# APPENDIX E1

Preliminary Geotechnical Evaluation

LGC Geotechnical, Inc.

January 21, 2022

Project No. 21250-01

Mr. Tom Dallape
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***Subject:*** ***Preliminary Geotechnical Evaluation for the Proposed Residential Development, Bluff Street and River Road, City of Norco, California***

In accordance with your request, LGC Geotechnical, Inc. has performed a geotechnical evaluation including near surface organic content for the proposed 34-acre residential development located to the east of the intersection of Bluff Street and River Road in the City of Norco, California. This report summarizes the results of our background review, subsurface exploration, and geotechnical analyses of the data collected, and presents our findings, conclusions, and preliminary recommendations for the proposed residential project.

If you should have any questions regarding this report, please do not hesitate to contact our office. We appreciate this opportunity to be of service.

Respectfully,

***LGC Geotechnical, Inc.***

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# *1.0 INTRODUCTION*

## *1.1 Purpose and Scope of Services*

This report presents the results of our geotechnical evaluation including near surface organic content for the proposed approximately 34-acre development in the City of Norco, California (see Site Location Map, Figure 1). The purpose of our work was to collect subsurface data in order to prepare a geotechnical report providing recommendations for design and construction of the proposed project. Our scope of services included:

- Review of pertinent readily available geotechnical information and geologic maps (Appendix A).
- Subsurface investigation including excavation, sampling, and logging of 7 small-diameter hollow stem borings.
- Excavation of 19 exploratory geotechnical trenches throughout the site to aid in estimating the depth of required removals during grading, assist in characterizing the near surface soils, and to assess the organic content of near surface "soils".
- Laboratory testing of representative samples obtained during our subsurface investigation (Appendix C).
- Geotechnical analysis and evaluation of the data obtained, including:
    - Suitability of the site for the proposed development from a geotechnical standpoint;
    - Description of the site geology, and subsurface soil and groundwater conditions;
    - Assessment of the organic content of near surface "soils" including recommendations for offsite organic export and/or mixing;
    - Evaluation of the seismic conditions at the site, including seismic design criteria based on the 2019 California Building Code (CBC); and
    - Recommendations for remedial grading operations and site preparation.
- Preparation of this report presenting our findings, conclusions and recommendations with respect to the proposed site development.

## *1.2 Existing Site Conditions and Proposed Improvements*

The roughly rectangular shaped site is approximately 34 acres in size with minor relief. The site is composed of two neighboring parcels, and is bounded to the north by Bluff Street, the south by existing residential development, the west by River Road, and to the East by additional residential development. The southern portion of the site is a former dairy that has been inactive for several years, while the northern area has been used by the city as a spoils/staging yard. There are currently active city water wells within the northern portion of the site. A review of historic aerial photographs suggests the southern site has been used as for dairy and/or agricultural use dating back to at least 1948.

Based on the preliminary grading plans (MDS, 2021), the site will consist of residential units and associated street improvements. Storm water infiltration is planned in proposed basins in the northeast and southwest portions of the site. We expect the proposed residential development will be at-grade with relatively light building loads. The site will have little relief with proposed cuts and fills anticipated to be on the order of 5 to 10 feet, respectively.

The recommendations provided herein are based upon the estimated structural loading and expected layout information above. We understand that project plans are currently being developed at this time; LGC Geotechnical should be provided with updated project plans and any changes to the assumed structural loads when they become available, in order to either confirm or modify the recommendations provided herein.

## *1.3 Subsurface Evaluation*

LGC Geotechnical performed a subsurface geotechnical evaluation of the site consisting of the excavation of 4 hollow-stem auger borings, 3 infiltration borings, and 19 exploratory geotechnical trenches including organic testing.

Seven hollow-stem borings (HS-1 through HS-4, I-1 through I-3) were drilled to depths ranging from approximately 5 to 51.5 feet below existing grade. An LGC Geotechnical representative observed the drilling operations, logged the borings, and collected soil samples for laboratory testing. The borings were excavated using a truck-mounted drill rig equipped with 8-inch-diameter hollow-stem augers. Driven soil samples were collected by means of the Standard Penetration Test (SPT) and Modified California Drive (MCD) sampler generally obtained at 2.5 to 5-foot vertical increments. The MCD is a split-barrel sampler with a tapered cutting tip and lined with a series of 1-inch-tall brass rings. The SPT sampler and MCD sampler were driven using a 140-pound automatic hammer falling 30 inches to advance the sampler a total depth of 18 inches. The raw blow counts for each 6-inch increment of penetration were recorded on the boring logs. Bulk samples were also collected and logged at select depths for laboratory testing. At the completion of drilling, the borings were backfilled with the native soil cuttings and tamped. Some settlement of the backfill soils may occur over time.

Field infiltration testing was performed within borings (I-1 through I-3) at total depths ranging from 5 to 11 feet below existing grade, respectively. An LGC Geotechnical staff engineer installed standpipes, backfilled the boring annulus with crushed rock, and pre-soaked the infiltration wells prior to testing. Infiltration testing was performed in accordance with the County of Riverside testing guidelines. The infiltration test wells were subsequently backfilled with native soils and at the completion of testing.

Nineteen exploratory geotechnical trenches (TP-1 through TP-19) were excavated utilizing a standard backhoe in order to estimate removal depths and obtain samples for laboratory testing. A staff geologist observed the operation, logged the geotechnical trenches and collected soil samples. Each exploratory geotechnical trench was also logged and sampled for the organic content of the near surface "soils." Organic samples were collected at various depths within each trench. The exploratory geotechnical trenches were subsequently backfilled with tamped native soils.

The approximate locations of borings and trenches are shown on the Geotechnical Map (Figure 2). Boring and geotechnical trench logs are presented in Appendix B.

### *1.4 Laboratory Testing*

Laboratory testing was performed on representative soil samples obtained from our subsurface evaluation. Laboratory testing included in-situ moisture and density tests, fines content, Atterberg Limits (liquid limit and plastic limits), collapse/swell potential, expansion index, laboratory compaction and corrosion (sulfate and chloride). Additionally, the near surface organic content trench samples were tested for characterization of the organic content (ASTM 2974).

The following is a summary of the laboratory test results.

- Dry density of the samples collected ranged from approximately 97 pounds per cubic foot (pcf) to 125 pcf, with an average of approximately 110 pcf. Field moisture contents ranged from approximately 2 percent to 34 percent, with an average of approximately 13 percent.
- 3 fines content tests were performed (passing No. 200 sieve). Results indicated fines contents from approximately 39 to 66%, with an average of 50%. Based on the Unified Soils Classification System (USCS), tested samples would be classified as "coarse-grained" and "fine-grained."
- One Atterberg Limit (liquid limit and plastic limit) test was performed. The result indicated a Plasticity Index value of 39.
- Two swell/collapse tests were performed. The plots are provided in Appendix C.
- One Expansion Index (EI) test was performed. The result indicates an EI value of 24, corresponding to "Low" expansion potential.
- One laboratory compaction test of a near surface sample indicated maximum dry density of 117.0 pcf with an optimum moisture content of 12 percent.
- Corrosion testing indicated a soluble sulfate content of less than approximately 0.016 percent, a chloride content of 960 parts per million (ppm), pH of 9.8, and a minimum resistivity of 1,900 ohm-centimeters.
- The organic content of the samples ranged from approximately 0.5 to 60.9 percent.

A summary of the results is presented in Appendix C. The moisture and dry density test results are presented on the boring logs in Appendix B.

# *2.0 GEOTECHNICAL CONDITIONS*

## *2.1 Regional Geology*

The subject site is located south of the San Gabriel Mountains within the broad alluvial plain of the Santa Ana River Basin, within the Peninsular Ranges Geomorphic Province. Specifically, the site is located within the northern portion of the Perris Block, a geologic zone consisting of granitics overlain by sedimentary deposits that are bounded by active faults including the northwest-trending Whittier-Elsinore Fault Zone at the southwest and the northwest-trending San Jacinto Fault Zone at the northeast (USGS, 2002). The roughly rectangular Perris Block is transected by the southwest-trending Santa Ana River that passes approximately 1,700 feet north of the subject site.

Regional geologic mapping and local topographic expressions do not indicate the presence of large-scale landslides within or adjacent to the project area.

## *2.2 Site Geology and Generalized Subsurface Conditions*

Based on regional mapping (USGS, 2002 & 2003), the subject site is underlain by Pleistocene-age very old alluvial channel deposits (Qvoa). These materials are locally overlain by thin areas of undocumented artificial fill. For the purposes of this study, these areas of fill are not differentiated from the native sediments.

As indicated in our field explorations, soils generally consisted of medium dense to dense sands and silty sands with thinner layers of stiff to very stiff fine-grained soils (i.e., silts and clays) to the maximum explored depth of approximately 50 feet below existing grade. Descriptions of the subsurface conditions are presented on the boring and geotechnical test pit logs located in Appendix B. A brief description of the site geologic units can be found below.

It should be noted that our excavations are only representative of the location and time where/when they are performed and varying subsurface conditions may exist outside of the performed location. In addition, subsurface conditions can change over time. The soil descriptions provided above should not be construed to mean that the subsurface profile is uniform, and that soil is homogeneous within the project area. For details on the stratigraphy at the exploration locations, refer to Appendix B.

## *2.3 Groundwater*

Our subsurface evaluation encountered groundwater boring HS-3 at approximately 43 feet below existing grade, at an approximate elevation of 523 feet msl. Groundwater levels recorded by the California Department of Water Resources approximately 0.5 miles to the north adjacent the Santa Ana River, indicate historical groundwater elevations ranging from 536 to 539 feet msl (CDWR, 2022), or approximately 31 to 34 feet below existing site grades.

In general, groundwater levels fluctuate with the seasons and local zones of perched groundwater may be present within the near-surface deposits due to local seepage or during rainy seasons. Groundwater conditions below the site may be variable, depending on numerous factors including seasonal rainfall, local irrigation and groundwater pumping, among others.

## 2.4 Field Infiltration Testing

Three field percolation tests were performed on Borings I-1, I-2, and I-3 to approximate depths of 5, 5, and 10 feet below existing grade, respectively. Estimation of infiltration rates was performed in general accordance with guidelines set forth by the Riverside County Flood Control (2011). In general, a 3-inch diameter perforated PVC pipe was placed in each borehole to be tested and the annulus was backfilled with gravel, including placement of about 2 inches of gravel at the bottom of the borehole. The infiltration wells were pre-soaked prior to testing. Based on the County of Riverside methodology, the calculated (observed) infiltration rates are provided in Table 1 below. These infiltration rates do not include any factor of safety (to be determined by the project Civil Engineer); however, they have been normalized to correct the 3-D flow that occurs within the field test to 1-D flow out of the bottom of the boring only. The locations and depths of the infiltration tests were coordinated with the civil engineer. The approximate infiltration test locations are shown on the Geotechnical Map (Figure 2) and the infiltration test data is included in Appendix D and summarized below.

***TABLE 1***

***Summary of Infiltration Testing***

| Infiltration Test Location | Infiltration Test Depth Below Existing Grade (ft) | Observed Infiltration Rate* (Inch/Hr.) |
|---|---|---|
| I-1 | 5 | 1.6 |
| I-2 | 5 | 0.8 |
| I-3 | 11 | 36.4 |

*Normalized to One-Dimensional Flow, does not include any Factor of Safety.

It should be emphasized that infiltration test results are only representative of the location and depth where they are performed. Varying subsurface conditions may exist outside of the test locations which could alter the calculated infiltration rates indicated above. Infiltration tests are performed using relatively clean water free of particulates, silt, etc. Refer to Section 4.8 for subsurface water infiltration recommendations.

