July 9, 2009

To: Laura Tam, SPUR

From: Doug Kimsey and Rebecca Long

Cc: Lisa Klein, Chuck Purvis, Carolyn Clevenger

Re: Response to Revised SPUR Analysis of the Regional HOT Lane Network

We have appreciated the opportunity discuss with you SPUR's analysis of the regional HOT network's impact on greenhouse gas emissions. For a number of reasons we stand by our assessment that the HOT network would reduce greenhouse gas emissions. Our reasoning is detailed in our response to the original SPUR analysis (attached here for reference – but with a few clarifying edits and technical corrections) and our further thoughts (below) following the revised SPUR analysis. In summary,

- We believe the regional travel demand model, which is peer-reviewed, validated and widely accepted among federal, state and local agencies as an analysis tool. As such, we believe our model is an appropriate and thorough means for analyzing induced demand.
- The model captures a important aspects of travel behavior that influence demand for driving and are not reflected in the model used by SPUR:
    - Network effects of providing faster travel times for carpools and buses;
    - Other factors that influence travel demand (e.g., auto ownership levels, transit service levels and congestion levels)
- The models referenced by SPUR are aggregate regression models, which are not intended for project-level analysis and therefore, in our opinion, make its results questionable at best.

Response to SPUR's Revised GHG Analysis

Below is MTC's response to SPUR's revised GHG analysis of the Bay Area Regional HOT Lane Network, transmitted by SPUR to MTC on June 17, 2009. The response provides additional background in two key areas of disagreement: 1) induced growth caused by HOT lanes and 2) separating the regional network into two parts – conversion and expansion.

1) Induced Growth

Elasticity Analysis

The literature review conducted by SPUR to develop a range of elasticity of VMT with respect to lane-miles refers to several reports by Hansen (1) and Noland, and others, with which MTC is very familiar. It is important to note some limitations about the models developed by Hansen, Noland and others.

- The Hansen models are aggregate regression models using California county-level and metropolitan-level data for the 1973 to 1990 time period. The Noland (1999) research is based on U.S. state-level data from 1984 to 1996. In both Hansen and Noland, VMT is a function of lane-miles (freeways, arterials, or both), population, personal income, population density, gasoline price, and a time lag variable.

- These models exclude: auto ownership levels, transit service levels, congestion levels, non-gasoline pricing (tolls, parking, fares), and economic levels (e.g., total employment). The reason these variables are excluded from the models is that the data was not available for the time periods under analysis. Excluding these variables from any model to predict vehicular travel is known as a "model specification error" and is a fatal flaw from a transportation policy analysis standpoint.

- A significant problem associated with Hansen and Noland is their use of lane-miles of highway as a surrogate for travel time changes associated with highway capacity changes. This is another form of model specification error. In this case, a variable such as travel time changes due to highway capacity changes, cannot be accurately measured, so a more readily available variable, in this case, lane-miles, is substituted.

- These aggregate models suggest that we could spend billions on transit systems and impose extensive value pricing programs to raise the cost of driving, but the models would predict precisely zero impact on changing VMT, clearly an inaccurate predictor of reality.

- The elasticity factors relied upon by SPUR not only do not take into account that the proposed new capacity will be tolled, they do not take into account the network benefits of providing transit services with much superior travel time that can effectively compete with auto travel.

- Furthermore, the elasticities developed by Hansen, Noland and others should not and cannot be used for project-level analyses. The best that can be said about these aggregate models is that they are good, aggregate time series models making the best use of readily available information. The worst that can be said about these models is that they have fatal model specification errors. Therefore, it is difficult to contemplate how these aggregate model elasticities could be applied to analyze induced demand at a corridor level, as they would yield specious results.

- The MTC model has gone through extensive peer review over time by other agencies and recognized experts in the travel demand model field. The model is updated and validated regularly. There are of course limitations to the model, but it is the best tool we have and is recognized by state and federal agencies as an effective, appropriate regional model fully capable of adequately developing forecasts such as those done for the HOT network. We believe that our current approach – using disaggregate travel behavior models applied at the system level – is an appropriate and thorough means for analyzing induced demand.

