

Site Conditions for Zone 5

11.1 General

As depicted in Plates 2 and 9, Zone 5 extends to the east from the northern terminus of I-710 through the cities of Alhambra, San Gabriel, Temple City, El Monte, and Arcadia to I-605. Zone 5 generally extends parallel to Valley Boulevard, north of I-10, and terminates at I-605 in the east. The northern limit roughly coincides with Las Tunas Drive/Live Oak Avenue/Arrow Highway. Zone 5 is approximately 9.5 to 11.0 miles long and as wide as 2.3 miles at its eastern end. The delineation of Zone 5 anticipates a connection between the northern terminus of I-710 and I-605. The general location of Zone 5 is shown in Figure 11-1.

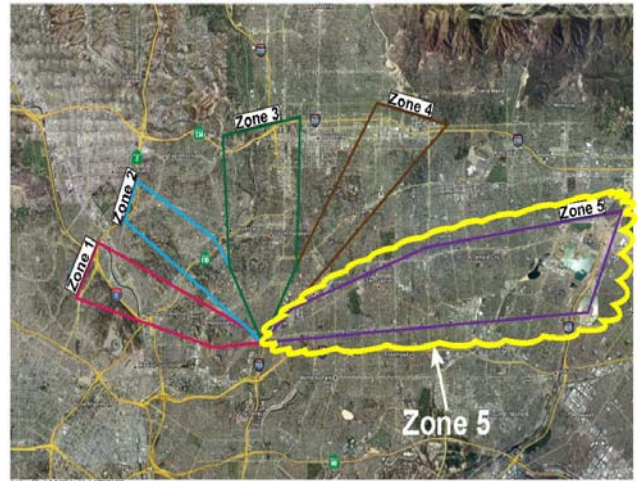


Figure 11-1. Zone 5 Location Map.

11.2 Existing Developments

The Zone 5 area is densely populated and urbanized with predominantly residential, commercial, and industrial developments. I-605, a major Southern California freeway, runs in a north-south direction and forms the easternmost terminus of the zone. The zone is roughly parallel to the east-west trend of I-10 that is located to the south. Other important surface roads that cross through Zone 5 in a north-south direction include (from west to east) Fremont Avenue, Atlantic Boulevard, Garfield Avenue, San Gabriel Boulevard, Rosemead Boulevard, Santa Anita Avenue, and Peck Road. Mission Road runs northeast-southwest in the western portion of the zone, whereas Valley Boulevard and Las Tunas Drive run parallel to the zone in its northern and southern limits, respectively. In addition, railroad tracks cross the western portion of the zone between Mission Road and Valley Boulevard.

The intermittent Alhambra, Rubio, and Eaton washes cross the western portion of the zone in a southeasterly direction, whereas the intermittent Arcadia and Santa Anita washes drain the central portion in a southerly direction. The perennial Rio Hondo and San Gabriel rivers run parallel and drain in a southwesterly direction the eastern portion of Zone 5. The Alhambra, Rubio, and Eaton washes drain into Rio Hondo River outside the southern limit of the zone. The Arcadia and Santa Anita washes also drain into the Rio Hondo River within Zone 5 limits.

Based on the densely urbanized nature of the San Gabriel Valley where Zone 5 is located, it is anticipated that a large network of shallow underground utilities are present directly underneath the surface streets. However, during this investigation, no major underground utility or other infrastructure was apparent that could potentially impact the excavation of a tunnel at an anticipated depth of 200 feet.

11.3 Zone Geology

11.3.1 Physiography

Zone 5 is mostly within the relatively flat San Gabriel Valley at an average topographic elevation of approximately 400 feet above msl. Rio Hondo, the San Gabriel River, and their tributaries, form the major stream system that drains the San Gabriel Valley. Both streams have headwaters in the San Gabriel Mountains to the north, where most of the runoff is derived. Both rivers have a common exit from the basin through Whittier Narrows from where they continue to the sea through the Los Angeles coastal plain. Rio Hondo drains the northwestern portion of the San Gabriel Basin and its tributaries, Alhambra, Rubio, Eaton, Arcadia, and Santa Anita washes enter the valley from the Raymond Basin located in the Pasadena area. All of the drainages are presently confined within riprap- or concrete-lined aqueducts except for spreading basins and quarries in the eastern portion of the zone.

