Bay Area High Occupancy Toll (HOT) Network Study

December 2008 Update

Metropolitan Transportation Commission

December 2008

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Why Pursue a Regional HOT Network?

High occupancy toll (HOT) lanes are a proven concept based on well-established technologies. Individual HOT lane corridors have operated effectively in southern California since the mid-1990s. Based on experience in Southern California and national trends, the California Performance Review conducted in 2005 recognized HOT lanes as a useful tool to address the state's mobility and infrastructure challenges. Several HOT lane corridor projects are scheduled to open in the Bay Area by 2015 under existing state legislative authority. The first of these will open on I-680 over the Sunol Grade in 2010. The other corridors include: I-580 through the Tri-Valley, and US 101 and State Route 85 in Santa Clara County. A number of other cities in the US have recently opened HOT lane facilities or plan to do so in the next five years.

This study advances the HOT lanes concept from individual corridors to a connected network spanning the Bay Area. A connected carpool network has been a regional goal 30 years in the making. The Regional HOT Network would accelerate completion of the region's carpool and bus priority system, presently incomplete due to lack of funding. Completion of the network would close gaps that inhibit seamless travel for carpools and buses and relieve bottlenecks where existing carpool lanes end.

In July 2008 MTC approved inclusion of the Regional HOT Network in the Draft Transportation 2035 Plan. In doing so, MTC endorsed a set of principles to guide implementation of the Network in collaboration with partner

Six Reasons to Pursue a Regional HOT Network

1. **Improve the efficiency of the freeway system** by making the best use of available capacity. HOT lanes offer demonstrated reductions in person-hours of delay and vehicle-hours of delay.
2. **Offer congestion insurance.** Experience shows travelers from all income groups and professions value having a reliable travel option when they most need it.
3. **Advance completion of the region's priority network for carpools and buses.** By generating revenue, the HOT network produces a revenue stream that can be used to finance gap closures and extensions to the region's carpool system – key air quality and congestion relief strategy 30 years in the making. Without this revenue stream, completion of the network would be delayed by decades. HOT Network revenue would also be available for other corridor improvements including new and enhanced transit.
4. **Introduce the region to user-fees, an emerging funding and demand management strategy**. Transportation pricing is among the most effective tools for reducing greenhouse gas and other vehicle emissions, vehicle miles driven and delay. Further, locally-controlled user-fees are likely to be an increasingly important source for funding transportation infrastructure and services needed to serve a growing region and can free up highway funds for other uses.
5. **Provide a seamless system for users.** Several counties within the region are pursuing HOT lanes for the reasons noted above. To best serve travelers, these projects should be coordinated from a design and operations standpoint. A network approach also promises a more robust and connected system to facilitate regional express bus service.
6. **Partnership offer efficiencies.** Coordination at the regional level avoids duplication in areas including design approach, toll collection, incident management and enforcement.

agencies. (See sidebar below.)

Regional High Occupancy Toll (HOT) Network Principles
(adopted by MTC in July 2008)

OBJECTIVES

- Manage the Bay Area's freeways more effectively to increase throughput and reduce delays
- Provide an efficient and seamless system for travelers
- Provide benefits to travelers within each corridor in proportion to revenue collected in that corridor
- Take advantage of existing highway right-of-way to implement the Regional HOT Network faster
- Use toll revenue collected from HOT lanes to finance, build, operate and maintain the network, and to provide transit services and other improvements in the HOT lane corridors

IMPLEMENTATION

1. **Collaboration and Cooperation** – MTC and BATA will work in concert with county congestion management agencies, Caltrans and the California Highway Patrol. A collaborative process shall establish implementation policies, including phasing of the Regional HOT Network, tolling and operations policies, and corridor investment plans.
2. **Corridor-Based Focus & Implementation** – The best model for implementation is a corridor-based framework that reflects the distinct communities and commute patterns within each corridor.
3. **Reinvestment within the Corridor** – Support for the Regional HOT Network will depend on showing that revenues collected in a corridor benefit travelers in that same corridor – through capital improvements on the freeway and parallel arterials, support for transit service and operations, and enhanced operations and management of the corridor.
4. **Corridor Investment Plans** – Reinvestment of revenues in each HOT lane corridor will be directed by Corridor Investment Plans developed by the stakeholder agencies within each corridor.
5. **Simple System** – Travelers deserve an efficient and easy-to-use system that includes safe and simple operations, consistent design and signage, common technology, and common public information and marketing.
6. **Toll Collection** – The Bay Area Toll Authority shall be responsible for toll collection.
7. **Financing** – A collaborative process will determine the best financing mechanism, which could include using the state-owned toll bridge enterprise as a financing pledge to construct the network.

The approach is to convert to HOT lanes approximately 500[1] miles of carpool lanes that exist today or will be built in the next four years with dedicated local sales tax, state and federal funding. The revenue generated would then be used to construct approximately 300 new miles of HOT lanes that close gaps and extend the system. (See map next page.)

[1] 400 lane miles exist today or are under construction and 100 are fully funded but not yet under construction.

Bay Area HOT Network[2]

This analysis suggests the region's carpool system can incorporate HOT lane functions and continue to offer priority for carpoolers and express buses, while improving overall freeway

[2] Some additional segments, including I-580 and I-238 west of I-680 in Alameda County and I-880 and Route 17 south of US 101 in Santa Clara County, are under study as part of continuing technical analysis. These may ultimately be incorporated into the regional network.

efficiency. It suggests there are enormous benefits in terms of reduced greenhouse gas emissions and delay associated with the Regional HOT Network because it generates revenue that allows the system to be completed decades sooner than a traditional carpool network, which would be funded through traditional sources. The study outlines a range of approaches to design and delivery, with associated delivery time frames and costs.

While current state law authorizes HOT lane projects in four Bay Area corridors, additional authority will be required to develop the complete network. Further, many policy considerations must be addressed before the region can develop a detailed HOT Network implementation plan. These include: governance, financing, specific corridor investment programs (including transit and other transportation improvements), and operations policies. These, as well as further technical studies, are underway or lie on the horizon.

About this Report

This report documents the analysis and assumptions underlying the Regional HOT Network adopted as part of the Draft Transportation 2035 Plan. Analysis completed to date consists of two major study efforts:

- **Initial Feasibility Study (Phase 1 and Phase 2, complete September 2007) and documented in Section I**. This effort defined the Regional HOT network, assessed general feasibility, defined a "full feature" design approach and phasing, and estimated associated revenues and costs.

- **Updated Assessment (Phase 2B Study, complete June 2008) and documented in Section II**. This effort defined a "rapid delivery" design approach and phasing, and revised the revenue, cost projections and financing analysis accordingly. The analysis from this effort is the basis for assumptions in the Draft Transportation 2035 Plan (anticipated release in December 2008). As part of this work, MTC also developed a preliminary estimate of travel time and greenhouse gas emissions associated savings with the Regional HOT Network.

The studies documented here are part of a broader, ongoing effort to develop the Regional HOT Network. Technical studies for an undertaking of this scale are necessarily iterative, starting with relatively broad analyses (such as those documented here) and refining the analyses over time. Current and future work to this end includes, but likely will not be limited to:

- **Phase 3 Study (anticipated completion, February 2009).** This effort will refine capital cost estimates for the Regional HOT Network. It will find a middle-ground between the "full feature" and "rapid delivery" design approaches based on a more detailed review of opportunities and constraints in selected corridors. In all likelihood, the HOT Network will include some elements of both design approaches: the "full feature" approach will likely be accommodated where it can be accommodated readily and the "rapid delivery" approach may be used in more constrained settings.

- **Revised Demand and Revenue (2009).** This effort is expected to revise demand and revenue forecasts based on the updated design and phasing assumptions. It will employ more resource-intensive forecasting approaches, including iteration between the travel and tolling models, and will provide a basis for associated analyses described below.

- **Associated Analyses: Equity and Emissions (2009).** Updated demand and revenue forecasts will generate refined forecasts of traffic, travel behavior and revenue. As such, they will provide a basis to review of the equity implications of the HOT Network (social and geographic) and to update analysis of vehicle emissions, including greenhouse gases.

- **Policy Discussions (ongoing)**. In fall 2008, executives from the region's county congestion management agencies, Caltrans, California Highway Patrol and the Metropolitan Transportation Commission (MTC) began to meet regularly to address major policy considerations associated with the Regional HOT Network. These include: governance, financing, corridor investment programs, education and outreach, and operations. These discussions will inform future legislation related to a Bay Area HOT Network.

- **Project-Level Design and Operations**. It will be necessary to complete a Project Study Report or Project Report for each major component of the network. This effort will include detailed operations analysis and refined design based on a much more detailed review of the project area.

- **Project-Level Environmental Review**. Each component of the HOT Network will undergo full, project-level environmental review, consistent with state and federal environmental review requirements.

Section I:
Initial Feasibility Study (Phase 1 and Phase 2)

Complete September 2007

Conducted by
Metropolitan Transportation Commission
in cooperation with Caltrans

1. Introduction

This first-order analysis suggests the region's HOV system can incorporate HOT lane functions and continue to offer priority for carpoolers and express buses, while improving overall freeway efficiency. Further, the Bay Area HOT network could be delivered by 2025 and could be self-financing over a 30-year period if developed and financed as a regional system rather than a corridor-by-corridor endeavor. Current state law does not, however, provide a governance framework for a truly regional network. Further discussions with state, regional and local stakeholders are necessary to define a workable governance structure.

This feasibility assessment should be viewed as a first step toward delivering a regional HOT network. In addition to assessing general financial feasibility, the study proposes a phased implementation plan, reviews travel and air quality benefits and identifies policy and governance considerations. As such it lays the groundwork for subsequent, more detailed analyses needed to address both technical and policy matters.

2. Summary of Preliminary Findings

The region's HOV system can incorporate HOT lane functions and continue to offer priority for carpoolers and express buses. As recent federal and state reviews show, California's HOV system will need to be managed to preserve timesavings as carpooling grows over time. A variety of strategies from increased enforcement to integrated corridor management can help HOV lanes operate more effectively as they become crowded over time and forestall more involved measures such as increasing carpool vehicle occupancy requirements or adding a second lane through dynamic lane management or widening, where possible. Even without introducing HOT lanes, carpool volumes in approximately six of the region's HOV corridors are projected to grow the point of crowding over significant distances between 2020 and 2030. Conditions are projected to become crowded in another nine HOV corridors between 2030 and 2040. When steps such as increasing carpool occupancy requirements or adding a second lane become necessary, HOT lanes can be introduced as a tool to ensure freeway capacity is used efficiently and to manage continuing operation.

A regional network of HOT lanes completed by 2025 can pay for itself over 30 years. Based on conservative cost and revenue estimates and a conservative approach to financing, revenues should be sufficient to cover operations costs and guarantee bond financing for conversion of existing HOV lanes and construction of gap closures and extensions to complete the network. (See Bay Area HOT Network Map, next page.)

The HOT network that operates full time or close to full time could generate net revenue to fund complementary transportation improvements while sustaining a high level of borrowing. Developing the network by 2025 requires several years of major capital outlays; the borrowing need is approximately $4.7 billion and requires 30-year financing to cover capital costs. However, revenue growth is robust in later years, and the network would generate positive cash flow, even accounting for financing costs, prior to 2030. Over 20 years, the regional network could generate net revenue up to $3 billion, after accounting for debt service payments. Restricting HOT lane operation to the most congested peak periods would likely dampen revenue generation to a point that would not sustain the borrowing required to deliver the complete network by 2025.

