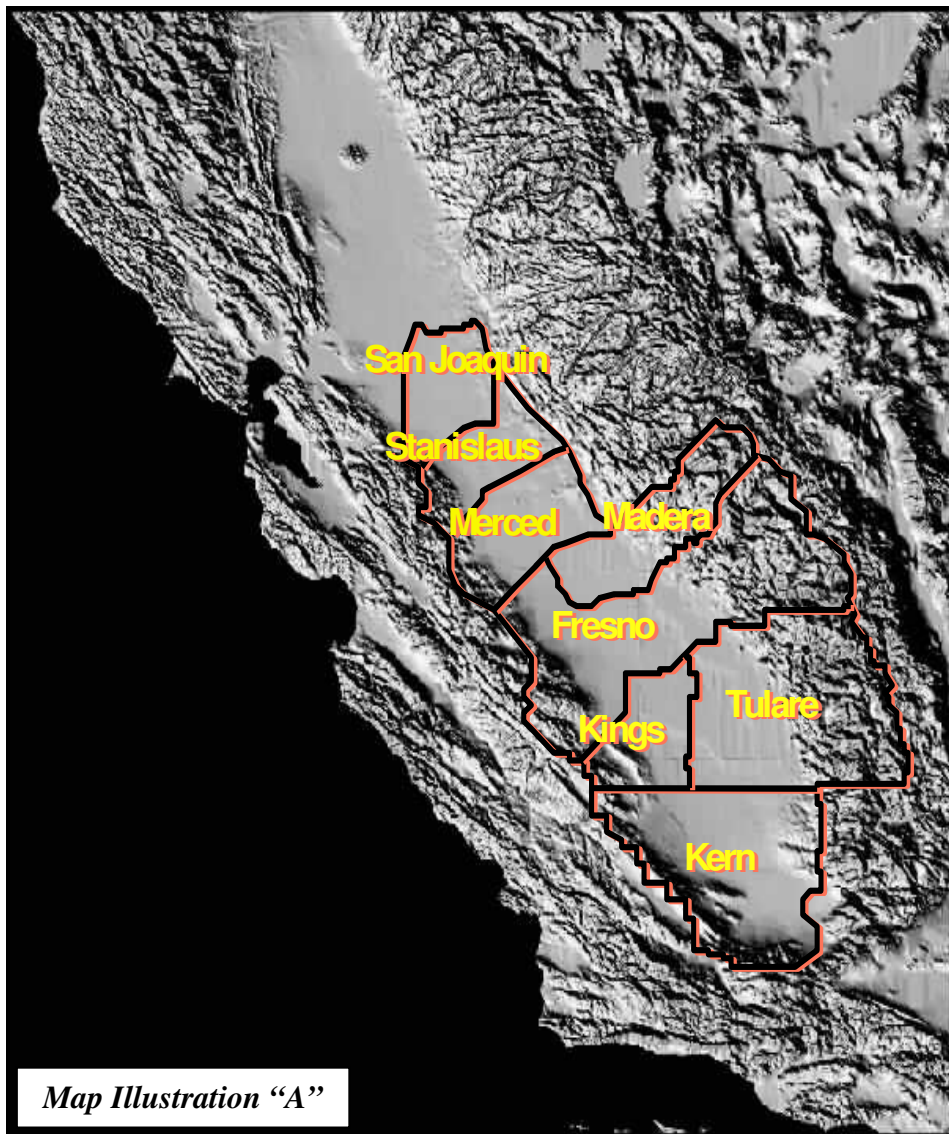
# 1 EXECUTIVE SUMMARY

In January 2002, the San Joaquin Valley Regional Transportation Planning Agencies (RTPAs) requested that the Department of Transportation (Caltrans) review potential measures in order to determine those that could be considered reasonable for implementation. Six Reasonably Available Control Measures (RACMs) were proposed by Caltrans, including the task to conduct a High Occupancy Vehicle (HOV) Lane Study. Through the development of this document, *The Technical Study for High Occupancy Vehicle Lanes on State Highways in the San Joaquin Valley*, the Department provides a measure that supports ongoing regional efforts to improve air quality conditions in the San Joaquin Valley Air Basin.

This document considers HOV lanes from a system perspective, including connectivity to local roadways, and transit services and facilities. In coordination with the San Joaquin Valley RTPAs, the Department obtained the most current information from the respective Regional Transportation Plans (RTPs) and corresponding traffic models. This coordination of information provided the consistency with regional planning activities as the Department proceeded to analyze HOV lanes through the process outlined in this document. This Technical Study will not be a plan or program for the implementation of HOV lanes in the San Joaquin Valley region, and HOV lanes are not to be considered as the Department's actual RACM.

Although this Technical Study must be considered a conceptual/planning-level study, it is based on the most current regional traffic data and industry accepted assumptions, standards and methodologies. More detailed corridor and project specific analysis must be performed before HOV lanes are considered as project alternatives to mixed-flow lanes. This document also fulfills a 2003/2004 Departmental Business Plan Goal of Productivity for Caltrans, Districts 6 and 10, further demonstrating the Department's commitment to improving mobility in California.

The counties within the San Joaquin Valley Air Basin considered in this document include: Fresno, Kern, Kings, Madera, Tulare, Merced, San Joaquin and Stanislaus. These counties are within the San Joaquin Valley Air Pollution Control District (SJVAPCD). It should be noted that only the western portion of Kern County is included in the SJVAPCD. The SJVAPCD can be viewed on the following page in Map Illustration "A":



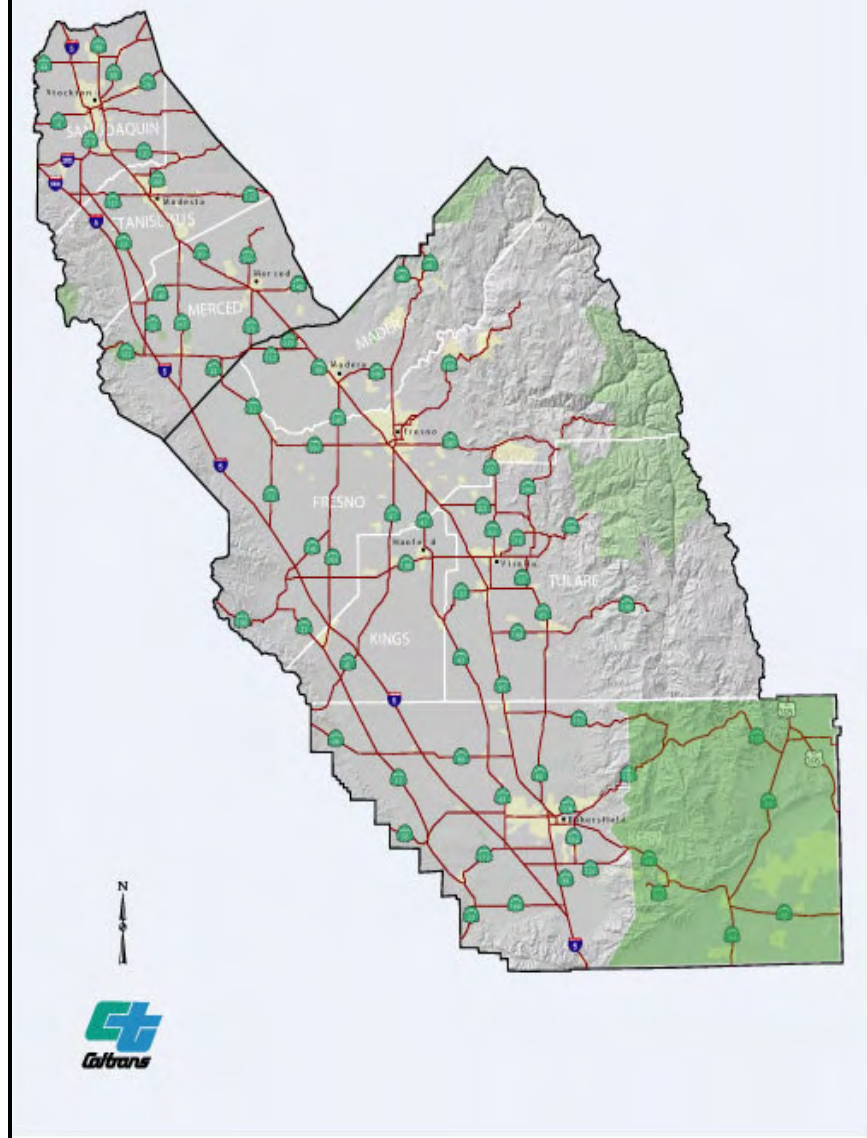
The San Joaquin Valley Air Pollution Control District boundaries are shown here in Map Illustration "A".

Any specific designation of a corridor for HOV purposes is out of the scope of this document.

## ***1.1 BACKGROUND***

On May 21, 2002, Caltrans, Districts 6 and 10, committed to completing an HOV Lane Study for the Directors of Districts 6 and 10. The purpose of this document was to respond to a request from the San Joaquin Valley RTPAs to develop RACMs to determine the feasibility of HOV facilities on all existing state highways throughout the San Joaquin Valley Air Basin. All state highways located within the San Joaquin Valley Air Basin are shown in Map Illustration "A-1" on the following page. Only freeway portions are chosen for HOV analysis.

