Executive Summary

This report summarizes the results of Exponent- Failure Analysis Associates' (Exponent) evaluation of Parson Brinkerhoff's safety assessment for the Westside Subway Extension Project, which is proposed to be constructed beneath portions of the City of Beverly Hills and contiguous portions of the City of Los Angeles. Exponent evaluated relevant geological, geotechnical, petrochemical and structural engineering hazards associated with the proposed construction, and evaluated the methodologies and metrics used to form the project's safety assessment conclusions. This evaluation is based on preliminary design documents prepared by Parsons Brinkerhoff on behalf of the Los Angeles County Metropolitan Transit Authority, reviewer comments, and other relevant documents.

The Westside Subway Extension Project is currently evaluating two tunnel alignment options through the Century City area, a southerly route associated with a station on Constellation Boulevard and a northerly route associated with a station on Santa Monica Boulevard. The choice between these two station alternatives is a critical design milestone that drives the rest of the design. A station located on Santa Monica Boulevard will be associated with construction of the subway tunnel beneath Santa Monica Boulevard and Wilshire Boulevard within the City limits. A station on Constellation Avenue would necessitate construction of the tunnel beneath historical Beverly Hills High School (BHHS), as well as a number of residences and businesses on the western side of the City.

While the *Century City Area Tunneling Safety Report* and *Century City Area Fault Investigation Report* outline many of the hazards associated with the tunneling project, such as fault rupture, gas explosion and ground settlement, Exponent's overarching opinion is that neither report demonstrates the presented findings as based on rigorous risk assessment(s) on these subjects. Specifically, no attempt is made to quantify or even qualitatively assess the potential risks from these scenarios. No quantitative or qualitative risk assessments have been presented to either a) estimate the likelihood of such events or b) characterize the potential severity of such events to the public.

Based on the findings reported in the Metro-sponsored reports and supporting review comments, momentum seems to be building against construction of a station on Santa Monica Boulevard based on perceived fault rupture hazards. It is Exponent's view that the alternative Constellation Boulevard station, while generally in a more favorable location with regards to faulting issues, is instead faced with potential methane gas hazards that could represent at least as great a hazard to the public as the faulting hazards associated with the Santa Monica Boulevard station. In the absence of a quantitative risk assessment, the choice between the stations is more likely to be made on the basis of risk perception rather than risk quantification. Additional steps can and should be performed at both station locations to better quantify the seismic and gas hazards at these locations. Potential adjustments to the proposed locations should also be considered.

The proposed tunneling project has been characterized as having a low probability of causing disturbance to overlying structures based on the application of a simplified methodology for assessing such hazards and optimistic assessments of tunneling proficiency using pressure-face tunnel boring machines (TBMs). Frequent reference is made to previous favorable experience in the Los Angeles Basin using such devices. Such references, however, have little meaning in the absence of detailed data from the earlier projects.

Even if the actual ground disturbances turn out to be as low as anticipated, the subway tunnels are projected to extend beneath older neighborhoods that are underlain by old, fragile water lines that could experience damage as a result of even minor soil disturbances. Special precautions will be needed to safeguard these lines from damage during construction.

Gas hazards will not be insignificant for the proposed project. Most of the narrative in the reports focuses on gas hazards within the tunnel segments during construction. Almost no attention is paid to the potential for gas releases to the surface as a result of tunneling activities or to the future safe operation of the Constellation station, which would extend into geological deposits that have been closely associated with gas hazards at other locations in the Los Angeles Basin.

Substantial shortcomings exist in the efforts carried out to date to locate early wildcat wells along the proposed subway alignments, especially in the vicinity of BHHS. The reports are mute regarding the potential surficial hazards of encountering well casings during drilling or the ramifications of having to stop drilling and remove a casing while the TBM is parked beneath a sensitive structure. It is Exponent's opinion that unknown factors such as these will preclude tunneling beneath the high school while in session.

With regards to future construction of deep foundations in the vicinity of subway tunnels, the reports are somewhat vague and address only the concerns raised by BHHS. Other stakeholders along the route may also anticipate future construction activities that could be potentially impacted by the presence of underlying subway tunnels.

During our review process Exponent recognized a short-coming of the presented assessment methodology that focuses solely on the safety issues, namely the lack of life-cycle analysis of the considered tunnel alignments of the Westside Subway Extension Project. Such an analysis would allow consideration of the safety risk management issues of the project within the broader spectrum of environmental and economic aspects of the selection process.

In summary, it is Exponent's opinion that additional effort is needed to accurately identify, quantify, rank and mitigate the potential hazards posed by the proposed Westside Subway Extension Project before one of the two presented alternatives, or a third alternative, are selected for implementation.

Limitations

The opinions and comments formulated during this assessment are based on information available at the time of the investigations. Exponent has no direct knowledge of, and offers no warranty regarding, the conditions beyond what was reviewed during our investigation. Comments regarding these conditions are professional opinions, derived in accordance with current standards of professional practice based on our engineering experience and judgment. Exponent has exercised usual and customary care in the conduct of this assessment. No guarantee or warranty as to future performance of any reviewed condition is expressed or implied.

The findings presented herein are made to a reasonable degree of engineering certainty, based on information possessed by Exponent as of the date of this report. This report may be supplemented to expand or modify our findings based on additional work or review of additional information.