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CALIFORNIA HIGH-SPEED RAIL AUTHORITY

TO: Chairman Pringle
                Members of the Authority Board

FROM: Mehdi Morshed, Executive Director

DATE: March 3, 2010

RE: Recent questions about ridership and revenue forecasts

At the February 4, 2010, Authority Board meeting in San Diego, a member of the public raised a series of questions during the public comment agenda item about the ridership and revenue forecasts the Authority has used in its planning for high-speed rail. Over the last month, my staff and consultants have continued to field questions about the ridership and revenue forecasts from members of the public and we have seen the topic covered in the media. In addition, the Authority has received California Public Records Act requests for public records related to the ridership and revenue forecasts. We are providing this memorandum in anticipation of further public comment on the ridership and revenue forecasts.

The High-Speed Rail Ridership and Revenue Forecasting Study was a state-of-the-practice transportation modeling effort designed to portray what future conditions might look like in California with and without a high-speed train. The study was performed by experts in the field of transportation modeling, Cambridge Systematics, Inc., and took roughly two years to complete.   The resulting ridership and revenue forecasts provided, and continue to provide, sound information that the Authority Board has considered in its planning decisions.

In light of recent questions about the ridership modeling and forecasts, this memorandum briefly describes the underlying model that was developed to generate the ridership and revenue forecasts, how the Authority has used the resulting forecasts, the public availability of the model, the peer review process that contributed to the model's development, and plans that are in development for future ridership and revenue forecasting.

We are also providing as an attachment to this memorandum an additional memorandum from Cambridge Systematics to the Authority that responds to some of the concerns raised in recent weeks about the ridership and revenue modeling.

I.   Development of the California Statewide High-Speed Rail Forecasting Model

In 2005, the Bay Area Metropolitan Transportation Commission (MTC) undertook a competitive bidding process to retain consulting services for a ridership and revenue forecasting study to

develop and apply a state-of-the-practice travel demand model that could be used by the Authority for its high-speed train planning and by MTC for its Bay Area Regional Rail planning.

Following a process that attracted bids from leaders in the transportation modeling industry, MTC selected Cambridge Systematics, Inc., to perform the work. Cambridge Systematics is an industry leader in transportation modeling and was deemed most qualified to undertake the work. MTC's highly respected lead transportation modeler, Chuck Purvis, managed the modeling effort.

The objective of the ridership and revenue forecasting study was to develop a new statewide network-based travel demand model that would serve a variety of planning and operational purposes:

- Evaluating high-speed rail ridership and revenue on a statewide basis;
- Evaluating potential alternative alignments for high-speed rail in and out of the San Francisco Bay Area;
- Providing a foundation for other statewide planning purpose, including high-speed rail alignment analysis, and for regional agencies to better understand interregional travel.

The purpose of travel demand models like the California High-Speed Rail Ridership and Revenue Model (HSR R&R Model) is to forecast future travel patterns and demand as a function of variables such as population and employment, travel time and cost, fuel costs, rail and airline schedules, etc. A model is developed through a process of estimation, calibration and validation based on historical observations of these variables combined with surveys of travelers and their travel choices in response to these variables. A validated model is then applied to forecast future travel based on specific assumptions of the future values of the variables.

Travel demand models provide valuable tools to assist planners and policy makers in analyzing the costs and benefits of various transportation alternatives since they provide consistent and reproducible forecasts of future travel based on the input assumptions. The HSR R&R Model was developed using accepted modeling practices, and has served as a state-of-the-practice tool to support the Authority's planning efforts.

The HSR R&R Model consists of separate, yet integrated, components for forecasting long-distance interregional travel and intraregional travel within urban areas. The model design was described in several publicly available documents during its development: *Model Design, Data Collection, and Performance Measures Technical Memorandum (May 2005)*; *Levels-of-Service Assumptions and Forecast Alternatives (August 2006)*; and *Interregional Model System Development (August 2006); Statewide Model Validation, Final Report (July 2007).*[1]

The model implementation procedures, coefficients, and constants have remained unchanged since February 7, 2007. Model development was supported by new transportation survey data and existing data from regional transportation agencies, the census, and other sources.