## San Joaquin Valley Air Pollution Control District



Map Illustration "A -1" illustrates all of the State highways in the San Joaquin Valley that were considered for analysis in this study.

In August 2002, an HOV Study Working Group was formed between the two Districts to analyze what corridors in the San Joaquin Valley might have potential to support HOV facilities currently or in the future given traffic projections to the year 2025<sup>1</sup>.

<sup>1</sup> 2025 was determined to be the most reasonable analysis year as future year statewide model is forecast to that year.

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This document was produced to analyze potential locations where HOV lanes should be further considered as a freeway project alternative to mixed-flow lanes and where it should not be further considered.

This Technical Study will assist in the preparation of subsequent HOV system plans and transportation system management strategies for Districts 6 and 10. A risk assessment of this study considers the following assumptions:

1. The product of this effort may assist in the preparation of subsequent HOV system plans and transportation system management strategies for Caltrans, Districts 6 and 10, in partnership with the San Joaquin Valley RTPAs;
2. The scoping of potential HOV lane locations and corridors, based on this document, may result in additional work and staff resources, and must be subject to more project-level scrutiny as appropriate;
3. HOV facilities that are inadequately planned and scoped may affect agency and public support towards future implementation of HOV systems;
4. Not all agencies are likely to agree with the assumptions, methodology and results of this study;
5. There may be issues with public acceptance of HOV facilities; and
6. HOV usage may not meet the expectations of this document.

On a national level, California has the most congested roads in the country. The bulk of that congestion resides in cities throughout California, such as Los Angeles, the Bay Area, and San Diego — the State's largest commercial centers and ports of entry. The Federal Highway Administration (FHWA) estimates that 46% of the nation's urban major highways will be congested during peak periods by 2020, compared with 28% in 1998<sup>2</sup>. By contrast, in 1998 more than 50% of California's urban major highways were already congested<sup>3</sup>.

From analyzing statistics from the State of California Department of Finance, growth over the next 20 years within the 8 counties of the San Joaquin Valley Air Pollution Control District will be almost 50% higher than what it is currently<sup>3</sup>.

By analyzing the report Vehicle Miles Traveled for the State of California<sup>4</sup>, vehicle miles traveled in California between the years 1978 through 1998 show a 3.01% increased growth rate per year. Additionally, interregional travel has increased, particularly in District 10 between the San Joaquin Valley and the Bay Area. It is

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<sup>2</sup> TRIP Study Washington, D.C.

<sup>3</sup> <http://www.dof.ca.gov/HTML/DEMOGRAP/E-1text.htm>

<sup>4</sup> Annual Data Collection by the California Department of Transportation

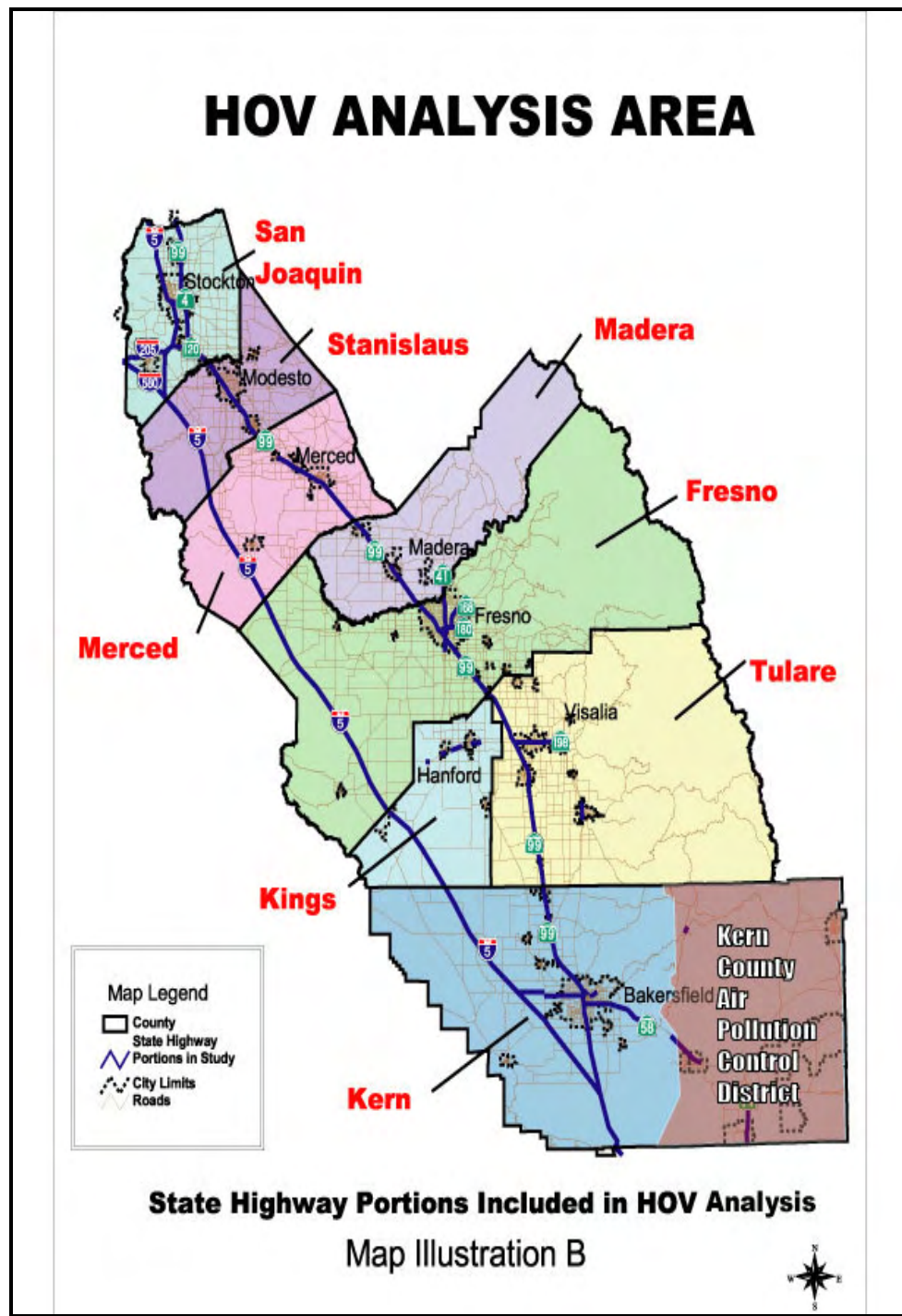
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recognized that the majority of this increase in travel is due to an imbalance between jobs, housing availability and affordable housing. This imbalance continues to exist between the northern San Joaquin Valley and the Bay Area.

If one looks solely at the state average rate (3.01%), the San Joaquin Valley traffic volumes are anticipated to double in approximately 23 years. As new facilities are being added and existing facilities are being expanded, it is important to look at alternatives to accommodate projected future congestion patterns. Strictly adding additional conventional lane miles may or may not be the best answer to increasing the efficiency of the facility and/or specific corridors. Alterations or additions to the existing systems must be closely analyzed to determine how carrying capacity and the overall efficiency of these facilities may be improved.

## ***1.2 STUDY CORRIDORS***

Initial identification of the corridors for analysis were determined by taking those California State Highway System (SHS) routes that traverse the San Joaquin Valley. The resulting study will be specific to the San Joaquin Valley and the state highway system that is owned, operated and maintained by Caltrans, Districts 6 and 10. Other highway corridors were not analyzed outside the boundaries of the San Joaquin Valley Air Basin. All other systems or facilities within these boundaries that are not owned and maintained by Caltrans were also excluded from this study. The first step was determining the corridors as shown in Map Illustration “B” on the next page.



From the existing State highways in the San Joaquin Valley Air Pollution Control District boundaries, the analysis area parameters were limited to only the freeway portions as are illustrated here in Map Illustration “B” (freeways portions are in blue).

In order to do this, the team looked at the criterion for HOV consideration and determined that all conventional highways and expressways within the analysis area would be excluded for the following reasons:

- HOV guidelines call for consideration of HOV lanes on freeways of 6 lanes or more in and surrounding urban areas only.
- Caltrans has no standard design guidelines for HOV facilities on conventional highways due to several complicating factors:

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1. HOV lanes on 2-lane conventional highways would disallow passing and may impact negatively on operations and safety;
  2. Lack of access controls, such as cross traffic and at-grade intersection complications, with HOV implementation;
  3. Conflicts with turning vehicles and left-turn movement on the system;
  4. Weaving patterns ranging from heavy-to-light would operationally discourage HOV lane feasibility;
  5. Potential loss of on-street parking and conflicts with delivery vehicles;
  6. Conflicts with driveways and land-use access; and
  7. Potential negative impact on the safety of pedestrian and bicycle traffic.

