APPENDIX C

Geotechnical Reports
October 24, 2018
Kleinfelder Project No.: 20182608.001A

Mr. Siva Sivapalan
Eastern Municipal Water District
2270 Trumble Road, PO Box 8300
Perris, California 92572-8300

Subject: Report of Geotechnical Investigation
Sky Canyon Sewer Project
Alignment 1C
Murrieta, California

Dear Mr. Sivapalan:

Kleinfelder is pleased to present this report summarizing our geotechnical investigation for the proposed Sky Canyon Sewer Line Project. The purpose of our investigation was to evaluate the subsurface conditions along the proposed pipeline replacement alignment and develop geotechnical recommendations for project design and construction. The proposed alignments are located within the private property just east of Winchester Road (HWY 79) and along Sky Canyon Drive in the city of Murrieta, California.

It is our opinion, from a geotechnical engineering perspective, that the proposed pipeline replacement may be constructed as proposed, provided the recommendations presented in this report are properly incorporated into project design and construction.

We appreciate the opportunity to be of service on this project. If you have any questions, comments, or require additional information, please do not hesitate to contact the undersigned at your convenience.

Respectfully submitted,
KLEINFELDER, INC.

Eric W. Noel, PE, GE
Principal Geotechnical Engineer

Richard F. Escandon, PG, CEG
Principal Engineering Geologist
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Appendix B  Laboratory Testing
Appendix C  Seismic Refraction Survey Report
1.0 INTRODUCTION

1.1 GENERAL

Kleinfelder was retained by Eastern Municipal Water District (EMWD) to conduct a geotechnical investigation for the Sky Canyon Sewer Project. The proposed alignment is located within the City of Murrieta in Riverside County, California. The approximate location and limits of the project are shown on Figure 1, Site Vicinity Map. The scope of our services was provided in our proposal entitled, Proposal for Geotechnical Investigation for Alignment #1A and #1B, Sky Canyon Sewer Project, Eastern Municipal Water District, Murrieta, California, dated March 19, 2018. Our investigation addressed several proposed alignment options, which aided in EMWD selecting Alignment 1C. This report presents our recommendations for Alignment 1C, but includes the field exploration and laboratory test results from all of the alignment options evaluated.

This report presents our conclusions and recommendations relative to the geotechnical aspects of project design and construction. Conclusions and recommendations presented in this report are based on the subsurface conditions encountered at the locations of our field excavations, and the provisions and requirements outlined in the Additional Services and Limitations sections of this report. Recommendations presented in this report should not be extrapolated to other areas or be used for other projects (beyond those expressly identified within) without our prior review and comment.

1.2 SITE AND PROJECT DESCRIPTION

We understand the project involves construction of approximately 6,670 feet of 36-inch diameter sewer pipeline located along private property adjacent to Winchester Road, and along Sky Canyon Drive. The alignment is located in unincorporated area of Riverside County.

The proposed sewer will connect to an existing 36-inch sewer (French Valley Phase II Sewer) at the north end of the project. At the south end of the project, the proposed sewer will be connected to a 30-inch sewer located at the intersection of Murrieta Hot Springs Road and Sky Canyon Drive.

Several alignments were previously considered and investigated, but EMWD ultimately selected Alignment 1C (see Figures 2A and 2B). This report is specifically for Alignment 1C, but includes the field exploration and laboratory test results from all of the alignments investigated. It is to our understanding that the pipeline will be constructed primarily in open cuts. However, we
understand that a biologically sensitive area exists near the northeast corner of the existing self-
storage development located on the east side of Winchester Road north of Technology Drive that
will necessitate the use of a trenchless installation method, such as jack and bore.

1.3 PURPOSE AND SCOPE

The purpose of our investigation was to evaluate subsurface conditions along the alignments and
provide geotechnical recommendations for design and construction of the pipeline. A description
of the scope of services performed is presented below:

Task 1 – Literature Review

We began our services by reviewing readily available online data and previous data collected in
and around the project area.

Task 2 – Field Investigation

Prior to conducting the field exploration, our proposed exploration locations were cleared of known
and identified, existing utility lines through Underground Service Alert (USA). The subsurface
exploration program included advancing a total of 21 exploratory borings along the proposed
alignments. We have included all of the borings advanced along all of the previously proposed
alignments.

The target depths of the borings were between 31 and 61 feet below existing grades (bgs). Borings 1A-B3, 1B-B1, 2A-B1, 2A-B2, 2A-B5, 2A-B11 and 2A-B12 encountered refusal on weathered granitic prior to achieving the target depth. Bulk and drive soil samples were obtained from the excavations for laboratory testing. A detailed description of the field investigation and the
logs of the excavations for this study are presented in Appendix A.

Task 3 – Seismic Refraction Survey

Nine (9) seismic refraction surveys were conducted along the proposed alignments where shallow
bedrock was anticipated. The purpose of this investigation was to assess the general seismic
velocity characteristics of the underlying earth materials and to evaluate whether high velocity
earth materials (non-rippable) are present at depths which would impact the proposed sewer
pipeline. A detailed report of the seismic refraction surveys is presented in Appendix C, Seismic
Refraction Survey Report.
Task 4 – Laboratory Soil Testing

Laboratory testing was performed on soil samples collected during our field exploration to substantiate field classifications and to evaluate the physical characteristics of the subsurface soils. Testing consisted of evaluating in-situ dry unit weight and moisture content, Sieve analysis, plasticity index, maximum dry unit weight and optimum moisture content, sand equivalent, direct shear, R-value and collapse potential. The laboratory tests performed for this geotechnical investigation are described and the test results are presented in Appendix B.

Task 4 – Geotechnical Analyses and Report Preparation

Field and laboratory findings were evaluated in conjunction with the proposed project use. This report includes discussions, conclusions, and recommendations regarding the following:

- A description of the proposed project including a site plan showing the approximate boring locations.
- A description of the subsurface site conditions encountered during our field investigation including groundwater conditions as encountered in our field exploration.
- Preliminary evaluation of the corrosion potential of the on-site soils
- A discussion of site conditions, including the excavation characteristics and geotechnical suitability of the site for the general type of construction proposed.
- A discussion of geohazards including faulting and liquefaction;
- Recommended trench sidewall slope inclinations and geotechnical engineering parameters for design of cantilevered and braced shoring.
- Evaluation and recommendations of the use of excavated materials, including suitability of excavated materials for pipe bedding and trench backfill. Recommendations for alternative backfill will be provided where necessary.
- Discussion regarding the potential for dewatering during construction
- Recommended trench backfill compaction procedures including compaction density requirements.
- Special preparation requirements for pipeline subgrade, if required.
• Coefficients of active earth pressure, coefficients of friction and values of cohesion for determining lateral loads.

• Recommendations for seismic design parameters in accordance with the 2016 CBC.

• An appendix, which will include a summary of the field investigation, logs of the borings, and laboratory testing program.
2.0 SITE CONDITIONS

2.1 REGIONAL SETTING

Regionally, the project is located in what is referred to as the Perris Block, an elongated relatively stable structural geologic block bounded on the northeast by the San Jacinto fault and the San Jacinto Mountains, and on the southwest by the Elsinore fault zone and Santa Ana Mountains. The block consists primarily of Cretaceous-age intrusive granitic rocks, older metasedimentary basement rocks, and intervening sediment-filled valleys.

2.2 GENERAL SUBSURFACE CONDITIONS

General subsurface soil conditions, based on our field observations at the locations of our borings, are presented in the following section. These conditions are presented as a general interpretation of similar soil conditions that may exist along portions of the proposed alignments between our borings and are presented for general informational purposes only. Soil conditions will vary in the vicinity of our boring locations and between or beyond the points explored and locations identified below. Detailed descriptions of the subsurface conditions encountered at the locations of our borings during our field investigation are presented on the Logs of Borings provided in Appendix A. We recommend that all individuals utilizing this report review the Logs of Borings presented in Appendix A for greater detail.

Locally, the project is located in the Murrieta Hot Springs area in Riverside County, California. Geologic units underlying the proposed alignments include, in order of increasing geologic age, Holocene young alluvium (Qya), older alluvial deposits (Qvoa), Pauba Formation sandstone (Qps), and Cretaceous-age granitic rock (Kgb).

Young Alluvium

The young alluvium (Qya) underlies the southernmost portion of all alignments within Sky Canyon Drive and was encountered in boring 2A-B14 to a depth of 35 feet. The young alluvium consists of silty sands, poorly-graded sands, and clayey sands.

Older Alluvium

The older alluvium (Qvoa) underlies the central portion of the project alignments and was encountered in borings 2A-B7, 2A-B8 and 1A-B5 to depths of 9 feet, 14 feet and 25 feet,
respectively, and in borings 2A-B1, 1B-B1 and 1B-B2 to depths of 10 feet. Undifferentiated alluvial deposits (Qyu) were also encountered in other borings generally ranging in depths from 5 to 7 feet. The older alluvium generally consists of various mixtures of silty sand, clayey sand, and sandy lean clay. The in-situ moisture content and dry densities of the older alluvial ranged from 7.1 percent to 15.1 percent for the moisture content and 109.2 to 131.6 pounds per cubic foot (pcf) for the dry densities of the samples tested.

**Pauba Formation Sandstone (Qps)**

Pauba Formation sandstone (Qps) underlies the southern portion of the alignment along Sky Canyon drive was encountered in boring 2A-B13. The Pauba sandstone was recovered in the boring as primarily clayey sand.

**Bedrock – Weathered Granitic Rock**

Granitic bedrock (Kgb) underlies the majority of the site either at or near the surface or at depth beneath the alluvial deposits and is exposed in outcrop in the northeastern portion of the site just east and northeast of borings 1A-B1 and 1A-B2. The bedrock ranges from dark grayish brown and yellowish brown to dark gray with black and white mottling. Weathering in the bedrock ranges from highly weathered to completely decomposed to slightly weathered. The depth of weathering is variable across the site. In general, the weathered rock decomposes to silty sand and clayey sand upon excavation. The weathered rock is generally weak to moderately strong. Harder rock, less weathered rock was also encountered in several borings. Drill refusal above the target drill depth was encountered in several borings at depths ranging from 5 to 31 feet below the ground surface. The shallowest refusal was at 5 feet in boring borings 2A-B11. The in-situ moisture content and dry densities of the granitic bedrock ranged from 1.2 percent to 20.8 percent for the moisture content and 88.5 to 136.8 pounds per cubic foot (pcf) for the dry densities of the samples tested.

Seven borings (1A-B3, 1B-B1, 2A-B1, 2A-B2, 2A-B3, 2A-B11, and 2A-B12) encountered refusal at depths ranging from approximately 5 to 35 feet bgs. As part of our field exploration, we performed nine seismic lines along the proposed Alignments to assist in evaluating the rippability of the bedrock materials. Further discussion on the bedrock excavatability is presented in Section 4.4.1, Excavation Characteristics and in Appendix C in this report.
2.3 GROUNDWATER

In the area of the proposed Sky Canyon Sewer project alignments, groundwater was encountered in our borings at depths ranging from 20 to 45 feet below the existing ground surface. In general groundwater was encountered as perched water in the bedrock at the interface of the weathered rock/hard unweathered bedrock, or as seepage along fractures in the rock.

Fluctuations of the groundwater level, localized zones of perched water, and soil moisture content should be anticipated during and following the rainy season. Irrigation and future development on surrounding properties can also cause a fluctuation of local groundwater levels. Based upon the currently proposed alignment invert elevations and the groundwater levels encountered during our field investigation, seepage or nuisance water may be encountered during construction above or in the near vicinity of portions of the pipeline.

Due to groundwater level variability in the area and along the alignment, water levels presented in this report may or may not be representative of those encountered at the time of construction. Presented in Table 1 below, are the groundwater locations and elevations encountered during our field investigation.

### Table 1

**Groundwater Elevations Encountered During Drilling**

<table>
<thead>
<tr>
<th>Boring</th>
<th>Proposed Invert depth of Pipe (ft.)</th>
<th>Approximate Ground Surface Elevation (ft.)</th>
<th>Approximate Groundwater Depth Below Ground Surface (ft.)</th>
<th>Approximate Groundwater Elevation Below Ground Surface (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A-B1</td>
<td>34</td>
<td>1324</td>
<td>40</td>
<td>1284</td>
</tr>
<tr>
<td>1A-B2</td>
<td>43</td>
<td>1327</td>
<td>45</td>
<td>1282</td>
</tr>
<tr>
<td>1A-B3</td>
<td>28</td>
<td>1305</td>
<td>Not Encountered</td>
<td>---</td>
</tr>
<tr>
<td>1A-B4</td>
<td>16</td>
<td>1297</td>
<td>Not Encountered</td>
<td>---</td>
</tr>
<tr>
<td>1A-B5</td>
<td>33</td>
<td>1320</td>
<td>Not Encountered</td>
<td>---</td>
</tr>
<tr>
<td>1B-B1</td>
<td>20</td>
<td>1310</td>
<td>30</td>
<td>1280</td>
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<tr>
<td>1B-B2</td>
<td>18</td>
<td>1303</td>
<td>29.5</td>
<td>1274</td>
</tr>
<tr>
<td>Boring</td>
<td>Invert depth of Pipe (ft.)</td>
<td>Approximate Ground Surface Elevation (ft.)</td>
<td>Approximate Groundwater Depth Below Ground Surface (ft.)</td>
<td>Approximate Groundwater Elevation Below Ground Surface (ft.)</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------</td>
<td>--------------------------------------------</td>
<td>---------------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>2A-B1</td>
<td>26</td>
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<tr>
<td>2A-B2</td>
<td>28</td>
<td>1321</td>
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<td>2A-B3</td>
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<td>42.5</td>
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<td>2A-B4</td>
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<td>2A-B9</td>
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<td>2A-B10</td>
<td>21</td>
<td>1242</td>
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<td>23</td>
<td>1213</td>
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<td>---</td>
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<tr>
<td>2A-B12</td>
<td>26</td>
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<td>25</td>
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<td>2A-B14</td>
<td>25</td>
<td>1118</td>
<td>35</td>
<td>1083</td>
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</table>

### 2.4 CORROSIVITY

Samples of the alignment soils were tested for potential corrosion to concrete and steel. The samples were tested in general accordance methodology presented within Caltrans California Tests to evaluate pH, resistivity, water-soluble sulfates, and chlorides content. We have provided the corrosion tests as requested, and these tests should be considered as only an indicator of soil corrosivity for the samples tested. Other soils found along the alignment may be more, less, or of a similar corrosive nature. The test results are presented in Table 2, Summary of Corrosion Test Results.
TABLE 2
Summary of Corrosion Test Results

<table>
<thead>
<tr>
<th>Boring</th>
<th>Depth (ft)</th>
<th>pH</th>
<th>Sulfate (ppm)</th>
<th>Chloride (ppm)</th>
<th>Minimum Resistivity* (ohm-cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A-B2</td>
<td>40</td>
<td>7.3</td>
<td>33</td>
<td>60</td>
<td>35850</td>
</tr>
<tr>
<td>1A-B4</td>
<td>20</td>
<td>7.0</td>
<td>43</td>
<td>126</td>
<td>4622</td>
</tr>
<tr>
<td>2A-B3</td>
<td>30</td>
<td>7.2</td>
<td>45</td>
<td>39</td>
<td>2728</td>
</tr>
<tr>
<td>2A-B8</td>
<td>20</td>
<td>7.6</td>
<td>36</td>
<td>108</td>
<td>1284</td>
</tr>
<tr>
<td>2A-B12</td>
<td>15 – 26</td>
<td>7.5</td>
<td>30</td>
<td>114</td>
<td>2990</td>
</tr>
</tbody>
</table>

*Resistivity performed under the saturated condition

Soils with the above resistivity values are normally considered “essentially non-corrosive” to “mildly corrosive” to buried ferrous metals (Roberge, 2006). The concentrations of soluble sulfate indicate that no additional minimum requirements for concrete based on ACI 318 Table 4.2.1 (ACI, 2011). Accordingly, American Concrete Institute only recommends that the concrete have compressive strength of 2,500 psi for this level of soluble sulfates. There are no other restrictions set by the American Concrete Institute regarding type of cement or maximum water-cement ratio used for this level of soluble sulfates.

Our scope of services does not include corrosion engineering and, therefore, a detailed analysis of the corrosion test results are not included. A qualified corrosion engineer should be retained to review the test results and design protective systems that may be required. Kleinfelder may be able to provide those services for an additional fee.

2.5 2016 CBC SEISMIC DESIGN PARAMETERS

According to the 2016 California Building Code, every structure, and portion thereof, including non-structural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7-10, excluding Chapter 14 and Appendix 11A. The Seismic Design Category for a structure may be determined in accordance with Section 1613.3.5 of the 2013 & 2016 CBC.

Based on information obtained from the investigation, published geologic literature and maps, and on our interpretation of the 2016 CBC criteria, it is our opinion that the project split into two
different site classes. Portions of the alignment south of the Murrieta Hot Springs Fault in our opinion is classified as Site Class B, “Rock”, and Portions of site north of the fault may be classified as Site Class C, “Very Dense Soil and Soft Rock”, according to Section 1613.3.2 of 2016 CBC and Table 20.3- 1 of ASCE/SEI 7-10. Approximate coordinates for sections of the alignments for the site are noted below.

North of Murrieta Hot Springs Fault

• Latitude: 33.563736 °N
• Longitude: 117.136976 °W

South of Murrieta Hot Springs Fault

• Latitude: 33.553240 °N
• Longitude: 117.137842 °W

The Risk-Targeted Maximum Considered Earthquake (MCER) mapped spectral accelerations for 0.2 seconds and 1 second periods (\( S_s \) and \( S_1 \)) were estimated using Section 1613.3 of the 2016 CBC and the U.S. Geological Survey (USGS) web based application (available at http://earthquake.usgs.gov/designmaps/us/application.php). The mapped acceleration values and associated soil amplification factors (\( F_a \) and \( F_v \)) based on the 2016 CBC and corresponding site modified spectral accelerations (\( S_{MS} \) and \( S_{M1} \)) and design spectral accelerations (\( S_{DS} \) and \( S_{D1} \)) are presented in the table following.

Table 3

<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
<th>RECOMMENDED VALUE</th>
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<tr>
<td>Site Class</td>
<td>B</td>
</tr>
<tr>
<td>( S_s ) (g)</td>
<td>1.849</td>
</tr>
<tr>
<td>( S_1 ) (g)</td>
<td>0.734</td>
</tr>
<tr>
<td>( F_a )</td>
<td>1.0</td>
</tr>
<tr>
<td>( F_v )</td>
<td>1.3</td>
</tr>
<tr>
<td>( S_{MS} ) (g)</td>
<td>1.849</td>
</tr>
<tr>
<td>( S_{M1} ) (g)</td>
<td>0.955</td>
</tr>
<tr>
<td>( S_{DS} ) (g)</td>
<td>1.233</td>
</tr>
<tr>
<td>( S_{D1} ) (g)</td>
<td>0.636</td>
</tr>
<tr>
<td>PGA_M (g)</td>
<td>0.718</td>
</tr>
</tbody>
</table>
3.0 GEOLOGIC HAZARDS

3.1 SEISMICITY

The site is located in the highly seismic southern California region within the influence of several fault systems that are considered to be active or potentially active. An active fault is a fault that has experienced seismic activity during historic time (since roughly 1800) or exhibits evidence of surface displacement during Holocene time (Bryant and Hart, 2007). The definition of “potentially active” varies. A generally accepted definition of “potentially active” is a fault showing evidence of displacement that is older than 11,000 years (Holocene age) and younger than 1.7 million years (Pleistocene age). However, “potentially active” is no longer used as criteria for zoning by the CGS. The terms “sufficiently active” and “well-defined” are now used by the CGS as criteria for zoning faults under the Alquist-Priolo Earthquake Fault Act. The definition “inactive” generally implies that a fault has not been active since the beginning of the Pleistocene Epoch (older than 1.7 million years old).

Based on review of active faulting data prepared by the California Geological Survey (CGS) (Bryant and Hart, 2007) the site is not located within a State-designated Alquist-Priolo Earthquake Fault Zone. However, the site is in close proximity to several active faults which could generate earthquakes. The active Elsinore fault zone is located approximately 3.5 miles southwest of the site and San Jacinto fault is located approximately 16.5 miles northeast of the site. These faults are capable of generating probable earthquake magnitudes on the order of Mw6.5 – 7.5 (SCEC, 2018). Therefore, there is a high potential for moderate to strong seismic shaking to occur during the design life of the project.
3.2 FAULTING

As stated above, based on review of active faulting data prepared by the California Geological Survey (CGS) (Bryant and Hart, 2007) the site is not located within a State-designated Alquist-Priolo Earthquake Fault Zone. However, the Murrieta Hot Springs fault crosses the southern portion of the alignment on Sky Canyon drive somewhere between borings 2A-B12 and 2A-B13. The precise location of the fault has not been determined and is beyond the scope of work for this project.

The Murrieta Hot Springs fault is not included within a State-designated Alquist-Priolo Earthquake Fault Zone and is not listed within the Southern California Earthquake Data Center database. However, the fault has been investigated by other consultants (Leighton, 1999; LOR, 1999). Fault trenching investigations by these consultants have provided evidence of recent fault activity in Holocene time (last 11,000 years). Although not listed as active by the State of California, the Murrieta Hot Springs fault is classified by Riverside County as active. More information on estimated displacement, slip rate, and reoccurrence interval for the Murrieta Hot Springs fault are unknown.
3.3 LIQUEFACTION

Liquefaction is the sudden loss of shear strength in a loose, saturated granular soil due to vibratory motions such as those associated with earthquakes. Seismically induced soil liquefaction generally occurs in loose, saturated, cohesionless soil when pore pressures within the soil increase during ground shaking. The increase in pore pressure transforms the soil from a solid to a semi-liquid state. These soils typically lose a portion or all of their shear strength and regain strength sometime after shaking stops.

The primary factors affecting the liquefaction potential of a soil deposit are: 1) intensity and duration of earthquake shaking, 2) soil type and relative density, 3) overburden pressure, and 4) depth to groundwater. Soils most susceptible to liquefaction are clean, loose, uniformly graded, fine-grained sands, and non-plastic silts that are saturated. Silty sands and silts are also susceptible to liquefaction.

The alignments are located within a Riverside County Liquefaction Hazard Zone (Riverside County Land Information System). The liquefaction potential in these areas is considered low based on the Riverside County Liquefaction Hazard maps. Based on the soil and groundwater conditions encountered and the anticipated pipeline invert elevations and the relatively shallow depth to bedrock, it is our opinion that liquefaction has a low potential to occur during a design earthquake event (DE).
4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL

Based on the field exploration, laboratory testing and geotechnical analyses conducted for this project, it is our opinion that it is geotechnically feasible to construct the proposed pipelines as planned, and as described within, provided the recommendations presented in this report are incorporated into the project design and construction. The following sections provide our conclusions and recommendations, from a geotechnical engineering standpoint, for pipeline design and construction.

4.2 AVERAGE SOIL PARAMETERS FOR PIPE DESIGN

Recommended soil parameters to be used in the design of below grade vitrified clay pipe (VCP), PVC, HDPE or DIP piping are provided below. These parameters are based upon the depth, soil type, and pipe proposed, and based upon the results of our field investigation, laboratory testing, engineering analysis, and the pipeline assumptions presented within. The parameters presented do not include a factor of safety. An appropriate factor of safety may be used by the project designer dependent upon project needs.

Average soil bulk dry unit weight \( \gamma_d = 115 \text{ pcf} \)
Average soil moist unit weight \( \gamma = 125 \text{ pcf} \)
Average soil saturated unit weight \( \gamma_s = 130 \text{ pcf} \)
Average Angle of internal friction of soils \( \phi = 30^\circ \)
Soil cohesion \( c = 150 \text{ psf} \)
Coefficient of friction between backfill and native soils \( f_s = 0.35 \)
Coefficient of active earth pressure \( K_a = .33^* \)
Coefficient of earth pressure at-rest \( K_o = .50^* \)
Coefficient of passive earth pressure \( K_p = 3.0^* \)
Coefficient of friction between the pipe-soil interface \( f = 0.30 \) (bedding-pipe-zone material)

*Calculations below the groundwater table should consider buoyant soil unit weights, surcharge loads, and include water pressure.
4.3 PIPE ANCHORAGE

Anchorage of pipe may be evaluated using frictional resistance along the pipe and passive pressure at thrust block locations. A frictional coefficient of 0.25 is recommended for the native soils and PVC, HDPE or DIP pipe.

Passive resistance for thrust blocks bearing against firm natural soil or properly compacted backfill can be calculated using an equivalent fluid pressure of 350 pcf. The maximum passive resistance should not exceed 3,000 psf. Note that the passive pressures presented above are ultimate values and have not been reduced by a factor of safety.

4.4 GUIDELINES FOR TEMPORARY EXCAVATIONS

4.4.1 Excavation Characteristics

The borings at the site were advanced using a CME-75 truck-mounted hollow-stem auger drill rig. Drilling was advanced with moderate to very difficult effort through the granitic rock encountered in majority of our borings. Borings 1A-B3, 1B-B1, 2A-B1, 2A-B2, 2A-B3, 2A-B11, and 2A-B12 encountered drilling refusal at depths ranging between 5 to 35 feet bgs due to shallow bedrock along the sewer main alignment. We anticipate that the excavation difficulty will vary between minimal excavation difficulties to hard excavation difficulties. This is assuming that large excavator type of equipment will be used for trenching. Continuous breaking, chemical cracking or other methods may be necessary in some areas of the alignments where shallow bedrock is encountered.

The excavation characteristics were estimated using the seismic velocity data from the seismic surveys that were conducted along the proposed alignments. A general rule of thumb is that an excavator can excavate material that has a seismic velocity less than 4,000 feet per second. The effectiveness of the operation depends on several factors, such as, the depth of the excavation, the reach of the excavator, and the width of the bucket. We anticipate that the material with a seismic velocity less than 4,000 feet per second will generally excavate like a soil with some gravel and cobbles, but may also consist of some material greater than 6 inches.

The contractor should carefully review the boring logs in this report and perform their own assessment of potential construction difficulties. Installation construction methods should be selected accordingly, and the associated costs should be included in the bid submittal. We recommend that the contractor’s actual method of construction be evaluated by the geotechnical
and civil engineer prior to construction to verify that the installation method is consistent with the design assumptions.

Alluvial soils associated with these improvements may exist that may require special attention during construction to avoid trench wall collapse, undermining, and damage to existing facilities. Shoring of trench walls or alternate methods of trench stability should be incorporated into the project planning.

We recommend that all individuals utilizing this report review the boring logs presented in Appendix A and the Seismic Refraction Survey Report in Appendix C for greater detail. Subsurface conditions will vary between and beyond the points explored and may differ from the general conditions presented above. If soil conditions are encountered during construction which differ from those described, we should be notified immediately in order that a review may be made. Supplemental recommendations and construction techniques may be required.

4.4.2 Temporary Slopes

Excavations must comply with applicable local, state, and federal safety regulations including the current OSHA Excavation and Trench Safety Standards. Construction site safety is the responsibility of the contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing the information below as a service to our client. Under no circumstances should the information provided be interpreted to mean that Kleinfelder is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

Minor sloughing and/or raveling of slopes should be anticipated as they dry out. Where space for sloped embankments is not available, shoring will be necessary. Based on our analysis of the subsurface conditions, we have provided in Table 4 below temporary slope inclinations for different materials and depths that will be encountered during excavation of the sewer main.
Table 4
Temporary Slope Inclinations

<table>
<thead>
<tr>
<th>Material</th>
<th>Slope Inclination (Horizontal:Vertical)</th>
<th>Max Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weathered Granitic Bedrock</td>
<td>3/4:1</td>
<td>45</td>
</tr>
<tr>
<td>Older Alluvium</td>
<td>1¼ :1</td>
<td>35</td>
</tr>
<tr>
<td>Younger Alluvium</td>
<td>1½ :1</td>
<td>25</td>
</tr>
</tbody>
</table>

Field conditions may vary and a representative of the geotechnical engineer of record should observe temporary slopes and excavations as modifications may be required based on the actual conditions encountered during excavation. However, an engineer or the field representative should observe the excavations so that modifications can be made to the excavations, as necessary, based on variations in the encountered soil conditions. All applicable excavation safety requirements and regulations, including OSHA requirements, should be met.

