APPENDIX G

Comments and Responses

APPENDIX G.1

TAC and SC

Review Comments and Responses

Project Name: SR-710 Tunnel Technical Study Draft Rpt QC Reviewer: Leland C. Dolley, City of Alhambra TAC & SC

Date: 12-04-09

Project Phase: Task Order No.4 – Draft Report Project Number: 378312. 04 Sheet: ___1___ of ___2___

I.D. No.	Section/ Page No.	Reviewer Comments	Responses
1	Section 4	It appears additions to the seismic data and body of information provided by a Committee member (with appropriate references) may have been included in the draft report in such a way as to draw undue attention to these data. The result then creates an over-emphasis in one zone on potential seismic risk. We have been told repeatedly in Committee meetings, and as recently as November 18, 2009, that cost estimating based on risk is beyond the scope of this Study. However, with an overemphasis in one zone for seismic risk it is possible the risk will not be evenly or fairly assessed, resulting in an inflated cost assessment in the future.	We agree with the comment that the assessment of risk and cost is beyond the scope of this study. We have reviewed the report, and, where the seismic risks appear to be exaggerated, we have revised the text accordingly. Some basic relative qualitative comparisons of fault rupture between the zones have been added in Attachment 1 of the Geotechnical Summary Report. As stated in the meetings, the seismic risk is manageable, as demonstrated in past successful projects. It is our opinion that appropriate engineering evaluation would be performed prior to determining the cost associated with the seismic risk. We do not believe that costs and/or risks should be assessed based on this study alone.
2		The seismic data and findings we are commenting on begins with the chart on page ES-13 entitled “Comparison of Zones”. There is a footnote (b) for Zone 3 in the column identifying “Number of Active Faults Crossing Zone”. Zone 3 has the number 3 in this column (highest of all the zones).The footnote reads “Includes potentially active faults”. We note the presentations to both Committees in November included the written statement “Several inactive faults within the Zone” on each page for the five Zones but did not say “Potentially inactive faults” for any Zone. How is it, then, that only Zone 3 has “Potentially active faults”?	The definitions of potentially active faults and active faults are not the same. Based on our review and current fault maps, potentially active faults are mapped to cross Zone 3 only. These potentially active faults are expected to be less active and do not represent a concern. Much smaller relative displacements are also expected for these faults. We had reported these faults to provide the necessary information related to faults. However, we do recognize how this could be misinterpreted. We have revised the table and the text accordingly to reflect the true intent.

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3		Page 4-11 Section 4.1.3, entitled "Geologic Structure", identifies by name a myriad of geologic formations in the project study area and states "Active faults…are the Raymond Fault and Alhambra Wash Faults. The Eagle Rock and San Rafael faults might be active but presently are generally considered to be potentially active. A potentially active fault is defined by the state as a fault that has experienced surface displacement within roughly the last 1.6 million years". We further note the report documents that only the Alhambra Wash and Raymond Fault are Alquist-Priolo Earthquake Fault Zones. The remainder of Section 4 (pages 4-15 through 4-20 detail an impressive array of faults, folds, thrust belts and the like with many identifying potential movements of various types in timeframes much shorter than 1.6 million years (e.g. recurrence intervals estimated in the 340 to 1,000 years range for the Upper Elysian Park Thrust and approximately a few thousand years for activity along the Hollywood Fault.). Interestingly, pg 4-17 documents a recent seismic event, the 1994 Northridge Earthquake, and states it "occurred on a southerly dipping subsurface fault, which was unknown prior to the earthquake". So is it indeed only Zone 3 which has potentially active faults? Perhaps the study should include other known and suspected faults in other Zones that would be considered potentially active as it has further identified for Zone 3. Additionally, Zones at risk from faults not physically bisecting the area of the Zone perhaps should also be considered for inclusion. We recognize local government's discretion in seismic planning for any level of risk they deem appropriate. However, we are aware of no action that has been taken to adopt that same policy level of risk or threat assessment to the spectrum of geologic hazard in the Study area. From a policy perspective, aren't all zones "potentially active"?	We understand the comment raised by the reviewer related to seismic hazard. Even though, southern California is in a seismically active region, not all areas are known to cross active faults. Our reference of zones crossing active or potentially active faults is based on what is known to the geologic and seismic community at the present time. Several faults are listed in the report for reference and are either within the study area or adjacent to the study area. Not all of them will pose fault rupture risk. They all will have an influence on the seismic design depending on the final alignment. Therefore, as requested for this study, we have listed the active and potentially active faults that are within the study area. We did not list all the inactive faults because they do not pose a fault rupture hazard. Furthermore, the Hollywood fault was not included because it does not cross any of the zones under evaluation. Although the potential presence of the Elysian Park Thrust represents a seismic hazard consideration for the entire region, it is not thought to represent a surface rupture hazard because it occurs at a significant depth below the zones. Therefore, it was not identified as a seismic hazard. We have clarified the faults that are within the study area and those outside the study area in Section 4.2 of the Geotechnical Summary Report. The report has been reorganized accordingly.
4	14-2	The statement in the Summary of Zone 3 page 14-2 "It appears these concerns are more extensive in Zone 3 than in either Zones 1 and 2" referring to geologic conditions seems to be out of place in a technical, factual study such as this one. We find the language curious at best and feel the sentence should be removed.	We have deleted the sentence.

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Project Name: SR-710 Tunnel Technical Study Draft Rpt QC Reviewer: **County of L.A. –Amir Alam** Date: 12/2/2009

Project Phase: Task Order No.4 – Draft Report Project Number: 378312. 04 Sheet: ___1___ of ___1___

I.D. No.	Section/ Page No.	Reviewer Comments	Responses
1		The draft report currently evaluates and compares several geotechnical challenges across the five zones such as faults, formations, groundwater contamination, gaseous conditions, settlement potential, hazardous materials, etc. However, the draft report currently does not identify if these challenges are only construction related issues, long term risks of geotechnical hazard, or both. Identifying these challenges as such will help in evaluating them properly.	We separated the geotechnical tunnel consideration into these categories and, as suggested, discussed the challenges as being related to design, construction, and operations. This information is presented in Attachment 1 of the geotechnical summary report.
2		The draft report currently discusses the possible mitigation measures that may be taken to address each of the geotechnical challenges identified. As engineers we know that some geotechnical challenges are easier to mitigate than others. However, the draft report currently does not discuss level of effort needed/ease of implementation for various mitigation measures, nor does it discuss the reliability/track record for the different mitigation measures. Doing so will assist in weighing the different geotechnical challenges and associated mitigation measures properly and not treating them all equally when comparing the five zones.	We have provided case histories on how each of the listed issues has been addressed on other tunnels, and, in response to your comment, we included additional information, such as concepts of how mitigation could be applied to this project. The application concepts provide assurance on the reliability of these mitigation measures. The discussion of concepts is presented in Attachment 2 of the geotechnical summary report. We agree that some of the issues are easier to address and some may be more difficult. However, as instructed by TAC/SC, we have not provided weighting for the challenges at this time. We hope that the added discussion will provide adequate information for the decisions makers to make appropriate evaluations.

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Project Name: SR-710 Tunnel Technical Study QC Reviewer: **City of Pasadena Mayor, Bill Bogaard** Date: 12-09-09

Project Phase: Task Order No.4 –Geotechnical Report Project Number: 378312. 04 Sheet: ___1___ of ___1___

I.D. No.	Section/ Page No.	Reviewer Comments	Responses
1		No comments were provided on the draft geotechnical summary report.	Questions raised by David Worrell, City of Pasadena representative, were answered during the Steering Committee meeting and included in the final meeting minutes.

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Project Name: SR-710 Tunnel Technical Study Draft Rpt QC Reviewer: **SCAG-Naresh Amatya** Date: 11-18-09

Project Phase: Task Order No.4 –Draft Report Project Number: 378312. 04 Sheet: ___1___ of ___2__

I.D. No.	Section/ Page No.	Reviewer Comments	Responses
1	Section 1.2.1/1-4	Discussion of SCAG does not belong in the section entitled "Previous Caltrans Evaluations." At a minimum, this section should include discussion of the previous EIS prepared by Caltrans in 1992 and updated in 1998. Discussion of the I-710 project in relation to SCAG could be included more appropriately as part of a regional transportation planning context. To that end, it would be appropriate to state that SCAG includes the I-710 extension as a tunnel in its adopted 2008 Regional Transportation Plan as part of a comprehensive, regional, multi-modal, and multi-billion dollar package of transportation improvements through 2035 that will help meet the region's long term mobility and air quality goals. It would also be appropriate to state that the voter-approved Measure R sales tax in Los Angeles County includes the I-710 extension, and that Metro's recently adopted Long-Range Transportation Plan also includes the I-710 extension.	We have revised the discussion as suggested. Discussion of SCAG is deleted from "Previous Caltrans Evaluations" and included in Section 1.2.4, 2008 Regional Transportation Planning. As suggested, previous Caltrans evaluations have been included in Section 1.2.1 of the Geotechnical Summary Report.

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2	Section 3.1/3-1	Please clarify the statement, "The locations of the borings and geophysical surveys were selected based on site reconnaissance and review of available geotechnical and geological information." More information should be made to clarify the following: -The exact criteria used to identify and select potential locations for borings: -The limitations on the number of borings that could be performed and the reasons for such limitations; -The dramatic variation by zone of the number of borings, either available from previous studies or conducted for the current study, and; -Why this variation does or does not impact the conclusions drawn from the analysis.	We have included discussion on the basis for the selection of the borings and the geophysical lines in Section 3.1 of the Geotechnical Summary Report. There were no limitations placed on the number of borings to be performed at this phase. The focus was to perform borings sufficient to provide information necessary for geotechnical feasibility evaluation. The primary focus was to characterize the various formations that were expected in each zone. One of the selection criteria was the number of boreholes and amount of data already available from previous geotechnical investigations conducted by others. The variation in the number of borings for each zone directly related to the level of information collected and level of confidence in the information available at each of the zone. The data collected from our borings, combined with existing data, allowed us to develop a geologic profile with reasonable certainty for the feasibility-level assessment. In our opinion, the amount of exploration performed is adequate for this study.

Review Comments and Responses

Project Name: SR-710 Tunnel Technical Study Draft Rpt QC Reviewer: **SGVCOG-N. Conway** Date: 11-20-09

Project Phase: Task Order No.4 –Draft Report Project Number: 378312. 04 Sheet: ___1___ of ___1___

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1		[In] the discussion of the geotechnical conditions that may cause challenges (i.e. ground stability, uniformity of conditions, natural gas potential, active faults, and soil/groundwater contamination), the report indicate which conditions primarily cause construction issues and which conditions may impact long-term operation of a tunnel. Additionally, it would be useful to include some information regarding the cost of the various methodologies and equipment discussed in Section 12 that has been developed to overcome various geotechnical challenges.	We have included discussions as requested to describe the various challenges to help the decision makers in Attachment 1 of the Geotechnical Summary Report. Providing a cost estimate is not a part of the study scope.
2		With regards to public outreach, the SGVCOG would like to request that two additional community meetings be held, one each in Zones 4 and 5. It is our concern that residents in these communities may not be aware that their communities are being considered as possible routes for the 710 gap closure.	Additional community meetings were conducted in the San Gabriel Valley.

Review Comments and Responses

Project Name: SR-710 Tunnel Technical Study Draft Rpt QC Reviewer: **La Canada Flintridge-B.Sydnor/K.Wilson**
Date: 11-5-09

Project Phase: Task Order No.4 –Draft Report Project Number: 378312. 04 Sheet: ___1___ of ___9___

I.D. No.	Section/ Page No.	Reviewer Comments	Responses
1		**LCF Comment No. 1: Caltrans has not Fully Evaluated the Effects of Active Faulting in the Tunnel Zone Comparisons.** **1A -** All five tunnel Zones are crossed by faults. All Zones, except Zone 1, are crossed by active or potentially active faults, and several zones are crossed by multiple active or potentially active faults. Although not stated in the report, the potentially active faults (*e.g.*, the San Rafael, the Eagle Rock, and the Highland Park faults) should be considered active for the purposes of evaluating tunnel fault crossings. As an example, the Highland Park fault is considered not active in the Draft Report (see section 8.4 Faulting), but little previous engineering geologic information had been developed along the fault where it is covered by young alluvium. Where the Highland Park fault is crossed by seismic reflection line Z3-G6, there seems to be a clear indication that the interpreted buried bedrock surface is offset between stations 700 and 900 (distances along the line in feet) based on the termination of the very clear reflector south of station 750. This offset also appears to extend into the overlying alluvium where reflector continuity appears to be affected (reflectors appear truncated, folded, and arched) in this interval (see Figure 1 below). This seems to be an example of the lack of time for complete analysis of the geophysical data by Certified Engineering Geologists (CEG) to bring a geologic perspective to this important data. Such reinterpretation of all seismic reflection profile lines must be conducted by a CEG and properly documented before the Final Report is prepared. 1B - The Draft Report takes the position that Caltrans can design a tunnel (for example, oversized vaults and segmental tunnel lining as outlined in the November 6, 2009 TAC PowerPoint presentation) that will	1A – The text discusses the effect of faulting as presented in Section 4 of the report. Known active faults and potentially active faults, as recognized by regulators, are addressed in the report. The seismic and geologic data were reviewed and interpreted by CEGs. All of the seismic data collected during this investigation were reviewed by the team. The Highland Park fault is an ancient feature and has never been considered to be an active or potentially active fault by any group or agency (CGS AP zones or Fault Evaluation Reports, the County or City of Los Angeles, Caltrans, USGS, etc.). The lack of activity was supported by the geophysical data collected by this investigation. The faulting seen on the Z3-G6 is within bedrock, as expected; there are bedrock reflectors that cross over the fault without offset. Land-based geophysics is always tenuous and frequently gives “noisy” returns. These can easily be misinterpreted as faults in the alluvium The present data are sufficient to concur with the inactivity of the Highland fault. As pointed out by the reviewer, all zones except Zone 1 are crossed by active faults. The key active and potentially active faults are shown in Plates 1 and 2. 1B - There are a number of tunnels in Los Angeles, for example the Metro Red Line in Hollywood, that have been built across an active fault. As discussed in Sections 12 and 13 of the draft Geotechnical Summary Report, technology is available to build tunnels through active fault crossings, accounting for fault displacement of the magnitude predicted for the Raymond fault. Although these faults have not experienced a design earthquake event, the existing tunnels

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		accommodate ruptures associated with crossing active faults. However, Caltrans does not discuss potential earthquake displacement risk to the tunnel structure and to tunnel occupants as compared to a tunnel without active faults. In addition, no examples are presented where these designs have been used and have successfully prevented tunnel damage from fault rupture. Mr. Bruce Schell, engineering geologist, stated at the November 6, 2009 TAC meeting that tunnel crossings by active faults are one of the most critical concerns faced within the five Zones. Yet it seems that no attempt has been made (see, for example, subsection 13.1.3 Faulting and Seismicity, Table 13-1, and section 14) to factor this concern into the Zone comparisons by discussing and considering relative risk related to allocation of design and construction resources, to tunneling safety, to potential tunnel repairs, and to ultimate user safety. 1C - The methodology used in the Draft Report to determine the size of these potential earthquake fault movements on the Raymond fault for a magnitude 6.7 earthquake yielded a maximum estimate of 4 feet (see subsection 4.2.1 Raymond Fault). Yet according to the Caltrans tunneling expert at the November 6, 2009 TAC meeting, the Metro Red Line tunnel crossing the Hollywood fault (assuming a lower magnitude 6.4 earthquake) yielded a 6.5-foot design offset. From the 1971 magnitude 6.6 San Fernando-Sylmar earthquake we know that at least 6.23-feet (1.9 meters) of left-lateral offset and 3.5-feet (1.07 meters) of vertical offset occurred. Therefore, detailed explanation of the lesser estimated offset on the Raymond fault for a larger earthquake should be explained and calculated with reference to the two cases mentioned above. In the aftermath of the 1992 Landers Earthquake, with about 4 meters of surface displacement, new formulas have been developed in the past decade by geologists and seismologists for evaluation of fault displacement. The Caltrans Draft Report needs to utilize current formulas that are documented in recently published seismology journals. Besides left lateral displacement on the Raymond fault, the Certified Engineering Geologists need to also consider the vertical-oblique component of the dipping fault plane, thus geometrically evaluating the	discussed in the draft report were designed in accordance with the then current standard of practice for tunnel design. We believe a similar approach will be used for the design of this tunnel. As the technical consultant, our task has been to provide an evaluation of subsurface conditions and provide a comparison across the zones. As requested by both TAC and SC members, our team did not provide comparison or relative magnitude of each of the risks. During previous meetings, the study team was asked to present the facts. Fault avoidance, risk, and cost are beyond our scope. We believe that these will be evaluated in detail during the environmental phase. 1C – The text has been revised to include a discussion of the methods used to determine the estimated fault movements presented in the draft report. This information is provided in Section 4.2.1.1 of the Geotechnical Summary Report. None of these faults have experienced any earthquake displacement in the past few hundred years, and, consequently, there is no direct experience upon which to base decisions related to fault displacement. The geotechnical industry standard approach for handling design for fault displacement is to estimate displacement by using what was referred to in the report as empirical fault and earthquake data. Basically, this method involves making comparisons to similar faults in similar geologic/tectonic environments throughout the world. There are different methods of doing this. For example, the fault displacement estimate can be based on the length of the fault or on the amount of displacement during known earthquakes of a magnitude similar to the one estimated for the fault of interest to the project. Published scientific journals, notably Wells and Coppersmith (1994), have compiled charts, graphs, and tables that list all known past earthquakes worldwide. As is standard practice in seismological research and the geotechnical industry, we used this method for our analysis. For instance, the Raymond fault is approximately 12 to 15 miles long; comparison to faults of similar size indicates that faults of this length have generated earthquakes in the range of 6.0 to 6.7 magnitude. Taking the worst-case (most conservative) scenario of magnitude 6.7, the typical displacements are in the range of 2 to

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		total fault displacement (net slip). The fault displacement should be stated as the mean value plus one and two standard deviations (+1 sigma and +2 sigma).	3.2 feet. In addition to using the worst case (largest magnitude), we took another conservative step by rounding off the maximum 3.2-foot displacement to 4 feet (a 25 percent increase). The implication by the reviewers that the displacement values are too small is simply not supported by standard procedures and by worldwide empirical data. This will be further evaluated during the environmental phase. Regarding using the Hollywood fault estimates or the 1971 San Fernando event instead of the worldwide empirical data as suggested by the reviewers, it should be noted that there are about 30 events of magnitude 6.5 to 6.8 earthquakes (i.e., similar to the 6.7 magnitude we used) in the worldwide database (including the San Fernando event) upon which to make a comparison. To forgo these comparisons in favor of just one event is not in accordance with the standard practice. The 1992 Landers event is also in the worldwide database (Wells and Coppersmith, 1994) and, therefore, was considered in our analysis. The use of mean plus two standard deviations represents conservatism that is not in accordance with standard practice. Even nuclear power plants use only one standard deviation. The state of the art in tunnel design is such that displacements along active faults and contaminated soil/groundwater can be accommodated in design.
		1D – Knowing that each of the tunnel Zones has unique fault crossing conditions as outlined above, it seems sensible to compare not only the "average" Zone geologic cross-section delineating fault crossings for each Zone (Plates 5 through 9), but to compare the Zones based on the potential for final tunnel Zone selection to implement an "active fault-avoidance" strategy. This comparison would allow decision-makers to consider this potential to avoid risks (including contaminated soil/groundwater and active faults) when implementing the as yet undefined process that will be used to determine the preferred Zone subject of the required EIR.	1D – The scope of the study is not to evaluate potential tunnel alignments, but to provide adequate information on the subsurface conditions for the selected zones. Fault avoidance and alignment selection are beyond the scope of this study.

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2		**LCF Comment No. 2: Caltrans' Earthquake Ground Motion Considerations are Overly Simplistic for the Tunnel Zone Comparisons.** Strong-motion seismology is treated in an overly simplistic manner and renders tunnel Zone comparisons deficient in this report (refer to page 4-18 subsection 4.3.2 Seismic Design Parameters). The earthquake ground motion peak ground acceleration contours (shown on Figure 4-9) are predicated on an unpublished 2007 internal Caltrans report (Merriam and Schantz, 2007) that has not been subjected to peer review and the associated map states that it "is for illustrative purposes to aid in determining the controlling fault" and does not incorporate site correction factors such as soil amplification and near-fault factors. Figure 4-9 wrongly treats all five zones as a hypothetical uniform slab-of-rock (Shear Wave Velocity = 760 meters/second) when all of the five tunnel Zones would be in both soft alluvium and rock. There are different seismology formulas for rock, soft rock, and stiff soil. Instead of an over-simplified and inappropriate contour map of ground motion, it is advisable to have a table of ground motions for each of the five zones, with multiple Zone segments classified based on changes in generalized lithology (soil and soft rock) along the axis of the generalized tunnel cross-sections shown in Plates 5 through 9. Using the deterministic peak ground acceleration values in Figure 4-9 very likely, and unnecessarily, yields values at some locations that are too high and at other locations far too low. Caltrans should use seismologic and active fault information from the consensus CGSUSGS-SCEC statewide model for California, which seems to have been considered by Schantz and Merriam (2009). Although we are uncertain as to the full background and peer review that is associated with the Caltrans ARS website, an approach similar to what is displayed there seems to apply more up-to-date seismology methods and should be applied to the comparison of the five tunnel Zones in the Draft Report. The tunnel Zone comparisons should be based on modern (post-February 2008) seismology formulas. These were substantially changed	We agree with the reviewer that the report does not go into a great depth on the discussion of the seismic design. Because no tunnel alignment was selected and detail seismic design is not part of the scope, Caltrans' recommended corrections were not applied to the peak ground acceleration. The seismic design parameters provided in the report are adequate for the geotechnical feasibility study. Detailed seismic design parameter recommendations will be addressed in the next phase of the project. As has been the practice with Caltrans projects, the seismic ground motions are generally estimated using Caltrans' suggested procedures. Caltrans design methods have been developed specifically for transportation projects; other methods developed for buildings may not be the most appropriate for tunnel projects. The Caltrans methods have built-in corrections for distance from faults, soil types, rock types, seismic velocities, etc. The methods are highly peer reviewed, and Dr. Chiou, the expert mentioned by the reviewers in connection with the NGA development, is involved in the Caltrans process. To suggest that the methods are too simplistic and not in accordance with modern seismic design procedures is not true. However, we agree that the procedure of comparing ground motion contours from the most recent Caltrans maps is simple, but it is also very convenient for use in this phase of an investigation. Our experience on hundreds of projects has shown that application of the correction factors rarely changes the design values given by the maps by great amounts (> 0.1g); therefore, comparing zones based on the contour map is a valid approach and provides a good estimate of final design values. Having stated this, we would always compare these results against methods of the USGS and the National Building Codes, as well as the California Building Code before finalizing any design. We question the statement by the reviewers that values at some locations are too high and others too low. No values are given by the reviewers to support this statement, and they do not provide the calculations or the methods used to make these calculations. In conclusion, we believe that the values presented are appropriate for this level of study.