## 2.5 Faulting and Seismic Hazards

California is located on the boundary between the Pacific and North American Lithospheric Plates. The average motion along this boundary is on the order of 50-mm/yr. in a right-lateral sense. The majority of the motion is expressed at the surface along the northwest trending San Andreas Fault Zone with lesser amounts of motion accommodated by sub-parallel faults located predominantly west of the San Andreas including the Elsinore, Newport-Inglewood, Rose Canyon, and Coronado Bank Faults. Within Southern California, a large bend in the San Andreas Fault north of the San Gabriel Mountains has resulted in a transfer of a portion of the right-lateral motion between the plates into left-lateral displacement and vertical uplift. Compression south and west of the bend has resulted in folding, left-lateral, reverse thrust faulting, and regional uplift creating the east-west trending Transverse Ranges and several east-west trending faults. Further south within the Los Angeles Basin, "blind thrust" faults are believed to have developed below the surface also as a result of this compression, which have resulted in earthquakes such as the 1994 Northridge event along faults with little to no surface expression.

Prompted by damaging earthquakes in Northern and Southern California, State legislation and policies concerning the classification and land-use criteria associated with faults have been developed. The Alquist-Priolo Earthquake Fault Zoning Act was implemented in 1972 to prevent the construction of urban developments across the trace of active faults. California Geologic Survey Special Publication 42 was created to provide guidance for following and implementing the law requirements. Special Publication 42 was most recently revised in 2018 (CGS, 2018). According to the State Geologist, an "active" fault is defined as one which has had surface displacement within Holocene time (roughly the last 11,700 years). Regulatory Earthquake Fault Zones have been delineated to encompass traces of known, Holocene-active faults to address hazards associated with surface fault rupture within California. Where developments for human occupation are proposed within these zones, the state requires detailed fault evaluations be performed so that engineering-geologists can identify the locations of active faults and recommend setbacks from locations of possible surface fault rupture.

The subject site is <u>not</u> located within an Alquist-Priolo Earthquake Fault Zone and no faults were identified on the site during our site evaluation. The possibility of damage due to ground rupture is considered low since no active faults are known to cross the site.

Secondary effects of seismic shaking resulting from large earthquakes on the major faults in the Southern California region, which may affect the site, include ground lurching, shallow ground rupture, soil liquefaction and dynamic settlement. These secondary effects of seismic shaking are a possibility throughout the Southern California region and are dependent on the distance between the site and causative fault and the onsite geology. A discussion of these secondary effects is provided in the following sections.

### *2.5.1 Liquefaction and Dynamic Settlement*

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave similarly to a fluid when subject to high-intensity ground shaking. Liquefaction occurs when three general conditions coexist: 1) shallow groundwater; 2) low density non-cohesive (granular) soils; and 3) high-intensity ground motion. Studies indicate that loose, saturated, near-surface, cohesionless soils exhibit the highest liquefaction potential, while dry, dense, cohesionless soils, and cohesive soils exhibit low to negligible liquefaction potential. In general, cohesive soils are not considered susceptible to liquefaction. Effects of liquefaction on level ground include settlement, sand boils, and bearing capacity failures below structures. Furthermore, dynamic settlement of dry sands can occur as the sand particles tend to settle and densify as a result of a seismic event.

Based on our review of the City of Norco Local Hazard Mitigation Plan (Norco, 2017), the subject site is in an area of potential liquefaction within which groundwater is shallower than 30 feet. The data obtained from our field evaluation indicates that the site contains isolated silty/sandy layers susceptible to liquefaction in the upper 50 feet. Liquefaction potential was evaluated using the procedures outlined by Special Publication 117A (SCEC, 1999 & CGS, 2008). Liquefaction analysis was performed on the 50-foot boring (HS-3) based on the seismic criteria ($PGA_M$) of the 2019 California Building Code (CBC) and the estimated high groundwater depth of 20 feet below existing grade.

Results indicate total seismic settlement, as a result of liquefaction of sand layers below 20 feet from the ground surface, on the order of 1.5-inches or less. Differential seismic settlement can be estimated as half of the total estimated settlement over a horizontal span of about 40 feet. Liquefaction calculations are provided in Appendix E.

### *2.5.2 <u>Lateral Spreading</u>*

Lateral spreading is a type of liquefaction-induced ground failure associated with the lateral displacement of surficial blocks of sediment resulting from liquefaction in a subsurface layer. Once liquefaction transforms the subsurface layer into a fluid mass, gravity plus the earthquake inertial forces may cause the mass to move downslope towards a free face (such as a river channel or an embankment). Lateral spreading may cause large horizontal displacements and such movement typically damages pipelines, utilities, bridges, and structures.

The site sandy soils anticipated to be left in place (below the recommended temporary removal and recompaction depths) generally have a SPT $(N_1)_{60}$ blow count well above 15. Soils with a corrected SPT $(N_1)_{60}$ blow count of 15 or greater are generally not considered susceptible to lateral spreading (Youd, Hansen, Bartlett, 2002). Furthermore, isolated sandy layers susceptible to liquefaction were generally found not to be laterally continuous and dense formational bedrock materials were encountered at a depth of approximately 50 feet below existing grade.

Due to the subsurface data, depth of proposed earthwork removals, presence of dense sandy soils below the recommended earthwork removals, and limited nature of potentially liquefiable soils, the potential for lateral spreading is considered low.

## *2.6 Seismic Design Criteria*

The site seismic characteristics were evaluated per the guidelines set forth in Chapter 16, Section 1613 of the 2019 California Building Code (CBC) and applicable portions of ASCE 7-16 which has been adopted by the CBC. **Please note that the following seismic parameters are only applicable for code-based acceleration response spectra and are not applicable for where site-specific ground motion procedures are required by ASCE 7-16.** Representative site coordinates of latitude 33.917662 degrees north and longitude -117.591572 degrees west were utilized in our analyses. The maximum considered earthquake (MCE) spectral response accelerations ($S_{MS}$ and $S_{M1}$) and adjusted design spectral response acceleration parameters ($S_{DS}$ and $S_{D1}$) for Site Class D are provided in Table 2 on the following page. Since site soils are Site Class D, additional adjustments are required to code acceleration response spectrums as outlined below and provided in ASCE 7-16. The structural designer should contact the geotechnical consultant if structural conditions (e.g., number of stories, seismically isolated structures, etc.) require site-specific ground motions.

A deaggregation of the PGA based on a 2,475-year average return period (MCE) indicates that an earthquake magnitude of 6.67 at a distance of approximately 10.49 km from the site would contribute the most to this ground motion. A deaggregation of the PGA based on a 475-year average return period (Design Earthquake) indicates that an earthquake magnitude of 6.64 at a distance of approximately 13.37 km from the site would contribute the most to this ground motion (USGS, 2014).

Section 1803.5.12 of the 2019 CBC (per Section 11.8.3 of ASCE 7) states that the maximum considered earthquake geometric mean ($MCE_G$) Peak Ground Acceleration (PGA) should be used for liquefaction potential. The $PGA_M$ for the site is equal to 0.795g (SEAOC, 2022).

***TABLE 2***

***Seismic Design Parameters***

| Selected Parameters from 2019 CBC, Section 1613 - Earthquake Loads | Seismic Design Values | Notes/Exceptions |
|---|---|---|
| Distance to applicable faults classifies the site as a "Near-Fault" site. | | Section 11.4.1 of ASCE 7 |
| Site Class | D* | Chapter 20 of ASCE 7 |
| Ss (Risk-Targeted Spectral Acceleration for Short Periods) | 1.713g | From SEAOC, 2021 |
| $S_1$ (Risk-Targeted Spectral Accelerations for 1-Second Periods) | 0.666g | From SEAOC, 2021 |
| $F_a$ (per Table 1613.2.3(1)) | 1.0 | For Simplified Design Procedure of Section 12.14 of ASCE 7, $F_a$ shall be taken as 1.4 (Section 12.14.8.1) |
| $F_v$ (per Table 1613.2.3(2)) | 1.7 | Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7 |
| $S_{MS}$ for Site Class D [Note: $S_{MS} = F_aS_S$] | 1.713g | - |
| $S_{M1}$ for Site Class D [Note: $S_{M1} = F_vS_1$] | 1.132g | Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7 |
| $S_{DS}$ for Site Class D [Note: $S_{DS} = (^2/_3)S_{MS}$] | 1.142g | - |
| $S_{D1}$ for Site Class D [Note: $S_{D1} = (^2/_3)S_{M1}$] | 0.755g | Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7 |
| $C_{RS}$ (Mapped Risk Coefficient at 0.2 sec) | 0.925 | ASCE 7 Chapter 22 |
| $C_{R1}$ (Mapped Risk Coefficient at 1 sec) | 0.915 | ASCE 7 Chapter 22 |
| *Since site soils are Site Class D and $S_1$ is greater than or equal to 0.2, the seismic response coefficient Cs is determined by Eq. 12.8-2 for values of $T \leq 1.5T_s$ and taken equal to 1.5 times the value calculated in accordance with either Eq. 12.8-3 for $T_L \geq T > T_s$, or Eq. 12.8-4 for $T > T_L$. Refer to ASCE 7-16. | | |

## *2.7 Organic Rich Soils*

A total of 32 bag soil samples were collected to determine their organic content (based on ASTM 2974). The organic content of the samples ranged from approximately 0.5 to 60.9 percent. In general, the organic content is higher near existing grade and decreases with depth. Table 7 (Appendix C) summarizes the measured organic content. The Geotechnical Map (Figure 2) and Table 7 provide our recommended depth of high organic export, which is based on a combination of the organic content laboratory test results and our visual observations of the trenches.

On average, the upper approximately 6 inches (0.5-foot) of “soil” across the southern portion previously used as a dairy of the site is recommended for export and disposal off-site due to high organic content (greater than 5.0 percent). It is expected that the next approximately 1 foot (at maximum) of soil below the recommended high organic export depth, within the transition zone, has an organic content between approximately 2 and 5 percent and can remain onsite. Below this, the materials are generally “clean” low organic soils. Recommendations for handling of organic rich soils are provided in the following “Organic Rich Soil Recommendations” Section 4.1.2.

