Appendix E3 Geotechnical Investigation (LOR Geotechnical)

Appendices

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LOR GEOTECHNICAL GROUP, INC.
Soil Engineering ▲ Geology ▲ Environmental

PRELIMINARY GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL AND COMMERCIAL SITES
CITY OF YUCAIPA
SAN BERNARDINO COUNTY, CALIFORNIA

PROJECT NO. 12829A.1
JULY 1, 2016

Prepared For:

City of Yucaipa
Community Development Department
34272 Yucaipa Boulevard
Yucaipa, California 92399

Attention: Mr. Joseph Lambert

6121 Quail Valley Court ▲ Riverside, CA 92507 ▲ (951) 653-1760 ▲ (951) 653-1741 (Fax) ▲ www.lorgeo.com

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Subject: Preliminary Geotechnical Investigation, Proposed Residential and Commercial Sites, City of Yucaipa, San Bernardino County, California.

LOR Geotechnical Group, Inc. is pleased to present this report summarizing our geotechnical investigation for the proposed residential and commercial sites within the northeastern portion of the City of Yucaipa. This report was based upon a scope of services generally outlined in our Proposal dated July 13, 2015 and other written and verbal communications with you.

In summary, it is our opinion that the sites can be developed from a geotechnical perspective, provided the recommendations presented in the attached report are incorporated into design and construction. The following executive summary reviews some of the important elements of the project, however, this summary should not be solely relied upon.

To provide adequate support for the proposed structures, we recommend that a compacted fill mat be constructed beneath footings and slabs. The compacted fill mat will provide a dense, high-strength soil layer to uniformly distribute the anticipated foundation loads over the underlying soil materials. All undocumented fill material and any loose alluvial materials should be removed from areas to receive engineered compacted fill. The data developed during this investigation indicates that removals of approximately 5 feet below existing grades will be required within the majority of the currently planned structural areas and structural fill areas. However, deeper removals could be required locally. The area of deeper removals appears to be isolated to the vicinity of our Boring B-2.

Very low expansive soils and a negligible sulfate content soils were encountered on the site. In addition, the site soils have very good R-value quality.

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Appendix B - Field Investigation Program, Boring Logs

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INTRODUCTION

During June of 2016, a Preliminary Geotechnical Investigation was performed by LOR Geotechnical Group, Inc., for proposed development of two separate properties located in the northeast portion of the city, southwest of the intersection of Oak Glen Road and Bryant Street. The larger parcel, referred to as the 'residential area' is located on the west side of 2nd Street approximately 1/4 mile south of Oak Glen Road and the smaller parcel, referred to as 'IERCD building pad' is located on the west side of Bryant Street approximately 1/4 mile south of Oak Glen Road. The purpose of this investigation was to provide a technical evaluation of the geologic setting of the sites and to provide geotechnical design recommendations for proposed development. The scope of our services included:

- Review of available geotechnical literature, reports, maps, and agency information pertinent to the study area;
- Geologic field reconnaissance mapping to verify the areal distribution of earth units and significance of surficial features as compiled from documents, literature, and reports reviewed;
- A subsurface field investigation to determine the physical soil conditions pertinent to the proposed development;
- Laboratory testing of selected soil samples obtained during the field investigation;
- Development of geotechnical recommendations for site grading and foundation design; and
- Preparation of this report summarizing our findings, and providing conclusions and recommendations for site development.

The approximate location of the sites is shown on the attached Index Map, Enclosure A-1, within Appendix A.

To orient our investigation at the site, a parcel map was furnished for our use. An image from Google Earth has been utilized as a base map for our Geotechnical Map, Enclosure A-2, in Appendix A.

PROJECT CONSIDERATIONS

Information furnished to this firm indicates that the western site is proposed for residential development while the eastern site will contain a commercial structure. Specific information pertaining to the types of structures that will be constructed was unavailable at this time. However, the residential structures are anticipated to be one to two stories and of wood or metal frame construction with plaster veneer exterior and light to moderate foundation loads are anticipated with such structures. Building type and anticipated foundation loads are uncertain for the commercial structure.

Grading plans were also not available at this time. However, much of the western site consists of relatively flat to gently rolling topography and, in these areas, it is likely that cuts and fills will reach maximum thicknesses of about 5 to10 feet. Within the eastern site, much of the property is quite low relative to the adjacent road grades. Depending upon site design, significant quantities of fill may be required for development of the proposed commercial construction.

EXISTING SITE CONDITIONS

Both the western and eastern sites consist of vacant land located within and/or adjacent to the drainage area of Oak Glen Creek. The western site is located on the west side of 2nd Street, south and west of an existing 4.5 acre residential property. This 9 acre site is comprised of APN 0303-151-36 (6.5 acres) and APN 0303-151-23 (2.5 acres). It is traversed by the flood controled and modified Oak Glen Creek in the southeast portion and county flood control improvements are present within and beyond the southwest corner of this property. Two shallow, earthen ditches that are apparently related to drainage control are located in this site. The larger ditch is roughly 3 feet deep, traverses the west-central portion of the property from northwest to southeast, and has been present since before 1938, the date of the earliest aerial photograph that we observed. The second, smaller ditch extends from the midpoint of the larger ditch as a straight line in a northeasterly direction. It is only 1 to 2 feet deep.

Earthen berms line either side of the banks of Oak Glen Creek where it traverses the western site and these are 3 to 5 feet in height. The far southwest corner of the property was fenced off and inaccessible at the time of our site investigation. The southwest portion of the site has been disturbed and locally contains fill soils related

to construction of adjacent flood control and water storage tank construction projects located to the west and south-southwest of the site, respectively.

As mentioned above, the site is bounded on the northeast by a residential property. Much of that 4.5 acre site consists of vacant, natural land. To the west are two large, metal, above-ground water storage tanks and to the southwest is land that has been modified through grading and the construction of concrete flood control structures. The majority of this site is covered by a light to moderate growth of annual grasses and weeds with a few scattered, small trees.

The eastern site is in a relatively natural condition along its western and southern sides but has had fill placed along the entire eastern side as a result of construction of adjacent Bryant Street. The fill is present as an approximately 2:1 (horizontal to vertical) slope that is about 25 feet in height and contains a couple of storm drain pipes that outlet along the toe of the slope. The fill slope blends into an east-west trending natural slope along the southern end of the property. The western portion of the site is covered by a moderately dense growth of brush and, overall, the site slopes to the west. To the south of this property is a vacant parcel with a tract of single-family homes to the southwest. Currently inactive portions of Oak Glen Creek are present to the west with modern day Oak Glen Creek channel located to the north of the site.

AERIAL PHOTOGRAPH ANALYSIS

During our investigation we reviewed a series of aerial photographs on file at the San Bernardino County Flood Control and Transportation Department, aerial photography collection. The photographs we reviewed were generally large scale regional photographs taken of the sites and surrounding area between 1938 and 2005.

The aerial photographs reviewed consisted of vertical aerial stereographic photograph pairs of varying scales. These photographs were viewed using stereoscopes with magnifications of 2X and 4X for three dimensional enhancement. Due to the relatively large photograph scales involved, the analysis and subsequent interpretation of detail from aerial photographs sometimes requires a degree of subjective judgment. The degree of certainty on the interpretation of details depends upon such factors as the scale and the quality of the photograph. A complete list of the aerial photographs reviewed is presented within the References at the end of this report.

The aerial photographs were examined in detail to assess the local and regional geologic and geomorphic characteristics of the site and vicinity, During our review, we also noted major changes that occurred onsite throughout this time span. A brief summary of the site and surrounding conditions at the various times and as reflected in the photographs is given below.

1. **July 4,1938, Flight No. USDA AXL-61, Photo No's. 58. 59 and 60, Scale 1" = 2,000'**
   August 10, 1938, Flight No. USDA AXL-79, Photo No's 96 - 98, Scale 1" = 2,000'

In these earliest available photographs, the western site appears to be in a largely natural condition and covered with a moderate growth of chaparral. Oak Glen Creek cuts across the southeast portion of the site as a fairly broad, shallow alluvial wash. Just east of the southeast corner of the western site, Oak Glen Creek diverges with Oak Glen Creek extending to the east and smaller Wilson Creek extending to the northeast. The eastern site itself is fairly flat-lying and mostly covered by a moderate growth of brush with annual grasses and weeds. A ditch or trench scar trends northwesterly across the west half of the property, extending up from Oak Glen Creek. A straight dirt road (over a utility line?) that starts at the intersection of Oak Glen Road and Bryant Street to the northeast, extends diagonally across the site and continues to the southwest after exiting the site near the southwest corner of the property. Second Street is present on the east side of the western site as a non-linear dirt road. The western site is bordered on the west, north and east by vacant, natural ground; on the south by Oak Glen Creek, and on the east by Second Street. Much of the nearby flat field areas are being dry land farmed.

The eastern site at this time was in a generally natural condition with somewhat heavier brush than the western site. A dirt trail entered the property from the west and extended a short distance to the north. Bryant Street existed as a two-lane paved road at this time.

Drainage across the two sites and adjacent areas consists of braided stream channels that drain to the southwest within the local area known as the North Bench. Within these photographs, the numerous separate drainage courses and raised alluvial terraces that typify this region are apparent as they have largely been unaffected by

development at this time. Just east of the eastern side of the western site, a linear band of locally heavier brush appears to be located along the north side of an elevated terrace of older alluvium, just south of an older, poorly defined stream channel. Both the vegetational lineament and the old channel are aligned parallel to upstream and adjacent drainage patterns. This linear feature, although possibly indicative of a fault, is likely just a band of vegetation formed as a result of local drainage and topographic conditions. No other possible fault related features were noted to be present within the sites or adjacent areas in these aerial photographs or subsequent aerial photographs that we reviewed.

2. **August 20, 1948, Flight No. U-37, Photo No. 23, Scale 1" = 1,400'**

The ditch or trench scar is still visible trending northwest from Oak Glen Creek across the western portion of the western property. The local drainages are re-vegetating following the 1938 flood event which apparently removed much of the pre-existing vegetation. The previously mentioned diagonal road scar across the western site and vicinity is now barely discernible. 2nd Street, although still a dirt road, is now located approximately along its present day location. Large areas to the north of the sites are being dry land farmed, but most areas around the sites appear as in the previous photographs. The developed area of Yucaipa has expanded noticeably in areas south of the sites.

3. **February 16, 1953, Flight No. AXL-42K, Photo No's. 83 and 84, Scale 1" = 2,000'**

Some areas between the two sites appear to have suffered a recent burn or otherwise had much of the vegetation removed. The ditch in the western site is still visible and the southwest to northeast trending feature noted in the 1938 photographs described above is again apparent, perhaps as the result of the construction of a fence along this linear alignment. Dry land farming practices now appear to extend onto the far west half of the far north portion of the western property. The dry land farming practices help to reveal local topographic variations and in these photographs it is evident that a lobe of higher, more resistant, older alluvial soils is present within the northwest portion of this property. Conditions around the eastern site remain much the same.

4. **November 8, 1955, Flight No. F-35, Photo No's. 2-119 and 2-120, Scale 1" = 1,700'**

The ditch or trench scar that trends northwesterly across the western site appears fresher in these photographs. As seen in previous photographs, this feature starts/ends at Oak Glen Creek and stops/starts at a change in topography near the northwest corner of the site. Parallel to and north of the fence that trends northeasterly across the trench and the site is a fairly linear new road scar or possibly a drainage scar as it aligns with Oak Glen Creek to the east. What appears to be a chicken farm has been built approximately one-quarter mile to the north of the western site. The eastern site again remains much the same as previously described.

5. **October 16, 1959, Flight No. AXL-17W, Photo No's. 131 - 133, Scale 1" = 2,000'**

The 'new' road or drainage mentioned above is returning to natural conditions. Otherwise, the western site and adjacent areas generally appear as described for the previous photographs. Along the east side of the eastern site, Bryant Street has been regraded and elevated.

6. **August 2, 1965, Flight No. EPH-4, Photo No. 177 and 178, Scale 1" = 2,000'**

There are now two small buildings (house and garage) just northeast of the western site located just west of now graded and straighter Second Street. There is a small clearing in the southeast corner of this property and a residence is also now located just south of the southeast corner of the western site. A borrow site is in operation southeast of the intersection of Oak Glen Road and Second Street and this is accessed via a dirt road that extends southeast from the southeast corner of the intersection. The eastern property appears much as previously described.

7. **March 1, 1968, Flight No. C-149, Photo No's. 17 - 19, Scale 1" = 2,000'**

There is now a residence or barn located on a relatively elevated area of land just north of the western site, near the northeast corner of the property. The northwest trending scar is becoming covered by vegetation. The eastern property appears much as previously described.

8. **August 8, 1968, Flight No. AXL-9JJ, Photo Nos. 56 and 57, Scale 1" = 2,000'**

The sites and vicinity generally appear as in the descriptions for the previous photographs. Bryant Street, adjacent to the eastern site, has two lanes in each direction.

9. **August 4, 1975, Flight No. NBS, Photo Nos. 102 - 104, Scale 1" = 400'**

A horse/hiking/bike trail now crosses the western site, extending southwesterly from Second Street and along the north side of Oak Glen wash. The borrow site to the northeast has expanded and shifted slightly to the east-southeast. Many new residences have been built in areas to the southwest and southeast of the sites. The eastern property appears much as previously described.

10. **June 8, 1979, Flight No. C-289, Photo Nos. 8 and 9, Scale 1" = 2,000'**

Clearing of the ground at the southeast corner of Second Street and Oak Glen Road has taken place as part of the start of construction of the City of Yucaipa maintenance yard. Additional residences have been built to the south of the sites.

11. **February 25, 1986, Flight No. C-450, Photo Nos. 41-43 and 75, Scale 1" = 2,000'**

These photographs show strong contrasts between previously eroded stream channels in the southern portion of the western site and more heavily vegetated land across most of the remainder of this property. The city yard to the northeast is now well established. By this time, continued development in the region has obliterated much of the geomorphology that could be seen in the earliest aerial photographs. Residential development now extends to the southwest corner of the eastern site.

12. **July 1, 1991, Flight No. C-487, Photo Nos. 91 and 92, Scale 1" = 2,000'**

In these photographs it appears that Oak Glen Creek across the south side of the western site has been modified through clearing of the vegetation and accentuation of the drainage limits.

13. April 20, 1996, Flight No. C-528, Photo Nos. 129, and 130, Scale 1" = 2,000'

Plow marks/clearing scars (about 50 feet wide paths) are visible near/west of the onsite residence and across local areas north of the site. Otherwise, the site and vicinity generally appear as described for the previous photographs.

14. June 15, 2001, Flight No. C-541, Photo Nos. 100 - 102, Scale 1" = 2,000'

Most of the western site has been cleared of all vegetation except for the largest bushes. Oak Glen Creek southwest of the site has been recently channelized and that construction work impacted the southwest corner of the property. In the southwest corner of the western site, one of two diversion/collection berms extends onto the property. The associated collection apron also extends onto the property. These improvements are related to development of the Chapman Heights community to the southwest. The slope along the west side of Bryant Street that extends down into the eastern side has been recently graded. This may be related to erosion repair or the installation of storm drain improvements within local areas of the slope.

15. January 18, 2005, Flight No. C-553, Photo Nos. 10-61 and -62, Scale 1" = 1,000'

By 2005, the tracts of homes located north and west of the western site and the two water tanks adjacent to the west side of the western site were built and the site and vicinity appears much as it does today. Surprisingly, the pre-1938 ditch that trends northwest across the west portion of the site is still quite apparent. On the east side of Bryant Street, just east of the eastern property, grading for the Oak Glen Creek Basins has started.

SUBSURFACE FIELD INVESTIGATION

Our subsurface field exploration program was conducted on June 1 and June 7 of this year and consisted of the excavation of 8 exploratory trenches using backhoe equipment and advancing 6 exploratory borings using a Mobile B-61 drill rig equipped with 8-inch diameter hollow stem augers. The trenches were excavated to depths ranging from approximately 8.5 to 15.5 feet below the existing ground surface. In-place density tests were taken in accordance with ASTM D 2922, the Nuclear Gauge

Method. Bulk samples of the encountered materials were obtained and returned to the laboratory in sealed containers for further testing and evaluation.