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		with the Next Generation Attenuation of Ground Motion Attenuation Models (NGA), a five-year national project involving teams of seismologists and geologists. Brian S.J. Chiou, Ph.D. Senior Seismologist in the Division of Research and Innovation, California Department of Transportation, was a co-author of the NGA Project. In addition, the Caltrans Draft report does not indicate what level of earthquake ground motion would be used for tunnel design; this would provide some benchmark for the tunnel Zone comparison. Will the 710 Tunnel be designed for 2 percent chance of exceedance in 50 years (the Maximum Considered Earthquake ground motion), or the less conservative 5 percent chance of exceedance in 50 years as shown on the Caltrans ARS website? Based on the relative importance of structures, different levels of ground-motion are considered. Since the ground motion may vary significantly among the five tunnel Zones, the ground motion differences need to be fully explained in the Draft Report.	
3		**LCF Comment No. 3: Near-Fault Ground Motion Effects are Improperly Omitted from Tunnel Zone Comparisons.** Earthquake ground motion is known to be significantly higher immediately adjacent to a rupturing fault, but near-field effects are not considered in the October 2009 Caltrans Draft Report. Near-field effects (see also Comment No. 2) need to be evaluated for all of the active faults crossing the various tunnel Zones as part of the tunnel comparison process. Near-field effects include important parameters. These should have separate line items in ground motion comparison tables within the Draft Report that would subsequently be used for any preferred tunnel Zone selection process. Following the 1992 Landers Earthquake, seismologists discovered in data recorded by strong-motion accelerometers that the near-field along the rupturing fault plane could have severe high-velocity pulses. Dozens of seismology publications since 1992 have evaluated fling-step and forward-directivity effects in the near-field, in addition to conventional analysis of peak ground acceleration (PGA). The Caltrans Draft Report does not evaluate near-field effects (especially forward directivity and high-velocity pulses) along the plane of the	Near-field effects are incorporated into the Caltrans seismic design methods. However, as stated above, all these factors are checked against other appropriate design methods. As discussed above, the 1992 Landers event is in the worldwide empirical data base and, therefore, was considered. However, the Landers event was a much larger earthquake, and it might not be appropriate for comparing to a smaller moderate-magnitude event like the one estimated for the project area. Many of the effects like “fling” and “directivity” are controversial (that is, they occur during some earthquake and not during others); therefore, there is little consensus within the seismic design community as to how to handle these effects. These types of details are not significant enough to eliminate any zone from further consideration. Faults and their general properties, which present potential hazards within each zone, have been presented in the draft report to allow comparison between zones. Evaluation/analysis of near-fault ground motions was not included as a part of our scope of work for this study. It is appropriate to consider these factors when tunnel alignments have

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		Raymond fault. The dip of the fault plane and the rake of the slip vector are parameters that influence near-field seismology. The seismologic and engineering implications of near-field effects must be considered now in the tunnel Zone comparison process and cannot wait until "later" at the design stage; it is a necessary and essential parameter that must be incorporated into the Draft Report now.	been selected for evaluation. Considering the width and length of the zones, analysis of near-fault ground motions would be not practical at this time. Furthermore, these will not have an impact on the comparison or screening of zones as stated above. The seismic design parameters provided in the report are adequate for the geotechnical feasibility study. Detailed seismic recommendations, including near-fault ground motion effects will be addressed in the next phase of the project.
4		**LCF Comment No. 4: Selection of Field Investigation Locations Contradicts a "Route-Neutral" Approach.** Route neutrality requires that new, project-specific field investigations be equitably distributed among the five Zones, ideally 20 percent in each Zone with modification based on Zone length. Field investigations developed a large amount of new field data using techniques representing the advanced state of current professional practice. About 35 percent of the new field studies were in Zone 3, the shortest of the Zones. About 11 percent each were in Zones 4 and 5, the longest Zones. Fifty percent of the new borings were in Zone 3 and 32 percent of the new geophysical profiles were in Zone 3. The decision process used to assure that the field investigation program activity distribution was equitable is not explained. For example, previous borings in Zones 4 and 5 are almost entirely groundwater production or groundwater monitoring wells with no information on geologic contacts and logs without geotechnical and engineering geology descriptors for the units encountered. By contrast, Zone 3 has approximately 20 previous geotechnical borings located proximal to the central portion of the Zone, all with geotechnical descriptions, laboratory test results, and field drilling/sampling information to evaluate material strength. New geophysical seismic reflection lines were limited to a total of four in Zones 4 and 5, while Zone 2 had four and Zone 3 had six seismic reflection lines. Regarding new continuous core borings drilled for this project, Zone 5 had none, Zone 4 had two, and Zone 3 had 12. As indicated above, it does not appear that the quality of existing data in Zones 4 and 5 (the longest Zones) was so good such that supplementation with current	We have included discussion on the basis for the selection of the boring and the geophysical line locations in Section 3.1 of the Geotechnical Summary Report. We disagree with the comment that the field exploration should be equitably distributed. The selected exploration location is based on the data available within each zone and on our understanding of the geologic conditions such that a similar level of data is available for each zone. There were no limitations placed on the number of borings to be performed in this phase. The focus was to perform borings sufficient to provide information necessary for geotechnical feasibility evaluation. The variation in the number of borings for each zone was based on the level of information collected and the level of confidence in the information available at each zone. The primary focus was to characterize the various formations that were expected in each zone. The data collected from our borings and existing information allowed us to develop geologic profiles with reasonable certainty for the feasibility-level assessment.

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		advanced techniques was not required. Conversely, there was a comparative abundance of previous geotechnical borings in Zone 3 (the shortest Zone) suggesting fewer new borings would be needed. In the November 6, 2009 TAC meeting, it was suggested that there are a greater number of potential problems and/or a greater geologic variability in Zone 3 versus Zones 4 and 5. If so, this must be explained in the report to verify that route neutrality was truly considered when the field investigation program was established.	
5		**LCF Comment No. 5: No Consideration is Given to the Effects of Liquefaction and Alluvium on Possible Ventilation and Emergency Evacuation Shafts.** Geologic and geotechnical information about potential ventilation (or other) shafts is lacking in the reports. In the TAC meeting of November 5, 2009, it was stated by Caltrans that the only ventilation would be along the axis of the tunnel bore(s). For tunnels approximately 5 to 8 miles long, this may be a vulnerable and unsafe design for which no justification has been presented. Most long vehicular tunnels (for example the Calle 30 Tunnel in Madrid referred to in subsection 12.2.2.1) need ventilation (exhaust from vehicles & intake of fresh air) typically about every half-mile. However, the ventilation design is further predicated on the relative potential for fault rupture closing the tunnel immediately after a large earthquake. Direct fault rupture could essentially choke-off the suggested axial ventilation system concurrent with fire in the tunnel (for example from vehicle fuel tanks). Firefighters and emergency services workers approaching from both directions would need fresh air should this vehicular tunnel collapse locally where ruptured along the fault plane. Ventilation shafts can also serve as emergency exits for trapped motorists in the event of an earthquake or massive traffic accident. Seismic safety and redundancy are vital for any of the five tunnel ventilation systems. This critical issue is inadequately addressed in the Draft report. The effects of seismically induced liquefaction are not evaluated for the ventilation or emergency shafts for the five tunnel Zones. In many cases, the tunnel would be in sedimentary rock (approximately 200 feet below	Ventilation and emergency access shafts were not evaluated as a part of this study. They will be evaluated in the next phase of the project when the technical, operational, and financial feasibility are considered, in addition to geotechnical feasibility. Portal alignment was also not selected as part of this study. We agree with the reviewer that effects of liquefaction may be important for shafts and portals. However, the selection of these elements is not a part of this study. The effects of liquefaction on these elements will be considered during the environmental phase. We agree that ventilation is a key element for vehicular traffic. Several techniques exist to provide ventilation, and these will be evaluated during future phases of the project.

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		the ground surface), while the vertical ventilation shafts would necessarily be located in soft, saturated alluvium that is vulnerable to liquefaction. The integrity of the shafts, as with portals, during a severe local earthquake need to be evaluated for adverse effects of shallow groundwater and liquefaction. In the Draft Report, there is no description of ventilation shafts. Specific, empirical data are needed (e.g., spacing, diameters, ductility of materials). Caltrans needs to evaluate seismic impedance for a two-layer case when the vertical shaft is in both soft, saturated alluvium (above) and firm sedimentary rock (below). The earthquake ground motion is very different for a two-layer case.	
6		**LCF Comment No. 6: California Geological Survey Groundwater Data are Not Adequately Presented.** Caltrans has not provided consistent hydrogeology maps with contours showing the shallow groundwater or perched water conditions. Appendix B Groundwater is only two pages long and provides little useful data. The California Geological Survey (CGS; Plate 1.2 in each report) has carefully compiled historically highest groundwater levels (depth contours) for each of the 1:24,000 quadrangles in the study area. This was done as part of the Seismic Hazard Mapping Program to assess liquefaction potential in the Pasadena, Los Angeles, El Monte, and Mount Wilson quadrangles. Groundwater elevation contours are plotted, yet the published CGS Seismic Hazard Report depth contours were largely ignored.	Historical information (including the aforementioned CGS Seismic Hazard Mapping reports) was used to provide groundwater information for the basins located within the study area. The collected groundwater information is presented in Plates 1 and 2. The information was also shown in the geologic cross sections.

I.D. No.	Section/ Page No.	Reviewer Comments	Responses
7		**LCF Comment No. 7: The Draft Report Indicates a Lack of Synthesis of Subsurface Geologic Data.** Caltrans and its consultants have amassed a large quantity of data as presented in the approximately 12,994 Draft Report pages. However, the subsurface geologic information is poorly integrated and synthesized. The raw data from the geophysical profiles have not been adequately interpreted and considered in the detailed representative geologic cross-sections along the five potential tunnel Zones. There is no data as yet from the newly installed groundwater monitoring wells. There are internal inconsistencies and minimal effort at an over-arching synthesis. Caltrans should take additional time and analysis effort to better evaluate and understand thee subsurface geologic data compilation.	The report was prepared in layman's terms, as specifically requested by TAC and SC members. The data collected were reviewed by the team and have been summarized in the report. The scope is to summarize the key facts relating to tunnels in each zone. In our opinion, we provided adequate description of the subsurface conditions to allow for evaluation of the subsurface conditions within each zone. Additional evaluation is not necessary.

Review Comments and Responses

Project Name: SR-710 Tunnel Technical Study Draft Final Report QC Reviewer: **La Canada Flintridge-B.Sydnor/K.Wilson**
Dated: 3-30-10

Project Phase: Task Order No.4 –Draft Final Report Project Number: 378312. 04 Sheet: ___1___ of ___8___

I.D. No.	Section/ Page No.	Reviewer Comments	Responses
1	General	**General Comments of March 2010 Volume 1:** 1A - We reiterate that Volume I indicates a lack of complete analysis and integration of the large amount of geology data, geophysical data, and other information presented in Volumes I through V, suggesting that with additional time and effort, a more robust and realistic comparison of the five SR-710 tunnel Zones would be possible.	1A - We disagree with this comment, as stated previously, the data collected was evaluated appropriately for feasibility assessment.
		1B - We continue to believe that several additional relevant technical and physical factors should have been used to assess geotechnical feasibility and to compare the five tunnel Zones, for example, liquefaction susceptibility for tunnel ventilation shafts, updated ground-motion values, and near-fault ground-motion effects.	1B - We disagree with this comment, these factors were not addresses for the reasons stated in our previous response. It is our opinion these factors will not impact the feasibility assessment.
		1C - In our opinion, new Table 13-2 on page 13-8, Summary of Significance of Geotechnical Conditions by Zone, is inadequate in its present form with respect to Zone comparisons for Active/Potentially Active Fault Crossings. It is not suitable based on its conflict with both known legally zoned active faults *(e .g.*, the Raymond and Alhambra Wash faults) and with the text of the SR-710 Tunnel report, which discusses potentially active fault crossings. We recommend that an additional column be added to Table 13-2 *(eight* columns total) and the two suggested fault columns [shown on the original comment letter (attached)] be moved to columns 2 and 3. Holocene Active Fault Crossings mapped at the surface should to be separated from Potentially Active Fault Crossings, which would include blind-thrust faults, such as the Elysian Park Anticline and lesser-known faults such as the San Rafael, Eagle Rock, and Highland Park faults.	1C - The evaluation of faults and their associated risks are considered appropriately. We disagree with the suggestion to include potentially active faults separately for the comparison. Blind-thrust faults and other active faults outside the study area should be considered for seismic loading and not for fault rupture potential. It is our opinion that the evaluation presented is appropriate for the feasibility study.

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		1D - There remains no clearly articulated process that will allow a more accurate analysis to determine the preferred tunnel Zone subject of the required California Environmental Quality Act (CEQA) Environmental Impact Report (EIR). The use of the 2007 Caltrans Project Risk Management Handbook is not appropriate for tunnels with acute geologic hazards (see below). 1E - The route-neutral requirement as stated on page ES- 1 "means that all routes receive equal attention and no route for the tunnel is favored over another," indicating that project-specific field investigations should be equitably distributed among the five tunnel Zones. Although some general language was added to Section 3.1, there remains no description of the criteria used to allocate resources among the five Zones. For example, how was it determined that such a high percentage of new/existing borings, hydrologic monitoring wells, and geophysical survey locations were placed in Zone 3 (the shortest Zone) as opposed to say Zone 5 (the longest Zone).	1D - The first portion of comment 1D is not in the scope of work for this study. We disagree with the second portion of comment 1D, also see response to comments 2A and 2B below. 1E - We refer the reviewer to our response to comment 6 below, and our previous response to the same comment. We disagree with the reviewers comment.
2	Attachment 1	**Comments more specifically to Attachment 1 are:** 2A - The Caltrans Project Risk Management Handbook (second edition, May 2007) is well written as a general construction policy manual and should have been modified for use with the proposed project some years ago. However, it applies to building highways and bridges, not deep large diameter tunnels with non-routine potential impacts from a range of geologic hazards *(e.g.,* active faults, gassy conditions, unstable ground, and liquefaction). It is not appropriate for use on this project at this intermediate study phase. 2B - Tunnels are not discussed in this statewide policy manual, which is focused on highways and short bridges. 2C - There is no clear explanation of the numerical ratings for the potential for Active and Potentially Active Fault Crossings that led to characterizing all five tunnel Zones as "Low". This seems improbable considering the situation with no such faults in Zone 1 and three such faults in Zone 3. In addition, the use of a 3300-year recurrence interval for the Raymond fault seems inappropriate when Weaver and Dolan (2000) indicate that the last significant earthquake	2A - We disagree with this comment. Our evaluation considered both the Caltrans Project Risk Management Handbook and British Tunneling Society Guidelines. We believe our approach is appropriate for comparison of the geologic conditions encountered for this study and considers the tunneling aspects appropriately as described in the British Tunneling Society Guidelines therefore it is appropriate. 2B - As stated in the attachment, the evaluation was based on the Caltrans Handbook and British Tunneling Society Guidelines. 2C - The basis for the evaluation is presented in the attachment. It appears that the reviewers have taken the referenced statements from Weaver and Dolan (2000) out of context. The referenced paper indicates: "Data from another of our paleoseismologic trenches yielded evidence for at least five latest Pleistocene earthquakes, including at least four surface ruptures that occurred during a brief, <\=10,000-year-long

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		occurred ~1000 to 2000 years ago. This suggests that 2000 years may have expired and 1300 years remain, thereby changing the Probability of Rupture to 8%.	period between ~31.5 and 41.5 ka. The <\=3300 year-long, average recurrence interval for these events is much shorter than the interval suggested for the past ~40,000 years by the frequency of paleoearthquakes recognized in previous trenches. Thus, either the 31.5 ka to 41.5 ka events represent a temporal cluster, and the recurrence interval for the fault is highly irregular, or at least half of all Raymond fault earthquakes that have occurred since ~31.5 ka have not yet been recognized." *-from Weaver and Dolan, 2000.* Based on this, it is clear that the recurrence interval estimated by Weaver and Dolan for the Raymond fault is uncertain. Our assessment for this study is appropriate and considers the activity noted on this fault by other researchers.
3	App G.1 (LCF Comment Responses)	**LCF Comment No. 1: Caltrans has not Fully Evaluated the Effects of Active Faulting in the Tunnel Zone Comparisons.** 3A - Our original comment stands. In order to comply with one of the stated purposes of the geotechnical study (page ES- I: "this information [geologic, groundwater, and seismic conditions] provides a basis for a comparison of the study zones with respect to tunneling"), the potential magnitude and slip direction(s) of surface faulting on the Raymond fault need to be fully evaluated at this current phase of work, not at some unspecified later date, *e.g.* during the environmental phase or "the detailed design stage" (page 4-13). 3B - We believe there are several technical and or program inconsistencies apparent in the responses and Volume I. Examples include: Weaver and Dolan (2000) are referenced as a primary source for information on the Raymond fault, yet several conclusions reached by Weaver and Dolan are not integrated into the analysis, such as: (a) evidence for substantial vertical displacement in trench exposures that contradicts the 15: 1 h:v ratio from one focal mechanism; (b) the possible connection between the Raymond and Hollywood faults yielding several meters of displacement in a magnitude 7 event; and (c) the application to the Attachment 1 analysis of the fact that the last surface displacement occurred ~1000-2000 years ago.	3A - We disagree with this statement, characteristics of the Raymond fault have been adequately addressed for this feasibility level study in our report. 3B - We disagree with this comment. The exact nature of future activity on the Raymond fault is unknown. We have reviewed published documents regarding the fault and the discussions and estimates presented in the report and in our previous response are consistent with the documents reviewed.

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		3C - In Section 10.4, page 10-3, it states that ... "the main branch of the Raymond fault is approximately several hundred feet wide." Yet on Plate 8, the fault zone could be locally as wide as 3,000 feet (which we agree may be the case). However, Figure 3 of Attachment 2 (the Dubnewych & Matthei report dated March 10, 2010) is a simplistic diagram for fault crossing that indicates one fault plane with no "fault zone" width. Again, only horizontal displacement is considered, with no recognition that the Raymond fault also has demonstrated a vertical component of movement.	3C - As stated in the attachment, the concept depicted on Figure 3 is not appropriate for fault offsets in excess of 6 to 12 inches. Figure 4 of the attachment would be appropriate for larger displacements, such as that of the Raymond fault. This method (Figure 4) could also be used to accommodate potential vertical offsets as well.
		3D - It is stated that "Known active faults and potentially active faults, *as recognized by regulators* [emphasis added], are addressed in the report." This narrow focus seems to: (a) remove the incentive to consider carefully the possibility that poorly studied faults *(e.g.*, the Highland Park fault) may show evidence for displacements in alluvium; and (b) concedes that regulators rather than practicing engineering geologists set the standard for the level of investigation.	3D - The study has considered all known faults. The Highland Park fault was evaluated and determined to be inactive. The methods utilized with regard to the evaluation of faulting are appropriate for this feasibility level study.
		3E - The exercise attempted in Attachment 1 suggests that the statement "Fault avoidance, risk, and cost are beyond our scope" is no longer true, since schedule and cost risk form the basis of the Caltrans risk management plan and cost as mentioned throughout Attachment 1. In addition, consideration of an "active fault-avoidance" strategy in the Zone comparison process would allow decision-makers to weigh the advantages of avoiding these potential risks when implementing the yet undefined process that will be used to determine the preferred Zone subject of the required EIR.	3E - We disagree with this comment. Costs, risks and fault avoidance strategies are beyond the scope of the study. The exercise provides a means for comparison of the potential challenges within each zone.
		3F - It is stated, "The state of the art in tunnel design is such that displacements along active faults ... can be accommodated in design." We understand that tunnel boring machines can advance a large-diameter adit and that oversized vaults can be excavated. However, none of the active fault-crossing remediation strategies is known to have survived actual earthquake fault displacements.	3F - The comment is correct in that “none of the active fault-crossing remediation strategies is known to have survived actual earthquake fault displacement”; because none of these previously constructed tunnels have experienced fault rupture. However, the construction methods presented in our report are accepted by the tunneling industry as an appropriate method to mitigate potential fault movement.