All trench excavations should be braced and shored in accordance with good construction practice and all applicable safety ordinances and codes. Stockpiled (excavated) materials placed near the edge of the excavation can impact the global stability of the excavation. Stockpiled material should not be placed closer to the edge of an excavation than a distance equal to the depth of the excavation or 4 feet, whichever is greater.

4.4.3 Shoring

Shoring may be required where soil conditions, space or other restrictions do not allow a sloped excavation. A braced or cantilevered shoring system may be used.

A temporary cantilevered shoring system should be designed to resist an active earth pressure equivalent to a fluid weighing 45 pounds per cubic foot (pcf). Braced or restrained excavations above the groundwater table should be designed to resist a uniform horizontal equivalent soil pressure of 65 pounds per cubic foot (pcf).

Fifty percent of an aerial surcharge (i.e. a surcharge covering a defined area) placed adjacent to the shoring may be assumed to act as a uniform horizontal pressure against the shoring. Special cases such as combinations of slopes and shoring or other surcharge loads may require an increase in the design values recommended above. These conditions should be evaluated by the
project geotechnical engineer on a case-by-case basis. The above pressures do not include hydrostatic pressures; it is assumed that drainage will be provided. If drainage is not provided, shoring extending below the groundwater level should be evaluated on a case-by-case basis.

Cantilevered shoring must extend to a sufficient depth below the excavation bottom to provide the required lateral resistance. We recommend required embedment depths be determined using methods for evaluating sheet pile walls and based on the principles of force and moment equilibrium. For this method, the passive pressure against shoring, which extends below the level of excavation may be assumed to be equivalent to a fluid weighing 350 pcf. Additionally, we recommend a factor of safety of at least 1.2 be applied to the calculated embedment depth and that passive pressure be limited to 3,000 psf.

The contractor should be responsible for the structural design and safety of all temporary shoring systems.

4.5 EXCAVATION

4.5.1 Soil Stripping and Demolition

Prior to backfilling operations, all vegetation, roots, organics, wet or soft soil, oversize material, etc., and deleterious materials should be removed from the excavation bottom and any material designated to be used as backfill.

Voids created by the removal of sub-surface obstructions (such as oversize material, underground utilities, etc.) should have all loose (soft) soil, organic matter, and other deleterious materials removed, and be backfilled with material placed, and compacted as engineered fill in accordance with the recommendations presented in this report. Pipes or utilities identified for removal or abandonment should be capped and reinforced (cement slurry injection, grouting, etc.) as required to prevent the migration of water and potential collapse due to decay or other forces, which could cause settlement of overlying soils, pipelines, or structures.

4.5.2 Overexcavation

Trench excavation operations must expose a firm subgrade that is free of significant voids, loose, soft, or wet soil, oversize material, organics, or other deleterious material. The subgrade soils exposed at the bottom of each excavation for the proposed pipeline should be observed by a representative from our firm prior to the placement of any pipeline or fill. If unsuitable conditions are encountered, additional removal and replacement of excavation bottom soils and/or other
remediation techniques may be required to provide a stable excavation bottom to uniformly support the pipe. Where loose/soft or wet soils are exposed at the pipe invert elevation, we recommend trenches be overexcavated to a depth of at least 8 inches below the bottom of the pipe invert section to allow for adequate bedding material. The trench bottom should be stabilized in accordance with EMWD specifications.

4.6 BACKFILL

4.6.1 Materials

Pipe zone backfill (i.e., material beneath (bedding) and in the immediate vicinity of the pipe extending to 12 inches above the pipe crown) should consist of sand or similar granular material having a minimum sand equivalent value of 30 and conform to EMWD specifications for backfill. The native soils do not meet these criteria. Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) and “general backfill” (i.e. materials placed for backfill of tunneling sending receiving shafts) may consist of native or import soil, which meets the requirements for engineered fill provided.

In general, well-graded mixtures of gravel, sand, and silt, with small quantities of cobbles (less than 6 inches maximum dimension), rock fragments, and/or clay are acceptable for use as import soil. Import materials, if required, should have a very low expansion potential, i.e. have an expansion index of less than 20. All import fill soils should be free from deleterious material and debris.

If import material is used for pipe zone backfill, we recommend it consist of well-graded fine to medium grained sand. In general, poorly graded coarse-grained sand and/or open-graded gravel should not be used for pipe or trench zone backfill due to the potential for soil migration into the relatively large void spaces present in this type of material and water seepage along trenches backfilled with coarse-grained sand and/or gravel. Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local building requirements and/or bedding requirements for specific types of pipes. We recommend the project civil engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

During excavation of the native soils, “oversize” rock material is any material with maximum dimension greater than 6 inches. Larger rocks over 6 inches in maximum dimension may possibly be used as trench backfill, but must be approved by the Geotechnical Engineer of Record and/or
the District. Approval would be based on the amount of oversized to be used, where the oversized is proposed to be used and the method of placement.

4.6.2 Compaction Criteria

All fill soils, native, imported, or blended soil mixes required to bring the site to final grade should be placed as compacted fill. All backfill (compacted fill) should be moisture conditioned to 0 to 3 percent above optimum moisture content and placed in horizontal lifts less than 6 inches in loose thickness and compacted to at least 90 percent of the maximum dry unit weight based on ASTM Test Method D 1557 or as approved by the project geotechnical engineer based upon site conditions. Beneath pavement sections, the upper 12 inches of trench backfill should be compacted to a minimum 95 percent relative compaction (ASTM D 1557). The pipeline or additional fill lifts should not be placed if soil conditions are not stable or if the previous lift did not meet the required minimum dry unit weight. Backfill materials should be brought up at substantially the same rate on both sides of the pipe. Reduction of the lift thickness may be necessary to achieve the above recommended compaction. Mechanical compaction is recommended; ponding or jetting is not recommended.

4.7 TEMPORARY DEWATERING

Based upon the currently proposed alignment invert elevations and the groundwater levels encountered during our field investigation, seepage or nuisance water may be encountered during construction above or in the near vicinity of portions of the pipeline.

A dewatering plan is not expected to be prepared for excavation and construction at this moment. Sump pumps may be required during construction to aid in mitigation of the seepage or nuisance water encountered in the excavations. If actual flows are heavier than anticipated than larger or additional sump pumps may be needed.

4.8 JACK AND BORE

As previously discussed, a biologically sensitive area is reported to exist near the northeast corner of the existing self-storage development located on the east side of Winchester Road north of Technology Drive. It is anticipated that the pipeline will cross this sensitive area by means of a trenchless installation method, such as jack and bore. Based on the results from our investigation and our understanding of the current project design, the jack and bore method is considered feasible. However, the contractor should review our findings to confirm that the selected excavation technique is feasible. The contractor should evaluate the soil conditions encountered
in our borings, the shear wave velocities measured from the seismic refraction surveys and the groundwater/moisture conditions to confirm the feasibility of the jack and bore method. Passive earth pressure developed at the jacking reaction block may provide support during pipe jacking operations. The allowable resistance for design of jacking reaction block(s) is 350 pcf at level undisturbed soil or weathered bedrock. For isolated thrust blocks, the resistance can be doubled, however some deformation is anticipated. Damage may occur if structures or other improvements are present in the direction of the thrust vector. This should be carefully considered by the contractor when selecting the jacking and/or receiving pit locations.

4.9 PRELIMINARY PAVEMENT SECTIONS

The appropriate pavement design section depends primarily on the shear strength of the subgrade soil exposed after grading and anticipated traffic over the useful life of the pavement. R-value testing should be performed during grading to verify and/or modify the preliminary pavement sections presented within this report. Pavement designs assume that heavy construction traffic will not be allowed on finished pavement sections.

Pavement sections presented in the table below are based on a design R-value of 25 which is the estimated R-Value of the surficial subgrade soils anticipated after trench backfilling, and current Caltrans design procedures. Various Traffic Indices (T.I.) were used for preliminary design purposes. We recommend that pavement sections be constructed utilizing the thickness provided in the following table, or the thickness of the actual pavement sections encountered along the alignment during our investigation provided in Table 6 (plus any additional section required by the governing agency for repaired sections), whichever is greater in section thickness. Pavement section thickness should be evaluated by the project engineer prior to placement.

<table>
<thead>
<tr>
<th>Traffic Index</th>
<th>Asphalt Concrete (in)</th>
<th>Aggregate Base (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 or less</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>4.5</td>
<td>10.5</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>13.5</td>
</tr>
</tbody>
</table>
### Table 6
**Thicknesses of Current Pavement Sections**

<table>
<thead>
<tr>
<th>Boring</th>
<th>Asphalt Concrete (in)</th>
<th>Aggregate base (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A-B1</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>2A-B2</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>2A-B3</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>2A-B4</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>2A-B5</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>2A-B6</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>2A-B7</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>2A-B8</td>
<td>4.5</td>
<td>10</td>
</tr>
<tr>
<td>2A-B9</td>
<td>4.5</td>
<td>10</td>
</tr>
<tr>
<td>2A-B10</td>
<td>4.5</td>
<td>10</td>
</tr>
<tr>
<td>2A-B11</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>2A-B12</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>2A-B13</td>
<td>4.5</td>
<td>12</td>
</tr>
<tr>
<td>2A-B14</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>

The recommended preliminary pavement sections are contingent on the following recommendations being implemented during construction:

- The upper 12 inches of subgrade soil below pavement sections should be compacted to a minimum of 95 percent relative compaction (ASTM D 1557). Fill should be placed in accordance with earthwork recommendations given in this report. This compacted subgrade thickness is in addition to the asphalt concrete and base course pavement sections.

- Subgrade soils and aggregate base should be in a stable, non-pumping condition at the time of are placement and compaction.

- At a minimum, asphalt concrete paving, aggregate base materials, and placement methods should conform to the Caltrans Standard Specifications, (latest edition).

- Aggregate base materials should meet the requirements for Class 2 Aggregate Base in Section 26 of the latest edition of the Caltrans Standard Specifications and should be compacted to at least 95 percent relative compaction (ASTM D 1557).

- All asphalt concrete should be compacted to at least 95 percent relative compaction relative to the maximum wet density.
• Within the structural pavement section areas, positive drainage (both surface and subsurface) should be provided. In no instance should water be allowed to pond on the pavement. Roadway performance depends greatly on how well runoff water drains from the site. This drainage should be maintained both during construction and over the entire life of the project.

• Proper methods, such as hot-sealing, should be employed to limit water infiltration into the pavement base course and/or subgrade at construction joints between existing and reconstructed asphalt concrete sections.

Pavement sections provided above are based on the soil conditions encountered during our field investigation and our assumptions regarding final alignment grades. We recommend representative roadway subgrade samples be obtained during grading and R-value tests performed. Should the results of these tests indicate a significant difference, the design pavement sections provided above may need to be revised.
5.0 ADDITIONAL SERVICES

5.1 ADDITIONAL SERVICES

It is recommended that Kleinfelder, Inc. be retained to review final plans and specifications. It has been our experience that this service provides an opportunity to review whether or not our recommendations have been properly interpreted and to correct possible misunderstandings of our recommendations prior to the start of construction.

In the event Kleinfelder is not retained to perform this recommended review, we will assume no responsibility for misinterpretation of our recommendations. The review will be completed on a time-and-expense basis in accordance with our current Fee Schedule at the time of our review.

5.2 CONSTRUCTION OBSERVATION AND TESTING

It is recommended that Kleinfelder, Inc. be retained to provide observation and testing services during all site earthwork, including demolition work, and construction of foundations. This will allow us the opportunity to compare actual subsurface soil conditions with those encountered during the field exploration and, if necessary, to provide supplemental recommendations, if warranted, due to unanticipated subsurface conditions. These services will be completed on a time-and-expense basis in accordance with our current Fee Schedule at the time of our work.
6.0 LIMITATIONS

Recommendations contained in this report are based on our field observations and subsurface explorations, laboratory tests, and our present knowledge of the proposed expansion construction. It is possible that soil conditions could vary between or beyond the points explored. If soil conditions are encountered during construction, which differ from those described herein, we should be notified immediately in order that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction changes from that described in this report, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions of this report are modified or approved in writing, by Kleinfelder. We have not reviewed the final plans for the project. The work performed was based on project information provided by Client. If Client does not retain Kleinfelder to review any plans and specifications, including any revisions or modifications to the plans and specifications, Kleinfelder assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, Client must obtain written approval from Kleinfelder’s engineer that such changes do not affect our recommendations. Failure to do so will vitiate Kleinfelder’s recommendations.

References to elevations and locations provided within this report were based upon general information provided for our use. Kleinfelder, Inc. did not provide surveying services and, therefore an opinion regarding the accuracy of the surface location or elevations with respect to the approved plans and current site surveying is not provided.

Our evaluation of subsurface conditions at the site has considered subgrade soil and groundwater conditions present at the time of our investigation. The influence(s) of post-construction changes to these conditions such as introduction of water into the subsurface will likely influence future performance of the proposed project. Whereas our scope of services addresses present groundwater conditions; future irrigation, broken water pipelines, etc. may adversely influence the project and should be addressed and mitigated, as necessary.

Other standards or documents referenced in any given standard cited in this report, or otherwise relied upon by the authors of this report, are only mentioned in the given standard; they are not incorporated into it or "included by reference", as the latter term is used relative to contracts or other matters of law.

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder’s profession practicing in the same locality, under
similar conditions and at the date the services are provided. Our conclusions, opinions and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no representation, guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided. The recommendations provided in this report are based on the assumption that Kleinfelder will be retained to provide a program of tests and observations during the construction phase in order to evaluate compliance with our recommendations and to evaluate the site conditions exposed. Information and recommendations presented in this report should not be extrapolated to other areas or be used for other projects without our prior review and response. The Client has the responsibility to see that all parties to the project, including the architect, civil designer, structural engineer, governing agency, etc., are made aware of this letter in its entirety and in order to verify that the recommendations are appropriate for the project currently proposed. Additionally, this report should be incorporated by reference into the contract and specification documents.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report. Land use, site conditions (both on site and off site) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

This report, and any future addenda or reports regarding this site, may be made available to bidders to supply them with only the data contained in the report regarding subsurface conditions and laboratory test results at the point and time noted. Bidders may not rely on interpretations, opinion, recommendations, or conclusions contained in the report. Because of the limited nature of any subsurface study, the contractor may encounter conditions during construction which differ from those presented in this report. In such event, the contractor should promptly notify the owner so that Kleinfelder’s geotechnical engineer can be contacted to confirm those conditions. We recommend the contractor describe the nature and extent of the differing conditions in writing and that the construction contract include provisions for dealing with differing conditions. Contingency funds should be reserved for potential problems during earthwork and foundation construction. Furthermore, the contractor should be prepared to handle contamination conditions encountered
at this site, which may affect the excavation, removal, or disposal of soil; dewatering of excavations; and health and safety of workers

The scope of our geotechnical services did not include any environmental site assessment for the presence or absence of hazardous/toxic materials. Kleinfelder will assume no responsibility or liability whatsoever for any claim, damage, or injury which results from pre-existing hazardous materials being encountered or present on the project site, or from the discovery of such hazardous materials.
7.0 REFERENCES


California Department of Water Resources (DWR), 2010. website: http://well.water.ca.gov/


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SITE VICINITY MAP

PROJECT: SKY CANYON SEWER PROJECT
ALIGNMENT 1C
MURRIETA, CALIFORNIA

SITE LOCATION

PROPOSED ALIGNMENT

FILE NAME: 20182608_Fig1_.mxd

ÉNÉRA

KLEINFELDER
Bright People. Right Solutions.
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Drilled approximately 10 ft or greater below invert depth

Refusal, greater than 5 ft from invert depth

V: Approximate depth to V = 4,000 ft/s
GW: Approximate ground water depth
bgs: Below Ground Surface
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LEGEND
- Proposed Alignment 1C
- Fault, solid where certain
- Fault, dashed where inferred
- Fault, dotted where concealed
- Contact, approximately located

PROJECT NO. 20182608
DRAWN: 10/2018
DRAWN BY: RA
CHECKED BY: EN
FILE NAME: 20182608 Fig3.mxd

GEOLOGY MAP FOR SKY CANYON SEWER
SKY CANYON SEWER PROJECT
ALIGNMENT 1C
MURRIETA, CALIFORNIA
APPENDIX A

FIELD EXPLORATION
APPENDIX A

FIELD EXPLORATION

The subsurface exploration program for the proposed project consisted of excavating and logging a total of 21 hollow-stem auger borings drilled to depth between approximately 5 and 61 feet bgs. The borings were drilled with a B-61 drill rig equipped with 8-inch hollow stem augers, provided by Cal Pac Drilling of Calimesa, California. The approximate locations of the borings are shown on Figure 2, Boring Location Map.

The logs of the borings are presented as appendices A-3 through A-23. An explanation to the logs is presented appendices A-1 and A-2. The logs of borings describe the earth materials encountered, samples obtained, and show field and laboratory tests performed. The logs also show the boring number, drilling date, boring elevation and the name of the logger and drilling subcontractor. A Kleinfelder staff engineer logged the borings using methods outlined in the Unified Soil Classification System (USCS) and general procedures established in ASTM D 2488. The boundaries between soil types shown on the logs are approximate because the transition between different soil layers may be gradual. Bulk and drive samples of representative earth materials were obtained from the borings at maximum intervals of approximately 5 feet.

In-place soil samples were obtained at the test boring locations using a Standard Penetration (SPT) or California-type Sampler driven a total of 18-inches (or until practical refusal) into the undisturbed soil at the bottom of the boring. The soil sampled by the SPT (2-inch O.D., 1.5 inches I.D.) or California-type sampler (3-inch O.D., 2.4 inches I.D.) was returned to our laboratory for testing. The samplers and associated rod (threaded) were driven using a 140-pound automatic hammer falling 30 inches. The total number of hammer blows required to drive the sampler the final 12 inches is termed the blow count and is recorded on the Logs of Borings. The blow count values on the boring logs are presented as field values and have not been corrected for the effects such as overburden pressure, sampler size, hammer efficiency, etc. Bulk samples of the surface soils were retrieved via hand auger equipment to 5 feet bgs. All borings were backfilled with soil cuttings and capped with cold patch asphalt.

In addition to our geotechnical borings, we also had a seismic refraction surveys conducted by Terra Geosciences of Loma Linda. Nine areas were selected in which shallow bedrock was anticipated along the proposed alignments. The locations can be seen in Figure 2, Exploration Location Map. The purpose of the seismic refraction surveys were to assess the general seismic velocity characteristics of the underlying earth materials and to evaluate whether high velocity earth materials (non-rippable) are present at depths which would impact the proposed sewer
pipeline. Further explanation of the methodology behind the surveys and detailed results can be found in Appendix C, Seismic Refraction Survey.
The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated. In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing. Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols. If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

### Abbreviations
- **WOH** - Weight of Hammer
- **WOR** - Weight of Rod

### UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

#### Clean Gravel
- **GW** - Well-graded gravels, gravel-sand mixtures with little or no fines
- **GP** - Poorly graded gravels, gravel-sand mixtures with little or no fines

#### Gravels with 5% to 12% Fines
- **GW-GM** - Well-graded gravels, gravel-sand mixtures with little fines
- **GP-GM** - Poorly graded gravels, gravel-sand mixtures with little fines

#### Gravels with > 12% Fines
- **GW-GC** - Well-graded gravels, gravel-sand-clay mixtures
- **GP-GC** - Poorly graded gravels, gravel-sand-clay mixtures

#### Sands with > 12% Fines
- **GW-GM** - Well-graded sands, sand-gravel mixtures with little fines
- **GP-GM** - Poorly graded sands, sand-gravel mixtures with little fines

#### Sands with > 12% Fines
- **GW-GC** - Well-graded sands, sand-gravel-clay mixtures
- **GP-GC** - Poorly graded sands, sand-gravel-clay mixtures

#### Silts and Clays with > 12% Fines
- **GW-GM** - Well-graded silts and clays, silty-sand-mixtures
- **GP-GM** - Poorly graded silts and clays, silty-sand-mixtures

#### Silts and Clays with > 12% Fines
- **GW-GC** - Well-graded silts and clays, silty-gravel mixtures
- **GP-GC** - Poorly graded silts and clays, silty-gravel mixtures

#### Silts and Clays with < 12% Fines
- **GW-GM** - Well-graded silts and clays, silty-sand mixtures
- **GP-GM** - Poorly graded silts and clays, silty-sand mixtures

#### Silts and Clays with < 12% Fines
- **GW-GC** - Well-graded silts and clays, silty-gravel-clay mixtures
- **GP-GC** - Poorly graded silts and clays, silty-gravel-clay mixtures

#### Fine Grained Soils
- **ML** - Inorganic silts and very fine sands, silty or clayey fine sands, silts with slight plasticity
- **CL** - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, clayey clays
- **CL-ML** - Inorganic clayey silts of low plasticity, gravelly clays, sandy clays, clayey clays
- **OL** - Organic silts & organic silty clays of low plasticity
- **MH** - Inorganic silts, micaceous or diatomaceous fine sand or silt
- **CH** - Inorganic clays of high plasticity, fat clays
- **OH** - Organic clays & organic silts of medium-to-high plasticity

### Ground Water Graphics
- **Level where first observed**
- **Level after exploration completion**
- **Additional levels after exploration**
- **Observed seepage**

### Notes
- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols. If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

### Abbreviations
- **WOH** - Weight of Hammer
- **WOR** - Weight of Rod

### Key Graphics
- **CA**
- **GC**
- **GM**
- **GW**
- **GP**
- **CU**
- **CC**
- **RF**
### Soil Description

**Soil Description Key**

- **Grai**n **Size**
  - **DESCRIPTION**: Boulders, Cobbles, Gravel, Sand, Fines
  - **SIZE**: >12 in. (304.8 mm.), 3 - 12 in. (76.2 - 304.8 mm.), 3/4 - 3 in. (19 - 76.2 mm.), 0.19 - 0.75 in. (4.8 - 19 mm.), 0.079 - 0.19 in. (2 - 4.9 mm.), 0.017 - 0.079 in. (0.43 - 2 mm.), 0.0029 - 0.017 in. (0.07 - 0.43 mm.), <0.0029 in. (<0.07 mm.)

- **Secondary Constituent**
  - **Term of Use**: Secondary Constituent is Fine Grained, Secondary Constituent is Coarse Grained
  - **Amount**: <5%, 15% to <30%

- **Moisture Content**
  - **DESCRIPTION**: Moist, Wet, Dry
  - **FIELD TEST**: Absence of moisture, dusty, dry to the touch, Visible free water, usually soil is below water table

- **Relative Density**
  - **DESCRIPTION**: Very Loose, Loose, Medium Dense, Dense, Very Dense
  - **APPROXIMATE SIZE**: >12 in. (304.8 mm.), 3 - 12 in. (76.2 - 304.8 mm.), 3/4 - 3 in. (19 - 76.2 mm.), 0.19 - 0.75 in. (4.8 - 19 mm.), 0.079 - 0.19 in. (2 - 4.9 mm.), 0.017 - 0.079 in. (0.43 - 2 mm.), 0.0029 - 0.017 in. (0.07 - 0.43 mm.), <0.0029 in. (<0.07 mm.)

- **Plasticity**
  - **DESCRIPTION**: Non-plastic, Low (L), Medium (M), High (H)
  - **FIELD TEST**: A 1/8-in. (3 mm.) thread cannot be rolled at any water content.

- **Angularity**
  - **DESCRIPTION**: Angular, Subangular, Rounded
  - **CRITERIA**: Particles have sharp edges and relatively plane sides with unpolished surfaces, Particles are similar to angular description but have rounded edges, Particles have nearly plane sides but have well-rounded corners and edges.

**Terzaghi and Peck, 1948; Lambe and Whitman, 1969; FHWA, 2002; and ASTM D2488**

**CONSIDERATIONS**

- **CONSISTENCY**
  - **DESCRIPTION**: Very Soft, Soft, Medium Stiff, Stiff, Very Stiff
  - **APPROXIMATE SIZE**: <2, 2 - 4, 4 - 8, 8 - 15, 15 - 30
  - **UNCONFIRMED COMPRESSIVE STRENGTH (Q prices)**: 0 - 15, 15 to <30, 30 to 50, 50 - 100, 100 - 200, 200 - 400, 400 - 800, 800 - 1600, 1600 - 3200, 3200 - 6400, 6400 - 12800

**Cementation**

- **DESCRIPTION**: Weakly, Moderately, Strongly
  - **FIELD TEST**: Crumbles or breaks with handling or slight finger pressure, Crumbles or breaks with considerable finger pressure, Will not crumble or break with finger pressure

**Visual / Manual Criteria**

- **DESCRIPTION**: Thumb will penetrate more than 1 inch (25 mm), Thumb will penetrate soil about 1 inch (25 mm), Thumb will penetrate soil 1/4 inch (6 mm), Thumb will not indent soil but readily indented with thumbnail

**Plasticity**

- **DESCRIPTION**: Non-plastic, Low (L), Medium (M), High (H)
  - **FIELD TEST**: A 1/8-in. (3 mm.) thread cannot be rolled at any water content.

**Angularity**

- **DESCRIPTION**: Angular, Subangular, Rounded
  - **CRITERIA**: Particles have sharp edges and relatively plane sides with unpolished surfaces, Particles are similar to angular description but have rounded edges, Particles have nearly plane sides but have well-rounded corners and edges.

**Terzaghi and Peck, 1948**

**Reactions with Hydrochloric Acid**

- **DESCRIPTION**: None, Weak, Strong
  - **FIELD TEST**: No visible reaction, Some reaction, with bubbles forming slowly, Violent reaction, with bubbles forming immediately

**Structure**

- **DESCRIPTION**: Stratified, Laminated, Fissured, Slickensided, Blocky, Lensed
  - **CRITERIA**: Alternating layers of varying material or color with at least 1/4-in. thick, note thickness, Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness, Breaks along defined planes of fracture with little resistance to fracturing, Fracture planes appear polished or glossy, sometimes striated, Cohesive soil that can be broken down into small angular lumps which resist further breakdown, Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay, note thickness.

**Sky Canyon Sewer Project**

- **Alignment**: 1A, 1B, 2A
- **Location**: Murrieta, CA
### Lithologic Description

#### Alluvium (Qyu)
- Clayey SAND (SC): fine-grained, dark reddish brown (5YR 3/4), trace white mottling, moist, trace medium-grained sand

#### Weathered Bedrock (Kab)
- GRANITE: excavates as Silty SAND (SM), trace clay, dark grayish brown (10YR 4/2), moist, very dense, iron oxide staining, mottled black and white
  - Decrease in sand, increase in fines, decrease in iron oxide staining, dense
  - Crushed rock in shoe of sampler, very dense, iron oxide staining
  - Decrease in fines
  - Increase in iron oxide staining, increase in moisture

---

<table>
<thead>
<tr>
<th>Sample</th>
<th>Sample Type</th>
<th>Bow Count (BC)</th>
<th>USCS Symbol</th>
<th>Water Content (%)</th>
<th>Void Ratio (p&lt;sub&gt;0&lt;/sub&gt;)</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Additional Tests/Remarks</th>
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</tr>
<tr>
<td>7</td>
<td>BC=21</td>
<td>50/5.5</td>
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</table>
Weathered Bedrock (Kgb):

- GRANITE: excavates as Silty SAND (SM), trace clay, dark grayish brown (10YR 4/2), moist, very dense, iron oxide staining, mottled black and white, dark yellowish brown (10YR 3/4), trace fine gravel, subangular to angular
- increase in gravel

- excavates as Clayey SAND (SC), fine-grained, very dark gray (10YR 3/10), moist, very dense, mottled black and white, iron oxide staining

- very dark gray (10YR 3/1) to black (10YR 2/1)

The boring was terminated because of practical auger refusal (•) at approximately 55.5 ft. below ground surface on bedrock. The boring was backfilled with auger cuttings on April 20, 2018.