## *3.0 CONCLUSIONS*

Based on the results of our subsurface geotechnical evaluation, it is our opinion that the proposed improvements are feasible from a geotechnical standpoint, provided that the recommendations contained in the following sections are incorporated during site grading and development. A summary of our geotechnical conclusions are as follows:

- The near-surface loose and compressible soils are not suitable for the planned improvements in their present condition (refer to Section 4.1). Organic rich soils (total organic carbon content generally greater than 5 percent) are not suitable for compacted fill soils from a geotechnical perspective.
- From a geotechnical perspective, onsite soils are anticipated to be suitable for use as general compacted fill provided the high organic content soils (soils with organic content greater than 5 percent) are removed from the site and the remaining soils with organic content between 2 and 5 percent are blended and mixed with "clean" soils and screened of construction debris and any oversized material (8 inches in greatest dimension).
- Groundwater was encountered in boring HS-3 at approximately 43 feet below existing grade. Historical levels recorded in the area indicate groundwater highs from approximately 31 to 34 feet below ground surface.
- The subject study area is not located within a mapped State of California Earthquake Fault Zone, and based upon our review of published geologic mapping, no known active or potentially active faults are known to exist within or in the immediate vicinity of the site. Therefore, the potential for ground rupture as a result of faulting is considered very low.
- The main seismic hazard that may affect the site is ground shaking from one of the active regional faults. The subject site will likely experience strong seismic ground shaking during its design life.
- Based on our review of the City of Norco Local Hazard Mitigation Plan (Norco, 2017), the subject site is bounded in an area of potential liquefaction within which groundwater is shallower than 30 feet. Total dynamic settlement is estimated to be on the order 1.5 inches or less. Differential settlement may be estimated as half of the total settlement over a horizontal span of 40 feet.
- Based on the results of preliminary laboratory testing, site soils are anticipated to have "Low" expansion potential. Final design expansion potential must be determined at the completion of grading.
- Based on the corrosion test results, soils are considered corrosive per the Caltrans criteria (Caltrans, 2018).
- Excavations into the existing site soils should be feasible with heavy construction equipment in good working order. We anticipate that the sandy and silty earth materials generated from the excavations will be generally suitable for re-use as compacted fill, provided they are relatively free of rocks larger than 8 inches in dimension, construction debris, and significant organic material.
- Some portion of the onsite soils have high fines content; therefore, are not suitable for backfill of site retaining walls. Therefore, import of sandy soils meeting project recommendations is required for retaining wall backfill.
- Field testing resulted in observed infiltration rates ranging from 0.8 to 36.4 inches per hour. The observed infiltration rates do not include a factor of safety. Discussion regarding infiltration is provided in Section 4.8.

## *4.0 RECOMMENDATIONS*

The following recommendations are to be considered preliminary and should be confirmed upon completion of grading and earthwork operations. In addition, they should be considered minimal from a geotechnical viewpoint, as there may be more restrictive requirements from the architect, structural engineer, building codes, governing agencies, or the owner.

It should be noted that the following geotechnical recommendations are intended to provide sufficient information to develop the site in general accordance with the 2019 CBC requirements. With regard to the possible occurrence of potentially catastrophic geotechnical hazards such as fault rupture, earthquake-induced landslides, liquefaction, etc. the following geotechnical recommendations should provide adequate protection for the proposed development to the extent required to reduce seismic risk to an "acceptable level." The "acceptable level" of risk is defined by the California Code of Regulations as "that level that provides reasonable protection of the public safety, though it does not necessarily ensure continued structural integrity and functionality of the project" [Section 3721(a)]. Therefore, repair and remedial work of the proposed improvement may be required after a significant seismic event. With regards to the potential for less significant geologic hazards to the proposed development, the recommendations contained herein are intended as a reasonable protection against the potential damaging effects of geotechnical phenomena such as expansive soils, fill settlement, groundwater seepage, etc. It should be understood, however, that our recommendations are intended to maintain the structural integrity of the proposed development and structures given the site geotechnical conditions but cannot preclude the potential for some cosmetic distress or nuisance issues to develop as a result of the site geotechnical conditions.

The geotechnical recommendations contained herein must be confirmed to be suitable or modified based on the actual as-graded conditions.

### *4.1 Site Earthwork*

Rough grading shall include export of high organic content soils, remedial earthwork grading including mixing and blending followed by placement of engineered compacted fill to design grades. Geotechnical recommendations for precise grading and construction of the proposed new improvements will be provided, as necessary.

We recommend that earthwork onsite be performed in accordance with the following recommendations, future grading plan review report(s), the 2019 CBC/City of Norco requirements, and the General Earthwork and Grading Specifications for Rough Grading included in Appendix E. In case of conflict, the following recommendations shall supersede those included in Appendix E. The following recommendations may be revised within future grading plan review reports or based on the actual conditions encountered during site grading.

#### *4.1.1 Site Preparation*

Prior to grading, areas to be developed should undergo the stripping and clearing of vegetation, high organic content soil removal/export and clearing of surface obstructions, pavements, foundation and slab elements from the site. Vegetation, debris and excessive organic material from livestock holding areas should be removed and properly disposed of offsite. Recommendations for removal of organic rich soils are provided in the following section. Holes resulting from removals of buried obstructions, which extend below proposed remedial and/or finish grades, should be replaced with suitable compacted fill material.

If cesspools or septic systems are encountered, they should be removed in their entirety. The resulting excavation should be backfilled with properly compacted fill soils. As an alternative, cesspools can be backfilled with lean sand-cement slurry. Any encountered wells should be properly abandoned in accordance with regulatory requirements.

#### *4.1.2 Organic Rich Soil Recommendations*

We recommend soils with an organic content greater than 5 percent be removed and exported from the site. For most of the site this is the top 6 inches (0.5-foot). Figure 2 outlines areas that contains high organic content needing removal and export. Our recommendations are based on the following assumptions; 1) all soils with "high" organic contents greater than 5 percent shall be removed and disposed of off-site, 2) "transitional" soils (soils with organic content ranging from 2 to 5 percent) shall be adequately mixed or blended with the "clean" soils (soils with organic content less than 2.0 percent), and 3) There will be sufficient "clean" soils to dilute the limited "transitional" soils during the grading operation. From a geotechnical perspective, organic content of compacted fill soils should not exceed 2 percent.

After export of the top 6 inches (0.5-foot) of material, remedial grading as described in the following section should result in organic content of the fill materials to be less than approximately 2 percent. If necessary to satisfy City requirements of documenting the organic content in the fill, samples should be collected during grading and tested for organic content.

We recommend the geotechnical consultant be present during grading to observe the mixing of the onsite soils and perform periodic testing of the compacted fill. Organic materials shall be thoroughly mixed such that no nesting of organic materials occurs. Removal of organic materials is to satisfy geotechnical concerns and does not mitigate the potential for methane gas. Some methane gas should be expected after grading especially in former wastewater areas. Methane potential shall be evaluated by others.

Areas were buried or mounded/stockpiled unsuitable materials (i.e., trash, debris and organic rich farming soil mix) are found shall not be reused as compacted fill. Some of the unsuitable materials such as trash/soil mixes and debris/soil mixes may be processed and cleaned on-site by separating the unsuitable materials (i.e., trash, debris and organics) from the soil prior to placing as fill. However, if cleaning and separating trash, debris and organics from the soil is not practical, the unsuitable materials shall be removed and exported from the site.

### *4.1.3 Removal Depths and Limits*

In order to provide a relatively uniform bearing condition for the planned improvements, we recommend the site soils be removed and recompacted. We recommend that soils within building pads be removed and recompacted to a minimum depth of 5 feet below existing grade (prior to organic removal). The envelope for removal and recompaction should extend laterally a minimum distance of 5 feet beyond the edges of the proposed improvements.

In areas of design cut, over-excavation shall extend a minimum of 5 feet below existing grade or a minimum of 3 feet below finished grade, whichever is deeper. In the design cut areas, this depth may be reduced if in-place alluvial materials are tested and found to have an in-situ dry density equal or greater than 90 percent relative compaction (based on American Standard of Testing and Materials [ASTM] Test Method D1557) and exhibit uniform conditions. A representative from LGC geotechnical should be on site to approve the removal bottom to ensure it is acceptable from a geotechnical standpoint, and free of organic content.

For minor site structures such as free-standing and screen walls, the removals should extend at least 3 feet beneath the existing grade or 2 feet beneath the base of foundations, whichever is deeper. Within pavement and hardscape areas, removals should extend to a depth of at least 2 feet below the existing grade. The over-excavation in any design cut areas of the pavement may be reduced by the depth of the design cut but should not be less than 1-foot below the finished subgrade (i.e., below planned aggregate base/asphalt concrete). In general, the envelope for over-excavation should extend laterally a minimum distance of 2 feet beyond the edges of the proposed improvements mentioned above.

Local conditions may be encountered during excavation that could require additional over-excavation beyond the above-noted minimum in order to obtain an acceptable subgrade. The actual depths and lateral extents of grading will be determined by the geotechnical consultant, based on subsurface conditions encountered during grading. Removal areas and areas to be over-excavated should be accurately staked in the field by the Project Surveyor.

### *4.1.4 Temporary Excavations*

Temporary excavations should be performed in accordance with project plans, specifications, and applicable Occupational Safety and Health Administration (OSHA) requirements. Excavations should be laid back or shored in accordance with OSHA requirements before personnel or equipment are allowed to enter. Based on our field investigation, the majority of site soils are anticipated to be OSHA Type “B” soils (refer to the attached boring logs). Sandy soils are present and should be considered susceptible to caving. Soil conditions should be regularly evaluated during construction to verify conditions are as anticipated. The contractor shall be responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Close coordination with the geotechnical consultant should be maintained to facilitate construction while providing safe excavations. Excavation safety is the sole responsibility of the contractor.

Vehicular traffic, stockpiles, and equipment storage should be set back from the perimeter of excavations a minimum distance equivalent to a 1:1(horizontal to vertical) projection from the bottom of the excavation or 5 feet, whichever is greater. Once an excavation has been initiated, it should be backfilled as soon as practical. Prolonged exposure of temporary excavations may result in some localized instability. Excavations should be planned so that they are not initiated without sufficient time to shore/fill them prior to weekends, holidays, or forecasted rain.

It should be noted that any excavation that extends below a 1:1 (horizontal to vertical) projection of an existing foundation will remove existing support of the structure foundation. If requested, temporary shoring parameters will be provided.

#### ***4.1.5 <u>Subgrade Preparation</u>***

In general, areas to receive compacted fill should be scarified to a minimum depth of 6 inches, brought to a near-optimum moisture condition (generally within optimum and 2 percent above optimum moisture content), and re-compacted per project requirements. Removal bottoms and areas to receive fill should be observed and accepted by the geotechnical consultant prior to subsequent fill placement.

#### ***4.1.6 <u>Material for Fill</u>***

From a geotechnical perspective, the onsite soils are generally considered suitable for use as general compacted fill, provided they are screened of organic materials, construction debris and any oversized material (8 inches in greatest dimension). From a geotechnical perspective, soils with an organic content of less than 2 percent are generally considered suitable for re-use as compacted fill.

From a geotechnical viewpoint, import soils for general fill (i.e., non-retaining wall backfill) should consist of clean, granular soils of Very Low expansion potential (expansion index 20 or less based on ASTM D4829). Import for retaining wall backfill should meet the criteria outlined in the paragraph below. Source samples should be provided to the geotechnical consultant for laboratory testing a minimum of three working days prior to any planned importation.

Retaining wall backfill should consist of granular free draining soils (sand equivalent of 30 or greater as determined by ASTM D2419 or CTM 217). Soils should also be screened of organic materials, construction debris, and any material greater than 3 inches in maximum dimension. The onsite soils are not considered suitable for retaining wall backfill due to their fines content (i.e., silt and clay content). Therefore, import of suitable soils meeting the criteria outlined above will be required.

Aggregate base should conform to the requirements of Section 200-2 of the most recent version of the Standard Specifications for Public Works Construction ("Greenbook") for untreated base materials and/or City of Norco requirements.

### *4.1.7 <u>Placement and Compaction of Fills</u>*

Material to be placed as fill should be brought to near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content) and recompacted to at least 90 percent relative compaction (per ASTM D1557). Moisture conditioning of site soils will be required in order to achieve adequate compaction. Drying and/or mixing the very moist soils will be required prior to reusing the materials in compacted fills. Soils are also present that will require additional moisture in order to achieve the required compaction.

The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in compacted thickness. Each lift should be thoroughly compacted and accepted prior to subsequent lifts. Generally, placement and compaction of fill should be performed in accordance with local grading ordinances and with observation and testing by LGC Geotechnical. Oversized material as previously defined should be removed from site fills.

During backfill of excavations, the fill should be properly benched into firm and competent soils of temporary backcut slopes as it is placed in lifts.