The borings were drilled to depths ranging from approximately 7 to 37 feet below the existing ground surface. Relatively undisturbed in-place and bulk samples of the materials encountered were obtained and returned to our geotechnical laboratory for further testing and evaluation. Samples of the encountered materials were obtained and returned to our geotechnical laboratory in sealed containers for further testing and evaluation. The approximate locations of our exploratory borings and trenches are presented on the attached Geotechnical Map, Enclosure A-2, Appendix A.

Logs of the subsurface conditions encountered in the exploratory trenches and borings were maintained by a geologist from this firm. A detailed description of the field exploration program and trench and boring logs is presented in Appendix B.

LABORATORY TESTING PROGRAM

Selected soil samples obtained during the field investigation were subjected to laboratory testing to evaluate their physical and engineering properties. Laboratory testing included moisture content, dry density, consolidation, laboratory compaction, direct shear, sieve analysis, R-Value, and soluble sulfate content. A detailed description of the laboratory testing program and the test results are presented in Appendix C.

GEOLOGIC CONDITIONS

Regional Geologic Setting

The subject sites are located within a large geomorphic province of southern California referred to as the Peninsular Ranges. The sites are located along the northern end of the Peninsular Ranges near the junction with the adjacent Transverse Ranges geomorphic province. These two provinces cover a large majority of southern California stretching from the Pacific coast inland to the San Andreas fault, south of the San Gabriel-San Bernardino Mountain ranges, and extending southward to the Mexican border and beyond.

The Peninsular Ranges province is characterized by a series of generally small northwesterly trending mountains ranges, such as the Santa Ana Mountains and the San Jacinto Mountains, separated by wide flat valleys. These extend from the Los Angeles region southeastward into Baja California. As previously noted, at the far northern end, this province meets the San Bernardino and the San Gabriel mountains which have a predominately east-west trend that is transversely oriented in regards to the predominately northwest structural grain of much of California; hence the name Transverse Ranges.

In the Yucaipa region, the San Andreas fault acts as the boundary between the Peninsular and Transverse Ranges provinces, with the site located southwest of this boundary. Here, the motion on this feature has typically resulted in the Peninsular Ranges Block sliding to the northwest in relation to the Transverse Ranges. While this motion is distributed along a very wide shear zone of various other major faults in the region, perhaps as much as one half of the total offset is thought to have occurred along the San Andreas fault.

Although the trend of the San Andreas fault is predominately a relatively straight line across much of California, in the area just north of Indio, the San Andreas fault has an approximately 15-mile wide step-over zone, stepping to the west and cutting across the San Gorgonio Pass then up to the eastern end of the city of Yucaipa. Beyond this area and to the northwest, the trend of the fault once again resumes a northwesterly course. The tectonic setting is complex and not completely understood, however, the general result is that along the San Gorgonio pass the motion changes from right lateral strike slip to thrusting. Within the Yucaipa region, this complex motion has resulted in several types of movement, including extension with the formation of fault grabens (down-dropped basins) in the area of the site and areas to the southwest and northeast of the site. Tectonic activity including essentially all types of fault motions, from right lateral strike slip, or horizontal, to thrusting and normal, or tensional faulting is evident locally. The Banning fault, lying along the base of the San Bernardino Mountains, appears to be the dominate thrust in the western end of the pass, joining the San Gorgonio Pass fault zone further to the east.

Site Geologic Conditions

The sites are located within Yucaipa Valley which is a northeast trending area of accumulated alluvial sediments situated southeast of the local Crafton Hills and part

of the Yucaipa Graben Complex mapped by Matti, et al. (2003). Arcuate fault scarps resulting from normal, dip-slip faults define this graben and it is believed that the graben itself formed due to localized extension in a regional zone of right step between the San Jacinto and San Andreas fault zones. Wilson and Oak Glen Creeks, the two main local drainage courses in this valley, merge just east of the eastern side of the western site and Oak Glen Creek runs east to west just north of the easterly site. In general, Pleistocene age sediments form the older, elevated surfaces in the site area and these have been incised by the local drainage courses to create the younger, typically low-lying, Holocene age alluvial deposits.

During our site investigation, we encountered younger alluvial soils within all our excavations. Not encountered but present on the site are very young alluvial sediments that are generally located along Oak Glen Creek. Due to access restrictions relating to property lines, biological concerns, flood control department restrictions, or other reasons, no borings or trenches were excavated within the far eastern and southeastern portions of the property, where the very young alluvial sediments are located. We have followed the nomenclature presented by Matti, et al. (2003) to create our Geologic Map of the property (Enclosure A-2). In general, the geologic materials within the site consist of young axial-valley sediments of Wilson and Oak Glen Creeks and become progressively younger in proximity to the natural drainages.

The youngest axial-valley sediments consist of recent stream channel deposits and these were observed to be mainly gravelly sands with silt. Away from the main active channels, the alluvial deposits become somewhat siltier and slightly indurated and cemented.

As previously mentioned, fill soils are present within the sites in several areas. For the eastern site, fill soils that were placed during the construction of adjacent Bryant Street extend into and along the eastern portion of the site. Periodic maintenance of this slope and an adjacent access road, that currently trends north-south across the central portion of the property, have also created a swath of fill located just west of the toe of this slope.

Disturbed ground and fill soils are widespread across the southwest portion of the western property and these appear to be the result of construction of both the adjacent water tanks and the flood control improvements. Fill soils make up the access road that leads to the water storage tanks. On the southwest side of the

channel that trends from southeast to northwest across this property is a berm that is two to four feet high and composed of undocumented fill soils and earthen berms of similar height line the tops of the banks for through-going Oak Glen Creek. Also, in the southwest portion of this site are stockpiles of boulders that, apparently, were placed onsite during construction of the adjacent improvements.

Groundwater Hydrology

Groundwater was not encountered within any of our subsurface excavations which extended to a maximum depth of 37 feet beneath the surface. Data available from the California Department of Water Resources indicates that the depth to groundwater in the vicinity of the sites ranges from approximately 225 feet to 460 feet beneath the surface. Well Station No. 340942N1170332W001, located just northeast of the northeast corner of the intersection of Oak Glen Road and Bryant Street, had depths to groundwater ranging 225 feet to 460 feet during the time period from 1987 to 2007. Well Station No's. 340468N1170368W001, 003, and 004, located about 1/8 mile southwest of the intersection of Oak Glen Road and Bryant Street, had depths to groundwater ranging 270 feet to 450 feet during the time period from 2005 to 2011. Also, Well Station No. 340428N1170357W001, located just southwest of the eastern site, slightly south of the intersection of Adams Street and Persimmon Avenue, had depths to groundwater ranging 305 feet to 380 feet during the time period from 1987 to 2000.

Surface Runoff

Current surface runoff of precipitation waters across the sites is largely from the east-northeast to the west-southwest as sheetflow into local small drainage courses that ultimately flow into Oak Glen Creek.

Mass Movement

The majority of the site areas consist of relatively flat surfaces with gently sloping areas in between. Locally, as in the southeastern portion of the property, the stream banks approach 2:1 (horizontal to vertical) with locally steeper areas. Considering the site geologic conditions and the overall gently sloping nature of the property, the potential for mass movement failures such as landslides or debris flows is considered very low. In addition, no loose, un-rooted rocks that could fall or topple and roll were

noted to be present above at or above the sites and the potential for rockfalls occurring at the sites is also considered to be nil.

Faulting

As shown on Enclosure A-4 in Appendix A, the sites are not located within an Alquist-Priolo Earthquake Fault Zone (APZ) designated by the State of California to include traces of suspected active faulting. However, as shown on Enclosure A-5 in Appendix A, two concealed fault traces associated with the Chicken Hill fault are mapped through the western site and are included on the Fault-Rupture Hazard Zones map prepared by the City of Yucaipa (2000). The southerly of these two concealed faults is at the same location as an inferred/concealed fault depicted on the geologic map for the Yucaipa quadrangle prepared by Matti, et al. (2003). Several subsurface investigations of faulting have been conducted across the mapped location of these faults in nearby areas and, as concluded within our Initial Fault Study (LOR, 2013) for the adjacent Wilson Creek Business Park Specific Plan site located immediately to the east of the western site, there is little evidence supporting a potential for surface fault rupture hazard at that site or in the adjacent areas.

The San Andreas fault is considered to be the major tectonic feature of California, separating the Pacific plate and the North American plate. The sense of movement is that the Pacific plate moves northwest relative to the North American plate. This type of motion is called right lateral strike slip. While estimates vary, the San Andreas fault is generally thought to have an average slip range on the order of 24 mm/yr and capable of generating large magnitude events on the order of 7.5 or greater.

In the Yucaipa region Matti, Morton, and Cox (1992) recognized at least four strands of this fault. These are: the Mill Creek, Wilson Creek, Mission Creek, and finally the San Bernardino segment which runs along the base of the local Mountains. From a location several miles northwest of the sites, the San Bernardino segment extends along the base of the mountains in a north 70 degrees west trend across the entire San Bernardino Valley. However, southeast of the San Bernardino Valley, the San Bernardino segment becomes much more complex. Matti et al (2003) suggests that in this area, the San Andreas fault is continuing the left stepping motion with a tendency for en echelon strands.

The San Jacinto fault zone, located approximately 14.5 kilometers (9 miles) to the southwest, is a sub-parallel branch of the San Andreas fault zone, extending from the northwestern San Bernardino area, southward into the El Centro region. This fault has been active in recent times with several large magnitude events. It is believed that the San Jacinto fault is capable of producing an earthquake magnitude on the order of 6.5 or greater.

Other faults in the area include the Western Heights fault which is located about 1.6 kilometers (1 mile) to the northwest, along the southeast side of the Crafton Hills. On the opposite side of the Crafton Hills, about 6.5 kilometers (4 miles) to the west-northwest, the Reservoir Canyon (Crafton) fault forms the northwest boundary of these hills.

Recent standards of practice have included a discussion of all potential earthquake sources within a 100 kilometer (62 mile) radius. However, while there are other large earthquake faults within a 100 kilometer (62 mile) radius of the site, none of these are considered as relevant to the site as the faults described above, due to their greater distance and/or smaller anticipated magnitudes.

Historical Seismicity

In order to obtain a general perspective of the historical seismicity of the sites and surrounding region, a search was conducted for seismic events at and around the area within various radii. This search was conducted utilizing the historical seismic search program by EPI Software, Inc. (Reeder, 2000). This program conducts a search of a user selected cataloged seismic events database, within a specified radius and selected magnitudes, and then plots the events onto an overlay map of known faults. For this investigation the database of seismic events utilized by the EPI program was obtained from the Southern California Seismic Network (SCSN) available from the Southern California Earthquake Center. At the time of our search the data base contained data from January 1, 1932 through December, 2010. For plotting purposes, a central location between the two sites was chosen as the site location.

In our first search, the general seismicity of the region was analyzed by selecting an epicenter map listing all events of magnitude 4.0 and greater, recorded since 1932, within a 100 kilometer (62 mile) radius of the site, in accordance with guidelines of the California Division of Mines and Geology. This map illustrates the regional seismic

history of moderate to large events. As depicted on Enclosure A-6, within Appendix A, the site lies within a relatively active region of southern California with numerous events located in the region. The San Jacinto fault appears especially active to the southeast, along the west side of the Salton Sea. The Landers and Big Bear events to the northeast of the site are also notable. Of all these events, the closest was a magnitude 4.0 located approximately 1.2 kilometer (0.7 mile) southeast of the site that occurred on June 16, 2005.

In the second search, the micro seismicity of the area lying within a 15 kilometer (9 mile) radius of the site was examined by selecting an epicenter map listing events on the order of 1.0 and greater since 1978. In addition, only the "A" events, or most accurate events were selected. Caltech indicates the accuracy of the "A" events to be approximately 1 km. The results of this search is a map that presents the seismic history around the area of the site with much greater detail, not permitted on the larger map. The reason for limiting the events to the last 35 ± years on the detail map is to enhance the accuracy of the map. Events recorded prior the mid 1970's are generally considered to be less accurate due to advancements in technology. As depicted on this map, Enclosure A-7, the subject site lies within an area with very numerous small events in the general area.

Secondary Seismic Hazards

Other secondary seismic hazards generally associated with severe ground shaking during an earthquake include liquefaction, seiches and tsunamis, earthquake induced flooding, landsliding and rockfalls, and seismic-induced settlement.

Liquefaction: The potential for liquefaction generally occurs during strong ground shaking within granular, loose sediments where the depth to groundwater is usually less than 50 feet. As the sites are underlain at depth by dense alluvium; the upper, loose alluvial soils are anticipated to be replaced with compacted fill; and the depth to groundwater is on the order of 250 feet or more, the possibility of liquefaction is considered to be nil.

Seiches/Tsunamis: The potential for the sites to be affected by a seiche or tsunami (earthquake generated wave) is considered nil due to absence of any large bodies of water near the sites.

Flooding (Water Storage Facility Failure): There are two large, aboveground, water storage tank located just west of the western property that could, conceivably, fail and flood adjacent or downstream areas. Although it appears that failure of these tanks would not impact the property, the potential for flooding due to failing of existing and/or proposed water storage facilities at or near the sites should be evaluated by the design civil engineer.

Seismically-Induced Landsliding: Due to the relatively flat-lying to gently rolling nature of the majority of the site areas and adjacent surrounding region and the lack of evidence for the existence of landslides in these areas, the potential for landslides to occur at or adjacent to the sites is considered to be very low to nil.

Rockfalls: In general, the sites are relatively flat and the potential for rockfalls to impact either site is considered to be very low to nil. Along the banks of Oak Glen Creek in the southeast portion of the western site, rocks could become dislodged and roll into the creek, but this should impact the adjacent, proposed development areas. Similarly, it is conceivable that rocks, should they have been incorporated as fill within the fill slope that supports Bryant Street, could become exposed and subject to rockfall in the event of severe erosion of this slope.

Seismically-Induced Settlement: Settlement generally occurs within areas of loose, granular soils with relatively low density. Since the sites are underlain by dense alluvial soils at depth and the earthwork operations anticipated to be conducted during the development of the site will mitigate any near surface loose soil conditions, the potential for settlement is considered low.

SOILS AND SEISMIC DESIGN CRITERIA (2013 California Building Code)

Section 1613 of Chapter 16 of the 2013 California Building Code (CBC) contains the procedures and definitions for the calculations of the earthquake loads on structures and non structural components that are permanently attached to structures and their supports and attachments.

It should be noted that the classification of use and occupancy of all proposed structures at the site, and thus design requirements, shall be the responsibility of the structural engineer and the building official.

CBC Earthquake Design Summary

The following earthquake design criteria have been formulated for the site utilizing the source referenced above. However, these values should be reviewed and the final design should be performed by a qualified structural engineer familiar with the region.

CBC 2013 SEISMIC DESIGN SUMMARY Site Location (WGS 84) 34.0463, -117.0407, Occupancy Category II	
Site Class Definition (Table 1613.2)	D
S_S Mapped Spectral Acceleration at 0.2s Period (Figure 1613.5(3))	1.851
S_1 Mapped Spectral Acceleration at 1.0s Period (Figure 1613.5(4))	0.843
F_A Short Period Site Coefficient at 0.2s Period (Table 1613.5.3(1))	1.0
F_V Long period Site Coefficient at 1.0s Period (Table 1613.5.3(2))	1.5
S_{MS} Adjusted Spectral Response Acceleration at 0.2s Period (eq. 16-37)	1.851
S_{M1} Adjusted Spectral Response Acceleration at 1.0s Period (eq. 16-38)	0.264
S_{DS} Design Spectral Response Acceleration at 0.2s Period (eq. 16-39)	1.234
S_{D1} Design Spectral Response Acceleration at 1.0s Period (eq. 16-40)	0.843
Seismic Design Category, Short Period (Table 1613.5.6 (1))	E
Seismic Design Category, Long Period (Table 1613.5.6 (2))	E

CONCLUSIONS

General

This investigation provides a broad overview of the geotechnical and geologic factors which are expected to influence future site planning and development. On the basis of our field investigation and testing program, it is the opinion of LOR Geotechnical Group, Inc. that the proposed developments are feasible from a geotechnical standpoint, provided the recommendations presented in this report are incorporated into design and implemented during grading and construction.