GROUNDWATER LEVEL INFORMATION:
Groundwater was observed at approximately 40 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
Field Exploration

Lithologic Description

Alluvium (Qyu): Clayey SAND (SC): fine to coarse-grained, dark reddish brown (5YR 3/4), moist, trace medium-grained sand

Weathered Bedrock (Kgb): GRANITE: excavates as Well-Graded SAND (SW-SM), trace clay, dark yellowish brown (10YR 3/4), moist, very dense, fine to medium-grained sand, iron oxide staining, dark grayish brown (10YR 4/2)

decrease in sand grain size with depth

excavates as Clayey SAND (SC), very dark gray (10YR 3/4), fine-grained sand, moist, very dense, trace medium sand

Laboratory Results

Graphical Log

Sample | Sample Type | Bow Count (BC) | Unconformable Boundary | Recovery (%) | Water Content (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/Remarks
--- | --- | --- | --- | --- | --- | --- | --- | ---
1 | 1 | 50 lb/6" | 1" | 50 lb/6" | 10" | 4 | 5 | hand auger refusal at 1.5 feet
2 | 2 | 50 lb/6" | 5" | 1" | 32 | 6 | 1 | 
3 | 3 | 50 lb/6" | 10" | 50 lb/6" | 10" | 5 | 1 | 
4 | 4 | 50 lb/6" | 5" | 50 lb/6" | 10" | 5 | 1 | 
5 | 5 | 50 lb/6" | 3" | 50 lb/6" | 10" | 5 | 1 | 
6 | 6 | 50 lb/6" | 3" | 50 lb/6" | 10" | 5 | 1 | 
7A | 7A | 50 lb/6" | 6" | 50 lb/6" | 10" | 5 | 1 | 
7B | 7B | 50 lb/6" | 4" | 50 lb/6" | 10" | 5 | 1 |
Weathered Bedrock (Kgb):
GRANITE: excavates as Well-Graded SAND (SW-SM), trace clay, dark yellowish brown (10YR 3/4), moist, very dense, fine to medium-grained sand, iron oxide staining,
increase in moisture
becomes wet
trace fine gravel, subangular
becomes very dark gray (10YR 3/1), iron oxide staining, clay nodules, mottled black and white
becomes black (10YR 2/1) with brownish yellow clay nodules, black and white mottling

The boring was terminated at approximately 61 ft. below ground surface. The boring was backfilled with auger cuttings on April 20, 2018.

K2 GROUNDWATER LEVEL INFORMATION:
Groundwater was observed at approximately 45 ft. below ground surface during drilling.
GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
**Alluvium (Qyu):**
Clayey SAND (SC): fine-grained, very dark brown (10YR 2/2), dry to moist, trace coarse-grained sand, subangular to angular, trace gravel, fine-grained, subrounded to subangular

**Weathered Bedrock (Kgb):**
GRANITE: excavates as Poorly Graded SAND (SP), fine to medium-grained, dark yellowish brown (10YR 4/4), dry to moist, very dense, trace coarse-grained sand, trace clay

The boring was terminated because of practical auger refusal (†) at approximately 26 ft. below ground surface on bedrock. The boring was backfilled with auger cuttings on April 19, 2018.

**Groundwater Level Information:**
Groundwater was not observed during drilling or after completion.

**General Notes:**
The exploration location and elevation are approximate and were estimated by Kleinfelder.

---

**Lithologic Description**

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Sample Number</th>
<th>Sample Type</th>
<th>Bow Count (BC)</th>
<th>Uncorr. Blows</th>
<th>USCS Symbol</th>
<th>Water Content (%)</th>
<th>Dry Unit Wt. (pcf)</th>
<th>Passing #4 (%)</th>
<th>Passing #200 (%)</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Remarks</th>
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<td>-1295</td>
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</table>
Alluvium (Qyu): Clayey SAND (SC): fine-grained, very dark brown (10YR 2/2), moist, trace medium-grained sand, dense, decrease in clay content with depth, trace gravel, fine-grained, subangular

Weathered Bedrock (Kgb): GRANITE: excavates as Poorly Graded SAND (SP), very dark grayish brown (10YR 3/2), dry to moist, very dense, fine to medium-grained, trace silt, iron oxide staining

excavates as Well-Graded Sand with SILT (SW-SM), very dark grayish brown (10YR-3/2), dry to moist, very dense, fine to medium-grained, trace silt, iron oxide staining

increase in clay content

excavates as Silty SAND (SM), grayish brown (10YR 5/2), moist, very dense, mottled white and black, trace clay

excavates at Poorly Graded SAND (SP), fine to medium-grained sand, very dense

The boring was terminated at approximately 31.5 ft. below ground surface. The boring was backfilled with auger cuttings on April 19, 2018.

Groundwater was observed at approximately 29.5 ft. below ground surface during drilling.

The exploration location and elevation are approximate and were estimated by Kleinfelder.
Field Exploration

**Lithologic Description**

- **Older Alluvium (Qvoa):** Clayey SAND (SC): fine to medium-grained, dark reddish brown (5YR 3/4), dry to moist, trace coarse-grained sand, subrounded

- **Silty SAND (SM):** fine to medium-grained, dark reddish brown (5YR 3/4), mottled white, dry to moist, medium dense, trace coarse sand, subangular, trace fine-grained gravel, subrounded to subangular

- Increase in clay content, decrease in medium-grained sand, micaceous

- Very dense

- **Sandy Lean CLAY (CL):** fine sand, low plasticity, very dark grayish brown (10YR 3/2), moist, soft, iron oxide staining

- **Poorly Graded SAND with Clay (SP-SC):** very dark grayish brown (10YR 3/2), mottled white, moist, dense, trace medium-grained sand, subangular, trace mica

- **Weathered Bedrock (Kgb):** GRANITE: excavates as Silty SAND (SM), trace low plasticity clay, very dark grayish brown (10YR 3/2), moist, very dense, mottled black and white, iron oxide staining, slightly friable, micaceous

Laboratory Results

- **Sample Number**
- **Sample Type**
- **Dry Unit Wt. (pcf)**
- **Passing #4 (%)**
- **Passing #200 (%)**
- **Liquid Limit**
- **Plasticity Index (NP=NonPlastic)**
- **Additional Tests/Remarks**

**Additional Details**

- **Latitude:** 33.56181° N
- **Longitude:** -117.13610° W
- **Approximate Ground Surface Elevation (ft.):** 1,320
- **Surface Condition:** Bare Earth

**Additional Information**

- **Drilling Company:** Cal Pac
- **Drill Crew:** James & Jeff
- **Drilling Equipment:** B-61
- **Hammer Type - Drop:** 140 lb. Auto - 30 in.
- **Auger Diameter:** 8 in. O.D.
Boring Log 1A-B5

**FIELD EXPLORATION**

**Sample Number**

<table>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>-1280</td>
<td>excavates as Silty SAND (SM), trace low plasticity clay, very dark grayish brown (10YR 3/2), moist, very dense, mottled black and white, iron oxide staining, slightly friable, micaeous</td>
<td>increase in silt, increase in white mottling</td>
<td>very dark grayish brown (10YR 3/2), decrease in iron oxide staining</td>
<td>excavates as Poorly Graded SAND with Silt (SP-SM), very dark gray (2.5Y 3/1), moist, very dense, mottled black and white, fine-grained sand, trace medium-grained sand</td>
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</table>

The boring was terminated at approximately 51 ft. below ground surface. The boring was backfilled with auger cuttings on April 20, 2018.

**LABORATORY RESULTS**

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Dry Unit Wt. (pcf)</th>
<th>Passing #4 (%)</th>
<th>Passing #200 (%)</th>
<th>Water Content (%)</th>
<th>Liquid Limit</th>
<th>Plasticity Index (NP=NonPlastic)</th>
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<tr>
<td>9</td>
<td>BC=50/5'</td>
<td>4'</td>
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<td>5.7</td>
<td>105.2</td>
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<td>10</td>
<td>BC=26             50/5'</td>
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<tr>
<td>11</td>
<td>BC=13             50/6'</td>
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<td>12</td>
<td>BC=39             50/4'</td>
<td>10'</td>
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</table>

**GROUNDWATER LEVEL INFORMATION:**

Groundwater was not observed during drilling or after completion.

**GENERAL NOTES:**

The exploration location and elevation are approximate and were estimated by Kleinfelder.
Older Alluvium (Qvoa): Clayey SAND (SC): fine to medium-grained, dark brown (10YR 3/3), moist, trace coarse-grained sand medium dense, iron oxide staining, moderately cemented

Weathered Bedrock (Kgb): GRANITE: excavates as Silty SAND (SM), fine-grained sand, trace non-plastic to low plastic clay, very dark gray (10YR 3/1), moist, very dense, trace gravel, fine-grained gravel, subrounded to subangular, trace iron oxide staining, micaceous crushed rock, up to 1-inch, strongly cemented

increase in clay content

excavates as Poorly Graded SAND (SP), fine to medium-grained sand, wet, very dense, trace silt, dark reddish brown (SYR 3/4)

The boring was terminated because of practical auger refusal (❑) at approximately 31 ft. below ground surface on bedrock. The boring was backfilled with auger cuttings on April 18, 2018.

Groundwater was observed at approximately 31 ft. below ground surface during drilling.

General Notes: The exploration location and elevation are approximate and were estimated by Kleinfelder.
<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Lithologic Description</th>
<th>Sample Number</th>
<th>Sample Type</th>
<th>Recovery Rate</th>
<th>Water Content (%)</th>
<th>Dry Unit Weight (pcf)</th>
<th>Passing #4 (%)</th>
<th>Passing #200 (%)</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Liquid Limit</th>
<th>Additional Tests/Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300</td>
<td>Older Alluvium (Qvoa): Clayey SAND (SC): fine to medium-grained, dark brown (10YR 3/3), moist, trace coarse-grained sand, trace gravel, subrounded, micaceous</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>hand auger to 5 feet - moderate to difficult</td>
</tr>
<tr>
<td>1295</td>
<td>Sandy Lean CLAY (CL): black (10YR 2/1): moist, stiff, fine to medium-grained sand, weakly cemented, trace mica</td>
<td>2</td>
<td>BC=8</td>
<td>11 14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1290</td>
<td>Weathered Bedrock (Kgb): GRANITE: excavates as Silty SAND (SM), very dark gray (10YR 3/1), fine to medium-grained sand, moist, very dense, iron oxide staining</td>
<td>3</td>
<td>BC=2</td>
<td>3 7</td>
<td>18°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1285</td>
<td>GRANITE: excavates as Silty SAND (SM), very dark gray (10YR 3/1), fine to medium-grained sand, moist, very dense, iron oxide staining</td>
<td>4</td>
<td>BC=15</td>
<td>26</td>
<td>12°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1280</td>
<td>dark grayish brown (10YR 4/2), decrease in clay content, decrease in iron oxide staining</td>
<td>5</td>
<td>BC=20</td>
<td>50/5.5°</td>
<td>10°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1275</td>
<td>increase in moisture</td>
<td>6</td>
<td>BC=50/4°</td>
<td>4°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1270</td>
<td>excavates as Poorly Graded SAND (SP), trace low plasticity clay, dark grayish brown (10YR 4/2), fine to medium-grained sand, crushed rock in shoe of sampler</td>
<td>7</td>
<td>BC=50/8°</td>
<td>6°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LABORATORY RESULTS**

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Water Content (%)</th>
<th>Dry Unit Weight (pcf)</th>
<th>Passing #4 (%)</th>
<th>Passing #200 (%)</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Liquid Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC=8</td>
<td>10.1</td>
<td>123.0</td>
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<tr>
<td>BC=15</td>
<td>11.9</td>
<td>129.0</td>
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<tr>
<td>BC=20</td>
<td>1.2</td>
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<tr>
<td>BC=50/4°</td>
<td>3.9</td>
<td>104.4</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>BC=50/8°</td>
<td>6°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The boring was terminated at approximately 41 ft. below ground surface. The boring was backfilled with auger cuttings on April 17, 2018.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
Asphalt: 5 inches
Base: 12 inches

Older Alluvium (Qvoa):
Silty SAND (SM): fine-grained, dark grayish brown (10 YR 4/7), dry to moist
medium dense, iron oxide and carbonate staining

Weathered Bedrock (Kgb):
GRANITE: excavates as Silty SAND (SM), fine-grained, very dark gray (10YR 3/1), dry to moist, very dense, iron oxide and carbonate staining
decrease in fines
gravel in cuttings, up to 1 inch, subangular
decrease in iron oxide staining

The boring was terminated because of refusal (†) at approximately 20 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on June 26, 2018.
Latitude: 33.56789° N
Longitude: -117.13675° W
Approximate Ground Surface Elevation (ft.): 1,317
Surface Condition: Asphalt

Asphalt: 5 inches
Base: 12 inches
Alluvium (Qyu): Poorly Graded SAND with Clay (SP-SC): fine-grained, black (10YR 2/1) to dark grayish brown (YR 4/7), moist, decrease in clay content with depth
dark brown (10YR 3/3), trace gravel, fine to medium-grained, subrounded to subangular
Weathered Bedrock (Kgb): GRANITE: excavates as Poorly Graded SAND (SP), fine to medium-grained, yellowish brown (10YR 4/2), dry to moist, medium dense, carbonate and iron oxide staining
increase in fines
very dense
excavates as Silty SAND (SM), fine-grained, dark grayish brown (10YR 3/3), moist, very dense
gravel in cuttings, fine to coarse-grained, up to 2 inches, subangular

The boring was terminated because of refusal ( ) at approximately 29 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on June 26, 2018.

Groundwater Level Information:
Groundwater was observed at approximately 26.5 ft. below ground surface during drilling.

General Notes:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
**Lithologic Description**

1. **Asphalt**: 6 inches
   - Base: 18 inches

2. **Alluvium (Qyu)**: Poorly Graded SAND with Clay (SP-SC) - fineto coarse-grained, dark grayish brown (10YR 4/2), dry to moist, decrease in clay content with depth; yellowish brown (10YR 4/2), iron oxide staining

3. **Weathered Bedrock (Kgb)**: GRANITE - excavates as Poorly Graded SAND (SP), fine to medium-grained, trace coarse-grained sand, yellowish brown (10YR 4/2), moist, very dense, iron oxide and carbonate staining

4. **Dry Unit Wt. (pcf)**: 100

5. **BC=50/3"**

6. **BC=36/50/8"**

7. **BC=15/35/50/6"**

**LABORATORY RESULTS**

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Sample Number</th>
<th>Sample Type</th>
<th>Bow Count BC</th>
<th>Uncont. Blows</th>
<th>Soil Recovery (%)</th>
<th>USCOS Symbol</th>
<th>Water Content (%)</th>
<th>Dry Unit Wt. (pcf)</th>
<th>USCSSymbol</th>
<th>Passing #200 (%)</th>
<th>Passing #400 (%)</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td></td>
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<tr>
<td>20</td>
<td>4</td>
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<tr>
<td>25</td>
<td>5</td>
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<tr>
<td>30</td>
<td>6</td>
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<tr>
<td>35</td>
<td>7</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Weathered Bedrock (Kgb): GRANITE: excavates as Poorly Graded SAND (SP), fine to medium-grained, trace coarse-grained sand, yellowish brown (10YR 4/2), moist, very dense, iron oxide and carbonate staining

The boring was terminated at approximately 51.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on June 26, 2018.

GROUNDWATER LEVEL INFORMATION: Groundwater was observed at approximately 42.5 ft. below ground surface during drilling.

GENERAL NOTES: The exploration location and elevation are approximate and were estimated by Kleinfelder.
### Lithologic Description

**Asphalt:** 5 inches

**Base:** 18 inches

**Alluvium (Qyu):** Poorly Graded SAND with Clay (SP-SC)
- fine-grained, black (10YR 2/1), moist, trace medium-grained sand

**Weathered Bedrock (Kbb):** excavates as
- Poorly Graded SAND (SP), fine to medium-grained, dark yellowish brown (10YR 4/6), dry, very dense, carbonate and iron oxide staining thoughout
- dry to moist, increase in fines, decrease in medium-grained sand
- dark grayish brown (10YR 4/2), increase in fines
- excavates as Silty SAND (SM), fine-grained, very dark gray (10YR 3/1), gravel in tip of sampler, up to 2 inches, subangular, micaceous
- excavates as Poorly Graded SAND (SP), fine to medium-grained, dark yellowish brown (10YR 4/6), wet, very dense

**Hammer Type - Drop:** 140 lb. Auto - 30 in.

**Additional Tests/Remarks:**
- hand auger to 5 feet - difficult
- r-value test

**LABORATORY RESULTS**

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Sample No.</th>
<th>Bow Core (Blows/6 in.)</th>
<th>Recovery</th>
<th>USCS Symbol</th>
<th>Water Content (%)</th>
<th>Dry Unit Wt. (pcf)</th>
<th>Passing #4 (%)</th>
<th>Passing #200 (%)</th>
<th>Plasticity Index (NP=NonPlastic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>1</td>
<td>BC=17 36 50/5&quot;</td>
<td>17&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td>2</td>
<td>BC=16 50/5&quot;</td>
<td>11&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alluvium</td>
<td>3</td>
<td>BC=25 50/5&quot;</td>
<td>6&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weathered</td>
<td>4</td>
<td>BC=24 50/1&quot;</td>
<td>5&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedrock</td>
<td>5</td>
<td>BC=50/4&quot;</td>
<td>4&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>BC=50/5&quot;</td>
<td>5&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>BC=50/5&quot;</td>
<td>5&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Blow Counts (BC)=Uncorr. Blows/6 in.**

**Graphical Log**

**Sample Type**
- Asphalt
- Base
- Alluvium
- Weathered Bedrock

**Note:**
- Latitude: 33.56556° N
- Longitude: -117.13726° W
- Approximate Ground Surface Elevation (ft.): 1,309
- Surface Condition: Asphalt

**Additional Details:**
- Sunny, 80s
- 6/26/2018
- Drilling Method: Hollow Stem Auger
- Drilling Equipment: 8-61

**Field Exploration**

**Laboratory Results**

**Additional Tests/Remarks**

**Sky Canyon Sewer Project Alignment 2A Murrieta, CA**
Weathered Bedrock (Kgb): excavates as Poorly Graded SAND (SP), fine to medium-grained, dark yellowish brown (10YR 4/6), dry, very dense, carbonate and iron oxide staining throughout.

The boring was terminated at approximately 45 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on June 26, 2018.

Groundwater was observed at approximately 36 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

GROUNDWATER LEVEL INFORMATION:
2 Groundwater was observed at approximately 36 ft. below ground surface during drilling.
Asphalt: 5 inches  
Base: 18 inches

Alluvium (Qyu):  Poorly Graded SAND (SP) fine-grained, very dark gray (10YR 3/1), moist, trace coarse-grained sand

Weathered Bedrock (Kgb): GRANITE excavates as Silty SAND (SM), fine-grained, very dark gray (10YR 3/1), dry to moist, dense, carbonate staining thoroughout

excavates as Clayey SAND (SC), fine-grained, dry to moist, very dense, trace iron oxide staining

excavates as Silty SAND (SM), fine-grained, very dark gray (10YR 3/1), moist, very dense, carbonate and iron oxide staining

excavates as Clayey SAND (SC), fine-grained, very dark gray (10YR 3/1), moist, dense, decrease in carbonate staining, increase in iron oxide staining

The boring was terminated because of practical auger refusal (†) at approximately 22 ft. below ground surface on bedrock. The boring was backfilled with auger cuttings and patched at surface on June 25, 2018.

GROUNDWATER LEVEL INFORMATION:
Groundwater was observed at approximately 20 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

The boring was terminated because of practical auger refusal (†) at approximately 22 ft. below ground surface on bedrock. The boring was backfilled with auger cuttings and patched at surface on June 25, 2018.
Asphalt: 5 inches
Base: 18 inches

Alluvium (Qyu): Poorly Graded SAND with Clay (SP-SC): fine-grained, dark brown (10YR 3/3), moist, trace coarse-grained sand, micaceous

Clayey SAND (SC): fine-grained, dark brown (10YR 3/3), moist, dense, trace medium-grained sand, carbonate staining

medium dense, increase in iron oxide staining

medium dense, increase in clay content, decrease in carbonate staining

Weathered Bedrock (Kgb): GRANITE: excavates as Clayey SAND (SC), fine-grained, dark brown (10YR 3/3), wet, very dense
decrease in clay content, increase in medium-grained sand

The boring was terminated at approximately 31.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on June 25, 2018.

Groundwater was observed at approximately 24 ft. below ground surface during drilling.

General Notes:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

Groundwater Level Information:
Groundwater was observed at approximately 24 ft. below ground surface during drilling.

General Notes:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

Additional Tests:
hand auger to 5 feet - moderate to difficult

direct shear test
Latitude: 33.56237° N
Longitude: -117.13810° W
Approximate Ground Surface Elevation (ft.): 1,297
Surface Condition: Asphalt

Groundwater was observed at approximately 28.5 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

LABORATORY RESULTS

Dry Unit Wt. (pcf)
Passing #4 (%)
Passing #200 (%)
Liquid Limit
Plasticity Index (NP=NonPlastic)
Additional Tests/Remarks

Boring terminated at approximately 31.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on June 25, 2018.
Asphalt: 4.5 inches

Base: BASE COURSE: 10 inches

Older Alluvium (Qvoa): Clayey SAND (SC): reddish brown (10YR 3/3), moist, medium dense, fine to medium-grained sand, trace gravel, subrounded decrease in clay, increase in silt and sand dark brown (10YR 3/3) with reddish brown (10YR 3/3) motting, increase in gravel, angular

Silty SAND (SM): fine-grained, reddish brown (10YR 3/3), moist, medium dense

Weathered Bedrock (Kgb): GRANITE: excavates as Poorly Graded SAND (SP), fine to coarse-grained, dark gray (10YR 4/1), moist, very dense, mottled black and white, trace silt,

The boring was terminated at approximately 31 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on April 17, 2018.

Groundwater was not observed during drilling or after completion.

GENERAL NOTES: The exploration location and elevation are approximate and were estimated by Kleinfelder.
### Lithologic Description

- **Asphalt:** 4.5 inches
- **Base:** 10 inches

**Alluvium (Qyu):** fine to coarse-grained, brown (10YR 5/3), dry to moist, trace fine gravel, subrounded

**Silty SAND (SM):** fine to coarse-grained, brown (10YR 5/6), increase in sand

**Weathered Bedrock (Kgb):** GRANITE: excavates as Clayey SAND (SC), fine-grained, light brownish gray (10YR 6/2), trace yellow and white mottling, medium dense, weakly to moderately cemented, slightly friable

**Well-Graded SAND with Silt (SW-SM):** fine to medium-grained, moist, very dense, trace clay, dark gray (10YR 4/4), slightly friable

**Dark brown (10YR 3/3):** trace black and white mottling, trace gravel, fine to medium-grained, subrounded to subangular, dense

**Dark gray (10YR 4/1):** very dense

**Additional Tests/Remarks:**
- Hand auger to 5 feet - easy to moderate
- Direct shear test
- Sand equivalent test

### Laboratory Results

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Sample Number</th>
<th>Sample Type</th>
<th>USCSS</th>
<th>USCS Symbol</th>
<th>Water Content (%)</th>
<th>Dry Unit Wt. (pcf)</th>
<th>Passing #4 (%)</th>
<th>Passing #200 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>asphalt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>BC=8</td>
<td>13</td>
<td>18</td>
<td>16.6</td>
<td>102.1</td>
<td></td>
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</tr>
<tr>
<td>15</td>
<td>3</td>
<td>BC=10</td>
<td>16</td>
<td>18</td>
<td>18</td>
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</tr>
<tr>
<td>20</td>
<td>4</td>
<td>BC=23</td>
<td>50/8'</td>
<td>12</td>
<td>4.5</td>
<td>112.8</td>
<td>99</td>
<td>12</td>
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<tr>
<td>25</td>
<td>5</td>
<td>BC=8</td>
<td>22</td>
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<td>18</td>
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<td></td>
</tr>
<tr>
<td>30</td>
<td>6</td>
<td>BC=50/8'</td>
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<td>6.5</td>
<td>120.1</td>
<td></td>
<td></td>
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<tr>
<td>35</td>
<td>7</td>
<td>BC=38</td>
<td>50/4'</td>
<td>4'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The boring was terminated at approximately 36.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on April 17, 2018.

Groundwater was observed at approximately 31.5 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
**Asphalt:** 4.5 inches  
**Base:** 10 inches  
**Alluvium (Qyu):** Silty SAND with Gravel (SM): fine to medium-grained, very dark gray (10YR 3/2), moist, with coarse gravel, up to 2-inches, angular  
  **Silty SAND (SM):** fine to medium-grained, very dark gray (10YR 3/2), dry to moist, medium dense, trace gravel, trace coarse sand  
**Weathered Bedrock (Kgb):** GRANITE: excavates as Silty SAND (SM), moist, dense, very dark white and black mottling, trace gravel, fine-grained, subrounded to subangular, micaceous  
  **trace iron oxide staining**  
  **GRANITE:** excavates as Clayey SAND (SC), very dark gray (10YR 3/2) with white and black mottling, fine to medium-grained sand, trace iron oxide staining  
  **trace iron oxide staining**  
  **excavates as Poorly Graded SAND (SP), fine to medium-grained sand, very dark gray (10YR 3/2), wet, very dense, some clay, iron oxide staining**  

**LABORATORY RESULTS**

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Sample Number</th>
<th>Sample Type</th>
<th>Bow Count (BC)</th>
<th>Water Content (%)</th>
<th>Liquid Limit</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>BC=8</td>
<td>9</td>
<td></td>
<td>11.6</td>
<td>115.6</td>
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<td>3</td>
<td>BC=14</td>
<td>15</td>
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<td>95</td>
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<tr>
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<td>101.4</td>
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<td>sand equivalent test</td>
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<tr>
<td>25</td>
<td>5</td>
<td>BC=16</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>sand equivalent test</td>
</tr>
<tr>
<td>30</td>
<td>6</td>
<td>BC=12</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>light chattering</td>
</tr>
<tr>
<td>35</td>
<td>7</td>
<td>BC=504</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Additional Tests/Remarks:**  
hand auger to 5 feet - difficult  
light chattering  
grinding

**FIELD EXPLORATION**

- **Lithologic Description**
- **Graphical Log**
- **Approximate Elevation (feet):**
  - Asphalt: 4.5 inches  
  - Base: 10 inches  
  - Alluvium (Qyu): Silty SAND with Gravel (SM): fine to medium-grained, very dark gray (10YR 3/2), moist, with coarse gravel, up to 2-inches, angular  
  - Silty SAND (SM): fine to medium-grained, very dark gray (10YR 3/2), dry to moist, medium dense, trace gravel, trace coarse sand  
  - Weathered Bedrock (Kgb): GRANITE: excavates as Silty SAND (SM), moist, dense, very dark white and black mottling, trace gravel, fine-grained, subrounded to subangular, micaceous  
  - trace iron oxide staining  
  - GRANITE: excavates as Clayey SAND (SC), very dark gray (10YR 3/2) with white and black mottling, fine to medium-grained sand, trace iron oxide staining  
  - trace iron oxide staining  
  - excavates as Poorly Graded SAND (SP), fine to medium-grained sand, very dark gray (10YR 3/2), wet, very dense, some clay, iron oxide staining

**LABORATORY RESULTS**

- **Sample Number**
- **Sample Type**
- **Bow Count (BC):** Uncorr. Blows/6 in.
- **Water Content (%)**
- **Liquid Limit**
- **Plasticity Index (NP=NonPlastic)**
- **Remarks**

**FIELD EXPLORATION**

- **Lithologic Description**
- **Graphical Log**
- **Approximate Elevation (feet):**
  - Asphalt: 4.5 inches  
  - Base: 10 inches  
  - Alluvium (Qyu): Silty SAND with Gravel (SM): fine to medium-grained, very dark gray (10YR 3/2), moist, with coarse gravel, up to 2-inches, angular  
  - Silty SAND (SM): fine to medium-grained, very dark gray (10YR 3/2), dry to moist, medium dense, trace gravel, trace coarse sand  
  - Weathered Bedrock (Kgb): GRANITE: excavates as Silty SAND (SM), moist, dense, very dark white and black mottling, trace gravel, fine-grained, subrounded to subangular, micaceous  
  - trace iron oxide staining  
  - GRANITE: excavates as Clayey SAND (SC), very dark gray (10YR 3/2) with white and black mottling, fine to medium-grained sand, trace iron oxide staining  
  - trace iron oxide staining  
  - excavates as Poorly Graded SAND (SP), fine to medium-grained sand, very dark gray (10YR 3/2), wet, very dense, some clay, iron oxide staining

**LABORATORY RESULTS**

- **Sample Number**
- **Sample Type**
- **Bow Count (BC):** Uncorr. Blows/6 in.
- **Water Content (%)**
- **Liquid Limit**
- **Plasticity Index (NP=NonPlastic)**
- **Remarks**
The boring was terminated at approximately 37.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on April 17, 2018.