Aggregate base material should be compacted to a minimum of 95 percent relative compaction at or slightly above optimum moisture content per ASTM D1557. Subgrade below aggregate base should be compacted to a minimum of 90 percent relative compaction per ASTM D1557 at near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content).

### *4.1.8 <u>Trench and Retaining Wall Backfill and Compaction</u>*

The onsite soils may generally be suitable as trench backfill, provided the soils are screened of rocks and other material greater than 6 inches in diameter and organic matter. If trenches are shallow or the use of conventional equipment may result in damage to the utilities, sand having a sand equivalent (SE) of 30 or greater (per California Test Method [CTM] 217) may be used to bed and shade the pipes. Sand backfill within the pipe bedding zone may be densified by jetting or flooding and then tamping to ensure adequate compaction. Subsequent trench backfill should be compacted in uniform thin lifts by mechanical means to at least the recommended minimum relative compaction (per ASTM D1557).

Retaining wall backfill should consist of sandy soils as outlined in preceding Section 4.1.6. The contractor should anticipate the importing of soils for the required retaining wall backfill. The limits of select sandy backfill should extend a minimum ½ the height of the retaining wall or the width of the heel (if applicable), whichever is greater, refer to Figures 3 and 4 (rear of text). Retaining wall backfill soils should be compacted in relatively uniform thin lifts to at least 90 percent relative compaction (per ASTM D1557). Jetting or flooding of retaining wall backfill materials should not be permitted.

A representative from LGC Geotechnical should observe, probe, and test the backfill to verify compliance with the project recommendations.

### *4.1.9 Shrinkage and Subsidence*

Allowance in the earthwork volumes budget should be made for an estimated 10 to 15 percent reduction in volume of near-surface (upper approximate 5 feet) soils. It should be stressed that these values are only estimates and that an actual shrinkage factor would be extremely difficult to predetermine. Subsidence due to earthwork equipment is expected to be up to 0.1 feet. These values are estimates only and exclude losses due to removal of vegetation or debris. The effective change in volume of onsite soils will depend primarily on the type of compaction equipment, method of compaction used onsite by the contractor, and accuracy of the topographic survey.

Due to the combined variability in topographic surveys, inability to precisely model the removals and variability of on-site near-surface conditions, it is our opinion that the site will not balance at the end of grading. If importing/exporting a large volume of soils is not considered feasible or economical, we recommend a balance area be designated onsite that can fluctuate up or down based on the actual volume of soil. We recommend a "balance" area that can accommodate a minimum of 5 percent (the greater the better) of the total grading volume be considered.

## *4.2 Preliminary Foundation Recommendations*

Given that the expansion index exceeds 20, the foundation systems shall be designed for effects of expansive soil. Preliminary conventional and post-tensioned foundation recommendations are provided in the following sections. Recommended soil bearing and estimated static settlement are provided in Section 4.3. Please note that the following foundation recommendations are preliminary and must be confirmed by LGC Geotechnical at the completion of project plans (i.e., foundation, grading and site layout plans) as well as completion of earthwork.

Preliminary foundation recommendations are provided in the following sections. Recommended soil bearing and estimated settlement due to structural loads are provided in Section 4.3.

### *4.2.1 Provisional Conventional Foundation Design*

Conventional foundations may be designed in accordance with Wire Reinforcement

Institute (WRI) procedure for slab-on-ground foundations per Section 1808 of the 2019 CBC to resist expansive soils. The following preliminary soil parameters may be used:

- Effective Plasticity Index: 15
- Climatic Rating: Cw = 15
- Reinforcement: Per structural designer.
- Moisture condition subgrade soils to 100 % of optimum moisture content to a depth of 12 inches prior to trenching for footings.

#### *4.2.2 Provisional Post-Tensioned Foundation Design Parameters*

The geotechnical parameters provided herein may be used for post-tensioned slab foundations with a deepened perimeter footing or a post-tensioned mat slab. These parameters have been determined in general accordance with the Post-Tensioning Institute (PTI) Standard Requirements for Design of Shallow Post-Tensioned Concrete Foundations on Expansive Soils, referenced in Chapter 18 of the 2019 CBC. In utilizing these parameters, the foundation engineer should design the foundation system in accordance with the allowable deflection criteria of applicable codes and the requirements of the structural designer/architect. Other types of stiff slabs may be used in place of the CBC post-tensioned slab design provided that, in the opinion of the foundation structural designer, the alternative type of slab is at least as stiff and strong as that designed by the CBC/PTI method.

Our design parameters are based on our experience with similar projects, laboratory test results, and the anticipated nature of the soil (with respect to expansion potential). Please note that implementation of our recommendations will not eliminate foundation movement (and related distress) should the moisture content of the subgrade soils fluctuate. It is the intent of these recommendations to help maintain the integrity of the proposed structures and reduce (not eliminate) movement, based upon the anticipated site soil conditions. Should future owners and/or property maintenance personnel not properly maintain the areas surrounding the foundation, for example by overwatering, then we anticipate for highly expansive soils the maximum differential movement of the perimeter of the foundation to the center of the foundation to be on the order of a couple of inches. Soils of lower expansion potential are anticipated to show less movement.

| ***TABLE 3*** <br> ***Preliminary Geotechnical Foundation Design Parameters*** | | |
|---|---|---|
| **Parameter** | **PT Slab with Perimeter Footing** | **PT Mat with Thickened Edge** |
| Expansion Index | Low[1] | Low[1] |
| Thornthwaite Moisture Index | -20 | -20 |
| Constant Soil Suction | PF 3.9 | PF 3.9 |
| Center Lift<br>Edge moisture variation distance, $e_m$<br>Center lift, $y_m$ | <br>9.0 feet<br>0.25 inch | <br>9.0 feet<br>0.30 inch |
| Edge Lift<br>Edge moisture variation distance, $e_m$<br>Edge lift, $y_m$ | <br>5.5 feet<br>0.55 inch | <br>5.5 feet<br>0.66 inch |
| Modulus of Subgrade Reaction, k (assuming presoaking as indicated below) | 200 pci | 200 pci |
| Minimum perimeter footing/thickened edge embedment below finish grade | 15 inches | 6 inches |

1. Assumed for preliminary design purposes. Further evaluation is needed at the completion of grading.
2. Recommendations for foundation reinforcement and slab thickness are ultimately the purview of the foundation engineer/structural engineer based upon geotechnical criteria and structural engineering considerations.
3. Recommendations for sand below slabs have traditionally been included with geotechnical foundation recommendations, although they are not the purview of the geotechnical consultant. The sand layer requirements are the purview of the foundation engineer/structural engineer and should be provided in accordance with ACI Publication 302 "Guide for Concrete Floor and Slab Construction".
4. Recommendations for vapor retarders below slabs are also the purview of the foundation engineer/structural engineer and should be provided in accordance with applicable code requirements.
5. Moisture condition to 100 % of optimum moisture content to a depth of 12 inches prior to trenching.

#### *4.2.3 Shallow Foundation Maintenance*

The geotechnical parameters provided herein assume that if the areas adjacent to the foundation are planted and irrigated, these areas will be designed with proper drainage and adequately maintained so that ponding, which causes significant moisture changes below the foundation, does not occur. Our recommendations do not account for excessive irrigation and/or incorrect landscape design. Plants should only be provided with sufficient irrigation for life and not overwatered to saturate subgrade soils. Sunken planters placed adjacent to the foundation, should either be designed with an efficient drainage system or liners to prevent moisture infiltration below the foundation. Some lifting of the perimeter foundation beam should be expected even with properly constructed planters.

In addition to the factors mentioned above, future owners/property management personnel should be made aware of the potential negative influences of trees and/or other large vegetation. Roots that extend near the vicinity of foundations can cause distress to foundations. Future owners (and the owner's landscape architect) should not plant trees/large shrubs closer to the foundations than a distance equal to half the mature height of the tree or 20 feet, whichever is more conservative unless specifically provided with root barriers to prevent root growth below the building foundation.

It is the owner's responsibility to perform periodic maintenance during hot and dry periods to ensure that adequate watering has been provided to keep soil from separating or pulling back from the foundation. Future owners and property management personnel should be informed and educated regarding the importance of maintaining a constant level of soil-moisture. The owners should be made aware of the potential negative consequences of both excessive watering, as well as allowing potentially expansive soils to become too dry. Expansive soils can undergo shrinkage during drying, and swelling during the rainy winter season, or when irrigation is resumed. This can result in distress to building structures and hardscape improvements. The builder should provide these recommendations to future owners and property management personnel.

#### *4.2.4 Slab Underlayment Guidelines*

The following is for informational purposes only since slab underlayment (e.g., moisture retarder, sand or gravel layers for concrete curing and/or capillary break) is unrelated to the geotechnical performance of the foundation and thereby not the purview of the geotechnical consultant. Post-construction moisture migration should be expected below the foundation. The foundation engineer/architect should determine whether the use of a capillary break (sand or gravel layer), in conjunction with the vapor retarder, is necessary or required by code. Sand layer thickness and location (above and/or below vapor retarder) should also be determined by the foundation engineer/architect.

### *4.3 Soil Bearing and Lateral Resistance*

Provided our earthwork recommendations are implemented, an allowable soil bearing pressure of 2,000 pounds per square foot (psf) may be used for the design of footings having a minimum width of 12 inches and minimum embedment of 12 inches below lowest adjacent ground surface. This value may be increased by 400 psf for each additional foot of embedment and 200 psf for each additional foot of foundation width to a maximum value of 3,000 psf. A mat foundation a minimum of 6 inches below lowest adjacent grade may be designed for an allowable soil bearing pressure of 1,200 psf. These allowable bearing pressures are applicable for level (ground slope equal to or flatter than 5H:1V) conditions only. Bearing values indicated are for total dead loads and frequently applied live loads and may be increased by ⅓ for short duration loading (i.e., wind or seismic loads).

Soil settlement is a function of footing dimensions and applied soil bearing pressure. In utilizing the above-mentioned allowable bearing capacity, assumed structural loads, and provided our earthwork recommendations are implemented, foundation settlement due to structural loads is anticipated to be on the order of 1-inch or less and ½-inch over a horizontal span of 40 feet for total and differential settlement, respectively. Differential settlement should be anticipated between nearby columns or walls where a large differential loading condition exists Furthermore, seismic settlement due to dry-sand settlement is anticipated to be 0.5 inches or less. Differential seismic settlement may be taken as half of the seismic settlement (i.e., ¼-inch over a horizontal span of 40 feet).

Resistance to lateral loads can be provided by friction acting at the base of foundations and by passive earth pressure. For concrete/soil frictional resistance, an allowable coefficient of friction of 0.35 may be assumed with dead-load forces. An allowable passive lateral earth pressure of 270 psf per foot of depth (or pcf) to a maximum of 2,700 psf may be used for the sides of footings poured against properly compacted fill. Allowable passive pressure may be increased to 360 pcf (maximum of 3,600 psf) for short duration seismic loading. This passive pressure is applicable for level (ground slope equal to or flatter than 5H:1V) conditions only. Frictional resistance and passive pressure may be used in combination without reduction. We recommend that the upper foot of passive resistance be neglected if finished grade will not be covered with concrete or asphalt. The provided allowable passive pressures are based on a factor of safety of 1.5 and 1.1 for static and seismic loading conditions, respectively. The structural designer should incorporate appropriate factors of safety and/or load factors in their design.