The subsurface conditions encountered in our exploratory trenches and borings are indicative of the locations explored. The subsurface conditions presented here are not

to be construed as being present the same everywhere on the site. If conditions are encountered during the construction of the project which differ significantly from those presented in this report, this firm should be notified immediately in order that we may assess the impact to the recommendations provided.

Foundation Support

Based upon the field investigation and test data, it is our opinion that the fill soils and the upper alluvial soils, will not, in their present conditions, provide uniform and/or adequate support for the proposed structures. However, the removal and recompaction of these soils will create an acceptable solution.

To provide adequate support for the proposed structures, we recommend that a compacted fill mat be constructed beneath footings and slabs. This compacted fill mat will provide a dense, high-strength soil layer to uniformly distribute the anticipated foundation loads over the underlying soils. The construction of this compacted fill mat should be done in conjunction with the removal of the existing unsuitable fill and near surface alluvial materials within the building pad areas.

Soil Expansiveness

As noted by our explorations and testing, the site surficial soils consist of gravelly sands, well graded sands and silty sands with a very low expansion potential. Therefore, conventional design and construction should be applicable for the development of the projects. Careful evaluation of on-site soils and any import fill for their expansion potential should be conducted during the grading operation.

Consolidation/Collapse

The vast majority of the on-site native materials were of sufficient in-place density to be considered to have a very low potential for consolidation/collapse. However, three samples, one within Boring B-1 and two within boring B-2, were found to be of low in-place density and consolidation testing was conducted on these as well as other samples. The testing indicated that samples at depths of 10 feet within boring B-2 have a moderate potential for consolidation/collapse while other consolidation tests indicated a very low potential for consolidation/collapse. Based on our investigation, this appears to be a local phenomenon occurring within the western portion of the

proposed site in the area of our boring, B-2. Supplemental investigation in the general area of boring B-2 to further identify the vertical and lateral extent (or lack of) such materials is a reasonable consideration.

Geologic Mitigations

No special geologic mitigation methods other than the geotechnical recommendations provided in the following sections are deemed necessary at this time.

Seismicity

Seismic ground rupture is generally considered most likely to occur along pre-existing active faults. Since no known active faults are known to exist at or project into the sites, the probability of ground surface rupture occurring at the site is considered nil.

Due to the site's close proximity to the San Andreas fault zone, as described above, it is reasonable to expect a strong ground motion seismic event to occur during the lifetime of the proposed development on the site. Large earthquakes could occur on other faults in the general area, but because of their lesser anticipated magnitude and/or greater distance, they are considered less significant than the San Andreas fault zone from a ground motion standpoint.

The effects of ground shaking anticipated at the subject site should be mitigated by the seismic design requirements and procedures outlined in Chapter 16 of the California Building Code. However, it should be noted that the current building code requires the minimum design to allow a structure to remain standing after a seismic event, in order to allow for safe evacuation. A structure built to code may still sustain damage which might ultimately result in the demolishing of the structure (Larson and Slosson, 1992).

RECOMMENDATIONS

General Site Grading

It is imperative that no clearing and/or grading operations be performed without the presence of a qualified geotechnical engineer. An on-site, pre-job meeting with the city, the contractor, and geotechnical engineer should occur prior to all grading related

related operations. Operations undertaken at the site without the geotechnical engineer present may result in exclusions of affected areas from the final compaction report for the project.

Grading of the subject sites should be performed in accordance with the following recommendations as well as applicable portions of the California Building Code, and/or applicable local ordinances.

All areas to be graded should be stripped of significant vegetation and other deleterious materials. These materials should not be incorporated within engineered compacted fill. It is our recommendation that any existing undocumented fills encountered be removed and replaced with engineered compacted fill. This pertains to all grading areas including proposed flatwork and/or paved areas. If this is not done, premature structural distress (settlement) of the flatwork and pavement may occur.

Cavities created by removal of subsurface obstructions should be thoroughly cleaned of loose soil, organic matter and other deleterious materials, shaped to provide access for construction equipment, and backfilled as recommended in the following Engineered Compacted Fill section of this report.

Initial Site Preparation

All undocumented fill material and any loose alluvial materials should be removed from structural areas and areas to receive engineered compacted fill. The data developed during this investigation indicates that removals on the order of approximately 5 feet will be required from currently planned structural areas. However, removals on the order of 12 feet in the area of Boring B-2 are anticipated. The actual depths of alluvial removals should be verified during the grading operation by observation and/or in-place density testing. Removals should expose alluvial materials with a relative in-situ compaction of at least 83 percent and/or an in-situ saturation of at least 85 percent.

Preparation of Fill Areas

Prior to placing fill, the surfaces of all areas to receive fill should be scarified to a depth of 6 to12 inches. The scarified soil should be brought to near optimum moisture content and recompacted to a relative compaction of at least 90 percent (ASTM D 1557).

Preparation of Building Pad Areas

All footings should rest entirely upon a minimum of 24 inches of properly compacted fill material placed over competent native soils. In areas where the required fill thickness is not accomplished through the removal of the existing fill and/or loose native soils, the footing areas should be further subexcavated to a depth of at least 24 inches below the proposed footing base grade, with the subexcavation extending at least 5 feet beyond the footing lines. Where removals in excess of 5 feet deep are required, the removal areas should extend laterally at a 1:1 ratio. The bottom of this excavation should then be scarified to a depth of at least 12 inches, brought to near optimum moisture content, and recompacted to at least 90 percent relative compaction (ASTM D 1557) prior to refilling the excavation to grade as properly compacted fill.

All building pad areas that are created through transition cut to fill should be over-excavated as described above. In addition, no structure should be placed across any areas where the ratio of the maximum depth of fill to minimum depth of fill is greater than a 3 to 1 ratio as measured from the bottom of the footing. For example, if one edge of the building pad of a cut-to-fill transition lot requires 10 feet of fill, then the cut portion of the lot should be over-excavated to a minimum of 3 feet below the footing elevations.

Engineered Compacted Fill

All fill materials should be free from organic matter and other deleterious materials. Unless approved by the geotechnical engineer, rock or similar irreducible material with a maximum dimension greater than 6 inches should not be buried or placed in building area fills (within two feet of the bottom of the footings), the upper one foot of road subgrade, or within trench backfill. Materials greater than 12 inches in diameter should be placed in approved disposal areas, typically 10 feet or more below proposed finish grade elevations. Rock disposal considerations should be more thoroughly evaluated once site grading plans have been developed.

Import soil materials, if required, should be inorganic, non-expansive granular soils free from rocks or lumps greater than 6 inches in maximum dimension. Sources for import fill should be approved by the geotechnical engineer prior to their use.

Fill should be spread in maximum 8-inch thick, uniform, loose lifts with each lift brought to near optimum moisture content and compacted to a relative compaction of at least 90 percent in accordance with ASTM D 1557. The upper 12 inches of areas to be paved should be compacted to at least 95 percent (ASTM D 1557).

Based upon the relative compaction of the alluvial soils determined during this investigation and the relative compaction anticipated for compacted fill soil, we estimate a compaction shrinkage factor of approximately 10 to 15 percent for the alluvium. Shrinkage factors should be monitored during construction. If percentages vary, provisions should be made to revise final grades or adjust quantities of borrow or export.

Careful evaluation of on-site soils and any import fill for their expansion potential should be conducted during the grading operations.

Short-Term Excavations

Following the California Occupational and Safety Health Act (CAL-OSHA) requirements, excavations 5 feet deep and greater should be sloped or shored. All excavations and shoring should conform to CAL-OSHA requirements.

Short-term excavation 5 feet deep and greater shall conform to Title 8 of the California Code of Regulations, Construction Safety Orders, Section 1504 and 1539 through 1547. Based on our exploratory trenches and borings and our observations, it appears that the alluvial soils can be classified as Type C soils. Deviation from the standard short-term slopes are permitted using option 4, Design by a Registered Professional Engineer (Section 1541.1).

Slope Construction

Preliminary data indicates that cut and fill slopes should be constructed no steeper than two horizontal to one vertical. Fill slopes should be overfilled during construction and then cut back to expose fully compacted soil. A suitable alternative would be to compact the slopes during construction, then roll the final slopes to provide dense, erosion-resistant surfaces.

Where fills are to be placed against existing slopes steeper than five horizontal to one vertical, the fill should be properly keyed and benched into competent native materials. The key, constructed across the toe of the slope, should be a minimum of 12 to 15-feet wide, a minimum of two feet deep at the toe, and sloped back at two percent. Benches should be constructed at approximately two to four feet vertical intervals. Typical keying and benching operations are presented on Enclosure D-1, within Appendix D.

Slope Protection

Since the native materials are susceptible to erosion by running water, measures should be provided to prevent surface water from flowing over slope faces. Slopes at the project should be planted with a deep rooted ground cover as soon as possible after completion. The use of succulent ground covers such as iceplant or sedum is not recommended. If watering is necessary to sustain plant growth on slopes, then the watering operation should be monitored to assure proper operation of the irrigation system and to prevent over watering.

Foundation Design

If the sites are prepared as recommended, structures may be safely founded on conventional shallow foundations, either individual spread footings and/or continuous wall footings, bearing on a minimum of 24 inches of engineered compacted fill placed over competent native materials. All foundations should have a minimum width of 12 inches and should be established a minimum of 12 inches below lowest adjacent grade.

Footings at least 12 inches wide and embedded a minimum of 12 inches below the lowest adjacent grade may be designed using a maximum soil bearing pressure of 2,000 pounds per square foot (psf) for dead plus live loads. Footings at least 12 to 15 inches wide and placed at least 18 inches below the lowest adjacent final grade could be designed for a maximum soil bearing pressure of 2,500 psf for dead plus live loads.

The above values are net pressures; therefore, the weight of the foundations and the backfill over the foundations may be neglected when computing dead loads. The values apply to the maximum edge pressure for foundations subjected to eccentric loads or overturning. The recommended pressures apply for the total of dead plus

frequently applied live loads, and incorporate a factor of safety of at least 3.0. The allowable bearing pressures may be increased by one-third for temporary wind or seismic loading. The resultant of the combined vertical and lateral seismic loads should act within the middle one-third of the footing width. The maximum calculated edge pressure under the toe of foundations subjected to eccentric loads or overturning should not exceed the increased allowable pressure. Buildings should be setback from slopes as detailed on the California Building Code.

Resistance to lateral loads will be provided by passive earth pressure and base friction. For footings bearing against compacted fill, passive earth pressure may be considered to be developed at a rate of 350 pounds per square foot per foot of depth. Base friction may be computed at 0.30 times the normal load. Base friction and passive earth pressure may be combined without reduction. These values are for dead load plus live load and may be increased by one-third for wind or seismic loading. Footings on very low expansive soils will not require any particular reinforcement from the geotechnical standpoint.

Settlement

Total settlement of individual foundations will vary depending on the width of the foundation and the actual load supported. Maximum settlement of shallow foundations designed and constructed in accordance with the preceding recommendations are estimated to be on the order of 0.5 inch. Differential settlements between adjacent footings should be about one-half of the total settlement. Settlement of all foundations is expected to occur rapidly, primarily as a result of elastic compression of supporting soils as the loads are applied, and should be essentially completed shortly after initial application of the loads.

Building Area Slab-on-Grade

Concrete floor slabs should bear on a minimum of 24 inches of engineered compacted fill placed over competent native materials. The final pad surfaces should be rolled to provide smooth, dense surfaces upon which to place the concrete. If very low expansive soils are found underlying slab areas, no particular geotechnical and/or structural mitigation measures to control expansive soil problems will be required.

Slabs to receive moisture-sensitive coverings should be provided with a moisture vapor barrier. This barrier may consist of an impermeable membrane. Two inches of sand over the membrane will reduce punctures and aid in obtaining a satisfactory concrete cure. The sand should be moistened just prior to placing of concrete. The slabs should be protected from rapid and excessive moisture loss which could result in slab curling. Careful attention should be given to slab curing procedures, as the site areas are subject to large temperature extremes, humidity, and strong winds.

Exterior Flatwork

To provide adequate support, exterior flatwork improvements should rest on a minimum of 12 inches of soil compacted to at least 90 percent (ASTM D 1557). If very low expansive soils are found underlying flatwork areas, as anticipated, no particular geotechnical and/or structural mitigation measures to counteract expansive soil problems will be required. Flatwork surface should be sloped a minimum of 1 percent away from buildings and slopes, to approved drainage structures.

Wall Pressures

The design of footings for retaining wall structures should be performed in accordance with the recommendations described earlier under Preparation of Building Pad Areas and Foundation Design. For design of retaining wall footings, the resultant of the applied loads should act in the middle one-third of the footing, and the maximum edge pressure should not exceed the basic allowable value without increase.

For design of retaining walls unrestrained against movement at the top, we recommend an equivalent fluid density of 35 pounds per cubic foot (pcf) be used. This assumes level backfill consisting of recompacted, non-expansive, native soils placed against the structures and within the back cut slope extending upward from the base of the stem at 35 degrees from the vertical or flatter.

Retaining walls subject to uniform surcharge loads within a horizontal distance behind the structure equal to the structural height should be designed to resist additional lateral loads equal to 0.3 times the surcharge load. Any isolated or line loads from adjacent foundations or vehicular loading will impose additional wall loads and should be considered individually.

To avoid over stressing or excessive tilting during placement of backfill behind walls, heavy compaction equipment should not be allowed within the zone delineated by a 45 degree line extending from the base of the wall to the fill surface. The backfill directly behind the walls should be compacted using light equipment such as hand operated vibrating plates and rollers. No material larger than 3 inches in diameter should be placed in direct contact with the wall.

Wall pressures should be verified prior to construction, when the actual backfill materials and conditions have been determined. Recommended pressures are applicable only to level, properly drained, non-expansive backfill with no additional surcharge loadings. If inclined backfills are proposed, this firm should be contacted to develop appropriate active earth pressure parameters.

Preliminary Pavement Design

Testing and design for preliminary on-site pavements was conducted in accordance with the California Highway Design Manual. Based upon our preliminary sampling and testing, and upon Traffic Indices generally used for these kinds of developments, it appears that the structural sections tabulated below should provide satisfactory pavements for the subject improvements:

AREA	T.I.	DESIGN R-VALUE	PRELIMINARY SECTION
Typical Residential Traffic	5.0/6.0	50	0.25' AC/0.35' AB
Light To Moderate Truck Traffic	7.0	50	0.35' AC/0.35' AB
AC - Asphalt Concrete AB - Class 2 Aggregate Base			

The above structural sections are predicated upon 90 percent relative compaction (ASTM D 1557) of all utility trench backfills and 95 percent relative compaction (ASTM D 1557) of the upper 12 inches of pavement subgrade soils and of any aggregate base utilized. In addition, the aggregate base should meet Caltrans specifications for Class 2 Aggregate Base.

In areas of the pavement which will receive high abrasion loads due to start-ups and stops, or where trucks will move on a tight turning radius, consideration should be

given to installing concrete pads. Such pads should be a minimum of 0.5 foot thick concrete, with a 0.50 foot thick aggregate base. Concrete pads are also recommended in areas adjacent to trash storage areas where heavier loads will occur due to operation of trucks lifting trash dumpsters.

The recommended 0.5 feet thick portland cement concrete (PCC) pavement section should have a minimum modulus of rupture (MR) of 550 pounds per square inch (psi).

It should be noted that all of the above pavement designs were based upon the results of preliminary sampling and testing, and should be verified by additional sampling and testing during construction when the actual subgrade soils are exposed. The actual design traffic index's for various roads should be supplied by the local controlling agency responsible for the roadways.

Sulfate Protection

The results of the soluble sulfate tests conducted on selected subgrade soils expected to be encountered at foundation levels are presented on Enclosure C. Based on the test results, it appears that there is a negligible to moderate sulfate exposure to concrete elements in contact with the on site soils per the 2013 CBC. This should be verified by additional sampling and testing when the actual finish and near finish surface soils are obtained.

Grading Plan Review/Supplemental Geotechnical Investigation

At the present time, no grading plans showing anticipated developed site conditions are available. Once these become available, they should be reviewed by this office in order to address potential site specific geotechnical and/or geologic concerns that could require mitigation. At that time, it may also prove beneficial to conduct limited supplemental geotechnical investigation within selected areas of the sites in order to focus on a particular concern or a particular area.