Due to these factors, Caltrans highway facilities that were not currently or forecast to be freeways were not analyzed for potential HOV facilities.

### ***1.3 METHODOLOGY***

In determining areas where there is potential need for HOV facilities, it was important to define regional congestion levels and identify future growth projections using the RTPs and the inclusive General Plan information for the 8 counties within the San Joaquin Valley. A tri-level process was used to identify and prioritize highway corridors. First, Caltrans developed a statewide Travel Demand Model (TDM) to which it then extracted specific information to those portions of the San Joaquin Valley, including the 8 counties of Fresno, Kern, Kings, Madera, Tulare, Merced, San Joaquin and Stanislaus. Caltrans was then able to develop the 8 county TDM. In the second step, the Caltrans TDM was then processed through a Geographical Information Systems (GIS) software application that utilizes level of service (LOS) performance measures for freeways from the Highway Capacity Manual (HCM)<sup>5</sup>. The third step is an analysis using FREQ<sup>6</sup> in order to demonstrate the effectiveness of LOS “E” or worse locations for potential HOV corridor limits.

This tri-level highway systems analysis provides an analysis scenario that is consistent with regional strategies and congestion performance measures as identified by the Caltrans State Highway Congestion Monitoring Program (HICOMP)<sup>7</sup>. The consolidation of information from the RTPs and the more specific traffic data and analysis from

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<sup>5</sup> Highway Capacity Manual 2000, Transportation Research Board ([http://trb.org/news/blurbs\\_detail.asp?id=1166](http://trb.org/news/blurbs_detail.asp?id=1166))

<sup>6</sup> FREQ Simulation Modeling Software, Institute of Transportation Studies  
(<http://www.its.berkeley.edu/computing/software/freq.html>)

<sup>7</sup> Caltrans State Highway Congestion Monitoring Program (<http://www.dot.ca.gov/cgi-bin/texis/webinator/search/?db=db&query=HICOMP>)

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Caltrans identifies congestion in urban areas and communities projected to continue with current population growth trends. The team then was able to focus on those areas in greater detail and eliminate less congested, lower population density (rural) areas throughout the San Joaquin Valley.

The highway corridors identified to experience recurrent congestion by falling below LOS “D” standards were determined to be potential HOV corridors. The following maps (“C”, “D” and “E”) depict the LOS within the 8 counties derived from the State Department of Transportation’s GIS LOS Application. Areas found within LOS “E” and “F” are being considered for further analysis for HOV facilities where the length of the facilities would merit consideration and travel-time savings would be a minimal of at least 5 minutes per trip, optimally 8 minutes of travel-time savings.

## ***1.4 CONCLUSIONS AND RECOMMENDATIONS***

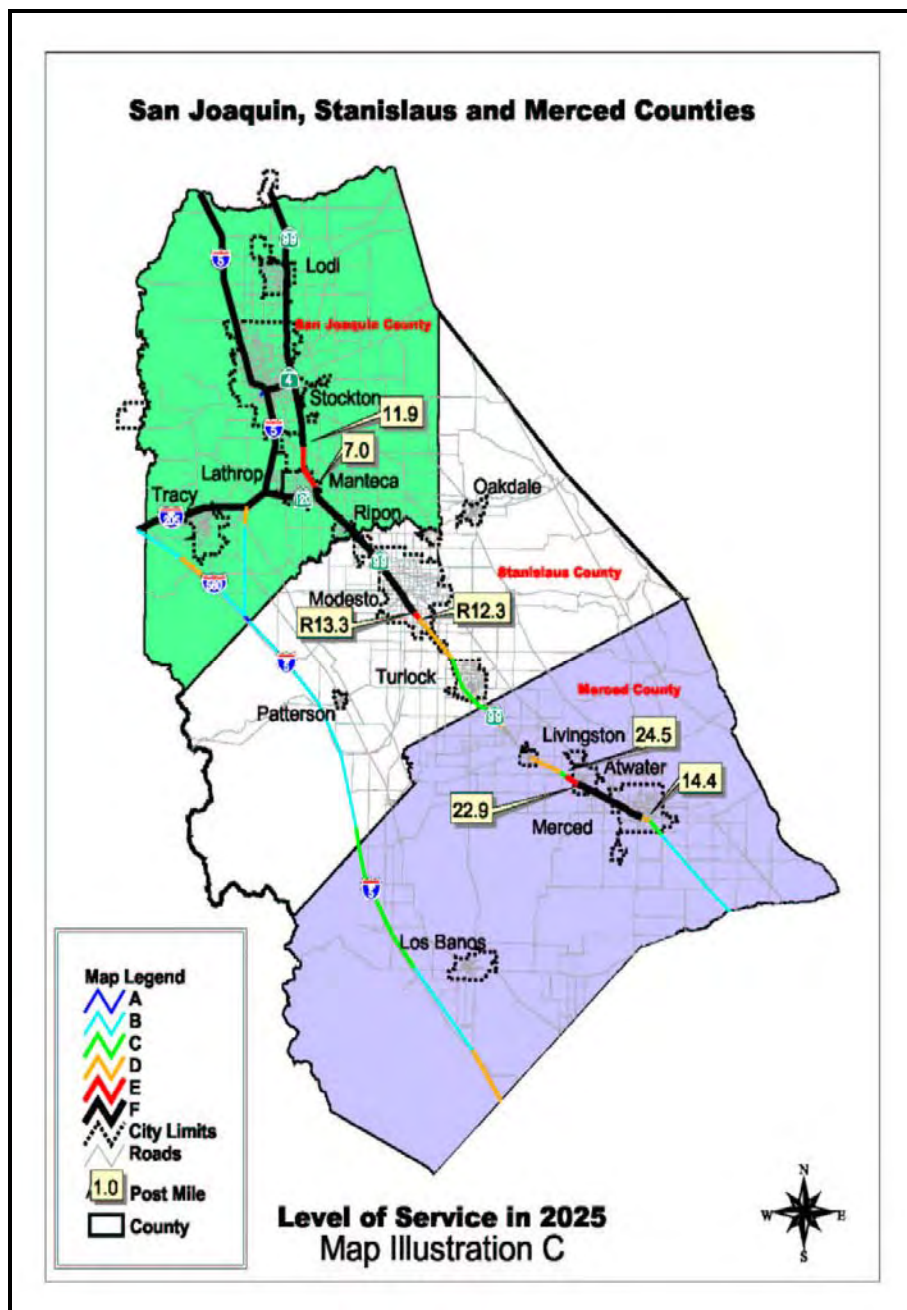
The purpose of this HOV Study is to identify potential HOV corridors in the San Joaquin Valley for improving air quality and reducing congestion. Based on the study findings, the projected growth in the San Joaquin Valley will necessitate the consideration of some form of congestion relief and HOV facilities are a considered alternative. Based on the delineated locations identified in this study as LOS “E” or worse, a more detailed engineering and operational analysis for the actual project-level feasibility will be performed as part of the Caltrans project scoping and development process. This next step will be initiated by a Project Study Report (PSR) and continued into the Project Approval and Environmental Development Phase (PA&ED).

The initial results of this HOV Study show expected, increased levels of congestion in the urban areas of the San Joaquin Valley resulting from localized traffic interaction and friction from interchanges and freeway-to-freeway mainline connectors. The subsequent FRE-Q analysis is used to further identify if HOV facilities will provide more efficient congestion relief than mixed-flow lane alternatives. Any further detailed efficiency or benefit analysis of HOV facilities is currently beyond the scope of this study.

It is the intent of Caltrans that this study will provide the basic framework for a series of future and long-term strategies. Strategies such as HOV facilities and other multi-modal transportation improvements may result in not only relieving congestion, but also assist in improving the overall air quality in the San Joaquin Valley. Ultimately, as a result of the cooperative planning, programming and funding strategies between Caltrans and the RTPAs, the applicability of HOV facilities as actual projects will be determined by more detailed technical studies.

The success of an HOV facility does not rely solely on the identification of logical road segments or corridors. Without public involvement and education, supporting policy and

programs, and interagency coordination, an HOV facility may be underutilized or not fulfill any expectations of adequate congestion relief. Although these initial findings identify the potential viability of HOV facilities, they are only the foundation of a more realistic approach into the viability of a system in reference to the traveling public. The State Department of Transportation cannot guarantee higher levels of rideshare by the traveling public, nor can the Department build and maintain HOV facilities if other facility types will prove more viable. The Department will continue to strive to achieve our goal of increasing mobility across California in the most efficient manner possible.