## *4.4 Retaining Wall Recommendations*

### *4.4.1 Toe-of-Slope Retaining Wall Earthwork Recommendations*

The toe-of-slope retaining wall may be designed as a conventional retaining wall. Prior to the construction of the retaining wall the existing soil should be removed and recompacted to a minimum of 2 feet below existing grade or 1-foot below proposed footings, whichever is greater. Where space is available, the envelope for removal and recompaction should extend laterally a minimum distance of 2 feet beyond the edges of the structure improvements.

In general, removal bottom areas and any areas to receive compacted fill should be scarified to a minimum depth of 6 inches, brought to near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content), and recompacted per project recommendations. Removal bottoms, over-excavation bottoms and areas to receive fill should be observed and accepted by the geotechnical consultant prior to subsequent fill placement. Soil subgrade for planned footings and improvements should be firm and competent.

Material to be placed as fill should be brought to near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content) and recompacted to at least 90 percent relative compaction (per ASTM D1557). Moisture conditioning of site soils will be required in order to achieve adequate compaction. Soils are present that will require additional moisture in order to achieve the required compaction. Drying and/or mixing the very moist soils may also be required prior to reusing the materials in compacted fill.

The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in compacted thickness. Each lift should be thoroughly compacted and accepted prior to subsequent lifts. Generally, placement and compaction of fill should be performed in accordance with local grading ordinances and with observation and testing performed by the geotechnical consultant. Oversized material as previously defined should be removed from site fills. During backfill of excavations, the fill should be properly benched into firm and competent soils of temporary backcut slopes as it is placed in lifts.

Retaining wall backfill should consist of sandy soils as outlined in Figures 3 and 4 (Rear of Text) and in the following Section (Toe-of-Slope Retaining Wall Lateral Earth Pressures). The limits of select sandy backfill should extend at minimum ½ the height of the retaining wall or the width of the heel (if applicable), whichever is greater (Figures 3 & 4). Retaining wall backfill soils should be compacted in relatively uniform thin lifts to at least 90 percent relative compaction (per ASTM D1557). Jetting or flooding of retaining wall backfill materials should not be permitted.

### *4.4.2 Toe-of-Slope Retaining Wall Lateral Earth Pressures*

Lateral earth pressures for approved native sandy or import soils meeting indicated project requirements are provided below. Lateral earth pressures are provided as equivalent fluid unit weights, in psf per foot of depth (or pcf). These values do not contain an appreciable factor of safety, so the retaining wall designer should apply the applicable factors of safety and/or load factors during design. A soil unit weight of 120 pcf may be assumed for calculating the actual weight of soil over the wall footing.

The following lateral earth pressures are presented in Table 4 on the following page for approved granular soils with a maximum of 35 percent fines (passing the No. 200 sieve per ASTM D-421/422) and a "Very Low" expansion potential (EI of 20 or less per ASTM D4829). Retaining wall backfill should be free of material greater than 3 inches in maximum dimension. The site contains soils that are not suitable for retaining wall backfill due to their expansion potential; therefore, import should be anticipated by the contractor for obtaining suitable retaining wall backfill soil. The wall designer should clearly indicate on the retaining wall plans the required select sandy soil backfill criteria. These preliminary findings should be confirmed during grading. Should the inclination of the slope above the proposed toe-of-slope retaining wall be steeper than a 2:1 (horizontal to vertical) slope, the provided recommendations should be reevaluated. If this is the case, additional analysis and updated recommendations should be expected.

***TABLE 4***

***Lateral Earth Pressures – Approved Imported Select Sandy Soils***

| Conditions | Equivalent Fluid Unit Weight (pcf) | Equivalent Fluid Unit Weight (pcf) |
|---|---|---|
| | **Level Backfill** | **2:1 Sloped Backfill** |
| | **Approved Imported Sandy Soils** | **Approved Imported Sandy Soils** |
| Active | 35 | 55 |
| At-Rest | 55 | 70 |

If the wall can yield enough to mobilize the full shear strength of the soil, it can be designed for "active" pressure. If the wall cannot yield under the applied load, the earth pressure will be higher. This would include 90-degree corners of retaining walls. Such walls should be designed for "at-rest." The equivalent fluid pressure values assume free-draining conditions. If conditions other than those assumed above are anticipated, the equivalent fluid pressure values should be provided on an individual-case basis by the geotechnical engineer.

Retaining wall structures should be provided with appropriate drainage and appropriately waterproofed. To reduce, but not eliminate, saturation of near-surface (upper approximate 1-foot) soils in front of the retaining walls, the perforated subdrain pipe should be located as low as possible behind the retaining wall. The outlet pipe should be sloped to drain to a suitable outlet. In general, we do not recommend retaining wall outlet pipes be connected to area drains. If subdrains are connected to area drains, special care and information should be provided to homeowners to maintain these drains. Typical retaining wall drainage is illustrated in Figures 3 and 4 (Rear of Text). It should be noted that the recommended subdrain does not provide protection against seepage through the face of the wall and/or efflorescence. Efflorescence is generally a white crystalline powder (discoloration) that results when water containing soluble salts migrates over a period of time through the face of a retaining wall and evaporates. If such seepage or efflorescence is undesirable, retaining walls should be waterproofed to reduce this potential. Please note that waterproofing and outlet systems are not the purview of the geotechnical consultant.

Surcharge loading effects from any adjacent structures should be evaluated by the retaining wall designer. In general, structural loads within a 1:1 (horizontal to vertical) upward projection from the bottom of the proposed retaining wall footing will surcharge the proposed retaining wall. In addition to the recommended earth pressure, retaining walls adjacent to streets should be designed to resist a uniform lateral pressure of 80 pounds per square foot (psf) due to normal street vehicle traffic if applicable. Uniform lateral surcharges may be estimated using the applicable coefficient of lateral earth pressure using a rectangular distribution. A factor of 0.45 and 0.3 may be used for at-rest and active conditions, respectively. The retaining wall designer should contact the geotechnical engineer for any required geotechnical input in estimating any applicable surcharge loads.

If required, the retaining wall designer may use the seismic lateral earth pressure increment as indicated in Table 5. This seismic increment should be applied in addition to the provided static lateral earth pressure using a triangular distribution with the resultant acting at H/3 in relation to the base of the retaining structure (where H is the retained height). Per Section 1803.5.12 of the 2019 CBC, the seismic lateral earth pressure is applicable to structures assigned to Seismic Design Category D through F for retaining wall structures supporting more than 6 feet of backfill height. This seismic lateral earth pressure is estimated using the procedure outlined by the Structural Engineers Association of California (Lew, et al, 2010) and the Federal Highway Administration (FHA, 2011). While not anticipated at this time, if a retaining wall greater than indicated in Table 5 is proposed, the retaining wall designer should contact the geotechnical consultant for specific seismic lateral earth pressure increments based on the proposed layout.

***TABLE 5***

***Seismic Lateral Earth Pressure Increment***

| **Maximum Retained Height (feet)** | **Equivalent Fluid Unit Weight (pcf)** | |
|---|---|---|
| | **Level Backfill** | **2:1 Sloped Backfill** |
| 8 | 10 | 15 |

### *4.4.3 Top-of-Slope Retaining Wall Design Recommendations*

Due to the moderately expansive nature of the onsite soils, special design considerations are needed for improvements located near the top-of-slope. As a result of the many factors, which influence the rate and magnitude of slope creep, it is not possible to accurately determine the extent or amount of slope creep that will occur. The amount of distress that occurs to these improvements as a result of slope creep depends to a certain extent on how much movement occurs and the flexibility of the improvements. For the purpose of this report, conventional retaining walls are generally considered to consist of masonry or concrete blocks.

The following recommendations have been developed by experience generated in working in similar geotechnical conditions rather than a calculated solution. These recommendations will not eliminate all movement of the relatively small top-of-slope retaining walls at the site but should limit movement to within tolerable limits of the structures thereby maintaining their function ability and reducing cosmetic distress. The following recommendations also assume proper homeowner/homeowner association maintenance, landscaping, and irrigation practices. Should future owners not properly maintain the subject slopes then additional distress may be observed.
In recognition that the subject top-of-slope retaining wall will be subject to slope creep and that

the proposed retaining wall will be retaining a maximum of 3 feet of select sandy backfill, we recommend incorporating a shallow grade beam and pile system into the design. Each pile should be a minimum of 12 inches in diameter, be longitudinally reinforced with a minimum of four No. 4 rebar and wrapped laterally. The top of all piles should be connected with a shallow grade beam. This grade beam should be a minimum of 12 inches deep by 12 inches wide and longitudinally reinforced with four No. 5 rebar and have a maximum embedment of 12 inches below finished grade. The walls should be provided with construction joints at each pile.

The actual design of the pile depth and components mentioned above should be carried out by the structural engineer based on the geotechnical design parameters presented on Figure 5 (Rear of Text). Additionally, we recommend the structural engineer incorporate into the design as much flexibility as possible so that the visual impact of movement is minimized. It should be noted that without deepened foundations such as piles, rigid improvements constructed near the top-of-slope area of the site may be subjected to rotation, vertical and horizontal separations and cracking, requiring additional maintenance over the life of the improvements. Should the retaining wall designer choose an alternative foundation system than what is recommended, these conditions may occur.

#### *4.4.4 Top-of-Slope Retaining Wall Backfill and Drainage Recommendations*

Lateral earth pressures are provided as equivalent fluid unit weights, in pound per square foot (psf) per foot of depth or pcf on Figure 5 (Rear of Text). The Active earth pressure values do not contain an appreciable factor of safety, so the retaining wall designer should apply the applicable factors of safety and/or load factors during design. The provided allowable passive pressure (Figure 5) is based on a factor of safety of 1.5 for static loading conditions. A soil unit weight of 120 pcf may be assumed.

Retaining wall backfill should consist of sandy soils with a maximum of 35 percent fines (passing the No. 200 sieve) per American Society for Testing and Materials (ASTM) Test Method D1140 (or ASTM D6913/D422) and a Very Low expansion potential (EI of 20 or less per ASTM D4829). Soils should also be screened of organic materials, construction debris and any material greater than 3 inches. The site contains soils that are not suitable for retaining wall backfill due to their expansion potential; therefore, import should be anticipated by the contractor for obtaining suitable retaining wall backfill soil.

For conventional retaining walls, the select sandy zone should extend a minimum of a 1:1 (horizontal to vertical) upward projection from the bottom of the retaining wall subdrain, refer to Figure 5. Retaining wall backfill soils should be compacted in relatively uniform thin lifts to a minimum of 90 percent relative compaction (per ASTM D1557). Jetting or flooding of retaining wall backfill materials should not be permitted. A representative from LGC Geotechnical should observe, probe, and test the backfill to verify compliance with the project recommendations.

Retaining wall structures should be provided with appropriate drainage and appropriately waterproofed. To reduce, but not eliminate, saturation of near-surface (upper approximate 1-foot) soils in front of the retaining walls, the perforated subdrain pipe should be located as low as possible behind the retaining wall. The outlet pipe should be sloped to drain to a suitable outlet. In general, we do not recommend retaining wall outlet pipes be connected to area drains.

If subdrains are connected to area drains, special care should be taken to maintain these drains. Typical retaining wall drainage is shown on Figure 5. It should be noted that the recommended subdrain does not provide protection against seepage through the face of the wall and/or efflorescence. Waterproofing and outlet systems are not the purview of the geotechnical consultant.

As mentioned above, top-of-slope retaining walls in moderately expansive soils are susceptible to rotation and lateral movement, although rarely fail. The recommendation for top-of-slope retaining walls are included in Figure 5 of this report. These recommendations are intended to minimize and reduce movement of this type of wall but will not completely eliminate it.