Construction Monitoring

As mentioned above, post investigation services are an important and necessary continuation of geotechnical work associated with planning and development of this project. Once project plans and specifications have been reviewed by this firm,

construction monitoring, including testing for on-site pavement design, should be performed after the site is rough graded. During and/or near the completion of site grading, additional R-value and soluble sulfate testing should be conducted to characterize selected areas and to develop site specific recommendations, as necessary.

During construction, sufficient and timely geotechnical observation and testing should be provided to correlate the findings of this investigation, and possible supplemental investigation, with the actual subsurface conditions exposed during construction. Items requiring observation and testing include, but are not necessarily limited to, the following:

1. Site preparation-stripping and removals.

2. Excavations, including approval of the bottom of excavation prior to filling.

3. Scarifying and recompacting prior to fill placement.

4. Subgrade preparation for pavements and slabs-on-grade.

5. Placement of engineered compacted fill and backfill, including approval of fill materials and the performance of sufficient density tests to evaluate the degree of compaction being achieved.

6. Foundation excavations, including footings.

TIME LIMITATIONS

The findings of this report are valid as of this date. Changes in the condition of a property can, however, occur with the passage of time, whether they be due to natural processes or the work of man on this or adjacent properties. In addition, changes in the Standards-of-Practice and/or Governmental Codes may occur. Due to such changes, the findings of this report may be invalidated wholly or in part by changes beyond our control. Therefore, this report should not be relied upon after a significant amount of time without a review by LOR Geotechnical Group, Inc. verifying the suitability of the conclusions and recommendations.

LIMITATIONS

This report contains geotechnical conclusions and recommendations developed solely for use by the City of Yucaipa Community Services Department, and their designates for the purposes described earlier. It may not contain sufficient information for other uses or the purposes of other parties. The contents should not be extrapolated to other areas or used for other facilities without consulting LOR Geotechnical Group, Inc.

The recommendations are based on interpretations of the subsurface conditions concluded from information gained from subsurface explorations, and a surficial site reconnaissance. The interpretations may differ from actual subsurface conditions, which can vary horizontally and vertically across the site. Due to possible subsurface variations, all aspects of field construction addressed in this report should be observed and tested by the project geotechnical consultant.

If parties other than LOR Geotechnical Group, Inc. provide construction monitoring services, they must be notified that they will be required to assume responsibility for the geotechnical phase of the project being completed by concurring with the recommendations provided in this report or by providing alternative recommendations.

The report was prepared using generally accepted geotechnical engineering practices under the direction of a state licensed geotechnical engineer. No warranty, expressed or implied, is made as to conclusions and professional advice included in this report. Any persons using this report for bidding or construction purposes should perform such independent investigations as deemed necessary to satisfy themselves as to the surface and subsurface conditions to be encountered and the procedures to be used in the performance of work on this project.

CLOSURE

It has been a pleasure to assist you with this project. We look forward to being of further assistance to you as construction begins.

Should you have any questions regarding this report, please do not hesitate to contact this office at your convenience.

Respectfully submitted,
LOR Geotechnical Group, Inc.

John P. Leuer, GE 2030
President

Robert M Markoff, CEG 2073
Engineering Geologist

RMM:DAW:JPL/ss

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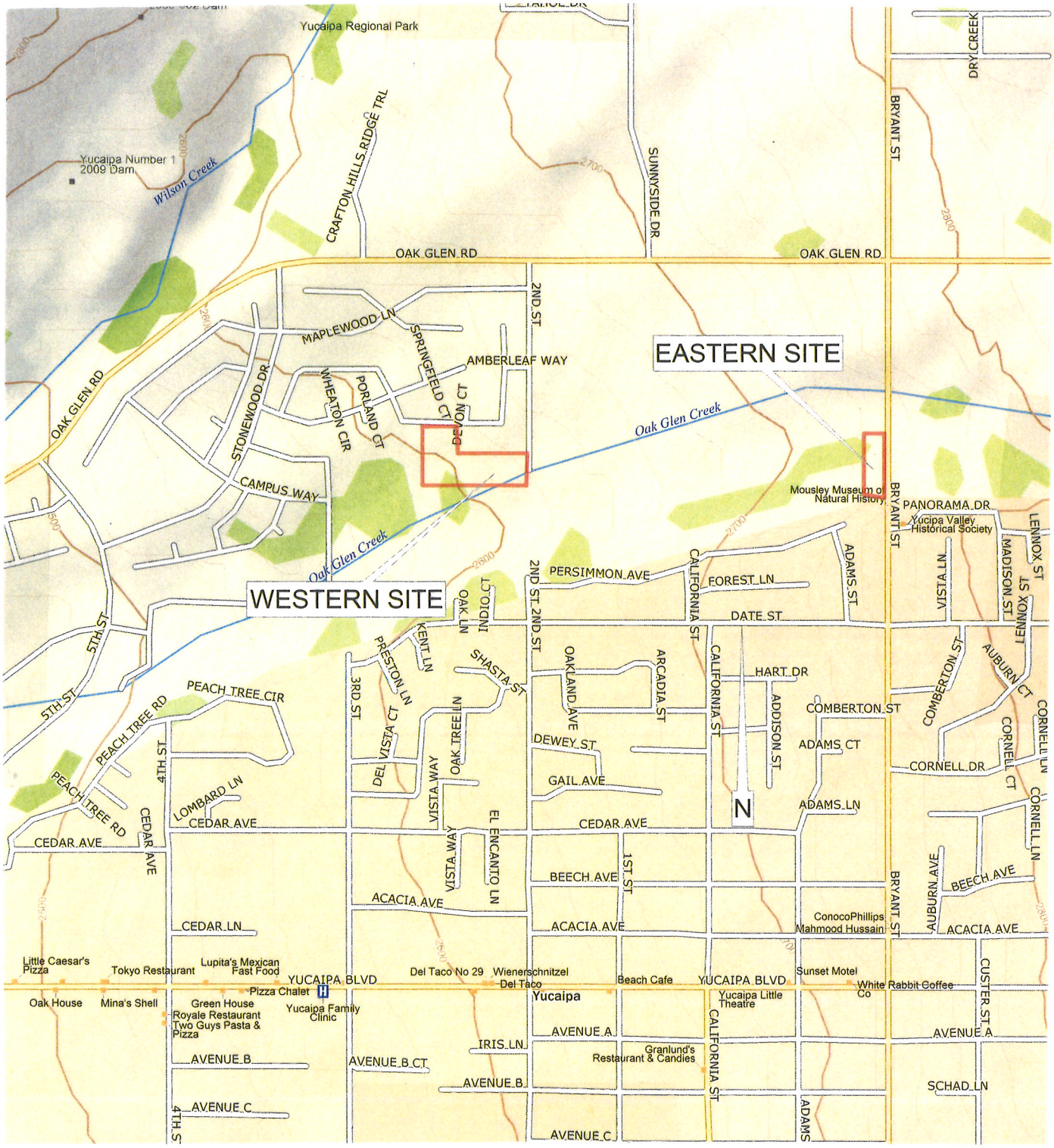
APPENDIX A

Index Map, Geotechnical Maps, Regional Geologic Map, Earthquake Fault Zone Map, Fault-Rupture Hazard Zones Map, and Historical Seismicity Maps

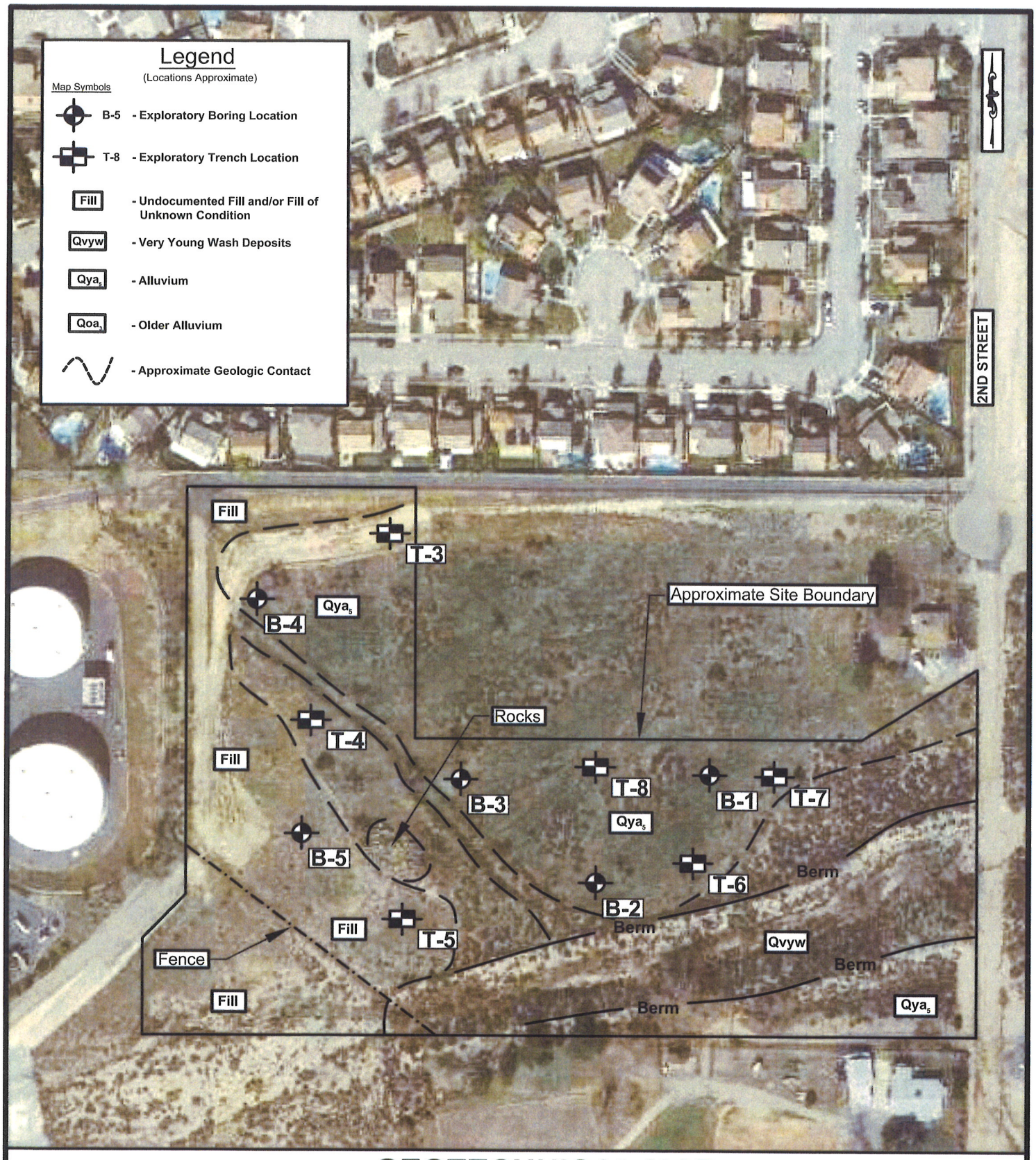


INDEX MAP

PROJECT:	PROPOSED RESIDENTIAL AND COMMERCIAL SITES, YUCAIPA, CA	PROJECT NO.:	12829A.1
CLIENT:	CITY OF YUCAIPA	ENCLOSURE:	A-1
LOR Geotechnical Group, Inc.		DATE:	JULY 2016
		SCALE:	1"=2,000'

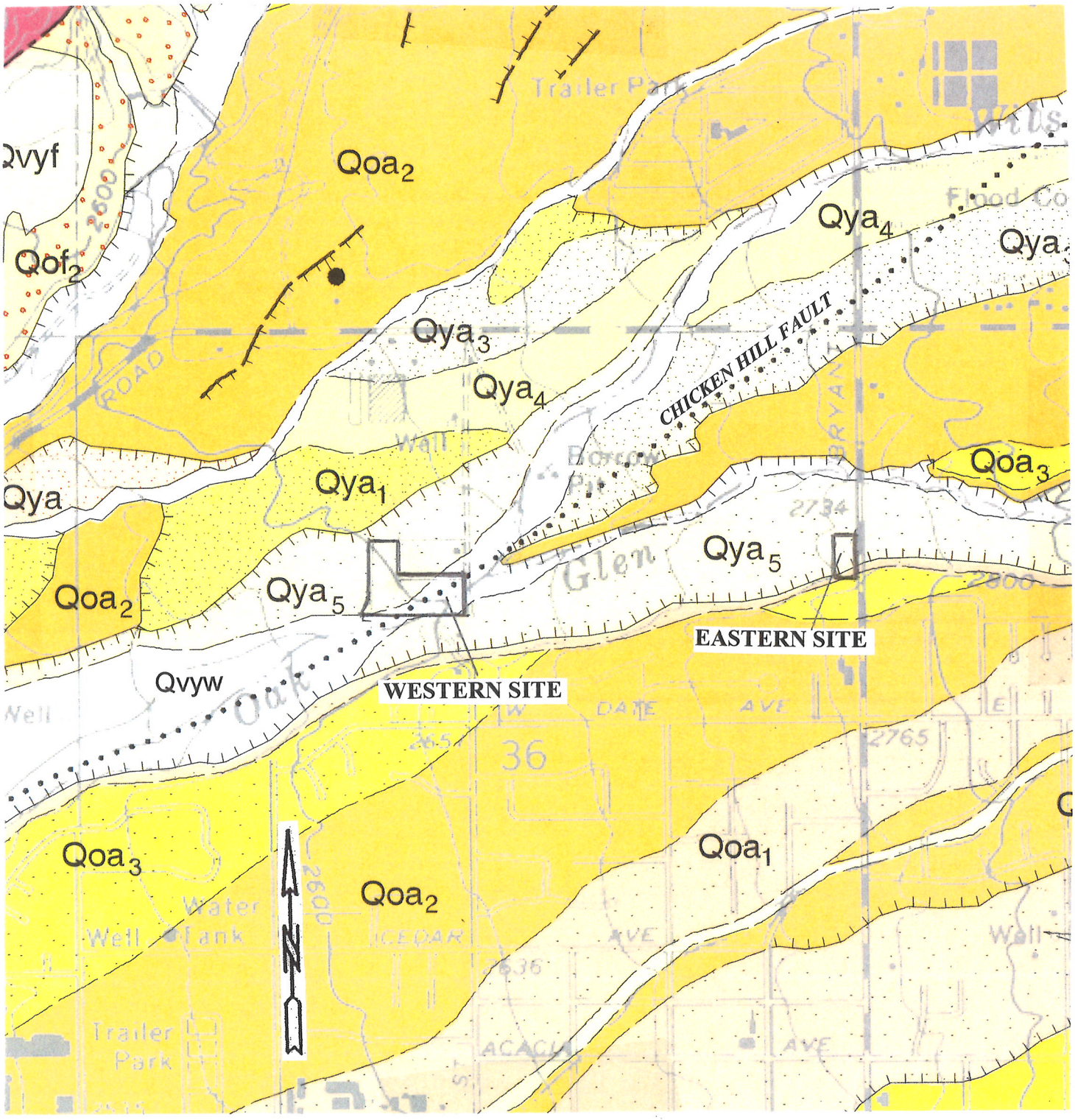
GEOTECHNICAL MAP

PROJECT:	EASTERN SITE, YUCAIPA, CALIFORNIA	**PROJECT NO:**	12829A.1
CLIENT:	CITY OF YUCAIPA	**ENCLOSURE:**	A-2a
LOR Geotechnical Group, Inc.		**DATE:**	JULY 2016
		SCALE:	1" ≈ 110'



GEOTECHNICAL MAP

PROJECT:	WESTERN SITE, YUCAIPA, CALIFORNIA	**PROJECT NO:**	12829A.1
CLIENT:	CITY OF YUCAIPA	**ENCLOSURE:**	A-2b
LOR Geotechnical Group, Inc.		**DATE:**	JULY 2016
		SCALE:	1" ≈ 170'



REGIONAL GEOLOGIC MAP (Matti et al, 2003)

PROJECT:	PROPOSED RESIDENTIAL AND COMMERCIAL SITES, YUCAIPA, CA	PROJECT NO.:	12829A.1
CLIENT:	CITY OF YUCAIPA	ENCLOSURE:	A-3a
LOR Geotechnical Group, Inc.		DATE:	JULY 2016
		SCALE:	1"=2,000'