Bay Area HOT Network[3]

[3] Map updated in September 2008 to more reflect projects under construction as of that date. Some additional segments, including I-580 and I-238 west of I-680 in Alameda County and I-880 and Route 17 south of US 101 in Santa Clara County, are under study as part of continuing technical analysis. These may ultimately be incorporated into the regional network.

Because the HOT network generates a revenue stream that permits bond financing, the network can be completed much more quickly than if developed using traditional funding sources. This itself offers benefits in the form of travel timesavings.

By more efficiently using freeway capacity and thereby reducing congestion, HOT lanes can reduce the cumulative amount of driving time for drivers in the regular, general-purpose lanes as well as those who choose to pay the toll for a faster, more reliable trip. Preliminary analysis suggests the regional HOT network could reduce the amount of freeway driving time (measured in vehicle hours) in the morning peak period by 21 percent in the adjacent general-purpose lanes. Further, by maintaining level of service standards in existing state law, average travel speeds of 54 miles per hour could be maintained in the HOT lane.

Even if the HOT network were merely to break even in the first 30 years, the region would gain tremendously by developing the HOT network. **Revenue from the HOT network would free up for other investments a total $2.6 billion (2006$) that would otherwise be spent to expand the HOV system.** Of this, nearly $1 billion is in region's current long-range transportation plan, *Transportation 2030*, and the remainder lies beyond the plans financial capacity.

It is critical to approach Bay Area HOV and HOT lanes from the perspective of a regional network. Tremendous benefits can accrue from a connected system. A 2003 performance audit of the Los Angeles HOV system found that fully two-thirds of the travel benefits are lost at gaps in the system where HOV traffic is forced to merge into remaining travel lanes.[4] From a financing and deliverability standpoint, too, the complete system can be achieved only by considering a network as a whole. Pooling revenues significantly increases bonding capacity and makes it possible to finance development of some corridors that are unlikely to generate the level of revenue required to be financeable on their own. Prior to 2030, most corridors essentially break even (i.e., their revenues cover their costs) and just a few corridors generate net revenue on the order required to secure the bonds. After 2030, a number of corridors begin to generate significant net revenues.

A governance structure must be put in place to deliver a regional HOT network. The governance structure needs to facilitate the development and operation of a network that provides a seamless experience for travelers while balancing state, regional and local interests. The current statutory framework approaches HOT lanes on a corridor-by-corridor basis and likely is not adequate to address the considerations involved in implementing a regional network.

3. Bay Area HOT Network Overview

The Network

The Bay Area's existing HOV system comprises approximately 400 miles of HOV lanes. Another 100 miles are currently under construction or fully funded and expected to open before 2015. The regional HOT network would be developed first by converting to HOT lanes the HOV lanes in place by 2015 and subsequently constructing direct connectors and approximately 300 miles of new HOT lanes to close gaps and extend the system. (See Bay Area HOT Network

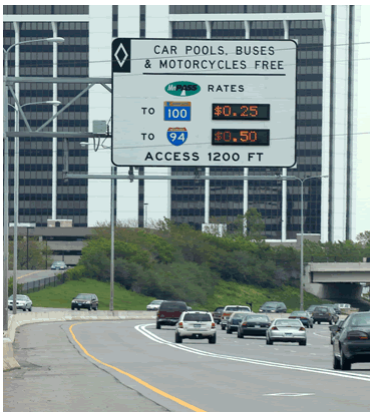
[4] Los Angeles County Metropolitan Transportation Authority. HOV Performance Program Evaluation Report (November 22, 2002).

map.) The network considered in this study would ultimately provide priority lanes on nearly 800 of the region's 1,200 directional miles of freeway.

Admittedly, this network leaves two considerable gaps in the HOV network where environmental, structural and traffic considerations pose exceptional challenges. One gap lies on the U.S. 101 corridor between San Francisco International Airport and San Francisco. A second lies on the I-880 corridor between the Oakland International Airport and the Bay Bridge approach. These segments are being evaluated in separate corridor studies.

Design

The design anticipated for the regional HOT network is similar in concept to that in place in Minneapolis, as shown below. A single HOT lane in each direction would be separated from its adjacent travel lanes by a painted double yellow stripes and four-foot buffer. In contrast to the existing, continuous access HOV lanes in the Bay Area, drivers would be able to enter and exit the lanes only at designated locations. This study assumes merge lanes to facilitate merging at those locations. (See example of merge lane, below.) The limited access design is a function of current electronic toll collection technologies, which use roadside toll readers to collect tolls based on use of the HOT lane.



Minneapolis I-394 HOT Lane

Example of Merge Lane at Carpool Lane Ingress Location

Tolls

As with existing carpool lanes, qualifying carpool and buses would use the lanes for free. Other vehicles would pay tolls collected using FasTrak® toll technology. Tolls would vary with traffic congestion, rising as traffic increases (in effect charging more when the HOT lane offers more travel time savings). To maintain priority for carpools and express buses, tolls would be set so the HOT lane operates at level of service C conditions or better, as required by current law. As traffic approaches the threshold, high toll rates would discourage tolled vehicles from entering the lane. Qualifying carpools and buses would always have priority access over toll-paying vehicles at no charge. Advance signage would allow other drivers to decide whether they want to enter the HOT lane given the toll rate in effect at the time. Travelers would typically pay 20 to 60 cents per mile in 2015 and 50 cents to $1 per mile in 2030 to bypass peak period traffic congestion (2006$). As space becomes very scarce in some corridors, posted toll rates may be higher to prevent the HOT lanes from becoming over crowded.

Enforcement

Revenues from the HOT lanes would be used to fund expanded enforcement by the California Highway Patrol (CHP). CHP officers would enforce both toll violations and HOV occupancy requirements. Technology is available identify vehicles that do not pay tolls. Currently, no technology exists to aid CHP officers in verifying vehicle occupancy, and visual verification is likely to be necessary at least in the near-term.

4. HOT Network Phasing

This study outlines a phasing plan to develop the regional HOT network by 2025. (See Bay Area HOT Network Phased Implementation maps, next page.) The four existing HOT lane demonstration projects will be in operation by 2015 and comprise the first pieces of the regional HOT network. Following this, the general strategy is to begin by converting to HOT those HOV lanes in place in 2015. As a second step, new HOT lanes would be constructed to close gaps. System extensions would tend to be the last pieces developed. A focused program management effort for project development, environmental and design would likely be required to undertake this effort.

A number of other important factors are considered in combination with the general strategy. These include: travel time savings and revenue generation, which will be highly correlated; benefits for HOT lane and transit operations; geographic balance so that portions of the region are not left behind for long periods of time; and consideration of actions needed to preserve HOV lane functionality, which is discussed further below. Project development and construction time requirements are also a consideration. Under current Caltrans protocols, project development and environmental process might take up to five years for segments where existing HOV lanes are converted to HOT lanes and closer to ten years for segments where new lanes must be constructed.

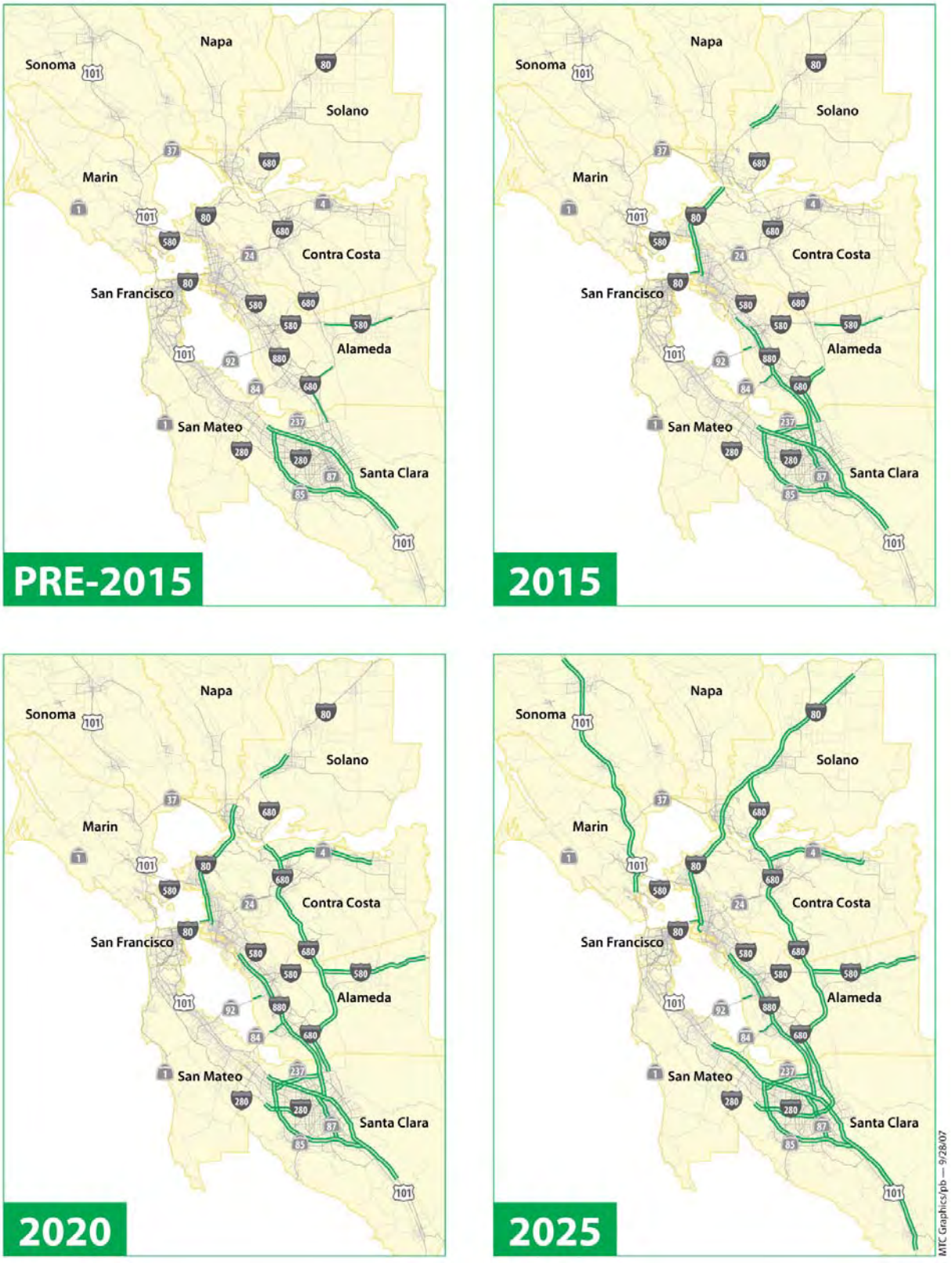
While it is important to think of the regional network as a single system, there are five geographic sub-areas (listed below) where sequencing and staging decisions have clear effects on other projects and so provide a framework for a phasing strategy.