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		3G - In addition to incorporating all of the information from Weaver and Dolan (2000), we suggest that the consultants consider Youngs and others, 2003, *EERI Earthquake Spectra*, vol. 19, and Kase (2010), to evaluate the probabilistic fault displacement.2	3G - Probabilistic analyses are generally performed during the design phase, when the seismic design criterion is established. The probabilistic analysis is not performed during the feasibility phase.
4	App G.1 (LCF Comment Responses)	**LCF Comment No. 2: Caltrans' Earthquake Ground Motion Considerations are Overly Simplistic for the Tunnel Zone Comparisons.** Our original comment stands. In addition, we offer the following comments: 4A - Earthquake ground -motion needs to be computed for each of the five tunnel Zones using modern (February 2008 attenuation formulas published in *EERI Earthquake Spectra)* and based on actual geologic subgrade, alluvium or soft rock, often in a two-layer case. Near-field ground-motion effects should also be considered at this time. These considerations should not be made in a later phase of work since they are instrumental in understanding the differences in Zone performance, including potential liquefaction related to ventilation shafts. The tunnel zone comparisons cannot go forward using the 2007 Merriam and Schantz report (reference is made to Figure 4-9 and Section 4.3.2). The CGS-USGS-SCEC statewide fault model should be used, along with the *actual* geologic subgrade of each tunnel Zone *(e.g.*, alluvium and soft rock). 4B - We believe it would be appropriate to have a written statement from Dr. Brian Chiou, Caltrans seismologist that indicates his level of involvement in selecting the ground motion analysis methods used in the March 2010 report. 4C - We find it difficult to reconcile statements that: (a) "To suggest that the methods are too simplistic and not in accordance with modern seismic design procedures is not true"; and (b) "However, we agree that the procedure of comparing ground motion contours from the most recent Caltrans maps is simple, but it is also very convenient for use in this phase of an investigation." We also do not believe that the geotechnical feasibility determination and the comparison of the five Zones should be based on finding "simple"	4A - We disagree with this comment. The methods utilized with regard to the evaluation of ground motion are appropriate for this feasibility level study. The feasibility of tunneling is not impacted by the ground motion values, however, the detailed tunnel designs will be dependent on using the appropriate values. As such, the ground motion analyses should be performed when alignment(s) are chosen for the tunnel and is appropriate during the design phase. 4B - A letter from Dr. Chiou is not necessary as he provided his input into the Caltrans data used and referenced in the report. 4C - It is our opinion that the methods used in the evaluation are appropriate for this feasibility level study. As such, no further evaluation is necessary.

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		and "convenient" procedures. Procedures should be rigorous and based on vetted geologic and seismologic information from published national journals, such as EERI *Earthquake Spectra* and the Bulletin of the Seismological Society of America. When lives the public health, safety and welfare, and billions of dollars of public funds are at stake, "simple" and "convenient" procedures are particularly inappropriate and irresponsible.	
5	App G.1 (LCF Comment Responses)	**LCF Comment No. 3: Near-Fault Ground Motion Effects are Improperly Omitted from Tunnel Zone Comparisons.** Our previous comment stands. In addition, we offer the following comments: 5A - Caltrans and its consultants have still not specified the level of earthquake ground motion that will be used for tunnel design in any of the five zones. Is it the Maximum Considered Earthquake, 2 percent chance of exceedence in 50 years? Is it a much less conservative 5 percent chance of exceedence in 50 years, as shown on the Caltrans ARS website? Since this would affect the comparison of the five Zones, affect the comparison of the five Zones, a stated purpose of the investigation, this question needs to be firmly answered at this stage, not at some undefined time in the future. Reference is made to ASCE Standard 7- 10, Minimum Design Loads for Buildings and other Structures, 2010 edition, which will be incorporated into the California Building Code, Title 24. The new 2010 edition specifies the MCE (2% in 50 years) level of earthquake ground-motion, and there is a new Risk-Targeted Spectral Response Acceleration for important structures with a 1 percent chance in 50 years. Refer to SSA *Seismological Research Letters*, vol. 81, no. 2, page 284, for six abstracts on ASCE Standard 7- 10. 5B - We do not agree that the "Near-field effects are incorporated into the Caltrans seismic design methods" that have been used in the March 2010 geotechnical report. The specific published formulas (author and date) must be cited. There is substantial consensus within the seismic design community as to how to handle these effects as demonstrated by numerous studies (e.g., Baker, 2007, BSSA, vol. 97,	5A - The decision on which seismic design criteria will be used will be determined in future phases of the project. This is not necessary for this feasibility level study. 5B - We disagree with this comment, Caltrans procedure allows for near-field correction.

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		P 1486; Luco & Cornell, 2007, EqSpectra, vol. 23, p. 357; and Tothong, Cornell, and Baker, 2007, EqSpectra. vol 23, p. 867)). It is not our suggestion that these near-fault effects be used "to eliminate any zone from further consideration", but only to compare the five Zones so that some later determination of one or more preferred Zones can be made.	
6	App G.1 (LCF Comment Responses)	**LCF Comment No. 4: Selection of Field Investigation Locations Contradicts a "Route-Neutral" Approach.** Our previous comment stands. In addition, we offer the following comment: From the March 2010 geotechnical summary report (page ES- 1), we understand that "Route-neutral means that all routes receive equal attention and no route for the tunnel is favored over another." This seems to indicate that each route (synonymous with Zone) would have a distribution of data (either already existing or new exploration) that is "equal". This can reasonably be interpreted as equivalent information per mile of Zone length or per square mile of area logically tempered by the relative complexity or presence/lack of hazards with which a tunnel might contend (e.g., see Attachment 1—challenges and opportunities). In this context, we do not understand how the statement can be made that "We [Caltrans/CH2M Hill] disagree with the comment that the field exploration should be equitably distributed." This indicates that new exploration locations were not selected based upon "a due consideration for what is fair, unbiased, or impartial."	We disagree with this comment for reasons stated in the previous response.
7	App G.1 (LCF Comment Responses)	**LCF Comment No. 5: No Consideration is Given to the Effects of Liquefaction and Alluvium on Possible Ventilation and Emergency Evacuation Shafts.** Our previous comment stands. The effects of liquefaction on ventilation tunnels still need to be considered now, not at some later time in the environmental phase, so that the five Zones can be properly compared. The comparison must be done with proper consideration of ventilation tunnels, since the number and spacing vary considerably for each Zone. Many of the ventilation tunnels would potentially collapse due to liquefaction and severe earthquake shaking. Some zones will need only a few ventilation shafts, other zones will need a greater number. This information can be shown in	We disagree with this comment for reasons stated in the previous response.

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		tabular format and shown on the geologic maps. Many zones will have a two-layer case of saturated alluvium overlying soft rock for the tunnel shafts, and this should be modeled for differential seismic shaking.	
8	App G.1 (LCF Comment Responses)	**LCF Comment No. 6: California Geological Survey Groundwater Data are Not Adequately Presented.** Our previous comment stands. There is no discussion of the future timetable for when new groundwater data would be recovered from the boreholes instrumented with piezometers. There should be useful groundwater data available, particularly given the nature of the precipitation in the winter of 2009·2010.	We stand by our previous response to this comment. Monitoring of piezometers will be conducted on a periodic basis.
9	App G.1 (LCF Comment Responses)	**LCF Comment No. 7: The Draft Report Indicates a Lack of Synthesis of Subsurface Geologic Data.** Our previous comment stands. We continue to believe that a comparison of the five Zones (as stated in the purpose) cannot be completed now or later without a more thorough integration and synthesis of the geophysical profiles and data from the newly installed groundwater monitoring wells.	We disagree with this comment for reasons stated in the previous response. The data collected during this study was appropriately considered in the feasibility evaluation.

MEMORANDUM

TO: Abdi Saghafi, CalTrans

FROM: Leland C. Dolley, City of Alhambra Representative TAC & Steering Committee

DATE: December 4, 2009

SUBJECTS: Preliminary Comments and Questions on Draft SR 710 Tunnel Feasibility Study Geotechnical Report Dated October 2009

This writing is in response to CalTrans' request for preliminary comments and questions from members of the Tunnel feasibility TAC and Tunnel Feasibility Steering Committee on the above referenced study. We understand there will be additional opportunities for comments as CalTrans has placed the study and appendices in public circulation and has scheduled a series of outreach meetings and requests for comments during the first quarter of 2010. We further understand the schedule calls for release of the final document in March 2010.

Overall, we find the Study and its voluminous appendices to be extremely thorough and generally responsive to various directives regarding the scope and direction of the work. We congratulate CalTrans and the Study Team. It is welcome news to finally establish beyond a reasonable doubt that a tunnel is a technically feasible construction approach to complete the gap in the SR710. CalTrans and Metro are now in position to proceed immediately to the EIR stage of the project.

The SR710 gap closure EIR will rely heavily on this geotechnical report in assessing geologic, groundwater and seismic conditions. Because of the "route neutral" directive in the preparation of this study, it is imperative that all conclusions be based on the technical findings and that reporting in all five study zones be standardized. We offer the following comments, questions and observations to assist the Study Team in these efforts:

It appears additions to the seismic data and body of information provided by a Committee member (with appropriate references) may have been included in the draft report in such a way as to draw undue attention to these data. The result then creates an over-emphasis in one zone on potential seismic risk. We have been told repeatedly in Committee meetings, and as recently as November 18, 2009, that cost estimating based on risk is beyond the scope of this Study. However, with an overemphasis in one zone for seismic risk it is possible the risk will not be evenly or fairly assessed, resulting in an inflated cost assessment in the future.

The seismic data and findings we are commenting on begins with the chart on page ES-13 entitled "Comparison of Zones". There is a footnote (b) for Zone 3 in the column identifying "Number of Active Faults Crossing Zone". Zone 3 has the number 3 in this column (highest of all the zones).The footnote reads "Includes potentially active faults".

We note the presentations to both Committees in November included the written statement "Several inactive faults within the Zone" on each page for the five Zones but

did not say “Potentially inactive faults” for any Zone. How is it, then, that only Zone 3 has “Potentially active faults”?

Page 2 Leland C. Dolley Comments
Draft SR 710 Tunnel Feasibility Geotechnical Report dated October 2009

Page 4-11 Section 4.1.3, entitled “Geologic Structure”, identifies by name a myriad of geologic formations in the project study area and states “Active faults…are the Raymond Fault and Alhambra Wash Faults. The Eagle Rock and San Rafael faults might be active but presently are generally considered to be potentially active. A potentially active fault is defined by the state as a fault that has experienced surface displacement within roughly the last 1.6 million years”. We further note the report documents that only the Alhambra Wash and Raymond Fault are Alquist-Priolo Earthquake Fault Zones.

The remainder of Section 4 (pages 4-15 through 4-20 detail an impressive array of faults, folds, thrust belts and the like with many identifying potential movements of various types in timeframes much shorter than 1.6 million years (e.g. recurrence intervals estimated in the 340 to 1,000 years range for the Upper Elysian Park Thrust and approximately a few thousand years for activity along the Hollywood Fault.). Interestingly, pg 4-17 documents a recent seismic event, the 1994 Northridge Earthquake, and states it “occurred on a southerly dipping subsurface fault, which was unknown prior to the earthquake”.

So is it indeed only Zone 3 which has potentially active faults? Perhaps the study should include other known and suspected faults in other Zones that would be considered potentially active as it has further identified for Zone 3. Additionally, Zones at risk from faults not physically bisecting the area of the Zone perhaps should also be considered for inclusion.

We recognize local government’s discretion in seismic planning for any level of risk they deem appropriate. However, we are aware of no action that has been taken to adopt that same policy level of risk or threat assessment to the spectrum of geologic hazard in the Study area. From a policy perspective, aren’t all zones “potentially active”?

The statement in the Summary of Zone 3 page 14-2 “It appears these concerns are more extensive in Zone 3 than in either Zones 1 and 2” referring to geologic conditions seems to be out of place in a technical, factual study such as this one. We find the language curious at best and feel the sentence should be removed.

We hope the above is useful to the team in readying the Study for the final round of outreach and review and comment. We thank CalTrans and the Study Team for its constantly professional approach to this undertaking and look forward to moving the SR 710 gap completion to reality in 2010. Please feel free to contact me directly at 310 939 7160 if you have any questions.

Raveendra, Ravee/SCO

From: Chandran, C. Yoga/SCO
Sent: Thursday, December 03, 2009 11:29 AM
To: Raveendra, Ravee/SCO; Jankly, Dan/SCO
Subject: FW: SR-710 TTS - Draft Geotechnical Report Comments from LA County

Attachments: pic32581.gif

pic32581.gif (4 KB)

Please also write the responses as we enter the comments.

-----Original Message-----
From: Abdi Saghafi [mailto:abdi_saghafi@dot.ca.gov]
Sent: Wednesday, December 02, 2009 1:20 PM
To: Deborah Harris; rbarrantes@thesierragrp.com; Chandran, C. Yoga/SCO; gsilva@thesierragrp.com
Subject: Fw: SR-710 TTS - Draft Geotechnical Report Comments from LA County

FYI

----- Forwarded by Abdi Saghafi/D07/Caltrans/CAGov on 12/02/2009 10:53 AM -----

"Alam, Amir" <AALAM@dpw.lacounty.gov>		To
12/02/2009 10:47 AM	<Abdi.Saghafi@dot.ca.gov>	cc
	<nenglund@lacbos.org>, <mcano@lacbos.org>, "DeChellis, Patrick" <pdechellis@dpw.lacounty.gov>, "Afshari, Shari" <SAFSHARI@dpw.lacounty.gov>, "Maselbas, Paul" <pmaselbas@dpw.lacounty.gov>, "Rena Salcedo" <rsalcedo@gcapservices.com>, "Rebecca Barrantes" <rbarrantes@thesierragrp.com>	Subject
	SR-710 TTS - Draft Geotechnical Report Comments from LA County	

Hello Abdi,

Representing both Supervisor Molina and Supervisor Antonovich, I am submitting to you the

comments below by the County of Los Angeles on the SR-710 Tunnel Technical Study Draft Geotechnical Study Report which I discussed at our last TAC meeting on 11/5/09.

Since this geotechnical study report will be read by many non-technical people, it is important to present the findings in as clear a way as possible so that a lay person can follow along and get the most out of it.
To this end, we have the following two comments:

- The draft report currently evaluates and compares several geotechnical challenges across the five zones such as faults, formations, groundwater contamination, gaseous conditions, settlement potential, hazardous materials, etc. However, the draft report currently does not identify if these challenges are only construction related issues, long term risks of geotechnical hazard, or both. Identifying these challenges as such will help in evaluating them properly.

- The draft report currently discusses the possible mitigation measures that may be taken to address each of the geotechnical challenges identified. As engineers we know that some geotechnical challenges are easier to mitigate than others. However, the draft report currently does not discuss level of effort needed/ease of implementation for various mitigation measures, nor does it discuss the reliability/track record for the different mitigation measures. Doing so will assist in weighing the different geotechnical challenges and associated mitigation measures properly and not treating them all equally when comparing the five zones.

Please contact me if you have any questions.

Regards,
Amir M. Alam
Senior Civil Engineer
Programs Development Division
L.A. County Department of Public Works
(626) 458-3912

From: Rena Salcedo [mailto:rsalcedo@gcapservices.com]
Sent: Tuesday, December 01, 2009 11:24 AM
To: Rena Salcedo
Cc: Rebecca Barrantes; Deborah Harris; Abdi Saghafi
Subject: SR-710 TTS TAC and SC: Draft Geotechnical Report Comments Deadline Extension
Importance: High

Dear Committee Members:

Please be advised that, due to the holidays, the due date for comments on the SR-710 Tunnel Technical Study Draft Geotechnical Study Report has been extended to December 4, 2009. Although the team has received comments from several of the committee members, we would like to provide the additional time for those members who have not responded. If you do not have any comments, kindly send an e-mail stating "No Comments".

Comments may be submitted via e-mail to:
to Abdi.Saghafi@dot.ca.gov.

Or via mail to:

Abdi Saghafi- MS#2
Program and Project Management
Caltrans- District 7
100 S. Main Street, Suite 100
Los Angeles CA 90012

If you have any questions related to this matter, please contact Abdi Saghafi, Caltrans Project Manager, at (213) 897-9810 or Abdi.Saghafi@dot.ca.gov.

Thank you,

Rena Salcedo

(Embedded image moved to file: pic32581.gif)cid:625191516@27082009-1E68

SR-710 Tunnel Technical Study Team
3412 North Eastern Avenue | Los Angeles, California 90032 T 323.222.1710 F 323.222.9710 | 1-877-710-4111 | www.710tunnelstudy.info

P Please consider the environment before printing this email and/or any attachments

OFFICE OF THE MAYOR

December 9, 2009

Abdi Saghafi
MS#2 Program and Project Management
Caltrans, District 7
100 S. Main St., Ste. 100
Los Angeles, CA 90012

Dear Mr. Saghafi:

I am writing in connection with the SR-710 Tunnel Technical Study, which has now reached a draft stage for the preliminary consideration of stakeholders in this project. Recognizing how complex the evaluation of the tunnel's feasibility might be, I am pleased that this milestone has been reached.

We will be reviewing the draft report and presumably will have opportunities to present comments and questions regarding it, recognizing that it is a first step in the process of evaluating the project's feasibility. I will be conferring with the City Manager regarding how the draft report might be reviewed with our community during the first quarter of next year.

In this regard, a copy of the City's letter dated August 12, 2009 to Mr. Failing is attached. It refers to our understanding that additional work will be done to complete the route feasibility review.

When convenient, would you advise what steps will be taken during the next year or two in regard to the tunnel feasibility effort, when the final report might become available, and when the additional studies (as mentioned in the letter to Mr. Failing) will get underway. One of the important questions in this regard is the qualifications of the parties conducting such studies and how they will be selected and paid.

We appreciate your keeping in touch with us in Pasadena regarding this matter. When complete information becomes available in the future, the City will consider its view on any project. Please let us know if we can be helpful in any way.

Sincerely,

BILL BOGAARD
Mayor

BB:jls

enclosure

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SOUTHERN CALIFORNIA

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November 18, 2009

Abdi Saghafi
Project Manager
Caltrans District 7
100 S. Main St., Suite 100
Los Angeles, CA 90012-3606

RE: Draft Geotechnical Summary Report, SR-710 Tunnel Technical Study

Dear Mr. Saghafi,

Thank you for the opportunity to submit comments on the Draft Geotechnical Summary Report, SR-710 Tunnel Technical Study. Our comments are as follows:

Section 1.2.1 Previous Caltrans Evaluations, Page 1-4

Discussion of SCAG does not belong in a section entitled "Previous Caltrans Evaluations." At a minimum, this section should include discussion of the previous EIS prepared by Caltrans in 1992 and updated in 1998.

Discussion of the I-710 project in relation to SCAG could be included more appropriately as part of a regional transportation planning context. To that end, it would be appropriate to state that SCAG includes the I-710 extension as a tunnel in its adopted 2008 Regional Transportation Plan as part of a comprehensive, regional, multi-modal, and multi-billion dollar package of transportation improvements through 2035 that will help meet the region's long-term mobility and air quality goals. It would also be appropriate to state that the voter-approved Measure R sales tax in Los Angeles County includes the I-710 extension, and that Metro's recently adopted Long-Range Transportation Plan also includes the I-710 extension.

Section 3.1 General, Page 3-1

Please clarify the statement, "The locations of the borings and geophysical surveys were selected based on the site reconnaissance and review of available geotechnical and geological information." More information should be provided to clarify the following:

- The exact criteria used to identify and select potential locations for borings;
- The limitations on the number of borings that could be performed and the reasons for such limitations;
- The dramatic variation by zone of the number of borings, either available from previous studies or conducted for the current study; and
- Why this variation does or does not impact the conclusions drawn from the analysis.

If you have any follow-up questions on these comments, please contact Philip Law at 213-236-1841.

Sincerely,

Naresh Amatya
Manager, Transportation Planning & Programming

San Gabriel Valley Council of Governments

3452 East Foothill, Suite 910, Pasadena, California 91107-3142 Phone: (626) 564-9702 FAX: (626) 564-1116 E-Mail SGV@sgvcog.org

November 20, 2009

Mr. Douglas R. Failing, Executive Director of Highway Programs
Metropolitan Transportation Authority (Metro)
C/O: State Route 710 Tunnel Study Community Information Office
3412 North Eastern Avenue
Los Angeles, CA 90032

Dear Mr. Failing:

On behalf of the San Gabriel Valley Council of Governments (SGVCOG), I would like to express our Agency's appreciation for the effort of you and the consultant on drafting this report, which embraces the directives and principles identified in the enabling legislation.

Upon reviewing the draft report, the SGVCOG's only recommendation is that in the discussion of the geotechnical conditions that may cause challenges (i.e. ground stability, uniformity of conditions, natural gas potential, active faults, and soil/groundwater contamination), the report indicate which conditions primarily cause construction issues and which conditions may impact long-term operation of a tunnel. Additionally, it would be useful to include some information regarding the cost of the various methodologies and equipment discussed in Section 12 that has been developed to overcome various geotechnical challenges.

With regards to public outreach, the SGVCOG would like to request that two additional community meetings be held, one each in Zones 4 and 5. It is our concern that residents in these communities may not be aware that their communities are being considered as possible routes for the 710 gap closure.

Thank you again for your leadership and the efforts of Caltrans and Metro on this study. Should you have any questions or wish to discuss this further, please contact me at (626) 564-9702.

Sincerely,

Nicholas T. Conway
Executive Director

Cc: Robert Urteaga, Montebello

November 30, 2009

VIA E-MAIL AND U.S. MAIL

California Department of Transportation, District 7
c/o
Mr. Abdi Saghafi
Project Manager, SR 710 Tunnel Technical Study
100 S. Main Street, Suite 100
Los Angeles, CA 90012-3606

Re: **City of La Cañada Flintridge's Comments and Objections**
Caltrans Draft Geotechnical Summary Report
SR-710 Tunnel Technical Study, Los Angeles County, California

Dear Mr. Saghafi:

GENERAL COMMENTS

An initial review on behalf of the City of La Cañada Flintridge1 was completed of the "Draft Geotechnical Summary Report SR-710 Tunnel Technical Study Los Angeles County, California, prepared for the California Department of Transportation by CH2M HILL, October 2009, Volume I of V." All volumes are listed in Table 1 below. The focus of the review was on Volume I with some review of portions of the support information in Volumes II through V.