HOT Lanes Compared to General Purpose Lanes

- MTC did not take issue with the Sightline Institute Study referenced in the original SPUR analysis simply because it is a research organization with a policy point of view. Our concern is that the study's methodology is not well documented and that the methodology that is documented is questionable at best as described in the rest of this memo. Furthermore, we don't believe that the Sightline analysis was ever intended to be used to evaluate un-priced general purpose lanes, which does not account for the different impact that priced lanes would have on travel behavior. Basing assessment of induced demand effects of HOT lanes from an analysis for general purpose lanes is greatly misleading.

- HOT lanes have a practical cap of vehicular capacity of approximately 1,600-1,800 vehicles per hour per lane in order to maintain free flow speeds, as required by law. (For single lane HOT lanes such as those proposed in the Regional Network, the effective capacity is closer to 1,600.) Once demand reaches that cap, no more vehicles can be accommodated. At this point, the cost of buying into the HOT lane will increase and delays in the general purpose lanes will increase as total corridor demand grows. This creates financial and travel time incentives for prior HOT toll-paying lane drivers to carpool or take transit. Our research has found very little information on the impact of existing or planned HOT lanes on VMT and emissions. In fact we found no evidence of increase in regional VMT as a result of the new capacity. There presently is no state or federal guidance for this type of analysis, FHWA is developing a framework for such guidance; the estimated completion date is later this summer

- While the 120 of newly expanded lane miles represents an increase of less than 5% of total lane freeway lane miles regionwide, the expansion represents less than a 1% increase of total roadway lane miles regionwide – in addition, this increase is spread out across the region so overall traffic inducement would be negligible in our opinion.

Congestion's Impact on Sprawl

- While congestion is one of the many factors that may constrain urban sprawl, it is an oversimplification to state that congestion is the greatest constraint. Our research has found very little information on the impact of existing or planned HOT lanes on VMT and emissions. Indeed, the recent RAND report *Equity and Congestion Pricing: A Review of the Evidence* (2009) also notes there has been little work on the long-term land-use impacts of congestion pricing. See http://www.rand.org/pubs/technical_reports/TR680/ p. xi.

- We maintain the impact of the added HOT lanes is distinguishable from other factors that might affect growth in VMT. In other words, we do not believe it is possible to establish a causal effect. Would VMT hold steady in these corridors if we did not add HOT lanes? Probably not, as regional economics and local land use policies are likely to have considerable effects on where people choose to live and where they work. Consider several corridors/areas where freeway widening has followed, rather than preceded growth over the past 10 years: Livermore, San Joaquin County and I-580; Solano County and I-80; Sonoma County and US 101.

2) Conversion vs. Expansion

- We do not agree that the HOT lane system – which is a network, not a consolidation of corridors – can be split into two components: 1) 500 miles of conversion and 2) 300 miles of expansion. The "expansion" element represents mainly gap closures and therefore is totally critical to building an effective network. The 120 miles of newly expanded lane miles, as opposed to HOV gap closures, represents an increase of less than 1% of total lane miles and capacity region wide.

- We have not examined conversion of general purpose lanes to HOT lanes at the network level. The risk of such a conversion is that by taking a lane, you would increase congestion and slow speeds in the remaining mixed flow lanes to a point that would increase emissions. For example, this was found to be the case in a past analysis of an HOV "take-a-lane" in the San Mateo 101 corridor. The negative impacts of converting a general purpose lane to a HOT lane would likely be less than for an HOV lane, to the extent a HOT lane makes better use of lane capacity. However, major traffic congestion impacts and increased emissions would still be a concern in highly congested corridors and corridors with heavy truck traffic.

- If not built as a HOT network, the network will likely eventually be built as an HOV network, though over a much longer period of time. The HOV network has long been included as a Transportation Control Measure (TCM) in federal and state clean air plans because it has demonstrated congestion and carpool incentive benefits. This fact was well documented in MTC's 2002 HOV Master Plan Update (see: http://www.mtc.ca.gov/planning/hov/2002HOV_Plan_Final.pdf Section 11, Air Quality Analysis).

- The advantage of the HOT network is that it delivers those benefits faster because the missing links can be built sooner. Our analyses over the past 7 years, starting with the 2002 HOV Master Plan Update, have consistently shown that HOV and HOT lanes can produce air quality benefits compared to No Build scenarios.