Bay Area HOT Network Sub-Area Groupings

Associated with I-680	Santa Clara/ San Mateo	Associated with I-80	Marin/ Sonoma	Associated with I-880
I-680 SR 4 I-580	US 101 SR 85 SR 87 SR 237 I-280 I-880 [1]	I-80 [2]	US 101	I-880 [3] SR 84 SR 92

[1] SR 237 to US 101 in Santa Clara County
[2] Bay Bridge to Yolo County Line
[3] Oakland to SR 237 in Santa Clara County

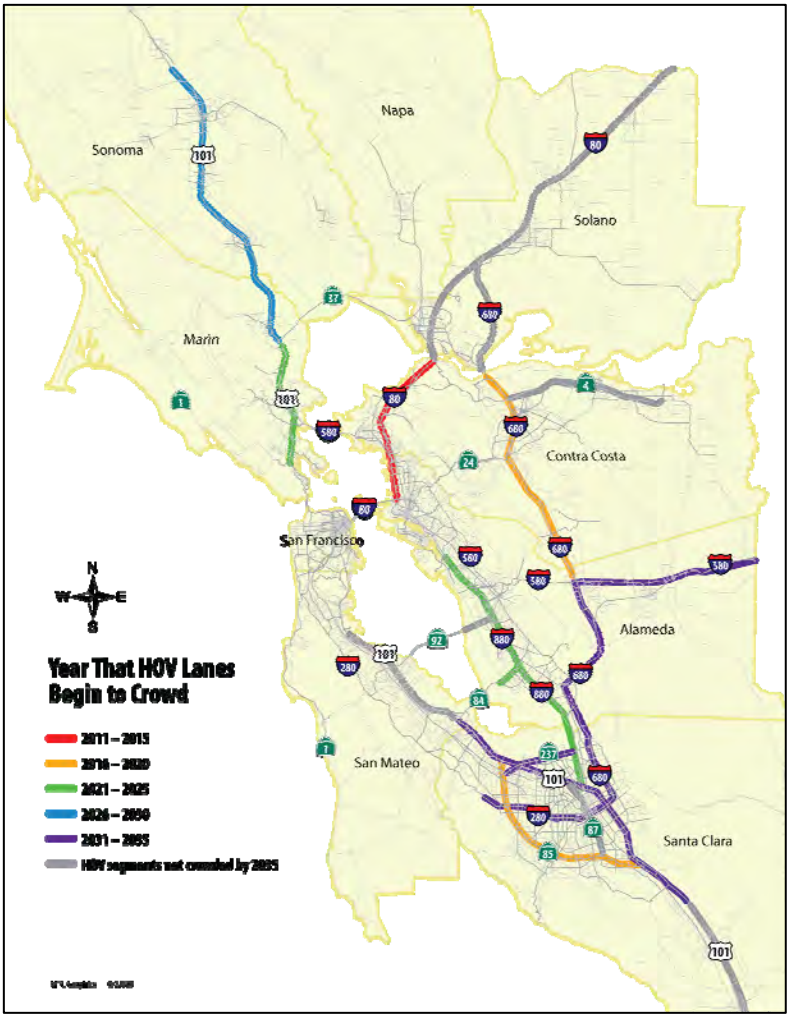
Bay Area HOT Network Phased Implementation



HOV Crowding and HOT Implementation

Analysis shows the region's HOV lanes will become increasingly crowded over time and will eventually jeopardize their ability to serve their very purpose – providing travel time advantages and reliable trips for carpools and express buses. Caltrans is currently developing a managed lanes business plan that will outline near-term and longer-term measures to address this concern. Near-term measures, such as better enforcement, incident management and freeway management strategies, can address spot crowding and slow its spread.

HOV Volumes Grow to the Point of Crowding Over Time



With the HOV/HOT Business Plan still under development, this study assumes the longer-term approach to preserve HOV lane function will be to increase carpool occupancy requirements. This is by no means the only solution, but it is likely to be the most cost-effective, longer-term solution in most Bay Area corridors. Other solutions would provide two HOV travel lanes either by widening to add a second HOV or HOT lane or by converting one adjacent general purpose lane to a dynamic dual lane that would operate as an HOV or HOT lane during the most congested periods only. While dual HOT lanes have many operational and safety advantages, this approach is likely to be feasible or cost-effective on a corridor basis in few Bay Area locations; however, it may be possible to create dual lanes in spot locations to alleviate choke points. HOT lanes complement all of these longer-term strategies by ensuring any new or "freed up" capacity created by the new strategy is fully utilized from the start.

In many Bay Area corridors, longer-term solutions will not need to come into play until 2030 or later. (See map above.) The phasing plan begins HOT lane operations much earlier in many of these corridors under existing carpool occupancy requirements. The lanes can continue to work as HOT lanes as long as carpool occupancy requirements are increased as the lane begins to crowd over significant distances.

In a few corridors, crowding is more imminent. In these corridors, HOT lane operation might be deferred until occupancy requirements need to be increased to preserve carpool and express bus function. This avoids the perception that the objective is to squeeze out carpools to make

room for tolled vehicles and avoids offering toll paying customers an option that is only short-lived.

Interstate 80 is a case of particular interest because the HOV lane is already experiencing crowding on a regular basis and is already restricted to carpools carrying three or more people. The HOV lane also serves a high volume of express buses, providing a reliable and fast trip through this top-ranked congested corridor. Conditions call for implementing near-term strategies very soon to preserve the function of this carpool lane. As in other corridors, these strategies will improve HOV lane operations and buy some time; however, a more far-reaching solution will be required in the not-too distant future. Possibilities include: restricting access to vehicles with four or more people or to buses and vanpools only or adding a dynamic dual lane that would operate as an HOV or HOT lane during the most congested periods only. A HOT lane function makes sense in any of these approaches because it ensures the lane or lanes are fully utilized.

5. HOT Network Cost, Revenue and Financing

Study Approach and Methodology Overview

This report reflects work undertaken over 18 months in two initial HOT network study phases that, together, comprise a first-order feasibility analysis and implementation plan. Phase 1 involved an assessment of the feasibility, costs and revenue associated with two distinct Bay Area HOT network configurations: (1) a partial network developed by converting only existing HOV lanes and those fully funded through year 2015; and (2) the complete network proposed in this report. Phase 1 suggested 30-year net revenue from the partial HOT network, if all corridors were converted in 2015, could cover most of the cost to complete the network. Phase 2 expanded the analysis of the complete network, refined cost estimates based on further experience with the I-680 Sunol HOT lane, and developed preliminary implementation and financing plans for phased development of the entire network by 2025.

As appropriate for a first-order assessment of a HOT network of this scale, the initial study phases use simplified, yet conservative, approaches to estimating costs and revenues. Capital costs are based on a range of unit costs that include contingencies of 40 to 60 percent. Revenue estimates are generated by a tolling model that builds on forecasts from the regional travel demand model. This preliminary analysis does not include, as a more detailed analysis would, feedback between the travel demand and revenue models or consideration of operational constraints. The revenue analysis includes several provisions that make revenue estimates conservative notwithstanding this simplification: (1) revenue is presented in a range where the low-end represents a 30 percent reduction from the toll model forecast; (2) revenue estimates assume a tolling policy that would maximize travel time savings rather than revenue; and, (3) a cautious approach is used to estimate revenue from the evening peak period. (See the appendices to this report for more detail on the study assumptions and methodology.)

Cost

The total capital cost to develop the regional HOT network is $4.8 billion dollars (2006$). This total includes conversion of HOV lanes that exist today and those that are fully funded ($1.4 billion) as well as widening to close gaps and extend the system ($3.4 billion). At the low cost end, converting HOV lanes to HOT lanes involves adding toll tag readers and signs and restriping the roadway. To be conservative, higher per mile costs are assumed in most

corridors, to reflect the likely need to add new pavement and right-of-way and, in some corridors, to modify existing structures to achieve a design consistent with Caltrans principles for the I-680 HOT lane demonstration project over the Sunol Grade:

- A single HOT lane in each direction would be separated from the adjacent general purpose lanes by a painted double-striped line and a four-foot buffer;
- Access and ingress locations would be separate and would include a weaving lane to allow traffic to transition between the faster HOT lane and slower adjacent lanes; and
- Space would be provided in the median for CHP patrols to provide enforcement.

It would be helpful to explore where modifications of this "ultimate" design protocol would be both operationally viable and less costly.

For segments where HOV lanes do not exist or are not otherwise funded, the capital cost estimate reflects the cost of widening to accommodate an additional travel lane in each direction as well as toll-related equipment and signs. The network cost also includes new, direct HOT lane to HOT lane connectors at major interchanges, including I-80/I-680, I-680/SR 4 and I-680/I-580. The cost estimate does not include direct access ramps or complementary express bus system enhancements, which should be considered among the possible investments for positive net toll revenue.

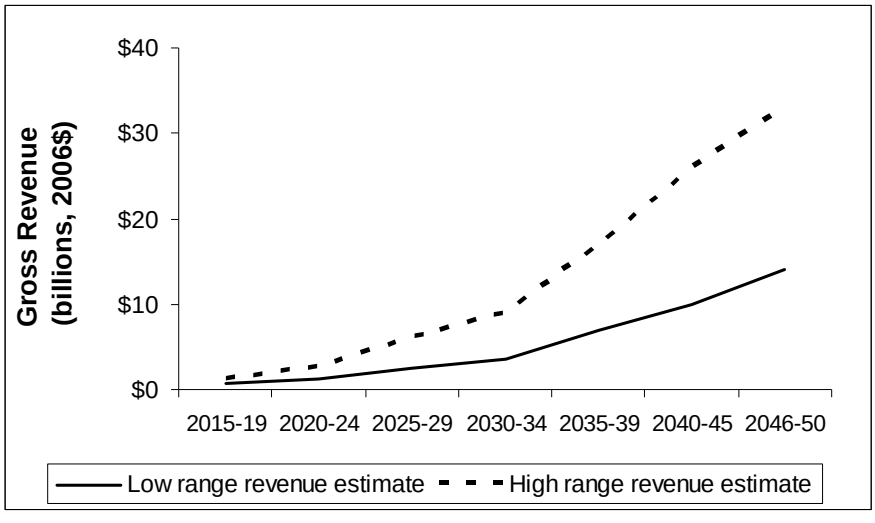
The operating and maintenance cost for the Bay Area HOT network is estimated to total $1.5 billion over 20 years. This includes CHP enforcement, toll equipment maintenance, communications, utilities, administration, FasTrak® toll tags and costs of processing toll transactions. This estimate does not include the cost to maintain the roadway itself. (See discussion below.)

Revenue and Financing

Revenue potential of the Bay Area HOT network depends on four principal factors: tolling policies, congestion levels, carpooling policies and demand, and the willingness of travelers to pay for a faster, more reliable trip.

With the phased plan developed in this study, the regional HOT network could generate between $8 and $11 billion in gross revenue between 2015 and 2035, assuming full time operation (24 hours per day, seven days per week). Analysis suggests revenue would grow steeply in the years beyond 2035, as real income rises (and travelers are willing to pay more for speed and reliability) and congestion levels and the length of congested peak periods grow. (See graph at right.)

Revenue Growth is Robust Over Time



Developing the regional HOT network by 2025 would require 30-year bond financing to cover approximately $4.7 billion in capital outlays. Debt service over 30 years would total $9.4 billion.

With the phased plan from this study, revenues from the HOT network are likely to cover costs over the 20 years between 2015 and 2035. If HOT revenues reach the high end of estimates to date, HOT network revenues could exceed costs, including debt service, by approximately $3.1 billion over that time. If revenues lie at the low end of current estimates, HOT network revenues are approximately equal to costs over the 20-year period.[5] (See table, below.)