GROUNDWATER LEVEL INFORMATION:
Groundwater was observed at approximately 30 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
Asphalt: 3 inches
Base: 12 inches
Weathered Bedrock (Kgb): GRANITE: medium-grained, very dark gray (10YR 3/2), excavates as Silty SAND (SM), fine to medium-grained, coarse gravel up to 3 inches, subrounded to subangular, trace cobbles, up to 4 inches very dense.

The boring was terminated after multiple attempts because of practical auger refusal at approximately 6 ft below ground surface on bedrock. The boring was backfilled with auger cuttings and patched at surface on April 18, 2018.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
Asphalt: 4 inches
Base: 12 inches
Alluvium (Qyu): Poorly Graded SAND (SP): fine to medium-grained, dark grayish brown (10YR 3/2), moist, increase in clay content

Weathered Bedrock (Kgb): GRANITE: excavates as Well-graded SAND with Silt (SW-SM), very dark grayish brown (10YR 3/2), dry to moist, very dense, mottled black and white, fine-grained sand, iron oxide staining, micaceous decrease in iron oxide staining

excavates as Poorly Graded SAND with Silt (SP-SM), dark grayish brown (10YR 3/2), moist, fine to medium-grained sand, trace iron oxide staining, micaceous

trace gravel, fine-grained, 3/4 inch, subangular

excavates as Clayey SAND (SC), dark yellowish brown (10YR 3/4), fine to medium-grained sand, micaceous

LABORATORY RESULTS

**Sample**

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Sample Type</th>
<th>Sample Number</th>
<th>Recovery (%)</th>
<th>USCS Symbol</th>
<th>Water Content (%)</th>
<th>Dry Unit Wt (pcf)</th>
<th>Passing #200 (%)</th>
<th>Passing #4 (inch)</th>
<th>Liquid Limit</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Additional Tests/Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>BS=17</td>
<td>1</td>
<td>12</td>
<td>12</td>
<td>3.0</td>
<td>112.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>hand auger to 5 feet - difficult</td>
</tr>
<tr>
<td>10</td>
<td>BS=15</td>
<td>2</td>
<td>12</td>
<td>12</td>
<td>100</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>moderate grinding and chattering</td>
</tr>
<tr>
<td>15</td>
<td>BS=39</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>10.6</td>
<td>124.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>BS=50/4'</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>BS=50/3'</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>BS=50/4.5'</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>BS=11</td>
<td>8</td>
<td>11</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The boring was terminated because of practical auger refusal (↓) at approximately 36.5 ft. below ground surface on bedrock. The boring was backfilled with auger cuttings and patched at surface on April 18, 2018.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
### LABORATORY RESULTS

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Approximate Elevation (feet)</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1140</td>
<td>Asphalt: 4.5 inches</td>
</tr>
<tr>
<td>10</td>
<td>1135</td>
<td>Base: 12 inches</td>
</tr>
<tr>
<td>15</td>
<td>1130</td>
<td>Pauba Formation: Sandstone (Qpsf): excavated as Silty SAND (SM) with Gravel, fine-grained sand, dark brown (10YR 3/3), moist, fine to coarse gravel up to 1 inch, subrounded to rounded, trace cobbles clay nodules, very dark brown (10YR 3/1), low to medium plasticity, iron oxide staining</td>
</tr>
<tr>
<td>20</td>
<td>1125</td>
<td>Clayey SAND (SC): fine to medium-grained, dark brown (10YR 3/3), moist, medium dense</td>
</tr>
<tr>
<td>25</td>
<td>1120</td>
<td>Silty SAND (SM): fine-grained, dark gray (10YR 3/1), moist, medium dense, trace clay, low plasticity, iron oxide staining</td>
</tr>
<tr>
<td>30</td>
<td>1115</td>
<td>Clayey SAND (SC): fine-grained, very dark gray (10YR 3/1) to black (10YR 2/1), moist, medium dense</td>
</tr>
<tr>
<td>-30</td>
<td>-1120</td>
<td>dark brown (10YR 3/3), loose, transitions to very dark gray (10YR 3/1) with depth, decrease in clay content</td>
</tr>
<tr>
<td>-25</td>
<td>-1125</td>
<td>dark brown (10YR 3/3)</td>
</tr>
<tr>
<td>-20</td>
<td>-1130</td>
<td>micaeous</td>
</tr>
<tr>
<td>-15</td>
<td>-1135</td>
<td>increase in clay content, trace gravel, 1 inch</td>
</tr>
<tr>
<td>-10</td>
<td>-1140</td>
<td>hand auger to 5 feet - moderate to hard</td>
</tr>
</tbody>
</table>

### FIELD EXPLORATION

<table>
<thead>
<tr>
<th>Dry Unit Wt. (pcf)</th>
<th>Passing #4 (%)</th>
<th>Passing #200 (%)</th>
<th>USC Symbol</th>
<th>Water Content (‰)</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Liquid Limit</th>
<th>Blow Counts (BC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.1</td>
<td>18°</td>
<td></td>
<td>BC=13</td>
<td>11</td>
<td>125.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.2</td>
<td>12°</td>
<td></td>
<td>BC=2</td>
<td>4</td>
<td>127.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.2</td>
<td>18°</td>
<td></td>
<td>BC=3</td>
<td>4</td>
<td>109.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### BORING LOG 2A-B13

- **Date Begin - End:** 4/19/2018
- **Logged By:** C. Coffey
- **Hor.-Vert. Datum:** Not Available
- **Plunge:** -90 degrees
- **Weather:** Cloudy, 60s
- **Drilling Method:** Hollow Stem Auger
- **Drilling Equipment:** B-61
- **Hammer Type - Drop:** 140 lb. Auto - 30 in.
- **Auger Diameter:** 8 in. O.D.
Clayey SAND (SC): fine-grained, very dark gray (10YR 3/1) to black (10YR 2/1), moist, medium dense

Silty SAND with Gravel (SM): fine to medium-grained, reddish brown (2.5YR 5/4), moist, dense, with gravel, coarse-grained, up to 2 inches, subrounded to subangular.

The boring was terminated at approximately 41.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on April 19, 2018.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
**LABORATORY RESULTS**

<table>
<thead>
<tr>
<th>Graphical Log</th>
<th>Sample Type</th>
<th>Dry Unit Wt. (pcf)</th>
<th>Passing #4 (%)</th>
<th>Passing #200 (%)</th>
<th>Water Content (%)</th>
<th>Liquid Limit</th>
<th>Plasticity Index (NP=NonPlastic)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample 1</strong></td>
<td>BC=8</td>
<td>14, 17</td>
<td>18°</td>
<td>99</td>
<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sample 2</strong></td>
<td>BC=4</td>
<td>11, 13</td>
<td>18°</td>
<td>12.0</td>
<td>121.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sample 3</strong></td>
<td>BC=6</td>
<td>13, 22</td>
<td>18°</td>
<td>13.5</td>
<td>117.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sample 4</strong></td>
<td>BC=4</td>
<td>11, 13</td>
<td>18°</td>
<td>3.4</td>
<td>113.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**
- Hand auger to 5 feet - easy to moderate, compaction test, r-value test
- Sand equivalent test

**FIELD EXPLORATION**

**Approximate Ground Surface Elevation (ft.):** 1,118

**Latitude:** 33.55291° N  
**Longitude:** -117.13783° W

**Drilling Method:** Hollow Stem Auger

**Drilling Equipment:** B-61  
**Hammer Type - Drop:** 140 lb. Auto - 30 in.

**Drill Crew:** James & Jeff

**Weather:** Cloudy, 60s

**Drilling Company:** Cal Pac

**Logged By:** C. Coffey

**Date Begin - End:** 4/19/2018

---

**Boring Log 2A-B14**

**Sky Canyon Sewer Project**

**Alignment 2A**

**Murrieta, CA**

**Date:** 7/1/2018

**Drawn By:** CC

**Revised:** 7/9/2018

**Checked By:** RF
**FIELD EXPLORATION**

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Weathered Bedrock (Kgb):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GRANITE: excavates as Poorly Graded SAND (SP), fine to medium-grained, dark grayish brown (10YR 4/2), wet, medium dense</td>
</tr>
<tr>
<td></td>
<td>dark yellowish brown (10YR 3/4)</td>
</tr>
</tbody>
</table>

The boring was terminated at approximately 41.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on April 19, 2018.

**LABORATORY RESULTS**

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Sample Type</th>
<th>Wet Content (%)</th>
<th>Dry Unit Wt (pcf)</th>
<th>Blowing #200 (%)</th>
<th>Plasticity Index (NP=NonPlastic)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>BC=8</td>
<td>18</td>
<td>16</td>
<td>19</td>
<td>18.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>120.7</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>BC=25</td>
<td>18</td>
<td>16</td>
<td>14</td>
<td>18.1</td>
<td></td>
</tr>
</tbody>
</table>

**GROUNDWATER LEVEL INFORMATION:**

Groundwater was observed at approximately 35 ft. below ground surface during drilling.

**GENERAL NOTES:**

The exploration location and elevation are approximate and were estimated by Kleinfelder.
APPENDIX B

LABORATORY TESTING

Laboratory tests were performed on drive and bulk soil samples to estimate engineering characteristics of the various earth materials encountered. Testing was performed in general accordance with procedures outlined in the American Society for Testing and Materials, or other accepted procedures.

LABORATORY MOISTURE AND DENSITY DETERMINATIONS

Natural moisture content and dry density tests were performed on selected soil samples. Moisture content was evaluated in general accordance with ASTM Test Method D 2216; dry unit weight was evaluated using procedures similar to ASTM Test Method D 2937. The results are presented on the Logs of Borings.

SIEVE ANALYSIS

Sieve analyses were performed on 21 samples of the materials encountered at the site to evaluate the grain size distribution characteristics of the soils and to aid in their classification. The tests were performed in general accordance with ASTM Test Method D 422. The test results are presented as in Appendix B, Figures B-1 through B-5 Grain Size Distribution.

PLASTICITY INDEX

Plasticity index testing was performed on four selected soil samples to determine plasticity characteristics and to aid in the classification of the soil. The tests were performed in accordance with ASTM Standard Test Method D 4318. The results are presented in Appendix B, Figures B-6 through B-8, Plasticity Testing

DIRECT SHEAR

Direct shear testing was performed on six relatively undisturbed samples to determine the soil shear strength and cohesion values in accordance with ASTM Standard Test Method D 3080. Samples were soaked to near saturation. The results are presented in Appendix B, Figures B-9 through B-14, Direct Shear Test.
MAXIMUM DENSITY/OPTIMUM MOISTURE TEST

Maximum density/optimum moisture testing was performed on four select bulk samples to determine compaction characteristics. The tests were performed in accordance with ASTM Standard Test Method D 1557. The results are presented in Appendix B, Figures B-15 through B-18, Compaction Curve.

COLLAPSE POTENTIAL

Collapse potential tests were performed on four select bulk samples to determine consolidation/collapse characteristics. The tests were performed in accordance with ASTM Standard Test Method D 2435. The results are presented in Appendix B, Figures B-19 through B-22, Consolidation Test.

R-VALUE

R-Value testing was performed on two select bulk samples to determine the resistance value of the soil. The tests were performed in accordance with ASTM Standard Test Method D 2844. The results are presented in Appendix B, Figures B-23 and B-24, R-Value.

EXPANSION INDEX

Expansion Index testing was performed on a select sample to determine the expansion potential of the soil. The test was performed in accordance with ASTM Standard Test Method D 4829. The results are presented in Appendix B, Figure B-25, Expansion Index Testing.
SAND EQUIVALENT

Sand equivalent testing was performed on two samples of the on-site soils to evaluate their relative proportions of clay-like or plastic fines in granular soils that pass the 4.75-mm (No. 4) sieve. The test was performed in general accordance with ASTM Standard Test Method D 2419. The test results are presented in Table B-1, Sand Equivalent Test Results.

<table>
<thead>
<tr>
<th>Boring</th>
<th>Depth (ft.)</th>
<th>Average Sand Equivalent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A-B1</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>1B-B1</td>
<td>10</td>
<td>31</td>
</tr>
</tbody>
</table>

CORROSIVITY TESTS

A series of chemical tests were performed on five selected soil samples near the invert depths of the sewer pipeline to estimate pH, resistivity, sulfate and chloride contents. Test results may be used by a qualified corrosion engineer to evaluate the general corrosion potential with respect to construction materials. The results are presented in Table B-2, Corrosion Test Results.

<table>
<thead>
<tr>
<th>Boring</th>
<th>Depth (ft.)</th>
<th>pH</th>
<th>Sulfate (ppm)</th>
<th>Chloride (ppm)</th>
<th>Resistivity (ohm-cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A-B2</td>
<td>40</td>
<td>7.3</td>
<td>33</td>
<td>60</td>
<td>35,850</td>
</tr>
<tr>
<td>1A-B4</td>
<td>20</td>
<td>7.0</td>
<td>43</td>
<td>126</td>
<td>4,622</td>
</tr>
<tr>
<td>2A-B3</td>
<td>30</td>
<td>7.2</td>
<td>45</td>
<td>39</td>
<td>2,728</td>
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<tr>
<td>2A-B8</td>
<td>20</td>
<td>7.6</td>
<td>36</td>
<td>108</td>
<td>1,284</td>
</tr>
<tr>
<td>2A-B12</td>
<td>15-26</td>
<td>7.5</td>
<td>30</td>
<td>114</td>
<td>2,990</td>
</tr>
<tr>
<td>SYMBOL</td>
<td>SAMPLE IDENTIFICATION</td>
<td>PERCENTAGES</td>
<td>ATTERBERG LIMITS</td>
<td>SOIL CLASSIFICATION</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------</td>
<td>-------------</td>
<td>------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GRAVEL</td>
<td>SAND</td>
<td>FINES</td>
<td>LL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>●</td>
<td>1A-B1</td>
<td>2</td>
<td>5</td>
<td>0.1</td>
<td>82.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td>1A-B2</td>
<td>5</td>
<td>20</td>
<td>0.2</td>
<td>91.2</td>
</tr>
<tr>
<td>▲</td>
<td>1A-B3</td>
<td>1</td>
<td>0-5</td>
<td>2.1</td>
<td>56.8</td>
</tr>
<tr>
<td>×</td>
<td>1A-B4</td>
<td>4</td>
<td>15</td>
<td>0.0</td>
<td>90.4</td>
</tr>
<tr>
<td>●</td>
<td>1A-B5</td>
<td>2</td>
<td>5</td>
<td>3.9</td>
<td>77.9</td>
</tr>
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<td>SYMBOL</td>
<td>SAMPLE IDENTIFICATION</td>
<td>PERCENTAGES</td>
<td>ATTERBERG LIMITS</td>
<td>SOIL CLASSIFICATION</td>
<td></td>
</tr>
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<td>--------</td>
<td>-----------------------</td>
<td>-------------</td>
<td>------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH (ft.)</td>
<td>GRAVEL</td>
<td>SAND</td>
</tr>
<tr>
<td></td>
<td>1B-B1</td>
<td>3</td>
<td>10</td>
<td>8.2</td>
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<tr>
<td></td>
<td>1B-B2</td>
<td>4</td>
<td>15</td>
<td>0.0</td>
<td>80.3</td>
</tr>
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</table>

**Grain Size Distribution**

**Sky Canyon Sewer Project**

**Alignment 1A and 1B**

**Murrieta, CA**

**Figure B-2**
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>PERCENTAGES</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH (ft.)</td>
<td>GRAVEL</td>
</tr>
<tr>
<td></td>
<td>2A-B1</td>
<td>3</td>
<td>10</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>2A-B2</td>
<td>3</td>
<td>10</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>2A-B2</td>
<td>5</td>
<td>20</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>2A-B3</td>
<td>3</td>
<td>10</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>2A-B4</td>
<td>3</td>
<td>10</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**GRAN SIZE DISTRIBUTION**

**FIGURE B-3**

Sky Canyon Sewer Project
Alignment 2A
Murrieta, CA
### Soil Classification

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>PERCENTAGES</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH (ft.)</td>
<td>GRAVEL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2A-B5</td>
<td>3</td>
<td>10</td>
<td>17.3</td>
</tr>
<tr>
<td></td>
<td>2A-B6</td>
<td>3</td>
<td>10</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>2A-B6</td>
<td>5</td>
<td>20</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>2A-B7</td>
<td>1</td>
<td>0-5</td>
<td>1.4</td>
</tr>
</tbody>
</table>

### Grain Size Distribution

<table>
<thead>
<tr>
<th>GRAIN SIZE DISTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUMULATIVE PERCENT PASSING</td>
</tr>
<tr>
<td>GRAIN SIZE IN MILLIMETERS</td>
</tr>
</tbody>
</table>

**FIGURE B-4**

Sky Canyon Sewer Project
Alignment 2A
Murrieta, CA

**PA:** 20182608.002A
**TESTED BY:** C. Castanar
**DATE:** 7/11/2018
**CHECKED BY:** J. Diaz
**DATE:** 7/11/2018
### Soil Classification

<table>
<thead>
<tr>
<th>Sample Identification</th>
<th>Depths (ft.)</th>
<th>Gravel</th>
<th>Sand</th>
<th>Fines</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Soil Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A-B8</td>
<td>1</td>
<td>7.5</td>
<td>53.8</td>
<td>38.7</td>
<td>28</td>
<td>17</td>
<td>11</td>
<td>Clayey Sand (SC)</td>
</tr>
<tr>
<td>2A-B9</td>
<td>4</td>
<td>14.1</td>
<td>87.0</td>
<td>11.6</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Well-graded Sand with Silt (SW-SM)</td>
</tr>
<tr>
<td>2A-B10</td>
<td>3</td>
<td>5.4</td>
<td>80.8</td>
<td>13.8</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Silty Sand (SM)</td>
</tr>
<tr>
<td>2A-B12</td>
<td>3</td>
<td>0.3</td>
<td>87.8</td>
<td>11.9</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Well-graded Sand with Silt (SW-SM)</td>
</tr>
<tr>
<td>2A-B14</td>
<td>1</td>
<td>1.5</td>
<td>72.0</td>
<td>26.5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Silty Sand (SM)</td>
</tr>
</tbody>
</table>

### Grain Size Distribution

The grain size distribution chart shows the percentage of soil passing through various sieve sizes, ranging from 100.000 to 0.001 mm. The chart includes a legend for symbols representing different soil types:

- **ymbol**: represents the sample identification.
- **Depth (ft.)**: specifies the depth of the sample.
- **Gravel**, **Sand**, **Fines**, **LL**, **PL**, **PI**: indicate the percentage of soil passing through different sieve sizes.

The chart also includes项目的名称, 日期, and the party responsible for testing and checking.

**Sky Canyon Sewer Project Alignment 2A, Murrieta, CA**

**Date**: 5/9/2018

**Project No.**: 20182608

**Tested By**: C. Massa

**Checked By**: J. Diaz

**By**: Kleinfelder - 620 Magnolia Avenue, Building G | Ontario, California 91762 | PH: (909) 657-1716 | FAX: (909) 988-0185 | www.kleinfelder.com
Testing performed in general accordance with ASTM D4318

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH (ft)</td>
</tr>
<tr>
<td></td>
<td>1A-B3</td>
<td>1</td>
<td>0-5</td>
</tr>
</tbody>
</table>

**PROJECT NO.:** 20182908.001A  
**TESTED BY:** C. Massa  
**DATE:** 5/10/2018  
**CHECKED BY:** J. Diaz  
**DATE:** 5/10/2018

Sky Canyon Sewer Project  
Alignment 1A and 1B  
Murrieta, CA

KLEINFELDER - 620 South Magnolia Ave, Bldg G | Ontario, CA | PH: (909) 657-1716 | FAX: (909) 988-0185 | www.kleinfelder.com
Testing performed in general accordance with ASTM D4318.

SILTY SAND (SM)

CLAYEY SAND (SC)

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
</tr>
<tr>
<td>●</td>
<td>2A-B6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲</td>
<td>2A-B7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EMWD Sky Canyon Sewer
Alignment 2A
Murrieta, CA

PLASTICITY TESTING

KLEINFELDER - 620 South Magnolia Ave, Bldg G | Ontario, CA | PH: (909) 657-1716 | FAX: (909) 988-0185 | www.kleinfelder.com
Testing performed in general accordance with ASTM D4318.
Performed in general accordance with ASTM D 3080

**DIRECT SHEAR TEST**

**Sky Canyon Sewer Project**
Alignment 1A and 1B
Murrieta, CA

**PROJECT NO:** 20182008.001A

**TESTED BY:** J. Diaz
**DATE:** 5/7/2018

**CHECKED BY:** J. Diaz
**DATE:** 5/7/2018

**SYMBOL** | **BORING NO.** | **SAMPLE NO.** | **DEPTH (ft)** | **COHESION (psf)** | **FRICTION ANGLE (deg)** | **SOIL CLASSIFICATION**
---|---|---|---|---|---|---
PEAK | 1A-B4 | 2 | 5' | 319.0 | 29 | Clayey Sand (SC )
ULTIMATE | 1A-B4 | 2 | 5' | 248.0 | 30 | Clayey Sand (SC )

**INITIAL MOISTURE (%):** 15.2% **NORMAL STRESS (psf):**

**INITIAL DRY DENSITY (pcf):** 114.0 **PEAK STRESS (psf):**

**FINAL MOISTURE (%):** 16.8% **ULTIMATE STRESS (psf):**

<table>
<thead>
<tr>
<th>SHEAR STRESS (PSF)</th>
<th>NORMAL STRESS (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>612</td>
<td>864</td>
</tr>
<tr>
<td>560</td>
<td>800</td>
</tr>
</tbody>
</table>
**DIRECT SHEAR TEST**

Sky Canyon Sewer Project
Alignment 1A and 1B
Murrieta, CA

**Figure B-10**

Performed in general accordance with ASTM D 3080

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (ft)</th>
<th>COHESION (psf)</th>
<th>FRICTION ANGLE (deg)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAK</td>
<td>1B-B1</td>
<td>4</td>
<td>15'</td>
<td>186.0</td>
<td>31</td>
<td>Silty Sand (SM)</td>
</tr>
<tr>
<td>ULTIMATE</td>
<td>1B-B1</td>
<td>4</td>
<td>15'</td>
<td>78.0</td>
<td>33</td>
<td>Silty Sand (SM)</td>
</tr>
</tbody>
</table>

| INITIAL MOISTURE (%) | 7.1% | Normal Stress (psf) | 500 | 1000 | 2000 |
| INITIAL DRY DENSITY (pcf): | 117.0 | Peak Stress (psf) | 396 | 936 | 1356 |
| FINAL MOISTURE (%) | 18.3% | Ultimate Stress (psf) | 324 | 840 | 1332 |

**PROJECT NO.** 20182608.001A

**TESTED BY:** J. Diaz

**DATE:** 5/7/2018

**CHECKED BY:** J. Diaz

**DATE:** 5/7/2018
INITIAL MOISTURE (%): 10.1%
INITIAL DRY DENSITY (pcf): 110.2
FINAL MOISTURE (%): 19.3%

Performed in general accordance with ASTM D 3080

SYMBOL | BORING NO. | SAMPLE NO. | DEPTH (ft) | COHESION (psf) | FRICTION ANGLE (deg) | SOIL CLASSIFICATION
---|---|---|---|---|---|---
PEAK | 2A-B3 | 6 | 25.0 | 432.0 | 31 | Poorly Graded Sand (SP)
ULTIMATE | 2A-B3 | 6 | 25.0 | 0.0 | 29 | Poorly Graded Sand (SP)

NORMAL STRESS (PSF)

SHEAR STRESS (PSF)

DIRECT SHEAR TEST

Sky Canyon Sewer Project
Alignment 2A
Murrieta, CA

Figure B-11
**INITIAL MOISTURE (%):**

**INITIAL DENSITY (pcf):**

**FINAL MOISTURE (%):**

Performed in general accordance with ASTM D 3080

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (ft)</th>
<th>COHESION (psf)</th>
<th>FRICTION ANGLE (deg)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAK</td>
<td>2A-B6</td>
<td>4</td>
<td>15.0</td>
<td>156.0</td>
<td>36</td>
<td>Poorly Graded Sand (SP)</td>
</tr>
<tr>
<td>ULTIMATE</td>
<td>2A-B6</td>
<td>4</td>
<td>15.0</td>
<td>132.0</td>
<td>27</td>
<td>Poorly Graded Sand (SP)</td>
</tr>
</tbody>
</table>

INITIAL MOISTURE (%): 14.0%

INITIAL DRY DENSTY (pcf): 109.1

FINAL MOISTURE (%): 18.7%

<table>
<thead>
<tr>
<th>SHEAR STRESS (PSF)</th>
<th>NORMAL STRESS (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>948</td>
</tr>
<tr>
<td>2000</td>
<td>1500</td>
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<td>3000</td>
<td>3084</td>
</tr>
<tr>
<td>4000</td>
<td>2184</td>
</tr>
<tr>
<td>5000</td>
<td>984</td>
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</table>

DIRECT SHEAR TEST

Sky Canyon Sewer Project
Alignment 2A
Murrieta, CA

**FIGURE** B-12
Performed in general accordance with ASTM D 3080

### Soil Classification

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (ft)</th>
<th>COHESION (psf)</th>
<th>FRICTION ANGLE (deg)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAK</td>
<td>2A-88</td>
<td>2</td>
<td>5'</td>
<td>306.0</td>
<td>31</td>
<td>Clayey Sand (SC)</td>
</tr>
<tr>
<td>ULTIMATE</td>
<td>2A-88</td>
<td>2</td>
<td>5'</td>
<td>102.0</td>
<td>31</td>
<td>Clayey Sand (SC)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INITIAL MOISTURE (%)</th>
<th>INITIAL DRY DENSITY (pcf)</th>
<th>FINAL MOISTURE (%)</th>
<th>NORMAL STRESS (psf)</th>
<th>SHEAR STRESS (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.3%</td>
<td>109.2</td>
<td>21.4%</td>
<td>500</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>700</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>900</td>
<td>2000</td>
</tr>
</tbody>
</table>