11.3.2 Stratigraphy

Three major geologic units occur within Zone 5, including the Puente and Fernando Formations, and Quaternary Alluvium. The approximate configuration of the interface between the underlying sedimentary bedrock and the overlying water-bearing Old Alluvium is generalized in Plates 2 and 9. However, it is important to realize that the geologic profile is idealized and simplified to represent the entire zone.

The majority of the tunnel in Zone 5 is expected to be within Old Alluvium. Both the east and the west portals could be located within the young alluvium. In the western portion of Zone 5, the thickness of the alluvium ranges from 0 to 250 feet; at the south-central portion of the zone, the thickness can be over 1,900 feet.

Old Alluvial materials are reported to consist of unsorted deposits of boulders, gravel, sand, silt, and clay. These deposits are generally coarser grained closer to the San Gabriel Mountains, and become finer grained farther toward the south, such as near Whittier Narrows. The sediments underlying the Rio Hondo and San Gabriel rivers drainage system and the alluvial fan built up by this system in the eastern portion of Zone 5 contain in general less finer-grained materials than the Old Alluvium present in other parts of the basin. The presence of interbedded aquitards is well documented within the Old Alluvium in the entire San Gabriel Basin (CDWR, 1966; CDM, 1998, 2006, 2008a, and 2008b; GeoSyntec, 2006a and 2006b; CH2M HILL, 2003, 2006, and 2009c).

Pliocene sedimentary rocks were encountered underlying Old Alluvium at a depth of approximately 4,100 feet just north of the Whittier Narrows Flood Control Basin, which probably represent the maximum thickness of Old Alluvium in the basin. The thickest alluvium fill along Zone 5 appears to be in the vicinity of the Rio Hondo and San Gabriel rivers and their floodplains (CDWR, 1966).

Very limited outcrops of the Fernando Formation and Puente Formation occur at the westernmost portion of Zone 5 (CDWR, 1966; Dibblee, 1989b and 1999; Tan, 2000b). In the subsurface, the Fernando Formation is interpreted to underlie Zone 5 east of the Highland Park fault, whereas the Puente Formation is interpreted to occur to the west of the same fault at a very shallow depth (Yeats, 2004). The Fernando Formation is reported to be composed predominantly of weakly cemented sandy siltstones and mudstones. Very few randomly oriented bedding attitudes were recorded at the same location. Bedding dip inclinations range from approximately 60 to 25 degrees within the massive claystone and are essentially flat within the massive siltstone. The few bedding attitudes and their random orientation might be an expression of the massive nature and the poorly developed bedding of the claystone and siltstone rocks of the Fernando Formation in the western portion of Zone 5.

The underlying Puente Formation is reported to consist of siltstones, shales, and conglomerates, with interbedded sandstone and mudstone.

11.3.3 Structural Geology

Zone 5 is in the western portion of the topographically flat alluvial San Gabriel Basin. The alluvial deposits in this basin are nearly horizontal or have a gentle inclination to the south, similar to the slope of the existing surface topography. A few north-northwest trending faults are reported to transect the westernmost portion of the San Gabriel Basin. The most notable of which are the Alhambra Wash, Workman Hill, and Highland Park faults (CDWR, 1966; Lamar, 1970; Dibblee, 1989b and 1999; Treiman, 1991b; Tan 2000b; Yeats, 2004). The specific faulting considerations associated with Zone 5 are discussed below. A detailed description of faulting is presented in Section 4.