HOT Network Cost and Revenues

	2015 to 2035 (billions of 2006$)	
	Low Estimate	**High Estimate**
Gross revenue	$8.0	$11.4
Operations and maintenance cost	-$1.6	-$1.6
Debt service [1]	-$6.7	-$6.7
Net revenue	-$0.3	$3.1

[1] Based on borrowing $4.7 billion over 30-years. Debt service repayment continues through 2045 for a 30-year total of $9.4 billion.

Modest adjustments to the phased plan can be expected to improve the outlook at the low end of the revenue estimate range while refined approaches to costs and revenues will eventually narrow the range over all.

In order to finance and deliver the regional network, it will be necessary to pool revenues and costs. Not surprisingly, some corridors are stronger than others in terms of revenue generation. (See Net Revenue Potential by Corridor table, next page.) The primary factors that affect net revenue generating potential over this period include:

- Extent of widening required to implement the HOT segment (HOT revenue from corridors that do not have an HOV lane that can be converted to HOT must cover costs of a new travel lane);
- Assumed HOT lane opening date;
- HOV volumes and date at which the carpool occupancy requirement for free passage increases due to growth in HOV volumes; and
- Congestion levels and willingness of travelers to pay for faster, more reliable travel.

While most corridors do break even over the 2015 to 2035 period, revenues from the high generation corridors are needed to ensure favorable financing and operate the network in the early and middle years. Further, a few corridors – especially those that start operation later – may require a longer period of time before revenues cover costs.

[5] Given the level of detail in this analysis a net revenue figure of plus or minus $300,000 million over 20 years can be considered breaking even.

Net Revenue Potential by Corridor, 2015 - 2035

Corridor [1]	Year HOT Lane Opens [2]	Year Carpool Occupancy Requirement Increases to 3+
Generates $1 Billion or More in Net Revenue [3]		
I-880 from 98th Ave. to SR 237 and northbound Bay Bridge approach	2015/2020	2025
I-680 from SR 84 to Calaveras	2010/2015	2035
US 101 from San Mateo County Line to Cochrane	2015/2025	2035
I-680 from SR 84 to I-80	2020/2025	2030/2040
Covers Costs		
SR 85	2013	2020
I-580	2013/2015	2035
SR 87	2015	2040
I-80 from Bay Bridge to Carquinez Bridge	2015	2015
SR 237	2020/2035	2035
SR 84 westbound Dumbarton Bridge Approach only	2015	2025
I-280	2020/2025	2035
SR 92 westbound San Mateo-Hayward Bridge Approach only	2015	
US 101 Millbrae to Santa Clara County Line	2020/2025	2035
I-80 from Carquinez Bridge to Yolo County line	2015/2020/2025	2040
SR 4 from SR 160 to I-680	2020	2020
Fails to Cover Costs		
US 101 from Windsor River Road to Corte Madera	2025/2030	2025/2030

[1] HOT lane corridors are bi-directional unless noted.

[2] First date indicates opening date for initial section; second date is opening date for later extension, if any.

[3] Each corridor projected to generate at least $1 billion in net revenue.

Impact of Tolling Policies on Revenue

Tolling policies also clearly influence revenue. Variations on tolling policies could affect the revenue outlook as follows:

- Tolling objective. The estimates above assume tolls are set to maximize freeway efficiency (measured by the value of time saved for all freeway users) as opposed to maximizing revenue. This is assumption consistent with a policy objective to improve freeway efficiency and makes revenue projections for this initial analysis more conservative. Policies that maximize revenue have been shown to increase revenue by at least 20 percent. However, these policies also result in higher tolls and lower HOT lane usage.

- Full time versus part-time tolling. Full time HOT network operation (24-hours per day, seven days per week) would represent a significant change in the Bay Area where the carpool lanes currently operate during peak commute hours only. Because HOT lanes

more effectively utilize freeway capacity, they can operate very effectively in the shoulder periods as well. Revenue generation during the shoulder periods is not insignificant, reflecting travelers' willingness to pay to bypass congestion in these periods.

Restricting HOT lane operations to the most congested peak periods only would likely dampen revenue generation to the point that borrowing requirements would need to be reduced. In-depth analysis for the I-680 Sunol corridor suggests that by limiting HOT lane operation to eight peak hours on weekdays and four peak hours on weekends yields 71 percent of the revenue generated by full time operation. Assuming a similar pattern holds for other corridors, the network would fail to cover 20-year costs (including financing) even under high revenue estimates for this study. Thus, developing the regional network might necessitate using a combination of state highway funding sources and bonding or slowing down implementation.

A less restrictive part time tolling policy that included operation over peak and shoulder periods would have much less significant impacts. By capturing peak and shoulder twelve hours on weekdays and 4 peak hours on weekends, revenue generation is roughly sufficient to cover costs at the high-range estimate.

- Hybrid vehicles. Revenue estimates for this study assume no special treatment for hybrid vehicles. Exempting hybrid vehicles from HOT lane tolls reduces the space available for free vehicles and could reduce revenues by 5 to 40 percent depending on the corridor.

Complementary Investments – Candidates for Net Revenue

While the first call on HOT network revenue should be operating and completing the system, revenue projection trends suggest a Bay Area HOT network will generate positive net revenue over time. The point at which net revenue is available for other investments depends both on tolling policies and financing terms. When the time comes, it will be important to make careful trade-offs between potential investments. The discussion among key stakeholders will need to consider regional and state transportation goals and policies, overall investment needs, and notions of equity. Some potential investments include:

- Express transit. Many regions use HOT lane revenue to provide enhanced express bus service, which both increases the number of people carried during peak periods and extends the benefits of the HOT lane directly to those who may not be able to pay the toll. The 20-year cost (2015 – 2035) for a full complement of enhancements to regional express bus service in HOT network corridors could reach $3.4 billion, though significant benefits could likely be achieved by implementing selected elements.[6] The time at which net revenue is available for expenditure is particularly significant when considering express bus services because toll revenue is likely the only funding resource available for funding operation of significant service enhancements.

- Roadway maintenance. Caltrans asked that the roadway maintenance costs of the HOT network be enumerated as part of this analysis. Using HOT network toll revenue to fund roadway maintenance would be a departure from current policy, under which the state

[6] Based on cost estimates for the express bus portion of the HOT/Bus scenario MTC is analyzing in the Transportation 2035 Vision.

funds roadway maintenance for state-owned roadways, including the existing HOT lanes in San Diego and Orange County toll roads. It is also true that those paying to use the HOT lanes will expect a high ride quality for their trip. The estimated 20-year cost (2015 – 2035) to maintain the HOT network roadway, including existing HOV lanes that are converted to HOT lanes, is $1.2 billion.

- Other mobility investments. While HOT lanes are important tool, other investments also will be needed to manage delay and improve mobility in each HOT corridor. These investments are identified in the *Transportation 2030 Plan* and could include ramp metering, auxiliary lanes and other freeway operational improvements, interchange improvements, and rail transit extensions and upgrades. HOT lanes would work in tandem with such improvements.

6. Traffic and Air Quality Benefits

Findings from this analysis are consistent with before and after studies showing HOT lanes improve overall traffic conditions by increasing congested travel speeds and vehicle throughput, while only modestly slowing travel for carpools and buses. The preliminary forecasts from this analysis suggest that, with build out of the regional HOT network, average travel speeds in 2035 could reach 39 miles per hour in the general purpose lanes during the AM peak period while maintaining average speeds in the range of 54 miles per hour in the HOT lane, consistent with level of service C operating standards. This sounds relatively unimpressive until compared with a system of HOV lanes over the same facilities for which forecasts show substantially reduced speeds in the general purpose lanes (32 miles per hour) but only modestly higher speeds in the HOV lane (56 miles per hour). Similarly, the regional HOT network could reduce total vehicle hours of travel during the morning peak hour by up to 13 percent compared to an HOV only network on the same freeway facilities. (See Traffic Characteristics table below.)

Traffic Characteristics of Bay Area HOT Network Compared to HOV Network in Year 2030 [1]

	HOV/HOT Lanes	General Purpose Lanes	Total/ Average All Lanes
AM Peak Hour Vehicle Hours Traveled (VHT)			
HOV network	10,410	120,890	131,290
HOT network	17,960	95,615	113,575
Percent change	73%	-21%	-13%
AM Peak Hour Average Speed (miles per hour) [2]			
HOV network	56	32	34
HOT network	54	39	41
Percent change	-3%	20%	21%

[1] Figures are for freeways with HOV or HOT lanes only and reflect results of analysis assuming existing HOV occupancy requirements for HOV and HOT lanes.
[2] Reflects travel in the peak and reverse peak direction.

Because HOT lanes reduce congestion and increase travel speeds, they reduce vehicle tailpipe emissions. In particular, preliminary analysis suggests that compared to a regional HOV

network, a regional HOT network could reduce carbon dioxide emissions in the morning peak period by about seven percent. (See Emissions table below.)

Emissions Associated with Bay Area HOT Network Compared to HOV Network in Year 2030 [1]

	Reactive Organic Gasses (ROG) (tons)	Nitrogen Oxide (NOx) (tons)	Particulate Matter (PM 10) (tons) [2]	Carbon Dioxide (CO2) (thousands of tons)
AM Peak Period Emissions - Two peak hours from 7 to 9 AM				
HOV network	2.10	2.18	0.20	4.65
HOT network	2.06	2.11	0.18	4.32
Percent change	-2%	-3%	-10%	-7%

[1] Figures are for emissions on freeways with HOV or HOT lanes only and reflect results of analysis assuming existing HOV occupancy requirements for HOV and HOT lanes.
[2] PM10 emissions reflect exhaust only and do not include tire and brake wear emissions.

It is important to acknowledge this simplified first-order analysis may overstate performance to some degree by not accounting fully for changes travelers might make in response to the improved travel speeds associated with the HOT lanes. For example, travelers who would otherwise choose to drive in the shoulder period might shift into the peak, resulting in somewhat slower travel speeds and potentially higher emissions. However, the comparison above between identical HOV and HOT networks in year 2030 likely understates the true benefits of a HOT network because funding simply is not available to complete the HOV network by that date. Further analysis comparing the regional HOT network and a smaller, less complete HOV system that could be constructed by 2030 likely would show equal or greater performance improvements.

7. Governance and Related Policy Decisions

Governance Structure

A central question for a regional HOT network relates to how it would be governed. Will the regional network be governed through a series of independent tolling authorities, much as the region's transit service is provided today? Or will it be governed through a single multi-jurisdictional authority charged with coordinating and balancing local, regional and state interests?

The framework established under current state law addresses HOT lanes as a corridor by corridor consideration in so far as it: permits limited projects in six corridors in northern California; provides governance structures reflecting corridor interests; and requires net toll revenue to be expended within the corridor of generation. The legislative framework recognizes a few important state and regional roles based on well established roles and responsibilities: design and construction of HOT lanes must be coordinated with Caltrans; CHP will provide enforcement; and the Bay Area Toll Authority will manage and operate the toll collection system. But it does not go far enough in reflecting the full range of coordination required for a regional network.