PARTIAL LEGEND
DESCRIPTION OF MAP UNITS

VERY YOUNG SURFICIAL DEPOSITS—Sediment recently transported and deposited in channels and washes, on surfaces of alluvial fans and alluvial valleys, and on hillslopes. Soil-profile development is non-existant to minimal. Includes:

Qvyw — **Very young wash deposits, active (latest Holocene)**—Unconsolidated sand and gravel deposits in active washes

Qya — **Young axial-valley deposits (Holocene and latest Pleistocene)**—Slightly to moderately consolidated silt, sand, and gravel. Units distinguished from each other on the basis of soil-profile development and relative position in local terrace-riser succession. Includes:

Qya5 — **Young axial-valley deposits, Unit 5 (latest Holocene)**

Qya4 — **Young axial-valley deposits, Unit 4 (late Holocene)**

Qya3 — **Young axial-valley deposits, Unit 3 (middle Holocene)**

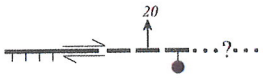
Qya1 — **Young axial-valley deposits, Unit 1 (early Holocene and latest Pleistocene)**

Old axial-valley deposits (late to middle Pleistocene)—Moderately to well consolidated silt, sand, and gravel. Units distinguished from each other on the basis of soil-profile development and relative position in local terrace-riser succession. Includes:

Qoa3 — **Old axial-valley deposits, Unit 3 (late to middle Pleistocene)**

Qoa2 — **Old axial-valley deposits, Unit 2 (late to middle Pleistocene)**

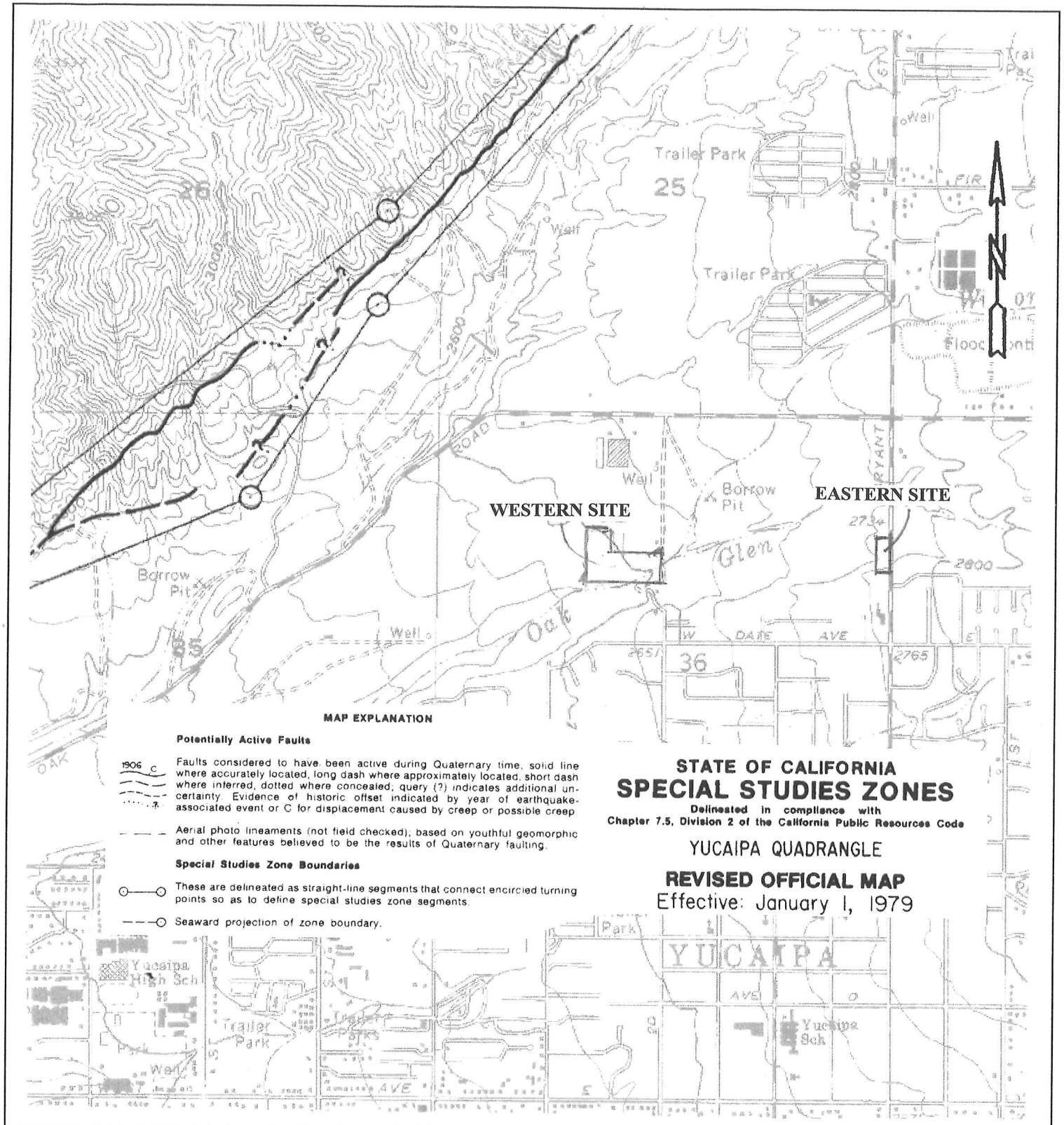
Qoa1 — **Old axial-valley deposits, Unit 1 (late to middle Pleistocene)**



Fault—Solid where meets map-accuracy standard; dashed where may not meet map-accuracy standard. Dotted where concealed by mapped covering unit; queried where existence uncertain. Hachures indicate scarp, with hachures on down-dropped block. Paired arrows indicate relative movement; single arrow indicates direction and amount of fault-plane dip. Bar and ball on down-thrown block

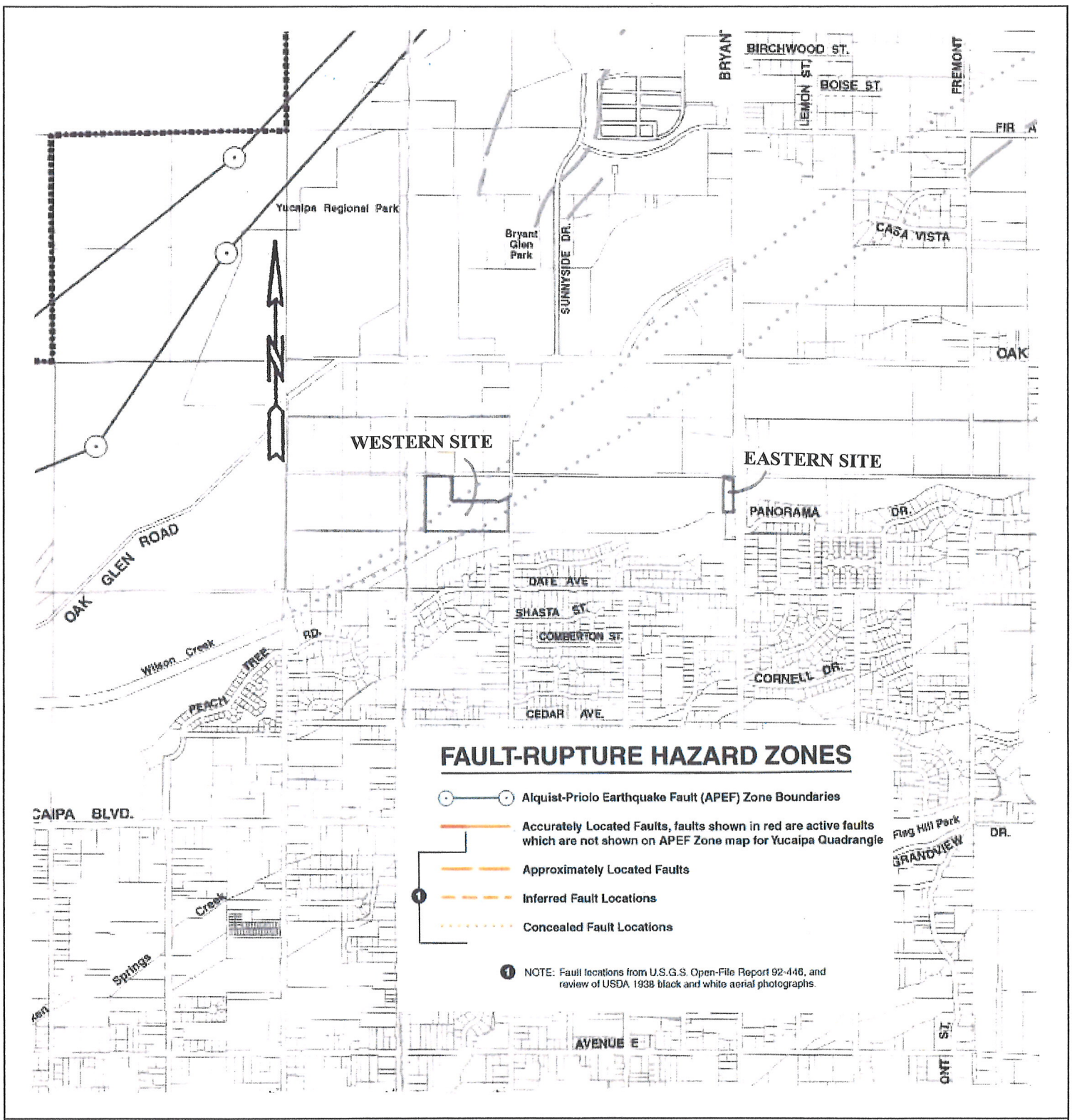
REGIONAL GEOLOGIC MAP EXPLANATION

PROJECT:	PROPOSED RESIDENTIAL AND COMMERCIAL SITES, YUCAIPA, CA	PROJECT NO.:	12829A.1
CLIENT:	CITY OF YUCAIPA	ENCLOSURE:	A-3b
LOR Geotechnical Group, Inc.		DATE:	JULY 2016
		SCALE:	N/A



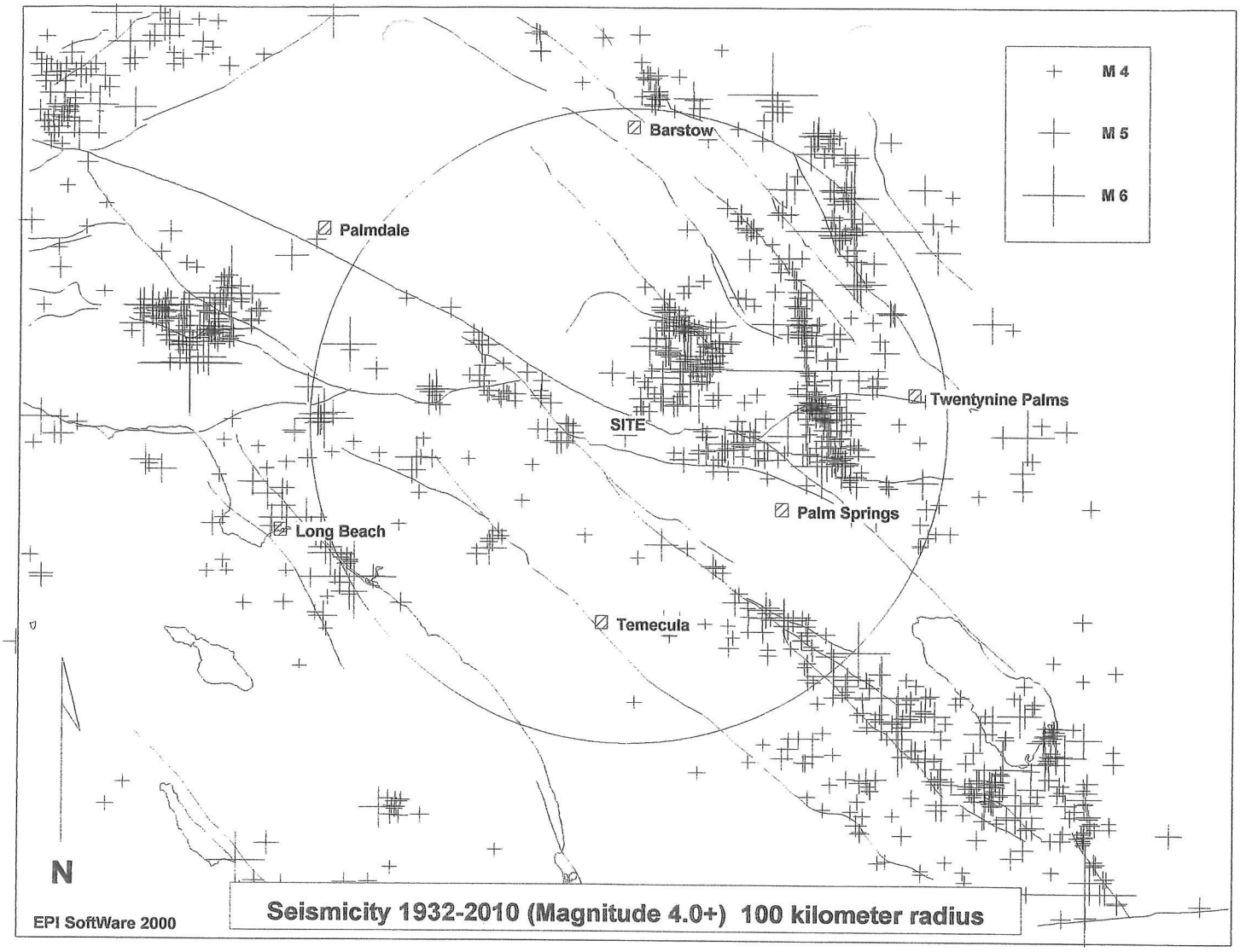
EARTHQUAKE FAULT ZONE MAP

PROJECT:	PROPOSED RESIDENTIAL AND COMMERCIAL SITES, YUCAIPA, CA	PROJECT NO.:	12829A.1
CLIENT:	CITY OF YUCAIPA	ENCLOSURE:	A-4
LOR Geotechnical Group, Inc.		DATE:	JULY 2016
		SCALE:	1"=1,600'



CITY OF YUCAIPA FAULT-RUPTURE HAZARD ZONES MAP

PROJECT:	PROPOSED RESIDENTIAL AND COMMERCIAL SITES, YUCAIPA, CA	PROJECT NO.:	12829A.1
CLIENT:	CITY OF YUCAIPA	ENCLOSURE:	A-5
LOR Geotechnical Group, Inc.		DATE:	JULY 2016
		SCALE:	1"=1,600'



SITE LOCATION: 34.0463 LAT. -117.0407 LONG.