Table 1: Caltrans Draft Geotechnical Report Volumes (Approximately 12,994 Pages)

PAGES	VOLUME	TITLE
185 pages	Volume I	Draft Geotechnical Summary Report, SR710 Tunnel Technical Study
956 pages + 1,468 photographs	Volume II	Appendix A - Boring Logs
		Appendix B - Groundwater Monitoring Data
1,219 pages	Volume III	Appendix C - Geophysical Investigation Data
1,339 pages	Volume IV	Appendix D - In Situ Test Results
		Appendix E - Laboratory Test Results
7,827 pages	Volume V	Appendix F - Environmental Site Assessment

1 Review performed by Robert H. Sydnor, Certified Engineering Geologist (CEG) 968 and Certified Hydrogeologist (CHG) 6, and Kenneth L. Wilson, CEG 928.

The engineering geology and seismology review comments are presented in five sections followed by a SUMMARY AND CONCLUSIONS section. In general:

- Volume I shows a lack of complete analysis and integration of the large amount of geology and geophysical data and information presented in Volumes II through V, suggesting that with additional time and effort, a more robust and realistic comparison of the five Zones could be provided.

- Several additional relevant technical and physical factors could have been used to compare the five Zones in order to allow for a more accurate and insightful analysis within the future, yet undefined, process that would be used to determine the preferred tunnel Zone subject of the required California Environmental Quality Act (CEQA) Environmental Impact Report (EIR).

- The concept of "Route Neutrality" requires that new, project-specific field investigations be equitably distributed among the five Zones. However, the decision process used to assure such a distribution is not explained. For example, why were such a high percentage of new borings, hydrologic monitoring wells, and geophysical survey locations placed in Zone 3 (the shortest Zone) as opposed to, for example, Zone 5 (the longest Zone)?

SPECIFIC COMMENTS

LCF Comment No. 1: Caltrans has not Fully Evaluated the Effects of Active Faulting in the Tunnel Zone Comparisons.

All five tunnel Zones are crossed by faults. All Zones, except Zone 1, are crossed by active or potentially active faults, and several zones are crossed by multiple active or potentially active faults. Although not stated in the report, the potentially active faults (*e.g.,* the San Rafael, the Eagle Rock, and the Highland Park faults) should be considered active for the purposes of evaluating tunnel fault crossings.

As an example, the Highland Park fault is considered not active in the Draft Report (see section 8.4 Faulting), but little previous engineering geologic information had been developed along the fault where it is covered by young alluvium. Where the Highland Park fault is crossed by seismic reflection line Z3-G6, there seems to be a clear indication that the interpreted buried bedrock surface is offset between stations 700 and 900 (distances along the line in feet) based on the termination of the very clear reflector south of station 750. This offset also appears to extend into the overlying alluvium where reflector continuity appears to be affected (reflectors appear truncated, folded, and arched) in this interval (see Figure 1 below). This seems to be an example

of the lack of time for complete analysis of the geophysical data by Certified Engineering Geologists (CEG) to bring a geologic perspective to this important data. Such reinterpretation of all seismic reflection profile lines must be conducted by a CEG and properly documented before the Final Report is prepared.

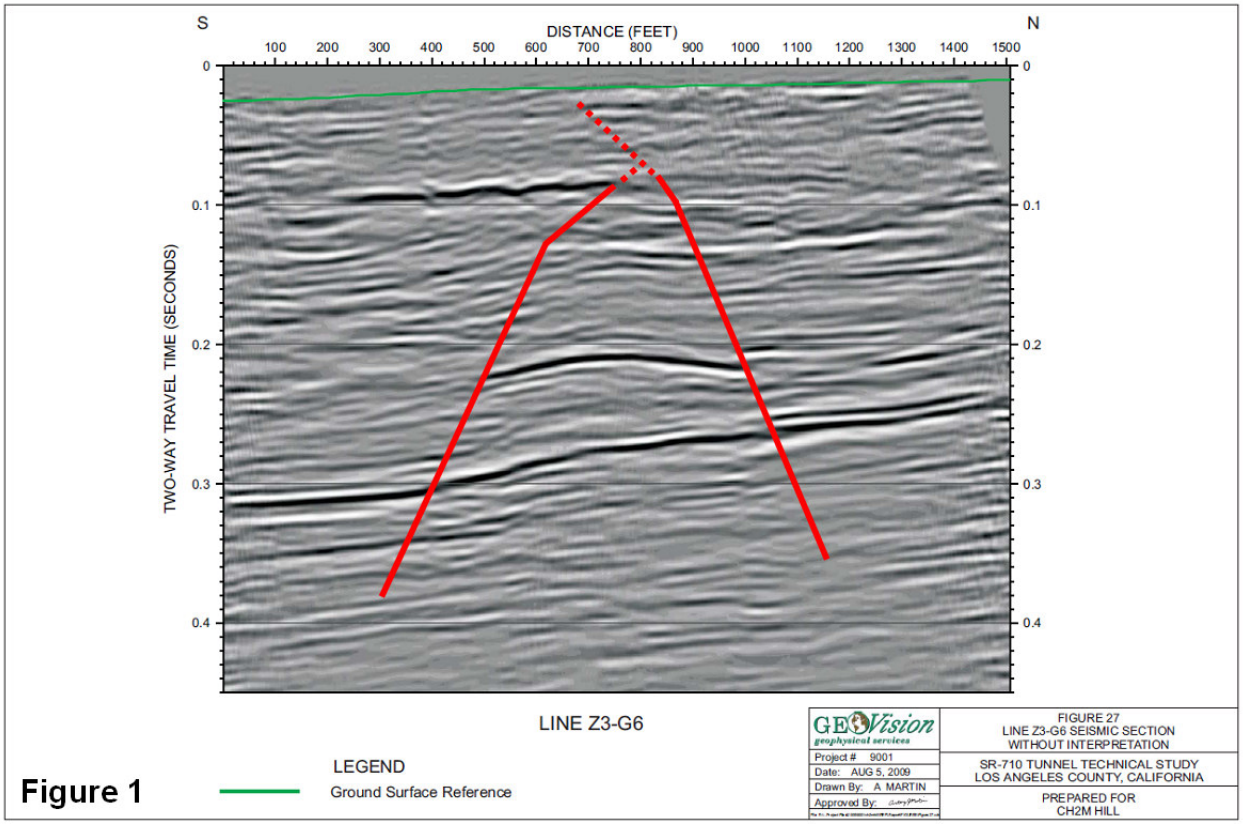


Figure 1

The Draft Report takes the position that Caltrans can design a tunnel (for example, oversized vaults and segmental tunnel lining as outlined in the November 6, 2009 TAC PowerPoint presentation) that will accommodate ruptures associated with crossing active faults. However, Caltrans does not discuss potential earthquake displacement risk to the tunnel structure and to tunnel occupants as compared to a tunnel without active faults. In addition, no examples are presented where these designs have been used and have successfully prevented tunnel damage from fault rupture.

Mr. Bruce Schell, engineering geologist, stated at the November 6, 2009 TAC meeting that tunnel crossings by active faults are one of the most critical concerns faced within the five Zones. Yet it seems that no attempt has been made (see, for example, subsection 13.1.3 Faulting and Seismicity, Table 13-1, and section 14) to factor this concern into the Zone comparisons by discussing and considering relative risk related to allocation of design and construction resources, to tunneling safety, to potential tunnel repairs, and to ultimate user safety.

The methodology used in the Draft Report to determine the size of these potential

earthquake fault movements on the Raymond fault for a magnitude 6.7 earthquake yielded a maximum estimate of 4 feet (see subsection 4.2.1 Raymond Fault). Yet according to the Caltrans tunneling expert at the November 6, 2009 TAC meeting, the Metro Red Line tunnel crossing the Hollywood fault (assuming a lower magnitude 6.4 earthquake) yielded a 6.5-foot design offset. From the 1971 magnitude 6.6 San Fernando-Sylmar earthquake we know that at least 6.23-feet (1.9 meters) of left-lateral offset and 3.5-feet (1.07 meters) of vertical offset occurred. Therefore, detailed explanation of the lesser estimated offset on the Raymond fault for a larger earthquake should be explained and calculated with reference to the two cases mentioned above.

In the aftermath of the 1992 Landers Earthquake, with about 4 meters of surface displacement, new formulas have been developed in the past decade by geologists and seismologists for evaluation of fault displacement. The Caltrans Draft Report needs to utilize current formulas that are documented in recently published seismology journals. Besides left-lateral displacement on the Raymond fault, the Certified Engineering Geologists need to also consider the vertical-oblique component of the dipping fault plane, thus geometrically evaluating the total fault displacement (net slip). The fault displacement should be stated as the mean value plus one and two standard deviations (+1 sigma and +2 sigma).

Knowing that each of the tunnel Zones has unique fault crossing conditions as outlined above, it seems sensible to compare not only the "average" Zone geologic cross-section delineating fault crossings for each Zone (Plates 5 through 9), but to compare the Zones based on the potential for final tunnel Zone selection to implement an "active fault-avoidance" strategy. This comparison would allow decision-makers to consider this potential to avoid risks (including contaminated soil/groundwater and active faults) when implementing the as yet undefined process that will be used to determine the preferred Zone subject of the required EIR.

LCF Comment No. 2: Caltrans' Earthquake Ground Motion Considerations are Overly Simplistic for the Tunnel Zone Comparisons.

Strong-motion seismology is treated in an overly simplistic manner and renders tunnel Zone comparisons deficient in this report (refer to page 4-18 subsection 4.3.2 Seismic Design Parameters). The earthquake ground motion peak ground acceleration contours (shown on Figure 4-9) are predicated on an unpublished 2007 internal Caltrans report (Merriam and Schantz, 2007) that has not been subjected to peer review and the associated map states that it "is for illustrative purposes to aid in determining the controlling fault" and does not incorporate site correction factors such as soil amplification and near-fault factors. Figure 4-9 wrongly treats all five zones as a hypothetical uniform slab-of-rock (Shear Wave Velocity = 760 meters/second) when all of the five tunnel Zones would be in both soft alluvium and rock. There are different seismology formulas for rock, soft rock, and stiff soil.

Instead of an over-simplified and inappropriate contour map of ground motion, it is advisable to have a table of ground motions for each of the five zones, with multiple Zone segments classified based on changes in generalized lithology (soil and soft rock) along the axis of the generalized tunnel cross-sections shown in Plates 5 through 9. Using the deterministic peak ground acceleration values in Figure 4-9 very likely, and unnecessarily, yields values at some locations that are too high and at other locations far too low.

Caltrans should use seismologic and active fault information from the consensus CGS-USGS-SCEC statewide model for California, which seems to have been considered by Schantz and Merriam (2009). Although we are uncertain as to the full background and peer review that is associated with the Caltrans ARS website, an approach similar to what is displayed there seems to apply more up-to-date seismology methods and should be applied to the comparison of the five tunnel Zones in the Draft Report.

The tunnel Zone comparisons should be based on modern (post- February 2008) seismology formulas. These were substantially changed with the Next Generation Attenuation of Ground Motion Attenuation Models (NGA), a five-year national project involving teams of seismologists and geologists. Brian S.J. Chiou, Ph.D. Senior Seismologist in the Division of Research and Innovation, California Department of Transportation, was a co-author of the NGA Project.

In addition, the Caltrans Draft report does not indicate what level of earthquake ground motion would be used for tunnel design; this would provide some benchmark for the tunnel Zone comparison. Will the 710 Tunnel be designed for 2 percent chance of exceedance in 50 years (the Maximum Considered Earthquake ground motion), or the less conservative 5 percent chance of exceedance in 50 years as shown on the Caltrans ARS website? Based on the relative importance of structures, different levels of ground-motion are considered. Since the ground motion may vary significantly among the five tunnel Zones, the ground motion differences need to be fully explained in the Draft Report.

LCF Comment No. 3: Near-Fault Ground Motion Effects are Improperly Omitted from Tunnel Zone Comparisons.

Earthquake ground motion is known to be significantly higher immediately adjacent to a rupturing fault, but near-field effects are not considered in the October 2009 Caltrans Draft Report. Near-field effects (see also Comment No. 2) need to be evaluated for all of the active faults crossing the various tunnel Zones as part of the tunnel comparison process. Near-field effects include important parameters. These should have separate line items in ground motion

comparison tables within the Draft Report that would subsequently be used for any preferred tunnel Zone selection process.

Following the 1992 Landers Earthquake, seismologists discovered in data recorded by strong-motion accelerometers that the near-field along the rupturing fault plane could have severe high-velocity pulses. Dozens of seismology publications since 1992 have evaluated fling-step and forward-directivity effects in the near-field, in addition to conventional analysis of peak ground acceleration (PGA).

The Caltrans Draft Report does not evaluate near-field effects (especially forward-directivity and high-velocity pulses) along the plane of the Raymond fault. The dip of the fault plane and the rake of the slip vector are parameters that influence near-field seismology. The seismologic and engineering implications of near-field effects must be considered now in the tunnel Zone comparison process and cannot wait until "later" at the design stage; it is a necessary and essential parameter that must be incorporated into the Draft Report now.

LCF Comment No. 4: Selection of Field Investigation Locations Contradicts a "Route-Neutral" Approach.

Route neutrality requires that new, project-specific field investigations be equitably distributed among the five Zones, ideally 20 percent in each Zone with modification based on Zone length. Field investigations developed a large amount of new field data using techniques representing the advanced state of current professional practice. About 35 percent of the new field studies were in Zone 3, the shortest of the Zones. About 11 percent each were in Zones 4 and 5, the longest Zones. Fifty percent of the new borings were in Zone 3 and 32 percent of the new geophysical profiles were in Zone 3.

The decision process used to assure that the field investigation program activity distribution was equitable is not explained. For example, previous borings in Zones 4 and 5 are almost entirely groundwater production or groundwater monitoring wells with no information on geologic contacts and logs without geotechnical and engineering geology descriptors for the units encountered. By contrast, Zone 3 has approximately 20 previous geotechnical borings located proximal to the central portion of the Zone, all with geotechnical descriptions, laboratory test results, and field drilling/sampling information to evaluate material strength. New geophysical seismic reflection lines were limited to a total of four in Zones 4 and 5, while Zone 2 had four and Zone 3 had six seismic reflection lines.

Regarding new continuous core borings drilled for this project, Zone 5 had none, Zone 4 had two, and Zone 3 had 12. As indicated above, it does not appear that the quality of existing

data in Zones 4 and 5 (the longest Zones) was so good such that supplementation with current advanced techniques was not required. Conversely, there was a comparative abundance of previous geotechnical borings in Zone 3 (the shortest Zone) suggesting fewer new borings would be needed. In the November 6, 2009 TAC meeting, it was suggested that there are a greater number of potential problems and/or a greater geologic variability in Zone 3 versus Zones 4 and 5. If so, this must be explained in the report to verify that route neutrality was truly considered when the field investigation program was established.

LCF Comment No. 5: No Consideration is Given to the Effects of Liquefaction and Alluvium on Possible Ventilation and Emergency Evacuation Shafts.

Geologic and geotechnical information about potential ventilation (or other) shafts is lacking in the reports. In the TAC meeting of November 5, 2009, it was stated by Caltrans that the only ventilation would be along the axis of the tunnel bore(s). For tunnels approximately 5 to 8 miles long, this may be a vulnerable and unsafe design for which no justification has been presented.

Most long vehicular tunnels (for example the Calle 30 Tunnel in Madrid referred to in subsection 12.2.2.1) need ventilation (exhaust from vehicles & intake of fresh air) typically about every half-mile. However, the ventilation design is further predicated on the relative potential for fault rupture closing the tunnel immediately after a large earthquake. Direct fault rupture could essentially choke-off the suggested axial ventilation system concurrent with fire in the tunnel (for example from vehicle fuel tanks). Firefighters and emergency services workers approaching from both directions would need fresh air should this vehicular tunnel collapse locally where ruptured along the fault plane. Ventilation shafts can also serve as emergency exits for trapped motorists in the event of an earthquake or massive traffic accident. Seismic safety and redundancy are vital for any of the five tunnel ventilation systems. This critical issue is inadequately addressed in the Draft report.

The effects of seismically induced liquefaction are not evaluated for the ventilation or emergency shafts for the five tunnel Zones. In many cases, the tunnel would be in sedimentary rock (approximately 200 feet below the ground surface), while the vertical ventilation shafts would necessarily be located in soft, saturated alluvium that is vulnerable to liquefaction. The integrity of the shafts, as with portals, during a severe local earthquake need to be evaluated for adverse effects of shallow groundwater and liquefaction. In the Draft Report, there is no description of ventilation shafts. Specific, empirical data are needed (e.g., spacing, diameters, ductility of materials).

Caltrans needs to evaluate seismic impedance for a two-layer case when the vertical shaft is in both soft, saturated alluvium (above) and firm sedimentary rock (below). The earthquake ground motion is very different for a two-layer case.

LCF Comment No. 6: California Geological Survey Groundwater Data are Not Adequately Presented.

Caltrans has not provided consistent hydrogeology maps with contours showing the shallow groundwater or perched water conditions. Appendix B Groundwater is only two pages long and provides little useful data. The California Geological Survey (CGS; Plate 1.2 in each report) has carefully compiled historically highest groundwater levels (depth contours) for each of the 1:24,000 quadrangles in the study area. This was done as part of the Seismic Hazard Mapping Program to assess liquefaction potential in the Pasadena, Los Angeles, El Monte, and Mount Wilson quadrangles. Groundwater elevation contours are plotted, yet the published CGS Seismic Hazard Report depth contours were largely ignored.

LCF Comment No. 7: The Draft Report Indicates a Lack of Synthesis of Subsurface Geologic Data.

Caltrans and its consultants have amassed a large quantity of data as presented in the approximately 12,994 Draft Report pages. However, the subsurface geologic information is poorly integrated and synthesized. The raw data from the geophysical profiles have not been adequately interpreted and considered in the detailed representative geologic cross-sections along the five potential tunnel Zones. There is no data as yet from the newly installed groundwater monitoring wells. There are internal inconsistencies and minimal effort at an over-arching synthesis. Caltrans should take additional time and analysis effort to better evaluate and understand thee subsurface geologic data compilation.

SUMMARY AND CONCLUSIONS

- Caltrans "route-neutral" evaluation has most new boreholes (48%), most geophysical profiles (32%), most hydrogeology monitoring wells (50%), and therefore, most new field studies (35%), in Zone 3. This does not reflect a route neutral approach.

- Despite the large quantity of data, additional review by engineering geologists is necessary to synthesize and integrate the drilling, geophysical, and hydrogeology information to obtain an adequate comparison of Zone characteristics.

- Earthquake fault-rupture through the tunnel requires more explanation regarding the level of certainty related to design risks and regarding the methodology used to substantiate the suggested 2- to 4-foot displacement on the Raymond fault (Zones 2, 3 and 4). Implications of a fault-avoidance strategy must be examined and emphasized in the Zone comparisons.

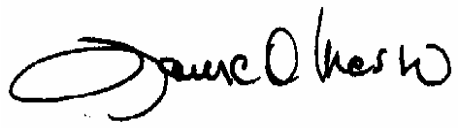
- Earthquake design analysis is deficient using only the deterministic peak ground acceleration (PGA) from the Caltrans 2007 map, which models the entire subgrade as rock rather than considering the areas of thick alluvium with different seismic response properties. Modern seismology attenuation relationships must be considered and applied to the Zone comparisons. The design level of earthquake ground motion needs to be stated as a benchmark for Zone comparison and defined as a relative importance factor (for example, 2 percent exceedance in 50 years or 5 percent exceedance in 50 years) for the proposed vehicular tunnel.

- Near-fault earthquake ground motion is significantly higher immediately adjacent to the rupturing fault and factors such as fling-step, forward-directivity, and large velocity pulses must be considered in the Zone comparison process, particularly for the active Raymond fault, which crosses several Zones (2, 3 and 4).

- Effects of seismically induced liquefaction on ventilation or emergency evacuation shafts in alluvium, of shallow and perched water conditions on tunnel flooding, and of methane gas must be more fully addressed.

Please contact us with any questions or comments. Thank you.

Sincerely,



Laura Olhasso,
Mayor

c: City Council
Robert Silverstein, Special Counsel
Kenneth Wilson, Geologist
Robert Sydnor, Geologist
Ann Wilson, Senior Management Analyst

March 30, 2010

VIA E-MAIL AND U.S. MAIL

Mr. Abdi Saghafi, Project Manager
California Department of Transportation
100 South Main Street
Los Angeles, CA 90012

SUBJECT: City of La Canada Flintridge Review Comments on: (1) Selected Portions of the "Caltrans Draft Final Geotechnical Summary Report SR-710 Tunnel Technical Study, Los Angeles County, California"; and (2) Appendix G.1 – TAC and SC Comments: Responses to La Cañada Flintridge Comments1

Dear Mr. Saghafi:

INTRODUCTION:

The City of La Cañada Flintridge (LCF) respectfully submits these additional comments and objections regarding the proposed SR-710 Tunnel project.

A review was completed of: (1) selected portions of the "Draft Final Geotechnical Summary Report SR-710 Tunnel Technical Study Los Angeles County, California, prepared for the California Department of Transportation by CH2M HILL, March 2010, Volume I of V"; and (2) the Caltrans/CH2M HILL/BS/SK responses to La Cañada Flintridge (LCF) comments (Appendix G.1 – TAC and SC Comments) on the October 2009 draft geotechnical summary report. The focus of the "Draft Final" report review was on Volume I, Attachments 1 and 2 with a cursory review of other sections of the report related to these attachments.