The proposed retaining wall should be designed in accordance with the California Building Code (CBC) with respect to foundation setback from the top-of-slope.

## *4.5 Pile Construction*

Pile boreholes should be plumb and free of loose or softened material. Extreme care in drilling, placement of reinforcement steel, and the pouring of concrete will be essential to avoid excessive disturbance of pile borehole walls. The pile reinforcing cage should be installed and the concrete pumped immediately after drilling is completed. Where applicable, concrete placement by pumping or tremie tube to the bottom of pile excavations is recommended. No borehole should be left open overnight. We recommend that pile boreholes not be drilled immediately adjacent to another pile until the concrete in the other pile has attained its initial set. A representative from LGC Geotechnical should be onsite during the drilling of pile boreholes in order to verify the assumptions made during the design stages.

The contractor should anticipate easy to moderately difficult drilling conditions. Some caving of drilled holes should be anticipated. The contractor should anticipate that any borehole left open for any extended period of time will likely experience additional caving and perched groundwater conditions. If caving occurs during CIDH construction, a temporary casing may be required.

## *4.6 Slope Creep*

As with most natural and manufactured fill slopes and pad areas, some degree of slope creep should be expected for this site. The amount of slope creep is usually influenced by such factors as the slope geometry, slope exposure, aspect, height, composition, as well as plant type, precipitation, irrigation and landscaping programs. Since the industry understanding of the slope creep is analytically in its infancy, our estimates of the extent and magnitude of slope creep are, therefore, based on our observations at previous sites with similar soil conditions. In general, the impacts of slope creep are most prevalent in the outer approximate 20 feet of the slope but can extend further into the lot. In general, more slope creep occurs as the slope height increases, expansion potential increases and changes in the moisture content of the soil occur. Slope creep is not expected to significantly influence the building structures that meet or exceed setback requirements but is anticipated to impact rear yard improvements like side yard walls, fences, retaining walls, swimming pool/spas, associated flatwork and other miscellaneous landscaping improvements.

To account for slope creep/lot stretching, a lateral earth equivalent fluid pressure of 60 pounds per cubic foot (pcf) should be applied to structural foundation improvements within the defined creep zone. The defined creep zone depends on the expansion potential of the fill soils comprising the slope. In general, for design purposes the lot stretching/creep zone should be any portion of the lot that is within 20 horizontal feet of the slope face. The creep zone may be defined by a line parallel to the surface and at a depth based on the table shown on Figures 5 and 6 (rear of text).

## *4.7 Lot Stretching*

Lot stretching is a term used to describe the predominately lateral deformation or extension of lots, which are located near the top-of-slopes generally containing expansive soils. Based on our previous experience, the effects of lot stretching generally extend further back from the top-of-slope than slope creep and have been observed up to 100 feet from the top-of-slope. In general, the effects of lot stretching manifest themselves in the form of distortion of improvements and/or separation of flatwork from adjacent improvements. It has been our experience that the effects of lot stretching generally do not significantly influence the performance of post-tensioned foundations. Although the effects of lot stretching have been observed for many years, it is still not completely understood. Based on limited theoretical models, lot stretching is believed to occur as a result of the wetting front gradually penetrating through expansive soils.

Although rear yard top-of-slope improvements are generally not considered structural, we recommend that decorative walkways, patios, pools and spas, and other landscaping features be constructed with flexibility to accommodate the effects of slope creep. Typical remediation methods include construction joints, separation joints, flexible pavers, flexible structures, or additional reinforcement to limit (not eliminate) cracking, rotation, etc. The exact amount of movement due to slope creep cannot be determined at this time; it is dependent to some extent upon irrigation practices of homeowners and homeowner associations. Lateral and vertical deflections on the order of 3 inches or more and/or angular rotation have been observed on projects with similar geotechnical conditions. More specific geotechnical recommendations for freestanding walls and fences close to the top-of-slopes are provided in this report. Please see previous section ("Slope Creep") for design recommendations to help reduce the effects of lot stretching. Estimated design loads due to lot stretching/slope creep are outlined in the above Section, "Slope Creep."

## *4.8 Fences and Freestanding Walls*

As their name indicates, freestanding walls are those walls, which are not designed to retain soil and/or water. These walls are generally located at the rear of the lot, or along the side yard or between lots.

Due to the expansive nature of the onsite soils, special design considerations are needed for improvements located near the top-of-slope. As a result of the many factors that influence the rate and magnitude of slope creep, it is not possible to accurately determine at the present time the extent or amount of slope creep. The amount of distress that occurs to these improvements as a result of slope creep depends, to a certain extent, on how much movement occurs and the flexibility of the improvements. For the purpose of this report, freestanding walls are generally considered to consist of masonry or concrete blocks, while flexible fences generally consist of wood or tube steel.

The following recommendations have been developed by experience generated in working in similar geotechnical conditions rather than a calculated solution. These recommendations will not eliminate all movement of freestanding walls at the site but should limit movement to within tolerable limits of the structures, thereby maintaining their functionality and reducing cosmetic distress. The following recommendations also assume proper homeowner/homeowner association maintenance, landscaping, and irrigation practices. Should future homeowners/homeowner associations not properly maintain the subject slopes, then additional distress may be observed.

### *4.8.1 Freestanding Walls at the Top-of-Slopes*

In recognition that the subject walls will be subject to slope creep, we recommend incorporating a shallow grade beam and CIDH pile system into the design as follows:

1. Freestanding walls located parallel to the top-of-slope should be supported on a shallow grade beam founded on 12-foot-long pile (as measured from finished grade) with a center-to-center spacing of 10 feet;
2. Freestanding walls located perpendicular to the top-of-slope should be supported on 12-foot-long caissons (as measured from finished grade) with a center-to-center spacing of 15 feet. Pile support is only required for the portion of the walls located within 15 feet of the top-of-slope;
3. Regardless of pile length, each caisson should be a minimum of 12 inches in diameter, be longitudinally reinforced with a minimum of four No. 4 rebar and wrapped laterally;
4. The top of all piles should be connected with a shallow grade beam. This grade beam should be a minimum of 12 inches deep by 12 inches wide and longitudinally reinforced with four No. 5 rebar and have a maximum embedment of 12 inches below finished grade; and
5. The walls should be provided with construction joints at each caisson.

As an alternative to the minimum recommendations above, the caissons may be designed using the geotechnical parameters for CIDH piles and the estimated creep zone provided in Figure 6 (rear of text). The actual design of the components mentioned above should be carried out by the structural designer. Additionally, we recommend the structural designer incorporate into the design as much flexibility as possible so that the visual impact of movement is minimized.

The above-recommendations are applicable to freestanding walls, which are within 15 horizontal feet of slopes, greater than 10 feet in height. For slope heights between 4 and 10 feet, the length of the pile need not be greater than the height of the slope. For slopes less than 4 feet, the pile recommendation may be waived, and the walls designed for level ground conditions.

## 4.9 ***Corrosivity to Concrete and Metal***

Although not corrosion engineers (LGC Geotechnical is not a corrosion consultant), several governing agencies in Southern California require the geotechnical consultant to determine the corrosion potential of soils to buried concrete and metal facilities. We therefore present the results of our testing with regard to corrosion for the use of the client and other consultants, as they determine necessary.

Corrosion testing of near-surface bulk samples indicated a soluble sulfate content value of 156 ppm (less than 0.02 percent) and a chloride content of 960 ppm. Based on Caltrans Corrosion Guidelines (2018), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 1,500 ppm (0.15 percent) or greater. Based on the test results, soils are not considered corrosive using Caltrans criteria.

Based on laboratory sulfate test results, the near surface soils are designated to a class "S0" per ACI 318, Table 19.3.1.1 with respect to sulfates. Concrete in direct contact with the onsite soils can be designed according to ACI 318, Table 19.3.2.1 using the "S0" sulfate classification.

Laboratory testing may need to be performed at the completion of grading by the project corrosion engineer to further evaluate the as-graded soil corrosivity characteristics. Accordingly, revision of the corrosion potential may be needed, should future test results differ substantially from the conditions reported herein. The client and/or other members of the development team should consider this during the design and planning phase of the project and formulate an appropriate course of action.

## 4.10 ***Preliminary Asphalt Concrete Pavement Sections***

For the purposes of these preliminary recommendations, we have selected a preliminary design R-value of 25 and calculated pavement sections for Traffic Indices of 4.5, 5.0 and 5.5. R-value testing of the street subgrade will need to be performed to confirm our preliminary testing results/assumptions once the streets have been graded to finish subgrade elevations and the final Traffic Index is determined by the Civil Engineer.

***TABLE 6***

***Preliminary Pavement Sections***

| **Assumed Traffic Index** | 4.5 | 5.0 | 5.5 |
|---|---|---|---|
| **R -Value Subgrade** | 25 | 25 | 25 |
| **AC Thickness** | 4.0 inches | 4.0 inches | 4.0 inches |
| **CAB Thickness** | 3.0 inches | 4.0 inches | 6.0 inches |

Increasing the thickness of asphalt or adding additional base material will reduce the likelihood of the pavement experiencing distress during its service life. The above recommendations are based on the assumption that proper maintenance and irrigation of the areas adjacent to the roadway will occur through the design life of the pavement. Failure to maintain a proper maintenance and/or irrigation program may jeopardize the integrity of the pavement.

Earthwork recommendations regarding aggregate base and subgrade are provided in the previous Section "Site Earthwork" and the related sub-sections of this report.

### 4.11 ***Nonstructural Concrete Flatwork***

Nonstructural concrete (such as flatwork, sidewalks, patios, etc.) has a potential for cracking due to changes in soil volume related to soil-moisture fluctuations. To reduce the potential for excessive cracking and lifting, concrete should be designed in accordance with the minimum guidelines outlined in Table 7 below. These guidelines will reduce the potential for irregular cracking and promote cracking along construction joints but will not eliminate all cracking or lifting. Thickening the concrete and/or adding additional reinforcement will further reduce cosmetic distress.

***TABLE 7***

***Preliminary Geotechnical Parameters for Nonstructural Concrete Flatwork Placed on Low Expansion Potential Subgrade***

| | Homeowner Sidewalks | Private Drives | Patios/Entryways | City Sidewalk Curb and Gutters |
|---|---|---|---|---|
| **Minimum Thickness (in.)** | 4 (nominal) | 4 (full) | 4 (full) | City/Agency Standard |
| **Presoaking** | Wet down prior to placing | Wet down prior to placing | Wet down prior to placing | City/Agency Standard |
| **Reinforcement** | — | No. 3 at 24 inches on centers | No. 3 at 24 inches on centers | City/Agency Standard |
| **Thickened Edge (in.)** | — | 8 x 8 | — | City/Agency Standard |
| **Crack Control Joints** | Saw cut or deep open tool joint to a minimum of $^1/_3$ the concrete thickness | Saw cut or deep open tool joint to a minimum of $^1/_3$ the concrete thickness | Saw cut or deep open tool joint to a minimum of $^1/_3$ the concrete thickness | City/Agency Standard |

| | | | | |
|---|---|---|---|---|
| **Maximum Joint Spacing** | 5 feet | 10 feet or quarter cut whichever is closer | 6 feet | City/Agency Standard |
| **Aggregate Base Thickness (in.)** | — | — | — | City/Agency Standard |

To reduce the potential for driveways to separate from the garage slab, the builder may elect to install dowels to tie these two elements together. Similarly, future homeowners should consider the use of dowels to connect flatwork to the foundation.