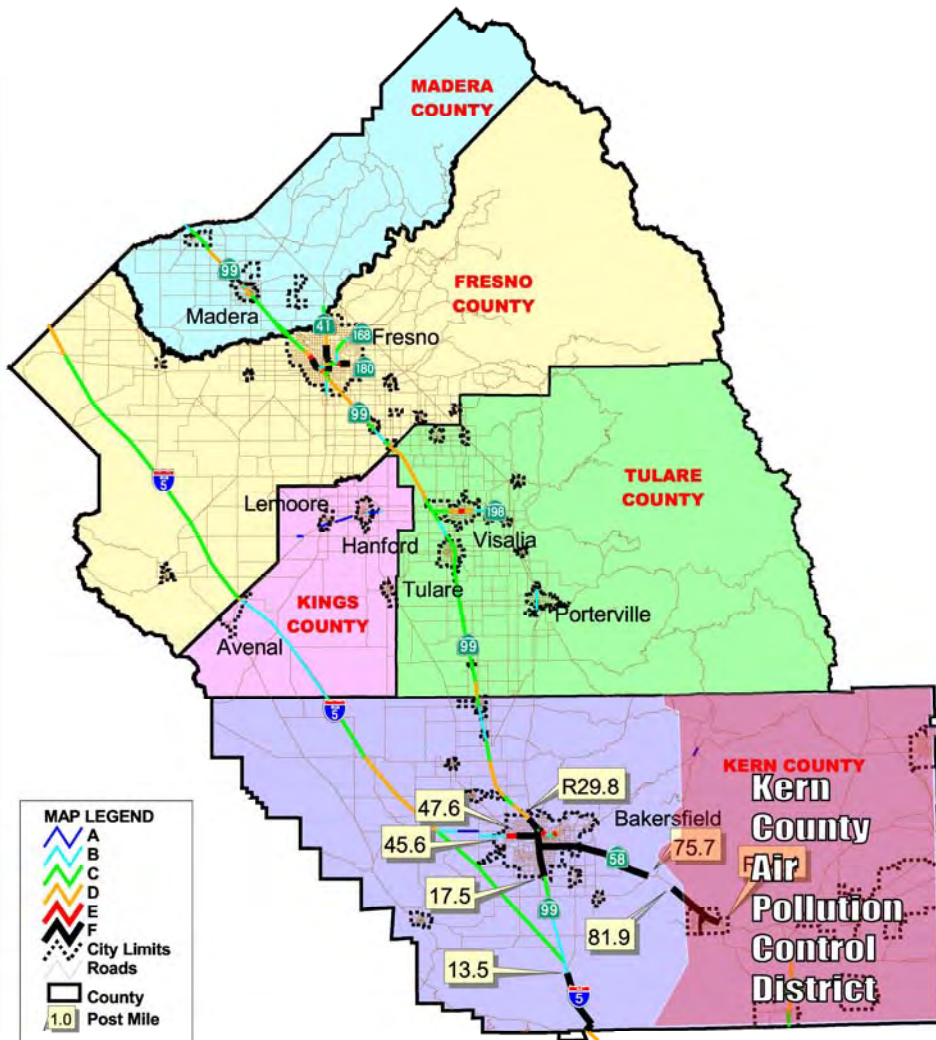
Map Illustration “C” depicts level of service in Merced, San Joaquin and Stanislaus counties within the year 2025. Postmiles are depicted where level of service “E” or “F” occurs. At these locations further analysis is merited for consideration of HOV facilities or other system improvements.

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Methods of effectiveness of HOV facilities will be measured by how corridors meet criteria that is addressed in this document. Criteria such as: (1) congestion levels; (2) travel patterns; (3) current bus and carpool volumes; (4) travel-time savings and travel-time reliability; (5) trip distance; (6) person through-put; (7) projected demand; (8) agency and public support; (9) enforcement; (10) cost-effectiveness; (11) physical characteristics of the corridor or roadway; (12) support facilities and services; (13) safety; and (14) system continuity will further delineate which areas will be considered for further analysis.

Map Illustration “D” depicts the LOS found in the 5 counties included in the study from Caltrans District 6.

## Madera, Fresno, Kings, Tulare and Kern Counties



Map Illustration “D” depicts level of service from the State Department of Transportation’s GIS Level of Service Application. The counties illustrated here are Fresno, Kern, Kings, Madera and Tulare.

Map Illustration “E” shows the City of Fresno’s LOS in 2025.



Map Illustration “E” depicts level of service within the area in and around the City of Fresno.

Due to the document timeline, the findings were completed before December 31, 2005. Any updates or future findings will be published and partners notified by the Department as necessary.

## **2 PROJECT BACKGROUND**

### ***2.1 PURPOSE***

Caltrans currently operates high occupancy vehicle (HOV) facilities in a select number of large metropolitan areas throughout California where there is a need for congestion relief and facility enhancement. Although HOV lanes are utilized as alternatives to additional lane miles within these areas, it is speculative whether these HOV systems will be feasible solutions or alternatives worth consideration as the San Joaquin Valley continues to grow and expand. Future projected travel patterns and growth rates prompt a consideration of potential areas within the San Joaquin Valley to determine if implementation of future HOV lane miles may increase overall efficiency of state routes throughout the Valley.

On May 21, 2002, Caltrans, Districts 6 and 10, committed to completing an HOV Study for the Directors of Districts 6 and 10 to determine the feasibility of HOV facilities on state highways throughout the San Joaquin Valley. Currently, State routes within the San Joaquin Valley do not have any HOV lanes. It is the goal of this document to determine potential areas within Districts 6 and 10 where HOV lanes might prove feasible alternatives to assist the Department in providing efficient and reliable travel in the future.

### **3 HOV STUDY TEAM**

The Caltrans High Occupancy Vehicle (HOV) Study Team was comprised of the following technical units within Caltrans Districts 6 and 10:

*Transportation Planning*

*Traffic Operations*

*Traffic Modeling and Forecasting*

All team members were selected for their experience and knowledge of traffic management and systems operations. A complete list of team members can be found in Appendix A.

It is our hopes that this information sharing will ensure that although these systems are maintained by Caltrans, the counties in which the facilities are located are informed of the analysis and evaluations that affect these specific areas.

The goal of this document is to establish the conceptual foundation for future planning and project-level analysis of potential HOV corridors within the San Joaquin Valley Air Basin.

## 4 STUDY OBJECTIVES

The purpose of this Technical Study is to identify congested corridors within Districts 6 and 10 to determine the feasibility of high occupancy vehicle (HOV) lanes. The major tasks involved are research reference materials, data collection, establish analytical methodology, develop and calibrate the computer model, and analyze results. The FREQ12 computer model, developed by Professor Dolf May at UC Berkeley, was the final analytical tool utilized for this study.

Through determining where HOV lanes may be feasible, Caltrans may begin investigating conceptual alternatives to increased lane miles due to population growth and travel projections. The identification of corridors with potential HOV lane success makes it possible to look at the traffic models throughout the RTP planning cycle to evaluate where, if at all, Caltrans and the Regional Transportation Planning Agencies (RTPAs) may want to consider implementation of HOV lanes.

Below is a summary of each step implemented within the study parameters.

### **Study Framework**

- *Research*
  - Existing facilities
  - Facility development
  - Facility types
  - HOV feasibility
- *Inventory*
  - Available traffic data
  - Park-and-ride lots in each county
  - Transit routes located along freeways
- *Establish Analytical Methodology*
  - Thresholds
  - Candidate corridors
  - GIS/LOS application
  - Vehicle occupancy studies plan
  - FREQ analysis methodology
- *Conduct Vehicle Occupancy Analysis*

- 
- *Compilations and Calculations*
    - Compile vehicle occupancy analysis data
    - FREQ data
    - Measures of effectiveness
    - Travel-time savings
    - Person through-put
    - Vehicle through-put
  - *Analysis*
    - Growth factors
    - FREQ analysis
    - Cost/benefit analysis
    - Corridor recommendations
  - *Findings and Conclusions*

## 5 CORRIDORS

In order to determine the potential opportunities for high occupancy vehicle (HOV) facilities within the San Joaquin Valley, it is necessary to look at specific criteria warranting a need for an HOV facility. In most, if not all cases, the need for an increase in carrying capacity of a facility is directly linked to congestion.

Congestion is defined by the State Highway Congestion Monitoring Program (HICOMP) as those areas or facilities where peak periods of traffic decrease overall speed to 35-miles per hour or below for a period of 15 minutes or longer. This congestion pattern must also be “recurrent” occurring regularly each weekday. Those areas were identified as urban communities projected to continue with current population growth trends. The team was then able to focus on those areas in greater detail and eliminate non-congestion, lower population density (rural) areas throughout the Valley.

The urban areas identified to experience recurrent congestion were also rated for their various levels of service. Through examining the Geographical Information Systems (GIS) Level of Service (LOS) Map Illustrations “C” through “E” (Appendix “B”) it can be determined that those areas falling below LOS “D” would have HOV feasibility potential.

The team began looking at which facilities within the San Joaquin Valley had the greatest existing or potential for congestion and, in turn, may have the greatest or potential need.

The following is a list of criteria that should be met in considering the feasibility of an HOV facility:

- Metropolitan areas vs. rural areas;
- *Future significant congested segments of freeway system*: level of congestion and length (from Congestion Management Plans);
- *Travel-time saving*: at least 1 minute of time saving per mile per typical commute trip, a total of 5 to 10 minutes of time savings is desirable;
- *User characteristics*: long distance travelers, minimal weaving;
- *Availability of HOV support facilities*: park-and-ride lots, transit facilities, ramp metering; and
- *Traffic forecast for 1 year from opening should be*: a minimum of 800 vehicles per hour per HOV lane during the peak period; and should be maintained at that level or better into the future.