1. Hansen, Mark and Yuanlin Huang. "Road Supply and Traffic in California Urban Areas." In Transportation Research A, Vol. 31, No. 3., pp. 205-218, 1997.

Response to SPUR's Original Analysis (Transmitted June 2009)
With clarifying edits made July 2009

This response consists of two parts. The first part summarizes a series of technical studies conducted by MTC on HOV and HOT lanes. This places the HOT network in the context of a long history of HOV network planning, where the HOV system has been a core emissions reduction strategy for the region. The second part reflects MTC's initial reaction to the methodology and assumptions in SPUR's original analysis of the HOT network's greenhouse gas emissions.

Part 1: Summary of MTC HOV/HOT Lanes Air Quality Studies: Dec. 2002 thru Feb. 2009

I. Introduction

Over the past several years, MTC has undertaken a series of technical studies of a regional network of HOV and HOT lanes. The 2002 HOV Lane Master Plan included a thorough review of HOV lane performance. An assessment of HOV lane usage from modeling forecasts conducted for the 2001 Regional Transportation Plan (RTP) and forecasts for the year 2010 developed specifically for the 2002 HOV Lane Master Plan also were completed. The 2002 HOV Lane Master Plan assessment led to the development of recommendations for how the HOV lane system could be expanded beyond what was already included in the 2001 RTP.

In Transportation 2030, MTC proposed building on the existing HOV system to create a regional network of HOT lanes by converting existing HOV lanes to HOT lanes and expanding the HOV/HOT system where possible. MTC and Caltrans, in cooperation with partner agencies, undertook a Regional High-Occupancy/Toll (HOT) Lanes Feasibility and Implementation Study intended to determine whether a regional network of HOT lanes is feasible, define a phased implementation plan, and provide a regional context for demonstration projects under development.

Phase 1 and Phase 2 of the HOT Lanes Study, completed fall 2007, found a regional HOT network is feasible financially and operationally. It estimated network costs and revenues and outlined a series of technical and policy issues for further exploration. A Phase 2B analysis by MTC suggested there may be ways to accelerate delivery of some portions of the HOT network and reduce costs through a "Rapid Delivery Design" approach that seeks to fit HOT lanes within existing right-of-way, which is now BATA's preferred design approach.

In July 2007, the MTC Planning Committee authorized staff to proceed with a performance-based approach to developing the Transportation 2035 Vision for the update of the RTP. The approach calls for assessing three investment scenarios relative to a set of specific performance targets of congestion, vehicle miles traveled, emissions, and equity. One of the investment scenarios analyzed in this study was the HOT lane network, closing gaps and extending the carpool/HOT system.

Each of the analyses of the regional HOV/HOT lane system development will be discussed below.

II. 2002 HOV Lane Master Plan Analysis

The analysis of HOV lane emissions was included as a "Further Study Measure" in the 2001 Ozone Attainment Plan. The HOV Plan update summarized the analysis of HOV lane emission benefits conducted for the Further Study Measure. The analysis combined the results of MTC's travel demand forecast model and generated emission inventories by utilizing the California Air Resources Board's (CARB) EMFAC emission model to quantify benefits.

The Further Study Measure component of the HOV Master Plan update focused on the air quality implications of the HOV Master Plan and also provided summary comparisons of the transportation performance of different HOV lane configurations.

Table 1: Findings (2010 Horizon Year ─ regionwide results ─ No Build vs. full HOV buildout):

	No Build	HOV Buildout (2001 RTP)	% Change
Peak Period VHD	372,900	323,800	- 13.2
Transit Ridership	1,436,300	1470,400	+ 2.4
Drive Alone	7,939,137	7,914,074	- < 1.0
Shared Ride (2+/3+)	4,911,766	4,909,748	+ < 1.0
VMT	193,301	192,209	- < 1.0
Ozone Precursors	329.26	327.00	- < 1.0

III. Regional High-Occupancy/Toll (HOT) Lanes Feasibility and Implementation Study

An expanded express lane network can encourage more transit use and carpooling and reduce congestion and increase travel speeds for the entire highway corridor, thereby reducing vehicle tailpipe emissions. Compard to a standard HOV network, an express lane network reduces carbon dioxide (CO_2) emissions in the morning peak period by 7 percent compared, as shown below. A HOT lane network also provides substantial public health benefits through a 10 percent reduction in particulate matter emissions, a primary contributor towards asthma.