New legislation will be needed to establish a governance framework to deliver a true connected Bay Area HOT network. The framework will need to recognize a balance between local interests with the strong regional and state roles required to deliver a complete regional network. Local interests are based on the responsibility to deliver benefits to constituents as well as prior investment of sales tax revenue and "county share" state funding in the HOV system and, in the cases of Alameda and Santa Clara counties, demonstration HOT lane corridors. Regional and state roles relate not only to those outlined in current state statute, but also to financing a complete network and operating it in a manner that is seamless and safe for travelers as they move among corridors and across county lines.

Governance arrangements for a regional network exist on a continuum from highly decentralized to highly centralized structures. On the most decentralized end, a series of independent county or corridor tolling authorities would coordinate with each other and regional and state interests through consultations or contractual agreements. On the most centralized end, the state itself would be the tolling authority and would set policy in consultation with local and regional entities. Regional entities empowered under state (SB 45, statues establishing the Bay Area Toll Authority) and federal law (SAFETEA-LU) provide models that lie in the middle of the continuum. In establishing a governance structure the strengths and weakness of each model must be considered in light of the policy decisions to be made and the goals of a regional HOT network.

Related Policy Decisions

Some governance related-questions may be addressed explicitly in revisions to state law that will establish the governance structure. Others will need to be addressed through coordinated decision-making under the established governance structure. The main governance-related responsibilities can be grouped under four main areas.

- Costs, revenues and financing. Where a HOT lane can generate significant revenue, its value is apparent to local, regional, and state organizations. With all such jurisdictions having more needs than can be funded from known sources, having a potentially significant on going and growing funding source become available is very significant. Key governance decisions address how HOT lane revenues may be reinvested in the transportation system, what types of investments are eligible, how they will be prioritized, and which entities have jurisdiction over various specific investment choices. The governance system will need to recognize the advantages to be gained by leveraging revenues to finance completion of the system while providing for an equitable way to reinvest revenues in complementary transit services and other roadway improvements within the corridor of origin. This may not result in the transitional county-based "return to source" model that characterizes a majority of transportation and highway funding.

- Tolling policies. This category includes a range of decisions that directly affect revenue, operations, and customer satisfaction. The governance structure must provide for decisions about how tolls will be set, for example tolls may be set to maximize travel time savings or to maximize revenue; procedures for increasing tolls; and how carpools, clean-fuel vehicles and hybrid vehicles will be tolled. The question of how many people must be in a carpool in order to qualify for free passage or reduced toll rates falls into this category. Consistency in tolling policies may be more important for some decisions than others.

- Operations & Design. Decisions in these categories similarly affect revenue and customer satisfaction, and they also have direct bearing on cost and safety. Operations decisions relate to the hours of HOT lane operation and enforcement practices including the level of enforcement provided. Design decisions include separation of the HOT lane from the general-purpose lanes, provisions for ingress and egress and enforcement, need for design exceptions, and signage.

- Private sector role. Private sector roles could vary from simple financing, as presumed in this implementation plan and allowed by current law, to a variety of public private partnership models. The latter could range from an operating concession to private development and/or ownership and could also include arrangements to expedite project delivery, such as design build approaches. The options here are closely tied to state law governing public-private ventures and are not explored in this study.

8. Next Steps (Identified Following Phase 1 and 2 Studies)

This initial assessment suggests a Bay Area HOT network can accelerate completion of a priority network for carpools and buses and improve freeway efficiency. Further because a HOT network is self-financing, its development could free close to two billion dollars that would otherwise be needed to complete the region's HOV system.

These findings suggest it is worthwhile to pursue the next steps on a path toward developing a regional HOT network. The conservative assumptions, large benefits and projected steep revenue growth curve in this analysis suggest cost may be even less of a constraint and, it may be worthwhile and feasible to deliver the network on an even more accelerated schedule. Further analysis could include an assessment of new project delivery staffing structures and review of design principles, to see if it is possible and beneficial to deliver a complete network before 2025. MTC wishes to pursue this additional analysis.

A general roadmap for advancing the HOT network includes the following next steps, some of which would need to proceed in parallel:

1. Refined analysis. Initial steps would consist of more detailed analysis to refine cost and revenue estimates and review operational concerns. Refining the cost estimates requires a more thorough review of the network's physical design, existing constraints and opportunities for ingress, egress and enforcement locations. Design refinements allow refined demand and revenue forecasts, which in turn permit a more detailed assessment of operations considerations. At each stage, it will be important to reconsider the basic parameters of the phasing and financing plans. A first pass would be more involved than the analysis conducted to date but still fairly general. Some specific areas requiring further review include:

   - Closing identified gaps in the network. The network studied to date leaves two significant gaps in the HOV network in two extremely constrained corridors: (1) the U.S. 101 corridor between San Francisco International Airport and San Francisco and (2) the I-880 corridor between the Oakland International Airport and the Bay Bridge approach. These segments deserve a closer look given the significance of these segments for regional mobility and the projected revenue growth potential for the regional HOT network. An initial assessment should compare the cost, traffic and environmental considerations of two admittedly controversial approaches to close the gap: (1) a low-cost, possibly near-term approach of converting an existing travel lane; and (2) a high-

cost, longer-term solution that would likely involve substantially rebuilding these corridors with HOT lanes.

- Interstate 80. Opportunities for incorporating HOT lanes in the I-80 corridor through Alameda and Contra Costa counties in conjunction with steps to preserve and improve the HOV function and overall traffic flow in the corridor.

- Toll plaza operations. Assessment of how to integrate HOT lanes at the toll plazas of Bay Area toll bridges. The existing toll plazas are designed to accommodate carpools, that do not pay a toll, and FasTrak® users and cash customers, that pay a uniform rate. Operational analysis will be needed to determine how to accommodate a fourth customer class, those who pay a premium rate to avoid a backup.

- Interface with other planned improvements. This means putting in place procedures so projects under development do not unwittingly preclude the option to provide a HOT lane in the future. It also means considering the potential traffic impacts of HOT lanes in freeway corridor management planning. Integration with other planned improvements could streamline project development and accelerate implementation of the HOT network.

Subsequent, even more detailed analysis would be conducted as part of the formal documents required in the Caltrans project development process (project study reports and project initiation documents). MTC and Caltrans are poised to kick off a planning-level review of design and refinements to cost estimates later this year.

2. Review of equity considerations. As refined design, demand and revenue analyses become available, it will be possible to assess the equity implications of the regional HOT network. This assessment will consider the distribution of benefits and impacts relative to geography and income level. The assessment will also document the benefits and impacts to transit users and carpoolers.

3. Governance. The region and state need to map out a governance structure for the regional HOT network. The governance structure must provide a means to establish a host of policies governing, design, tolling and operations practices, and revenue allocation. Several models are possible. These initial study results provide a sufficient basis to begin a dialogue among key regional and state stakeholders about governance. Participants will need to find a solution that allows regional objectives to be achieved (e.g., completion of a regional network) while respecting consideration of local interests (some degree of equity based on past investment and system use). Governance discussions also should address potential roles for the private sector. Ultimately, legislative action would be required to enable development of a regional network and, most likely, to transition the current authorized corridor demonstration projects into a regional governance structure.

4. Public dialog. A certain degree of public dialog and education about HOT lanes has already begun in conjunction with the Alameda and Santa Clara county demonstration projects. This will ramp up over the next year with advancements in project development, the kick off of I-680 HOT lane marketing and education campaign, and the update of the regional long-range transportation plan. The region should expand and piggyback on these efforts over time in conjunction with the steps described here to advance the regional network. However, the biggest opportunity to engage the public in a broad discussion about a regional network

will be when Bay Area residents get their first hands on experience with the opening of the I-680 HOT lane in 2010.

5. Financing. The HOT network financing plan will need to be updated as cost and revenue projections are refined. Potential financiers will require investment grade analyses before underwriting bonds. However, it is wise to initiate discussions with potential financiers fairly early to better understand their assessment of risks relative to key governance and policy decisions. For example, financiers will be keenly interested in policies that govern tolling rates, treatment of carpools, and hours of operation. Reducing the uncertainties likely to be seen by financiers may enable the region to use a lower coverage ratio (the ratio between available revenues and the debt repayment amounts).

Section II:
Updated Assessment (Phase 2B)

Complete June 2008

1. Introduction

Subsequent to the Phase 1 and Phase 2 analysis completed in September 2007 (see Section I), MTC staff considered whether it might be possible to complete the Regional HOT Network even faster by pursuing a less capital-intensive, interim, design approach. Those queries gave rise to analysis conducted between September 2007 and June 2008 and summarized here. The principle components include:

- Comparison of design approaches and definition of a "rapid delivery" design intended to minimize the need for new pavement and right-of-way
- Revised phasing plan[7]
- Revised capital and operating costs and financing analysis
- Preliminary estimates of delay and greenhouse gas emissions savings

The results of this revised analysis form the basis for the phasing, cost and revenue assumptions for the Regional HOT Network in the Draft Transportation 2035 Plan. As such, costs and revenues in this section are presented in escalated dollars for the period between 2009 and 2033.

Key findings include:

There are significant benefits to speeding completion of the Regional HOT Network. A "rapid delivery" approach, compared to the "full feature" design approach assumed in the Phase 1 and 2 studies, could advance completion of the Regional HOT Network by up to 10 years. Benefits include savings in construction costs ($4.6 billion) and travel time (80 million person hours of travel through 2050), and reduced greenhouse gas emissions (10 million tons through 2050). The specific rapid delivery design principles outlined here may not be where the region ultimately wishes to land; however, the magnitude of the potential savings suggests it makes sense to look at alternative approaches to design and delivery.

Earlier implementation of the Regional HOT Network does not generate significant additional gross revenue but does produce more net revenue, due to capital cost savings. Revenue potential is highest in later years, as congestion grows and after carpool demand has increased to the point at which it is necessary to increase carpool occupancy requirements to keep the lanes free flowing.

There are precedents within California and nationally for a "rapid delivery" approach, which aims to speed delivery and reduce costs. Examples include carpool lanes in southern California on Route 91 and Route 55 and in the Bay Area on Interstate I-680, which were initially opened with designs reflecting exceptions to Caltrans standards. These corridors were widened and reconstructed to accommodate full design attributes as funding became available. HOT lanes on I-95 in Miami provide another example. In 2007, the U.S. Department of Transportation awarded funding for this project, which will open at the end of 2008. Because it is not feasible to widen the freeway, the typical section will include several design exceptions to fit two directional HOT lanes within the existing paved area: no inside shoulder, narrow (10.5- to 11-foot) travel lanes and a reduced one- to two-foot buffer between the HOT lanes and adjacent general purpose lanes.

[7] Note that the Regional HOT Network definition is unchanged from earlier analysis. See map in Section I (page I-2).

2. "Rapid Delivery" Design Approach

The principle goal in considering "rapid delivery" approach is to further accelerate completion of the HOT network in order to deliver congestion and emissions relief sooner. A secondary goal includes taking advantage of a window of opportunity presented by the prevailing philosophy in the U.S. Department of Transportation and State of California, both of which have expressed strong support for innovative financing and demand management approaches involving congestion pricing.

In Section I of this report, MTC estimated the Regional HOT Network could be complete by 2025 assuming a "full-feature" HOT Network: all improvements built to full Caltrans design standards for shoulder and lane widths; buffer separation between the HOT and adjacent general-purpose lane; and separated ingress and egress locations with merge lanes (See figure on page I-4 for an example of a merge lane). This approach would require significant widening. Widening would be required to accommodate new travel lanes and full shoulders in many places where carpool lanes do not currently exist. Widening would also likely be required throughout the existing carpool network to accommodate the merge lanes required at access and egress locations. This "full feature" approach can be said to represent an ultimate build out or high-end cost estimate. Further, this approach has potentially significant environmental impacts requiring detailed environmental review and long construction times.