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## ***5.1 DETERMINING PARAMETERS FOR HOV FACILITIES***

High occupancy vehicle lane criteria may or may not substantiate the implementation of an HOV facility based on how well the measurements meet the highest expectations of the goals, measuring the effectiveness and analyzing additional factors that determine where an HOV system is feasible or infeasible (these parameters are explained below). Following the parameters portion of this section is a listing of all corridors that were included and studied in this process of analysis of the feasibility of HOV systems for Districts 6 and 10.

## ***5.2 THE GOALS OF AN HOV SYSTEM***

- 1) Increase the people-moving capacity of the freeway system;
- 2) Reduce overall vehicular congestion and motorist delay by encouraging greater HOV use;
- 3) Provide time and commute cost savings to the users of HOV lanes;
- 4) Increase overall efficiency of the system by allowing high occupancy vehicles to bypass congestion; and
- 5) Improve air quality by decreasing total network vehicular emissions.

## ***5.3 MEASURES OF EFFECTIVENESS***

The following are measures of effectiveness suggested in the HOV Systems Manual published by the Transportation Research Board. They were used as guidelines for this study. The HOV facility should:

- 1) Increase the per-lane efficiency of the total freeway facility;
- 2) Improve the capability of a congested freeway corridor to move more people by increasing the number of persons per vehicle;
- 3) Increase the operating efficiency of bus service in the freeway corridor, especially if the service will use the facility;
- 4) Provide travel-time savings and a more reliable trip time to high occupancy vehicles utilizing the facility;
- 5) Provide favorable impacts on air quality and energy consumption;
- 6) Not unduly impact the operation of the freeway general-purpose mainlines;
- 7) Be safe and should not unduly impact the safety of the freeway general-purpose mainlines;
- 8) Have local agency and public support;
- 9) Be a cost-effective transportation improvement.
- 10) Have an increase in the peak-hour, peak direction person volume resulting from the HOV facility at least greater than the percentage increase from a mixed-flow lane.

## 5.4 WHERE ARE HOV SYSTEMS FEASIBLE AND/OR INFEASIBLE

Methodologies were established by the project team to identify potential routes for HOV systems. All conventional highways and expressways were eliminated for consideration for the following reasons:

- 1) HOV guideline recommends consideration of HOV lanes on existing freeways of 3 lanes or more in each direction.
- 2) There are no standard design guidelines for HOV lanes on conventional highways and expressways.
- 3) There is no access control on conventional highway which means:
  - Conflicts with turning vehicles and cross traffic at at-grade intersections will create difficulty in HOV implementations;
  - Heavy and short weaving sections would operationally discourage HOV lane uses;
  - Conflicts with driveways and land-use access; and
  - Potential loss of on-street parking and conflicts with delivery vehicles in urban areas.
- 4) Potential negative impact on the safety of pedestrian and bicycles.
- 5) HOV lanes on 2-lane conventional highways would disallow passing and would impact negatively on operations and safety.

## 5.5 EXISTING CORRIDORS

As a result, the potential routes for HOV lane consideration were narrowed to urban freeways with recurrent congestion. These routes were identified from the State HICOMP. Seven locations were selected as listed in Table “A” for District 6:

**Table “A”: Study Locations for District 6**

<i>Location</i>	<i>County</i>	<i>Route</i>	<i>Post Mile (PM) Limits</i>	<i>From</i>	<i>To</i>
1	Ker	58	R52.4/R60.5	SR-99 Interchange	Vineland Road
2	Ker	99	18.5/30.5	Hoskins Road	7 <sup>th</sup> Standard Road
3	Tul	198	R3.7/R13.7	SR-99 Interchange	Road 156
4	Fre/Mad	41	R21.1/R1.7	Jensen Avenue	Childrens Boulevard
5	Fre	99	17.6/31.0	Orange Avenue	Herndon Avenue
6	Fre	168	R0.3/R9.2	SR-180 Interchange	Temperance Avenue
7	Fre	180	R54.5/R63.8	Marks Avenue	Fowler Avenue

In District 10, traffic data was collected and analyzed from freeway segments on I-5, I-205, SR-4 and SR-120 in Merced, San Joaquin and Stanislaus counties. The I-205 freeway in San Joaquin County was used as a corridor case study to represent all freeway

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segments in District 10 because of the availability of traffic information and because the I-205 freeway functions as a collector corridor for interregional commute trips from the northern San Joaquin Valley region to the Bay Area.

A complete tabular analysis of vehicle occupancy and traffic counts for I-205 can be found in Appendix “D”. In Appendix “E” is a less comprehensive, limited analysis of vehicle occupancy on routes listed in Table “B” for SR-99, I-5 and I-205.

**Table “B”: Study Locations for District 10**

<i>Location</i>	<i>County</i>	<i>Route</i>	<i>Post Mile (PM) Limits</i>	<i>From</i>	<i>To</i>
1	SJ/Sta	99		Sacramento County Line	Merced County Line
2	SJ	5		City of Stockton Northern Limits	City of Stockton Southern Limits
3	SJ	205	0/12.7	I-5	Alameda County Line
4	SJ	4		SR-99	I-5
5	SJ	120		Yosemite Avenue UC	Moffat Blvd. OH

## **6 MODELING ANALYSIS AND DATA COLLECTION**

### **6.1 VEHICLE OCCUPANCY ANALYSIS AND DATA COLLECTION**

The most important data required for this analysis were freeway and ramp volumes, vehicle classification and occupancy, and freeway geometric information. Hourly volumes for freeway mainline and ramps were collected from existing count stations.

Truck percentages were obtained from the 2001 Annual Average Daily Truck (AADT) traffic published by Caltrans. Freeway geometric information was gathered mainly from highway logs, Digital Highway Inventory Photography Program (DHIPP) and field observations.

Vehicle occupancy data was not readily available for all freeways. Field observations were required for this task. Methodologies for this task were developed in conjunction with information collected by District 10. A sample size of at least 10% of the peak-hour volume was collected at each route. Count locations were chosen at most congested freeway segments at approximately 10-mile intervals. The occupancy classifications recorded were 1, 2, 3, 4+ and bus/transit. All data for District 6 were collected during the month of May 2003, before the summer begins, as traffic pattern varies during the summer periods. The District 6 vehicle occupancy survey results were listed on the following page in Table “C”. The vehicle occupancy survey results for I-205 in District 10 can be found in Appendix “C”. The random samples of freeway portions merited for overall vehicle occupancy counts within District 10 are found in Appendix “D”.

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**Table “C”: District 6 Vehicle Occupancy Data**

Location	Co	Rte	Dir	Period	Date of Survey	Count Location	1	2	3+	Buses
1	Ker	58	E	PM	05/21/03	Chester Avenue	70.6%	23.8%	4.0%	1.6%
			W	AM	05/21/03	Chester Avenue	82.7%	14.8%	1.6%	1.0%
2	Ker	99	N	AM	05/21/03	North of California Avenue	82.4%	15.4%	1.7%	0.5%
			S	PM	05/21/03	North of California Avenue	69.6%	27.3%	2.3%	0.8%
3	Tul	198	E	PM	05/19/03	Junction 63	79.6%	15.1%	4.6%	0.7%
			W	AM	05/19/03	Junction 63	79.7%	16.3%	4.0%	0.0%
4	Fre	41	N	PM	05/15/03	Gettysburg Avenue	76.0%	19.0%	4.9%	0.1%
			S	AM	05/15/03	Gettysburg Avenue	88.1%	9.8%	0.8%	1.3%
5	Fre	99	N	PM	05/21/03	Pacific Avenue	76.3%	16.6%	4.2%	2.9%
			S	AM	05/14/03	South of Belmont Avenue	74.4%	19.7%	5.2%	0.6%
6	Fre	168	E	PM	05/14/03	North of McKinley Avenue	87.2%	11.7%	0.9%	0.1%
			W	AM	05/14/03	North of McKinley Avenue	89.4%	9.6%	0.6%	0.4%
7	Fre	180	E	AM	05/20/03	West of Cedar Avenue	82.3%	12.5%	4.4%	0.8%
			W	PM	05/20/03	West of Cedar Avenue	92.6%	6.8%	0.6%	0.0%
			E	AM	05/27/03	East of Van Ness Avenue	76.2%	17.3%	5.0%	1.5%
			W	PM	05/27/03	East of Van Ness Avenue	68.0%	24.2%	5.9%	2.0%
<b>AVERAGE =</b>							<b>79.7%</b>	<b>16.2%</b>	<b>3.2%</b>	<b>0.9%</b>

## **6.2 I-205 CASE STUDY**

A case study was conducted in District 10 using I-205. The I-205 freeway was chosen for this case study because it functions as a collector corridor for interregional commute trips from the northern San Joaquin Valley region to the Bay Area. The high occupancy vehicle (HOV) lane analysis for I-205 is presented as a representative sample of other freeway segments in District 10 and cannot be considered as a prerequisite for scoping potential, specific HOV strategies for I-205.