Following this introduction, the engineering geology and seismology review comments are presented in three sections: (1) GENERAL COMMENTS OF MARCH 2010 VOLUME 1; (2) COMMENTS ON CALTRANS RESPONSES IN APPENDIX G.1; and (3) GEOLOGY AND SEISMOLOGY REFERENCES.

GENERAL COMMENTS OF MARCH 2010 VOLUME 1:

We reiterate that Volume I indicates a lack of complete analysis and integration of the large amount of geology data, geophysical data, and other information presented in Volumes II through V, suggesting that with additional time and effort, a more robust and realistic comparison of the five SR-710 tunnel Zones would be possible.

---

1 Robert H. Sydnor, Certified Engineering Geologist (CEG) 968 and Certified Hydrogeologist (CHG) 6, and Kenneth L. Wilson, CEG 928.

We continue to believe that several additional relevant technical and physical factors should have been used to assess geotechnical feasibility and to compare the five tunnel Zones, for example, liquefaction susceptibility for tunnel ventilation shafts, updated ground-motion values, and near-fault ground-motion effects.

In our opinion, new Table 13-2 on page 13-8, Summary of Significance of Geotechnical Conditions by Zone, is inadequate in its present form with respect to Zone comparisons for Active/Potentially Active Fault Crossings. It is not suitable based on its conflict with both known legally zoned active faults (*e.g.*, the Raymond and Alhambra Wash faults) and with the text of the SR-710 Tunnel report, which discusses potentially active fault crossings. We recommend that an additional column be added to Table 13-2 (*eight* columns total) and the two suggested fault columns be moved to columns 2 and 3. Holocene-Active Fault Crossings mapped at the surface should to be separated from Potentially Active Fault Crossings, which would include blind-thrust faults, such as the Elysian Park Anticline and lesser-known faults such as the San Rafael, Eagle Rock, and Highland Park faults.

Zone Number	**Holocene-Active Fault Crossing**	**Potentially Active Fault Crossing**
1	Low No mapped active faults; refer to Executive Summar ES-6 and Table 13-1.	Low About five inactive faults will be encountered; there is uncertainty about their relative activity. Refer to Exec Summary, page ES-6
2	Low to Moderate The Raymond fault crosses the corner of the northw end, but depending on final SR-710 alignment, it co above-grade, and not in a tunnel. Refer to Executiv Summary, page ES-7 and Table 13-1.	Low to Moderate About seven inactive faults will be encountered; there uncertainty about their relative activity. See Table 13-
3	High Raymond fault legally zoned under the Alquist-Prio Fault displacement needs to be probabilistically con with 1σ and 2σ error bars assuming an ≈Mw6.7 eart A total of two active faults cross Zone 3 according t Table 13-1.	Moderate to High In addition to the known active Raymond fault, the Sa and Eagle Rock faults are potentially active. A total o faults cross Zone 3 according to Table 13-1.
4	Moderate The active Raymond fault crosses the northern part, it may not be in a tunnel (depending on the final alig Refer to Executive Summary, page ES-8 and Table	Moderate Five faults cross Zone 4, but they are buried in young so it is difficult to assess their relative activity. See Ex Summary, page ES-8 and Table 13-1
5	Low to Moderate The Alhambra Wash fault, legally zoned under the A Priolo Act, is one active fault whose activity is not v known within the project area.	Low to Moderate The inactive Workman Hill fault projects into Zone 5 are a total of 3 faults. Insights from the 1986 Whittier Earthquake lead geologists and seismologists to be un about the location of blind thrust faults in this zone.

There remains no clearly articulated process that will allow a more accurate analysis to determine the preferred tunnel Zone subject of the required California Environmental Quality Act (CEQA) Environmental Impact Report (EIR). The use of the 2007 Caltrans Project Risk Management Handbook is not appropriate for tunnels with acute geologic hazards (see below).

The route-neutral requirement as stated on page ES-1 "means that all routes receive equal attention and no route for the tunnel is favored over another," indicating that project-specific field investigations should be equitably distributed among the five tunnel Zones. Although some general language was added to Section 3.1, there remains no description of the criteria used to allocate resources among the five Zones. For example, how was it determined that such a high percentage of new/existing borings, hydrologic monitoring wells, and geophysical survey locations were placed in Zone 3 (the shortest Zone) as opposed to say Zone 5 (the longest Zone).

Comments more specifically to Attachment 1 are:

a. The Caltrans Project Risk Management Handbook (second edition, May 2007) is well written as a general construction policy manual and should have been modified for use with the proposed project some years ago. However, it applies to building highways and bridges, not deep large-diameter tunnels with non-routine potential impacts from a range of geologic hazards (*e.g.,* active faults, gassy conditions, unstable ground, and liquefaction). It is not appropriate for use on this project at this intermediate study phase.
b. Tunnels are not discussed in this statewide policy manual, which is focused on highways and short bridges.
c. There is no clear explanation of the numerical ratings for the potential for Active and Potentially Active Fault Crossings that led to characterizing all five tunnel Zones as "Low". This seems improbable considering the situation with no such faults in Zone 1 and three such faults in Zone 3. In addition, the use of a 3300-year recurrence interval for the Raymond fault seems inappropriate when Weaver and Dolan (2000) indicate that the last significant earthquake occurred ~1000 to 2000 years ago. This suggests that 2000 years may have expired and 1300 years remain, thereby changing the Probability of Rupture to 8%.

COMMENTS ON CALTRANS RESPONSES IN APPENDIX G.1:

Please refer to Appendix G.1 for the LCF comments on the October 2009 Draft report and the corresponding Caltrans/CH2M HILL/BS/SK responses. What follows are comments on the Caltrans/CH2M HILL/BS/SK responses listed by LCF original comment headings.

LCF Comment No. 1: Caltrans has not Fully Evaluated the Effects of Active Faulting in the Tunnel Zone Comparisons

Our original comment stands. In order to comply with one of the stated purposes of the geotechnical study (page ES-1: "this information [geologic, groundwater, and seismic conditions] provides a basis for a comparison of the study zones with respect to tunneling"), the potential magnitude and slip direction(s) of surface faulting on the Raymond fault need to be fully evaluated at this current phase of work, not at some unspecified later date, *e.g.* during the environmental phase or "the detailed design stage" (page 4-13).

We believe there are several technical and/or program inconsistencies apparent in the responses and Volume 1. Examples include:
Weaver and Dolan (2000) are referenced as a primary source for information on the Raymond fault, yet several conclusions reached by Weaver and Dolan are not integrated into the analysis, such as: (a) evidence for substantial vertical displacement in trench exposures that contradicts the 15:1 h:v ratio from one focal mechanism; (b) the possible connection between the Raymond and Hollywood faults yielding several meters of displacement in a magnitude 7 event; and (c) the application to the Attachment 1 analysis of the fact that the last surface displacement occurred ~1000-2000 years ago.

In Section 10.4, page 10-3, it states that ..."the main branch of the Raymond fault is approximately several hundred feet wide." Yet on Plate 8, the fault zone could be locally as wide as 3,000 feet (which we agree may be the case). However, Figure 3 of Attachment 2 (the Dubnewych & Matthei report dated March 10, 2010) is a simplistic diagram for fault crossing that indicates one fault plane with no "fault zone" width. Again, only horizontal displacement is considered, with no recognition that the Raymond fault also has demonstrated a vertical component of movement.

It is stated that "Known active faults and potentially active faults, *as recognized by regulators* [emphasis added], are addressed in the report." This narrow focus seems to: (a) remove the incentive to consider carefully the possibility that poorly studied faults (*e.g.,* the Highland Park fault) may show evidence for displacements in alluvium; and (b) concedes that regulators rather than practicing engineering geologists set the standard for the level of investigation.

The exercise attempted in Attachment 1 suggests that the statement "Fault avoidance, risk, and cost are beyond our scope" is no longer true, since schedule and cost risk form the basis of the Caltrans risk management plan and cost as mentioned throughout Attachment 1. In addition, consideration of an "active fault-avoidance" strategy in the Zone comparison process would allow decision-makers to weigh the advantages of avoiding these potential risks when implementing the yet undefined process that will be used to determine the preferred Zone subject of the required EIR.

It is stated, "The state of the art in tunnel design is such that displacements along active faults ... can be accommodated in design." We understand that tunnel boring machines can advance a large-diameter adit and that oversized vaults can be excavated. However, none of the active fault-crossing remediation strategies is known to have survived actual earthquake fault displacements.

In addition to incorporating all of the information from Weaver and Dolan (2000), we suggest that the consultants consider Youngs and others, 2003, *EERI Earthquake Spectra*, vol. 19, and Kase (2010), to evaluate the probabilistic fault displacement.2

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2 (1) Youngs, Robert R., Arabasz, W.J., Anderson, R.E., Ramelli, A.R., Ake, J.P., Slemmons, D.B., McCalpin, J.P., Doser, D.I., Fridrich, C.J., Swan, F.H.III, Rogers, A.M., Yount, J.C., Anderson, L.W., Smith, K.D., Bruhn, R.L., Knuepfer, P.LK., Smith, R.B., dePolo, C.M., O'Leary, D.W., Coppersmith, K.J., Pezzopane, S.K., Schwartz, D.P., Whitney, J.W., Olig, S.S., and Toro, Gabriel R., 2003,

LCF Comment No. 2: Caltrans Earthquake Ground Motion Considerations are Overly Simplistic for the Tunnel Zone Comparisons

Our original comment stands. In addition, we offer the following comments:

Earthquake ground-motion needs to be computed for each of the five tunnel Zones using modern (February 2008 attenuation formulas published in *EERI Earthquake Spectra*) and based on actual geologic subgrade, alluvium or soft rock, often in a two-layer case. Near-field ground-motion effects should also be considered at this time. These considerations should not be made in a later phase of work since they are instrumental in understanding the differences in Zone performance, including potential liquefaction related to ventilation shafts. The tunnel zone comparisons cannot go forward using the 2007 Merriam and Schantz report (reference is made to Figure 4-9 and Section 4.3.2). The CGS-USGS-SCEC statewide fault model should be used, along with the *actual* geologic subgrade of each tunnel Zone (*e.g.*, alluvium and soft rock).

We believe it would be appropriate to have a written statement from Dr. Brian Chiou, Caltrans seismologist that indicates his level of involvement in selecting the ground motion analysis methods used in the March 2010 report.

We find it difficult to reconcile statements that: (a) "To suggest that the methods are too simplistic and not in accordance with modern seismic design procedures is not true"; and (b) "However, we agree that the procedure of comparing ground motion contours from the most recent Caltrans maps is simple, but it is also very convenient for use in this phase of an investigation." We also do not believe that the geotechnical feasibility determination and the comparison of the five Zones should be based on finding "simple" and "convenient" procedures. Procedures should be rigorous and based on vetted geologic and seismologic information from published national journals, such as EERI *Earthquake Spectra* and the Bulletin of the Seismological Society of America. When lives the public health, safety and welfare, and billions of dollars of public funds are at stake, "simple" and "convenient" procedures are particularly inappropriate and irresponsible.

LCF Comment No. 3: Near-Fault Ground Motion Effects are Improperly Omitted from Tunnel Zone Comparisons

Our previous comment stands. In addition, we offer the following comments:

Caltrans and its consultants have still not specified the level of earthquake ground motion that will be used for tunnel design in any of the five zones. Is it the Maximum Considered Earthquake, 2 percent chance of exceedence in 50 years? Is it a much less conservative 5 percent chance of exceedence in 50 years, as shown on the Caltrans ARS website? Since this would affect the comparison of the five Zones,

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S.S., and Toro, Gabriel R., 2003, A methodology for probabilistic displacement hazard analysis (PFDHA): EERI *Earthquake Spectra*, vol. 19, no. 1, p. 191–219. (2) Kase, Y., 2010, Slip-length scaling law for strike-slip multiple segment earthquakes based on dynamic rupture simulations: *Bulletin of the Seismological Society of America*, vol. 100, no. 2, p. 473-481.

affect the comparison of the five Zones, a stated purpose of the investigation, this question needs to be firmly answered at this stage, not at some undefined time in the future. Reference is made to ASCE Standard 7-10, Minimum Design Loads for Buildings and other Structures, 2010 edition, which will be incorporated into the California Building Code, Title 24. The new 2010 edition specifies the MCE (2% in 50 years) level of earthquake ground-motion, and there is a new Risk-Targeted Spectral Response Acceleration for important structures with a 1 percent chance in 50 years. Refer to SSA *Seismological Research Letters*, vol. 81, no. 2, page 284, for six abstracts on ASCE Standard 7-10.

We do not agree that the "Near-field effects are incorporated into the Caltrans seismic design methods" that have been used in the March 2010 geotechnical report. The specific published formulas (author and date) must be cited. There is substantial consensus within the seismic design community as to how to handle these effects as demonstrated by numerous studies (e.g., Baker, 2007, BSSA, vol. 97, p 1486; Luco & Cornell, 2007, EqSpectra, vol. 23, p. 357; and Tothong, Cornell, and Baker, 2007, EqSpectra, vol 23, p. 867)). It is not our suggestion that these near-fault affects be used "to eliminate any zone from further consideration", but only to compare the five Zones so that some later determination of one or more preferred Zones can be made.

LCF Comment No. 4: Selection of Field Investigation Locations Seem to Contradict a Route-Neutral Approach

Our previous comment stands. In addition, we offer the following comment:

From the March 2010 geotechnical summary report (page ES-1), we understand that "Route-neutral means that all routes receive equal attention and no route for the tunnel is favored over another." This seems to indicate that each route (synonymous with Zone) would have a distribution of data (either already existing or new exploration) that is "equal". This can reasonably be interpreted as equivalent information per mile of Zone length or per square mile of area logically tempered by the relative complexity or presence/lack of hazards with which a tunnel might contend (e.g., see Attachment 1--challenges and opportunities). In this context, we do not understand how the statement can be made that "We [Caltrans/CH2M Hill] disagree with the comment that the field exploration should be equitably distributed." This indicates that new exploration locations were not selected based upon "a due consideration for what is fair, unbiased, or impartial."

LCF Comment No. 5: No Consideration is Given to the Effects of Liquefaction and Alluvium on Possible Ventilation and Emergency Evacuation Shafts

Our previous comment stands. The effects of liquefaction on ventilation tunnels still need to be considered now, not at some later time in the environmental phase, so that the five Zones can be properly compared. The comparison must be done with proper consideration of ventilation tunnels, since the number and spacing vary considerably for each Zone. Many of the ventilation tunnels would potentially collapse due to liquefaction and severe earthquake shaking. Some zones will need only a few ventilation shafts, other zones will need a greater number. This information can be shown in tabular format and shown on the geologic maps. Many zones will have a two-layer case of saturated alluvium overlying soft

have a two-layer case of saturated alluvium overlying soft rock for the tunnel shaft, and this should be modeled for differential seismic shaking.

LCF Comment No. 6: California Geological Survey Groundwater Data are Not Adequately Presented

Our previous comment stands. There is no discussion of the future timetable for when new groundwater data would be recovered from the boreholes instrumented with piezometers. There should be useful groundwater data available, particularly given the nature of the precipitation in the winter of 2009-2010.

LCF Comment No. 7: The Draft Report Indicates a Lack of Synthesis of Subsurface Geologic Data

Our previous comment stands. We continue to believe that a comparison of the five Zones (as stated in the purpose) cannot be completed now or later without a more thorough integration and synthesis of the geophysical profiles and data from the newly installed groundwater monitoring wells.

GEOLOGY AND SEISMOLOGY REFERENCES:

American Society of Civil Engineers, 2010, Minimum Design Loads for Buildings and other Structures: ASCE Standard 7-10. (This new edition for 2010 replaces previous edition of 2005. ASCE Standard 7 is directly incorporated in the California Building Code, CCR Title 24, so is pertinent to all projects in California.)

Crouse, C.B., 2010, New Provisions for Peak Ground Acceleration and Vertical Component Design Response Spectra in the 2010 NEHRP Seismic Provisions and ASCE 7-10 Standard: SSA Seismological Research Letters, vol. 81, no 2, March/April 2010 issue, p. 284, abstract.

Jones, Lucille M., Sieh, Kerry E., Hauksson, Egill, and Hutton, L. Katherine, 1990, The 3 December 1988 Pasadena, Earthquake; evidence for strike–slip motion on the Raymond Fault: Bulletin of the Seismological Society of America, vol. 80, no. 2, p. 474–482.

Kase, Y., 2010, Slip-length scaling law for strike-slip multiple segment earthquakes based on dynamic rupture simulations: Bulletin of the Seismological Society of America, vol. 100, no. 2, p. 473-481.

Luco, N., 2007, Structure-specific scalar intensity measures for near-source and ordinary earthquake ground-motions: EEEI Earthquake Spectra, vol. 23, no. 2, p. 357-392.

Luco, N., 2010, New Risk-Targeted Seismic Design Maps for Model Building Codes: SSA Seismological Research Letters, vol. 81, no 2, March/April 2010 issue, p. 284. (abstract for talk at the annual meeting of the Seismological Society of America)

Oakeshott, Gordon B., editor, 1955, Earthquakes in Kern County, California, during 1952: California Division of Mines (currently the California Geological Survey) Bulletin 171, 283 pages, Section 6, Earthquake Damage to Railroads in Tehachapi Pass, pages 241-248.

Petersen, Mark D., Harmsen, S., Ruksales, K., and Luco, N., 2010, The 2008 U.S. National Seismic Hazard Map Applications for Building Codes: SSA Seismological Research Letters, vol. 81, no 2, March/April 2010 issue, p. 284. (Abstract for talk at the annual meeting of the Seismological Society of America.)

Tuthong, P., Cornell, C.A., and Baker, J.W., 2007, Explicit directivity-pulse inclusion in probabalistic seismic hazard analysis: EERI Earthquake Spectra, vol. 23, no. 4, p. 867-891.

Weaver, Kristin D., and Dolan, James F., 2000, Paleoseismology and geomorphology of the Raymond Fault, Los Angeles County, California: Bulletin of the Seismological Society of America, vol. 90, no. 6, p. 1409–1429.

Wells, Donald L., and Coppersmith, Kevin J., 1994, New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement: Bulletin of the Seismological Society of America, vol. 84, p. 974–1002.

Youngs, Robert R., Arabasz, W.J., Anderson, R.E., Ramelli, A.R., Ake, J.P., Slemmons, D.B., McCalpin, J.P., Doser, D.I., Fridrich, C.J., Swan, F.H.III, Rogers, A.M., Yount, J.C., Anderson, L.W., Smith, K.D., Bruhn, R.L., Knuepfer, P.LK., Smith, R.B., dePolo, C.M., O'Leary, D.W., Coppersmith, K.J., Pezzopane, S.K., Schwartz, D.P., Whitney, J.W., Olig, S.S., and Toro, Gabriel R., 2003, A methodology for probabilistic displacement hazard analysis (PFDHA): EERI Earthquake Spectra, vol. 19, no. 1, p. 191–219.

Sincerely,

Stephen Del Guercio,
City Councilmember
Steering Committee Member, SR-710 Tunnel Technical Study

c: City Council Members
Mark R. Alexander, City Manager
Carol Liu, Senator
Anthony J. Portantino, Assembly Member

TAC and SC Meeting Minutes

TAC and SC Meeting Minutes

Technical Advisory Committee Meeting Minutes
SR-710 Tunnel Technical Study
November 5, 2009 4:00 p.m.
San Marino Center
Final

I. CALL TO ORDER –

The meeting was called to order at 4:10 pm.

INTRODUCTIONS AND MEETING OVERVIEW

The following people attended the meeting:

TAC Members Present:	**Absent/No Alternate Present:**
Amir Alam, Senior Civil Engineer, Representative for County Supervisor, Gloria Molina, 1st District (Also representing District 5 as an Alternate for Pat DeChellis)	Thomas E. Mitchell, Assistant Traffic & Transportation Administrator, City of Glendale
Rey Alfonso, Assistant City Engineer, City of Monterey Park (Alternate for June Yotsuya)	**Elected Officials:**
Shahrzad Amiri, Deputy Executive Officer, METRO	Yvonne Hsu, District Representative, Office of Congressman Adam Schiff, U.S. House of Representatives, 29th District
Marisa Creter, San Gabriel Valley Council of Goverments (Alternate for Nicholas Conway)	Elizabeth Delgado, Field Representative, Office of United States Senator Dianne Feinstein
Leland Dolley, City of Alhambra	Julianne Hines, District Director, Office of Assemblymember Anthony Portantino, 44th District
Richard A. Gutschow, City of South Pasadena	John Hisserich, Constituent Services, Office of Assemblymember Paul Kerkorian, 43rd District
Paul Habib, Northeast Area Director/Public Works Manager, Office of Los Angeles Councilman Jose Huizar, CD-14	Arturo Chavez, District Director, Office of Senator Gilbert Cedillo, District 22
Bahman Janka, Transportation Administrator, City of Pasadena	Mark Alexander, City Manager, City of La Cañada Flintridge
Ryan Kuo, Associate Transportation Planner, Southern California Association of Governments (Alternate for Philip Law)	Barbara Messina, Councilmember, City of Alhambra
Pratheep Piratheepan, Senior Transportation Engineer, Caltrans District 7	Mary Chavez, Director of Public Works, City of Alhambra
Eugene Sun, Mayor, City of San Marino	
Ken Wilson, City of La Cañada Flintridge (Alternate for Ann Wilson)	

Caltrans District 7 Staff: Abdi Saghafi, Project Manager Maria Raptis, Public Information Officer Pratheep Piratheepan, Geotechnical Lead Design Unit, Caltrans District 7 Derek Higa, Senior Transportation Engineer Ainsley Chiang, Transportation Engineer Maria Quinonez, Chief, Design Shiva Karimi, Geotechnical Engineer **Metro Staff:** Doug Failing, Executive Director of Highway Programs Lynda Bybee, Deputy Executive Officer of Regional Communications	**Technical Consultants:** Yoga Chandran, Project Manager, CH2M HILL Ramon Chavez, Senior Geologist, CH2M HILL Steve Dubnewych, TBM Expert, Jacobs Engineering Steve Klein, Tunnel Structure Lead, Jacobs Engineering Bruce Schell, Senior Geologist, Earth Mechanics Ravee Raveendra, Senior Project Engineer, CH2M HILL **Community Facilitation Consultants:** Rebecca Barrantes, The Sierra Group Glenda Silva, The Sierra Group Rena Salcedo, GCAP Services Claudia Gonzalez, GCAP Services Katherine Padilla, KP&A John Limon, KP&A

For the purpose of review, Committee Member's names are spelled out during the question and answer periods. Project Staff names are denoted by their first initial and spelling of their last name.