11.4 Faulting

The Alhambra Wash fault is currently zoned as an APEFZ for a short distance of approximately 2 miles (CDMG, 1991). The northernmost limit of the designated APEFZ is located approximately 1.2 miles south of Zone 5. However, the geomorphic evidence in the form of weakly developed elevation changes suggests that the Alhambra Wash fault may continue well beyond the designated APEFZ limits and that it might represent a longer fault (Tan, 2000b; Bullard and Lettis, 1993; Treiman, 1991b). Surface wave modeling for soundings Z5-S8 and Z5-S9 located at the eastern and western portions of seismic line Z5-G2, indicate that there is not significant lateral velocity variation in the immediate vicinity of the seismic line within the upper 200 feet. However, seismic-reflection data (line Z5-G2, Appendix C.2) with a much deeper zone of investigation revealed deformed Quaternary sediments along the projection of this fault. Therefore, it is assumed that the Alhambra Wash fault is projected to intersect Zone 5 and is considered to be active fault. As discussed in Section 4.2, the approximate magnitude of the maximum earthquake on the Alhambra Wash fault could be about 6.25. Based on this, potential surface rupture displacement along the Alhambra Wash fault would be expected to be much less than those that would be expected along the Raymond fault (less than 2 to 4 feet, see Section 4.2).

In addition to the active Alhambra Wash fault, three inactive faults cross Zone 5. The Workman Hill fault, Highland Park fault, and Montebello fault are interpreted to cross Zone 5 in the western portion of the zone. None of these faults are well known; they are

interpreted from sparse subsurface data such as groundwater and oil-well data and are not exposed at the surface.

Based on hydrostratigraphic evaluation of the San Gabriel Valley Area 3 Superfund Site Remedial Investigation, the potential presence of a northwest-trending structural bedrock discontinuity is inferred in the Alhambra and South Pasadena areas of the San Gabriel Basin (CH2M HILL, 2009c). The inferred bedrock discontinuity is shown from approximately the intersection of I-10 and Garfield Avenue in Alhambra on the south toward Raymond Hill and SR-110 in South Pasadena to the north. According to CH2M HILL, the existence of this structural bedrock discontinuity might explain a significant disparity in groundwater levels between the western and eastern portions and might correspond to an unnamed fault zone that extends across this area to the Raymond fault. On the other hand, the data that led to interpretation of the feature were not of high resolution and, thus, the feature may represent either the East Montebello fault or the Alhambra Wash fault (or both).

11.5 Groundwater and Surface Water Conditions

According to the MSGW (2006) groundwater-contour map for the entire basin, the groundwater levels in 2006 occurred at a depth of approximately 300 feet and at 0 to 100 feet in the western and eastern portions, respectively. CDMG identifies historical highest groundwater levels at 100 to 150 feet and 10 to 50 feet in the western and eastern portions, respectively, of Zone 5.

Groundwater flows to the east from the westernmost limit of Zone 5 to the vicinity of Alhambra Wash. The groundwater flow reverses to a westerly direction from the easternmost portion of the zone to the same general area of the Alhambra Wash (Plates 2 and 9). Recharge basins that can seasonally become lakes are present in the eastern portion of Zone 5 between the Rio Hondo and San Gabriel rivers (Dibblee, 1999). Numerous gravel pits are also present within this area.

From west to east, surface water features located within Zone 5 include Alhambra Wash, Easton Wash, Arcadia Wash, and Rio Hondo. The San Gabriel River and Santa Fe Flood Control Basin are located in the eastern portion of Zone 5.

11.6 Hazardous Materials

The ISAs and ESA identified the numerous open cases located within Zone 5. The locations of these sites are shown in Figure 6-1.

Portions of the San Gabriel Valley OU Area 1 (El Monte) and OU Area 3 (Alhambra) NPL Sites are located in Zone 5. The approximate plume boundaries for San Gabriel Valley OU Area 1 (El Monte) and the well locations associated with Alhambra OU Area 3 that have detections above MCLs are shown in Figure 6-1.