## **6.3 FIRST LEVEL OF ANALYSIS: DEVELOPMENT AND REFINEMENT OF THE ANALYSIS TOOL-DERIVING THE TRAFFIC MODEL FOR THE EIGHT COUNTIES**

The HOV lanes first level of analysis was implemented through the extraction from the State of California, Department of Transportation 2000 and 2025 (statewide) traffic models, the analysis area which consists of: Fresno, Kern, Kings, Madera, Tulare, Merced, San Joaquin and Stanislaus counties. These counties were used together as one 8 county model for the second level of analysis as explained in the following section. One derivation was made for the base year: 2000 and one for the future year 2025. The 2000 and 2025 statewide models were developed by the Division of Transportation System Information (TSI) in Caltrans Headquarters and were adapted for the HOV lanes

second level of analysis utilizing the District 10 Geographical Information Systems (GIS) Level of Service (LOS) Application.

#### ***6.4 SECOND LEVEL OF ANALYSIS: USING THE GIS LOS APPLICATION***

The HOV lanes second level of analysis was conducted using a software tool first developed originally through the funding of a State Planning and Research (SP&R) grant. The modeling application was developed by Merced County Association of Governments (MCAG) and was used for travel forecasting and analysis within Caltrans District 10 in 1997. The project entailed taking the MCAG travel demand model (TDM), integrating it with the ArcView GIS 3.X application and using computer programming to illustrate LOS on a model network. This endeavor utilized the calculation methodology from the 1997 Highway Capacity Manual for freeways, multi-lane and 2-lane conventional highways. The product is a map illustrating colored-link segments of traffic congestion from LOS “A” to “F”.

The tool was then upgraded to display LOS on freeways within the 8 counties in the San Joaquin Valley Air Basin using the 2000 Highway Capacity Manual. The District 10–Level of Service ArcView 3.X Application Upgrade was completed in December 2003 by Caltrans Headquarters, Office of Geographic Information Systems (GIS) (see Appendix “E” for the LOS application upgrade documentation). A calibration methodology was used to adjust traffic volumes based on the 2000 Traffic Volumes on California State Highways guide. Districts 6 and 10 conducted a quality assurance effort to ensure accuracy of data for both Districts. The final LOS results can be seen in Map Illustrations “C” through “E”, Appendix “B”. From the established post mile locations from the The District 10–Level of Service ArcView 3.X Application Upgrade modeling, results for areas becoming LOS “E” and “F” in 2025 were then delineated, which will enable future analysis by the State Department of Transportation.

#### ***6.5 THIRD LEVEL OF ANALYSIS: PROCEDURE USING FREQ***

The next stage to be studied at a higher level of analysis uses FREQ on an exemplary HOV candidate freeway corridor, which in District 10 is the I-205 corridor in the AM peak direction. In District 6, FREQ is conducted for all urban freeway corridors having some level of congestion. One table is presented to demonstrate examples of the technical results and HOV determinations from the FREQ analysis. Conclusions from the analysis are presented here for Districts 6 and 10, and are discussed in more detail on Page 6-23.

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**Table “D”: FREQ Analysis Results for Caltrans Districts 6 and 10**

<i>Location</i>	<i>County</i>	<i>Route</i>	<i>Dir</i>	<i>Is HOV Lane Feasible?</i>	<i>Reason</i>
1	Ker	58	EB	No	Delay low and/or at isolated locations
			WB	No	Delay low and/or at isolated locations
2	Ker	99	NB	Yes	
			SB	No	Demand higher than HOV lane capacity
3	Tul	198	EB	No	Delay low and/or at isolated locations
			WB	No	Delay low and/or at isolated locations
4	Fre/Mad	41	NB	No	Demand higher than HOV lane capacity
			SB	Yes	
5	Fre	99	NB	No	Demand higher than HOV lane capacity
			SB	No	Demand higher than HOV lane capacity
6	Fre	168	EB	No	Delay low and/or at isolated locations
			WB	Yes	
7	Fre	180	EB	No	Delay low and/or at isolated locations
			WB	No	Delay low and/or at isolated locations
8	SJ	205	EB	Yes	Demand higher than HOV lane capacity
			WB	Yes	Demand higher than HOV lane capacity

The results of this analysis in District 6 indicate that the HOV (3+) alternatives would result in under-utilization of the HOV lane (generally less than 400 vehicles per hour) for all routes and would not significantly improve the freeway system.

High occupancy vehicle (2+) lanes are found to be feasible for Ker-99, Fre/Mad-41 and Fre-168 for at least one direction. However, adding mixed-flow lanes would provide similar or better performance in terms of increase in speed and reduction in delay and travel-time. Therefore, the mixed-flow lane alternatives are preferred.

For District 10, the FREQ analysis results show that for I-205, with aggressive ramp metering, the mainline flow will likely show significant improvement. When an HOV lane is introduced to the mainline, it is likely that further improvement to the mainline regional, interregional and transit trip through-put would also occur.

The complete analysis for the results for both Caltrans Districts 6 and 10 can be found in Appendix “F”.

This HOV Study solely focuses on the freeway mainline. Ramps and connectors were not included in the scope of the document. It is anticipated that HOV bypasses at freeway connectors would not be constructed by itself, but as part of an HOV system in

the freeway corridor. The current policy requires that an HOV lane be provided at all metered ramps as recommended in the Caltrans Highway Design Manual<sup>8</sup>.

Since this is a planning-level study, which projects traffic patterns 25 years in the future, many assumptions were made to ease the complication of analysis. In addition, right-of-way, structures, utilities, drainage and cost were not included in the investigation. Therefore, a detailed HOV investigation is recommended at the project-level when freeway widening is required.



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<sup>8</sup> Highway Design Manual, State of California Department of Transportation, 11-1-2001, pg 500-16

## **7 HOV SYSTEMS BACKGROUND**

### ***7.1 HIGH OCCUPANCY VEHICLE LANE POLICY***

Numerous statutes and policy memoranda affect the planning and implementation of high occupancy vehicle (HOV) facilities. It is important to note that these systems are already examined for the purposes of transportation throughout the San Joaquin Valley. It is stated in the Departments' Policy and Procedures Memorandum (P89-01) that the "Department will consider an HOV lane alternative for projects which add capacity to metropolitan freeways or proposed new metropolitan freeways." The Department continues to work with Regional Transportation Planning Agencies (RTPAs) in the conceptual planning phase to consider development of regional HOV lane system plans in metropolitan areas and will consider inclusion of these systems in the Regional Transportation Plans (RTPs).

### ***7.2 HIGH OCCUPANCY VEHICLE SYSTEMS PURPOSE AND DEFINITION***

Although often referred to as commuter, carpool or transit lanes, HOV lanes are facilities that have been designated for specific use by the traveling public. Criteria for lane usage, such as passenger vehicle minimums of two or more persons, transit vehicles, trucks and motorcycles assist in improving the mobility of a corridor by managing the traffic through the corridor. High occupancy vehicle facilities emphasize person movement rather than vehicle movement. The purpose of HOV lane usage is to promote an increase in persons per vehicle, transit, vanpool and all forms of ridesharing. The incentive for ridesharing and HOV utilization is savings in commute/travel-time experienced through the corridor during peak periods of traffic. By using the capacity of the freeway efficiently, HOV systems may reduce overall vehicular congestion and subsequent motorist delay while increasing the overall freeway capacity and mobility through the region.

### ***7.3 TYPES OF HIGH OCCUPANCY VEHICLE FACILITIES***

There are about 100 HOV projects nationwide representing over 1,000-route miles. There are also HOV lanes in Canada and in a wide variety of locations abroad.

An HOV lane's appearance is very similar to any other highway lane, except that it is typically delineated with signs and diamonds painted on the pavement. But there is a great deal of variety in the design and operation of HOV lanes. Some, called concurrent flow lanes, lie adjacent to and operate in the same direction as general-purpose lanes.