MINIMUM LOCATION QUALITY: C

TOTAL # OF EVENTS ON PLOT: 1499

TOTAL # OF EVENTS WITHIN SEARCH RADIUS: 572

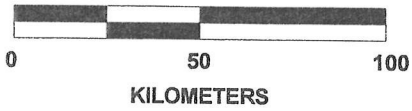
MAGNITUDE DISTRIBUTION OF SEARCH RADIUS EVENTS:

4.0- 4.9 : 518
5.0- 5.9 : 48
6.0- 6.9 : 4
7.0- 7.9 : 2
8.0- 8.9 : 0

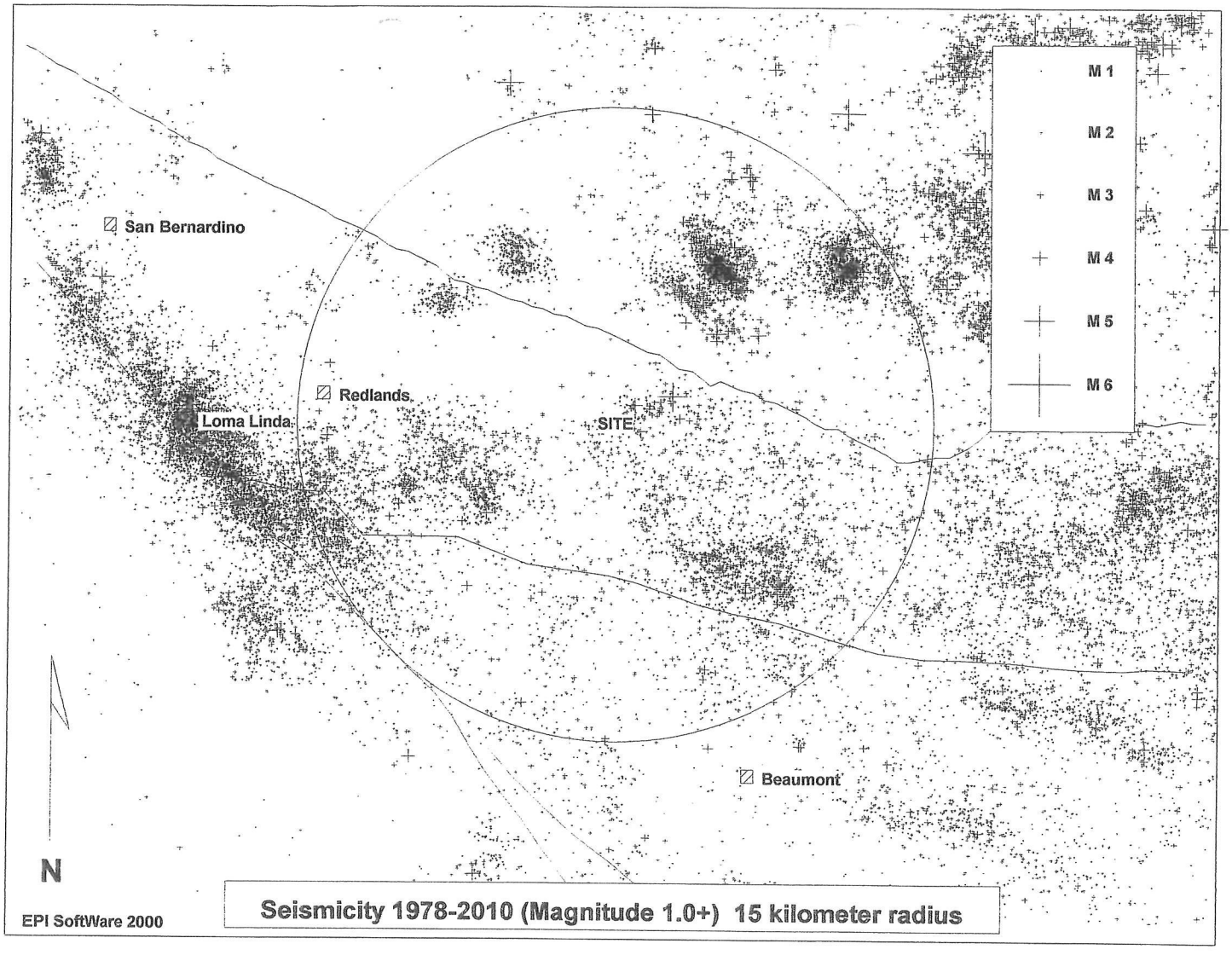
CLOSEST EVENT: 4.0 ON MONDAY, JUNE 27, 2005 LOCATED APPROX. 1.2 KILOMETERS NORTHEAST OF THE SITE

LARGEST 5 EVENTS:

7.3 ON SUNDAY, JUNE 28, 1992 LOCATED APPROX. 58 KILOMETERS EAST OF THE SITE
7.1 ON SATURDAY, OCTOBER 16, 1999 LOCATED APPROX. 93 KILOMETERS NORTHEAST OF THE SITE
6.4 ON SUNDAY, JUNE 28, 1992 LOCATED APPROX. 26 KILOMETERS NORTHEAST OF THE SITE
6.4 ON SATURDAY, MARCH 11, 1933 LOCATED APPROX. 98 KILOMETERS SOUTHWEST OF THE SITE
6.1 ON THURSDAY, APRIL 23, 1992 LOCATED APPROX. 67 KILOMETERS EAST OF THE SITE



Enclosure A-6



SITE LOCATION: 34.0463 LAT. -117.0407 LONG.

MINIMUM LOCATION QUALITY: A

0 7 15
KILOMETERS

TOTAL # OF EVENTS ON PLOT: 21330

TOTAL # OF EVENTS WITHIN SEARCH RADIUS: 7600

MAGNITUDE DISTRIBUTION OF SEARCH RADIUS EVENTS:

1.0- 1.9 : 6210
2.0- 2.9 : 1288
3.0- 3.9 : 91
4.0- 4.9 : 11
5.0- 5.9 : 0
6.0- 6.9 : 0
7.0- 7.9 : 0
8.0- 8.9 : 0

CLOSEST EVENT: 1.8 ON FRIDAY, SEPTEMBER 03, 1982 LOCATED APPROX. .1 KILOMETER OF THE SITE

LARGEST 5 EVENTS:

4.9 ON THURSDAY, JUNE 16, 2005 LOCATED APPROX. 2 KILOMETERS NORTHEAST OF THE SITE
4.7 ON THURSDAY, OCTOBER 01, 1998 LOCATED APPROX. 13 KILOMETERS NORTHEAST OF THE SITE
4.7 ON SUNDAY, AUGUST 16, 1998 LOCATED APPROX. 13 KILOMETERS NORTHEAST OF THE SITE
4.6 ON MONDAY, JUNE 29, 1992 LOCATED APPROX. 9 KILOMETERS NORTHEAST OF THE SITE
4.4 ON TUESDAY, JUNE 30, 1992 LOCATED APPROX. 6 KILOMETERS NORTHEAST OF THE SITE

Enclosure A-7

APPENDIX B

Field Investigation Program and Boring Logs

APPENDIX B
FIELD INVESTIGATION

Subsurface Exploration

The site was investigated on June 1 and June 7, 2016, and consisted of excavating 8 exploratory trenches to depths between 8.5 and 15.5 feet below the existing ground surface and advancing 6 exploratory borings to depths of between 7 and 37 feet below the existing ground surface. The approximate locations of our trenches and borings are shown on Enclosure A-2, within Appendix A.

The trenching exploration was conducted using a New Holland LB 75B backhoe with a 24-inch bucket. The soils/bedrock encountered were continuously logged by an engineering geologist from this firm who visually observed the site, maintained detailed logs of the trenches, obtained disturbed soil samples for laboratory evaluation and testing, and classified the soils encountered by visual examination in accordance with the Unified Soil Classification System.

In-place density determinations were conducted at selected levels within the trenches utilizing the Nuclear Gauge Method (ASTM D 2922). Disturbed soil samples were obtained at earth material changes and other selected levels within the trenches. The samples were placed in sealed containers for transport to our geotechnical laboratory.

The drilling exploration was conducted using a Mobile B-61 drill rig equipped with 8-inch diameter hollow stem augers. As with the exploratory trenches, the soils encountered within the borings were continuously logged by a geologist from this firm who created detailed logs of the borings, obtained undisturbed, as well as disturbed, soil samples for evaluation and testing, and classified the soils by visual examination in accordance with the Unified Soil Classification System.

Relatively undisturbed samples of the subsoils were obtained at a typical maximum interval of 5 feet. The relatively undisturbed samples were recovered by using a California split barrel sampler of 2.50-inch inside diameter and 3.25-inch outside. The sampler was driven by a 140-pound automatic trip hammer dropped from a height of 30 inches. The number of hammer blows required to drive the sampler into the ground the final 12 inches were recorded and further converted to an equivalent SPT N-values which are included in the boring logs.

The undisturbed soil samples were retained in brass sample rings of 2.42 inches in diameter and 1.00 inch in height, and placed in sealed plastic containers. Disturbed soil samples were obtained at selected levels within the borings and placed in sealed containers for transport to our geotechnical laboratory.

All samples obtained were taken to our laboratory for storage and testing. Detailed logs of the trenches and boring are presented on the enclosed Trench and Boring Logs, Enclosures B-1 through B-14. A Boring/Trench Log Legend and Soil Classification Chart are presented on Enclosures B-i and B-ii, respectively.

CONSISTENCY OF SOIL

SANDS

SPT BLOWS	CONSISTENCY
0-4	Very Loose
4-10	Loose
10-30	Medium Dense
30-50	Dense
Over 50	Very Dense

COHESIVE SOILS

SPT BLOWS	CONSISTENCY
0-2	Very Soft
2-4	Soft
4-8	Medium
8-15	Stiff
15-30	Very Stiff
30-60	Hard
Over 60	Very Hard

SAMPLE KEY

Symbol	Description
	INDICATES CALIFORNIA SPLIT SPOON SOIL SAMPLE
	INDICATES BULK SAMPLE
	INDICATES SAND CONE OR NUCLEAR DENSITY TEST
	INDICATES STANDARD PENETRATION TEST (SPT) SOIL SAMPLE

TYPES OF LABORATORY TESTS

1. Atterberg Limits
2. Consolidation
3. Direct Shear (undisturbed or remolded)
4. Expansion Index
5. Hydrometer
6. Organic Content
7. Proctor (4", 6", or Cal216)
8. R-value
9. Sand Equivalent
10. Sieve Analysis
11. Soluble Sulfate Content
12. Swell
13. Wash 200 Sieve
14. Corrosion

BORING LOG LEGEND

PROJECT:	PROPOSED RESIDENTIAL AND COMMERCIAL SITES, YUCAIPA, CA	PROJECT NO.	12829A.1
CLIENT:	CITY OF YUCAIPA	ENCLOSURE:	B-i
LOR Geotechnical Group, Inc.		DATE:	JULY 2016

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

PARTICLE SIZE LIMITS

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

12" 3" 3/4" No. 4 No. 10 No. 40 200
(U.S. STANDARD SIEVE SIZE)

SOIL CLASSIFICATION CHART

PROJECT:	PROPOSED RESIDENTIAL AND COMMERCIAL SITES , YUCAIPA, CA	PROJECT NO.:	12829A.1
CLIENT:	CITY OF YUCAIPA	ENCLOSURE:	B-ii
LOR Geotechnical Group, Inc.		DATE:	JULY 2016

LOG OF BORING B-1

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0	12	8, 9, 10	1.4		111.3			SM	@ 0 feet, ALLUVIUM: SILTY SAND, approximately 10% gravel, 15% coarse-grained sand, 25% medium-grained sand, 30% fine-grained sand, and 20% silty fines, brown, damp, loose to medium dense.
5	7		2.1		106.9			SW	@ 4.5 feet, WELL GRADED SAND, approximately 10% fine gravel, 15% coarse-grained sand, 35% medium-grained sand, 35% fine-grained sand, and 5% silty fines, light brown, dry, loose to medium dense.
	17		1.9		112.3				@ 7 feet, slightly coarser grained, medium dense.
10	18		3.0		116.5				@ 10.5 feet, includes minor silt (layer of silty sand).
	27		2.4		119.9			SM	@ 12 feet, SILTY SAND, approximately 15% fine gravel, 20% coarse-grained sand, 30% medium-grained sand, 25% fine-grained sand, and 20% silty fines, brown, moist, medium dense.
15	19		3.1		115.5				
20	36		2.2		116.8			SW	@ 19 feet, WELL GRADED SAND, approximately 20% gravel with cobbles, 25% coarse-grained sand, 25% medium-grained sand, 25% fine-grained sand, and 5% silty fines, brown, damp, medium dense to dense.
25	73					=			@ 25 feet, abundant cobbles, likely boulders.
30									END OF BORING (REFUSAL) No Fill No Groundwater No Bedrock
35									
40									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 7, 2016
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-1

LOG OF BORING B-2

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0	10		1.5		108.1			SM	@ 0 feet, ALLUVIUM: SILTY SAND, approximately 15% gravel, 15% coarse-grained sand, 25% medium-grained sand, 25% fine-grained sand, and 20% silty fines, brown, damp, loose to medium dense.
5	7		2.7		106.4			SW	@ 4 feet, WELL GRADED SAND, approximately 15% gravel, 20% coarse-grained sand, 25% medium-grained sand, 35% fine-grained sand, and 5% silty fines, brown, damp, loose to medium dense.
	29		1.0		124.0				@ 7 feet, includes minor cobbles, possible boulders.
10	13		2.2		104.5				@ 10 feet, less gravel.
	7		3.1		109.2			SM	@ 12 feet, SILTY SAND, approximately 10% fine gravel, 20% coarse-grained sand, 25% medium-grained sand, 30% fine-grained sand, and 15% silty fines, brown, moist, medium dense.
15	26		1.5		114.0			SW	@ 15 feet, WELL GRADED SAND, approximately 20% gravel with cobbles, 15% coarse-grained sand, 25% medium-grained sand, 35% fine-grained sand, and 5% silty fines, brown, damp, medium dense.
20	20		4.5		118.7				
25	73		2.3						@ 24 feet, includes cobbles, possible boulders, hard drilling.
30									END OF BORING (REFUSAL) No Fill No Groundwater No Bedrock
35									
40									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 7, 2016
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-2

LOG OF BORING B-3

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0	8		1.0		109.4			SM	@ 0 feet, ALLUVIUM: SILTY SAND, approximately 10% gravel, 15% coarse-grained sand, 25% medium-grained sand, 35% fine-grained sand, and 15% silty fines, brown, damp, loose to medium dense.
5	10	2	2.7		110.0			SW	@ 6 feet, WELL GRADED SAND, approximately 15% gravel, 20% coarse-grained sand, 25% medium-grained sand, 35% fine-grained sand, and 5% silty fines, light brown, damp, medium dense.
	17		2.0		106.3				
10	22		1.9		112.4				@ 12 feet, minor cobbles, difficult drilling.
15	33		1.5						@ 15 feet, increase in gravel percentage, trace of cobbles.
20	36		2.1		117.1				
25	81		3.7						@ 24 feet, increase in cobbles, boulders likely.
30									END OF BORING (REFUSAL) No Fill No Groundwater No Bedrock
35									
40									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 7, 2016
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-3

LOG OF BORING B-4

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0	56	9, 10	1.8					SM	@ 0 feet, ALLUVIUM: SILTY SAND, approximately 10% gravel, 15% coarse-grained sand, 25% medium-grained sand, 25% fine-grained sand, and 25% silty fines, brown, damp, loose to medium dense.
5	49		4.5		102.9				
	24		2.5		115.8				@ 6.5 feet, medium dense, slight increase in gravel.
10	26		4.7		113.4				@ 9 feet, minor cobbles. @ 10 feet, silty sand. @ 12 feet, minor cobbles.
15	26		2.3		110.1			SW	@ 14 feet, WELL GRADED SAND, approximately 20% gravel, 20% coarse-grained sand, 25% medium-grained sand, 30% fine-grained sand, and 5% silty fines, light brown, damp, medium dense.
20	29		3.5		123.4			SM	@ 19 feet, SILTY SAND, approximately 10% gravel, 15% coarse-grained sand, 25% medium-grained sand, 30% fine-grained sand, and 20% silty fines, brown, moist, medium dense.
25	39		1.7						@ 28 feet, cobbles and boulders, hard drilling.
30	144		2.0						END OF BORING (REFUSAL) No Fill No Groundwater No Bedrock
35									
40									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 7, 2016
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-4

LOG OF BORING B-5

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0	27		4.0		120.2			SM	@ 0 feet, FILL: SILTY SAND, approximately 15% gravel, 15% coarse-grained sand, 25% medium-grained sand, 25% fine-grained sand, and 20% silty fines, brown, damp, loose to medium dense.
5	25		4.1		121.3				@ 5 feet, moist and medium dense.
	27		2.3		111.4			SW	@ 6 feet, ALLUVIUM: WELL GRADED SAND, approximately 15% gravel, 20% coarse-grained sand, 25% medium-grained sand, 35% fine-grained sand, and 5% silty fines, light brown, damp, medium dense.
10	16	2	2.7		114.7			SM	@ 9.5 feet, SILTY SAND, approximately 10% gravel, 20% coarse-grained sand, 25% medium-grained sand, 30% fine-grained sand, and 15% silty fines, brown, moist, loose to medium dense.
	12	2	4.6		109.8				@ 12 feet, increase in fine-grained sand.
15	20		1.9		116.2			SW	@ 14 feet, WELL GRADE SAND, approximately 15% gravel, 20% coarse-grained sand, 30% medium-grained sand, 30% fine-grained sand, and 5% silty fines, light brown, damp, medium dense.
20	46		2.4		116.8				@ 20 feet, slight increase in gravels.
25	31		1.7						@ 25 feet, increase in coarse-grained sand percentage.
30	34								
35	77		2.6						@ 34 feet, increase in gravel, likely cobbles and boulders.
40									END OF BORING (REFUSAL) Fill to 6' No Groundwater No Bedrock