Phases 1 and 2 Evaluation

This analysis finds a complete HOT network would result in lower CO_2 emissions than a complete HOV network. (See Table 2, below.) It should be noted that comparing a complete HOV network to that of a complete HOT network greatly understates the benefits of an Express Lane Network since it doesn't take into account that the HOT network could be built 20-40 years earlier than an HOV network that is dependent upon existing pay-as-you-go funding. Taking this time difference into account, the express lane network saves approximately 10 million tons of CO_2 between 2009 and 2050.

Preliminary analysis conducted in fall 2007 shows the Regional HOT Network would reduce carbon dioxide emissions compared to a scenario in which the carpool network is completed on a pay-as-you-go basis. By completing the network sooner, thereby expanding capacity and using existing lanes more efficiently, the Regional HOT Network improves congested travel speeds and reduces carbon dioxide emissions.

The analysis indicates that building out the carpool network on a pay-as-you-go basis would result in approximately 4.7 million more tons of carbon dioxide emissions between 2010 and 2033 (the Transportation 2035 period) and 10 million more tons between 2010 and 2050 than building the Regional HOT Network (see Table 3, below). Emissions savings are projected to grow rapidly between 2015 and 2030, when the carpool network would be expanding very slowly but the HOT Network would be complete (under the "rapid delivery" approach) or expanding quickly (under the "full feature" approach). (See Table 4, below for a comparison of emissions in year 2030.) After 2030, emissions savings are projected to decline as the fleet becomes significantly more fuel efficient.

The difference in carbon dioxide emissions between the two approaches to delivering the Regional HOT Network is much less pronounced. The "rapid delivery" approach is projected to save approximately 600,000 tons of carbon dioxide emissions over the period between 2009 and 2050. Nearly all the savings would accrue in 2030 or earlier.

Table 2: Emissions Associated with Express Lane Network vs. a Standard HOV Network, 2030

	Reactive Organic Gases (tons)	Nitrogen Oxide (NOx) (tons)	Particulate Matter (PM_{10}) (tons)	Carbon Dioxide (CO_2) (thousands of tons)
Morning Commute Peak Period Emissions – Two peak hours from 7 to 9 am				
HOV network (800 lane miles)	2.10	2.18	0.20	4.65
HOT network (800 lane miles)	2.06	2.11	0.18	4.32
Percent change	-2%	-3%	-10%	-7%

Source: Bay Area High Occupancy Toll (HOT) Network Study, December 2008 Update. (p. I-14)

Table 3: Cumulative Carbon Dioxide Emissions for HOV and Express Lane Networks

	Carbon Dioxide Emissions (thousands of tons)				
	Annual			**Cumulative**	
	In Year 2015	**In Year 2030**	**In Year 2050**	**2010 through 2033**	**2010 through 2050**
Pay-As-You-Go HOV Network	8,500	7,788	7,474	206,097	335,290
Express Lanes Build Out	8,460	7,415	7,176	201,405	325,029
Difference	40	373	298	4,692	10,261

Source: Bay Area High Occupancy Toll (HOT) Network Study, December 2008 Update. Appendix 12 (p. II-38)

Table 4: HOT Lane Feasibility: Compared to pay-as-you go HOV (partial buildout) vs. Express Lane buildout in <u>2030</u>:

	Pay-As-You Go HOV (550 lane miles)	Express Lane Buildout (800 lane miles)	% Change
VHT per year (in millions)	425	350	-17.6
PHT per year (in millions)	489	403	-17.6
CO_2 (in 1,000 of tons per year)	7,788	7,415	-4.8

Source: Bay Area High Occupancy Toll (HOT) Network Study, December 2008 Update. Appendices 11 and 12 (pp. II-34 and II-38)

IV. 2035 Vision and Transportation 2035 Plan HOT Lane Analyses

In the 2035 Vision analysis, the regional HOT lanes network was defined by some 757 lane-miles of HOT lanes. Buses and carpools were coded in the highway network to use the HOT lanes free of charge; other vehicles would pay a toll to use the lanes. The number of toll paying vehicles would be monitored and controlled though toll rates so the HOT lanes do not become overcrowded and slow down.