Others, called contra flow lanes, operate in the opposite direction of adjacent lanes, enabling HOV traffic to drive on the "wrong" side of the highway with barriers separating them from oncoming traffic. Reversible lanes, usually placed in the highway median, run in one direction in the morning, then in the opposite direction in the afternoon. Bus ways are usually physically separated from adjacent lanes and are reserved for bus use only. High occupancy vehicle lanes are delineated by several methods, including barriers, medians rumble strips, buffer areas and pavement markings. There are several types of HOV facilities:

- Mainline HOV
- Contra flow
- Concurrent flow
- Reversible lanes
- Bus ways

#### ***7.4 HIGH OCCUPANCY VEHICLE LANE BENEFITS***

The benefits to HOV lanes can only be achieved through need and use. It is important to note that the purpose of HOV facilities is to achieve the most benefits to the overall facility and concurrent usage. High occupancy vehicle lanes may maximize the efficiency of our existing freeway facilities through the following achievements:

- Increasing vehicle occupancy rates
- Providing congestion relief to facility
- Increasing carrying capacity of system
- Improve trip reliability through decreased travel-times

##### ***Additional Benefits:***

- Less fuel consumption with single occupancy vehicle (SOV) trip reductions
- Decreases in vehicle emissions due to network SOV trip reductions

##### ***Building HOV Lanes Would Help to Avoid:***

- Prohibitive land costs
- Increased construction costs
- Worsening traffic congestion and air pollution
- Right-of-way and environmental constraints

#### ***7.5 HIGH OCCUPANCY VEHICLE FEASIBILITY***

Although there are many benefits that can be attributed to the designation or building of an HOV facility, there are constraints which make even a congested area unable to incorporate such facilities. Some prohibitive factors, such as:

- *Physical and financial constraints:* geometric and right-of-way constraints, cost;
- *Number of lanes on existing highway:* 2-lane conventional highway should be omitted;
- *Travel pattern:* short length travel, heavy weaving;
- Installation of HOV lanes should have no negative impact on general-purpose lanes;
- Installation of HOV lanes should be more cost-effective compared to adding general-purpose lanes;
- Public acceptance is crucial to the success of HOV facilities; and
- HOV lanes should have favorable or neutral impact on air quality and fuel consumption.

## **7.6 HIGH OCCUPANCY VEHICLE CONNECTIVITY**

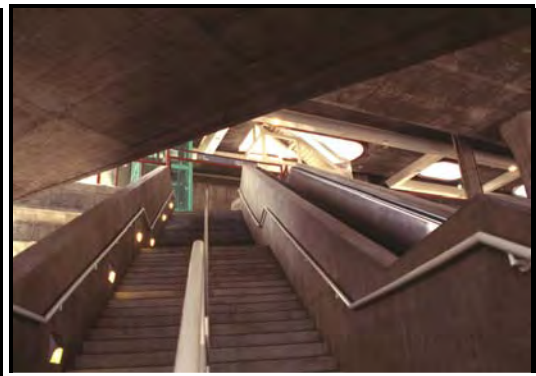
The purposes of developing an HOV lane are to reduce traffic congestion and to improve air quality. Traffic congestion is reduced by making bus trips quicker, as buses will be able to move through the HOV lane much more time efficiently and get to its destinations much faster and with greater reliability, than if it was in a conventional travel lane. Therefore utilizing an HOV lane facility can greatly improve the time and the value of commuting by bus. As well, an HOV facility can greatly increase the functionality of the highway system's overall efficiency by decreasing the number of vehicles on the highway by replacing single occupancy vehicles with buses, vanpools and carpools. There are a number of features that will improve the value of an HOV lane by improving connectivity for transit. Using a direct connector facility allows buses and other high occupancy vehicles to directly access city streets and does not nullify the effectiveness of the facility by forcing HOV vehicles back into the mainstream of traffic. This avoids delays associated with weaving through traffic to exit an off-ramp.

Provided below is an example of a direct connector facility located in Southern California.



Another potential beneficial feature of an HOV system may include bus loading systems located in medians below or above an HOV facility as can be found below in the following photographs taken in Southern California.





Transit connectivity at loading stations along HOV corridors including multi-level loading for both directions of travel can have an enormous benefit in increasing the efficiency with which a transit bus can transport a large group of people from an origin point to a destination point, with minimal time loss, due to congestion compared to a conventional travel lane.

HOV facilities include looping areas where transit buses can loop around in the correct direction so that drivers can park to unload the buses into the pedestrian friendly side of the terminal and pedestrians can then load onto a different bus safely without ever stepping into traffic.



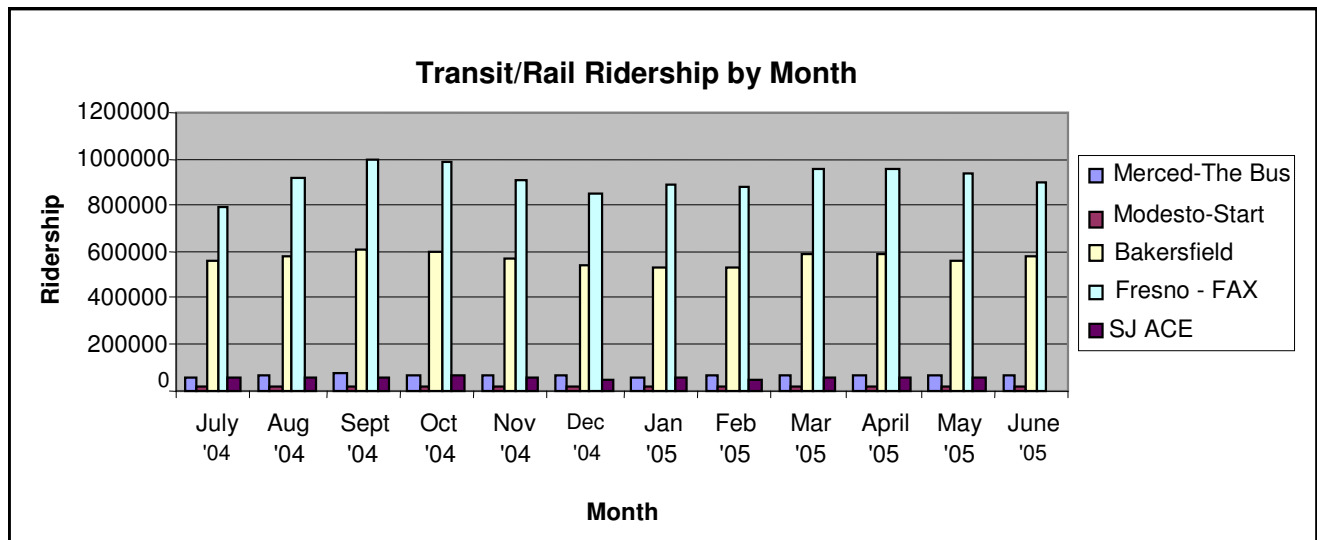
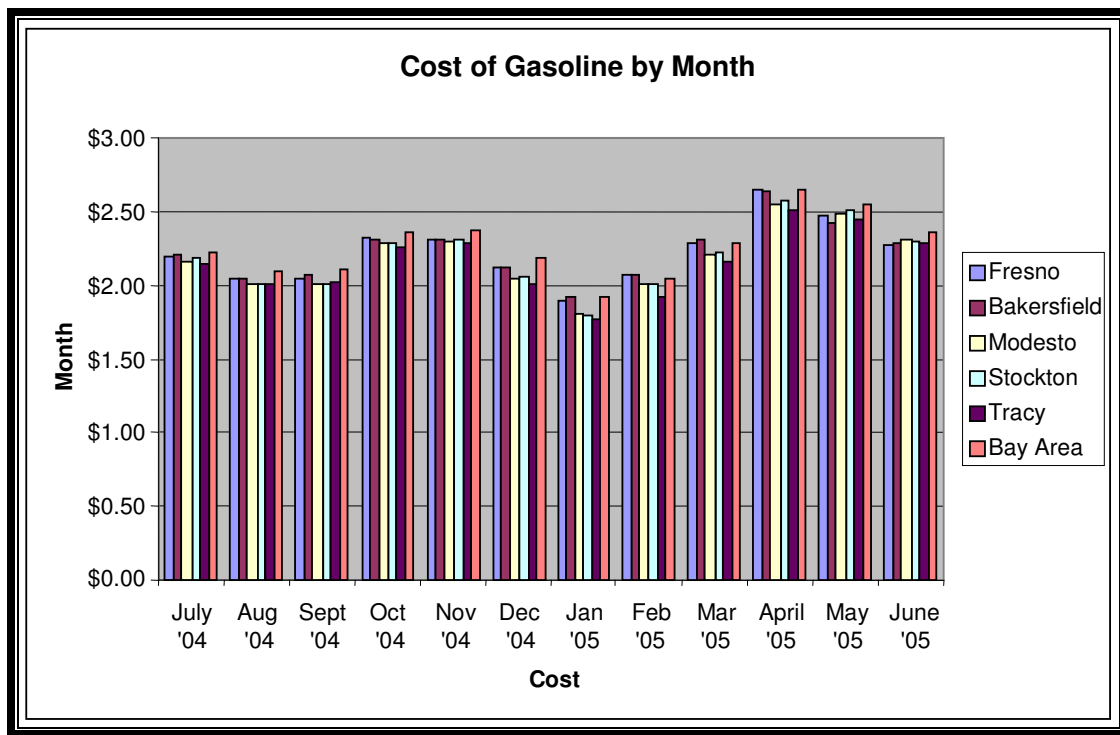
A dedicated HOV bus loading station can include a shelter and a pedestrian walkway which may be connected to a park-and-ride lot.



## **7.7 OTHER CONSIDERATIONS**

Regular gasoline has increased at an average rate of 6% per year from 1990 to 2005 and from 2002 to 2005 (3 years) it has increased at a rate of 24% per year.

