

Summary and Conclusions

Information in this report provides a preliminary summary of geotechnical conditions within the five zones being considered for the SR-710 tunnel. This section briefly summarizes some of the key tunneling considerations for each zone. Refer to Section 13 for additional details and Sections 7 through 11 for the individual zone descriptions.

Zone 1

A tunnel in Zone 1 will be mostly in the Puente Formation, a weak to moderately strong formation composed mainly of sandstone and siltstone. The low strength and uniform nature of this formation are favorable for modern TBMs. Higher progress rates are expected in this zone, as compared to the other zones (except Zone 2). Alluvium may be encountered in the portal areas requiring localized ground improvement or groundwater control measures to avoid ground movements that could damage surface facilities. Although, the Puente Formation is not expected to produce significant groundwater inflows into the tunnel, high inflows could be encountered in the lower cover beneath the Los Angeles River. These inflows can be controlled by grouting ahead of the tunnel excavation; however, there are still higher tunneling risks associated with the portion of the tunnel beneath the river. In this area, the groundwater may be contaminated due to the Superfund site in this zone. Methane gas also has been encountered in the Puente Formation at other tunneling projects in Los Angeles. Both of these issues will require special safety precautions and will be a factor in the selection of tunneling equipment and procedures. However, methods have been developed to allow safe tunnel construction where these conditions are present.

Zone 2

A tunnel in Zone 2 will encounter mainly the Puente Formation and the Topanga and Fernando Formations, two similar weak sedimentary formations. Less alluvium is expected in the portal areas due to the topography, which is more steep and hilly. Similar to Zone 1, weak sedimentary formations are expected to be favorable for efficient tunnel construction. Comparison between Zones 1 and 2 also shows: (1) in Zone 2, there is no Los Angeles River crossing and no Superfund sites; (2) there is similar potential for encountering methane gas in both Zones 1 and 2; and (3) a tunnel in Zone 2 will cross the active Raymond fault at the northwest corner of the zone, whereas this will not occur in Zone 1. A special tunnel design will be required for the fault crossing to avoid rupture of the tunnel and possible collapse due to an earthquake on this fault. Similar fault crossings have been designed for the Los Angeles Metro's Hollywood Hills tunnel, which crosses the Hollywood fault.

Zone 3

A tunnel in Zone 3 will encounter the greatest range of geologic conditions compared to the other zones. These conditions include weak sedimentary rocks, strong granitic rocks, and alluvium. Such a range of conditions is likely to result in less-efficient tunneling operations and

lower overall progress rates. Mixed face transitions from one geologic formation to the next will also likely result in more difficult tunneling operations and reduced progress rates. Tunneling through the alluvium will require specialized tunnel equipment to avoid surface settlement and damage to surface facilities. It appears these concerns are more extensive in Zone 3 than in either Zones 1 or 2. The active Raymond fault is also present in Zone 3. The crossing of the Raymond fault in Zone 3 is likely to be in a deep reach of the tunnel distant from the portal. This crossing is likely to require a special lining like the Metro Red Line crossing of the Hollywood fault. This fault may be acting as a groundwater barrier where it crosses the tunnel, which may require some additional grouting to maintain tunnel stability. The potential for methane gas appears to be lower in this zone than in Zones 1 and 2 because less of the tunnel is in the Puente Formation and no Superfund sites are present, thereby reducing the potential for encountering contaminated groundwater.

Zone 4

A tunnel in Zone 4 will encounter mainly alluvium or unconsolidated soil deposits. Most of the tunnel will be in cohesionless soil deposits below the groundwater table, requiring positive groundwater control to avoid loss of ground and surface settlement. Specialized tunnel machines that are sealed to preclude groundwater inflows can be used; however, tunnel progress rates will be lower than in Zones 1 and 2 where the tunnel is in rock formations, and probably will be less than in Zone 3, too. In addition, constructing tunnels in alluvium involves some inherent risks because any loss of ground or overexcavation in the tunnel can lead to ground movements, surface settlement, and possible damage to surface facilities. This type of risk is limited in Zones 1, 2, and 3. A Superfund site is located at the southwest end of this zone. This can be handled as discussed above for Zone 1; however, the performance of the concrete tunnel lining in this chemical environment (type and concentration of the contaminants) must be evaluated to determine if measures are required to protect the structural integrity of the tunnel. A tunnel in this zone will cross two active faults, the Raymond fault and Alhambra Wash fault. These two locations will require special fault-crossing designs, as discussed above for Zone 2. Due to portions of the tunnel being in the Puente Formation, there is some potential for gas to be encountered in this zone, but the risk is much lower than in Zones 1 and 2 and probably lower than Zone 3.

Zone 5

A tunnel in Zone 5 will encounter mainly alluvium or unconsolidated soil deposits, similar to Zone 4. Tunneling concerns and risks are the same as discussed above for Zone 4. Groundwater control and potential ground movements will need to be controlled, similar to Zone 4, to avoid damage to surface facilities. Tunnel progress rates will not be as high as in Zones 1 and 2, and probably will be less than in Zone 3. Differences between Zone 4 and Zone 5 include: (1) in Zone 5, there is no crossing of the Raymond fault zone, and (2) the extent of the Superfund sites (or potential groundwater contamination) appears to be more extensive. Therefore, only one active fault (Alhambra Wash fault) crossing will need to be evaluated, and a greater length of tunnel could be exposed to chemical attack if the contaminants present at the Superfund sites are aggressive to concrete. The potential for encountering methane gas in this zone is approximately the same as in Zone 4.

Conclusion

Sections in this report contain detailed information about the geology, faults, seismicity, groundwater, contaminated materials, and potential for gassy conditions within each zone. This information provides a basis for evaluating the geotechnical feasibility of tunneling within each of the zones. Based on the information collected and reviewed as part of the current geotechnical study, tunneling is geotechnically feasible in all five zones. Geotechnical feasibility implies that it is feasible to construct a tunnel in the geologic formations expected, including the geotechnical conditions associated with these formations using currently available tunneling technologies. Section 12 discusses several tunnel projects and the construction technologies available for conditions similar to those present within the zones under consideration for this project.