What if the region aimed to complete the HOT network must faster by pursuing a strategy to fit the HOT lanes within existing pavement and minimize widening wherever possible and safe? MTC estimates it might be possible to complete the network eight to ten years faster using a "rapid delivery" approach assuming design exceptions where needed, consistent with past practice to develop carpool lanes in California.[8] Carpool systems in California have often been created by converting the inside shoulder to a carpool lane and narrowing adjacent lanes with a goal to provide the greatest system level mileage of carpool lane benefits early and fill in the harder-to-implement gaps as funding became available.

Design principles assumed for the "rapid delivery" approach are listed below (see next page). The approach to convert existing carpool lanes would be to install toll collection equipment and signs and re-stripe travel lanes to provide a buffer between the HOT lane and adjacent general-purpose lane; no widening would be undertaken.[9] For new HOT lanes, where no carpool lanes exist, widening would be minimized as much as possible to stay within the existing paved right-of-way. If needed, travel lanes and the inside shoulder would be narrowed, assuming they have not been narrowed for a prior project. In some cases, it may be necessary to add pavement in existing median or on the right side. In extreme cases, there simply is not enough space within the existing right-of-way to allow for a new HOT lane, and new right-of-way would need to be acquired. The end result would be a slimmed-down cross section in the many constrained parts of the Bay Area freeway system. The figure (page II-4 below) compares a typical cross section under the "full feature" approach from Section I with a "minimum" cross section that would be developed on constrained freeway segments under the "rapid delivery" approach.

[8] See Appendix 7 for specific examples.
[9] This is the approach pursued for the Minneapolis I-394 and Seattle SR-167 HOT lanes.

"Rapid Delivery" Design Principles[10]

Converting Existing Carpool lanes to HOT lanes

- To achieve a 4 foot buffer between the HOT and adjacent general-purpose lane, either reduce the inside shoulder to between 8 and 2 feet or narrow existing travel lanes from 12 to 11 feet. However, the right most mixed lane, which serves truck traffic, would not be narrowed.
- If the existing carpool and general-purpose lanes are already 11 feet in width and there is no room to spare in the inside shoulder, then no buffer would be provided between the HOT and general-purpose lanes. The right shoulder would not be narrowed.

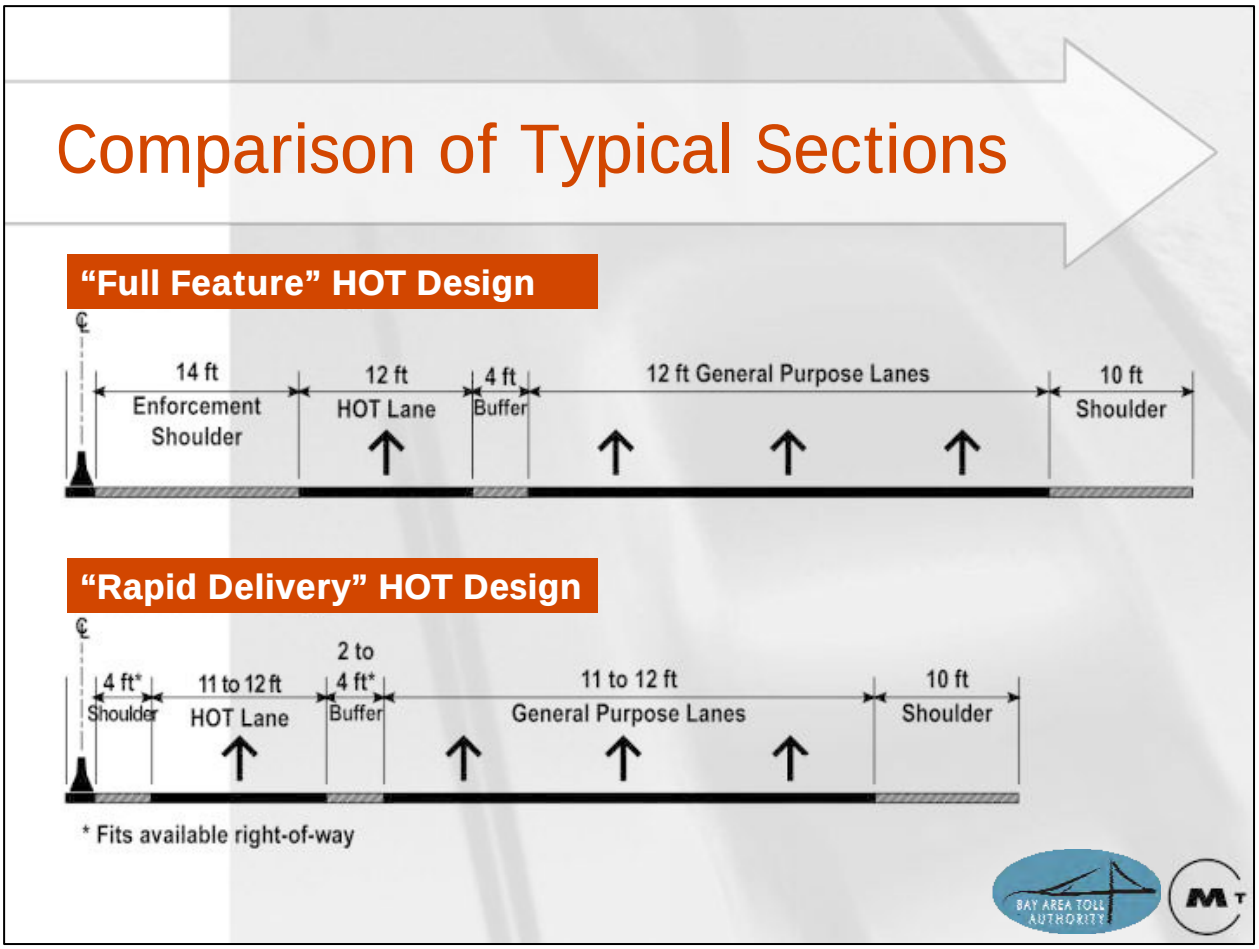
Widening for New Travel Lanes

- Widen into the median where space exists. The total space needed is 18 to 24 feet in each direction to accommodate a 12-foot travel lane, 4-foot buffer and 2 to 8 foot median shoulder.
- If the area in the median is not sufficient, narrow the HOT and mixed use lanes from 12 to 11 feet. However, the right most mixed lane, which serves truck traffic, would not be narrowed.
- If narrowing of lanes would not provide the needed width, outside widening would be required. Right shoulders would be narrowed only at bridges to avoid structural widening or replacement.
- If there is not sufficient space within the existing right-of-way based on the above criteria, review potential to provide a 14-foot cross section (12 foot travel lane plus 2 foot median shoulder) in each direction by making the same trade-offs.
- As a last resort, new right-of-way would need to be acquired.

Conversions and Widenings

- Ingress/egress areas would be combined (rather than separate) and designated with broken striping only. No merge lanes would be provided.
- Signing would be minimized to one dynamic sign at each ingress/egress area with periodic static signing mounted on the median barrier.
- No additional enforcement areas would be provided beyond those already existing.

[10] See Appendix 8 for more detail and drawings. These principles are consistent with guidelines from the American Association of State Highway and Transportation Officials.



Southern California Carpool Lane Access/Egress Design (I-210, Pasadena)

To minimize needed widening, access and egress design would be modeled on the approach used for carpool lanes in southern California (see right). HOT lanes in Seattle on SR-167 and Minneapolis on I-394 employ a similar access design. The "rapid delivery" approach assumes does not include merge lanes at access or egress locations.

This approach enables build out in a much shorter time frame by minimizing freeway widening and the associated environmental impacts (hence minimizing the time needed for environmental review) and construction time. It also would deliver the initial HOT network at a lower cost, leaving additional revenue for a range of potential improvements including enhanced incident management, corridor transit enhancements, expanded maintenance or eventually restoring portions of the HOT network to standards.

The "rapid delivery" approach requires, in addition to design exceptions, an accelerated approach to project design and delivery. This would include, at a minimum: concurrent project-

level studies such as project study reports and environmental assessments, accelerated approval of project development documents and simultaneous construction of multiple corridors. Such an effort would require dedicating personnel and resources above and beyond those currently available at MTC and Caltrans. There are existing models for such efforts. One is the Santa Clara County Measure A sales tax program, for which Caltrans provided dedicated staff at a satellite office. Alternative project delivery model also merit review. These include: accelerated design-bid-build, design-build (applied for the SR 73 and SR 125 toll roads in Southern California), design-build operate maintain (applied for the I-95 HOT lanes in Miami), and public private partnerships (applied for the I-495 HOT lanes in Virginia).

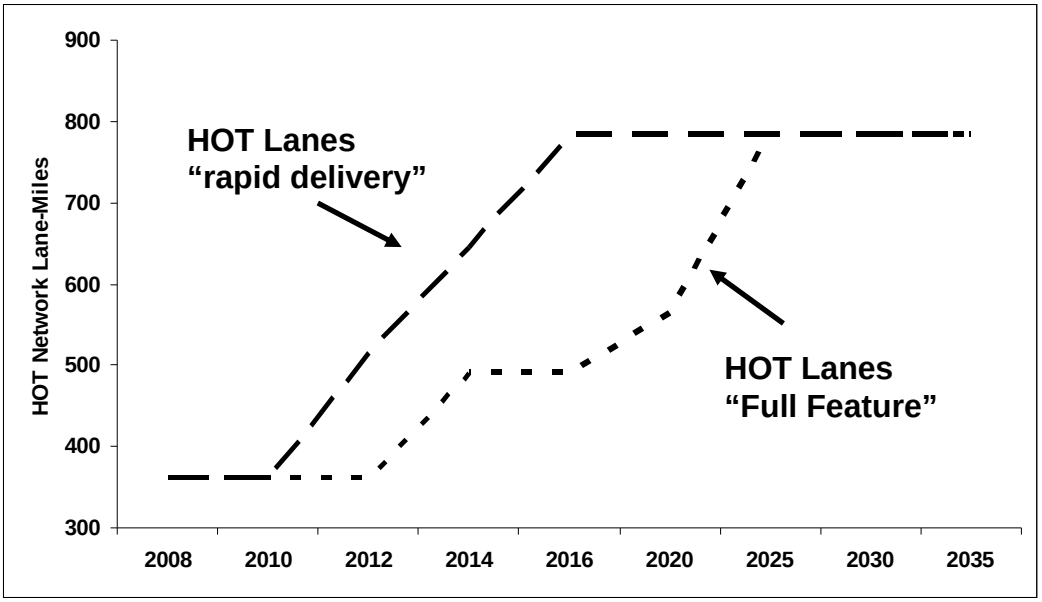
3. "Rapid Delivery" Implementation Schedule, Cost, Revenue and Financing

This section presents an overview of the Regional HOT Network implementation schedule, costs, revenue and financing approach. More detail on cost methodology and on the implementation schedule, costs and revenue for individual corridors is presented in Appendices 8 and 9.