The meeting started at approximately 4:10 p.m.

Welcome: Doug Failing, Metro Executive Director of Highway Programs
Doug Failing thanked the Technical Advisory Committee (TAC) members for their participation in the process. Mr. Failing facilitated the introductions of present TAC members, Caltrans staff, Metro staff, consultants, and representatives of elected officials.

Meeting Overview: Doug Failing, Metro Executive Director of Highway Programs
Mr. Failing ensured that Committee members were provided the Draft Geotechnical Summary Report in advance of the public, allowing them the opportunity to review it prior to public distribution. He also informed attendees that Caltrans and Metro would not be proceeding with the additional technical studies proposed in Task Order No. 5. He added that Committee members had provided valuable input and very clearly requested a postponement of these activities. Mr. Failing stated that he was depending on the TAC to review the Draft Geotechnical Summary Report, ask questions and communicate with their representatives and counterparts on the Steering Committee.

Mr. Failing proceeded to highlight the meeting objectives, which were to review the findings of the exploration program, summarize contents of the Draft Geotechnical Summary Report, and discuss planned outreach activities. He clarified who would be covering each agenda item, stating that Yoga Chandran would discuss analysis of the geology for each zone, Steve Klein would discuss tunneling considerations for each zone, and both Yoga Chandran and Rebecca Barrantes would review the public outreach process for the Draft Geotechnical Summary Report.

Mr. Failing reviewed the guiding principles, which were to develop reliable geotechnical data for tunnel options, respect route neutrality, and to clearly communicate the purpose and scope of the study to solicit public input. He then turned the meeting over to Yoga Chandran.

Geotechnical Summary Report: Yoga Chandran/Geotechnical Team
Mr. Chandran identified the purpose of the study, which is to consider all practical routes for the extension of the SR-710, gather information on sub-surface conditions, and provide for public input and involvement. He expressed that they had been successful in accomplishing the purposes of the study with outreach ongoing into early 2010. He also acknowledged and extended his gratitude to Caltrans' geotechnical staff, which were involved throughout the study and provided assistance to the CH2M Hill team.

The following objectives of the study were reviewed:

- Investigate a total of 5 zones
- Collect geotechnical, geological, and hydro-geological information for each zone
- Use the information obtained to perform geotechnical related screening.

The main tasks accomplished under the scope of the study were discussed next, including review of existing information; completion of field exploration, totaling 25 deep core borings, 17 seismic reflection lines, and 78 surface wave measurements; validation of the data; and preparation of a Draft Geotechnical Summary Report.

Finally, Mr. Chandran began to discuss the Draft Geotechnical Summary Report and the findings contained within the report for each zone. He reviewed the organization of the report, which consists of five volumes, with the Main Report contained in Volume 1, and the remaining volumes containing appendices with detailed data. He then highlighted the major topics of each section in Volume 1.

Below is a summary of notes pertaining to each Report section:

- Sections 2, Data Collection & Review – Multiple sources of existing data were utilized, and they provided the basis for determining the activities required in the exploration program for the study.
- Section 3, Exploration Summary – A table summarizing all exploration activities for each zone, such as the number of borings completed during the study and the number of existing borings used, was reviewed. This table was provided on page 11 in the TAC meeting PowerPoint presentation.
- Section 4, Summary of Data Faulting – A geotechnical map using dots to show the boring collected and performed during the study was shown, with an emphasis placed on the fault locations. The Raymond Fault, which crossed Zones 2, 3, and 4, was indicated as the most significant. Mr. Chandran noted that the extension of the Alhambra Fault is shown for the first time in this map and was not previously thought to extend as far as it did, adding that this was CH2M Hill's contribution. Both Alhambra Wash and Raymond are active faults.
- Sections 5, Groundwater Conditions - There are a total of five groundwater basins, including San Gabriel Basin, Raymond Basin, Eagle Rock Basin, San Fernando Basin, and the Central Basin. The review of the groundwater conditions indicates that the tunnel does not affect the surface water features.
- Section 6, Hazardous Waste Studies – Summarizes findings from a hazardous waste study. These findings were mainly based on historical documents information and database search. Contaminated groundwater and soil was identified in Zones 1, 4, and 5. The map shown was different from the one shown previously because the Environmental Protection Agency (EPA) recently updated their map and the contamination site boundaries have been changed. For example, they removed the limits from Zone 4. The technical team was advised not to change this map or use any variations of this map due to liability issues.

Mr. Chandran noted that Sections 7 to 11 pertain to subsurface soil conditions of the five zones. Maps showing the plain view and representative geologic profile view for each zone were presented.

- Section 7 – Consists of findings for Zone 1, which consists of fairly uniform material, which primarily consists of sedimentary rock of the Puente formation. There is also some alluvium in the northwest corner, which is part of the contaminated Superfund Site. The groundwater table for the alluvium is within 20 to 50 feet below ground surface. There are no known active faults in this zone. There is potential for gassy conditions, which must be taken into consideration for design and construction activities. There have already been two tunnels constructed in Zone 1 and they were successfully completed. A 3-dimensional view of the subsurface profile was shown to illustrate the generalized soil conditions for Zone 1.

- Section 8 - Consists of findings for Zone 2, which mostly consists of Topanga and Puente formations. Both of these materials are fairly uniform from a tunneling perspective. There are also some Fernando formations in a small portion of the zone. As with Zone 1, there is some alluvium, which is fairly shallow. Some alluvium is in the portal area and most of it is in the mid-section of Zone 2. There is one active fault in the northwest corner of the zone. Depending on the tunnel alignment, it may affect the portal area but not the tunnel area. A 3-dimensional view of the subsurface profile was shown to illustrate the generalized soil conditions for Zone 2.

- Section 9 - Consists of findings for Zone 3. There is more variation in material types. The southern half is mostly Puente and Topanga formations, similar to what you see in Zones 1 and 2. There is also some hard rock encountered, and alluvium in the northern portion of the zone. Zone 3 includes the active Raymond Fault as well as two potentially active faults, the Eagle Rock and San Rafael Faults. The groundwater depths are variable. A 3-dimensional view of the subsurface profile was shown to illustrate the generalized soil conditions for Zone 3.

  Mr. Chandran characterized sedimentary rock as soft rock and igneous and metamorphic rock as hard rocks to give the audience a better understanding of the geological formations discussed.

- Section 10 - Consists of findings for Zone 4. This zone consists of alluvium and bedrock. The tunnel would be predominantly within the alluvium zone. The Puente formation mostly exists at the southern end of the zone. There are two active faults: The Raymond and Alhambra Wash Faults. There is a potential for high groundwater inflows in alluvium and a potential for caving soils. Due to the faults, the groundwater levels are not uniform across the zone. The Superfund site is located in the central portion of the zone. A 3-dimensional view of the subsurface profile was shown to illustrate the generalized soil conditions for Zone 4.

- Section 11 - Consists of findings for Zone 5. This is similar to Zone 4. If the tunnel were to be constructed in Zone 5, it would be mostly in alluvial, except on the western end where it goes through the Topanga formation. The surface water feature would impact the east portal zone and would be a constraint from a tunneling perspective. Puente or Fernando formation would be mostly present in the southwest portion. The Alhambra Wash Fault is located in this zone. There is a Superfund Site located in the south central portion of Zone 5. The Rio Hondo and San Gabriel Rivers are in the eastern portion of the zone. A 3-dimensional view of the subsurface profile was shown to illustrate the generalized soil conditions for Zone 5.

Mr. Chandran summarized the geotechnical findings for each zone. These are detailed in a table on page 41 of the PowerPoint presentation. He added that the maximum fault rupture displacement for the Raymond Fault is 4 feet, while for the others it is considerably less than 4 feet, noting that this displacement could be mitigated in design based on the available technology.

Mr. Failing quickly acknowledged the arrival of additional guests before handing the meeting over to Steve Klein.

Tunneling Considerations: Steve Klein, Geotechnical Team

Mr. Klein provided an overview of the findings regarding the geotechnical feasibility of constructing a tunnel in any of the zones. He stated that it was determined to be feasible to tunnel in all five zones from a geological point of view, adding that each zone has some challenges. He also noted that there is technology available to address these challenges, citing constant improvement of tunnel construction since the 1950s, extending their availability to build tunnels in complex geotechnical conditions through methods used in Los Angeles and world-wide.

He addressed the topic of ground stability, which was stated to be an issue mostly in alluvium and soil deposits because these materials are not strong enough to resist the movements in a tunnel. Mr. Klein informed attendees that this would be extensive in Zones 4 and 5, but would also occur somewhat in Zone 3 and in the portal areas of Zones 1 and 2. He noted that tunneling machines have been developed to address such issues and showed the tunnel technology used to build a highway tunnel in Madrid, a 50 foot diameter Earth Pressure Balance Machine. A machine similar to this one was used in the Metro Eastside Extension project. This technology allows you to seal out the groundwater pressure and avoid material from invading the tunnel. He also referred to a Slurry Tunnel Boring Machine (TBM), which involves installation of a water tight lining and is designed to resist ground loads. The same technique was used for Metropolitan Water District's Arrowhead Tunnel in San Bernardino and could be used for this project. Mr. Klein stated that specialized testing for the gaskets showed that it could withstand 900 feet of external groundwater pressure, which is roughly three times what has been done worldwide. The groundwater pressure for this tunnel would probably be about 200 feet.

Next Mr. Klein addressed the issue of uniformity of materials, stating that it has been described during the meeting that some areas contain variable materials such as soil, soft rock, and hard rock. He stated that this is a construction challenge. The example of Zone 3 was provided, which contains a range of materials from soil to harder rocks. Noting that there are different ways to handle this, he referred to a Los Angeles Metropolitan Water District project with variation in geological material, where he used a TBM with rock/soil cutterhead that is adaptable to a variety of geological conditions.

Mr. Klein discussed natural gas, noting that some geological formations have natural gas in various percentages, with the Puente formation containing high amounts. He added that because the occurrence of natural gas is not uncommon, there are well established procedures for dealing with natural gas. Mr. Klein explained that ventilation is critical in removing natural gases from a tunnel, and other useful features would be using special electrical connections that are spark-free to prevent ignitions. Additionally, there is a safety feature that shuts all power down during construction if gas levels reach a certain point. It was mentioned that smoking and lighters in tunnels would be prohibited during construction.

He moved along to the topic of active faults, stating that the biggest issue is designing and constructing a tunnel for seismic conditions that is safe during operations. He stated that in an instance where a tunnel crossed a fault, an oversized vault section could be built within the tunnel to withstand movement during an earthquake. A schematic showing the configuration of such a vault was shown. Mr. Klein added that this concept considers a possible displacement of about 8.5 feet as the result of an earthquake and a similar concept is used for a Metro project that goes through the Hollywood Hills to mitigate a displacement of 6.5 feet. He also added that his firm designed this concept for the East Bay Municipal Utility District and they won an innovation award for using this technology this year from the American Society of Engineers. Mr. Klein briefly reviewed another technique utilizing segmental linings providing tunnel flexibility to deal with fault crossings in conditions where less displacement was anticipated.

The issue of contaminated soil and groundwater was discussed. Mr. Klein reminded attendees that some of the zones contained Superfund Sites and stated that from a liability point of view, they cannot allow the plume to migrate and must dispose of contaminated material properly. He added that disposal costs can be significant depending on the nature of the contaminants. A solution utilizing a pressurized machine that can tunnel through the groundwater without having to de-watering outside of the tunnel envelope was discussed. The issue of contaminated soil mainly impacts Zones 1, 4 and 5.

Mr. Klein summarized the geotechnical challenges he covered, adding that technology exists today to address these challenges and that ultimately tunneling is feasible in all zones. He closed by reviewing the tunnel study schedule, pointing out that the Final Geotechnical Summary Report will be issued in early 2010.

Rebecca Barrantes then solicited questions from the Committee, which are summarized below.

Questions, Answers, and Comments following the presentation:

For the purpose of review, Committee Member's names are spelled out during the question and answer periods. Project Staff names are denoted by their first initial and spelling of their last name.

Ken Wilson: All five zones are crossed by faults and several zones have been crossed by multiple active faults. The report takes the approach that Caltrans can design a tunnel that will accommodate ruptures associated with crossing active faults; however Caltrans has not discussed displacement risks or examples where these designs have been used that have successfully prevented damage from fault rupture. What are the risks to the proposed tunnel at active fault crossings? How do these risks increase the cost of design and construction? What methodology was used to determine the potential earthquake fault movements and to assess whether these risks are worth taking when an active fault avoidance strategy could be pursued through, for example Zone 1? (Mr. Wilson is an Engineering Geologist who is the Alternate for official TAC representative Ann Wilson).

Y. Chandran: In terms of faults, there are a number of tunnels in Los Angeles, for example, the Metro Red Line in Hollywood, that have been built across an active fault. Fault rupture displacement will be the risk for the proposed SR-710 tunnel at active fault crossings. As discussed in Section 12 and 13 of the Draft Geotechnical Summary Report, technology is available to build tunnel through active fault crossings. A variety of factors should be looked at to determine if they make sense before we decide Zone 1, Zone 2, Zone 3, Zone 4 or Zone 5. As the technical consultant, our task has been to provide an evaluation of subsurface conditions and provide a comparison across the zones. That is what we provided. The decision making process incorporates asking the TAC and SC to provide recommendations based on our findings, and I think we have stuck to that at the comparison level. Fault avoidance, risk, and cost are beyond our scope. These are good questions and are to be asked of Caltrans.

Ken Wilson: What was the methodology used to determine the 2 to 4 foot fault displacement?

B. Schell: None of these faults have ever experienced any earthquake displacement since anyone has been around and consequently we have no direct experience with each fault. The standard way of handling this is by using what was referred to in the report as empirical fault earthquake displacement or fault length earthquake displacement. Basically, we make comparisons with data from all faults across the world. There are different methods of doing this. For example, you can make the fault displacement

determination based on the length of the fault by analyzing all the faults in the world of a certain length and the displacements earthquakes have generated. There are available charts and tables that list this data worldwide. That is the method we used for our analysis. For instance, the Raymond Fault is approximately 12-15 miles long, and we will go to these tables and look at what kind of a fault is 12-15 miles long, the estimated magnitude of an earthquake caused by such a fault, and potential fault displacements. The Raymond fault can generate anywhere from a 6.0 to 6.7 magnitude earthquake and 6.7 magnitude earthquakes generally have displacement in the 2 to 3 foot range. We estimated a conservative average fault displacement of 2 to 4 foot generally using the empirical formulas. The calculated value was 3.2 feet, but we rounded it to 4 feet. That is our methodology. For larger earthquakes, we will get larger displacements. We also have to consider how much conservatism we want to build into this tunnel. Of course with increasing conservatism, we will have increasing costs.

Y. Chandran: When designing for a fault we would do a risk-based analysis and some probabilistic seismic hazard analysis. Design fault displacement will be evaluated based on probability analysis and the actual design of the tunnel. Fault crossing risk will be evaluated in the next phase of the project. It is not in our scope to come up with this analysis for the purpose of this study.

S. Klein: Generally, when we begin the design phase of major facilities, we will have a panel of seismic experts who will review this and discuss the methodology used to establish the faults and the seismology-tectonic models that are used to model the structure and potential movement you could get. When you get into final design, you can use sophisticated science such as probabilistic seismic hazard analysis, as Yoga mentioned. There will be greater details regarding displacements formulas in the next phase of the project.

B. Schell: All of the details of these items would be presented in a document such as an Environmental Impact Report (EIR). That is not the scope of this phase, but in the next phase, the EIR phase, that would be covered in excruciating detail.

Ken Wilson: The seismic design parameters at this comparison stage appear to consider only the 2007 Caltrans map, which indicates a peak ground acceleration of about 60-90% force of gravity. That is a very small range to compare and contrast across the zones. The report indicates that Caltrans procedure commonly requires several adjustments to these values based on fault types and the distance of the faults. Why can't such adjustments be

applied comparatively at this stage? Should these adjustments include the consideration of bedrock versus alluvial formation sub-grade? The engineering characteristics of near fault ground motion, such as forward directivity, fling effects, and large velocity pulses.

B. Schell: Those are mostly design questions and this is a geotechnical feasibility study. That level of detail will enhance understanding that perhaps some zones are more feasible than others and this will be addressed during an environmental review, when it comes to that stage. For this study, we wanted to include ballpark estimates so the public could get an idea of what we are looking at and whether or not those things are feasible. We are saying, yes, it is all feasible; however, as you mentioned the rock type and distances to faults are items that will all have to be addressed. With respect to the faulting, Zone 1 would be of the least concern. The fault of principle concern would be the Raymond Fault, which would have the largest displacements and be a more significant issue than, for example, the Alhambra Wash Fault. There are also questions about whether the Alhambra Wash Fault would be close enough to the tunnel to be an issue.

Y. Chandran: From a tunneling perspective, fault rupture/displacement is a more critical factor than seismic design criteria. The seismic process is important and should be more of a design issue than something considered for a feasibility study. In our opinion, feasibility depends on fault rupture and what the displacement would be and whether the peak ground acceleration is 0.6, 0.7, or 0.8 would be considered in the design and counterpoint design. We provided adequate information and checked at a pretty high-level without going too much into depth.

B. Schell: History has shown that tunnels are a good place to be during an earthquake, if you do not have fault rupture. If you just had the shaking, you would probably rather be in the tunnel than in your home.

Ken Wilson: Your field investigation has generated a lot of field data, which is summarized in the table (provided in the meeting presentation). 35% of the new field studies were in Zone 3, which is the shortest zone, and about 11% each in Zones 4 and 5. Was the greater number of investigations in Zone 3 related to a greater number of problems versus Zones 4 and 5? You discussed some of the variability in Zone 3 already. Also, shouldn't the comparisons of the five zones consider tunnel alignment location flexibility, particularly in Zone 1, to avoid potential problems and maybe reduce costs and risks at this stage of the comparison?

Y. Chandran: In terms of the exploration, I think you have answered your own question. Field investigations were planned based on the available data and the variability of geology in each zone. We had tremendous existing data in

Zones 1, 2, 4, and 5 and the least amount in Zone 3. That was one of the reasons for the focus. Also, much of the geological variability was in Zone 3 and we put more of an emphasis on this zone. We know that Zone 3 has more variable geology than the other zones. Those are the reasons why more exploration activities were conducted in Zone 3.

Regarding your other question, we tried to stay away from choosing an alignment during this study and did not want to address tunnel alignment location if we did not have enough information about alignments. Tunnel alignments will be considered if it moves into the next phase.

Ken Wilson: Ventilation and emergency access shafts were mentioned in the context of previous tunnel study done by Metro, but there is no mention of the number or spacing of shafts that might be associated with the project, or the potential relationship or performance of these shafts with respect to the individual geologic settings. We all know that you have gone through the alluvium and so forth. Why doesn't the Draft Report consider shaft construction as well as portal requirements and their geologic settings when you are comparing the five zones?

Y. Chandran: In order for us to assess the ventilation shaft, we have to perform detailed evaluation about the air quality and ventilation, and that is not within the scope of this study. We looked at intermediate shafts in our preliminary review and determined that concepts exist that preclude the design from having an intermediate shaft. The ventilation shafts will be addressed in future phases.

S. Klein: Emergency egresses (access sites) from the tunnel are generally located approximately every 650 feet and would require cross passages. It would not be required to have them go to the ground surface. Normally, for example in mass transit tunnels, you have cross passages that go from one tunnel to the other. If there is a problem in one tunnel, people can be evacuated into an adjacent tunnel. There is not necessarily a surface access point.

Ken Wilson: The published California Geological Survey (CGS) has its own map that shows depth contours for historically high groundwater. The draft report uses this information but it was not clear whether it used all of this information. Also, the tunnel depth is typically the vertical reference in the report and all of these groundwater contours are at an elevation, so looking at the map makes it difficult to figure out where the groundwater table is. That would be one suggestion. The last question is, should there be an estimated gallon per minute groundwater inflow in these various kinds of

formations where one may be able to also do a comparative evaluation between all five zones?

Y. Chandran: CGS groundwater data and all of the drilling and geophysical data were considered for the groundwater evaluation. For example, we used data from the San Gabriel Basin for elevations and Raymond Basin for depths. However, groundwater contours in elevations were provided based on the map developed for the groundwater basins. We did not change it to depth contours to avoid errors during interpretation. Groundwater inflows were not evaluated at this level.

B. Schell: In very simple terms, any parts of the tunnel that go through alluvium will be below the groundwater table and so there will be potential groundwater in-flows in those portions of the tunnel. There is not a lot of water in the rock formations, except perhaps close to the faults, where this is an unknown. Some of the faults may be fractured and that may allow in-flows. That is something that needs to be addressed; however any part of the tunnel constructed in alluvium will be below the water.

R. Chavez: We used historical information to provide groundwater information for basins in the San Gabriel Valley. Each one of these basins is being monitored on an annual basis and groundwater control maps are produced. The most recent one we have is from 2007. From that perspective, we have abundant good quality data on groundwater. This is due to the great number of production wells located in those basins.