The T-2035 "Vision Analysis" – No Build to HOT/express bus alternative comparison in 2035 (no L/U-pricing) produced the following results:

	No Build	HOT/Express Bus	% Change
VMT/capita	21.3	21.0	-1
VHD/capita	72	61	-15
CO_2	77	75	-3
Transit Trips	1,937,513	2,210,880	14
Drive Alone	9,819,693	9,752,874	-1
Shared Ride (3+)	2,073,257	2,112,640	2
VMT	193,301,707	190,994,442	-1

Sources: Transportation 2035 Performance Assessment Report, December 2008 and Transportation 2035 Travel Forecasts Data Summary, December 2008

Part 2: Comments on SPUR Evaluation with respect to Travel Demand Modeling and "Induced Growth" Observations (as they relate to HOT Lanes)

- There are conflicting forecasts of the traffic and emission impacts of HOT lane additions
- Most of the conflict seems to center around the purported "induced growth" impacts of adding freeway capacity
- We need to make sure that when we talk about induced growth, we are using the same definitions:
  - there is "induced" modal shift created by adding capacity – that is, building highway lanes will encourage more vehicle travel
  - there is "induced" time of day shift – in capacity constrained conditions, those that are traveling in the peak shoulders choose to shift into the peak periods because there is now capacity available to do so
  - there is "induced" spatial shift – that is, those currently traveling on a parallel local road will shift to the improved freeway because it provides a less congested and faster trip
  - lastly, there is "induced" new trips – trips that were previously not made because it was either too much of a hassle to travel before a facility was expanded and/or the expanded facility encouraged more development and therefore more trips
- MTC's travel demand model currently captures the first three "induced shifts"; regarding the last "shift"
  - first, we not yet seen a credible analysis that proves that added freeway capacity induces more development and therefore more trips
  - research we have done indicates that corridor travel is far more dependent on a variety of other factors beyond transportation improvements, including regional and national economic conditions, local land use and development policies and improvements made elsewhere on the region's transportation system
  - as such, transportation is always playing "catch up" as evidenced by the current congestion we see today and the fact that road expansion accounts for about 5% of total RTP expenditures, while regional growth in people and jobs over the next 25 years will be more than 30%.
  - the proposed 300 lane miles of express lanes account for an overall increase in total freeway lane miles; these new lane miles are spread across the region and are relatively short extensions of existing or funded HOV/express lanes, so it's difficult to say that these various new segments are "growth inducing"
  - with that said, we would concede that there might a very small number of non-work trips that would not otherwise be taken during the shoulder of the peak periods that are not captured by the forecasts

Reaction to SPUR's Assessment of Express Lanes Impacts

- The basis of SPUR's assertion that HOT lanes would induce more traffic and cause more emissions is based on an analysis done by Sightline Institute, a self-described think tank based in Seattle, WA concerned mostly with promoting sustainable communities
- The citing in SPUR's paper was a summary that I'm assuming is backed by a more robust analysis and data set that I couldn't locate on their web page – it's difficult to tell how they arrived at some of their assumptions
- A few comments on Sightline's analysis
  1. the assumptions are based on a typical metro area highway expanding from 4 to 6 lanes; my assumption is that these assumptions are based on adding mixed flow lanes, which would be very different from adding an HOV or Express (tolled) lane, especially converted express lanes, which is more than 60% of our express lane network
  2. as such, the analysis seems to ignore that fact that HOV/Express lanes would make transit and carpooling more attractive and thus increase their use
  3. it ignores that fact that the vast majority (up to 90% in some corridors) of all peak period trips are work trips; these trips would not be "new induced trips" as described above because existing forecast work trip demand is sufficient to fill up any available capacity – there simply is very little freeway capacity for adding new trips
  4. the analysis goes out to 50 years – although we've attempted to go beyond our traditional 25-year forecast horizon, most notably for the Regional Rail Plan and some of the HOT lane work, we are mostly in unchartered territory and should characterize results in a very large range
  5. looking at Sightline's web page, it's interesting to note that they are promoting "congestion pricing" – although in fairness they seem to be mostly referencing several cordon pricing projects, they do recognize that pricing concepts will need to be done incrementally – we acknowledge that express lanes are a first step toward introducing price signals into the transportation system.