**Project Information**

**PROJECT NO.:** 20182608.0024  
**TESTED BY:** J. Diaz  
**DATE:** 5/7/2018  
**CHECKED BY:** J. Diaz  
**DATE:** 5/7/2018

**Direct Shear Test**

Sky Canyon Sewer Project  
Alignment 2A  
Murrieta, CA

**Figure** B-13
Performed in general accordance with ASTM D 3080

### Soil Classification

**Well-Graded Sand with Silt (WS-SM)**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (ft)</th>
<th>COHESION (psf)</th>
<th>FRICTION ANGLE (deg)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAK</td>
<td>2A-B9</td>
<td>4</td>
<td>15'</td>
<td>84.0</td>
<td>33</td>
<td>Well-Graded Sand with Silt (WS-SM)</td>
</tr>
<tr>
<td>ULTIMATE</td>
<td>2A-B9</td>
<td>4</td>
<td>15'</td>
<td>30.0</td>
<td>30</td>
<td>Well-Graded Sand with Silt (WS-SM)</td>
</tr>
</tbody>
</table>

### Initial Values

- **INITIAL MOISTURE (%):** 4.5%
- **INITIAL DRY DENSITY (pcf):** 112.8
- **FINAL MOISTURE (%):** 16.0%

### Stress Table

<table>
<thead>
<tr>
<th>NORMAL STRESS (PSF)</th>
<th>SHEAR STRESS (PSF)</th>
<th>FRICION ANGLE (deg)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
<td>33</td>
<td>Well-Graded Sand with Silt (WS-SM)</td>
</tr>
<tr>
<td>3000</td>
<td>0</td>
<td>33</td>
<td>Well-Graded Sand with Silt (WS-SM)</td>
</tr>
</tbody>
</table>

**Sky Canyon Sewer Project**
**Alignment 2A**
**Murrieta, CA**

**KLEINFELDER - 620 Magnolia Avenue, Building G | Ontario, California 91762 | PH: (909) 657-1716 | FAX: (909) 988-0185 | www.kleinfelder.com**
**Boring No.:** 1A-B3  
**Sample No.:** 1  
**Depth:** 0-5  
**Material Description:** Clayey Sand (SC)

<table>
<thead>
<tr>
<th></th>
<th>Uncorrected</th>
<th>Corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Dry Unit Weight (pcf)</td>
<td>125.8</td>
<td>125.8</td>
</tr>
<tr>
<td>Optimum Water Content (%)</td>
<td>8</td>
<td>8.0</td>
</tr>
<tr>
<td>Oversize Fraction, retained on 3/8 (%)</td>
<td>&lt;5</td>
<td></td>
</tr>
<tr>
<td>Bulk Specific Gravity of Oversize Fraction</td>
<td>na</td>
<td></td>
</tr>
</tbody>
</table>

*na = not applicable*

Tested in accordance with: ASTM D1557, Method B

<table>
<thead>
<tr>
<th></th>
<th>105</th>
<th>115</th>
<th>125</th>
<th>135</th>
<th>145</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry Unit Weight (pcf)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water Content (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Compaction Curve](image)
Boring No.: 2A-B2
Sample No.: 1
Depth: 0 - 5
Material Description: Clayey Sand (SC)

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Uncorrected</th>
<th>Corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Dry Unit Weight (pcf)</td>
<td>134</td>
<td>na</td>
</tr>
<tr>
<td>Optimum Water Content (%)</td>
<td>8.2</td>
<td>na</td>
</tr>
<tr>
<td>Oversize Fraction, retained on 3/8 (%)</td>
<td>&lt;5</td>
<td></td>
</tr>
<tr>
<td>Bulk Specific Gravity of Oversize Fraction</td>
<td>na</td>
<td></td>
</tr>
</tbody>
</table>

na = not applicable

 Tested in accordance with: ASTM D1557, Method B

Compaction Curve

Figure B-16

Sky Canyon Sewer Project
Alignment 2A
Murrieta, CA
Boring No.: 2A-B8
Sample No.: 1
Depth: 0-5
Material Description: Clayey Sand (SC)

<table>
<thead>
<tr>
<th></th>
<th>Uncorrected</th>
<th>Corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Dry Unit Weight (pcf)</td>
<td>131.3</td>
<td>131.3</td>
</tr>
<tr>
<td>Optimum Water Content (%)</td>
<td>8.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Oversize Fraction, retained on 3/8 (%)</td>
<td>&lt;5</td>
<td></td>
</tr>
<tr>
<td>Bulk Specific Gravity of Oversize Fraction</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

na = not applicable

Tested in accordance with: ASTM D1557, Method B

FIGURE

B-17
**Boring No.:** 2A-B14  
**Sample No.:** 1  
**Depth:** 0-5  
**Material Description:** Silty Sand (SM)

<table>
<thead>
<tr>
<th></th>
<th>Uncorrected</th>
<th>Corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Dry Unit Weight (pcf)</td>
<td>131.3</td>
<td>131.3</td>
</tr>
<tr>
<td>Optimum Water Content (%)</td>
<td>8.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Oversize Fraction, retained on 3/8 (%)</td>
<td>&lt;5</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Bulk Specific Gravity of Oversize Fraction</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

Tested in accordance with: ASTM D1557, Method B
Testing performed in general accordance with ASTM D2435/D2435M - 11

**SAMPLE IDENTIFICATION**

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (ft.)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B-B1</td>
<td>2</td>
<td>5</td>
<td>Clayey Sand (SC)</td>
</tr>
</tbody>
</table>

**INITIAL MOISTURE (%):** 7.1  
**INITIAL DRY DENSITY (PCF):** 120.6  
**FINAL MOISTURE(%):** 12.6

---

---
Testing performed in general accordance with ASTM D2435/D2435M - 11

<table>
<thead>
<tr>
<th>SAMPLE IDENTIFICATION</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
</tr>
<tr>
<td>1B-B1</td>
<td>2</td>
</tr>
</tbody>
</table>

INITIAL MOISTURE (%): 7.1
INITIAL DRY DENSITY (PCF): 120.6
FINAL MOISTURE(%): 12.6

---

**CONSOLIDATION TEST**

Sky Canyon Sewer Project
Alignment 1A and 1B
Murrieta, CA

---

CONSOLIDATION TEST

---

FIGURE B-20
Testing performed in general accordance with ASTM D2435/D2435M - 11

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (ft.)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A-B4</td>
<td>2</td>
<td>5</td>
<td>Poorly Graded Sand (SP)</td>
</tr>
</tbody>
</table>

INITIAL MOISTURE (%): 3.8
INITIAL DRY DENSITY (PCF): 124.5
FINAL MOISTURE (%): 7.8
Testing performed in general accordance with ASTM D2435/D2435M - 11

<table>
<thead>
<tr>
<th>SAMPLE IDENTIFICATION</th>
<th>SOIL CLASSIFICATION</th>
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<tr>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
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<tr>
<td>2A-B13</td>
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INITIAL MOISTURE (%): 6.5
INITIAL DRY DENSITY (PCF): 102.6
FINAL MOISTURE(%): 16.2
Boring No.: 2A-B4
Sample No.: 1
Depth: 0-5'
Material Description: Clayey Sand / Silty Sand (SC / SM)

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<th>Specimen No.</th>
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<th>B</th>
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<tr>
<td>Moisture at Test (%)</td>
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<td>8.3</td>
<td>9.2</td>
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<tr>
<td>Dry Unit Weight at Test (pcf)</td>
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<td>125.7</td>
<td>123.9</td>
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<td>0.0</td>
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<tr>
<td>Exudation Pressure (psi)</td>
<td>540.0</td>
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<td>172.6</td>
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<tr>
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**R - VALUE AT 300 PSI EXUDATION PRESSURE**  25

Test Procedure: ASTM D2844
**Boring No.:** 2A-B14  
**Sample No.:** #1  
**Depth:** 0-5  
**Material Description:** Silty Sand (SM)

<table>
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<td>Exudation Pressure (psi)</td>
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<td>R-VALUE AT 300 PSI EXUDATION PRESSURE</td>
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</table>

Test Procedure: ASTM D2844

---

**KLEINFELDER - 620 Magnolia Avenue, Building G | Ontario, California 91762 | PH: (909) 657-1716 | FAX: (909) 988-0185 | www.kleinfelder.com**
### Expansion Index Test Results

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Sample No.</th>
<th>Depth (ft)</th>
<th>Initial Moisture (%)</th>
<th>Compacted Dry Density (PCF)</th>
<th>Final Moisture (%)</th>
<th>Volumetric Swell (IN)</th>
<th>Expansion Index</th>
<th>Expansion Potential</th>
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<td>1A-B3</td>
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<td>11.5%</td>
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<td>18.2%</td>
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Testing performed in general accordance with ASTM D4829

---

**Sky Canyon Sewer Project**
Alignment 1A and 1B
Murrieta, CA

---

**EMWD Sky Canyon Sewer**
Alignment 2A
Murrieta, CA

---

**EXPANSION INDEX TESTING**

KLEINFELDER - 620 South Magnolia Ave, Bldg G | Ontario, Ca | PH: (909) 657-1716 | FAX: (909) 988-0185 | www.kleinfelder.com
## CORROSION TEST RESULTS

**Client Name:** Kleinfelder  
**AP Job No.:** 18-0514  
**Project Name:** EMWD Sky Canyon Sewer  
**Date:** 05/14/18  
**Project No.:** 20182608.001A

<table>
<thead>
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<th>Boring No.</th>
<th>Sample No.</th>
<th>Depth (feet)</th>
<th>Soil Type</th>
<th>Minimum Resistivity (ohm-cm)</th>
<th>pH</th>
<th>Sulfate Content (ppm)</th>
<th>Chloride Content (ppm)</th>
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<tr>
<td>1A-B2</td>
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<td>40</td>
<td>SM</td>
<td>35850</td>
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<td>SM</td>
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<td>43</td>
<td>126</td>
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<tr>
<td>2A-B8</td>
<td>5</td>
<td>20</td>
<td>ML</td>
<td>1284</td>
<td>7.6</td>
<td>36</td>
<td>108</td>
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<tr>
<td>2A-B12</td>
<td>4&amp;7 Combined</td>
<td>15&amp;26</td>
<td>CL/SC</td>
<td>2990</td>
<td>7.5</td>
<td>30</td>
<td>114</td>
</tr>
</tbody>
</table>

**NOTES:**  
Resistivity Test and pH: California Test Method 643  
Sulfate Content: California Test Method 417  
Chloride Content: California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested
APPENDIX C

SEISMIC REFRACTION SURVEY
SEISMIC REFRACTION SURVEY
SKY CANYON SEWER PROJECT
CITY OF MURRIETA, CALIFORNIA

Project No. 183102-1
July 11, 2018

Prepared for:

Kleinfelder
2280 Market Street, Suite 300
Riverside, CA  92501
EXECUTIVE SUMMARY

As requested, this firm has performed a geophysical survey using the seismic refraction method for the above-referenced site. The purpose of this investigation was to assess the general seismic velocity characteristics of the underlying earth materials and to evaluate whether high velocity granitic bedrock (non-rippable) may be present. Additionally, the structure and seismic velocity distribution of the subsurface earth materials was also assessed. This report will describe in further detail the procedures used and the results of our findings, along with presentation of representative seismic models for the survey traverses.

For this study, as selected by your office, nine survey traverses (Seismic Lines S-1 through S-9) were performed along the shoulder Winchester Road (Highway 79), Sky Canyon Drive, and also within an open field west of Winchester Road, in the City of Murrieta, California. These traverses were located in the field by use of Google™ Earth imagery (2018). The approximate locations of these traverses have been approximated on a captured Google™ Earth image (2018), as presented on the Seismic Line Location Map, Plate 1.

This opportunity to be of service is sincerely appreciated. If you should have questions regarding this report or do not understand the limitations of this study or the data and results that are presented, please do not hesitate to contact our office.

Respectfully submitted,
TERRA GEOSCIENCES

Donn C. Schwartzkopf
Principal Geophysicist
PGP 1002
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<td>Excavation Considerations</td>
<td>Appendix C</td>
</tr>
<tr>
<td>References</td>
<td>Appendix D</td>
</tr>
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</table>
INTRODUCTION

The subject survey area is generally located along the open/landscaped shoulder of Winchester Road (Highway 79), Sky Canyon Drive, and also within an open field, in the City of Murrieta, California. The approximate locations of these traverses are shown on a captured Google™ Earth (2018) image, as presented on Plate 1. Surficial geologic mapping by Kennedy and Morton (2003), as shown on Figure 1 below, indicate the subject survey area to underlain by several geologic units, consisting of young alluvial channel deposits (map symbol Qya); very old alluvial channel deposits (map symbol Qvoa); sedimentary bedrock which includes a sandstone member of the Pauba Formation (map symbol Qpfs) and an unnamed sandstone unit (map symbol QTsw); and granitic rock consisting mainly of hornblende gabbro (map symbol Kgb).

FIGURE 1- Geologic Map (Kennedy and Morton, 2003), survey lines shown in red.
SEISMIC REFRACTION SURVEY

Methodology

The seismic refraction method consists of measuring (at known points along the surface of the ground) the travel times of compressional waves generated by an impulsive energy source and can be used to estimate the layering, structure, and seismic acoustic velocities of subsurface horizons. Seismic waves travel down and through the soils and rocks, and when the wave encounters a contact between two earth materials having different velocities, some of the wave's energy travels along the contact at the velocity of the lower layer. The fundamental assumption is that each successively deeper layer has a velocity greater than the layer immediately above it. As the wave travels along the contact, some of the wave's energy is refracted toward the surface where it is detected by a series of motion-sensitive transducers (geophones). The arrival time of the seismic wave at the geophone locations can be related to the relative seismic velocities of the subsurface layers in feet per second (fps), which can then be used to aid in interpreting both the depth and type of materials encountered.

Field Procedures

Nine seismic refraction survey lines (Seismic Lines S-1 through S-9) have been performed across the locations as selected by you. The traverses were located in the field by use of Google™ Earth imagery (2018), along with GPS coordinates, and have been delineated on the Seismic Line Location Map, as presented on Plate 1. These lines were 150 to 200 feet in length, which consisted of a total of twenty-four 14-Hertz geophones, spaced at regular six- to eight-foot intervals, in order to detect both the direct and refracted waves. A 16-pound sledge-hammer was used as the energy source to produce the seismic waves.

Seven shot points were utilized along each spread using forward, reverse, and several intermediate locations in order to obtain high resolution survey data for velocity analysis and depth modeling purposes. Multiple hammer impacts were utilized at each shot point location in order to increase the signal to noise ratio, which enhanced the primary seismic “P”-waves. The seismic wave arrivals were digitally recorded in SEG-2 format on a Geometrics StrataVisor™ NZXP model signal enhancement refraction seismograph. The data was acquired using a sampling rate of 0.0625 milliseconds having a record length of 0.064 to 0.12 seconds. No acquisition filters were used during data collection.

During acquisition, the seismograph displays the seismic wave arrivals on the computer screen which were used to analyze the arrival time of the primary seismic “P”-waves at each geophone station, in the form of a wiggle trace for quality control purposes in the field. If spurious “noise” was observed, the shot location was resampled during relatively quieter periods. Each geophone and seismic shot location was surveyed using a hand level and ruler for topographic correction, with “0” being the lowest point along each survey line.
Data Processing

The recorded seismic data was subsequently transferred to our office computer for processing and analyzing purposes, using the computer programs **SIPwin (Seismic Refraction Interpretation Program for Windows)** developed by Rimrock Geophysics, Inc. (2004); **Refractor** (Geogiga, 2001-2017); and **Rayfract™** (Intelligent Resources, Inc., 1996-2017). All of the computer programs perform their individual analyses using exactly the same input data, which includes the first-arrival times of the “P”-waves and the survey line geometry.

- **SIPwin** is a ray-trace modeling program that evaluates the subsurface using layer assignments based on time-distance curves and is better suited for layered media, using the “Seismic Refraction Modeling by Computer” method (Scott, 1973). The first step in the modeling procedure is to compute layer velocities by least-squares techniques. Then the program uses the delay-time method to estimate depths to the top of layer-2. A forward modeling routine traces rays from the shot points to each geophone that received a first-arrival ray refracted along the top of layer-2. The travel time of each such ray is compared with the travel time recorded in the field by the seismic system. The program then adjusts the layer-2 depths so as to minimize discrepancies between the computed ray-trace travel times and the first arrival times picked from the seismic waveform record. The process of ray tracing and model adjustment is repeated a total of six times to improve the accuracy of depths to the top of layer-2. This first-arrival picks were then used to generate the Layer Velocity Model using the **SIPwin** computer program, which presents the subsurface velocities as individual layers and is presented within Appendix A for reference. In addition, the associated Time-Distance Plot, which shows the individual data picks of the first “P-wave” arrival times, also appears in Appendix A.

- **Refractor** is seismic refraction software that also evaluates the subsurface using layer assignments utilizing interactive and interchangeable analytical methods that include the Delay-Time method, the ABC method, and the Generalized Reciprocal Method (GRM). These methods are used for defining irregular non-planar refractors and are briefly described below. The **Delay-Time** method will measure the delay time depth to a refractor beneath each geophone rather than at shot points. Delay-time is the time spent by a wave to travel up or down through the layer (slant path) compared to the time the wave would spend if traveling along the projection of the slant path on the refractor. The **ABC** (intercept time) method makes use of critically refracted rays converging on a common surface position. This method involves using three surface to surface travel times between three geophones and the velocity of the first layer in an equation to calculate depth under the central geophone and is applied to all other geophones on the survey line. The **GRM** method is a technique for delineating undulating refractors at any depth from in-line seismic refraction data consisting of forward and reverse travel-times and is capable of resolving dips of up to 20% and does not over-smooth or average the subsurface refracting layers. In addition, the technique provides an approach for recognizing and compensating for hidden layer conditions.
Rayfract™ is seismic refraction tomography software that models subsurface refraction, transmission, and diffraction of acoustic waves which generally indicates the relative structure and velocity distribution of the subsurface using first break energy propagation modeling. An initial 1D gradient model is created using the DeltaV method (Gebrande and Miller, 1985) which gives a good initial fit between modeled and picked first breaks. The DeltaV method is a turning-ray inversion method which delivers continuous depth vs. velocity profiles for all profile stations. These profiles consist of horizontal inline offset, depth, and velocity triples. The method handles real-life geological conditions such as velocity gradients, linear increasing of velocity with depth, velocity inversions, pinched-out layers and outcrops, and faults and local velocity anomalies. This initial model is then refined automatically with a true 2D WET (Wavepath Eikonal Traveltime) tomographic inversion (Schuster and Quintus-Bosz, 1993).

WET tomography models multiple signal propagation paths contributing to one first break, whereas conventional ray tracing tomography is limited to the modeling of just one ray per first break. This computer program performs the analysis by using the same first-arrival P-wave times and survey line geometry that were generated during the initial layer velocity model analyses. The associated Refraction Tomographic Model for Seismic Line S-1, which displays the subsurface earth material velocity structure, is represented by the velocity contours (isolines displayed in feet/second), supplemented with the color-coded velocity shading for visual reference, are presented within Appendix B.

The combined use of these seismic refraction computer programs provided a more thorough and comprehensive analysis of the subsurface structure and velocity characteristics. Each computer program has a specific purpose based on the objective of the analysis being performed. SIPwin and Refractor were primarily used for detecting generalized subsurface velocity layers providing “weighted average velocities.” The processed seismic data of these two programs were compared and averaged to provide a final composite layer velocity model which provided a more thorough representation of the subsurface (see Appendix A).

Rayfract™ provided tomographic velocity and structural imaging that is very conducive to detecting strong lateral velocity characteristics such as imaging corestones, dikes, and other subsurface structural characteristics (see Appendix B).

SUMMARY OF GEOPHYSICAL INTERPRETATION

It is important to consider that the seismic velocities obtained within bedrock materials are influenced by the nature and character of the localized major structural discontinuities (foliation, fracturing, relic bedding, etc.), creating anisotropic conditions. Anisotropy (direction-dependent properties of materials) can be caused by “micro-cracks,” jointing, foliation, layered or inter-bedded rocks with unequal layer stiffness,
small-scale lithologic changes, etc. (Barton, 2007). Velocity anisotropy complicates interpretation and it should be noted that the seismic velocities obtained during this survey may have been influenced by the nature and character of any localized structural discontinuities within the bedrock underlying the subject site. Generally, it is expected that higher (truer) velocities will be obtained when the seismic waves propagate along direction (strike) of the dominant structure, with a damping effect when the seismic waves travel in a perpendicular direction. Such variable directions can result in velocity differentials of between 2% to 40% depending upon the degree of the structural fabric (i.e., weakly-moderately-strongly foliated, respectively).

The first computer analytical method described below that was used for data analysis is the traditional layer method (SIPwin and Refractor). Using this method, it should be understood that the data obtained represents an average of seismic velocities within any given layer. For example, high seismic velocity boulders, dikes, or other local lithologic inconsistencies, may be isolated within a low velocity matrix, thus yielding an average medium velocity for that layer. Therefore, in any given layer, a range of velocities could be anticipated, which can also result in a wide range of excavation characteristics.

In general, the site where locally surveyed, was noted to be characterized by three major subsurface layers (Layers V1, V2, and V3, see Appendix A) with respect to seismic velocities. The following velocity layer summaries have been prepared with respect to the SIPwin and Refractor analysis, with the representative Layer Velocity Model being presented within Appendix A, along with the respective Time-Distance Plot for reference.

**Velocity Layer V1**: The surficial layer (V1) yielded a seismic velocity range of 1,324 to 1,669 fps, which may be comprised of artificial fill, alluvial deposits, topsoil, colluvium, and/or completely-weathered and fractured bedrock materials, which is typical for these types of unconsolidated surficial earth materials.

- **Velocity Layer V2**: The second layer (V2) has a seismic velocity range of 2,369 to 3,810 fps, which may be indicative of indurated older alluvium and consolidated sedimentary bedrock. These velocities may also indicate the presence of highly-weathered granitic bedrock that is generally homogeneous with a relatively wide spaced joint/fracture system and/or the possibility of buried relatively-fresher boulders within a highly decomposed bedrock matrix.

- **Velocity Layer V3**: The third layer (V3) most likely indicates the presence of highly-to moderately-weathered granitic bedrock, having a seismic velocity range of 4,563 to 8,447 fps. These higher velocities signify the decreasing effect of weathering as a function of depth and could indicate the presence of abundant widely-scattered buried fresh large crystalline boulders in highly- to moderately-weathered matrix, or possibly a slightly-weathered to fresher crystalline bedrock matrix, that has a wide-spaced fracture system.
Table 1 below summarizes the results of the survey lines with respect to the “weighted average” seismic velocities for each layer, as discussed above.

### TABLE 1 - VELOCITY SUMMARY OF SEISMIC SURVEY LINES

<table>
<thead>
<tr>
<th>Seismic Line</th>
<th>V1 Layer (fps)</th>
<th>V2 Layer (fps)</th>
<th>V3 Layer (fps)</th>
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<tr>
<td>S-1</td>
<td>1,647</td>
<td>2,607</td>
<td>4,563</td>
</tr>
<tr>
<td>S-2</td>
<td>1,669</td>
<td>3,188</td>
<td>8,345</td>
</tr>
<tr>
<td>S-3</td>
<td>1,553</td>
<td>3,810</td>
<td>8,345</td>
</tr>
<tr>
<td>S-4</td>
<td>1,636</td>
<td>2,795</td>
<td>7,226</td>
</tr>
<tr>
<td>S-5</td>
<td>1,339</td>
<td>2,455</td>
<td>8,447</td>
</tr>
<tr>
<td>S-6</td>
<td>1,336</td>
<td>2,369</td>
<td>7,467</td>
</tr>
<tr>
<td>S-7</td>
<td>1,550</td>
<td>3,351</td>
<td>5,832</td>
</tr>
<tr>
<td>S-8</td>
<td>1,324</td>
<td>2,446</td>
<td>6,360</td>
</tr>
<tr>
<td>S-9</td>
<td>1,389</td>
<td>3,153</td>
<td>8,345</td>
</tr>
</tbody>
</table>

Using Rayfract™, tomographic refraction models were also prepared for comparative purposes. The tomographic method better illustrates the general structure and velocity distribution of the subsurface, using velocity contour isolines, as presented within Appendix B. These models display the entire subsurface wave penetration that was imaged based on the ray sampling coverage of the seismic data that were acquired during the processing. Although no discrete velocity layers or boundaries are created such as in the layer models, these models generally resemble the corresponding overall average layer velocities as presented within Appendix A. Contact boundaries for the variable earth materials present within the project study area, cannot be discerned.

In general, the seismic velocity of the deeper bedrock materials gradually increases with depth, with observable lateral velocity differentials suggesting the local presence of weathering differentials, buried corestones, and/or dike structures.
GENERALIZED RIPPABILITY CHARACTERISTICS OF BEDROCK

The rippability performance chart prepared by Caterpillar, Inc. (2017) has been provided as Figure 2 below for reference, based on a D9R/D9T dozer. This chart has been prepared for conventional bulldozer equipment and cannot be directly correlated with trenching equipment such as used at the subject site. Currently, there are no published performance charts available that compare rippability potentials versus seismic velocity for excavator-type equipment. Trenching operations, of which this project will most likely utilize, that utilize large excavator-type equipment within granitic bedrock materials, typically encounter very difficult to non-productable conditions where seismic velocities are generally greater than 4,000± fps, with lower velocities for smaller backhoe-type equipment.

FIGURE 2- Caterpillar D9R Ripper Performance Chart (2017).

GEOLOGIC & EARTHWORK CONSIDERATIONS

To evaluate whether a particular bedrock material can be ripped or excavated, this geophysical survey should be used in conjunction with the geologic and/or geotechnical report and/or information gathered for the subject project which may describe the physical properties of the bedrock. The physical characteristics of bedrock materials
that favor ripping generally include the presence of fractures, faults, and other structural discontinuities, weathering effects, brittleness or crystalline structure, stratification or lamination, large grain size, moisture permeated clay, and low compressive strength. If the bedrock is foliated and/or fractured at depth, this structure could aid in excavation production.

Unfavorable bedrock conditions can include such characteristics as massive and homogeneous formations, non-crystalline structure, absence of planes of weakness, fine-grained materials, and formations of clay origin where moisture makes the material plastic. Use of these physical bedrock conditions along with the subsurface velocity characteristics as presented within this report should aid in properly evaluating the type of equipment that will be necessary and the production levels that can be anticipated for this project.

Although primarily prepared for conventional bulldozer-type equipment, a summary of excavation considerations is included within Appendix C in order to provide you and your grading contractor with a better understanding of the complexities of excavation in bedrock materials, so that proper planning and excavation techniques can be employed. Some techniques and/or principles may be applicable to your site-specific project.

**SUMMARY OF FINDINGS AND CONCLUSIONS**

The raw field data was considered to be of good quality with moderate amounts of ambient “noise” that was introduced during our survey, predominantly from vehicular traffic originating along Winchester Road, Sky Canyon Drive, and Murrieta Hot Springs Road, as well as local air traffic. Analysis of the data and picking of the primary “P”-wave arrivals was therefore performed with some difficulty, with minor interpolation of some data points being necessary. Every effort was made to obtain seismic records with the least amount of background noise but could not be completely eliminated.

