FINAL REPORT

Independent Peer Review of the California High-Speed Rail Ridership and Revenue Forecasting Process

Findings and Recommendations from the January-March, 2011 Review Period

July 22, 2011

The California High Speed Rail Authority (HSRA) convened an independent peer review of the ridership and revenue forecasting process and outcomes. Reporting to the Executive Director, the Panel is charged with providing a comprehensive in-depth review of the models used to estimate ridership and revenue and the forecasts derived from them. The Panel held its first meeting at the Authority offices in Sacramento on Monday and Tuesday, January 10-11, 2011. This report summarizes the key issues, findings, and recommendations of the Panel.

The Panel consists of five members:

- Frank Koppelman, PhD, Professor Emeritus of Civil Engineering, Northwestern University (chair)
- Kay W. Axhausen, Dr.Ing., Professor, Institute for Transport Planning and Systems, ETH Zurich (Swiss Federal Institute of Technology Zurich)
- Billy Charlton, San Francisco County Transportation Authority
- Eric Miller, PhD, Professor, Department of Civil Engineering and Director, Cities Centre, University of Toronto
- Kenneth A. Small, PhD., Professor Emeritus, Department of Economics, University of California-Irvine

Rick Donnelly, PhD, AICP of Parsons Brinckerhoff served as facilitator and recorder of the meeting. In this capacity he serves at the convenience of the chair rather than as member of the project management consultant team.

The Panel has based their comments and recommendations upon a review of a large number of reports and information generated by Cambridge Systematics, Inc. (CS), the developers of the model, as well as resulting forecasts developed for the Authority. These reports are identified in the Appendix to this report. Several panelists also reviewed the recent critique of the model and forecasts by the Institute of Transportation Studies (Brownstone et al. 2010) and subsequent correspondence about it. That critique provided additional insight into the forecasts and the controversies surrounding them, but did not frame the Panel's deliberations.

The views expressed in this report are consensus findings reached through a high degree of agreement and common thinking among the panelists.

Overall the Panel was impressed with many aspects of the work on ridership and revenue forecasting completed to date on the project. The approach undertaken by CS was ambitious, it represented a significant improvement in practice in several respects (for example, through the development and linkage of a complex set of advanced models), and it demonstrated commendable openness. However, there are important technical deficiencies in the model and the documentation thereof. The purpose of this report is to provide a critical review of the models and associated forecasts, focusing on those aspects that are questionable or deserving of more work.

1 Charge to the Panel

Roelof van Ark, Executive Director of the Authority, opened the meeting by welcoming the Panel, introducing them to the project, and outlining his charge to its members. A relative newcomer to the project, his near-term priority is to strengthen the organization with top-notch, committed professionals. He is also committed to increased accountability and transparency in their work, including all aspects of the ridership and revenue forecasting. His goal is to address differences in a professional manner, using open and honest dialogue. This is one of four independent review panels serving the Authority. Like the others, this Panel will report directly to the Executive Director.

The Panel's work to date has looked at the system as a whole. Ultimately the Panel's reviews are expected to assist the Authority's need for technical support in completing an update to the business plan, and investment and risk analyses. It is the Panel's understanding that the model was not designed to support the analysis of the Minimal Operable Section (MOS) and associated detailed analyses. Mr. van Ark noted the controversy to date with the forecasts and underlying models, which in part motivated the formation of this Panel. However, the purpose of this Panel is not to further debate those controversies. Rather, the Authority is highly interested in the advice of this Panel about where to go next in their forecasting efforts, based upon the progress and capabilities to date. In addition to conducting more detailed analyses, the Authority requires the capability to assess public-private financing schemes and station area developments. It also desires to not waste taxpayer money on unnecessary and unproductive modeling and data collection.