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 7, 2016
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-5

LOG OF BORING B-6

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SM	@ 0 feet, FILL: SILTY SAND, fine to coarse-grained sand with minorgravel, brown, damp, loose, abundant cobbles and boulders (from 1' to 2' in diameter).
	10		2.0		119.8	▮		SM	@ 2 feet, ALLUVIUM: SILTY SAND, approximately 15% gravel, 15% coarse-grained sand, 25% medium-grained sand, 25% fine-grained sand, and 20% silty fines, brown, damp, loose to medium dense.
5	10		3.8		111.0	▮			@ 5 feet, sandier, contains minor cobbles and boulders.
									END OF BORING (REFUSAL) Fill to 2' No Groundwater No Bedrock
10									
15									
20									
25									
30									
35									
40									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 7, 2016
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-6

LOG OF TRENCH T-1

DEPTH IN FEET	TEST DATA: LABORATORY TESTS		ESTIMATED COMPACTION (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SM	@ 0 feet, FILL: SILTY SAND, approximately 10% cobble and boulders (to 1.5' in diameter), 15% gravel, 10% coarse-grained,20% medium-grained sand, 25% fine-grained sand, and 20% slity fines, brown, damp, loose, likely that most tailings and debris from adjacent fill soil.
	3, 7, 10, 11		80	2.3	110.4			SM	@ 1.5 feet, ALLUVIUM: SILTY SAND, approximately 15% gravel, 20% coarse-grained sand, 20% medium-grained sand, 25% fine-grained sand, and 20% silty fines, brown, damp, loose to medium dense.
			79	2.7	108.9				
5									
									@ 9 feet, includes numerous boulders (to 3" in diameter).
10									
									END OF TRENCH (REFUSAL) Fill to 1.5' Heavy Caving No Groundwater No Bedrock
15									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE EXCAVATED:	May 1, 2016
		EQUIPMENT:	NH LB 75B
		BUCKET W.: 2'	ENCLOSURE: B-7

LOG OF TRENCH T-2

DEPTH IN FEET	LABORATORY TESTS		ESTIMATED COMPACTION (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SM	@ 0 feet, FILL: SILTY SAND, approximately 5% cobble with trace of boulders (to 1' in diameter), 10% gravel, 20% medium-grained sand, 30% fine-grained sand, and 20% slity fines, brown, damp, loose.
								SW	@ 3.5 feet, ALLUVIUM: WELL GRADED SAND, approximately 10% gravel, 20% coarse-grained sand, 30% medium-grained sand, 35% fine-grained sand, and 5% silty fines, light brown, damp, loose to medium dense, crudely stratified.
5			79	1.2	109.1				
10									@ 12 feet, trench caved severly. END OF TRENCH (CAVED)
15									Fill to 3.5' Heavy Caving No Groundwater No Bedrock

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE EXCAVATED:	May 1, 2016
		EQUIPMENT:	NH LB 75B
		BUCKET W.: 2'	ENCLOSURE: B-8

LOG OF TRENCH T-3

DEPTH IN FEET	LABORATORY TESTS		ESTIMATED COMPACTION (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SM	@ 0 feet, ALLUVIUM: SILTY SAND, approximately 10% gravel, 20% coarse-grained sand, 25% medium-grained sand, 30% fine-grained sand, and 15% slity fines, brown, damp, loose.
			75	3.9	104.0				
			84	2.6	116.4				
5									@ 5 feet, has occasional sand layers, sand to sand with silt.
10									@ 12 feet, increase in silt and moisture content.
15									
									END OF TRENCH **No Fill** **Heavy Caving** **No Groundwater** **No Bedrock**

PROJECT:	**Preliminary Geotechnical Investigation**	PROJECT NUMBER:	**12829A.1**
CLIENT:	**City of Yucaipa CDD**	ELEVATION:	**N/A**
LOR GEOTECHNICAL GROUP INC.		DATE EXCAVATED:	**May 1, 2016**
		EQUIPMENT:	**NH LB 75B**
		BUCKET W.: **2'**	ENCLOSURE: **B-9**

LOG OF TRENCH T-4

DEPTH IN FEET	LABORATORY TESTS		ESTIMATED COMPACTION (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SM	@ 0 feet, ALLUVIUM: SILTY SAND, approximately 10% gravel, 20% coarse-grained sand, 25% medium-grained sand, 30% fine-grained sand, and 15% slity fines, brown, damp, loose.
	3, 7, 10, 11		76	1.3	98.9				@ 3 feet, slight increase in density with slight increases in silt and moisture contents.
5			80	3.8	104.1				
								SM	@ 6 feet, SILTY SAND, approximately 5% gravel, 10% coarse-grained sand, 20% medium-grained sand, 35% fine-grained sand, and 30% silty fines, brown, moist, medium dense.
								SW	@ 9 feet, GRAVELLY SAND, approximately 20% gravel, 15% coarse-grained sand, 25% medium-grained sand, 35% fine-grained sand, and 5% silty fines, light brown, damp.
10									
								SM	@ 13 feet, SILTY SAND, approximately 10% gravel, 10% coarse-grained sand, 25% medium-grained sand, 30% fine-grained sand, and 30% silty fines, brown, damp.
15									@ 15 feet, includes cobbles and boulders.

END OF TRENCH

No Fill
No Caving
No Groundwater
No Bedrock

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE EXCAVATED:	May 1, 2016
		EQUIPMENT:	NH LB 75B
		BUCKET W.: 2'	ENCLOSURE: B-10

LOG OF TRENCH T-5

DEPTH IN FEET	LABORATORY TESTS		ESTIMATED COMPACTION (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SM	@ 0 feet, FILL: SILTY SAND, approximately 5% gravel, 10% coarse-grained sand, 20% medium-grained sand, 30% fine-grained sand, and 35% slity fines, brown, damp, medium dense.
			83	2.0	114.4			SW	@ 2 feet, ALLUVIUM: WELL GRADED SAND, approximately 10% gravel, 15% coarse-grained sand, 30% medium-grained sand, 40% fine-grained sand, and 5% silty fines, light brown, dry, loose to medium dense, subject to caving.
			81	2.3	107.7				
5									@ 6 feet, includes minor cobbles.
									@ 8.5 feet, trench caved heavily.
									END OF TRENCH
10									No Fill Heavy Caving No Groundwater No Bedrock
15									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE EXCAVATED:	May 1, 2016
		EQUIPMENT:	NH LB 75B
		BUCKET W.: 2'	ENCLOSURE: B-11

LOG OF TRENCH T-6

DEPTH IN FEET	LABORATORY TESTS		ESTIMATED COMPACTION (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SM	@ 0 feet, ALLUVIUM: SILTY SAND, approximately 10% gravel, 15% coarse-grained sand, 20% medium-grained sand, 30% fine-grained sand, and 25% silty fines, brown, damp, loose.
			92	1.6	128.2			SW SM	@ 1.5 feet, GRAVELLY SAND WITH SILT, approximately 5% cobbles, 20% gravel, 15% coarse-grained sand, 20% medium-grained sand, 30% fine-grained sand, and 10% silty fines, brown, damp, loose to medium dense.
			85	1.7	117.4			SM	@ 3 feet, SILTY SAND WITH GRAVEL AND COBBLES, approximately 10% cobbles, 20% gravel, 15% coarse-grained sand, 20% medium-grained sand,15% fine-grained sand, and 20% silty fines, brown, damp, massive, loose to medium dense.
5									
									@ 7 feet, clean sand layer.
									@ 8 feet, increase in gravel and cobbles.
10									
									@ 11 feet, minor boulders (to 2' in diameter).
									END OF TRENCH (REFUSAL) No Fill Heavy Caving No Groundwater No Bedrock
15									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE EXCAVATED:	May 1, 2016
		EQUIPMENT:	NH LB 75B
		BUCKET W.: 2'	ENCLOSURE: B-12

LOG OF TRENCH T-7

DEPTH IN FEET	LABORATORY TESTS		ESTIMATED COMPACTION (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SW	@ 0 feet, ALLUVIUM: **GRAVELLY SAND WITH SILT, approximately 15% gravel with a trace of cobbles, 20% coarse-grained sand, 30% medium-grained sand, 25% fine-grained sand, and 10% silty fines, brown, damp, loose to medium dense, massive to crdely stratified, subject to caving.**
			92	1.7	121.7				@ 3 feet, decrease in gravel content, stratified sand with minor fine gravel.
5			84	3.9	110.6				
								SM	@ 7 feet, SILTY SAND, approximately 10% gravel, 10% coarse-grained sand, 20% medium-grained sand, 30% fine-grained sand, and 30% silty fines, brown, damp.
								SW	@ 9 feet, GRAVELLY SAND, approximately 15% cobbles and a trace of boulders (to 2' in diameter), 15% coarse-grained sand, 20% medium-grained sand, 45% fine-grained sand, and 5% silty fines, brown, damp, hard ecavation,
10									
									END OF TRENCH No Fill Heavy Caving No Groundwater No Bedrock
15									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE EXCAVATED:	May 1, 2016
		EQUIPMENT:	NH LB 75B
		BUCKET W.: 2'	ENCLOSURE: B-13

LOG OF TRENCH T-8

DEPTH IN FEET	LABORATORY TESTS		ESTIMATED COMPACTION (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SW SM	@ 0 feet, ALLUVIUM: SAND WITH SILT, approximately 5% gravel, 20% coarse-grained sand, 25% medium-grained sand, 40% fine-grained sand, and 10% silty fines, light brown, dry, loose.
	3, 7, 10, 11		79	1.7	108.8			SM	@ 2 feet, SILTY SAND, approximately 5% gravel, 15% coarse-grained sand, 30% medium-grained sand, 35% fine-grained sand, and 15% silty fines, brown, damp, loose to medium dense.
			81	1.8	111.5				
5									@ 7 feet, minor cobbles.
10									END OF TRENCH (CAVED) No Fill Heavy Caving No Groundwater No Bedrock
15									

PROJECT:	Preliminary Geotechnical Investigation	PROJECT NUMBER:	12829A.1
CLIENT:	City of Yucaipa CDD	ELEVATION:	N/A
LOR GEOTECHNICAL GROUP INC.		DATE EXCAVATED:	May 1, 2016
		EQUIPMENT:	NH LB 75B
		BUCKET W.: 2'	ENCLOSURE: B-14

APPENDIX C

Laboratory Testing Program and Test Results

APPENDIX C
LABORATORY TESTING

General

Selected soil samples obtained from the borings and trenches were tested in our geotechnical laboratory to evaluate the physical properties of the soils affecting foundation design and construction procedures. Laboratory testing included moisture content, dry density, consolidation, laboratory compaction, direct shear, sieve analysis, consolidation, R-Value, and soluble sulfate content. Descriptions of the laboratory tests are presented in the following paragraphs.

Moisture-Density Tests

The moisture content and dry density information provides an indirect measure of soil consistency for each stratum, and can also provide a correlation between soils on this site. The dry unit weight and field moisture content were determined for selected undisturbed samples, in accordance with ASTM D 2937 and 2922, and ASTM D 2216, respectively, and the results are shown on the Trench and Boring Logs, Enclosures B-1 through B-14 for convenient correlation with the soil profile.

Consolidation Tests

The apparatus used for the consolidation tests (odometer) is designed to test a one-inch high portion of the undisturbed soil sample as contained in a sample ring. Porous stones and filler paper are placed in contact with the top and bottom of the specimen to permit the addition or release of water. Loads are applied to the test specimen in specified increments, and the resulting axial deformations are recorded. The results are plotted as log of axial pressure versus consolidation or compression, expressed as strain or sample height.

Samples are tested at field and greater-than field moisture contents. The results are shown on Enclosures C-2 through C-4.

Laboratory Compaction

Selected soil samples were tested in the laboratory to determine compaction characteristics using the ASTM D 1557 compaction test method. The results are presented in the following table:

LABORATORY COMPACTION				
Trench Number	Sample Depth (feet)	Soil Description (U.S.C.S.)	Maximum Dry Density (pcf)	Optimum Moisture Content (percent)
T-1	2 - 5	(SM) Silty Sand	138.5	6.0
T-4	3 - 5	(SM) Silty Sand	130.5	7.0
T-7	3 - 6	(SW) Gravelly Sand	132.0	4.5

Direct Shear Tests

Shear tests are performed with a direct shear machine in general accordance with ASTM D 3080 at a constant rate-of-strain (usually 0.05 inches/minute). The machine is designed to test a sample partially extruded from a sample ring in single shear. Samples are tested at varying normal loads in order to evaluate the shear strength parameters, angle of internal friction and cohesion. Samples are tested in remolded condition (90 percent per ASTM D 1557) and soaked, according to conditions expected in the field.

The results of the shear tests are presented in the following table:

DIRECT SHEAR TESTS				
Trench Number	Sample Depth (feet)	Soil Description (U.S.C.S.)	Apparent Cohesion (psf)	Angle of Internal Friction (degrees)
T-1	2 - 5	(SM) Silty Sand	100	37
T-4	3 - 5	(SM) Silty Sand	150	33
T-7	3 - 6	(SW) Gravelly Sand	200	35

Sieve Analysis

A quantitative determination of the grain size distribution was performed for selected samples in accordance with the ASTM D 422 laboratory test procedure. The determination is performed by passing the soil through a series of sieves, and

recording the weights of retained particles on each screen. The results of the sieve analyses are presented graphically on Enclosure C-1.

Sand Equivalent

The sand equivalent of selected soils were evaluated using the California Sand Equivalent Test Method, Caltrans Number 217. The results of the sand equivalent tests are presented with the grain size distribution analyses on Enclosure C-1.

R-Value Test

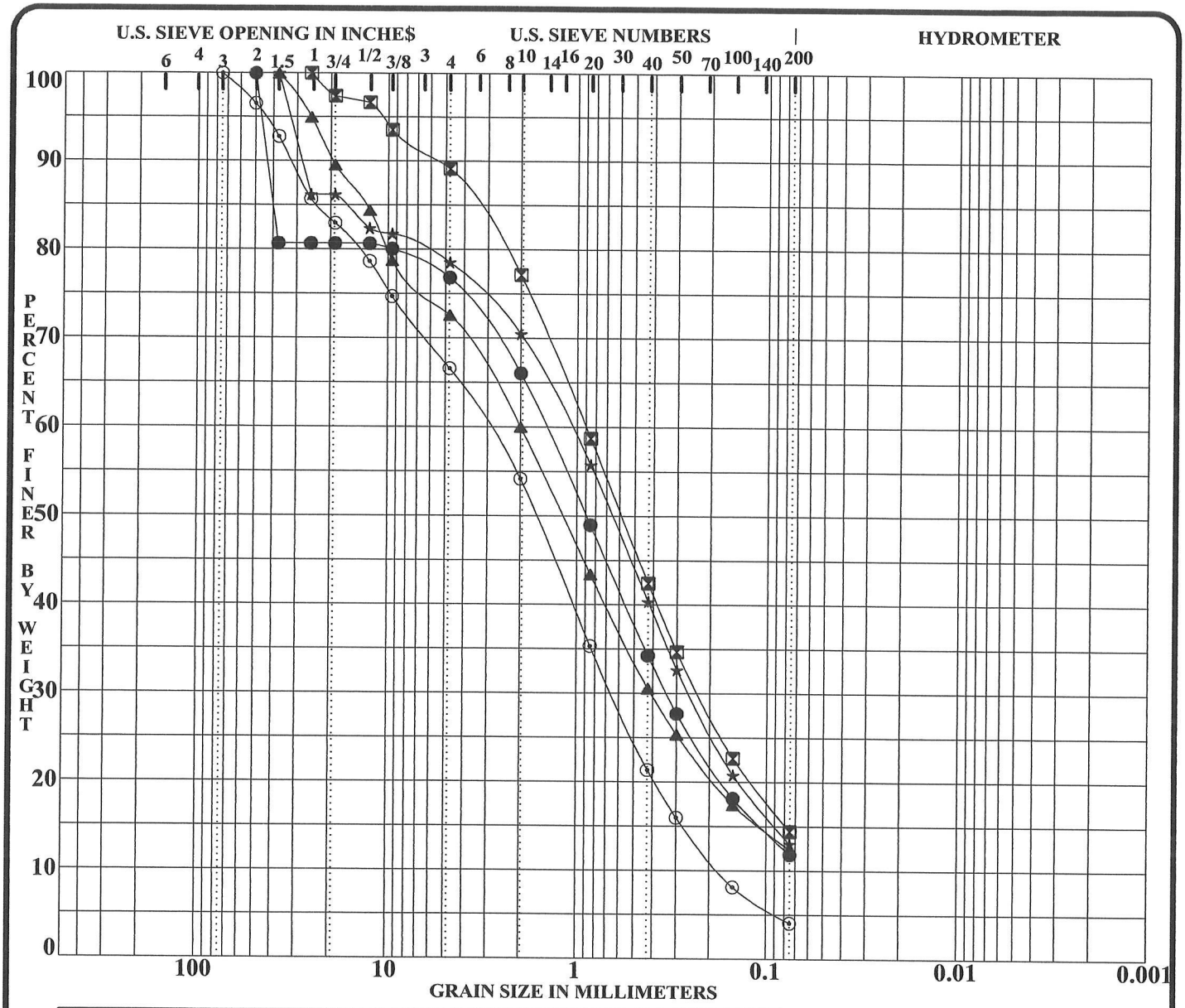
Soil samples were obtained at probable pavement subgrade level and sieve analysis and sand equivalent tests were conducted. Based on these indicator tests, a selected soil sample was tested to determine its R-value using the California R-Value Test Method, Caltrans Number 301. The results of the sieve analysis, sand equivalent, and R-value tests are presented on Enclosure C-1.