Based on the results of our comparative seismic analyses of the computer programs **SIPwin, Refractor, and Rayfract™**, the seismic refraction survey line models appear to generally coincide with one another, with some minor variances due to the methods that these programs process, integrate, and display the input data. The anticipated excavation potentials of the velocity layers encountered locally during our survey are as follows:

- **Velocity Layer V1:**
  
The upper V1 layer (average weighted velocity of 1,324 to 1,669 fps) is believed to be comprised of a variety of materials that consist of artificial fill, alluvial deposits, topsoil, colluvium, and/or completely-weathered and fractured bedrock materials. No excavation difficulties are expected within this velocity layer, however, isolated floaters (i.e., boulders, corestones, dikes, etc.) may be encountered and could produce somewhat difficult conditions locally.
- **Velocity Layer V2:**
  The second V2 layer (average weighted velocity of 2,369 to 3,810 fps) may consist of a variety of earth materials, which could include indurated older alluvium, consolidated sedimentary bedrock, and/or highly-weathered bedrock. With the assumed use of large excavator-type equipment, these materials should excavate with minimal difficulty, however, deep trenching typically results in a loss of mechanical and weight advantage for the excavators, resulting in the need for some breaking and/or light blasting to obtain desired grade. Isolated floaters (i.e., boulders, corestones, lithologic variations, etc.) could be present within granitic materials and could produce somewhat difficult conditions locally.

- **Velocity Layer V3:**
  The third V3 layer is believed to consist of highly- to moderately-weathered granitic bedrock. Hard excavation difficulties within this deeper velocity layer (average weighted velocity range of 4,563 to 8,447 fps) should be anticipated if encountered during grading. This layer may consist of relatively homogeneous bedrock, or could possibly contain higher velocity scattered corestones, dikes, and other lithologic variables, within a relatively lower velocity bedrock matrix. Continuous blasting/breaking may be necessary within this velocity layer to achieve desired grade.

The ray sampling coverage of the subsurface seismic waves that were acquired during the processing of the tomographic models using Rayfract™, appeared to be of good quality which was verified by having a Root Mean Square Error (RMS) of 1.0 to 3.0 percent (see lower right-hand corner of each model). The RMS error (misfit between picked and modeled first break times) is automatically calculated during the processing routine, with a value of less than 2.0% being preferred. Based on the tomographic modeling and typical excavation characteristics observed within granitic bedrock of the southern California region, anticipation of gradual increasing hardness with depth should be anticipated during grading. Some lateral velocity variations should be expected to be encountered across the site generally due to the presence of buried corestones and/or dikes.

It should be noted that since the proposed construction project (i.e. utility infrastructure) will most likely be using conventional trenching equipment, there are no currently published rippability performance charts available that compare rippability potentials versus seismic velocity for excavator-type equipment, as previously discussed. The rippability comparison charts such as prepared by Caterpillar (2000 and 2017) are tailored for conventional bulldozer equipment and cannot be directly correlated. However, we understand from many excavation contractors that trenching operations (using large excavators) within bedrock materials which have seismic velocities generally greater than 4,000- to 4,500±-feet per second typically encounter very difficult to non-productable conditions, depending upon the type and size of equipment being used.
It is important to note that some of our survey lines were performed within the dirt/landscaped shoulder of the roads. The distance from the survey lines to the proposed pipeline could vary laterally up to 60± feet) therefore, there may be local differentials encountered during excavation of the pipeline with respect to the data presented within this report.

CLOSURE

The field geophysical survey was performed by the undersigned using "state of the art" geophysical equipment and techniques along the selected traverse locations. The seismic data was further evaluated using recently developed computerized tomographic inversion techniques to provide a more thorough analysis and understanding of the subsurface velocity and structural conditions. It should be noted that our data presented within this report was obtained along nine specific locations therefore other areas in the local vicinity may contain different velocity layers and depths not encountered during our field survey. Additional survey traverses may be necessary to further evaluate the excavation characteristics across other portions of the study area where cut grading will be proposed, if warranted. Estimates of layer velocity boundaries as presented in this report are generally considered to be within 10± percent of the total depth of the contact.

It is important to understand that the fundamental limitation for seismic refraction surveys is known as nonuniqueness, wherein a specific seismic refraction data set does not provide sufficient information to determine a single “true” earth model. Therefore, the interpretation of any seismic data set uses “best-fit” approximations along with the geologic models that appear to be most reasonable for the local area being surveyed. Client should also understand that when using the theoretical geophysical principles and techniques discussed in this report, sources of error are possible in both the data obtained and in the interpretation and that the results of this survey may not represent actual subsurface conditions. These are all factors beyond Terra Geosciences control and no guarantees as to the results of this survey can be made. We make no warranty, either expressed or implied.

In summary, the results of this seismic refraction survey are to be considered as an aid to assessing the rippability and excavation potentials of the bedrock locally. This information should be carefully reviewed by the grading contractor and representative “test” excavations with the proposed type of excavation equipment for the proposed construction should be considered, so that they may be correlated with the data presented within this report. It should be noted that the decision for blasting of bedrock materials for facilitating the excavation process is sometimes made based upon economic production reasons and not solely on the rippability (velocity/hardness) characteristics of the bedrock.
SEISMIC LINE LOCATION MAP

From Google™ Earth imagery (2018).
APPENDIX A

LAYER VELOCITY MODELS
SEISMIC LINE S-4

North 12° East >

LAYER VELOCITY MODEL

TIME-DISTANCE PLOT
SEISMIC LINE S-6
North 22° East >

LAYER VELOCITY MODEL

TIME-DISTANCE PLOT
SEISMIC LINE S-8
North 4° East >

LAYER VELOCITY MODEL

TIME-DISTANCE PLOT
APPENDIX B

REFRACTION TOMOGRAPHIC MODELS
SEISMIC LINE S-1
North 86° East →

REFRACTION TOMOGRAPHIC MODEL

Seismic Source
Geophone Receiver

SCALE: Vertical Exaggeration 1.5X
RMS error 1.4%, Rayfract Version 3.35
SEISMIC LINE S-2
North 6° West →

REFRACTION TOMOGRAPHIC MODEL

 SCALE: 1:1 (Horizontal = Vertical)
RMS error 1.2%, Rayfract Version 3.35
SEISMIC LINE S-4
North 12° East →

REFRACTION TOMOGRAPHIC MODEL

Scale: 1:1 (Horizontal = Vertical)
RMS error 1.5%, Rayfract Version 3.35
SEISMIC LINE S-5
North 11° East →

REFRACTION TOMOGRAPHIC MODEL

SCALE: 1:1 (Horizontal = Vertical)
RMS error 1.0%, Rayfract Version 3.35
SEISMIC LINE S-8
North 4° East →

REFRACTION TOMOGRAPHIC MODEL

SCALE: 1:1 (Horizontal = Vertical)

RMS error 2.9%, Rayfract Version 3.35
SEISMIC LINE S-9
North 1° East →

REFRACTION TOMOGRAPHIC MODEL

SCALE: 1:1 (Horizontal = Vertical)

RMS error 3.0%, Rayfract Version 3.35
EXCAVATION CONSIDERATIONS

These excavation considerations have been included to provide the client with a brief overall summary of the general complexity of hard bedrock excavation. It is considered the client’s responsibility to ensure that the grading contractor they select is both properly licensed and qualified, with experience in hard-bedrock ripping processes. To evaluate whether a particular bedrock material can be ripped, this geophysical survey should be used in conjunction with the geologic or geotechnical report prepared for the project which describes the physical properties of the bedrock. The physical characteristics of bedrock materials that favor ripping generally include the presence of fractures, faults and other structural discontinuities, weathering effects, brittleness or crystalline structure, stratification of lamination, large grain size, moisture permeated clay, and low compressive strength. Unfavorable conditions can include such characteristics as massive and homogeneous formations, non-crystalline structure, absence of planes of weakness, fine-grained materials, and formations of clay origin where moisture makes the material plastic.

When assessing the potential rippability of the underlying bedrock of a given site, the above geologic characteristics along with the estimated seismic velocities can then be used to evaluate what type of equipment may be appropriate for the proposed grading. When selecting the proper ripping equipment there are three primary factors to consider, which are:

♦ **Down Pressure available at the tip, which determines the ripper penetration that can be attained and maintained,**

♦ **Tractor flywheel horsepower, which determines whether the tractor can advance the tip, and,**

♦ **Tractor gross-weight, which determines whether the tractor will have sufficient traction to use the horsepower.**

In addition to selecting the appropriate tractor, selection of the proper ripper design is also important. There are basically three designs, being radial, parallelogram, and adjustable parallelogram, of which the contractor should be aware of when selecting the appropriate design to be used for the project. The penetration depth will depend upon the down-pressure and penetration angle, as well as the length of the shank tips (short, intermediate, and long).

Also, important in the excavation process is the ripping technique used as well as the skill of the individual tractor operator. These techniques include the use of one or more ripping teeth, up- and down-hill ripping, and the direction of ripping with respect to the geologic structure of the bedrock locally. The use of two tractors (one to push the first tractor-ripper) can extend the range of materials that can be ripped. The second tractor can also be used to supply additional down-pressure on the ripper. Consideration of light blasting can also facilitate the ripper penetration and reduce the cost of moving highly consolidated rock formations.

All of the combined factors above should be considered by both the client and the grading contractor, to ensure that the proper selection of equipment and ripping techniques are used for the proposed grading.
REFERENCES


August 19, 2020
Kleinfelder Project No. 20182608.003A

Mr. Ryan M. Huston, PE
Kennedy/Jenks Consultants, Inc.
38977 Sky Canyon Drive, Suite 100
Murrieta, California 92563

SUBJECT: Geotechnical Supplemental Report
Sky Canyon Sewer Project
Murrieta, California

REFERENCE: Report of Geotechnical Investigation, Sky Canyon Sewer Project, Alignment 1C, Murrieta, California, Prepared by Kleinfelder, Dated December 21, 2018

Dear Mr. Huston:

Kleinfelder is pleased to present this Geotechnical Supplemental Report for the Eastern Municipal Water District (EMWD) Sky Canyon Sewer Project. This report presents updated recommendations for an additional jack and bore crossing along Sky Canyon Drive beneath Murrieta Hot Springs Road, updated recommendations for the jack and bore crossing at the jurisdictional water crossing area near the northeast corner of the existing self-storage development located on the east side of Winchester Road, north of Technology Drive and additional subsurface and groundwater conditions information.

On December 21, 2018, Kleinfelder prepared a Report of Geotechnical Investigation for the project. The purpose of our 2018 investigation was to evaluate the subsurface conditions along the proposed alignment and develop geotechnical recommendations for project design and construction. Based on updated project plans and the findings of our 2018 report, a supplemental investigation was requested and performed.

This report presents the findings of our supplemental geotechnical investigation performed for the project. The investigation included three (3) hollow-stem auger borings, one (1) rock core boring, three (3) piezometer installations, and laboratory testing of samples collected from the borings.

PURPOSE AND SCOPE

The purpose of this supplemental report is to provide updated geotechnical design parameters and recommendations for the proposed jack and bore crossings along Sky Canyon Drive beneath Murrieta Hot Springs Road and at the jurisdictional water crossing area near the northeast corner of the existing self-storage development located on the east side of Winchester Road, north of Technology Drive. Additionally, we have provided bedrock subsurface and groundwater conditions near stations 30+00, 47+00, and 72+00. This supplemental report includes the following:

- A description of the subsurface conditions and groundwater conditions encountered at the supplemental exploration locations;
- Updated Geotechnical Engineering Parameters for Tunnel Operations;
• Updated Excavation Characteristics and
• Figures and appendices including investigation locations, subsurface cross-sections, logs of the borings, and laboratory test results.

PROJECT DESCRIPTION

The project involves construction of approximately 6,670 feet of 36-inch diameter sewer pipeline located along private property adjacent to Winchester Road, and along Sky Canyon Drive (See Figure 1, Site Vicinity Map). The alignment is located in an unincorporated area of Riverside County.

The proposed sewer will connect to an existing 36-inch sewer (French Valley Phase II Sewer) at the north end of the project. At the south end of the project, the proposed sewer will be connected to a 30-inch sewer located near the intersection of Murrieta Hot Springs Road and Sky Canyon Drive.

The jack and bore crossing along Sky Canyon Drive beneath Murrieta Hot Springs Road is approximately 260 feet long (Sta. 8+60 to Sta. 11+20). The invert is planned at approximately 20 to 25 feet below ground surface (bgs).

The jack and bore crossing at the jurisdictional water crossing area near the northeast corner of the existing self-storage development located on the east side of Winchester Road, north of Technology Drive is approximately 68 feet long (Sta. 53+15 to Sta. 53+83). The invert is planned at approximately 15 feet below ground surface (bgs).

FIELD INVESTIGATION

The supplemental field investigation performed for the Sky Canyon Sewer Project included drilling, logging, and sampling of three (3) hollow-stem auger borings, one (1) rock core boring, and three (3) piezometer installations. The following sections describe the methods and procedures used for drilling and field testing during the course of our fieldwork.

Utility Clearance

Prior to beginning the field exploration program, Kleinfelder marked the proposed exploration sites in the field for Underground Service Alert (USA) clearance. USA identified potential conflicts between the planned exploration locations and existing, documented, underground utilities. Additionally, Kleinfelder subcontracted Pacific Coast Locators of La Crescenta, California, to perform a ground penetrating radar (GPR) survey near our exploration locations. The purpose of the GPR survey was to reduce the risk of encountering unidentified buried utilities. Our drilling subcontractors used a hand auger to excavate to 5 feet bgs prior to drilling.

Hollow-Stem Auger Boring

Kleinfelder performed three 8-inch diameter hollow-stem auger borings (B-1, B-2, and B-4) to investigate the subsurface conditions at the proposed jack and bore crossings. Borings B-1 and B-2 were drilled at the approximate locations of the jacking and receiving pits, respectively, of the jack and bore crossing along Sky Canyon Drive beneath Murrieta Hot Springs Road. Boring B-4 was drilled at the approximate location of the jacking pit of the jack and bore crossing at the jurisdictional water crossing area near the northeast corner of the existing self-storage development located on the east side of Winchester Road, north of Technology Drive. The approximate locations of the borings are shown on Figure 2, Exploration Location Map.
The hollow-stem auger borings were drilled to a depth ranging from approximately 25½ to 36½ feet bgs. The borings were drilled using a GT8 or CME-75 truck-mounted drill rig provided by 2R Drilling of Chino, California. In-place soil samples were obtained using a Standard Penetration Test (SPT) or California-type sampler. Bulk samples were collected from the auger cuttings. Following completion of drilling, the borings were backfilled with auger cuttings and the surface restored with quickset concrete dyed black, if drilled in asphalt.

Rock Core Boring

Kleinfelder performed one HQ rock core boring (B-3) to further investigate the subsurface conditions near Station 30+00. This area was previously explored by Kleinfelder on April 18, 2018 using hollow-stem auger drilling methods, where refusal was encountered at approximately 6 feet bgs after multiple attempts (see Boring 2A-11 of our referenced 2018 report). The approximate location of the boring is shown on Figure 2, Exploration Location Map.

The rock core boring was drilled to a depth of approximately 35 feet bgs. The boring was advanced using a Diedrich D-50 drill rig provided by Pacific Drilling of San Diego, California. Rock core runs up to 5 feet were obtained and stored in core boxes. Following completion of drilling, the boring was backfilled with cuttings and the surface restored with quickset concrete dyed black.

Piezometer Installation

Kleinfelder performed three 8-inch diameter hollow-stem auger borings (P-1 to P-3) to investigate the subsurface conditions near stations 47+00, 54+00, and 72+00 and install piezometers for groundwater monitoring purposes. The approximate locations of the piezometers are shown on Figure 2, Exploration Location Map.

The piezometers were drilled to a depth ranging from approximately 25½ to 50½ feet bgs. The drilling was performed using a CME-75 truck-mounted drill rig provided by 2R Drilling of Chino, California. In-place soil samples were obtained using a SPT sampler. Following completion of drilling, the piezometers were installed by placing 2-inch slotted PVC screen backfilled with well sand and completed with a well cap and flush-mount well cover embedded in concrete.

At P-1 and P-2, groundwater measurements were collected at the time the piezometers were installed (February 14, 2020) and 4 additional measurements (April 2, May 19, July 16, and July 29, 2020) to evaluate the changes in groundwater level over time. At P-3, groundwater measurements were collected at the time the piezometer was installed (July 29, 2020). These measurements are presented in Table 1 in the Groundwater section of this report.

Logging and Sampling

Subsurface conditions encountered in the field explorations were logged and sampled by a Kleinfelder engineer or geologist. Soils were logged in general accordance with the Unified Soils Classification System (USCS). Samples were collected as described above and transported to our laboratory in Ontario, California and AP Engineering in Pomona, California for testing. A Certified Engineering Geologist reviewed the boring logs after obtaining laboratory test results.

A detailed description of the boring logs for this study are presented in Appendix A.
LABORATORY TESTING

Laboratory testing was performed on samples collected during our field exploration to substantiate field classifications and to evaluate the physical characteristics of the subsurface materials. Testing consisted of evaluating in-situ dry unit weight and moisture content, sieve analysis, Atterberg Limits, maximum dry unit weight and optimum moisture content, sand equivalent, direct shear, corrosion potential and unconfined compressive strength. The test results for this supplemental investigation are presented in Appendix B.

SUBSURFACE CONDITIONS

Subsurface conditions encountered in our supplemental investigation are similar to those encountered in our referenced 2018 report. Detailed descriptions of the subsurface conditions encountered at the locations of our borings during our field investigation are presented on the boring logs provided in Appendix A. We recommend that all individuals utilizing this report review the boring logs presented in Appendix A.

The following sections describe the subsurface conditions underlying the proposed alignment at the locations of our supplemental investigation.

Jack and Bore Crossing, Sky Canyon Drive and Murrieta Hot Springs Road (B-1 and B-2)

Native material consisting of young alluvium (Qya) was encountered in B-1 and B-2 to the approximate depths explored of 36½ and 31½ feet bgs, respectively. The alluvium generally consisted of various mixtures of silty sand and poorly graded sand with varying amounts of gravel, silt, and clay. The in-situ moisture content ranged from 3.2 to 18.8 percent and dry density of the alluvium material ranged between 103.4 to 132.5 pounds per cubic foot. A subsurface cross-section within this portion of the project is presented on Figure 3.

Near Station 30+00 (B-3)

Cretaceous age hornblende gabbro of the Peninsular Ranges batholith was encountered at approximately 8 feet bgs in B-3 to the approximate depth explored of 35 feet bgs. Approximately 8 feet of artificial fill overlies the bedrock. The bedrock generally consisted of medium- to very coarse-grained hornblende gabbro. The bedrock was observed to be moderately weathered and intensely to moderately fractured. Photos of the rock cores are presented in Appendix C. Unconfined compressive strength results of 5 rock core samples collected from depths of 16.6, 23, 31.5, 32, and 34, ranged from 7,801 to 13,683 pounds per square inch (psi).

Review and comparison of current surface grade elevations along Sky Canyon Drive with historic USGS topographic maps of the area prior to the roadway construction indicates the roadway was cut into the natural surface. From approximate Station number 25+00 to 34+00 roadway grading cut approximately 20 to 50 feet into the former ground surface. At the location of rock core boring B-3, the roadway was cut approximately 20 feet. A boring location map showing 1953 topo within this portion of the project is presented on Figure 4.

Jack and Bore Crossing, Jurisdictional Water Crossing Area (B-4 and P-2) and near Sta. 47+00 (P-3) and Sta. 72+00 (P-1)

Approximately 1 to 4.5 feet of tilled soil/artificial fill overlying native material consisting of older alluvium (Qvoa) and weathered granitic bedrock (Kgb) was encountered in B-4 and P-1 to P-3 to the maximum depths explored ranging from approximately 25½ to 50½ feet bgs. The tilled
soil/artificial fill generally consisted of silty sand, clayey sand, and lean clay with varying amounts of sand and gravel. The older alluvium generally consisted of medium dense to very dense silty sand and clayey sand with varying amounts of gravel and was encountered to a depth ranging from approximately 6 to 25 feet bgs. Weathered granitic bedrock was generally encountered underlying the older alluvium and excavated as sand-, silt-, and gravel-size particles. Drilling difficulty generally increased with depth and refusal was encountered at P-1 at a depth of approximately 40 feet bgs. A subsurface cross-section within this portion of the project is presented on Figure 5.

GROUNDWATER CONDITIONS

In the areas of our supplemental investigation, groundwater was encountered in borings B-1, B-2, B-4, P-1, P-2, and P-3 at depths ranging from approximately 8 to 45 feet bgs (see Table 1). During our referenced 2018 geotechnical investigation, groundwater was encountered in our borings at depths ranging from 20 to 45 feet below the existing ground surface (bgs).

Piezometer P-1 was installed in the vicinity of the previous boring 2A-B2. Groundwater in boring 2A-B2 at the time of drilling was measured at approximately 26.5 feet bgs. Groundwater levels measured in piezometer P-1 started at an approximate depth of 25.3 feet, rose to approximately 22.6 feet, and then dropped to approximately 22.9 feet.

Piezometer P-2 was installed in the vicinity of the previous boring 1A-B4. Groundwater was not encountered in boring 1A-B4 which was drilled to a depth of approximately 31.5 feet bgs. Groundwater levels measured in piezometer P-2 started at an approximate depth of 10.6 feet, rose to approximately 8.5 feet, and then dropped to approximately 9.5 feet.

Piezometer P-3 was installed in the vicinity of the previous boring 1A-B5. Groundwater was not encountered in boring 1A-B5 which was drilled to a depth of approximately 51 feet bgs. Groundwater levels measured in piezometer P-3 started at an approximate depth of 44.9 feet.

Fluctuations of the groundwater level, localized zones of perched water, and increased soil moisture content should be anticipated during and following the rainy season. Local irrigation and surface drainages can also cause a fluctuation of local groundwater levels.

Due to groundwater level variability in the area and along the alignment, water levels presented in this report may or may not be representative of those encountered at the time of construction.
### Table 1

**Groundwater Elevations Encountered During Drilling**

<table>
<thead>
<tr>
<th>Boring</th>
<th>Proposed Invert depth of Pipe (ft.)</th>
<th>Approximate Ground Surface Elevation (ft.)</th>
<th>Approximate Groundwater Depth Below Ground Surface (ft.)</th>
<th>Approximate Groundwater Elevation (ft.)</th>
<th>Date of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>25</td>
<td>1116</td>
<td>22</td>
<td>1094</td>
<td>5/18/2020</td>
</tr>
<tr>
<td>B-2</td>
<td>20</td>
<td>1118</td>
<td>23</td>
<td>1095</td>
<td>5/18/2020</td>
</tr>
<tr>
<td>B-3</td>
<td>23</td>
<td>1220</td>
<td>Not Encountered</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>B-4</td>
<td>15</td>
<td>1298</td>
<td>21.5</td>
<td>1276.5</td>
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<tr>
<td>P-1</td>
<td>32</td>
<td>1323</td>
<td>25.3</td>
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<td>2/14/2020</td>
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<td></td>
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<td>1299.2</td>
<td>4/2/2020</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>1300.4</td>
<td>5/19/2020</td>
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<td>22.9</td>
<td>1300.1</td>
<td>7/29/2020</td>
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<td>1288.4</td>
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<td>11.5</td>
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</tr>
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<td></td>
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<td>1289.6</td>
<td>7/16/2020</td>
</tr>
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<td></td>
<td>9.5</td>
<td>1289.5</td>
<td>7/29/2020</td>
</tr>
<tr>
<td>P-3</td>
<td>36</td>
<td>1322</td>
<td>44.9</td>
<td>1277.1</td>
<td>7/29/2020</td>
</tr>
</tbody>
</table>
UPDATED GEOTECHNICAL ENGINEERING PARAMETERS FOR TUNNEL OPERATIONS

This section presents the anticipated conditions and ground behavior for the proposed jack and bore tunnel crossing along Sky Canyon Drive beneath Murrieta Hot Springs Road and at the jurisdictional water crossing area near the northeast corner of the existing self-storage development located on the east side of Winchester Road, north of Technology Drive. The conditions and anticipated behaviors are based on our project understanding, borehole and laboratory data, and groundwater information.

Anticipated Conditions for Tunnels
The proposed tunnel along Sky Canyon Drive beneath Murrieta Hot Springs Road is anticipated to be excavated in native young alluvium materials at the proposed tunnel depth. The alluvium materials are described in the Subsurface Conditions section of this report and are anticipated to be composed of various mixtures of silty sand and poorly graded sand with varying amounts of gravel, silt, and clay. Based on the laboratory data from Borings B-1 and B-2, the fines content (passing No. 200 sieve) ranges from 4 to 37 percent with an average of 21 percent. Sand content generally ranges from 96 to 100 percent in the alluvial soils. The anticipated soils described above represent the alluvium as a whole and variations with depth are likely to occur.

The proposed tunnel at the jurisdictional water crossing area near the northeast corner of the existing self-storage development located on the east side of Winchester Road, north of Technology Drive is anticipated to encounter weathered bedrock at the jacking pit and native older alluvium materials at the receiving pit, at the proposed tunnel depth. The materials are described in the Subsurface Conditions section of this report and are anticipated to be composed of silty sand and clayey sand with varying amounts of gravel in the older alluvium.

Weathered bedrock is anticipated to be excavated as sand-, silt-, and gravel-size particles. The anticipated soils described above represent the materials as a whole and variations with depth are likely to occur.

At both jack and bore crossings, groundwater was measured above the tunnel elevation during our supplemental investigation and is anticipated to be encountered during tunneling if excavations are performed during and/or following the rainy season. Additionally, localized zones of perched water, and increased soil moisture content could occur during and following the rainy season and other precipitation events.

We recommend tunneling to be performed and completed prior to the rainy season (dry season) or that a dewatering plan be prepared to maintain the groundwater level below the tunnel elevation during construction.

Anticipated Behavior During Tunnel Construction
This section presents the anticipated ground behavior for the soil conditions anticipated along the jack and bore tunnel alignments. We anticipate the tunnel crossings will be constructed using auger boring (jack and bore) methods, but we have also included discussions on pipe jacking and small diameter tunnel boring machines (TBM). Typical ground behavior during tunnel construction is described based on these methods.