2 Understanding of the current forecasting process

CS was hired by the Metropolitan Transportation Commission (MTC) in 2004 to develop a statewide multi-modal travel demand model to help evaluate alignments for segments of the high-speed rail (HSR) network. The model relied on trip tables and adapted mode choice models of existing travel demand models to forecast intra-regional travel in the two largest metropolitan areas to be served by HSR – namely, San Francisco (the MTC model) and Los Angeles (the SCAG model). In addition, a population-based estimate of intra-regional travel was used for forecasting HSR trips within San Diego. The intra-regional mode choice models are traditional nested logit models, with the top-level choice being that between motorized and non-motorized modes. HSR was added to the transit nest in each instance.

For inter-regional travel, a four step sequential model was developed that included trip frequency, destination choice, mode choice, and assignment components. The inter-regional mode choice model included a primary mode choice (car, rail, HSR, or air) and then a choice of access/egress modes. Trips by mode from the intra-regional and inter-regional models, along with intra-regional auto trips estimated from the Caltrans Statewide model, were aggregated prior to the assignment step.

The data used to estimate the inter-regional models was compiled from several sources. The main source was a stated preference survey that was conducted at airports, rail stations and by telephone from August to November of 2005. On-board surveys were conducted on the Altamont Commuter Express and the Metrolink trains in October and November of 2005. Telephone sur-

veys of Amtrak passengers from the Capitol Corridor, the Pacific Sunliner, and the San Joaquin services were conducted during the same time frame. Air passenger surveys were done at six California airports (Sacramento, San Jose, San Francisco, Fresno, Oakland and San Diego) between August and November 2005. Unfortunately, surveying was not allowed at airports in the Los Angeles area. An effort was made to represent travel in and out of the LA area by over-sampling flights to these airports from surveyed airports. Finally, a random-digit-dialing telephone survey was conducted to capture auto trips in the San Diego, Los Angeles, Bakersfield, Tulare County, Fresno, Merced, San Francisco Bay Area, Modesto/Stockton, and Sacramento regions in August 2005. Overall, surveys from 3,172 respondents were collected during the study (1,234 air, 249 rail on-board, 181 rail telephone, and 1,508 auto).

The other primary data source for model development was the Caltrans Household Survey, conducted in 2000-2001. This was an activity-based survey that collected information from 17,040 households in all 58 counties in California. In addition, several surveys were used for model calibration (i.e., adjustment of various alternative-specific coefficients) to match known aggregate properties of travel patterns. For validation, checks of model predictions against additional known aggregate properties of travel patterns were evaluated. The main data sources for calibration and validation of the inter-regional models were the 1995 American Travel Survey, 2000 Census Transportation Planning Package, USDOT 10% air passenger ticket sample data for 2000, rail passenger data from California rail operators, Caltrans Household Survey, and traffic counts obtained from the Caltrans traffic count database. The intra-regional models were not calibrated and validated by CSI because they were assumed to have been calibrated and validated by the local agencies. The 2000 highway assignment validation results were summarized by facility type, area type, region and gateway. All highway summaries were reported to be within three percent of observed data.

The inter-regional model was finalized in February 2007. In 2008, the SCAG intra-regional models were refined, and in 2010 some changes were made to fix anomalies in the MTC models. During the same time, detailed travel forecasts under a no-build scenario (i.e., without HSR) were developed for 2030 using the model, and 2035 forecasts were developed by factoring up the 2030 results.

In addition, the model was used to analyze four main sets of scenarios including an HSR system as currently planned by the HSRA, either for Phase I or for the full system:

- Baseline assumptions plus various air and HSR fare structures and auto-operating costs; these resulted in figures used in the 2008 business plan;
- One of the fare structures analyzed in the initial set of scenarios (set 1 above) plus an 8% assumed increase in air and auto costs and a revised service plan;
- Assumptions of the second set of scenarios, but with an increase in the assumed parking costs at HSR stations;
- Assumptions of the third set of scenarios, but using the revised rather than original SCAG and MTC intra-regional models. This fourth set of assumptions was used in the EIR/EIS overall forecast of riders and revenue.