Portions of the OU Area 1 (El Monte) within Zone 5 are known to be contaminated with chlorinated VOCs including the following: 1,4 Dioxane, 1,1-Dichloroethene (1,1-DCA), 1,2-Dichloroethane (1,2-DCA), 1,2-Dichloroethene (1,2-DCE), Benzene, Hexachrome (Cr⁶⁺), Perchlorate (ClO₄), n-Nitrosodimethylamine (NDMA), nitrate (NO₃), TCE, and PCE

(CDM, 2008a, 2008b). In 1984, a study of the San Gabriel Valley groundwater was initiated by USEPA to determine the nature and extent of contamination. In March 1995, an agreement was reached between USEPA and 15 potentially responsible parties (PRPs) to complete a regional investigation of the area, which was completed in 1998. An Interim ROD was signed in June 1999 (USEPA, 2009c). Compliance Monitoring Plans for the Gabriel Valley OU Area 1 (El Monte) were completed in October 2006 and January 2008. USEPA is currently designing the containment system to control the movement of the contaminants and anticipates construction in the next few years.

Portions of the OU Area 3 (Alhambra) within Zone 5 are known to be contaminated with chlorinated VOCs including the following: tetrachloroethylene (PCE), and trichloroethylene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), 1,2,3-trichloropropane (1,2,3-TCP), carbon tetrachloride (CCl₄), perchlorate, and nitrate as NO₃ (CH2M HILL, 2009). A summary description of the activities and investigations that have been performed at the San Gabriel Valley OU Area 3 (Alhambra) is provided in Section 10.6.

Thirty-nine localized groundwater or soil contamination sites (including the San Gabriel Valley Area 3 [Alhambra] NPL Site and San Gabriel Valley OU Area 1 [El Monte] NPL Site) are located within Zone 5. Four of these sites are located in proximity (that is, less than 0.5 mile) to a portal zone for Zone 5 and one site with localized groundwater contamination is located in the central portion of Zone 5; the five sites are summarized below:

- United Rock Products, 1245 Arrow Highway E., Irwindale, California (Map ID: 7/4-5). This site is located within 0.5 mile of the eastern portal for Zone 5. The site has soil impacted with diesel, waste oil, motor oil, hydraulic oil, and lubricating oil. This site is considered to have a potential to impact the project because it is located within the eastern portal zone for Zone 5 and has impacted the soil.
- NU-WAY Industries, 400 Live Oak Avenue E., Irwindale, California (Map ID: 28/4). This site is located within 0.5 mile of the eastern portal for Zone 5. The site has soil impacted with gasoline. This site is considered to have a potential to impact the project because it is located within the eastern portal zone for Zone 5 and has impacted the soil.
- Agere Systems, 4920 N. Rivergrade Road, Irwindale, California (Map ID: 4920 N. Rivergrade Rd.). This site is located within 0.5 mile of the eastern portal for Zone 5. The site has soil impacted with diesel. This site is considered to have a potential to impact the project because it is located within the eastern portal zone for Zone 5 and has impacted the soil.
- ARCO Station No. 6109, 3201 West Valley Boulevard, Alhambra, California (Map ID: 590/14). This site is located within 0.5 mile of the southern portal for Zone 5. The site has groundwater impacted with GRO, MTBE, and tertiary butyl alcohol (TBA). This site is considered to have a potential to impact the project because it is located within the western portal zone for Zone 5 and has impacted the groundwater.
- Al Sal Oil Company, 911 S. San Gabriel Boulevard, San Gabriel, California (Map ID: 261/8). This site is located in the central portion of Zone 5. The site has impacted the groundwater with TPHg and MTBE at depths exceeding approximately 204 feet bgs. This site is considered to have a potential to impact the project because it

has impacted the groundwater at a depth of greater than 200 feet (near the tunnel crown) near the center of Zone 5.

The remaining 32 sites (not including the NPL sites) with localized soil or groundwater contamination were identified as being in the central portion of Zone 5 and are considered to have a low potential impact to the project because they are located greater than 0.5 mile from a portal zone or are characterized with soil or groundwater contamination at a depth of less than 150 feet bgs. Additional details for each of these sites, including the corresponding soil and/or groundwater contaminants, their corresponding concentrations, and depths of maximum concentration are included in the ESA in Appendix F.

11.7 Potential for Naturally Occurring Gas

The alluvium making up the San Gabriel Basin is not a producer of hydrocarbons. However, there are rocks that serve as the source for hydrocarbons at the southern and western margins of the basin, and small oil fields are located around the southern margin. The basin represents an important groundwater aquifer and no incidents of naturally occurring hydrocarbons have been reported. Therefore, the potential for naturally occurring gas to be encountered within Zone 5 is considered low.