The native alluvial soils described above are considered soft ground conditions for tunneling. Soft ground behavior is described in terms of the Tunnelman’s Ground Classification, developed by Terzaghi (1950) and later modified by Heuer (1974). The Tunnelman’s ground classification for soft ground is presented in Table 2 below.
<table>
<thead>
<tr>
<th>Classification</th>
<th>Behavior</th>
<th>Typical Soil Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm</td>
<td>Heading can be advanced without initial support, final lining can be constructed before ground starts to move.</td>
<td>Loess above the water table, hard clay, marl, cemented sand and gravel when not highly overstressed.</td>
</tr>
<tr>
<td>Raveling</td>
<td>Chunks or flakes of materials begin to drop out of the arch or walls sometime after the ground has been exposed, due to loosening, over-stress and &quot;brittle&quot; fracture. In fast raveling ground, the process starts within a few minutes, otherwise the ground is slow raveling.</td>
<td>Residual soils or sand with small amounts of binder may be fast raveling below the water table, slow raveling above. Stiff fissured clay may be slow or fast raveling depending upon degree of overstress.</td>
</tr>
<tr>
<td>Slow Raveling</td>
<td>Ground squeezes or extrudes plastically into tunnel, without visible fracturing or loss of continuity, and without perceptible increases in water content. Ductile, plastic yield and flow due to overstress.</td>
<td>Ground with low frictional strength. Rate of squeeze depends on degree of overstress. Occurs at shallow to medium depth in clay of very soft to medium consistency. Stiff to hard clay under high cover may move in combination with raveling at execution surface and squeezing at depth behind face.</td>
</tr>
<tr>
<td>Fast Raveling</td>
<td>Granular materials without cohesion are unstable at a slope greater than their angle of repose (approx. 30 - 35 degrees). When exposed at steep slopes they run like granulated sugar or dune sand until the slope flattens to the angle of repose.</td>
<td>Clean, dry granular materials. Apparent cohesion in moist sand, or weak cementation in any granular soil, may allow the material to stand for a brief period of raveling before it breaks down and runs. Such behavior is cohesive running.</td>
</tr>
<tr>
<td>Running</td>
<td>A mixture of soil and water flows into the tunnel like a viscous fluid. The material can enter the tunnel from the invert as well as from the face, crown, and wall, and can flow for great distances, completely filling the tunnel in some cases.</td>
<td>Below the water table in silt, sand, or gravel without enough clay content to give significant cohesion and plasticity. May also occur in highly sensitive clay when such material is disturbed.</td>
</tr>
<tr>
<td>Flowing</td>
<td>Ground absorbs water, increases in volume, and expands slowly into the tunnel.</td>
<td>Highly preconsolidated clay with plasticity index in excess of about 30, generally containing significant percentages of montmorillonite.</td>
</tr>
</tbody>
</table>

For tunnels above groundwater during excavation, we anticipate slow to fast raveling and running conditions in the native alluvium generally comprised of various mixtures of clayey sand, silty sand and poorly graded sand with varying amounts of gravel, silt, and clay. Flowing conditions may also be encountered if excavation is performed below groundwater. The granitic bedrock encountered in Boring B-4 is described as moderately to slightly weathered. Where weathered bedrock is encountered, the weathered rock may also behave as a soft-ground.
material. The weathered bedrock was excavated using a hollow-stem-auger drill rig to a depth of 25 feet suggesting the weathered bedrock is excavatable and may be anticipated to behave as a firm to slow raveling material. However, some harder and stronger bedrock may be encountered during tunneling that was not encountered during drilling of boring B-4.

Tunnel Excavation and Support Considerations
Typically, on a tunnel project, the Owner, in collaboration with the tunnel designer, evaluate allowable tunneling methods to be used for the project based on the ground conditions, but ultimately the means and methods are the responsibility of the Contractor in conformance with the project contract specifications. The following sections provide a summary of some of the tunnel methods that might be considered for the project. It is expected that a designer or contractor would propose equipment and methods that would address the anticipated conditions described with respect to each example of tunneling method.

Tunnel Excavation
Several tunnel excavation and support methods are commonly used for short tunnels in soft ground conditions. Factors to consider in selecting tunneling methods include:

- Ground conditions;
- Size and length of tunnel;
- Ground cover;
- Groundwater;
- Cobbles and boulders;
- Potential for ground loss during tunneling; and
- Potential negative impacts on adjacent facilities such as roadways and utilities.

Alternative tunnel excavation methods for the project based on the proposed tunnel size and length and anticipated ground conditions are discussed in the following sections along with pros and cons of each method. It should be noted that with each tunnel method, additional mitigation measures may be required to address the potential for caving and ground loss. The tunnel excavation methods described below are some of the more commonly used methods for small diameter tunnels that are relatively short in length.

Auger Boring
Auger boring is an unguided or minimally guided and steered trenchless construction method and is often described as the oldest mechanized method. Auger boring, also referred to as (bore and jack) advances a steel casing into the ground while simultaneously removing the spoils using an auger. As each auger and casing is advanced, a subsequent auger and casing is added within the launch shaft and advanced into the ground. This process is continued until the casing arrives at the reception shaft. Upon completion of the tunnel, the auger is used to remove spoil from the casing. A second pipe, referred to as a carrier pipe, is inserted into the casing and the pipeline completed. Typically, the casing is over sized to allow the carrier pipeline and grade to be adjusted within the casing. This final adjustment must meet the pipeline’s operational requirements. The annulus between the casing and carrier pipe is typically filled with cementitious grout.

Auger boring tends to work well in soils and rock, with appropriate powered equipment and bits, and not so well in gravels, cobbles, and boulders where the auger is not at least three times the diameter of the rock particle. Auger boring does not work well below groundwater and normally requires dewatering.
Auger boring methods are generally used for diameters ranging from 8 to 60 inches but are most commonly used for the 12- to 36-inch range. These methods are generally an economical method of installing pipe but have some limitations. Like other open-face tunnel methods, auger methods do not provide a means to provide stability at the face. For auger excavation methods within the casing, cobbles and boulders may also impede excavation.

Pipe Jacking
Pipe jacking is a guided and steered trenchless construction method that allows for man entry. Pipe jacking drives a casing pipe, normally a steel casing or reinforced concrete pipe (RCP), into the ground with manned excavation. Excavation can take place within a shield or by equipping the leading edge of the pipe with a cutter or shoe to protect the pipe. The casing pipe is driven forward using a jacking frame. As the casing is advanced, spoils are removed at the face. Each subsequent casing is added within the launch shaft and advanced into the ground. This process is continued until the casing arrives at the reception shaft. Upon completion of the tunnel, the casing is clean of spoils.

Pipe jacking works well in most ground types above the groundwater table, or if dewatering is conducted within the shafts and along the tunnel alignment. Open-shield or open face pipe jacking operations have the benefit of being able to handle large obstructions, such as cobbles and boulders through the face of the shield or pipe. This advantage is beneficial when cobbles and boulders are anticipated to be encountered during tunneling. A major drawback in open-face tunnel operations is the potential for instability and collapse at the face.

Microtunneling
Microtunneling is a method of installing pipe below the ground by jacking the pipe behind a remotely-operated microtunnel boring machine (MTBM). Pipe sections are installed behind the MTBM as it is advanced. The pipe sections provide ground support as the MTBM advances. The minimum depth of cover for the operation is generally 6 feet or 1.5 to 2 times the outer diameter of the pipe being installed (Najafi, 2013), whichever is greater.

The MTBM uses a rotating cutter head that is designed for the anticipated ground conditions. Excavated soils generated at the face of the machine pass through the cutter head through muck bucket openings. Where difficult ground control is anticipated, a slurry MTBM may be used to aid in face control. This method provides slurry to the MTBM heading where the tunnel face is protected with pressure from the slurry mix. The excavated soil generated at the face is mixed with the slurry and transported to the surface where the slurry is separated from the spoils and the slurry is returned to the face of the MTBM.

Of the tunneling methods discussed in this report the use of a MTBM is the most costly and is not considered economically feasible considering the short length of the tunnel.

Settlement Potential and Ground Monitoring
A primary concern for the project is the potential for ground settlement above the tunnel due to ground losses during tunneling. Ground losses may occur as the result of soil movement in front of the excavation by means of running and/or caving or may also occur as a result of soil movement around the cutting edge or tail of the tunneling machine. Ground losses may also occur as the result of soil movement downward toward the support system as it leaves the tail of the machine. We recommend that the ground surface and other vital structures (utilities, roadways, etc.) be monitored for settlement and signs of distress prior to, during and following tunnel construction.
Anticipated Conditions for Shafts
Jacking and receiving pits (shafts) for tunneling are anticipated to be excavated in native alluvial or weathered bedrock materials. The alluvial materials are described in the Subsurface Conditions section of this report and are anticipated to be composed of various mixtures of clayey sand, silty sand and poorly graded sand with varying amounts of gravel, silt, and clay. Weathered bedrock is anticipated to be excavated as sand-, silt- and gravel-size particles.

The groundwater table was located above the bottom of the planned jacking and receiving pit elevations during our supplemental investigation and is anticipated to be encountered during shaft construction if performed during or following the rainy season. Localized zones of perched water and increased soil moisture content could also occur during and following the rainy season and other precipitation events.

We recommend shaft construction to be performed and completed prior to the rainy season (dry season) or that a dewatering plan be prepared such that the groundwater is maintained below the shaft invert elevations during construction.

The following conditions are anticipated for temporary excavations and shoring:

1. Soils will run when encountered above groundwater elevations or flow when encountered below groundwater elevations and left unsupported. At locations where excavations or shoring allow lateral deflection or material to run into excavations, the potential for settlement, undermining, or other adverse impacts to existing facilities and structures exists.

2. We anticipate that the soil deposits should be excavatable using conventional excavation equipment such as an excavator or backhoe.

3. Loose, low cohesion soils in the form of running sands are likely to be encountered during excavation. This condition could result in instability and caving of excavation sidewall materials.

4. Existing underground utilities are located within or near planned shaft locations. Settlement can cause damage to the underground utilities. Special attention should be paid during construction to avoid undermining or damaging existing utilities.

For recommendations on temporary slopes and shoring, see section 4.4, Guidelines for Temporary Excavations, of our referenced 2018 Report of Geotechnical Investigation.

Design Parameters for Jacking Pit Walls
Provided below are recommendations for boring and pipe jacking pit operations. If additional pipe jacking locations are proposed, it is recommended that further analyses and testing be conducted to confirm and/or modify the findings presented in this section and make further recommendations as required.

Passive jacking resistance of jacking pit walls can be estimated using an equivalent fluid weight of 350 psf per foot of depth. The total allowable pressure should not exceed 3,000 pounds per square foot (psf). Frictional resistance between pipeline casing and the granular soils can be estimated using a frictional coefficient of 0.35. These values do not include a factor of safety and it is possible that greater frictional resistance could be encountered. The required passive jacking resistance of the jacking pit walls is dependent on the contractor’s means and methods, material
and equipment choices, ground improvement techniques, etc. Wall designs and allowable jacking loads should be provided by a licensed engineer experienced in designing jacking pits for trenchless construction. Also, potential ground and wall deformations should be evaluated and mitigated, especially if survey and laser guidance is mounted on the walls for alignment control. If soil and groundwater conditions encountered during construction differ from those described, our firm should be notified immediately in order that a review may be made, and supplemental recommendations, if required, can be provided.

**UPDATED EXCAVATION CHARACTERISTICS**

As discussed in the Subsurface Conditions section above, Boring B-3 encountered weathered bedrock from a depth of approximately 8 feet to the maximum depth explored (approximately 35 feet). The bedrock was observed to be moderately weathered and intensely to moderately fractured. Unconfined compressive strength results of 5 rock core samples collected from depths of 16.6, 23, 31.5, 32, and 34, ranged from 7,801 to 13,683 pounds per square inch (psi). The degree of fracturing observed suggests that much of the rock encountered may be excavatable with large excavator-type of equipment. However, it is likely that zones of less fractured rock may be encountered that would require additional means such as continuous breaking, chemical cracking or other methods to remove the bedrock. We recommend that the contractor review the information presented in this report, as well as our 2018 report when developing the construction means and methods.

**UPDATED RECOMMENDATIONS**

Based on the findings of our supplemental investigation, the recommendations described in our referenced 2018 Report of Geotechnical Investigation remain applicable unless superseded herein.

**LIMITATIONS**

Findings presented in this report are based on our subsurface explorations, laboratory tests, and our present knowledge of the proposed project. It is possible that soil conditions could vary between or beyond the points explored. If soil conditions are encountered during construction, which differ from those described herein, we should be notified immediately in order that we may review the information and provide additional evaluation. If the scope of the proposed construction changes from that described in this report, the findings contained in this report may not be applicable. The work performed was based on project information provided by Client. If there are any changes in the field to the plans, Client should notify Kleinfelder to evaluation whether the conditions described herein are applicable to the project.

References to elevations and locations provided within this report were based upon general information provided for our use. Kleinfelder, Inc. did not provide surveying services and, therefore an opinion regarding the accuracy of the surface location or elevations with respect to the approved plans and current site surveying is not provided.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

A more detailed summary of Limitations is provided in our referenced 2018 Report of Geotechnical Investigation.
CLOSURE

We appreciate the opportunity to be of service on this project. If you have any questions, comments, or require additional information, please do not hesitate to contact the undersigned at your convenience.

Sincerely,

KLEINFELDER

Hector Marquez, EIT
Staff Engineer

Michael O. Cook, PG, CEG
Senior Engineering Geologist

Eric W. Noel, PE, GE
Principal Geotechnical Engineer

Attachments: References
            Figures
            Appendix A – Field Exploration
            Appendix B – Laboratory Test Results
            Appendix C – Rock Core Photos
REFERENCES


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REFERENCE: BASE MAP PROVIDED BY KENNEDY/JENKS CONSULTANTS, UNDATED

EXPLANATION

P-3 APPROXIMATE PIEZOMETER LOCATION
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EXPLORATION LOCATION MAP
SKY CANYON SEWER PROJECT
MURRIETA, CALIFORNIA

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LEGEND

- Approximate Piezometer Location
- Proposed Sewer Alignment

NOTE: ft - Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Approximate Ground Elevation (ft)

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SKY CANYON SEWER PROJECT
MURRIETA, CALIFORNIA

EXPLORATION LOCATION MAP
FIGURE 2D

LEGEND

- Approximate Piezometer Location
- Proposed Sewer Alignment

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SKY CANYON SEWER PROJECT
MURRIETA, CALIFORNIA
EXPLORATION LOCATION MAP
FIGURE 2D

LEGEND

- Approximate Piezometer Location
- Proposed Sewer Alignment

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The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated. In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.

Ground Water Graphics:
- **W**ater level (level where first observed)
- **W**ater level (level after exploration completion)
- **W**ater level (additional levels after exploration)
- **O**bserved seepage

Notes:
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- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, i.e., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SM-GM, SW-SC, SC-SM.
- If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

Abbreviations:
- **W**eight of **H**ammer
- **W**eight of **R**od

Coarse Grained Soils:
- **GW** - WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
- **GW-GM** - WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
- **GW-GC** - WELL-GRADED GRAVELS, GRAVEL-SAND-CLAY MIXTURES
- **GP** - POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
- **GP-GM** - POORLY GRADED GRAVELS, GRAVEL-SAND-CLAY MIXTURES WITH LITTLE CLAY FINES
- **GP-GC** - POORLY GRADED GRAVELS, GRAVEL-SAND-CLAY MIXTURES
- **GM** - SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
- **GC** - CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
- **GC-GM** - CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES

Sands:
- **SW** - WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
- **SP** - POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
- **SW-SM** - WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
- **SW-SC** - WELL-GRADED SANDS, SAND-GRAVEL-MIXTURES WITH LITTLE CLAY FINES
- **SP-SM** - POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
- **SP-SC** - POORLY GRADED SANDS, SAND-GRAVEL-MIXTURES WITH LITTLE CLAY FINES
- **SM** - SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
- **SC** - CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
- **SC-SCM** - CLAYEY SANDS, SAND-SILT-CLAY MIXTURES

Silty Clays:
- **ML** - INORGANIC SILTS AND VERY FINE SANDS, SANDS WITH SLIGHT PLASTICITY
- **CL** - INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SAND CLAYS, LEAN CLAYS
- **CL-ML** - INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SAND CLAYS, LEAN CLAYS
- **OL** - ORGANIC SILTS & ORGANIC Silty Clays of Low Plasticity, Organic Silts & Organic Silty Clays
- **MH** - INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR Silt
- **CH** - INORGANIC CLAYS OF HIGH PLASTICITY, FAY CLAYS
- **OH** - ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

Silt and Sands:
- **Cu** - CUPRUM (Liquid Limit less than 50)
- **Cu4 and/or 1Cc3** - CUPRUM (Liquid Limit less than 50)
- **Cu6 and/or 1Cc3** - CUPRUM (Liquid Limit less than 50)
- **Cu4 and/or 1Cc3** - CUPRUM (Liquid Limit less than 50)
- **Cu6 and/or 1Cc3** - CUPRUM (Liquid Limit less than 50)

Abbreviations:
- **BULK / GRAB / BAG SAMPLE**
- **MODIFIED CALIFORNIA SAMPLER** (2 or 2-1/2 in. (50.8 or 63.5 mm.) outer diameter)
- **CALIFORNIA SAMPLER** (3 in. (76.2 mm.) outer diameter)
- **STANDARD PENETRATION SPLIT SPOON SAMPLER** (2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)
- **HQ CORE SAMPLE** (2.500 in. (63.5 mm.) core diameter)
- **SHELBENY STEM AUGER**
- **HOLLOW STEM AUGER**
- **SOLID STEM AUGER**
- **WASH BORING**
- **SONIC CONTINUOUS SAMPLER**

Graphics Key:

**FIGURE A-1**

Sky Canyon Sewer Project
Murrieta, CA
**CONSISTENCY - FINE-GRAINED SOIL**

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<th>SPT - N&lt;sub&gt;s&lt;/sub&gt;</th>
<th>Pocket Pen (tsf)</th>
<th>UNCONFINED COMPREHENSIVE STRENGTH (Q/psf)</th>
<th>VISUAL / MANUAL CRITERIA</th>
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<td>Very Soft</td>
<td>&lt;2</td>
<td>PP &lt; 0.25</td>
<td>&lt;500</td>
<td>Thumb will penetrate more than 1 inch (25 mm). Exudates between fingers when squeezed.</td>
</tr>
<tr>
<td>Soft</td>
<td>2 - 4</td>
<td>0.25 &lt; PP &lt; 0.5</td>
<td>500 - 1000</td>
<td>Thumb will penetrate soil about 1 inch (25 mm). Remolded by light finger pressure.</td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>4 - 8</td>
<td>0.5 &lt; PP &lt; 1</td>
<td>1000 - 2000</td>
<td>Thumb will penetrate soil about 1/4 inch (6 mm). Remolded by strong finger pressure.</td>
</tr>
<tr>
<td>Stiff</td>
<td>8 - 15</td>
<td>1 &lt; PP &lt; 2</td>
<td>2000 - 4000</td>
<td>Can be imprinted with considerable pressure from thumb.</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>15 - 30</td>
<td>2 &lt; PP &lt; 4</td>
<td>4000 - 8000</td>
<td>Thumb will not indent soil but readily indented with thumbnail.</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt;30</td>
<td>4 &lt; PP</td>
<td>&gt;8000</td>
<td>Thumb will not indent soil.</td>
</tr>
</tbody>
</table>

**REACTION WITH HYDROCHLORIC ACID**

- **None**
  - No visible reaction
- **Weak**
  - Some reaction, with bubbles forming slowly
- **Strong**
  - Violent reaction, with bubbles forming immediately

**ANGULARITY**

- **Angular**
  - Particles have sharp edges and relatively plane sides with unpolished surfaces.
- **Subangular**
  - Particles are similar to angular description but have rounded edges.
- **Subrounded**
  - Particles have nearly plane sides but have well-rounded corners and edges.
- **Rounded**
  - Particles have smoothly curved sides and no edges.
**ROCK QUALITY DESIGNATION (RQD)**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>CRITERIA [in (mm)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>0 - 25</td>
</tr>
<tr>
<td>Fair</td>
<td>25 - 50</td>
</tr>
<tr>
<td>Moderate</td>
<td>50 - 75</td>
</tr>
<tr>
<td>Good</td>
<td>75 - 90</td>
</tr>
<tr>
<td>Excellent</td>
<td>90 - 100</td>
</tr>
</tbody>
</table>

**APERTURE**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>CRITERIA [in (mm)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight</td>
<td>&lt;0.04 (&lt;1)</td>
</tr>
<tr>
<td>Open</td>
<td>0.04 - 0.20 (0.15)</td>
</tr>
<tr>
<td>Wide</td>
<td>&gt;0.20 (&gt;0.5)</td>
</tr>
</tbody>
</table>

**BEDDING CHARACTERISTICS**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>CRITERIA [in (mm)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Laminated</td>
<td>0.1 - 0.4 (2.5 - 10)</td>
</tr>
<tr>
<td>Thin Laminated</td>
<td>&gt;0.1 (&gt;2.5)</td>
</tr>
</tbody>
</table>

**CORE SAMPLER TYPE GRAPHICS**

- **EX CORE BARREL**
  (0.846 in. (21.5 mm.) core diameter)
- **HQ CORE SAMPLE**
  (2.500 in. (63.5 mm.) core diameter)
- **NO CORE SAMPLE**
  (1.874 in. (47.6 mm.) core diameter)
- **NX CORE SAMPLE**
  (2.154 in. (54.7 mm.) core diameter)

**FIELD TEST**

- Indented by thumbnail
- Crumbles under firm blows of geological hammer.
- Can be peeled by a pocket knife.
- Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single firm blow of a geological hammer.
- Specimen requires more than one blow of geological hammer to fracture it.
- Specimen can only be chipped with a geological hammer.

**RELATIVE HARDNESS / STRENGTH DESCRIPTIONS**

<table>
<thead>
<tr>
<th>GRADE</th>
<th>UCS (Mpa)</th>
<th>FIELD TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>R0 Extremely Weak</td>
<td>0.25 - 1.0</td>
<td>Indented by thumbnail</td>
</tr>
<tr>
<td>R1 Very Weak</td>
<td>1.0 - 5.0</td>
<td>Crumbles under firm blows of geological hammer.</td>
</tr>
<tr>
<td>R2 Weak</td>
<td>5.0 - 25</td>
<td>Can be peeled by a pocket knife.</td>
</tr>
<tr>
<td>R3 Medium Strong</td>
<td>25 - 50</td>
<td>Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single firm blow of a geological hammer.</td>
</tr>
<tr>
<td>R4 Strong</td>
<td>50 - 100</td>
<td>Specimen requires more than one blow of geological hammer to fracture it.</td>
</tr>
<tr>
<td>R5 Very Strong</td>
<td>100 - 250</td>
<td>Specimen can only be chipped with a geological hammer.</td>
</tr>
<tr>
<td>R6 Extremely Strong</td>
<td>&gt; 250</td>
<td></td>
</tr>
</tbody>
</table>

**ADDITIONAL TEXTURAL ADJECTIVES**

- No evidence of chemical / mechanical alteration; rings with hammer blow.
- If numerous enough that only thin walls separate individual pits or vugs, this term further describes the preceding nomenclature to indicate cell-like form.
- Bedding Planes
  Planes dividing the individual layers, beds, or stratigraphy of rocks.
- Joint
  Fracture in rock, generally more or less vertical or traverse to bedding.
- Seam
  Applies to bedding plane with unspecified degree of weather.

**CORE DESCRIPTION KEY**

- Albite
- Apatite
- Biotite
- Clay
- Calcite
- Chlorite
- Epidote
- Iron Oxide
- Manganese
- Muscovite
- Pyrite
- Quartz
- Py
- Sand
- Sericite
- Ser
- Silt
- Talc
- Ta
- Unknown

**DENSITY/SPACING OF DISCONTINUITIES**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfractured</td>
<td>&gt;6 ft. (&gt;1.83 meters)</td>
</tr>
<tr>
<td>Slightly Fractured</td>
<td>2 - 6 ft. (0.601 - 1.83 meters)</td>
</tr>
<tr>
<td>Moderately Fractured</td>
<td>8 in - 2 ft. (203.20 - 609.60 mm)</td>
</tr>
<tr>
<td>Highly Fractured</td>
<td>2 - 8 in (50.80 - 203.30 mm)</td>
</tr>
<tr>
<td>Intensely Fractured</td>
<td>&lt;2 in (&lt;50.80 mm)</td>
</tr>
</tbody>
</table>

**ADDITIONAL TEXTURAL ADJECTIVES**

- Pit (Pitted)
  Small openings (usually lined with crystals) ranging in diameter from 0.03 ft. (3/8 in.) to 0.33 ft. (4 in.) (10 to 100 mm.).
- Vug (Vuggy)
  An opening larger than 0.33 ft. (4 in.) (100 mm.), size descriptions are required, and adjectives such as small, large, etc., may be used.
- Cavity
  If numerous enough that only thin walls separate individual pits or vugs, this term further describes the preceding nomenclature to indicate cell-like form.
- Honeycombed
  Small openings in volcanic rocks of variable shape and size formed by entrapped gas bubbles during solidification.
- Vesicle (Vesicular)
  Small openings in volcanic rocks with variable shape and size formed by entrapped gas bubbles during solidification.

**DRAWN BY**: HMC
**CHECKED BY**: MC
**DATE**: 5/20/2020

---

Sky Canyon Sewer Project
Murrieta, CA
Asphalt Concrete: approximately 3 inches
Aggregate Base: approximately 6 inches
Alluvium (Qva): fine to coarse-grained, brown, moist, subangular gravel up to 1 inch, trace clay and mica trace subangular gravel up to 3 inches medium dense
Silty SAND (SM): fine to coarse-grained, dark gray, moist, dense, trace clay
medium dense, iron oxide staining
Poorly Graded SAND with Silt (SP-SM): fine to coarse-grained, brown, moist to wet, dense, trace subangular gravel up to 1 inch
fine to medium-grained, wet, medium dense, little to no gravel, micaceous
fine to coarse-grained, dense

The boring was terminated at approximately 36.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface with quickset concrete dyed black on May 18, 2020.
Approximate Ground Surface Elevation (ft.): 1,118.5
Surface Condition: Asphalt

Approximate Elevation (feet)

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Asphalt Concrete: approximately 4 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Aggregate Base: approximately 10 inches</td>
</tr>
<tr>
<td>10</td>
<td>Alluvium (Qya): fine to coarse-grained, brown, moist, subangular gravel up to 1 inch, trace clay very dense, little to no gravel, interbedded with dark gray clayey sand</td>
</tr>
<tr>
<td>15</td>
<td>Silty SAND with Gravel (SM): fine to coarse-grained, brown, moist, subangular gravel up to 1 inch, trace clay very dense, little to no gravel, interbedded with dark gray clayey sand</td>
</tr>
<tr>
<td>20</td>
<td>Poorly Graded SAND (SP): fine to coarse-grained, brown, moist to wet, medium dense, trace subangular gravel up to 1 inch</td>
</tr>
<tr>
<td>25</td>
<td>Silty SAND (SM): fine to coarse-grained, brown, moist to wet, medium dense</td>
</tr>
<tr>
<td>30</td>
<td>Poorly Graded SAND (SP): fine to coarse-grained, grayish brown, wet, medium dense, trace subangular gravel up to 1 inch</td>
</tr>
</tbody>
</table>

The boring was terminated at approximately 31.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface with quickset concrete dyed black on May 18, 2020.

Groundwater was observed at approximately 23.5 ft. below ground surface during drilling.

Groundwater was observed at approximately 23.5 ft. below ground surface at the end of drilling.