### *4.12 Subsurface Water Infiltration*

Recent regulatory changes have occurred that mandate storm water be infiltrated below grade rather than collected in a conventional storm drain system. Typically, a combination of methods are implemented to reduce surface water runoff and increase infiltration including; permeable pavements/pavers for roadways and walkways, directing surface water runoff to grass-lined swales, retention areas, and/or drywells, etc. It should be noted that collecting and concentrating surface water for the purpose of intentionally infiltrating below grade, conflicts with the geotechnical engineering objective of directing surface water away from slopes, structures and other improvements. The geotechnical stability and integrity of a site is reliant upon appropriately handling surface water. From a geotechnical perspective, we do not recommend that surface water be intentionally infiltrated into the subsurface soils.

Considering the results of the infiltration testing, if required, stormwater may be infiltrated into the subsurface soils at the depths tested below existing grade, using the values presented in Table 1 and the appropriate County of Riverside Flood Control (2011) safety factors. The Civil Engineer should determine the appropriate safety factor applicable to the proposed infiltration system. Results of field infiltration testing are provided in Appendix D.

The following should be considered for design of any required infiltration system:

- Water discharge from any infiltration systems should not occur within the zone of influence of foundation footings (column and load bearing wall locations). For preliminary purposes we recommend a minimum setback of 15 feet from the structural improvements, or the County recommended minimum setback, whichever is more conservative.
- An adequate setback distance between any infiltration facility and adjacent private property should be maintained.
- It may be prudent to provide an overflow system directly connected to the storm drain system in order to prevent failure of the infiltration system, either as a result of lower than anticipated infiltration and/or very high flow volumes. It should be noted that if pretreatment of runoff to remove debris, soil particles, etc., cannot be performed, design infiltration rates may need to be further reduced. Over time, siltation and plugging may reduce the infiltration rate and subsequent effectiveness of the infiltration system.

- Any designed infiltration system will require routine periodic maintenance.
- As with any systems that are designed to concentrate the surface flow and direct the water into the subsurface soils, some type of nuisance water and/or other water-related issues should be expected.

LGC Geotechnical should be provided with details for any planned required infiltration system early in the design process for geotechnical input.

### *4.13 Control of Surface Water and Drainage Control*

From a geotechnical perspective, we recommend that compacted finished grade soils adjacent to proposed structures be sloped away from the proposed structures and towards an approved drainage device or unobstructed swale. Drainage swales, wherever feasible, should not be constructed within 5 feet of buildings. Where lot and building geometry necessitates that drainage swales be routed closer than 5 feet to structural foundations, we recommend the use of area drains together with drainage swales. Drainage swales used in conjunction with area drains should be designed by the project civil engineer so that a properly constructed and maintained system will prevent ponding within 5 feet of the foundation. Code compliance of grades is not the purview of the geotechnical consultant.

Planters with open bottoms adjacent to buildings should be avoided. Planters should not be designed adjacent to buildings unless provisions for drainage, such as catch basins, liners, and/or area drains, are made. Overwatering must be avoided.

### *4.14 Geotechnical Plan Review*

Project plans (grading, foundation, etc.) should be reviewed by this office prior to construction to verify that our geotechnical recommendations have been incorporated. Additional or modified geotechnical recommendations may be required based on the proposed layout.

### *4.15 Geotechnical Observation and Testing*

The recommendations provided in this report are based on limited subsurface observations and geotechnical analysis. The interpolated subsurface conditions should be checked in the field during construction by a representative of LGC Geotechnical. Geotechnical observation and testing is required per Section 1705 of the 2019 California Building Code (CBC).

Geotechnical observation and/or testing should be performed by LGC Geotechnical at the following stages:

- During grading (removal bottoms, fill placement, etc.);
- During retaining wall backfill and compaction;
- During utility trench backfill and compaction;

- After presoaking building pad and other concrete-flatwork subgrades, and prior to placement of aggregate base or concrete;
- Preparation of pavement subgrade and placement of aggregate base;
- After building and wall footing excavation and prior to placement of steel reinforcement and/or concrete; and
- When any unusual soil conditions are encountered during any construction operation subsequent to issuance of this report.

## *5.0 LIMITATIONS*

Our services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable soils engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

This report is based on data obtained from limited observations of the site, which have been extrapolated to characterize the site. While the scope of services performed is considered suitable to adequately characterize the site geotechnical conditions relative to the proposed development, no practical evaluation can completely eliminate uncertainty regarding the anticipated geotechnical conditions in connection with a subject site. Variations may exist and conditions not observed or described in this report may be encountered during grading and construction.

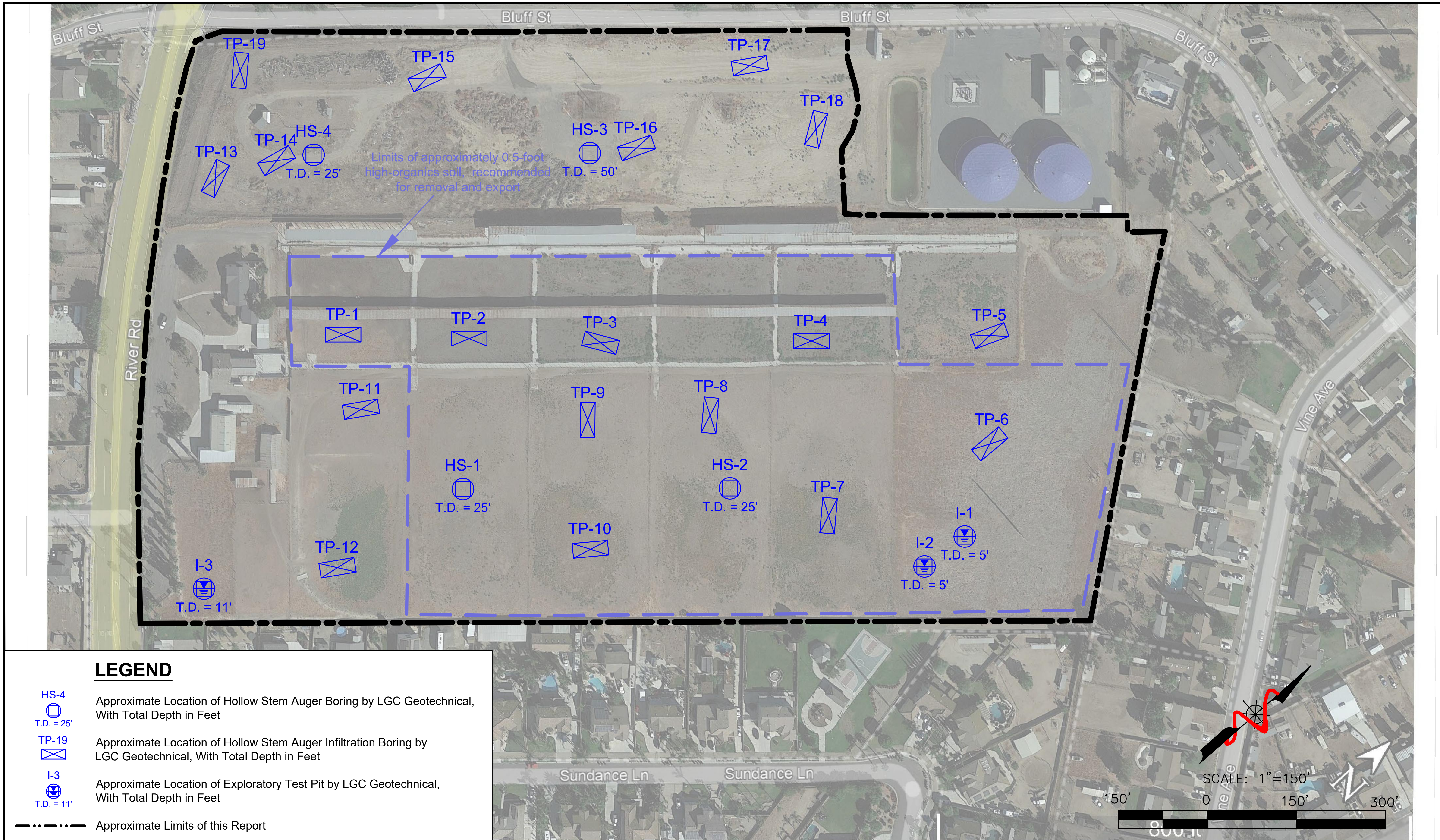
This report is issued with the understanding that it is the responsibility of the owner, or of his/her representative, to ensure that the information and recommendations contained herein are brought to the attention of the other consultants (at a minimum the civil engineer, structural engineer, landscape architect) and incorporated into their plans. The contractor should properly implement the recommendations during construction and notify the owner if they consider any of the recommendations presented herein to be unsafe, or unsuitable.

The findings of this report are valid as of the present date. However, changes in the conditions of a site can and do occur with the passage of time, whether they be due to natural processes or the works of man on this or adjacent properties. The findings, conclusions, and recommendations presented in this report can be relied upon only if LGC Geotechnical has the opportunity to observe the subsurface conditions during grading and construction of the project, in order to confirm that our preliminary findings are representative for the site. This report is intended exclusively for use by the client, any use of or reliance on this report by a third party shall be at such party's sole risk.

In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and modification.


| | | |
|---|---|---|
| **FIGURE 1** **Site Location Map** | PROJECT NAME | River Road - Norco, Dallape |
| | PROJECT NO. | 21250-01 |
| | ENG. / GEOL. | TJL / BPG |
| | SCALE | Not to Scale |
| | DATE | January 2022 |

LGC Geotechnical, Inc.




## LEGEND

| | |
|---|---|
| HS-4 T.D. = 25' | Approximate Location of Hollow Stem Auger Boring by LGC Geotechnical, With Total Depth in Feet |
| TP-19 | Approximate Location of Hollow Stem Auger Infiltration Boring by LGC Geotechnical, With Total Depth in Feet |
| I-3 T.D. = 11' | Approximate Location of Exploratory Test Pit by LGC Geotechnical, With Total Depth in Feet |
| — · · — | Approximate Limits of this Report |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## Geotechnical Map

| | |
|---|---|
| PROJECT NAME | River Road - Norco Dallape |
| PROJECT NO. | 21250-01 |
| ENG. / GEOL. | TJL/BPG |
| SCALE | 1" = 150' |
| DATE | January 2022 |