Overall the model responded reasonably, with ridership and revenue being affected by changes in fare price, parking costs and levels of service. All of the original model development and some of its early application were performed under the MTC contract, which was completed in September 2008. A small amount of model application work for the HSRA, contracted by the Parsons Transportation Group, was also completed in parallel with the MTC contract. CSI has served the HSRA since September 2008 through the program management contract held by PB Americas, Inc. During this time some model refinement was carried out, as well as further development and interpretation of forecasts.

3 Incomplete documentation

The Panel found several instances of incomplete or outdated information in the documentation, or could not locate such if it did exist. Two major areas were identified as key omissions that should be addressed quickly. It is expected that these information are readily available to the model developers, or can be quickly summarized from their work completed to date.

3.1 Inputs to model application

The assumptions about, data development, and summaries of several key inputs to the model should be documented. We could find little or no discussion of these inputs and their underlying assumptions:

- Fare levels or structure
- Levels of highway and airport congestion
- Levels of service (train frequency)
- Levels of ridership and service on competing intercity bus services
- Fuel prices (sensitivity tests on auto operating cost assumptions are advised)
- Induced effects
- Competitive responses from other modes (sensitivity tests of both reduced fares and varied levels of service). These include especially the airline industry, but also "curbside" express intercity bus services that have grown rapidly in the last decade in the Eastern and Midwestern United States.
- Socioeconomic and land use forecast inputs

The level of service topic is particularly important to tie to operating and business assumptions made by the Authority, and should be attributed as such. For example, the frequencies in San Francisco (8 million residents) in full build-out of 12 trains per hour are comparable to Tokyo, with 30 million residents). The Panel questioned whether such assumptions are realistic, and what the effect of lower levels of service (decreased frequency) on ridership would be. These issues should be clearly addressed in the documentation.

3.2 Validation and documentation

There appeared to be considerable confusion between estimation, calibration, and validation in the documentation. While this is not unique to these reports, we feel that the following definitions are widely accepted and should be used in both the revision of current documentation and in all future work:

- *Model estimation* is the inference of model form and parameters from survey data and the related statistical testing of those parameters as well as of alternative model formulations (i.e. specifications).
- *Model calibration* is the adjustment of the completed model system, mainly through changes in alternative-specific constants, so that its predictions match specific targets generated from observed data (including the data used in estimation).
- *Model validation* is the testing, and perhaps further adjustment, of the model system using data other than (and usually newer than) the data from which it was estimated.

There is no evidence that model validation defined in this manner was carried out. Rather, elements of the model were estimated using travel survey data collected in 2005. The resulting model was calibrated to observed data from the year 2000. Moreover, the targets used in calibration appear to reflect essentially the same information as that used in estimation.

A more thorough descriptive analysis and interpretation of the data used to build the model would have been helpful for our analyses. Some of the analyses needed before the Panel can complete our review of the current model include:

For the calibration year only
- Maps, graphs, and tabular summaries of statistical measures of the deviation between assignment results and observed modal flows (road, air, rail)
- Tabular summaries of comparison of assigned versus observed screen line volumes

For both calibration and forecast years
- Overall mode shares by origin-destination distance
- Mode shares by income
- Tables and maps of long distance trips per day by person type (income, region of residence, etc.) and trip purpose
- Summary of income elasticities by mode

For forecast years only
- Mode shares by network distance from HSR stations (distinguished among HSR stations with different access modes)
- Tables of own- and cross-elasticities by mode for the time and cost variables across the state, by origin-destination distance or inter-regional pairs, by income group and distance band from the HSR stations
- A brief assessment of access and egress mode shares (and parking demand in particular) detailed appropriately by HSR station
- Analysis of the effects on forecasts of expert judgments that were made to override estimated model coefficients

As a further check on model validity, it would be useful to compare key results with what has been observed in other systems, as discussed earlier. Such external comparisons have the advantage of implicitly incorporating various practical considerations that cannot easily be included in a mathematical model. These include operational problems, cutbacks due to inadequate funding, unanticipated responses of competitive suppliers, and feedback effects from a project on

local employment. Flyvbjerg et al. (2007) suggest a somewhat formal process for such comparisons called reference class forecasting that is commended for consideration. A similar but less formal approach would be to identify a few relevant case studies for comparison. In either case, when results differ, much can be learned from examining the reasons. The hope here is to avoid the types of systematic over-estimates of demand that Flyvbjerg et al. identified in other large rail projects around the world.