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[1] All report titles are based on task deliverables in the Metropolitan Transportation Commission contract.

The new survey effort included over 10,000 "stated-preference choice exercises" that allow the resulting model to predict travel demand for the new high-speed rail travel option. All aspects of this survey effort, including the sampling plan, followed state-of-the-practice guidelines and were vetted through peer review. The new transportation surveys are discussed in *High-Speed Rail Study Survey Documentation (December 2005)*. Other data sources are discussed in *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study, Socio-Economic Data, Transportation Supply, and Base-Year Travel Patterns Data (December 2005); and Statewide Model Validation, Final Report (July 2007)*.

The resulting HSR R&R Model forecasts future travel conditions using assumptions for input variables that were developed through public processes conducted by regional planning agencies throughout California. Travel demand was first predicted without a high-speed train, and then with a high-speed train under various assumptions of alignments, station locations, fares, and operating plans. The model and its development are summarized in *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study, Final Report (July 2007)*. Validation of the model is summarized in *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study, Statewide Model Validation, Final Report (July 2007).* The ridership and revenue forecasts generated from the model are documented in *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study, Ridership and Revenue Forecasts, Final Report (August 2007).*

II.   The Authority's Use of Ridership and Revenue Forecasts Generated By The Model

The Authority has used the results from the California Statewide High-Speed Rail Forecasting Model in several ways. Ridership and revenue forecasts were utilized in the Bay Area to Central Valley Programmatic Environmental Impact Report/Environmental Impact Statement (EIR/S) to assess transportation, air quality, and growth inducing impacts of the various high-speed train network alternatives studied in that document. These forecasts were also used to assess how well a potential alignment or station location within the Bay Area to Central Valley EIR/S could meet the Authority's objective for the high-speed train system of maximizing ridership and revenue potential. The ridership and revenue forecasts indicated that both the Altamont Pass and the Pacheco Pass network alternatives have high ridership and revenue potential. Therefore the forecasts were not used as a basis for the Authority's staff recommendations that distinguished between the Altamont Pass and the Pacheco Pass. (Bay Area to Central Valley High-Speed Train, Preferred Network Alternative, HST Alignments, and Station Locations, p. 16 (Nov. 14, 2007).)

Model forecasts have also been used in ongoing statewide planning for the HST system. Since early 2008, the same model has continued to be applied under different assumptions of input variables. Resulting ridership and revenue forecasts have been used to support the development of the Business Plans and the regional environmental/engineering process.

III.   Public Availability of the California Statewide High-Speed Rail Forecasting Model

The HSR R&R Model is a software tool that was developed under a contract entered into and managed by the MTC. It is our understanding that the model, including all input variables used for the Bay Area to Central Valley EIR/S, has been publicly available directly from MTC since it was completed in 2007. Any member of the public who wishes to have access to the model can make a request to MTC, which has modeling experts on staff that can assist with making the model available.

It is also our understanding that some entities, including representatives of Caltrans, the University of California at Davis, the University of California at Berkeley, and the University of Calgary, have requested and received some or all of the model files.

The HSR R&R Model has been used to support regional and statewide transportation planning needs beyond the needs of the California High-Speed Rail Authority. For example:

- MTC used the model as part of the *Regional Rail Study* and the *Growing Smarter in the I-80 Corridor Study*;

- The model was used during the recent *High-Speed Rail Border Extension Feasibility Study* conducted by the San Diego Association of Governments (SANDAG);

- Model results were used during the recent *San Joaquin Valley Express Bus Study* conducted by the Merced County Association of Governments;

- Model results are being used for the ongoing update of MTC's *Regional Aviation System Plan*;

- Model results will be used in SANDAG's upcoming *Air-Rail Network Connection Study*; and,

- The model served as the starting point for the travel model component of the California Statewide Traffic Model Framework being developed by Caltrans and the University of California at Davis.