11.8 Geotechnical Considerations for Tunnel Design and Construction

11.8.1 Key Ground Characteristics

Based on the results of this evaluation, the key geologic factors for this zone in terms of tunnel design and construction considerations (along the generalized geologic profile shown in Plate 9) are:

- Subsurface conditions are fairly uniform in this zone at tunnel depth and consist mainly of Old Alluvium with a limited amount of sedimentary rocks (Fernando and Puente Formations) near the southern end of the zone. The majority of the tunnel is expected to be in the Old Alluvium. The Old Alluvium is generally expected to be uncemented coarse sand and gravel interbedded with sand, silt, and clay. The Fernando Formation is expected to consist of siltstone and claystone. The Puente Formation is expected to be composed of clayey siltstone and silty claystone (commonly called mudstone), as well as some sandstone.
- The Old Alluvium exhibits the strength characteristics of a soil with low cohesion (i.e., low undrained shear strength). The Fernando and Puente Formations are expected to be moderately weak to weak rock. Cobbles and boulders can be expected in the Old Alluvium. Strong cemented layers and concretions may be encountered in the Puente Formation.
- Alhambra Wash fault is considered active and projects into this zone. The inactive Workman Hill fault projects toward the western portion of the zone.

- Most of the tunnel in this zone would be at or below the groundwater table. Depth to groundwater varies; however, the depth could be as shallow as zero feet below grade at some locations. Groundwater inflows could occur when tunneling below the groundwater table in alluvium. Additionally, many aquitards exist throughout this zone.
- The perennial Rio Hondo and San Gabriel River, as well as recharge lakes, are located in the eastern portion of this zone.
- As a result of the shallow historical highest groundwater level, and based on the composition of the shallow alluvial materials that occur along the eastern portion of Zone 5, potentially liquefiable conditions have been identified for the general area. In addition, based on the potential presence of lakes at the easternmost portion of the zone and the perennial character of the Rio Hondo and San Gabriel River, potentially liquefiable conditions are anticipated at the eastern portal area (CDMG, 1998a, 1998b, 1999a, and 1999b).
- One Superfund site is located in the south-central portion of the zone, which could be a source of soil and groundwater contamination in this zone. Seven other sites with various levels of soil and groundwater contamination are also present in this zone close enough to potentially impact the tunnel. Most of these sites are located near the eastern portal or central portion of this zone.
- There is a low potential for encountering naturally occurring gas in this zone due to the limited portion of the tunnel in the Puente Formation.

11.8.2 Preliminary Assessment of Tunneling Considerations

Information presented above and in previous sections of this report was used to perform a preliminary assessment of tunnel design and construction requirements, as summarized below.

Tunnel excavation in this zone would be mostly through uncemented, very dense, alluvial silt, sand and gravel. Cobbles and boulders are also expected throughout the alluvium. The remaining portion of the excavation will be through the Fernando Formation and Puente Formation. Considerations for tunneling in these geologic and groundwater conditions are similar to those of Zone 4 because the geology is expected to be very similar. Excavation methods, support requirements, and settlement control measures will be similar to those discussed for Zone 4.

Zone 5 has active and inactive steeply dipping faults that have the potential to act as groundwater barriers. Because the groundwater levels vary greatly over this zone, the excavation method and lining should be designed to be able to accommodate the wide range in hydrostatic pressures, as in Zone 4.

Special considerations will need to be made for excavating through and lining the tunnel in an active fault zone as discussed in Zones 3 and 4. Additionally, because there is a potential for tunneling through two Superfund sites with VOC-contaminated soil and groundwater, precautions such as those described previously should be taken with regard to excavation and the disposal of contaminated muck and other considerations for tunneling in and near a contaminated area.

Based on the information collected and reviewed in Zone 5, tunneling is feasible in this zone from the geotechnical standpoint. Subsurface conditions and other tunneling considerations discussed for this zone should be further evaluated in more detailed tunnel design studies.