Yet another check would be to compare the assumed characteristics of air service with what has developed in other places when HSR service is introduced. The model assumes a rather passive response by air carriers, but the history of U.S. air deregulation suggests that air carriers in fact react strongly to changes in their competitive environment. Evidence from other places where HSR has been introduced, as well as from the extensive theoretical and empirical literature on the airline industry, will help assess the likelihood of drastic changes in air carrier pricing and service. Such changes might include price wars on the one hand or complete abandonment of the market by airlines on the other. Either outcome could have drastic impacts on HSR ridership and revenue. The research literature has begun to develop models specifically designed to analyze how the airline industry would respond to the introduction of HSR services (e.g., Adler et al. 2010).

4 Short term issues

The Panel has significant concerns about the model formulation, primarily with respect to specification that should have been addressed during previous work. Pending improvements to the model, we recommend that any use of the model include some steps to make the demand forecasts more conservative, especially in forecasts for financial (investment and risk) analysis.

4.1 Representation of distance in destination and mode choice models

The current model classifies travel further than 100 miles as long distance trips. This demarcation seems reasonable, especially given that a similar definition was used in the 1995 American Traveler Survey, which was an important source of such information at the time this model was developed. The choice of an ultimately arbitrary division of the travel market into two distance segments, however well justified, might lead to discontinuities between them. The CSI models report should show explicitly that this is not a problem. Otherwise, CSI should consider joint models in which distance is entered in a non-linear manner (e.g., a Box-Cox transformation) and as part of suitable interaction terms. Such non-linear formulations are moderately more difficult to estimate, but can be estimated using several off-the-shelf software packages and common languages including Biogeme, ALOGIT, and Gauss.

A second issue of concern to the Panel is the non-monotonic nature of the cubic functions of distance specified for some trip purposes. We recommend that a Box-Cox transform be adopted to ensure that the distance function is monotonic. This would reduce the number of estimated parameters by one, and it appears it would make only a small difference in goodness of fit based upon our inspection of the estimated curves.

4.2 Observed heterogeneity

Observed heterogeneity in the mode choice models was apparently not investigated with respect to trip-makers' preferences for specific modes or differential sensitivity to different level of service measures. These and other interaction terms that might normally be expected in such models are missing in this one. Interactions between socioeconomic variables (income, etc.) and time/cost variables should be included in the model. The effect of such variables is to account for heterogeneity in traveler response (i.e., for variation across the population of travelers in how various service characteristics are evaluated). Such heterogeneity has been found in virtually every study that has looked for it, and in some cases detailed results turn out quite different when it is included. The Panel found no evidence that these results are biased in aggregate or that any differences are in a particular direction as a consequence, but believes it is a relatively simple improvement that will make the model more reliable. This is also a near-term high priority item.

4.3 Inadequate exploration of level of service variables

The Panel found no evidence that alternative representations of level of service variables were investigated, which is important to obtaining a good behavioral representation and sensitivity to changes in service. Examples of such alternative specifications include:

- Replacing the simple headway variable by its inverse (frequency of service) or some other non-linear transformation;
- Dividing the cost variable by some function of income, in order to represent the well-established tendency of higher income travelers to exhibit less sensitivity to cost; and
- Dividing out-of-vehicle time by some function of overall travel distance, in order to represent the reduced importance of out-of-vehicle time with increasing trip length.

It is essential that the model be appropriately sensitive, as one of the chief causes of over-optimistic demand forecasts in other studies has been that financial constraints may lead to less frequent service or lower speeds than planned. At a minimum, this sensitivity analysis should include documenting the effect of varying levels of service on the resulting forecasts.