The exploration location and elevation are approximate and were estimated by Kleinfelder.
### Asphalt Concrete
- Approximately 4 inches

### Artificial Fill
- To approximately 8 feet bgs

### BEDROCK

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Coordinates Not Available Approximate Ground Surface Elevation (ft.): 1,220</th>
</tr>
</thead>
<tbody>
<tr>
<td>1215</td>
<td></td>
</tr>
<tr>
<td>1210</td>
<td></td>
</tr>
<tr>
<td>1205</td>
<td></td>
</tr>
</tbody>
</table>

#### Formation and Rock Type

<table>
<thead>
<tr>
<th>Formation</th>
<th>Color</th>
<th>Weathering</th>
<th>Bedding</th>
</tr>
</thead>
<tbody>
<tr>
<td>GABBRO (Kgb) Hornblende Gabbro</td>
<td>Dark gray and white speckled, fine to coarse-grained, moderately weathered, intensely fractured, Fe stains along joints, some gypsum infil, some carbonate infil</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Sample Information

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Box Number</th>
<th>Run Number</th>
<th>Recovery (NR=No Recovery)</th>
<th>Drill Time</th>
<th>Drill Rate (min/ft)</th>
<th>RQD (%)</th>
<th>Relative Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>NR</td>
<td>10:01 10:30 [7.29]</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>12°</td>
<td>10:40 10:48 [8.00]</td>
<td>0</td>
<td>R3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>30°</td>
<td>10:56 11:13 [5.67]</td>
<td>0</td>
<td>R3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>30°</td>
<td>11:20 11:54 [17.00]</td>
<td>0</td>
<td>R3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>53°</td>
<td>12:00 12:28 [5.60]</td>
<td>20</td>
<td>R4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Discontinuity Description

- Fracture#: (Depth), Type, Relative Dip, Density or Spacing, Degree of Infilling, Infilling Type, Aperture, Surface Weathering, JRC

- (12.5'), Rubble consisting of dark gray/black and white speckled, Gabbro clasts, pea size to coarse gravel size
- (13'), IF, J, O, Fi, Ca
- (14'), IF, J, O, Fi, Ca, Fe, JRC 18-20
- (17'), ~6-inch core from Run 3
- (18.3'), Shear, Cl, Pa, T, JRC 2-4

---

**Sky Canyon Sewer Project**

**Murrieta, CA**

**DATE: 6/22/2020**

**REVISED:** -

**PROJECT NO.: 20182608**

**DRAWN BY:** HM

**CHECKED BY:** MC

**REVISIONS:** -
ROCK CORING LOG B-3

Graphical Log

FORMATION AND ROCK TYPE, COLOR, GRAIN/PARTICLE SIZE, WEATHERING, BEDDING, DENSITY OR SPACING

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Approximate Ground Surface Elevation (ft.): 1,220</th>
</tr>
</thead>
</table>

**BEDROCK GABBRO (Kgb) Hornblende Gabbro:**
- Dark gray and white speckled, fine to coarse-grained, moderately weathered, intensely fractured, Fe stains along joints, some gypsum infill, some carbonate infill

**Discontinuity Description**
- Fracture#: (Depth), Type, Relative Dip, Density or Spacing, Degree of Infilling, Infilling Type, Aperture, Surface Weathering, JRC

<table>
<thead>
<tr>
<th>Sample</th>
<th>Run Number</th>
<th>Sample Type</th>
<th>Recovery (NR=No Recovery)</th>
<th>Drill Time</th>
<th>RQD (%)</th>
<th>Relative Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>53° (cont.)</td>
<td>12:00 12:28</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>49°</td>
<td>12:32 12:58 (5:42)</td>
<td>21</td>
<td>R4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>54°</td>
<td>13:24 13:51 (5:19)</td>
<td>57</td>
<td>R4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>8</td>
<td>12° 13:53 14:05 (12:00)</td>
<td>100</td>
<td>R4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>8</td>
<td>12° 13:53 14:05 (12:00)</td>
<td>100</td>
<td>R4</td>
<td></td>
</tr>
</tbody>
</table>

The exploration was terminated at approximately 35 ft. below ground surface. The exploration was backfilled with cuttings and patched at surface with quickset concrete dyed black on June 09, 2020. Drilled to approximately 9 ft. with 8-inch Hollow Stem Auger. Rock was encountered at a depth of 8 ft. during this exploration. Coring started at a depth of 9 ft.

GROUNDWATER LEVEL INFORMATION:
- Groundwater was not observed during drilling or after completion.

Sky Canyon Sewer Project
Murrieta, CA

DATE: 6/22/2020
REVIS: -
Tilled Soil
Silty SAND (SM): fine to coarse-grained, dark brown, dry, loose
Older Alluvium (Qvoa)
Clayey SAND (SC): fine to coarse-grained, dark reddish brown, dry to moist
Weathered Bedrock (Kgb)
GRANITE: dark grayish brown, dry to moist, densely, moderately to slightly weathered, excavates as fine to coarse-grained silty sand, micaceous
dark yellowish brown, very dense, trace clay
excavates as fine to coarse-grained well graded sand with silt, trace clay
dark grayish brown, moist to wet, iron oxide staining, little to no clay
wet, excavates as fine to coarse-grained silty sand, trace clay

The boring was terminated at approximately 25.5 ft. below ground surface. The boring was backfilled with auger cuttings on July 29, 2020.

GROUNDWATER LEVEL INFORMATION:
Groundwater was observed at approximately 22.5 ft. below ground surface during drilling.
Groundwater was observed at approximately 21.5 ft. below ground surface at the end of drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

Boring Log B-4
The exploration location and elevation are approximate and were estimated by Kleinfelder.
Approximate Ground Surface Elevation (ft.): 1,323.0
Surface Condition: Bare Earth

Tilled Soil/Manure/Grass: moist to wet
Artificial Fill
Clayey SAND with Gravel (SC): fine to medium-grained, olive brown, moist, subrounded gravel up to 3 inches
Older Alluvium (Qva)
Silty SAND with Gravel (SM): fine to coarse-grained, light brownish gray, moist, very dense, subangular gravel up to 3 inches
Silts and gravel present
Silty SAND (SM): fine to coarse-grained, yellowish brown, moist, very dense
Weathered Bedrock (Kgb)
GRANITE: yellowish brown, dry to moist, very dense, excavates as fine to coarse-grained silty sand with subangular gravel up to 1 inch
light brownish gray, little to no gravel
trace subangular gravel up to 1 inch
gray, little to no gravel

LABORATORY RESULTS
Sample
Sample Type
Dry Unit Wt. (pcf)
Passing #4 (%)
Passing #200 (%)
Liquid Limit
Plasticity Index (NP=NonPlastic)

1
BC=50/6"
6"

2
BC=40/50/3"
14"

3
BC=50/2"
4"

4
BC=24/50/4"
16"

5
BC=50/1"
11"

6
BC=50/6"
12"

FIELD EXPLORATION
Sample
Sample Type
Dry Unit Wt. (pcf)
Passing #4 (%)
Passing #200 (%)

Silts and gravels present

Weathered Bedrock (Kgb)
GRANITE: yellowish brown, dry to moist, very dense, excavates as fine to coarse-grained silty sand with subangular gravel up to 1 inch

Approximate Ground Surface Elevation (ft.): 1,323.0
Surface Condition: Bare Earth

Approximate Ground Surface Elevation (ft.): 1,323.0
Surface Condition: Bare Earth
Approximate Ground Surface Elevation (ft.): 1,323.0
Surface Condition: Bare Earth

Lithologic Description

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Graphical Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>1255</td>
<td></td>
</tr>
<tr>
<td>1260</td>
<td></td>
</tr>
<tr>
<td>1265</td>
<td></td>
</tr>
<tr>
<td>1270</td>
<td></td>
</tr>
<tr>
<td>1275</td>
<td></td>
</tr>
<tr>
<td>1280</td>
<td></td>
</tr>
<tr>
<td>1285</td>
<td></td>
</tr>
</tbody>
</table>

Weathered Bedrock (Kgb)
GRANITE: yellowish brown, dry to moist, very dense, excavates as fine to coarse-grained silty sand with subangular gravel up to 1 inch wet, iron oxide staining

The piezometer was terminated because of practical auger refusal (†) at approximately 40.2 ft. below ground surface on Bedrock. The piezometer was backfilled with sand and pipe on February 14, 2020.
Approximate Ground Surface Elevation (ft.): 1,299.0
Surface Condition: Bare Earth

Lithologic Description

Tilled Soil/Manure/Grass: moist to wet
Artificial Fill
Lean CLAY with Sand (CL): reddish brown, moist, fine to coarse-grained sand
increase in sand
Clayey SAND (SC): fine to coarse-grained, reddish brown, moist, decrease in fines with depth
Older Alluvium (Qvoa)
Clayey SAND (SC): fine to coarse-grained, reddish brown, moist, very dense, trace subangular gravel up to 0.5 inch
Weathered Bedrock (Kgb)
GRANITE: light brownish gray, moist, very dense, excavates as fine to coarse-grained poorly graded sand, trace fines

The piezometer was terminated at approximately 25.5 ft. below ground surface. The piezometer was backfilled with sand and pipe on February 14, 2020.

GROUNDWATER LEVEL INFORMATION:
- Groundwater was observed at approximately 19.1 ft. below ground surface during drilling.
- Groundwater was observed at approximately 10.6 ft. below ground surface at the end of drilling.
- Groundwater was observed at approximately 8.5 ft. below ground surface 3.5 months after drilling completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
Tilled Soil
Silty SAND (SM): fine to coarse-grained, dark reddish brown, dry, loose

Older Alluvium (Qvoa)
Silty SAND (SM): fine to coarse-grained, dark reddish brown, dry to moist, trace clay
medium dense, weakly cemented

dense, trace mica

increase in clay

Clayey SAND (SC): fine to coarse-grained, dark yellowish brown, moist, dense, weakly to moderately cemented

hard drilling, smoke observed from borehole

Weathered Bedrock (Kgr)
GRANITE: light yellowish brown, moist, dense, decomposed to highly weathered, excavates as fine to medium-grained silty sand, trace clay

fine to coarse-grained

2" SCH 40 Slotted PVC Screen backfilled with #3 Sand

Date Begin - End: 7/29/2020
Logged By: H. Marquez
Hor.-Vert. Datum: Not Available
Plunge: -90 degrees
Weather: Sunny, 80s
Exploration Diameter: 8 in. O.D.

Dry Unit Wt. (pcf)
Passing #4 (%)
Passing #200 (%)
Approximate Ground Surface Elevation (ft.): 1,322.0 Surface Condition: Bare Earth
Approximate Elevation (feet)
Graphical Log
Depth (feet)
Laboratory Results
Sample Number
Sample Type
USC Symbol
Water Content (%)
Liquid Limit
Plasticity Index

1
BC=5 6 7 18°

2
BC=13 15 18 16°

3
BC=12 13 17 18°

4
BC=12 20 18 18°

5
BC=12 16 20 18°

6
BC=16 18 27 18°

Drilling Company: 2R Drilling
Drill Crew: Miguel/Brad
Drilling Equipment: CME-75
Hammer Type - Drop: 140 lb. Auto - 30 in.

Drilling Method: Hollow Stem Auger

BC=567
BC=131518
BC=121317
BC=122018
BC=161827
The piezometer was terminated at approximately 50.5 ft. below ground surface. The piezometer was backfilled with sand and pipe on July 29, 2020.

Groundwater was observed at approximately 44.9 ft. below ground surface after drilling completion.

The exploration location and elevation are approximate and were estimated by Kleinfelder.
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>PERCENTAGES</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BORING NO.</td>
<td>DEPTH (ft.)</td>
<td>GRAVEL</td>
<td>SAND</td>
</tr>
<tr>
<td>◆</td>
<td>B-1</td>
<td>10</td>
<td>3.8</td>
<td>59.5</td>
</tr>
<tr>
<td>■</td>
<td>B-1</td>
<td>25</td>
<td>3.1</td>
<td>89.4</td>
</tr>
<tr>
<td>▲</td>
<td>B-2</td>
<td>15</td>
<td>0.0</td>
<td>95.7</td>
</tr>
<tr>
<td>X</td>
<td>B-2</td>
<td>20</td>
<td>0.4</td>
<td>64.1</td>
</tr>
</tbody>
</table>

**GRAIN SIZE DISTRIBUTION**

Sky Canyon Sewer Project
Murrieta, CA

PROJECT NO.: 20207000.001A
TESTED BY: J. Diaz
DATE: 6/2/2020
CHECKED BY: J. Diaz
DATE:
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>PERCENTAGES</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH (ft.)</td>
<td>GRAVEL</td>
</tr>
<tr>
<td>🔺</td>
<td>6</td>
<td>B-4</td>
<td>1</td>
<td>1 - 5</td>
</tr>
<tr>
<td>□</td>
<td>6</td>
<td>B-4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>▲</td>
<td>6</td>
<td>B-4</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>×</td>
<td>6</td>
<td>B-4</td>
<td>6</td>
<td>25</td>
</tr>
</tbody>
</table>

### Grain Size Distribution

**Sky Canyon Sewer Project**  
**Murrieta, CA**

**Cobble** | **Gravel** | **Sand** | **Silt** | **Clay**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>PERCENTAGES</th>
<th>ATTERBERG LIMITS</th>
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<tbody>
<tr>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH (ft.)</td>
<td>GRAVEL</td>
</tr>
<tr>
<td>🔺</td>
<td>6</td>
<td>B-4</td>
<td>1</td>
<td>1 - 5</td>
</tr>
<tr>
<td>□</td>
<td>6</td>
<td>B-4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>▲</td>
<td>6</td>
<td>B-4</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>×</td>
<td>6</td>
<td>B-4</td>
<td>6</td>
<td>25</td>
</tr>
</tbody>
</table>

**Grain Size Distribution**

**Sky Canyon Sewer Project**  
**Murrieta, CA**

**Cobble** | **Gravel** | **Sand** | **Silt** | **Clay**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>PERCENTAGES</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH (ft.)</td>
<td>GRAVEL</td>
</tr>
<tr>
<td>🔺</td>
<td>6</td>
<td>B-4</td>
<td>1</td>
<td>1 - 5</td>
</tr>
<tr>
<td>□</td>
<td>6</td>
<td>B-4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>▲</td>
<td>6</td>
<td>B-4</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>×</td>
<td>6</td>
<td>B-4</td>
<td>6</td>
<td>25</td>
</tr>
</tbody>
</table>
Testing performed in general accordance with ASTM D4318

**SOIL CLASSIFICATION**
- Silty Sand (SM)
- Silty Sand with Gravel (SM)

**ATTERBERG LIMITS**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B-1</td>
<td>LL: 19</td>
<td>PL: 17</td>
</tr>
<tr>
<td></td>
<td>B-2</td>
<td>LL: 24</td>
<td>PL: 21</td>
</tr>
</tbody>
</table>

**PROJECT NO.:** 20182608.003A
**TESTED BY:** J. Calderon
**DATE:** 5/28/2020
**CHECKED BY:** J. Diaz
**DATE:** 6/4/2020

**PLASTICITY TESTING**

Sky Canyon Sewer Project
Murrieta, CA
Testing performed in general accordance with ASTM D4318

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SAMPLE IDENTIFICATION</th>
<th>ATTERBERG LIMITS</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BORING NO.</td>
<td>SAMPLE NO.</td>
<td>DEPTH (ft)</td>
</tr>
<tr>
<td>◆</td>
<td>B-4</td>
<td>1</td>
<td>1 - 5</td>
</tr>
</tbody>
</table>

**Figure**

**Project No.:** 20182608.003A  
**Tested By:** C. Massa  
**Date:** 8/7/2020  
**Checked By:** J. Diaz  
**Date:**  

**Sky Canyon Sewer Project**  
**Murrieta, CA**
Performed in general accordance with ASTM D 3080

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (ft)</th>
<th>COHESION (psf)</th>
<th>FRICTION ANGLE (deg)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAK</td>
<td>B-1</td>
<td>3</td>
<td>10.0</td>
<td>145.0</td>
<td>35</td>
<td>Silty Sand (SM)</td>
</tr>
<tr>
<td>ULTIMATE</td>
<td>B-1</td>
<td>3</td>
<td>10.0</td>
<td>163.0</td>
<td>32</td>
<td>Silty Sand (SM)</td>
</tr>
</tbody>
</table>

INITIAL MOISTURE (%): 10.8% Normal Stress (psf) 1000 2000 4000
INITIAL DRY DENSITY (pcf): 125.8 Peak Stress (psf) 775 1620 2880
FINAL MOISTURE (%): 15.9% Ultimate Stress (psf) 745 1500 2665

PROJECT NO.: 20182608.003A
TESTED BY: C. Massa
DATE: 6/1/2020
CHECKED BY: J. Diaz
DATE: 6/4/2020

DIRECT SHEAR TEST

Sky Canyon Sewer Project
Murrieta, CA

FIGURE

KLEINFELDER - 620 Magnolia Avenue, Building G | Ontario, California 91762 | PH: (909) 657-1716 | FAX: (909) 988-0185 | www.kleinfelder.com
Performed in general accordance with ASTM D 3080

### Soil Classification

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (ft)</th>
<th>COHESION (psf)</th>
<th>FRICTION ANGLE (deg)</th>
<th>SOIL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEAK</td>
<td>B-2</td>
<td>4</td>
<td>15.0</td>
<td>0.0</td>
<td>33</td>
<td>Poorly Graded Sand (SP)</td>
</tr>
<tr>
<td>ULTIMATE</td>
<td>B-2</td>
<td>4</td>
<td>15.0</td>
<td>0.0</td>
<td>31</td>
<td>Poorly Graded Sand (SP)</td>
</tr>
</tbody>
</table>

| INITIAL MOISTURE (%) | 3.8% | Normal Stress (psf) | 1000 | 2000 | 4000 |
| INITIAL DRY DENSITY (pcf) | 99.2 | Peak Stress (psf) | 564  | 1368 | 2568 |
| FINAL MOISTURE (%) | 27.4% | Ultimate Stress (psf) | 468  | 1200 | 2412 |
Boring No.: B-1  
Sample No.: 1  
Depth (feet.): 1-5  
Material Description: Silty Sand w/ Gravel (SM)

<table>
<thead>
<tr>
<th></th>
<th>Uncorrected</th>
<th>Corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Dry Unit Weight (pcf)</td>
<td>133.5</td>
<td>na</td>
</tr>
<tr>
<td>Optimum Water Content (%)</td>
<td>7.7</td>
<td>na</td>
</tr>
<tr>
<td>Oversize Fraction, retained on 3/8 (%)</td>
<td>&lt;5</td>
<td></td>
</tr>
<tr>
<td>Bulk Specific Gravity of Oversize Fraction</td>
<td>na</td>
<td></td>
</tr>
</tbody>
</table>

na = not applicable

Tested in accordance with: ASTM D1557, Method B

Compaction Curve

FIGURE

Sky Canyon Sewer Project  
Murrieta, CA
## CORROSION TEST RESULTS

**Client Name:** Kleinfelder  
**Project Name:** Sky Canyon Sewer Project  
**Project No.:** 20182608.003A  
**AP Job No.:** 20-0550  
**Date:** 06/01/20

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Sample No.</th>
<th>Depth (feet)</th>
<th>Soil Description</th>
<th>Minimum Resistivity (ohm-cm)</th>
<th>pH</th>
<th>Sulfate Content (ppm)</th>
<th>Chloride Content (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>4</td>
<td>15</td>
<td>Silty Sand</td>
<td>4459</td>
<td>7.9</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>B-2</td>
<td>3</td>
<td>10</td>
<td>Silty Sand</td>
<td>2886</td>
<td>8.2</td>
<td>22</td>
<td>23</td>
</tr>
</tbody>
</table>

**NOTES:**  
Resistivity Test and pH: California Test Method 643  
Sulfate Content: California Test Method 417  
Chloride Content: California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested
## CORROSION TEST RESULTS

Client Name: Kleinfelder  
AP Job No.: 20-0550  
Project Name: Sky Canyon Sewer Project  
Date: 08/11/20  
Project No.: 20182608.003A

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Sample No.</th>
<th>Depth (feet)</th>
<th>Soil Description</th>
<th>Minimum Resistivity (ohm-cm)</th>
<th>pH</th>
<th>Sulfate Content (ppm)</th>
<th>Chloride Content (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-4</td>
<td>1</td>
<td>1-5</td>
<td>Clayey Sand</td>
<td>1,804</td>
<td>6.9</td>
<td>63</td>
<td>46</td>
</tr>
</tbody>
</table>

**NOTES:**  
Resistivity Test and pH: California Test Method 643  
Sulfate Content: California Test Method 417  
Chloride Content: California Test Method 422  
ND = Not Detectable  
NA = Not Sufficient Sample  
NR = Not Requested
UNCONFINED COMPRESSION STRENGTH
OF INTACT ROCK CORE SPECIMEN
(ASME D7012 Method C)

<table>
<thead>
<tr>
<th>Project Name: Sky Canyon Sewer Project</th>
<th>Prepared by NG</th>
<th>Date 06/18/20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No. 20182608.003A</td>
<td>Tested by NG</td>
<td>Date 06/18/20</td>
</tr>
<tr>
<td>Boring No B-3</td>
<td>Calculated by JP</td>
<td>Date 06/19/20</td>
</tr>
<tr>
<td>Sample No 1</td>
<td>Checked by AP</td>
<td>Date 06/19/20</td>
</tr>
<tr>
<td>Depth: 16.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lithologic Description of the Rock: Rockcore

INITIAL CONDITION OF SPECIMEN

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Height</th>
<th>Weight Before</th>
<th>Area</th>
<th>Volume</th>
<th>Unit Weight</th>
<th>h/d Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.400</td>
<td>4.960</td>
<td>1059.02 g</td>
<td>4.52</td>
<td>22.4</td>
<td>179.8 pcf</td>
<td>2.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Container No.</th>
<th>Wt. Wet Soil+Container (g)</th>
<th>Moisture After Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>700.50</td>
<td>0.58</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wt. Dry Soil+Container (g)</th>
<th>Wt. Container (g)</th>
<th>Moisture, (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>697.27</td>
<td>142.27</td>
<td>0.58</td>
</tr>
</tbody>
</table>

SHEARING DATA

<table>
<thead>
<tr>
<th>Axial Load (lbs)</th>
<th>Compressive Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35290</td>
<td>7801</td>
</tr>
</tbody>
</table>

*Failure Types:
1. Cone
2. Cone and Split
3. Columnar Vertical Cracking
4. Shear
5. Side Fracture (Top or Bottom)
6. Side Fracture (Pointed)
7. Other

Remarks: ________________________________

Specimen Pictures:

[Image of specimen after test]
UNCONFINED COMpressive STRENGTH
OF INTACT ROCK CORE SPECIMEN
(ASTM D7012 Method C)

Project Name: Sky Canyon Sewer Project
Prepared by NG  Date 06/18/20
Project No. 20182608.003A  Tested by NG  Date 06/18/20
Boring No B-3  Calculated by JP  Date 06/19/20
Sample No 2  Checked by AP  Date 06/19/20
Depth: 23-24

Lithologic Description of the Rock: Rockcore

INITIAL CONDITION OF SPECIMEN

| Diameter   | 2.400 in |
| Height     | 5.030 in |
| Weight Before | 1088.44 g |
| Area       | 4.52 in² |
| Volume     | 22.8 in³ |
| Unit Weight| 182.2 pcf |
| h/d Ratio  | 2.1 |

Moisture After Test
- Container No.:
- Wt. Wet Soil+Container (g) 302.42
- Wt. Dry Soil+Container (g) 302.16
- Wt. Container (g) 141.96
- Moisture, (%) 0.16

SHEARING DATA

<table>
<thead>
<tr>
<th>Axial Load (lbs)</th>
<th>Compressive Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>61900</td>
<td>13683</td>
</tr>
</tbody>
</table>

**Failure Types:**
- 1 Cone
- 2 Cone and Split
- 3 Columnar Vertical Cracking
- 4 Shear
- 5 Side Fracture (Top or Bottom)
- 6 Side Fracture (Pointed)
- 7 Other

Specimen Pictures:

Remarks: 

[Images of specimen pictures]
UNCONFINED COMPRESSIVE STRENGTH
OF INTACT ROCK CORE SPECIMEN
(ASTM D7012 Method C)

Project Name: Sky Canyon Sewer Project
Prepared by NG Date 06/18/20
Project No. 20182608.003A Tested by NG Date 06/18/20
Boring No B-3 Calculated by JP Date 06/19/20
Sample No 3 Checked by AP Date 06/19/20
Depth: 31.5

Lithologic Description of the Rock: Rockcore

INITIAL CONDITION OF SPECIMEN

Diameter: 2.400 in
Height: 4.430 in
Weight Before: 967.47 g
Area: 4.52 in²
Volume: 20.0 in³
Unit Weight: 183.9 pcf
h/d Ratio: 1.8

Container No. Moisture After Test
Wt. Soil+Container (g) 438.64
Wt. Dry Soil+Container (g) 438.40
Wt. Container (g) 140.91
Moisture, (%) 0.08

SHEARING DATA

Axial Load
Compressive Strength (psi)

<table>
<thead>
<tr>
<th>Axial Load (lbs)</th>
<th>Compressive Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55860</td>
<td>12348</td>
</tr>
</tbody>
</table>

*Failure Types:

1. Cone
2. Cone and Split
3. Columnar Vertical Cracking
4. Shear
5. Side Fracture (Top or Bottom)
6. Side Fracture (Pointed)
7. Other

Specimen Pictures

Remarks: *The length to diameter ratio of the sample specimen does not meet the minimum specified ratio of 2.0:1*
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
(ASTM D7012 Method C)

Project Name: Sky Canyon Sewer Project
Prepared by NG Date 06/18/20
Project No. 20182608.003A Tested by NG Date 06/18/20
Boring No B-3 Calculated by JP Date 06/19/20
Sample No 4 Checked by AP Date 06/19/20
Depth: 32-32.5

Lithologic Description of the Rock: Rockcore

<table>
<thead>
<tr>
<th>Diameter (in)</th>
<th>Height (in)</th>
<th>Weight Before (g)</th>
<th>Container No.</th>
<th>Moisture After Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.396</td>
<td>5.060</td>
<td>1104.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area (in²)</th>
<th>Volume (in³)</th>
<th>Unit Weight (pcf)</th>
<th>h/d Ratio</th>
<th>Compressiive Strength (psi)</th>
<th>Axial Load (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.51</td>
<td>22.8</td>
<td>184.3</td>
<td>2.1</td>
<td>10732</td>
<td>48390</td>
</tr>
</tbody>
</table>

**Shearing Data**

<table>
<thead>
<tr>
<th>Specimen Pictures After Test</th>
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<table>
<thead>
<tr>
<th>Failure Types:</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
</tbody>
</table>

**Remarks:**

---

Compressive Specimen Pictures

Strength (psi)

10732

1

2

3

4

5

6

7

X

1

Cone

2

Cone and Split

3

Columnar Vertical Cracking

4

Shear

5

Side Fracture (Top or Bottom)

6

Side Fracture (Pointed)

7

Other
**UNCONFINED COMPRESSION STRENGTH OF INTACT ROCK CORE SPECIMEN**

(ASTM D7012 Method C)

<table>
<thead>
<tr>
<th>Project Name: Sky Canyon Sewer Project</th>
<th>Prepared by: NG</th>
<th>Date: 06/18/20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.: 20182608.003A</td>
<td>Tested by: NG</td>
<td>Date: 06/18/20</td>
</tr>
<tr>
<td>Boring No.: B-3</td>
<td>Calculated by: JP</td>
<td>Date: 06/19/20</td>
</tr>
<tr>
<td>Sample No.: 5</td>
<td>Checked by: AP</td>
<td>Date: 06/19/20</td>
</tr>
<tr>
<td>Depth: 34-34.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lithologic Description of the Rock: Rockcore

### INITIAL CONDITION OF SPECIMEN

<table>
<thead>
<tr>
<th>Diameter: 2.400 in</th>
<th>Height: 4.900 in</th>
<th>Weight Before: 1037.38 g</th>
<th>Area: 4.52 in²</th>
<th>Volume: 22.2 in³</th>
<th>Unit Weight: 178.3 pcf</th>
<th>h/d Ratio: 2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Container No.</th>
<th>Wt. Wet Soil+Container (g)</th>
<th>Moisture After Test</th>
<th>Wt. Dry Soil+Container (g)</th>
<th>Wt. Container (g)</th>
<th>Moisture, (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>516.80</td>
<td>0.73</td>
<td>514.11</td>
<td>144.28</td>
<td></td>
</tr>
</tbody>
</table>

### SHEARING DATA

<table>
<thead>
<tr>
<th>Axial Load (lbs)</th>
<th>Compressive Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41810</td>
<td>9242</td>
</tr>
</tbody>
</table>

**Failure Types:**

1. Cone
2. Cone and Split
3. Columnar Vertical Cracking
4. Shear
5. Side Fracture (Top or Bottom)
6. Side Fracture (Pointed)
7. Other

**Remarks:**

---

**Specimen Pictures After Test**

![Specimen Picture]
APPENDIX C
ROCK CORE PHOTOS
The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Kleinfelder makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.
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Run 6c-27.5 to 28.7 ft
Run 7a-29.5 to 31.0 ft
Run 7b-31.0 to 33.5 ft
Run 7c-32.5 to 34.0 ft
Run 8-34.0 to 35.0 ft

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