Soluble Sulfate Content Tests

The soluble sulfate content of selected subgrade soils was evaluated. The concentration of soluble sulfates in the soils was determined by measuring the optical density of a barium sulfate precipitate. The precipitate results from a reaction of barium chloride with water extractions from the soil samples. The measured optical density is correlated with readings on precipitates of known sulfate concentrations. The test results are presented on the following table:

SOLUBLE SULFATE CONTENT TESTS

Trench Number	Sample Depth (feet)	Soil Description	Sulfate Content (percent by weight)
T-1	2 - 5	(SM) Silty Sand	<.005
T-4	3 - 5	(SM) Silty Sand	<.005
T-7	3 - 6	(SW) Gravelly Sand	<.005



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Soil Classification	SE	RV			Cc	Cu
●	B-1	1 - 4 ft.	(SM) Silty Sand	45	81			1.27	24.0
⊠	B-4	1 - 4 ft.	(SM) Silty Sand	48					
▲	T-1	2 - 5 ft.	(SM) Silty Sand					1.55	37.0
★	T-4	3 - 5 ft.	(SM) Silty Sand						
⊙	T-7	3 - 6 ft.	(SW) Gravelly Sand with Silt					0.80	16.9

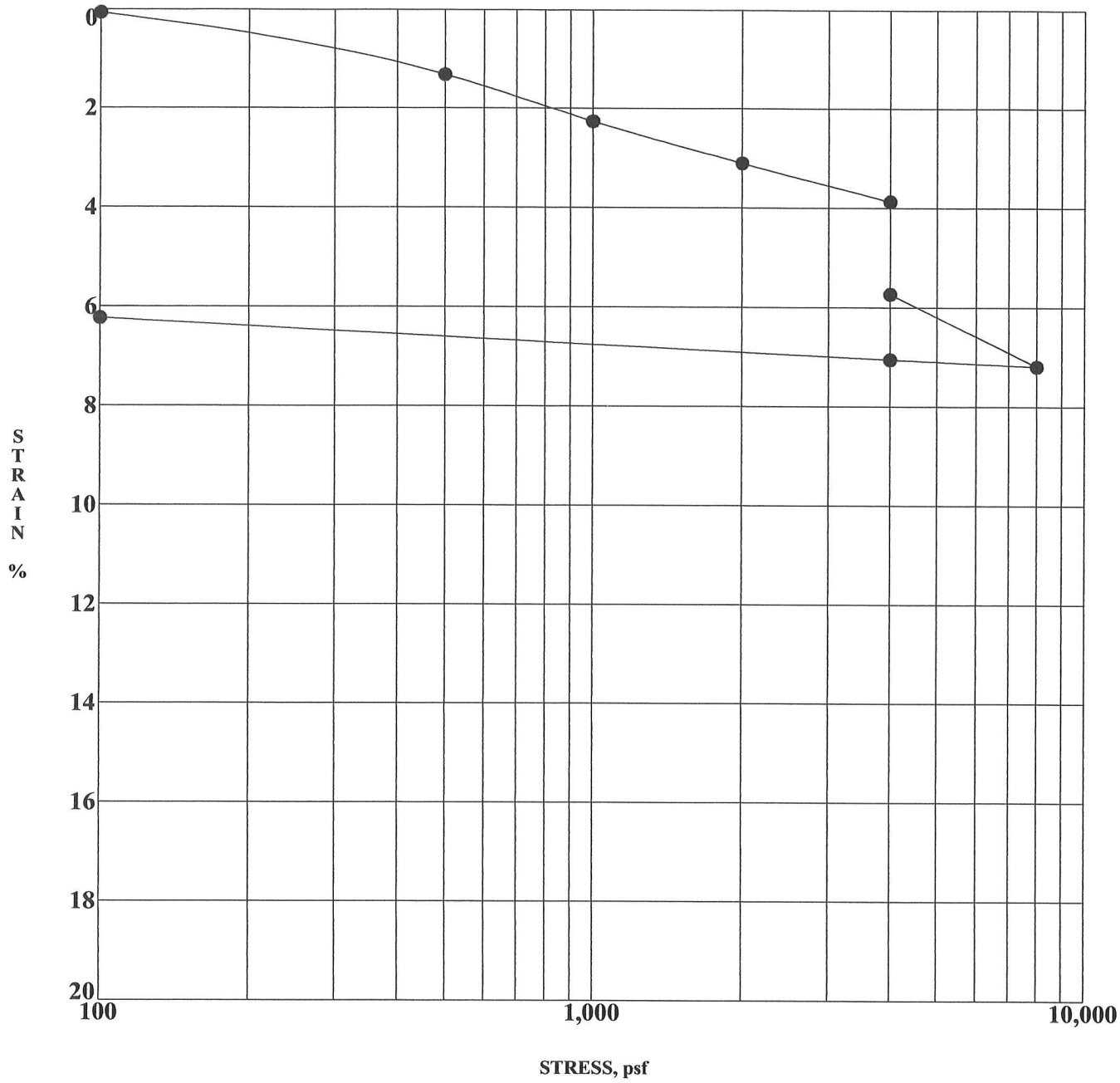
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	1 - 4 ft.	50.00	1.48	0.339		23.2	65.0	11.8	
⊠	B-4	1 - 4 ft.	25.40	0.90	0.229		10.9	74.7	14.4	
▲	T-1	2 - 5 ft.	37.50	2.00	0.409		27.4	60.2	12.4	
★	T-4	3 - 5 ft.	37.50	1.09	0.257		21.5	65.5	13.0	
⊙	T-7	3 - 6 ft.	75.00	3.00	0.653	0.1771	33.4	62.5	4.1	

PROJECT *Preliminary Geotechnical Investigation*

PROJECT NO. *12829A.1*
DATE *7/1/16*

GRADATION CURVES
LOR Geotechnical Group, Inc.

ENCLOSURE C-1



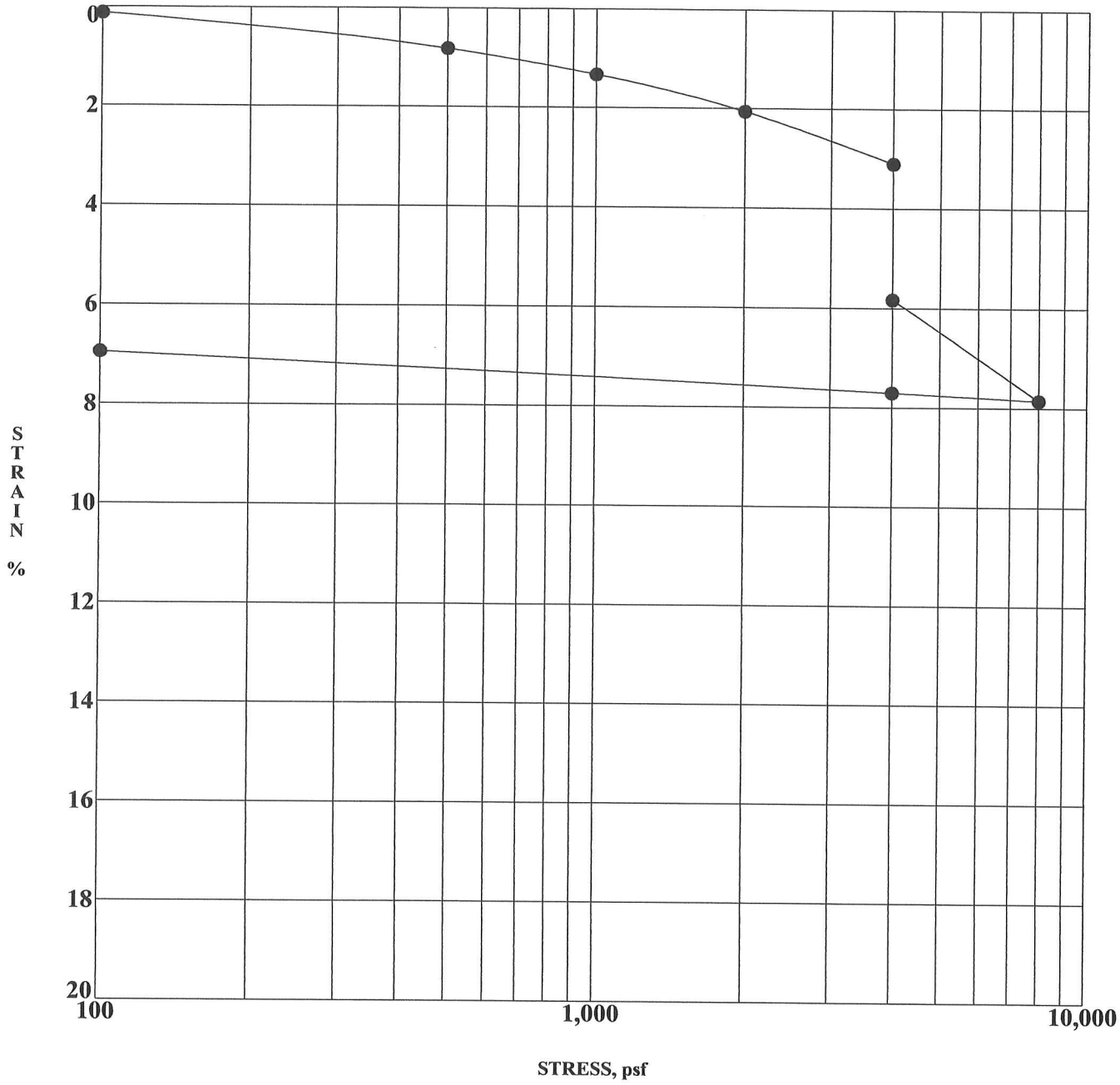
Specimen Identification		Classification	DD	MC%
● B-1	5.0	(SW) Well Graded Sand	107	3

PROJECT *Preliminary Geotechnical Investigation*

PROJECT NO. *12829A.1*
DATE *7/1/16*

CONSOLIDATION TEST
LOR Geotechnical Group, Inc.

ENCLOSURE C-2



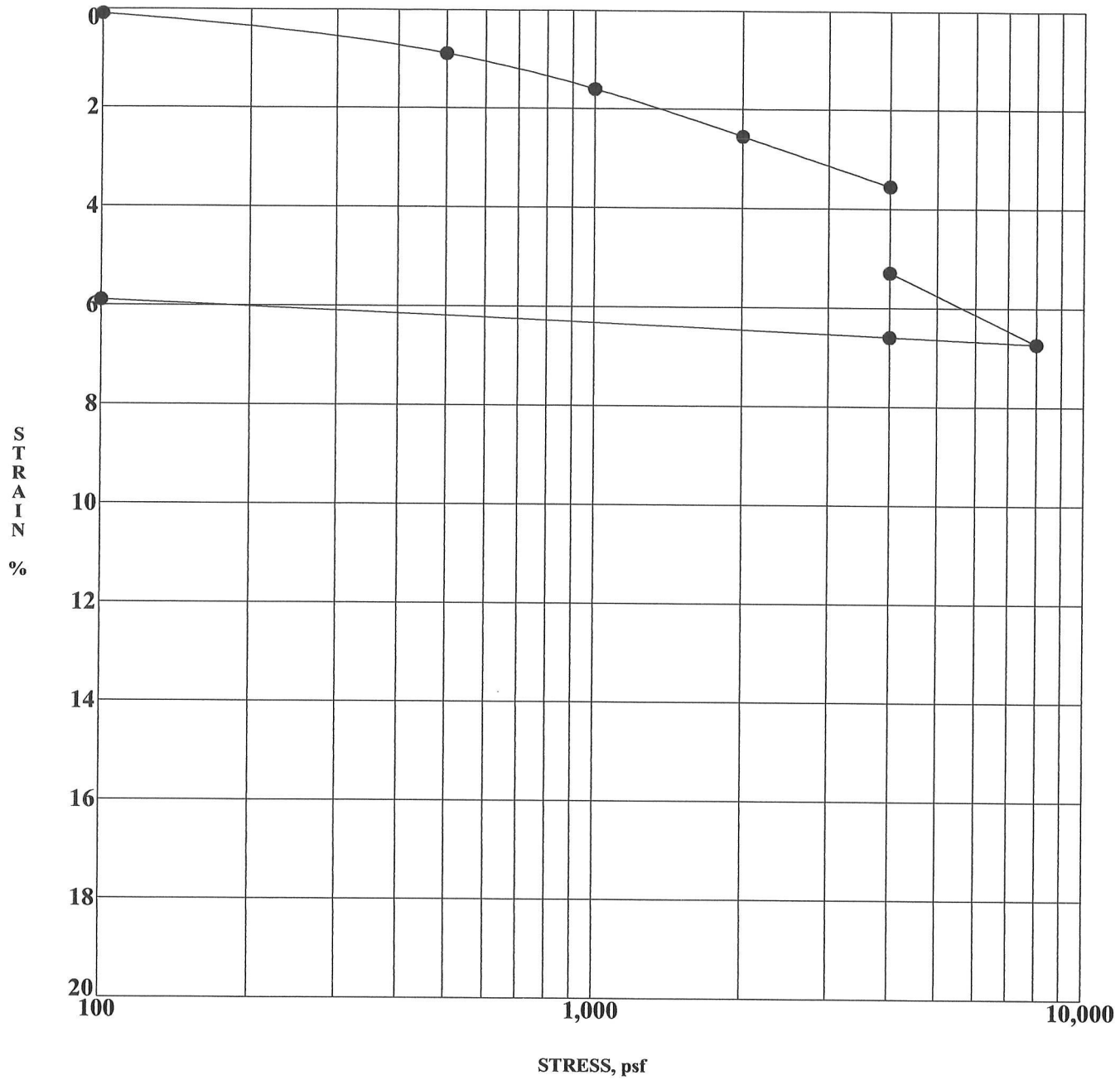
Specimen Identification		Classification	DD	MC%
● B-5	10.0	(SM) Silty Sand	112	3

PROJECT *Preliminary Geotechnical Investigation*

PROJECT NO. *12829A.1*
DATE *7/1/16*

CONSOLIDATION TEST
LOR Geotechnical Group, Inc.

ENCLOSURE C-3



Specimen Identification			Classification	DD	MC%
●	B-5	12.0	(SM) Silty Sand	102	5

PROJECT *Preliminary Geotechnical Investigation*

PROJECT NO. *12829A.1*
DATE *7/1/16*

CONSOLIDATION TEST
LOR Geotechnical Group, Inc.

ENCLOSURE C-4