4.4 Inadequate justification of constraint on out-of-vehicle travel time

The Panel felt that the constraint imposed on out-of-vehicle travel time in the main mode choice model was unjustified. The rationale for asserting a substantially different value was understood to revolve around the difficulties of calibrating the final model, and the fact that the asserted value (1.0) is roughly consistent with assumptions that (a) out-of-vehicle time equals one-half the headway and (b) out-of-vehicle time is valued twice as much as in-vehicle time. The Panel feels that these two assumptions are valid only for urban trips with small headways, and thus do not justify changing an empirically estimated value – especially because the estimated value is consistent with other results for intercity markets where behavior is much different from an urban market. Specifically, Adler et al. (2005) found that headway for an intercity trip is valued at 0.2 to 0.25 as much as in-vehicle travel time; this result is further supported by unpublished values found by PB in their statewide modeling work. Furthermore, the Panel suspects that difficulties in calibration might have been influenced by under-specification of the choice models as discussed in section 2.3 above.

We want to highlight that the headway variable captures the impact of the schedule delay (the difference, early or late, between desired and scheduled departure time, and not of any initial waiting time at first boarding. The initial waiting time has been shown to be the choice of the traveler reflecting their risk preference with respect to access time, time needed at the station or the stop. If needed, the model should include a variable to capture the waiting times at any transfer, as these are outside of the control of the traveler.

4.5 Excessive use of alternative-specific constants

The destination and mode choice models at both the intra-regional and inter-regional levels have a surprisingly large number of constants. While difficult to independently assess, it would appear that these constants exerted a significant influence on the forecasts, which the Panel feels is an undesirable property of the model. We believe this may be a symptom of an under-specified or mis-specified model as discussed in the above sections (i.e., a model with an inadequate set of observable variables explaining behavior or with an important parameter constrained inappropriately). It is hoped that addressing the issues identified in previous sections will reduce the need for such constants.

5 Long term issues

Several important issues were identified that should be considered to enhance the improved model to provide the best possible estimates of HSR ridership. While not practical to address all of these issues immediately, the Panel believes that their consideration will measurably enhance the utility and credibility of the model and forecasts obtained using it. As per Section 4, pending improvements to the model, we recommend that any use of the model include some steps to make the demand forecasts more conservative, especially in forecasts for financial (investment and risk) analysis.

5.1 Model validation

Apparent omissions in model validation concerned the Panel. It was strongly felt that a number of checks on the reasonability and validity of the model should have been carried out and documented, to include:

- Comparisons to other observations and forecasts in California developed from data sets that are different from those used in this model (e.g., California statewide model, 2001 NHTS);
- Comparisons of forecasted ridership to actual ridership on HSR systems in other parts of the world;[1]
- Sensitivity testing of the importance of assumed HSR levels of service and of alternate assumptions about highway and airport congestion;
- Sensitivity testing of the effects of alternate levels of socioeconomic variables used in forecasting, using independent estimates of growth from sources such as Global Insight,

[1] It is recognized that such comparisons are difficult because no comparable service exists within the USA, and several important traveler and social differences exists between North Americas, Europeans, and Asians. However, it is felt that these differences should at least be tabulated and discussed.

the Federal Reserve Bank of San Francisco, Bureau of Business and Economic Research, and published U.S. Department of Commerce and Census trends;
- Sensitivity testing of assumptions about parking availability at planned HSR stations.

Some of these comparisons may of necessity be more qualitative than the more familiar statistical tests of model performance, but they are essential when modeling non-existent major new transportation modes or services like HSR.

5.2 Stated preference (SP) bias

Another major concern to the Panel is the potential influence of bias introduced by the use of stated preference (SP) survey data in model development. Respondents have been observed in many SP surveys to exhibit various systematic biases concerning their responses to hypothetical options. These biases depend greatly on the details of the survey, as well as the local environment of the respondents themselves. The research community has developed many guidelines to minimize such bias, and this needs to be fully discussed in the validation of the model. It is especially important in this case, because HSR mode share in the "main mode" choice model is determined solely by the SP responses. Thus, if respondents systematically overstate or understate their willingness to ride HSR (perhaps because they support it or oppose it as a concept) the resulting bias will be carried over directly into the HSR ridership forecasts.