IV.   The Peer Review Process for the California Statewide High-Speed Rail Forecasting Model

Peer review is considered a "best practices" technique when developing travel demand models like the HSR R&R Model. Peer review provides, "an objective assessment of a travel demand model with respect to state-of-practice and agency modeling goals." (Federal Highway Administration, TMIP Peer Review Program. (www.fhwa.dot.gov/hep/step/success_mtf.htm.) A peer review process helps ensure that the modeling team's technical processes meet an agency's needs, and also meet the standards of professional practice. (http://tmip.fhwa.dot.gov/resources/peer_review/.) Importantly, a good peer review process will provide up-front guidance to the model development team on key issues such as intended use of the model, basic model structure, survey design and sampling plan, model estimation results, and reasonableness of validation. While a peer review process may also review and comment upon

the reasonableness of model results, peer review generally does not approve or accept specific model details.

The High-Speed Rail Ridership and Revenue Forecasting Study incorporated a robust peer review process at multiple stages of model development. The peer review panel was comprised of international modeling and high-speed rail experts from academia, public agencies, and the private sector. Interaction with the panel occurred on three occasions, with panel members providing technical guidance for the model design, model development, and the resulting forecasts of ridership and revenue. Comments from the first peer review panel meeting resulted in changes to the proposed approaches to the model structure, the survey data collection plan, and to the proposed performance measures. Comments from the second peer review panel meeting resulted in changes to different aspects of the interregional model and to the forecast assumptions. The third peer review exchange focused on model validation and the final ridership and revenue forecasts. In summary, the High-Speed Rail Ridership and Revenue Forecasting Study integrated peer review at multiple stages. The overall model structure, details, input variables, and the resulting ridership and revenue forecasts were products of an extensive peer review process.

IV.   Plans for Additional Refinements to Ridership and Revenue Forecasting

The Authority has an ongoing need for ridership and revenue forecasts to assist it with planning and development of the HST system, with refinements to its Business Plan, and with its engagement of private sector financing for the HST system.   Additional ridership and revenue forecasts are being planned that will build on the prior effort, incorporate model refinements that provide additional functionality, and assist the Authority with understanding the magnitude and nature of ridership and revenue risk due to the inherent uncertainty with the future levels for the input variables. This entire model refinement, application and risk analysis process will include the appropriate integration of peer review. Information about this process will provided to the Board and the public at various points as it evolves.

Attachment:
Memorandum from George Mazur, Cambridge Systematics, to Mehdi Morshed, California High-Speed Rail Authority (March 3, 2010).

Memorandum

TO: Mehdi Morshed, Executive Director
              California High-Speed Rail Authority

FROM: George Mazur, Principal
              Cambridge Systematics, Inc.

DATE: March 3, 2010

RE: High-Speed Rail Ridership and Revenue Model

In response to your request, this memorandum addresses some of the concerns raised in recent weeks regarding the High-Speed Rail Ridership and Revenue Model (HSR R&R Model). The model is sound and was developed through a state-of-the-practice peer reviewed process. Cambridge Systematics stands behind the model and the model development process.

1. **What is a "travel demand model"?** A travel demand model is a tool for making predictions about people's travel patterns. A model consists of a series of mathematical equations that produce forecasts of the number, origin and destination, travel mode, and travel route for trips as a function of variables such as population and employment, travel time and cost, fuel costs, rail and airline schedules, and a number of other variables. The mathematical equations in the model include coefficients and constants that describe the importance of each input variable in a traveler's decisions regarding the number of trips, destination, travel mode, and travel route. Typically, the mathematical equations, including the constants and coefficients, reside in computer software files that are used to apply the model. In applying the model, assumed values for the variables are input to the model, and the computer software applies the mathematical equations to these assumed values in order to make travel predictions. In the following questions and answers, the word "model" specifically refers to the mathematical equations, including the coefficients and constants, and does not include the assumed values that are input to the model.