Implementation Schedule

By minimizing the need for new construction and associated environmental review through the "rapid delivery" approach, it might be possible to complete the Regional HOT Network as early as 2016. This assumes project design and development would begin in 2009. All existing and funded carpool lanes would open as HOT lanes in 2011. New lanes where median or right-side widening would be required would open in 2013 or 2014. The most constrained segments, where new right-of-way would be required, would open last in 2016. These time lines are admittedly aggressive and assume the expedited project delivery approaches as described above. The graph below compares the implementation schedules for the "full feature" and "rapid delivery" approaches.

Comparison of HOT Network Build Out Schedule
Under "Rapid Delivery" and "Full Feature" Design Approach



Cost and Revenue

Approach

The general approach to estimate capital costs for the ”rapid delivery” design is similar in concept to that used to estimate costs for the “full feature” design in Section I. Capital costs are based on a range of unit costs that include contingencies of 40 to 60 percent. For costing purposes, network segments are classified in one of five unit-cost categories[11]:

- Conversion of existing (or funded) carpool lanes. No widening required
- Low cost widening. Sufficient right-of-way exists in the median to allow for a new 12-foot HOT lane plus a 4-foot buffer and minimum 2-foot median shoulder.
- Medium cost left-side widening. Sufficient right-of-way exists to create a new 12-foot HOT lane plus a minimum 2-foot median shoulder by widening in the median and possibly by narrowing the median shoulder width and some travel lanes.
- Medium cost right-side widening. Sufficient right-of-way exists to create a new 12-foot HOT lane plus a minimum 2-foot median shoulder by widening to the right and possibly narrowing some travel lanes.
- High cost. There is not sufficient right-of-way to allow for a 12-foot travel lane and 2-foot shoulder. New right-of-way would have to be acquired.

Annual operating and maintenance costs under the “rapid delivery” approach are assumed to be the same on a per mile basis as for the “full feature” approach. Operating and maintenance costs include enforcement by the California Highway Patrol, toll equipment maintenance, communications, utilities, administration, FasTrak® toll tags and processing of toll transactions.[12] The operating and maintenance cost estimate does not include the costs of roadway maintenance or enhanced incident management, though both could be considered potential expenditures for new revenue or could be included in future cost estimates as a result of future policy decisions as they directly affect customer experience.

Revenue estimates for the “rapid delivery” HOT Network are based on those developed for the “full feature” approach documented in Section I of this report. Interpolation was used to project annual revenues associated with earlier opening of various network segments. Revenue estimates for the “rapid delivery” and “full featured” roll-out reflect identical assumptions about the year in which carpool occupancy requirements would be increased from 2-person to 3-person.[13]

“Rapid Delivery” Network Costs

The total capital cost for the Regional HOT Network under the “rapid delivery” approach is estimated to be $3.7 billion in escalated dollars ($3 billion in 2006 dollars). Roughly 20 percent of the cost is associated with conversion of existing or funded carpool lanes, which accounts for more than half the network lane miles. The remaining 80 percent of the cost is associated with widening to close gaps and extend the system. Significantly, though just 3 percent of the total

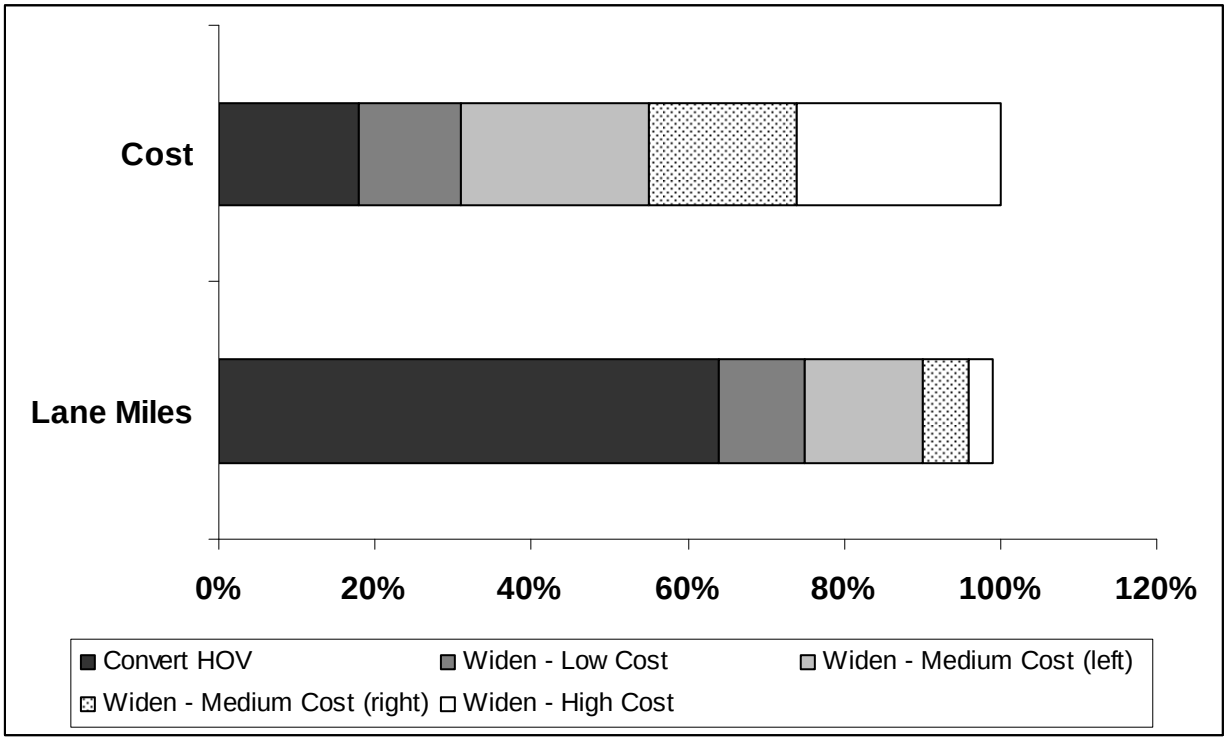
[11] Appendix 8 shows the unit cost for each category with breakdown by major cost component. The appendix also includes maps showing each network segment by cost category.
[12] See Section I and Appendix 3 for the methodology and assumptions for operating and maintenance cost estimates.
[13] See Section 1 (page I-7 and I-11) and Appendix 2.

mileage falls into the "high cost" category, this category accounts for about one quarter of the total capital cost, as shown in the graph below.

Not surprisingly, the capital cost for the "rapid delivery" approach is considerably lower than for the "full feature" approach. The "full feature" approach is estimated to cost $8.3 billion (escalated). Approximately $3.2 billion of the total $4.6 billion in savings from the "rapid delivery approach results from building the network faster and avoiding inflation-related cost increases. The remaining $1.4 billion in savings comes from the less capital intensive design.

The total operating and maintenance cost for the period between 2009 and 2033 is estimated to be $1.9 billion (escalated).

Regional HOT Network by Cost Category – "Rapid Delivery" Approach



"Rapid Delivery" Network Revenue Estimates

Gross revenue for the Regional HOT Network under the rapid delivery approach is estimated to range between $13.7 and $18.8 billion in escalated dollars for the period between 2009 and 2033. This compares to estimated gross revenue ranging from $11.9 to $16.8 billion (escalated) under the "full feature" design approach. Completing the network sooner provides a relatively limited revenue boost for two reasons: 1) carpool volumes are expected grow faster under the "rapid delivery" approach, as a result of closing gaps and extending the system and this leaves less room for tolled vehicles 2) revenue growth is more modest in the early years than later years as overall congestion is less severe; further in the later years, the networks are identical after 2025, when the "full feature" network is projected to be complete.

The low-end revenue estimate ($13.7 billion) is used for all subsequent analysis. Using this estimate, the "rapid delivery" Regional HOT Network is projected to generate revenue of $8.1 billion net of operating and maintenance and capital costs[14]. The cost of financing the Regional HOT Network is discussed below.

Financing Analysis

As with the "full feature" network, revenue in the early years is relatively modest; big jumps in revenue occur after 2025 when congestion levels become more severe and carpool levels are high enough to merit increasing carpool occupancy requirements from two-persons to three-persons in some corridors. As a result, a pay-as-you-go option is not feasible and bond financing is required to build the Regional HOT Network, even under the lower-cost "rapid delivery" approach.

Assuming a 6.5 percent interest rate, the total cost to finance the Regional HOT Network with the "rapid delivery" approach is estimated to be $2.0 billion between 2009 and 2033. The bonds are assumed to be 40-year term, and debt service payments would continue beyond the year 2033.

After capital cost, debt service and operating and maintenance cost, the estimated net revenue over the period 2009 – 2033 is $6.1 billion in escalated dollars (see table below). This is the amount of discretionary funding included in the Transportation 2035 Plan from the Regional HOT Network.

Revenue and Costs for "Rapid Delivery" Approach

	Years 2009 – 2033 escalated dollars
Gross Revenue*	$13.7 billion
Operating and maintenance costs	$1.9 billion
Capital Cost	$3.7 billion
Financing Cost	$2.0 billion
Net Revenue	$6.1 billion

* Reflects low-end revenue estimate

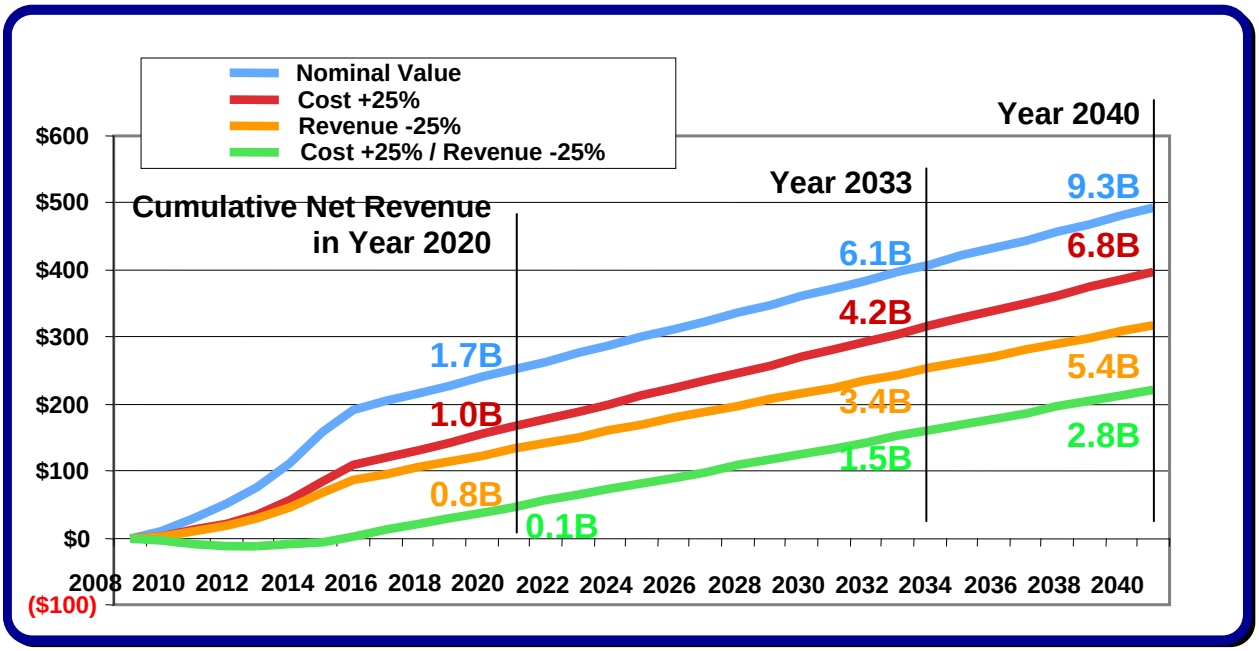
As part of the financing assessment, MTC conducted series of "stress tests" to test financing viability if costs were to be higher or revenues lower than current estimates. The stress test considered the following scenarios (see chart below):

- Costs increase by 25 percent
- Revenues decrease by 25 percent
- Costs increase by 25% and revenues decrease by 25%

Notably, the net revenue for the period between 2009 and 2033 could fall to as low as $1.5 billion, should the worst stress test case materialize. However, even under these circumstances, the network is judged to be financeable if the Bay Area Toll Authority were authorized to provide back up through the short period projected to have negative cash flows (approximately 2010 through 2015).