We can suggest two ways to address SP bias:

- Examine other studies in the United States where there is more opportunity for internal validation though a combination of SP and revealed preference (RP) survey questions. Where HSR exists, it would be possible to question respondents about both their actual (RP) mode choices and their responses to hypothetical changes in the system (SP). Techniques are available to compare the two in order to illuminate systematic differences. This methodology is well developed in the research literature. Even where true HSR does not exist, a "near HSR" service – such as Amtrak's Acela service in the Northeast Corridor – would generate useful comparison data. The Panel recommends a search for existing combined RP/SP data sets. If found, an assessment of SP survey bias and a comparison of survey questions and methods with those used by CSI should be undertaken to learn as much as possible about whether such bias might affect the SP data used in the California HSR ridership forecasts. Even studies from abroad can be used for this purpose, despite their limitations for direct comparison of model results due to differences in urban development patterns, urban transit systems, and socio-demographics.
- It is possible to consider HSR as a drastic improvement to existing conventional rail service. California has two of the most well used conventional rail corridors in the United States (Los Angeles-San Diego and San Francisco-Sacramento). It is possible to perform a combined RP/SP survey in these corridors, where respondents are asked both about their use of existing conventional rail and about their hypothetical use of improved service, including both minor and major increases in speed. This will permit a direct investigation of SP bias in California data. Such an investigation is highly recommended as part of any enhancement of this model, as further elaborated in section 6 below.

6 Econometric issues

The survey designed and conducted for CSI included the use of Choice Based Sampling. That is, the sample was biased both for administrative purposes and to ensure that a minimum number of respondents were found to choose each of the major modes (both existing and proposed). The use of a choice based sample is known to bias estimation results unless the estimation procedure is modified to take account of this sampling. The method used by CSI, which was believed to be correct at the time of model estimation, has since been shown to be incorrect and a new procedure has been developed which is correct (Bierlaire et al. 2007). Future estimation work should take advantage of this new knowledge.

7 Data requirements for model enhancement

CSI has presented the Authority with a proposed work plan to continue the evolution of the forecasting process and the underlying models. The Panel focused primarily on the current models and forecasts in this first meeting, which precluded a careful and thorough review of this proposal. However, it was clear even from a cursory review that further data collection will be required for the evolution of the models, even if they are not made available for the re-estimation of the models implied above.

Two tasks – 16 and 17, presumably additions to previous work – are identified in the proposal. Task 16 includes plans for data collection to assist with updating the models, both to refine the existing model as well as support re-estimation of the enhanced model. The Panel supports this proposal. In fact, it is recommended that the data collected be expanded beyond that described in the proposal.

Several panelists advanced the notion that a combined RP/SP survey would be useful, especially if well designed to illuminate the SP response bias in the California context. It obviously cannot be measured for the HSR mode, as it does not presently exist, but would allow its measurement for other modes. Targeted sampling in heavily used conventional rail corridors in the state (i.e., San Diego-Los Angeles, San Francisco-Sacramento) is recommended as a means of conducting SP experiments in an environment as close to HSR as possible. This would allow the direct comparison of SP to RP coefficients, a key to quantifying the effect of respondent bias. Several successful protocols are available to help with design, such as the PAPI or CATI-KITE surveys (Frei et al. 2010).

In order to be useful for model estimation, and especially within the context of the recommendations contained herein, the RP data should include information about several aspects of the long distance trip, to include:

- Primary mode of transport
- Modes of access and egress
- Station choice
- Destination and group (party) size
- Trip frequency and primary purpose

The use of an eight-week retrospective survey of long distance travel is highly recommended. Such an approach will yield a substantially larger amount of data on such trips than the traditional 24 or 48-hour diaries typically used in household travel surveys.

The Panel has learned that plans for the design of a new statewide travel survey are underway, and perhaps complete. It is highly recommended that the Authority quickly determine the status of such efforts and opportunities for collaboration. The ability to share costs, eliminate duplication of effort, and ensure consistency with other California models should not be lost.