2. **Did the model itself change as a result of peer review?** Yes. A preliminary model structure was established in May 2005 and extensively discussed at the first peer review meeting on June 8, 2005. The peer review panel offered comments on the model structure, and adjustments were made in response to those comments. This revised structure was reflected in the initial model estimation results that were provided to the peer review panel in advance of the second meeting on June 2, 2006. No further changes were made to the model structure after that time.

3. **Did the model's coefficients and constants change after the June 2006 peer review meeting?** Yes. The peer review panel reviewed coefficients that were produced through

initial model estimation. The panel extensively debated the coefficients and variables, and offered feedback and guidance to the model development team in full knowledge that coefficient values could change through the process of model calibration and validation and that the constants would be estimated at a later date. The model development team proceeded with normal model calibration and validation activities to address the panel's feedback and develop the final model. These activities and the final model included adjustments to the coefficients and estimation of a variety of model constants. The constants and coefficients were final as of February 7, 2007, and did not change after that date.

4. **When was the model "final" for purposes of conducting model runs that would be used by the Authority?** February 7, 2007.

5. **How many versions of the model have been used for forecasting?** Only one fully developed model has ever existed, and this model has been used to prepare all forecasts.

6. **Why were the final coefficients not included in the *Final Report* nor an update of the *Task 5A Report*?** The *Final Report* is one of three items that comprised a "final deliverable" package under Cambridge Systematics' contract with MTC. The other two elements are a *User's Guide* and the model itself. These three items were produced as a related set, with the *Final Report* providing a non-technical explanation of the model itself, development activities, and results. The *User's Guide* serves as a technical companion to the Final Report with a particular emphasis on model operation. The "model itself" documents the equations, coefficients and constants, socioeconomic dataset, transportation networks, and related technical details.

   The Task 5A Report was a milestone deliverable under Cambridge Systematics' contract with MTC, and it explained the process and results at the time of initial model estimation. The final coefficients and constants are the product of model calibration and validation, which occurred after initial model estimation. As such, it would have been inappropriate to update the *Task 5A Report*.

7. **Does the survey sample that was used in model development appropriately represent the transportation choices made by California's interregional travelers?** Yes. A widely used practice known as "choice-based sampling" was used on this project to collect sufficient data representing all trip purposes and feasible travel options between California's regions. Choice-based sampling is an appropriate random sampling technique for capturing the traveler choice behavior necessary for model estimation, and it is a more efficient method for collecting the necessary data than alternatives like "simple random sampling". Importantly, choice-based sampling is a widely used and accepted practice in the travel modeling profession. The overall survey sampling plan was extensively debated at the first peer review meeting, and the implemented sampling plan reflected peer review guidance.

8. **Was any modeling information withheld from the public?** No. Recently, a member of the public requested summary information regarding the final constants and coefficients from the Authority. The Authority asked Cambridge Systematics to assist in responding

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to this request for information by compiling the final constants and coefficients for the model. Cambridge Systematics responded to the Authority's request for assistance by compiling summary tables of the final constants and coefficients and providing them to the Authority with a memorandum dated January 29, 2010. While the final constants and coefficients had not been compiled into summary table format prior to the January 29, 2010 memorandum, the information contained in the tables has been publicly available in a different form since 2007.

9. **A press release from the Authority referenced a typographical error in the summary table. What is the typographical error?** The information about final model constants and coefficients that the Authority provided to a requester at the end of January in summary table form contained an unfortunate typographical error, a decimal point was misplaced. The coefficient for "service headway" in the main mode choice model for long-distance business trips was listed as -0.179 in the original table that was provided to the requestor; the correct value is -0.0179. The existence of the typographical error in the table provided to the Authority on January 29, 2010 has been identified to the requester of the information.

10. **Were there any changes in model coefficients or constants that resulted in changes to the ridership and revenue numbers for Altamont Pass and Pacheco Pass?** No. Once the constants and coefficients were finalized in February 2007, all applications of the travel model, including ones conducted for Altamont Pass and Pacheco Pass in the Bay Area to Central Valley Program-Level EIR/S, used those same final coefficients and constants. There have not been any changes to the constants and coefficients since February 7, 2007.