Y. Chandran: We conducted packer testing to characterize the formation of the geologic materials and permeability data is available for alluvium. Alluvium can vary from location to location because of the inherent variability within the formation. We could estimate the groundwater inflow; however at this stage, it is not a critical issue to get estimated gallon per minute groundwater inflow for the formations.

S. Klein: From a practical standpoint, when we are in alluvium, we are not going to be prepared to deal with the loss of ground that would be associated with allowing groundwater into the tunnel because of the settlement that may occur. The top trend in the construction industry is to use these pressurized face machines to balance the groundwater pressures, put in the water tight lining, and avoid all of the issues associated with the impact of groundwater. That is really something that is huge in urban environments. The project I referred to earlier with the Metropolitan Water District was not in an urban area but we were in a national forest that had very sensitive groundwater resources that they were concerned about protecting.

B. Schell: All of the borings are being monitored now and it takes about 1 to 2 years to get enough information about groundwater.

Amir Alam: First of all, I would like to commend CH2M Hill on the report. You can tell that a lot of thought and effort went into it, and it is a quality product. This report is going to be looked at by a lot of non-geotechnical people. I appreciate that you took the time to make it as easily understandable to the layperson as possible with the glossary, appendices, and the way the information was written. To further that and increase the usefulness of the report, since it will be considered by Caltrans and Metro in going forward with the next step in deciding the alignment, I would like to make a suggestion. During the comparison, you list several factors that need to be considered and you compare these various factors in the different zones, such as the number of faults, the number of formations. One thing that you may want to consider that may be useful for the layperson is that some of these factors are strictly construction related and some have an impact on the consideration of the long term geotechnical risk. Maybe you would want to identify which one is only construction related, which one is long term, and which are both. The second comment I have is that you mentioned the factors in the geotechnical mitigation required to mitigate these hazards. You discussed the mitigation measures that could be taken. The final outcome is that it is technically feasible to construct a tunnel from a geotechnical standpoint. The mitigations are not ranked equally. In other words, some mitigation is easier to implement, while others are a lot tougher to implement. Describing the ease of implementation of the mitigation may be helpful to assist people with better understanding this report, and also the reliability of the mitigation method. Some mitigation methods have been proven historically and you can say it takes care of the problem and mitigates the risk down to nothing. For others, the risk factor is still there. That kind of information would be helpful in the future steps.

Y. Chandran: We agree with your first comment and will separate the geotechnical tunnel consideration in these categories. Regarding the ranking of mitigation, we will consider it. However, there are additional details and studies should be performed to rank the mitigation measures. It will be performed in the next phase of the would be project.

Richard Gutschow: In looking at the feasibility study, we always think in terms of “can-do” for alternative routes and we base our decisions on what we find in the ground. I want you to differentiate between empirical data and what actual data that you have obtained in the field from laboratory tests. What I am interested in is whether or not you are able to go on in a feasibility study and determine costs from the investigations that you have used currently.

Y. Chandran: The current study was performed only to evaluate the geotechnical feasibility and the technical team was not asked to look at cost. This request is similar to what Amir Alam asked about ranking the challenge of implementing mitigations. The most challenging may not be the most costly. Without having some definite alignment, we are not able to provide a detailed cost estimate.

S. Klein: In order to come up with costs, we would have to do some technical evaluations, such as those proposed in Task Order No. 5, which was not approved. We do not have alignments for any of the zones or concepts for connecting to any of the existing freeway systems. There are several factors that need to be considered for a cost estimate. It will be very premature to talk about the tunnel cost at this time.

Richard Gutschow: It is very simple to say that everything is feasible. We have determined that and knew this early in the study. In the drilling process you are able to look at what you have in the ground and you have tested that material and are finding out the degree of difficulty that it takes to tunnel through the various regions. That is related to costs. Difficulty is related to costs. Is your data or what you have obtained in the field capable of helping you arrive at your degree of difficulty?

S. Klein: In the testing that we have completed, and in the different formations that Yoga Chandran has addressed, we have not found anything that is unusual. There have been tunnels constructed through these formations in Southern California and in some of Metro's projects, Metropolitan Water District's projects, and Department of Water and Power projects. We have not found anything unusual in these zones in terms of the strength or weakness of the materials that would cause us any concerns from a tunnel construction point of view. I think the data is consistent with what we would expect for these materials. In terms of what is going to be required of a tunnel in these zones, we do not know. We do not know the size of the tunnel that we are talking about. We know that is has to be large enough to host a significant number of automobiles, if constructed; however we do not know if it will be a 40 foot, 50 foot, or 60 foot diameter tunnel. We suspect it is going to be in that range, but that is about as far as we can go.

Richard Gutschow: Will the exploration and testing that you have completed allow you to determine if you will need a 50 foot diameter tunnel, or 60 foot tunnel?

S. Klein: If we were to go to some sort of preliminary engineering stage, we would have enough information to serve as a good starting point. We have

collected a significant amount of data in the area and have gone out and collected actual site specific data as well.

Richard Gutschow: What does safe mean? Does it mean that the tunnel will not collapse or rupture? Does it also ensure safe driving through a tunnel if it is in motion?

S. Klein: When I was talking about safety, it was with respect to the vault section. If you are in the tunnel when a fault ruptures, we do not know exactly what is going to happen to the people in the cars. After an earthquake, we would like to successfully evacuate people and allow emergency response vehicles into the tunnel as soon as possible to provide emergency assistance and transport injured people to hospitals for treatment. That is what we mean by safe operations. In terms of what happens to the vehicles in a tunnel during an earthquake, it would be very difficult to predict what might happen. Some of these earthquakes could produce significant vibration.

Y. Chandran: During an earthquake, what you feel in the tunnel would be less than what you would feel at the surface.

Paul Habib: We have all agreed that this will be route neutral from the beginning. There is one site that is consistent with each zone and that is the starting point on Valley Boulevard. The portal will begin around there. That directly affects the community of El Sereno. Our concern is that there needs to be more information on that starting point because no matter which direction you go in, the tunnel is going to start there. We have also made it clear in the past that we prefer that the tunnel start south of Valley Boulevard so that by the time you are underground, you are not affecting homes and residences and would have less impact. What we did not see in the boring analysis is attention to that area, which is the starting point area (portal) of the tunnel. Again, we have no idea what the tunnel alignment may be, but we all know where it would start. That information would be useful regardless. More information south of Valley Boulevard from the I-10 and I-710 interchange should be evaluated if we are to discuss the tunnel.

Yoga Chandran asked for clarification on what type of information Mr. Habib was requesting for the southern portal. Mr. Failing interjected in to assure Mr. Habib that he would make sure that his concerns were addressed in the Draft Geotechnical Summary Report and that they could discuss this separately, if needed.

Paul Habib: Yes, I would like this to be addressed in the Final Report, if not now then at some point in the future.

Lee Dolley: It has been a long time since we started but you should all be complimented, because the time in getting this done is really a short period of time. We started last summer and are here today with a report that gives a lot of information. Whoever did the glossary did a superb job because I thought the report was the health bill, it was so large, and it was very helpful. That last not so terribly facetious thing I would say is that I do not know how safe I would feel driving down the 110 freeway, as compared with in the tunnel, during an earthquake.

Next Steps: Rebecca Barrantes, Community Facilitation Team

Ms. Barrantes then moved on to the next steps in the study, with a focus on the outreach process and upcoming meetings. She noted that comments from the TAC and SC regarding the draft report are due November 30th, 2009. She also informed them that three regional community meetings would be held early next year, as well as the last round of committee meetings. The breakdown is as follows:

- Comments due from Committees: November 30, 2009
- Community Meetings: January-February 2010 to review the Draft Geotechnical Summary Report
- Final Geotechnical Summary Report: February-March 2010
- Committee Meetings: March 2010 to review the Final Geotechnical Summary Report

Moving along to the public outreach process, Ms. Barrantes provided the scheduled dates for the upcoming regional community meetings.

- La Canada Flintridge, Glendale, Northeast Los Angeles – Currently looking for a location in Glendale, possibly at Wilson Middle School

- Pasadena, South Pasadena, and San Marino – This will take place at the San Marino Center on January 26, 2010

- El Sereno, Monterey Park, Alhambra – This will take place at the Los Angeles Christian Presbyterian Church during the week of February 1, 2010

Ms. Barrantes pointed out that once the dates and locations are finalized, the team would inform Committee members and communities via email and by posting meeting information on the website. She added that a large turnout was anticipated at these meetings and that, in terms of outreach, they have a much bigger reach this time due to a large network of people interested in the study that have already attended previous meetings and are in our database.

Ms. Barrantes informed the attendees that the entire Draft Geotechnical Summary Report (all 5 Volumes) is available on DVD at public library locations listed on the website and also on the study website (www.710tunnelstudy.info).

Ms. Barrantes then asked the committee if the SR-710 Tunnel Technical Study team had accomplished what was requested with respect to the format and information presented in the Draft Geotechnical Summary Report. Committee members such as Ann Wilson and Paul Habib had specific suggestions. In summary, the committee asked that the report be provided in laymen's terms, information be presented without bias, and that the report be presented in a real time application. Committee members agreed that their expectations had been met.

Questions, Answers, and Comments following the presentation:

Bahman Janka: The process you have outlined is about this study. What happens after this? Is some version of Task Order No. 5 going to be complete and when? Also, will Caltrans or Metro be completing the next phase?

D. Failing: On completion of the study, we will go back to the various parties for some decisions to be made. If a decision is made not to move forward, then obviously nothing will move forward and there would not be any more decisions, or any more studies to follow up. If the decision is made that there is enough information to warrant additional studies, then the information we have gathered under Task Order No. 5, which is a summary of thoughts that we felt were presented out of the questions of the various communities, does need to be addressed. Whether the exact venue for that is a full environmental document or a study like this that addresses specific questions, is not something that I can answer at this time. Certainly Metro Board input will be important and Caltrans input, possibly involving their California Transportation Commission, will be important too. I would think that we have a lot of good data which could be gathered through Task Order No. 5. In addition to "Don't do it" comments we have received a lot of important input on the issues that were put forward. That would be valuable information on considering anything that goes forward.

Julianne Hines: What is the purpose of the three community meetings that you are having early next year? If your comments are due in November 30th, how are you going to incorporate the feedback from the community in a matter of a few weeks?

R. Barrantes: We are going to have the Steering Committee meeting on November 18th and comments from both Committees regarding the Draft Geotechnical Summary Report are due on November 30th. We will incorporate revisions to the report based on feedback from the committees. That is the

document that we will take out to the community to get their input. The report will not be final until community meeting feedback is incorporated. It will be final after we get through the three community meetings. The purpose of the community meetings is to have an opportunity to discuss the findings with the community.

Julianne Hines: Will you incorporate the feedback from the community into the final report?

R. Barrantes: Yes. Yoga, can you please help me address this in more detail?

Y. Chandran: The presentation provided to the community during the next round of meetings will show the feedback received from the Committees. I do not think that there will be another Draft Report issued that will incorporate their feedback and we will make that clear in the presentation. Any feedback we get from the community as part of the outreach process will be incorporated into the Final Report. The reason we delayed the final report until March was to get community input and we will definitely include that feedback in the report.

Meeting was adjourned at 5:50 PM.

Steering Committee Meeting Minutes
SR-710 Tunnel Technical Study
November 18, 2009 6:00 p.m.
San Marino Crowell Library
FINAL

I. CALL TO ORDER –

The meeting was called to order at 6:10 pm.

INTRODUCTIONS AND MEETING OVERVIEW

The following people attended the meeting:

SC Members Present:	**Absent/No Alternate Present:**
Naresh Amatya, Manager of Transportation Planning, Southern California Association of Governments (SCAG)	Ms. Nicole Englund, Transportation Deputy, Office of Los Angeles County Supervisor Gloria Molina, 1st District
Lynda Bybee, Deputy Executive Officer of Regional Communications, Los Angeles County Metropolitan Transportation Authority (Metro)	Stephen Zurn, Director of Public Works, City of Glendale
Michael Cano, Transportation Deputy, Office of Los Angeles County Supervisor Michael D. Antonovich, 5th District	**Elected Officials:**
Nicholas Conway, SGVCOG (Alternate for Robert Urteaga)	Julianne Hines, District Director, Office of Assemblymember Anthony Portantino, 44th District
Stephen A. Del Guercio, Councilmember, City of La Cañada Flintridge	Susan Wong, Field Deputy, Office of Councilmember Ed P. Reyes, 1st Council District
Lee Dolley, Representative, City of Alhambra	Steven Placido, Vice Mayor, City of Alhambra
Philip C. Putnam, Councilmember, City of South Pasadena	Ann Wilson, Senior Management Analyst, City of La Cañada Flintridge (TAC Member)
Eugene Sun, Mayor, City of San Marino	
Edel Vizcarra, Planning and Transportation Deputy, Office City of Los Angeles Councilmember Jose Huizar, 14th District	
David Worrell, Representative, City of Pasadena	

Caltrans District 7 Staff: Abdi Saghafi, Project Manager Deborah Harris, Chief, Media Relations & Public Affairs Maria Raptis, Public Information Officer Pratheep Piratheepan, Geotechnical Lead Design Unit, Derek Higa, Senior Transportation Engineer Ainsley Chiang, Transportation Engineer John Ehsan, Caltrans Senior Planner **Metro Staff:** Doug Failing, Executive Director of Highway Programs Lynda Bybee, Deputy Executive Officer of Regional Communications	**Technical Consultants:** Yoga Chandran, Project Manager, CH2M HILL Ramon Chavez, Senior Geologist, CH2M HILL Steve Dubnewych, TBM Expert, Jacobs Engineering Steve Klein, Tunnel Structure Lead, Jacobs Engineering Bruce Schell, Senior Geologist, Earth Mechanics Ravee Raveendra, Senior Project Engineer **Community Facilitation Consultants:** Rebecca Barrantes, The Sierra Group Glenda Silva, The Sierra Group Rena Salcedo, GCAP Services Debbie Rusas, GCAP Services Katherine Padilla, KP&A John Limon, KP&A

For the purpose of review, Committee Member's names are spelled out during the question and answer periods. Project Staff names are denoted by their first initial and spelling of their last name.

The meeting started at approximately 6:10 p.m.

Welcome: Doug Failing, Metro Executive Director of Highway Programs
Doug Failing, Metro Executive Director of Highway Programs, facilitated the introductions of present SC members, Caltrans staff, Metro staff, consultants, representatives of elected officials and additional guests.

Meeting Overview: Doug Failing, Metro Executive Director of Highway Programs

Mr. Failing mentioned that the Technical Advisory Committee (TAC) met on November 5, 2009 and proceeded to highlight the meeting objectives, which were to review the findings of the exploration program, summarize contents of the SR-710 Tunnel Draft Geotechnical Summary Report (Draft Report), and discuss planned outreach activities. He noted that at the last joint Committee meeting additional technical studies proposed in Task Order No. 5 were presented, adding that committee members provided valuable input and very clearly requested a postponement of these activities until a better point in time. Mr. Failing then thanked the Steering Committee (SC) members for their input on Task Order No. 5, adding that the overwhelming response received by the SC was utilized by Caltrans and Metro to make the decision. He informed the SC that they should have received a letter from Randy Iwasaki, Caltrans Director, notifying them that Task Order No. 5 would not proceed. Mr. Failing then acknowledged the geotechnical team and those who contributed to the Draft Report for their tremendous effort.

Mr. Failing then turned the meeting over to Yoga Chandran.

Draft Geotechnical Summary Report: Yoga Chandran/Geotechnical Team
Mr. Chandran acknowledged the Caltrans geotechnical staff for assisting with field exploration activities and data analysis, Prof. Geoff Martin of Metro, for assisting with the review process, and CH2M HILL technical team for their tremendous efforts considering the time constraints.

The guiding principles of the study were reviewed, which are to: respect route neutrality; clearly communicate the purpose and scope of the study; consider all practical routes; and develop reliable geotechnical information for tunnel options. He added that all of these principles had been upheld throughout the study process.

The following objectives of the study were reviewed:

- Investigate a total of 5 zones
- Collect geotechnical, geological, and hydro-geological information for each zone
- Use the information obtained to perform geotechnical related screening

The main tasks accomplished under the scope of the study were discussed next, including review of existing information; completion of field exploration, totaling 25 deep core borings, 17

seismic reflection lines and 78 surface wave measurements; evaluation of the data; and preparation of a Draft Geotechnical Summary Report.

Finally, Mr. Chandran began to discuss the Draft Report. He reviewed the organization of the report, which consists of five volumes, with the main report contained in Volume 1, which is the main text, and the remaining volumes containing appendices with detailed data. He reviewed a summary of observations for each zone, highlighting key information collected as listed below.

Below is a summary of observations pertaining to major sections in Volume 1 of the Draft Report:

- Section 2 – Data Collection & Review: Multiple sources of existing data were utilized, and they provided the basis for determining the activities required in the exploration program for the study. Examples of existing data utilized included local basin water wells, sewer tunnels, faults, seismic, and gas information.
- Section 3 – Exploration Summary: A table summarizing all exploration activities for each zone, such as the number of borings completed during the study and the number of existing borings used was reviewed. This table was provided on page 11 in the TAC meeting PowerPoint presentation.
- Section 4 – Summary of Data & Faulting: A map using dots to show the information collected during the study was shown, with an emphasis placed on the faulting information. The Raymond Fault, which crossed Zones 2, 3, and 4, was indicated as the most important. Mr. Chandran noted that the extension of the Alhambra Fault is shown for the first time in this map and was not previously thought to extend as far as it did, adding that this was CH2M Hill's contribution. Both are considered active faults.
- Section 5 – Groundwater Conditions: There are a total of five groundwater basins, including San Gabriel Basin, Raymond Basin, Eagle Rock Basin, San Fernando Basin, and the Central Basin. The review of the groundwater conditions indicates that the tunnel does not affect the surface water features.
- Section 6 – Hazardous Waste Studies: A summary showing the findings from a hazardous waste study was presented. These findings were mainly based on historical documents, information and databases. Contaminated groundwater and soil was identified in Zones 1, 4, and 5. There are also a few isolated contaminated areas that are not considered to be an issue in the zones. This map is different from the one shown before, because the Environmental Protection Agency (EPA) just updated their map and the boundaries have been changed. For example, they removed the limits from Zone 4. The technical team was advised by the EPA and others not to change this map or use any variations of this map due to liability issues. Zone 1 has a containment system in place. Zone 4 is still being evaluated limits of contamination and a Record of Decision is expected within the next 2 years. Once the Record of Decision is accepted containment plans can be developed. In Zone 5, a Record of Decision has been completed and containment expected in the next few years.

Mr. Chandran noted that Sections 7 – 11 pertain to subsurface soil conditions of the five zones. Maps showing the plain view and cross section view for each zone were presented.

Note: sedimentary rock is soft rock, and igneous and metamorphic rock is hard rock.

- Section 7 – Consists of Zone 1 findings. Zone 1 consists of fairly uniform material, which primarily consists of sedimentary rock of the Puente formation, which is weak sandstone. There is also some alluvium in the northwest corner, which is part of the Superfund Site. The groundwater table for the alluvium is within 20 – 50 feet below ground surface. There are no known active faults in this zone. There is a potential for gassy conditions, which must be taken into consideration for design and construction activities. There have already been two tunnels constructed in Zone 1 and they were successfully completed.

- Section 8 - Consists of Zone 2 findings. Zone 2 mostly consists of Topanga and Puente formations. Both of these materials are fairly uniform and fairly similar from a tunneling perspective. There are also some Fernando formations in a small portion of the zone. As with Zone 1, there is some alluvium, which is fairly shallow. Some of the alluvium is in the portal area and most of it is in the mid-section of Zone 2. This zone is slightly more variable than Zone 1. There is one active fault in the northwest corner of the zone. Depending on the tunnel alignment, it may affect the portal area but not the tunnel area. Groundwater is about 20 feet below ground surface.

- Section 9 - Consists of findings for Zone 3. There is more variation in the material types. The southern half is mostly Puente and Topanga formations, similar to what you see in Zones 1 and 2. There is also some hard rock encountered, and alluvium in the northern portion of the zone. Zone 3 includes the active Raymond Fault as well as two potentially active faults, the Eagle Rock and San Rafael Faults. On the Raymond Fault, a displacement of 4 feet is expected as a result of seismic activity. The groundwater depths are variable.

- Section 10 - Consists of findings for Zone 4. This zone consists mostly of alluvium. The tunnel would be predominantly within the alluvium zone. The Puente formation mostly exists at the southern end of the zone. There are two active faults: the Raymond and Alhambra Wash Faults. The faults act as a groundwater barrier. There is a potential for high groundwater inflows in alluvium and a potential for caving soils. The Superfund Site is located in the central portion of the zone.

- Section 11 - Consists of findings for Zone 5. This is similar to Zone 4. Zone 5 is mostly in alluvium. There is a potential for high groundwater inflows in alluvium and a potential for caving soils. Puente and Fernando formations are mostly present in the southwest portion. The Alhambra Wash Fault, which is an active fault, is in this zone. There is a Superfund Site located in the mid portion of Zone 5. The surface water feature would impact the east portal zone and would be a constraint from a tunneling perspective.

Mr. Chandran then summarized the technical team's findings for each zone. These are detailed in a table on page 41 of the PowerPoint presentation. The meeting was handed over to Steve Klein.

Tunneling Considerations: Steve Klein, Geotechnical Team

Mr. Klein provided an overview of the findings regarding the geotechnical feasibility of constructing a tunnel in any of the zones. Key geotechnical factors for tunneling, such as type of material, uniformity, and groundwater were quickly highlighted. Mr. Klein stated that it was determined to be feasible to tunnel in all five zones from a geotechnical point of view, adding that each zone has some challenges. He also noted that there is technology available to address these challenges, citing constant improvement of tunnel construction since the 1950s, extending their availability to build tunnels in complex geotechnical conditions through methods used in Los Angeles and world-wide.