Due to the increasing cost of gasoline, an analysis was done as to whether the rising cost of fuel has improved transit ridership in the San Joaquin Valley. On Wednesday, August 17, 2005, gas pumps reached record highs to an average \$2.77 in California according to the front page of the Sacramento Bee. Within the last 72 hours the average price of gasoline as of September 5, 2005, in Stockton, CA according to [www.gasbuddy.com](http://www.gasbuddy.com) was \$3.13 per gallon. Due to this alarming rise in gasoline, transit ridership by area is compared to cost of gasoline on a month-by-month basis between July 2004 and July 2005 in the San Joaquin Valley. The American Automobile Association (AAA) has been conducting an ongoing analysis of the cost of gasoline for the major cities within the United States. A comprehensive survey was derived from several local transit agencies within the San Joaquin Valley. Some data was not available at the time the transit ridership counts by month were collected.



(Data sheets can be found in Appendix "G")

It can be observed from the graphs above that October 2004 and April 2005 riderships, and cost of gasoline correlated together; therefore, it is possible that high gas prices may be affecting transit ridership. However, with transit costs increasing due to higher fuel costs, this may affect transit ridership in a negative manner and could be slowing down the transition. Although there may be a limited correlation between higher transit ridership and the escalating cost of gasoline, other circumstances affecting ridership may be more reflective on the peak periods of transit usage, such as the time of year (i.e., when school is opened or closed or when there is adverse weather). These other factors may have a more significant affect on transit ridership than gas prices. The analysis suggests that a correlation may exist to a certain extent and could potentially generate

some of an increased influence if gasoline prices continue to climb. If the cost of gas does continue to rise, per chance the interest in transit ridership may change.

In the last couple of months there has been a wave of purchases of hybrid vehicles, including a back order of purchases in order for drivers to get more miles to the gallon, compared to a regular gas powered vehicle, to combat the increasing cost of gasoline. In addition, they are also purchasing hybrids and alternative fuel vehicles to be able to use HOV lanes. The State of California has established that some alternative fueled vehicles will be given the right to use HOV lanes in the State of California (see Appendix “H” for a complete list of all alternative fuel, hybrid and full electric vehicles qualifying).

According to the California Air Resources Board web site at: <http://arbis.arb.ca.gov/msprog/carpool/carpool.htm> “Recent enactment of the 2005 Federal Transportation Bill allows California to fully implement Assembly Bill 2628 (AB 2628)”. AB 2628, signed into law on September 23, 2004, allows single-occupant use of HOV lanes by the cleanest alternative fuel, hybrid and full-electric vehicles. Use of these lanes with only one occupant requires an identification sticker issued by the California Department of Motor Vehicles (DMV).

Park-and-ride availability plays a key role in whether an HOV facility will be utilized by buses, carpools and vanpools. Park-and-ride maps for each Caltrans District are provided in Appendix “I”. Two maps are provided which illustrate transit connectivity in combination with adjacent Caltrans freeway right-of-way for the cities of Fresno and Bakersfield within District 6, and also can be viewed in Appendix “J”. Express bus service, commuter rail and park-and-ride potential connectivity for I-205 is also found in Appendix “J” for the District 10 case study.

## 8 CONCLUSION

In summary, several conclusions can be made from the results of this High Occupancy Vehicle (HOV) Study. High occupancy vehicle lanes as a project alternative will have different results regarding the impacts and benefits on the State Highway System (SHS) and to the San Joaquin Valley depending on the area of implementation. The expected benefits of HOV lanes, based on existing HOV systems that are already in place, are a proven fact in the reduction of emissions and the overall through-put of people versus automobiles. The overall cost benefit related to savings in travel-time and cost of delay in dollars must be measured with the consideration of other factors such as the completeness of the HOV system, including those in adjacent counties and regions, connectivity with alternative modes, and the implementation of complimentary transportation components, such as ramp meters, park-and-ride lots, transit service, and Intelligent Transportation Systems (ITS) technologies. Urban areas that are experiencing rapid growth in population and employment have the most to gain because of the incentives associated with HOV systems. The benefits are more realized if the urban areas are within a defined region, such as a unified air pollution control district, or if there are adjacent regions with established urban centers.

In the region of the San Joaquin Valley, the northern counties of San Joaquin and Stanislaus already have an established commute pattern to and from the Bay Area and the Sacramento regions due to the available employment in those areas and the abundance of affordable housing in the Valley. An established SHS in these counties, already burdened with existing traffic congestion, shows the most potential for the implementation of a successful HOV system, particularly because there is already a demand for alternative modes of travel and opportunities to accommodate the long-range commute patterns.

In District 6, HOV lanes were also found to be feasible for State Routes 99 (SR-99) in Kern and Fresno County, SR-41 (Fresno County), and SR-180 (Fresno County), although the technical results of the HOV analysis showed that mixed-flow lanes on these freeways would still provide better performance in terms of speed, reduced delay and travel-time. The reason for this is the nature of the isolation of the centralized urban centers in the counties of Fresno and Kern, which often results in shorter commute travel, more localized traffic movement on the freeway resulting in more weaving movement and merge-diverge conflicts on the freeways.

In conclusion, *The Technical Study for High Occupancy Vehicle Lanes on State Highways in the San Joaquin Valley*, provides valuable information that can be referenced when considering the feasibility of HOV lanes as part of a concerted effort to

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improve air quality in the San Joaquin Valley. It is still the recommendation of this study that information is consistently collected and updated, and that additional and more detailed technical analysis and investigations be performed when considering the implementation of HOV lanes as part of any transportation improvement project.

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Appendices are located in the CD.

## 10 APPENDIX A

<b>HOV Study Team</b>		<b>District</b>
Alan McCuen	Deputy Director Planning/Local Assistance	6
Ken Baxter	Deputy Director Planning/Local Assistance	10
Carlos Yamzon	System Planning and Travel Forecasting	10
Albert Lee	Traffic Operations	6
Warren Lum	Traffic Operations	6
John Liu	Traffic Operations	6
David Berggren	Systems Planning	6
Vu H Nguyen	Traffic Operations	10
Hongloan Luong	Traffic Operations	10
Betty Kibble	Planning	10
Jim Ecclestone	Planning	10
Jenny Huntsman	Air Quality Coordinator	6
Sally Rodeman	Air Quality Coordinator	10
Dana Cowell	Former Deputy Director Planning/Local Assistance	10
<b>Technical Working Group</b>		<b>District</b>
Carlos Yamzon	System Planning and Travel Forecasting	10
Albert Lee	Traffic Operations	6
Warren Lum	Traffic Operations	6
Jenny Huntsman	Air Quality Coordinator	6
Sally Rodeman	Air Quality Coordinator	10
Jim Ecclestone	Planning	10
Vu H Nguyen	Traffic Operations	10
Hongloan Luong	Traffic Operations	10

## **11 APPENDIX B**

### ***11.1 MAP ILLUSTRATION “A-1”***

### ***11.2 MAP ILLUSTRATION “B”***

### ***11.3 MAP ILLUSTRATION “C”***

### ***11.4 MAP ILLUSTRATION “D”***

### ***11.5 MAP ILLUSTRATION “E”***

FOUND IN CD IN FILE LABELED APPENDIX B

## **12 APPENDIX C**

### ***12.1 I-205 TRAFFIC DATA COMPILATION AND VEHICLE OCCUPANCY ANALYSIS***

FOUND IN CD IN FILE LABELED APPENDIX C

## **13 APPENDIX D**

### ***13.1 DISTRICT 10 VEHICLE OCCUPANCY COUNT SAMPLING***

FOUND IN CD IN FILE LABELED APPENDIX D

## **14 APPENDIX E**

### ***14.1 GIS LOS APPLICATION DOCUMENTATION***

FOUND IN CD IN FILE LABELED APPENDIX E

## **15 APPENDIX F**

### ***15.1 DISTRICT 6 FREQ***

FOUND IN CD IN FILE LABELED APPENDIX F

## **16 APPENDIX G**

### ***16.1 TRAFFIC RIDERSHIP AND GAS PRICES***

FOUND IN CD IN FILE LABELED APPENDIX G

## **17 APPENDIX H**

### ***17.1 ASSEMBLY BILL 2628 (AB 2628): LIST OF HYBRID AND ALTERNATIVE FUELED VEHICLES ALLOWED WITH SOLO DRIVERS ON HOV LANES***

FOUND IN CD IN FILE LABELED APPENDIX H

## **18 APPENDIX I**

### ***18.1 PARK-N-RIDE DISTRICT 6***

### ***18.2 PARK-N-RIDE DISTRICT 10-MERCED***

### ***18.3 PARK-N-RIDE DISTRICT 10-STANISLAUS***

### ***18.4 PARK-N-RIDE DISTRICT 10-SAN JOAQUIN***

FOUND IN CD IN FILE LABELED APPENDIX I

## **19 APPENDIX J**

### ***19.1 TRANSIT ROUTES IN BAKERSFIELD AND FRESNO COMPARED TO LEVEL OF SERVICE***

### ***19.2 CONNECTIVITY I-205***

FOUND IN CD IN FILE LABELED APPENDIX J