8 Conclusions

The current model system represents an ambitious step towards defining the best practice in North America, replacing ad hoc and closed proprietary models used in many previous HSR feasibility studies. In many ways the model is generally well founded and implemented. However, in order to have full confidence in it the issues identified in Section 4 must be addressed quickly. Moreover, the incomplete, unclear, or out-of-date elements of the documentation discussed in Section 3 must be completed as part of the short-term actions. Once these issues are addressed the Panel will be in a position to make a more definitive determination about the model and forecasts derived from it.

References

Adler, N., Pels, E. & Nash, C. (2010), "High-speed rail and air transport competition: Game engineering as tool for cost-benefit analysis", *Transportation Research Part B*, 44(7): 812-833.

Adler, T., Falzarano, S. & Spitz, G. (2005), "Modeling service trade-offs in air itinerary choices", *Transportation Research Record*, 1915, 20-26.

Bierlaire, M., Bolduc, D. & McFadden, D. (2008), "The estimation of generalized extreme value models from choice-based samples", *Transportation Research Part B*, 42(4), 381-394.

Brownstone, D., Hansen, M. & Madanat, S. (2010), "Review of Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study", Research Report UCB-ITS-RR-2010-1, Institute of Transportation Studies, University of California-Berkeley.

Flyvbjerg, B., Holm, M.K.S. & Buhl, S.L. (2006), "Inaccuracies in travel forecasts", *Transport Reviews*, 26(1), 1-24.

Frei, A., Kuhnimhof, T. & Axhausen, K.W. (2010), "Long distance travel in Europe today: experiences with a new survey," unpublished presentation at the 89th Annual Meeting of the Transportation Research Board, Washington, D.C., January.

Appendix: Materials Consulted

Cambridge Systematics prepared all documents listed unless otherwise indicated.

2005-07 model development and results

- 2010 Project Level EIR/EIS Technical Appendix (prepared by Parsons Brinckerhoff) Ridership and Revenue (Draft), December 2010
- Report to the Legislature (Business Plan) (prepared by the California High-Speed Rail

- Authority)
  Source Document 5: Ridership and Revenue Forecasts (by PB), November 7, 2008
- Bay Area/California High-Speed Rail Ridership and Forecasting Study
  - Findings from Third Peer Review Panel Meeting, September 2007
  - Ridership and Revenue Forecasts, August 2007
  - Statewide Model Networks, August 2007
  - Final Report, July 2010
  - Statewide Model Validation, July 2007
  - Interregional Model System Development, August 2006
  - Level-of-Service Assumptions and Forecast Alternatives, August 2006
  - Findings from Second Peer Review Panel Meeting, July 2006
  - Socioeconomic Data, Transportation Supply & Base Year Travel Patterns Data,
  - December 2005
  - Findings from First Peer Review Panel Meeting, July 2005
  - Model Design, Data Collection and Performance Measures, May 2005
- High Speed Rail Study Survey Documentation, December 2005 (Corey, Canapary & Galanis Research)

2008-10 Technical Reports and Forecasts

- Ridership and Revenue Results
  - Revised Service Plan May 2009, August 14, 2009
  - Hanford/Visalia, March 16, 2010
  - Alternative Alignment Between Gilroy and Merced, March 8, 2010
  - Split SF Terminal Operations Scenario and New Caltrain Operating Plan, August 17,
  - 2010
  - Inland Empire Alignment and Station Alternatives, August 17, 2010
  - Alternative Station Configurations in San Diego County, August 17, 2010
  - Alternative Station Locations in the San Fernando Valley, August 17, 2010
  - Anaheim 3 Trains Per Hour Scenario, August 17, 2010
  - San Gabriel Valley Alignment and Station Location Alternatives, August 17, 2010
  - Increased Parking Cost Scenario and Revised 2035 Factoring Process, January 14,
  - 2010
  - Increased Parking Cost Scenario, March 9, 2010
- Ridership and Revenue Forecasting for the Finance Plan, October 2008
- Refinement and Recalibration of the MTC Intraregional Model, March 2010