He addressed the topic of ground stability, which is an issue mostly in alluvium and soil deposits because these materials are not strong enough to resist the movements in a tunnel. This is normally a major issue in urban areas. Mr. Klein informed attendees that this would be extensive in Zones 4 and 5, but would also occur somewhat in Zone 3 and in the portal areas of Zones 1 and 2. He noted that tunneling machines have been developed to address such issues and showed the tunnel technology used to build a highway tunnel in Madrid, a 50 foot diameter Earth Pressure Balance Machine. A similar machine was also used in the Metro Eastside Extension project. It allows you to seal out the groundwater pressure and avoid material from invading the tunnel. You can tunnel without loss of ground or damage to surface conditions using these types of machines. He also referred to a Slurry Tunnel Boring Machine (TBM), which involves installation of a water tight lining and is designed to resist ground loads. The same technique was used for the Metro Arrowhead Tunnel project in San Bernardino and could be used for this project. Mr. Klein stated that specialized testing for the gaskets showed that it could withstand 900 feet of external groundwater pressure, which is roughly three times what has been done worldwide.

Mr. Klein addressed the issue of uniformity of materials, showing a portion of Zone 3, which contains soil, weak sedimentary rock, and hard rock. Tunnel Boring Machines have been developed to go through a variety of materials. A machine utilized for the Riverside Badlands tunnel, dealt with variances in geotechnical materials, was shown to demonstrate existing tunneling capabilities. The specific capabilities of the TBM with rock/soil cutterhead were reviewed; the machine is adaptable to excavate variable geological conditions.

Mr. Klein discussed natural gas, noting that the Puente formation, which contains high amounts, has been found in various tunnels throughout Los Angeles. The Northeast Interceptor Sewer Tunnel, which is partially located in Zone 1, was provided as a recent example of tunneling through gassy conditions. He added that proper safety precautions and equipment selection is key and these types of tunnels are closely regulated by California Occupational Safety and Health (Cal OSHA) to ensure that safety issues are being properly handled. Mr. Klein explained that ventilation is critical in removing natural gases from a tunnel. Useful features to account for the existence of natural gas in a tunnel would be special electrical connections that are spark-free to prevent ignitions, and a safety feature that shuts all power down during construction if gas

levels reach a certain point. He stressed that gassy conditions have been encountered in a number of projects in Los Angeles and tunnels have been built safely through the use of such techniques.

He moved along to the topic of active faults, stating Zones 2, 3, 4 and 5 contain active faults. If a tunnel is built across an active fault, it is possible that a large earthquake could shear a tunnel if it were not designed to compensate for fault displacement. He stated that in an instance where a tunnel would cross a fault, one would have to build an oversized vault section within the tunnel that could withstand the movement in the event of an earthquake. Metro has accounted for this situation in the Metro Red Line Hollywood Hills Tunnel. A schematic showing the configuration of such a vault was shown. Mr. Klein added that this concept considers a possible displacement of about 7.5 feet as the result of an earthquake and a similar concept is used for the Metro Red Line Hollywood Hills project to mitigate a displacement of 6.5 feet. He also added that his firm designed this concept for the East Bay Municipal Utility District and they won an innovation award this year from the American Society of Engineers for using this technology. Mr. Klein briefly reviewed another technique utilizing segmental linings to deal with fault crossings if less movement was anticipated.

Finally, the issue of contaminated soil and groundwater was discussed. Mr. Klein stated that this is a potential safety hazard and liability issue, adding that they cannot allow the plume to migrate and must dispose of contaminated material properly. He noted that disposal costs can be significant depending on the nature of the contaminants. A solution utilizing a pressurized machine, where you can tunnel through the groundwater without having to do de-water outside of the tunnel envelope, was discussed. The issue of contaminated soil mainly impacts Zones 1, 4 and 5.

Mr. Klein summarized the geotechnical challenges he covered, adding that technology exists today to address these challenges and that ultimately tunneling is feasible in all zones. He closed by reviewing the Tunnel Technical Study schedule, pointing out that a Final Geotechnical Summary Report would be issued in early 2010, after a cycle of community and committee meetings are completed.

Rebecca Barrantes then reviewed comments and questions provided by the Technical Advisory Committee (TAC) during the November 5, 2009 meeting. Items are included on presentation Slides 61 and 62 of the Steering committee (SC) Meeting No. 6 presentation. Doug Failing gave a brief overview of what the next steps would consist of, which would begin with Caltrans and Metro reporting the geotechnical findings to their respective Boards, soliciting additional feedback from the committees and community, utilizing this information to complete the Final Report, and presenting the Final Report to the Committees and Metro Board. Finally, they would identify a series of next steps based on input from their governing bodies. Next, Ms. Barrantes solicited questions from the Committee, which are summarized below.

Questions, Answers, and Comments following the presentation:

For the purpose of review, Committee Member's names are spelled out during the question and answer periods. Project Staff names are denoted by their first initial and spelling of their last name.

Nick Conway: Was there any consideration given to breaking down the differences in how each geotechnical factor impacted the respective zones in terms of construction challenges versus operating challenges? (Referring to Slide 41 of the meeting presentation)

Y. Chandran: No, we have not done so. This comment was also received at the last TAC meeting, where someone suggested that the geotechnical challenges be separated into construction related and performance related. We will make those changes to the report later when we finalize the report.

Mike Cano: What kinds of formations exist in the Eastside Extension and North Hollywood project tunnels? Are any formations similar to those encountered in the zones of this study?

S. Klein: The Eastside Extension was built in a Fernando formation, which is similar to formations encountered in the northeast interceptor sewer in Zone 1. It is a very similar sedimentary rock formation and is weak from a rock perspective, but fairly stable from a soil perspective. The formations in the Hollywood Hills have various types of granitic rock similar to Zone 3.

Y. Chandran: Section 12 of the Draft Geotechnical Summary Report discusses similarities in formations encountered in the study zones and existing tunnels.

Edel Vizcarra: The Metro Red Line project encountered the Hollywood Fault and gassy conditions. Are those similar challenges to those found in these zones?

Y. Chandran: Yes, the challenges are similar.

Stephen Del Guercio: We have been provided with a lot of data and certain challenges have been identified for tunneling. What we have not done is discussed what the data means. If something is a challenge, is it a challenge in terms of safety and operations, or in terms of design cost? In terms of relative ranking between these challenges (not zones), I am not getting a sense of which are easy and which are difficult. For example, soil and groundwater contamination do not strike me as a big concern. Based on

the presentation, we have technology that can deal with the challenges of contaminated groundwater. Groundwater is also only toxic in terms of drinking water, but not when one comes into contact with it in other ways. If we were to look at another challenge, such as active faults, from what I understand there is a larger concern due to potential fault rupture. Not identifying the implications for these challenges, in terms of safety and design costs, does not make the information useful to whoever is going to read it as the next step. What I would hope is that as a Committee, we could be a part of that next step and have that discussion in the appropriate forum because we now have the data needed to discuss these types of things. I understand that there is earthquake risk for active faults. I do appreciate your designs, but I would like to know how concerned we should be about the risks. Should we consider a strategy of designing around the risks or should we avoid the risk by going to another location? What are the costs associated with the risks? Will it cost five times more because a certain route is chosen? The public wants to know these things and that is what we found out when we did our public outreach. The public wanted to know about cost and safety. With all due respect, simply saying that we have good technology without providing the reader of the report with the background and implications of the data is a shortcoming. If this is not addressed now, it certainly should be. That is the public forum that I had in mind when I signed up for the Committee, to come here and be able to understand and then go back and share with the community, so the public has trust and makes informed judgments that are based on good data analysis.

Y. Chandran: That is an excellent question. We intentionally steered away from characterizing the geotechnical challenges in terms of degree of difficulty because this was requested by the Committee in SC and TAC Meeting No. 5 when we presented the data from the exploration activities. We were told not to make any conclusions and to instead present unbiased data and let the Committee review and make decisions about what is major or minor based on their interpretation. We can go back and do that, but we did not take that step on purpose because it was requested not to during one of the committee meetings. In terms of cost, this is a key component; however we do not want to look at costs based on geotechnical data alone. We need to look at other factors, in addition to geotechnical data; otherwise we will get a skewed view of the cost. This is something that can be looked at in the future at the next step.

S. Klein: This information alone may not mean a lot to you, but it is what is needed to develop a feasible design and construction concept for the tunnel. If we address these challenges, we can come up with a design and construction concept for a tunnel in any one of these zones. Once we

have that, we can go to the business of determining costs. We are in a process and have completed the first step by doing comprehensive evaluation (as represented in the report). We have collected significant information that allows us to go to the next step. These are not all of the challenges because we highlighted the key challenges.

Edel Vizcarra: I understand the concerns of the City of La Canada Flintridge and ultimately Zone 3 would affect your city, but we hope that this does not become a scare tactic, where the risk of faults would be characterized in a way that would encourage people to look at Zones 1 and 2 instead. When people hear "fault," they automatically think that the tunnel is going to cave. If you are going to list whether there are faults and what the negative impacts are, you should do the same for other challenges, such as high gas potential and soil contamination.

Stephen Del Guercio: That is exactly my point, which is to give decision makers all of the information needed to determine if something is a showstopper or not, such as cost. I am using that (faults) as one example.

Edel Vizcarra: I agree; however it seemed that in your comment you indicated that faults are the biggest concern. In reviewing the table provided in the presentation, I can see that Zone 1 is the only zone without active faults and I do not want it to get shifted over there.

Stephen Del Guercio: I am simply saying that faults do rupture and that is fairly significant.

Edel Vizcarra: Yes, and there are explosions when gasses are encountered.

Mike Cano: In prior discussions we worked on better defining what the scope of this study was. Addressing some of these issues and trying to overlay evaluative criteria was something to be done in another study effort, not in this one. This study effort was very clearly and narrowly defined.

Y. Chandran: Yes, our understanding was that looking at cost, design and construction implications were to be done in a future study effort. We were directed to present the data and facts and let the Committee make determinations based on what was presented. We steered away from making our own interpretations.

David Worrell: I agree with the general thrust of Steve's question. We start with the conclusion that all routes are feasible. I can say that everything is feasible as long as you do not care about how much money it costs. I understand your approach that there are a lot more issues in addition to geotechnical that need to be considered; however we have spent tons of money to get to this point and all we have is a chart that shows

challenges and a comment that we are presenting data to the Steering Committee and Technical Advisory Committee to make decisions on. If you were making a presentation to the Board of Directors of a company, they would be extremely disappointed with this because the obvious question that people have is what the data means. I cannot conclude a meaning from any of this. How can I make a decision on any of this? This is geotechnical data that is not accompanied with any advice as to what it means. This may make sense to the technical people, but this does not make sense to me. We need a little more help in figuring out what this means. What am I going to tell the City of Pasadena? What does "all routes are feasible" mean?

D. Failing: What started the study was that very question. I had the conversation with a number of elected officials who were concerned that Caltrans and Metro were putting out the idea of a tunnel when it was not clear if it was feasible at all. We had to answer that question before we could consider any next steps. It was very clear that they did not want us to proceed any further than that. It was also very clear that they wanted us to maintain route neutrality and not look at specific routes. Instead, we looked at zones. The team has been really challenged with this task. If there is a concern about this, you can point back to me because we have been very limiting on the team. They would like to do a lot more than this, but I have been very limiting based on that commitment made at a political level to keep this down to these specific questions before anyone looks at making a further step. I worked very hard to hold them back because that is how I saw the mission of the questions I was asked.

David Worrell: What would you have to find to conclude that tunneling was not feasible? I am not being argumentative. I do not have a position on this. I am not for or against tunneling. I am not for or against a specific zone. This presentation tells me that we have giant technical capabilities and we can solve any tunneling problem.

D. Failing: What I gather from the presentation is that there are technical challenges that we have solved before in the area and there is nothing that would cause us to completely avoid x, y, or z. I do think there were issues raised that do not indicate a challenge within a zone that is limited to that entire zone. We are simply being told that if we were to focus on that zone, certain challenges should be considered. This study went through a very careful deliberative process that ultimately indicates there are no showstoppers and we can deal with anything within any of the zones within a relative comfort zone. This is my interpretation. If we do decide to proceed, we can rely on the more technical environmental type of questions that would be asked, such as whether a project has a

purpose or need met, and what are issues that, from a true environmental standpoint, would define a certain zone. My interpretation of your question is that you are asking if we are going to present something just to throw the Committee off track, get them to agree to go forward and then bait and switch the tunnel. I can say very clearly that the answer is no. The question that I was asked to proceed with has been answered.

Lynda Bybee: I felt that the team produced examples of similar geotechnical conditions where tunnels have been successfully constructed and those problems solved. We have the recent example of our Gold Line Extension, which is a mile and three quarters long in similar formation. We had absolutely no settlement and no incidents with that tunnel. We have had seismic activity since we tunneled under the Cahuenga Pass and have had no incidents there. There are practical examples of this in the Draft Report. The point is that as professionals in this area, we have seen these conditions before and we have solutions for these.

Mike Cano: I would like to commend you because you have done very good work here. I also recognize the interesting political constraints put on you, such as route neutrality, which was not a concept that my boss supported because it seemed to dilute the point of the study. You also had limited funding. This process has gone on for a long time and there are a lot of different facets to it that have answered a very basic question. Tunneling is technically feasible. The next step is to go back to the Metro Board to see if they have received Measure R money and what is to be spent on the project. Obviously, they are going to have more information than before to make a decision but that is a future task order for a different Board, not this Board. I can understand the frustration of this Board for not having the answers to questions such as cost, financing and different issues that were never part of the scope of the study. I do not want to criticize the study team for doing what we told them to do from the beginning, which has been as political as it has been technical. I would like to congratulate you and I hope that we can move on to the next step.

Nick Conway: What would be the cost and time involved with addressing the additional issues that have been raised?

Y. Chandran: Task Order No. 5 attempted to address some of those issues. The timeline to complete that was 3 to4 months. The task order would have addressed these issues at a conceptual level. I believe the fee to complete that was about $1 million dollars.

Nick Conway: At the last meeting, we scoped down the product that we received tonight. There were many other elements in that task that I think could have been done. Now certain question have been raised tonight that

would require you to go back and get that information, primarily as they relate to this exhibit, such as to flush it out more and discuss in greater detail the impacts associated with each one of these conditions, put some numbers to it and ultimately get the cost effectiveness in broad terms.

Y. Chandran: We can look at details, in terms of what needs to be done from a design or conceptual standpoint and address those geotechnical challenges. If we had to do that in all five zones in that detail, we would have to go back and analyze that more to determine a timeline.

Nick Conway: I am not asking for an answer tonight. I think that before you advance this, questions have been raised about trying to get a clear picture with the hope of getting consensus. The Committee should get that information back because we scoped this down to get to this point. Maybe without having to dismiss everything, we could go back and pick up certain subtasks and finish that effort now.

Y. Chandran: We will consult with Metro and Caltrans regarding that.

Lee Dolley: I understood this to be a feasibility study. This was not to find out all the environmental concerns, but whether tunneling could be done or not. We are in the process of commenting on 150 pages of geotechnical information. This information is not unclear. There could be a lot of next steps and I am looking forward to them. I have never in my 40 to 50 years encountered a Committee like this. It is extraordinary that this happened and it is a good thing.

Philip Putnam: Some of these issues have not been addressed. For example, the fault issue is not just about whether it is an active fault, but is also about whether the tunnel crosses perpendicular to the fault, runs parallel to the fault before it crosses the fault, and issues like that. There are a lot of similar issues for the other geotechnical challenges that have not been discussed. Are these problems being fleshed out at this stage or are they going to be dealt with at a later time?

Y. Chandran: In general, when crossing a fault, you want to cross perpendicularly. We did not focus on specific alignments, and we did not discuss that in detail. Perhaps we can include some of that information in the report. That is a valid request and we should address that in the conceptual portion of the report.

Philip Putnam: These are all valid questions that were addressed by Del Guercio and the representative of Pasadena, but I do not know how you can address them without knowing more about an alignment. I do not see how that can be done.

Y. Chandran: Yes, it is true. Some type of an alignment is necessary to quantify certain things.

Philip Putnam: Are you going to assume a couple of potential alignments to discuss those? Are you going to boil this down? We had discussions before and it seemed like Zones 4 and 5 would parallel existing surface routes. It would not make any sense from a transportation perspective. I do not know when you plan on eliminating some of these routes on the basis of common sense. Not that I want to tunnel in any of the other zones, you cannot study everything.

D. Failing: In my opinion, the time to begin eliminating things would be at one of those next steps. This is hypothetical. If you go into environmental phase, when you start scoping, you begin whittling down things that are not probable and put a little data behind it. For instance a traffic analysis may show that Zones 4 and 5 would be less desirable. Again, I very firmly directed this team not to conduct traffic analysis on any of the zones because it would cloud route neutrality. I am hard pressed to suggest a step that begins to eliminate routes for nothing other than a geotechnical issue.

Philip Putnam: I am not suggesting you to do that or that it is appropriate here. I am wondering what the next steps are and how this gets addressed moving forward.

D. Failing: I look forward to having that conversation with the Metro Board.

Mike Cano: Does this body (Committee) that has been constituted expire in March when the presentation is done or does it shift in terms of the scope? I do not want to see parallel decision making bodies. The MTA Board would be the primary decision making body.

D. Failing: The input received from the body has been invaluable, whether I agree or disagree with what was said or not. It has been invaluable to shaping data sets. The SC and TAC are currently constituted at the time that this study is accepted and done. If there are next steps going forward, it would be my recommendation that if not this very same body, that a similar advisory body be constituted, because, again, the input has been invaluable. Nothing is done in a vacuum anymore. I can make recommendations, but have a Board that will tell me what they think and I would follow that.

Lynda Bybee: Typically our outreach on major projects includes advisory committees and sometimes multiple committees to address the issues.

Nick Conway: We are supposed to get our comments in and then get a draft report. Is that what the process is?

Y. Chandran: We accept your comments and will have a series of three community meetings. Based on your comments, we will incorporate them into the presentation. Once we receive feedback from the community meetings, we plan to finalize the report in the February or March timeframe, where we will incorporate comments from both committees and feedback from the community.

Nick Conway: Returning to the question that I had earlier, because we scoped this down to specific points, can we go back and pick up one or two of the subtasks (from Task Order No. 5) to address questions raised by Steve and others. When does that get played into this? Does it? Will that get kicked to the next step?

D. Failing: I will sit back with the team and play that back. We have received good comments. Can we do something at a conceptual level that still keep us in the concept of route neutrality to address these issues in a relatively decent time frame and present that to the public and go forward with that? That is a good question, we need to address that, and we need to take a little time to take a look at that and have a conversation with our technical experts and make a decision on that as we go forward. I think that can be addressed relatively quickly yet we would need to keep it within the concept of our overall principles. We will have that discussion.

Next Steps: Rebecca Barrantes, Community Facilitation Team

Ms. Barrantes explained plan for the next steps in the study, with a focus on the outreach process and upcoming meetings. She noted that comments requested from the TAC and SC regarding the draft report will be due November 30, 2010. She also informed them that three regional community meetings would be held mid-January to early February of 2010, where the public will review the presentation provided at this meeting with modifications based on the comments provided. She noted that the report is in draft stages throughout this process, but the final report will be completed in late February or early March. The breakdown is as follows:

- Comments due from Committees: November 30, 2009
- Community Meetings: Mid-January to early February 2010 to review the Finalized Draft Geotechnical Report
- Final Summary Report: Late February to early March 2010
- Committee Meetings: Late February to early March 2010 to review the Final Geotechnical Report

Moving along to the public outreach process, Ms. Barrantes provided the scheduled dates for the upcoming regional community meetings.

- La Canada Flintridge, Glendale, Northeast Los Angeles – January 20, 2010 at Wilson Middle School.

- Pasadena, South Pasadena, and San Marino – This will take place at the San Marino Center on January 26, 2010.

- El Sereno, Monterey Park, Alhambra – This will take place at the Los Angeles Christian Presbyterian Church during the week of February 2, 2010

Ms. Barrantes pointed out that all of these meetings would take place from 6 pm to 8 pm. Mr. Edel Vizcarra interrupted to comment on the community meeting schedule. The following questions and requests ensued.

Questions, Answers, and Comments following the presentation:

Edel Vizcarra: It appears that each meeting is held for three cities, but in Northeast Los Angeles there are six or seven different communities that are just as large as any city. Would it make sense to have one individual meeting for Northeast Los Angeles?

D. Failing: I will take this as guidance from the Steering Committee.

Nick Conway: Piggybacking off the concerns of Northeast Los Angeles, we have potential corridors going to the San Gabriel Valley. How are the 1.5 million people in the east San Gabriel Valley going to be brought into this decision making process to express their views on the feasibility of having a tunnel in the San Gabriel Valley?

R. Barrantes: Are you specifically referring to Zones 4 and 5?

Nick Conway: I would urge those cities east of San Marino up to the foothills to have at least 2-3 input sessions if we are going based off communities and population centers. You cannot just have one meeting for the San Gabriel Valley.

Ms. Barrantes informed the attendees that the SR-710 Tunnel Technical Study Draft Geotechnical Summary Report is available on DVD at public library locations listed on the website and also on the study website (www.710tunnelstudy.info). She noted that it would be available in Spanish and Chinese by the end of the week.

A Committee member commented that additional libraries would need to be provided with copies of the report in light of Mr. Conway's requests for additional community meetings in the San Gabriel Valley.

Lastly, Ms. Barrantes reviewed the next steps which included continued feedback on the draft report, submittal of comments and completion of the Final Report, followed by a presentation to the committees.

Meeting was adjourned at 7:50 PM.