[14] Financing costs would further decrease net revenue.

Financing Analysis Stress Tests



4. HOT Network Benefits: Travel Time and Greenhouse Gas Emissions

To understand the potential benefits of the Regional HOT Network, and of faster implementation in particular, MTC compared projected person hours of travel and greenhouse gas emissions under three scenarios:

1. **Carpool Pay-As-You-Go Network.** Complete the 800-mile network as a system of carpool lanes, funded principally through State Transportation Improvement Program (STIP) funds and local sales tax contributions. The implementation schedule is driven by available funding, and does not assume advances through Grant Anticipation Revenue Vehicles (GARVEE) or bond financing. Under this funding approach, the network could be completed in year 2050 at a capital cost of $8.8 billion (escalated). [15]

2. **"Full Feature" HOT Network.** Complete the network as a system of HOT lanes based on the design and phasing described in Section I of this report. Under this approach the network could be completed by 2026 at a capital cost of $8.3 billion (escalated, does not reflect cost of debt service).

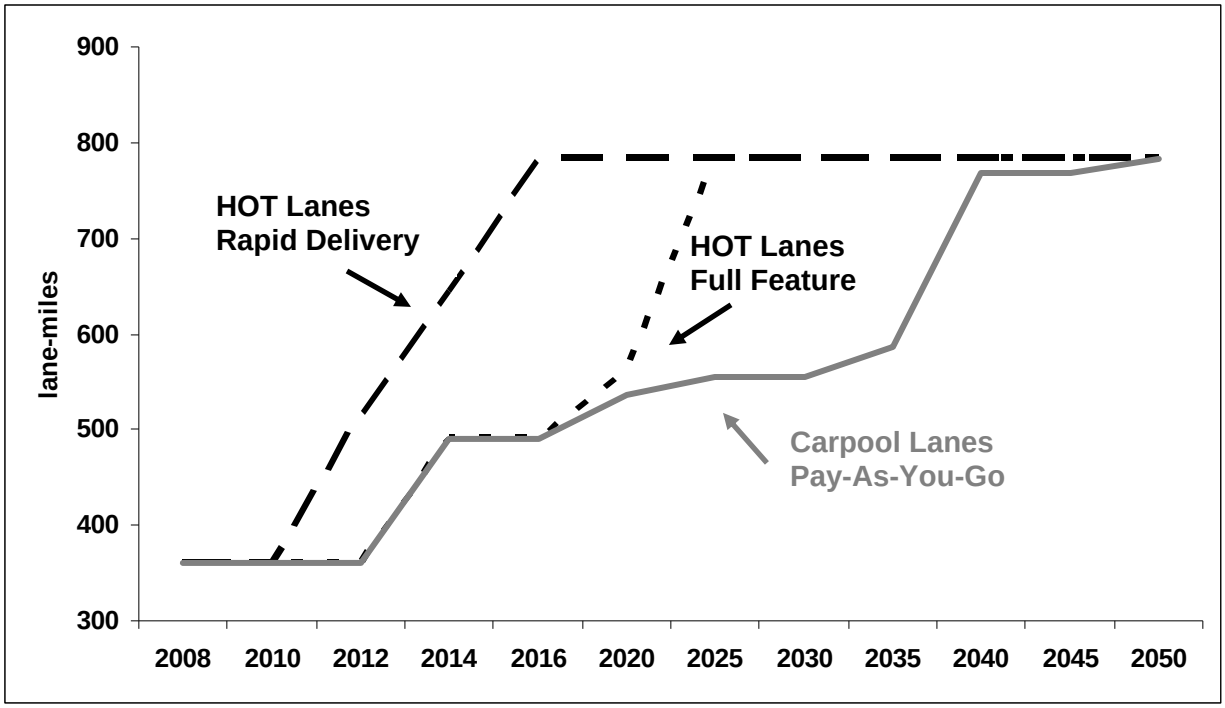
3. **"Rapid Delivery" HOT Network.** Complete the network as a system of HOT lanes based on the design and phasing described above in Section II of this report. Under this approach the network could be completed as soon as 2016 at a capital cost of $3.7 billion (escalated, does not reflect cost of debt service).

[15] Note that this is a different approach than in the comparison in Section 1 between a carpool network and HOT network. The analysis in Section I compares HOT and carpool systems assuming the same number of lane miles in both scenarios in any given year. This Section II analysis assumes the carpool system is built out more slowly so the number of lane miles in the carpool system is smaller than that in the HOT system in any given year. See Appendix 10.

The graph below compares the timelines for completing the network under each of the three scenarios.

As with other results presented in this report, estimates are based on a first-order analysis and should be considered preliminary. This analysis does not reflect, as more detailed forecasts in the future will, feedback between the travel demand and tolling models that would project changes in travel modes or routes. In addition, estimates of travel time and emissions presented here reflect travel only on that portion of the freeway system associated with the regional HOT network (approximately 800 directional miles). For example, travel on parallel arterials or freeways that do not have carpool or HOT lanes is not included in the totals. In effect, this approach holds vehicle miles of travel constant. Future, more detailed analysis will reflect feedback between the tolling and travel demand models; it will address impacts on mode of travel and vehicle miles traveled and will also revisit travel time and greenhouse gas emissions, as described under "Next Steps" at the end of this report.

Comparison of Schedules for Regional HOT Network and Carpool Network



Travel Time

Compared to building the carpool system on a pay-as-you-go basis, the Regional HOT Network reduces aggregate travel time for two reasons. First, as described above, the Regional HOT Network can be completed 25 to 35 years faster than the carpool network, eliminating bottlenecks and offering congestion relief sooner on segments where carpool lanes do not currently exist. Second, the HOT Network makes more efficient use of freeway capacity by ensuring carpool lanes are well-used; this tends to increase speeds in the general-purpose lanes and reduce aggregate travel time.

The potential savings are tremendous. In 2030, the HOT Network would reduce person hours of travel by 78 to 86 million hours compared to the less-complete carpool system. Between 2010

and 2050, the Regional HOT Network could generate cumulative travel time savings between 2.5 to 3.4 billion person hours. This travel time savings has an estimated economic value of $97 to $155 billion dollars.[16]

The travel time savings offered by the "rapid delivery" HOT Network compared to the "full feature" HOT network are smaller but still significant, totaling nearly 800 million person hours between 2010 and 2050. The economic value of this savings is estimated to be roughly $18 billion. Most of travel time savings occur between 2015, as the "rapid delivery" network nears completion, and 2025, when the "full feature" network can be completed.

Savings in Person Hours of Travel

	Millions of Person Hours of Travel				
	Annual				Cumulative
	In Year 2010	In Year 2015	In Year 2030	In Year 2050	2010 through 2050
Compared to Carpool Pay-As-You-Go Network					
"Full Feature" HOT Network	0	16	78	106	2,567
"Rapid Delivery" HOT Network	0	51	86	106	3,361
Compared to "Full Feature" HOT Network					
"Rapid Delivery" HOT Network	0	35	8	0	795

Note: Numbers may not total due to rounding

Greenhouse Gas Emissions

Preliminary analysis conducted in fall 2007 shows the Regional HOT Network also 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 10 million tons more carbon dioxide emissions from 2009 to 2050 than building the Regional HOT Network (see table, 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). After 2030, emissions savings are projected to decline as the fleet becomes significantly more fuel efficient.[17]

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

[16] See Appendix 11 for forecasts for each scenario. The economic value of travel time savings is based on the average Bay Area wage rate and estimated value of time for trucks, as documented in Appendix 11.

[17] This analysis assumes implementation of Phase I of the Pavley legislation (AB 1493), which translates to an average fuel economy for the Bay Area passenger vehicle fleet of approximately 27 miles per gallon in year 2035. Note that with implementation of the Pavley Phase II fuel economy standards, which translate to an average fuel economy of approximately 32 miles per gallon, the carbon dioxide emissions savings from the Regional HOT Network would likely be smaller.

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.

Savings in Greenhouse Gas Emission

	Carbon Dioxide Emissions (Thousands on tons)				
	Annual				Cumulative
	In Year 2010	In Year 2015	In Year 2030	In Year 2050	2010 through 2050
Compared to Carpool Pay-As-You-Go Network					
"Full Feature" HOT Network	0	0	372	298	9,643
"Rapid Delivery" HOT Network	53	40	372	298	10,261
Compared to "Full Feature" HOT Network					
"Rapid Delivery" HOT Network	53	40	0	0	617

Note: Numbers may not total due to rounding

5. Next Steps

It is important to recognize the analysis summarized here represents the first stage in a series of technical reviews that will successively refine and update our understanding of the Regional HOT Network.

The "rapid delivery" approach represents one end of a spectrum of approaches to designing and delivering the Regional HOT Network, while the "full feature" approach represents the other end of the spectrum. In all likelihood, the Regional HOT Network ultimately will land somewhere in the middle and include design features of both. Current and future work includes, but likely will not be limited to:

- **Phase 3 Study (anticipated completion, February 2009).** This effort will attempt to find a middle-ground between the "full feature" and "rapid delivery" design approaches based on a more detailed review of opportunities and constraints in selected corridors. It will further refine HOT Network cost estimates. In all likelihood, the HOT Network will include some elements of both design approaches: the "full feature" approach will likely be accommodated where it can be accommodated readily and the "rapid delivery" approach may be used in more constrained settings.

- **Revised Demand and Revenue (2009).** This effort is expected to revise demand and revenue forecasts based on the updated design and phasing assumptions. It will employ more resource-intensive forecasting approaches, including feedback between the tolling and travel demand models, and will provide a basis for associated analyses described below.

- **Associated Analyses: Equity and Emissions (2009).** Updated demand and revenue forecasts will generate refined forecasts of traffic, travel behavior and revenue. As such, they will provide a basis to review of the equity implications of the HOT Network (social and geographic) and to update analysis of vehicle emissions, including greenhouse gases.

- **Project-Level Design and Operations**. It will be necessary to complete a Project Study Report or Project Report for the network. This effort will include detailed operations analysis and refined design based on a much more detailed review of the project area.

- **Project-Level Environmental Review**. The HOT Network will undergo full, project-level environmental review, consistent with state and federal environmental review requirements.

At the same time, partner agencies throughout the region will need to tackle a series of policy issues. These include: governance, financing, corridor investment programs, education and outreach, and operations. These discussions will inform any future legislation related to a Bay Area HOT Network.