8 CONCLUSIONS

The August 24, 2014 M6.0 South Napa earthquake was the largest earthquake in the San Francisco Bay area since the October 17, 1989 M6.9 Loma Prieta earthquake. The rupture mechanism was primarily strike-slip and surface fault rupture was pervasively expressed along much of the ruptured fault plane trending NNW and extending for a distance of 12-14 km from the hypocenter. Surface faulting damaged homes, underground utilities, and other infrastructure when it traversed developed areas, such as the Browns Valley area in western Napa. The earthquake itself produced intense pulse-like motions that caused significant damage to older structures in parts of the City of Napa and immediately surrounding area. Noticeably, there was lack of liquefaction and liquefaction-induced ground failure resulting from this event, even in areas previously identified as being susceptible to the liquefaction hazard. Dam and levee performance was generally excellent, and only a few cases of minor cracking of dams and levees were observed. Similarly, underground storage caverns at local wineries performed well, with only minor cracking reported at some of the installations. The most unusual and distinct damage were compressional and extensional failures of relatively new, stiff concrete sidewalks and curbs in the Browns Valley area. The sidewalk failures appeared to be distinct from the surface fault rupture and appear to be a manifestation of localized zones of compression and extension, possibly induced by intense transient surface waves.

The observations and data presented in this report help document the geotechnical effects of the South Napa earthquake. There are several research opportunities presented by this event. Much can be learned by a comprehensive study of the ground motions produced by this earthquake, including near-fault velocity-pulse effects, the unusually intense high frequency spikes in the acceleration time series at the Carquinez bridge site, and the effects of the Napa basin and local site effects on ground motion characteristics. Most of the strong motion sites require shear wave velocity measurements to characterize the V_{s30} of the sites. The characteristics of surface fault rupture were well captured, and they offer the opportunity to better understand the characteristics of ground deformations in close proximity to the fault rupture. The effect of surface fault rupture on homes and other infrastructure is a particularly fruitful avenue of further study. Structures with different foundations can be investigated to better understand how each foundation system responds to and performs in areas of ground deformation from surface faulting. The alternating patterns of sidewalk compression zones and extension zones are relatively unique observations of ground performance that may provide insights regarding transient ground motions in the very near fault zone. Conversely, the ground deformation recorded in the sidewalks in the Browns Valley area may be a result of secondary ground deformation resulting from surface faulting, compacted earth fill, or slope movements. Thus, further study of these ground deformations is warranted. Sites that were previously mapped as being liquefiable, which did not exhibit surface manifestations of liquefaction, should be characterized better and added to the liquefaction triggering database. The cause of damage of buried utilities in areas that did not undergo permanent ground displacements should be investigated. Lastly, the documented performance of dams, levees, other earth structures, and natural slopes provides the opportunity to evaluate commonly employed analytical procedures. Thus, the South Napa earthquake presents several important opportunities to advance the profession's understanding of the geotechnical effects of earthquakes. We hope that this report provides observations and data that support fruitful follow-on research activities.