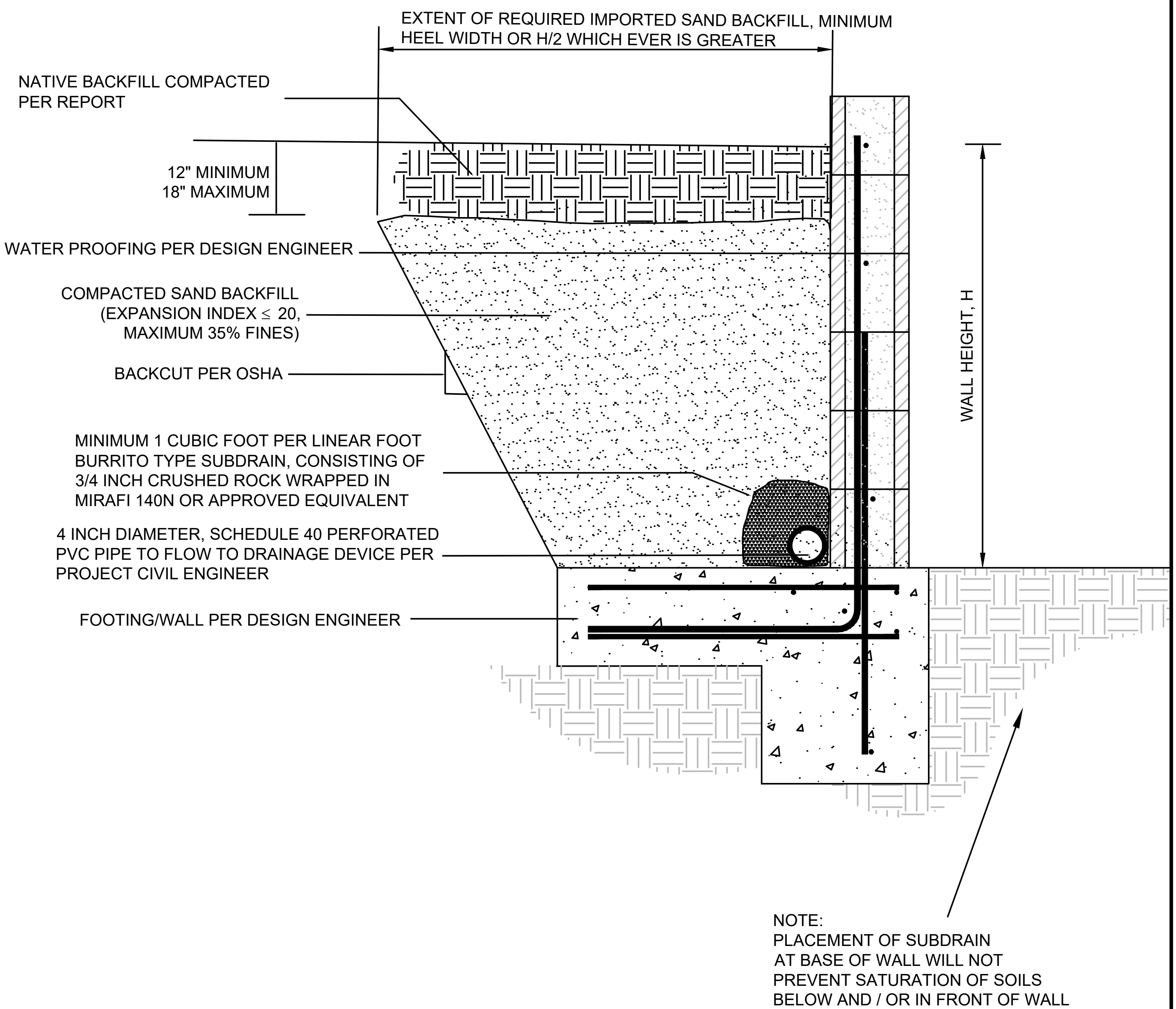


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**FIGURE 3**
**Retaining Wall Backfill Detail**

| | |
|---|---|
| PROJECT NAME | River Road - Norco, Dallape |
| PROJECT NO. | 21250-01 |
| ENG. / GEOL. | TJL / BPG |
| SCALE | Not to Scale |
| DATE | January 2022 |

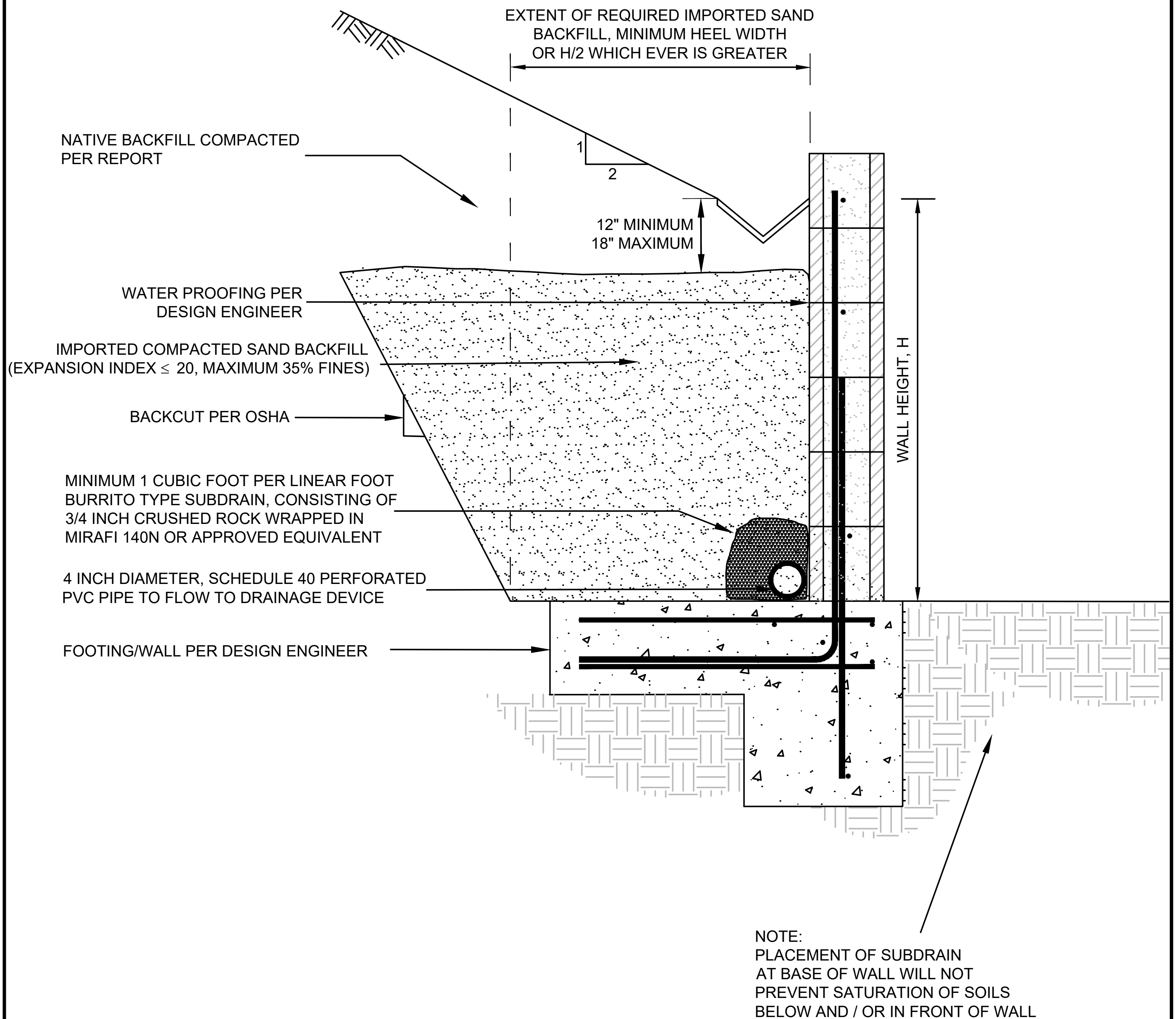


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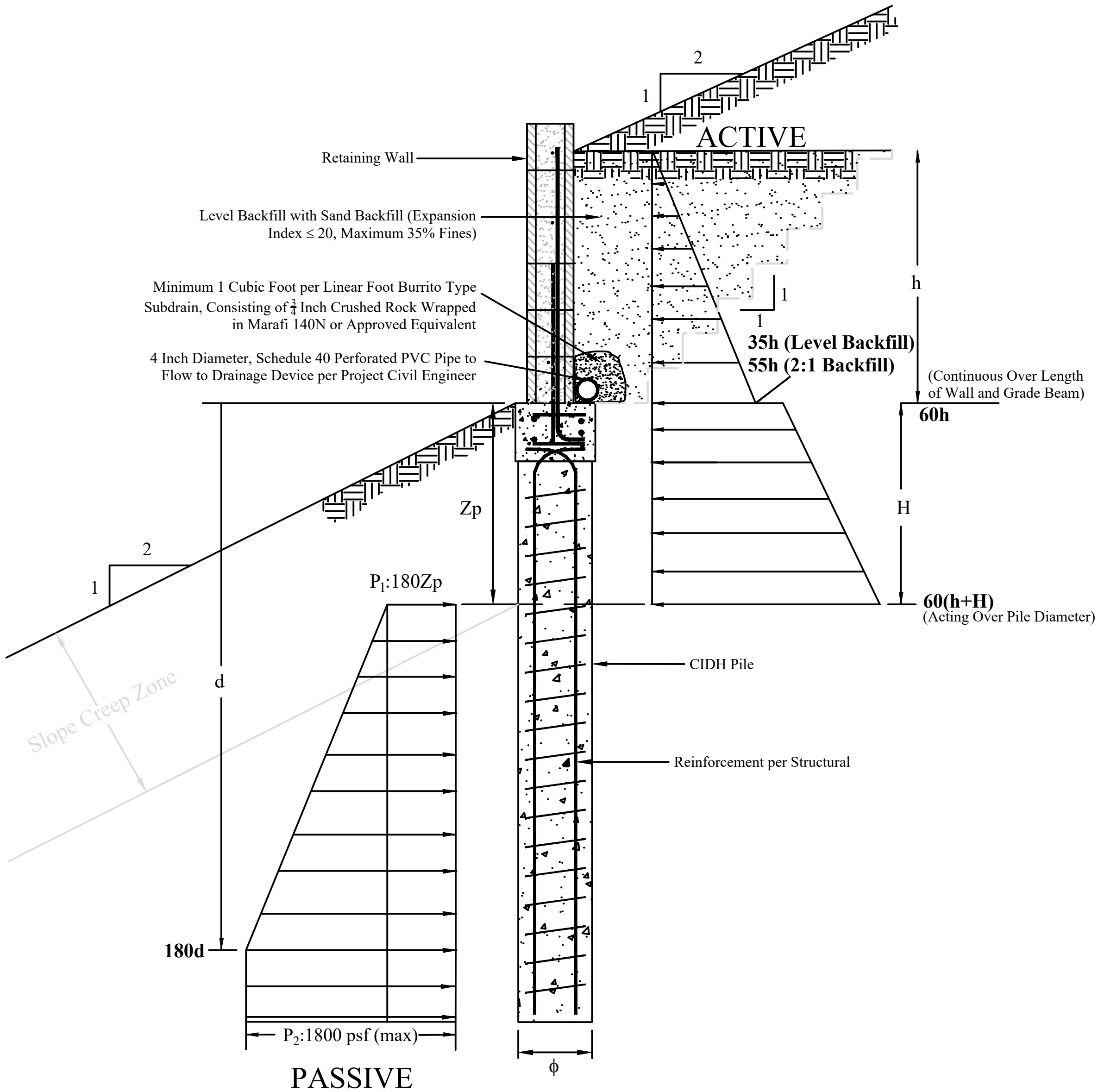
**FIGURE 4**

**Retaining Wall Backfill Detail**

**2:1 Backfill**

| | |
|---|---|
| PROJECT NAME | River Road - Norco, Dallape |
| PROJECT NO. | 21250-01 |
| ENG. / GEOL. | TJL / BPG |
| SCALE | Not to Scale |
| DATE | January 2022 |




## LATERAL EARTH PRESSURES

| | |
|---|---|
| Soil Creep | |
| $A_1$ | Pier & Grade Beam: 60 pcf |
| Passive | |
| $P_1^{ab}$ | 180Zp (psf) |
| $P_2^{ab}$ | 1800 psf (max) |

a) Includes Arching Factor of 2 Based on Isolated Piers Spaced a Minimum of 3 Diameters on Center

b) Where Foundation is in Fill Neglect Upper 1ft

Note: Structural Engineer to Apply Suitable Factor of Safety and/or Load Factor in Design

## ALLOWABLE VERTICAL LOADS

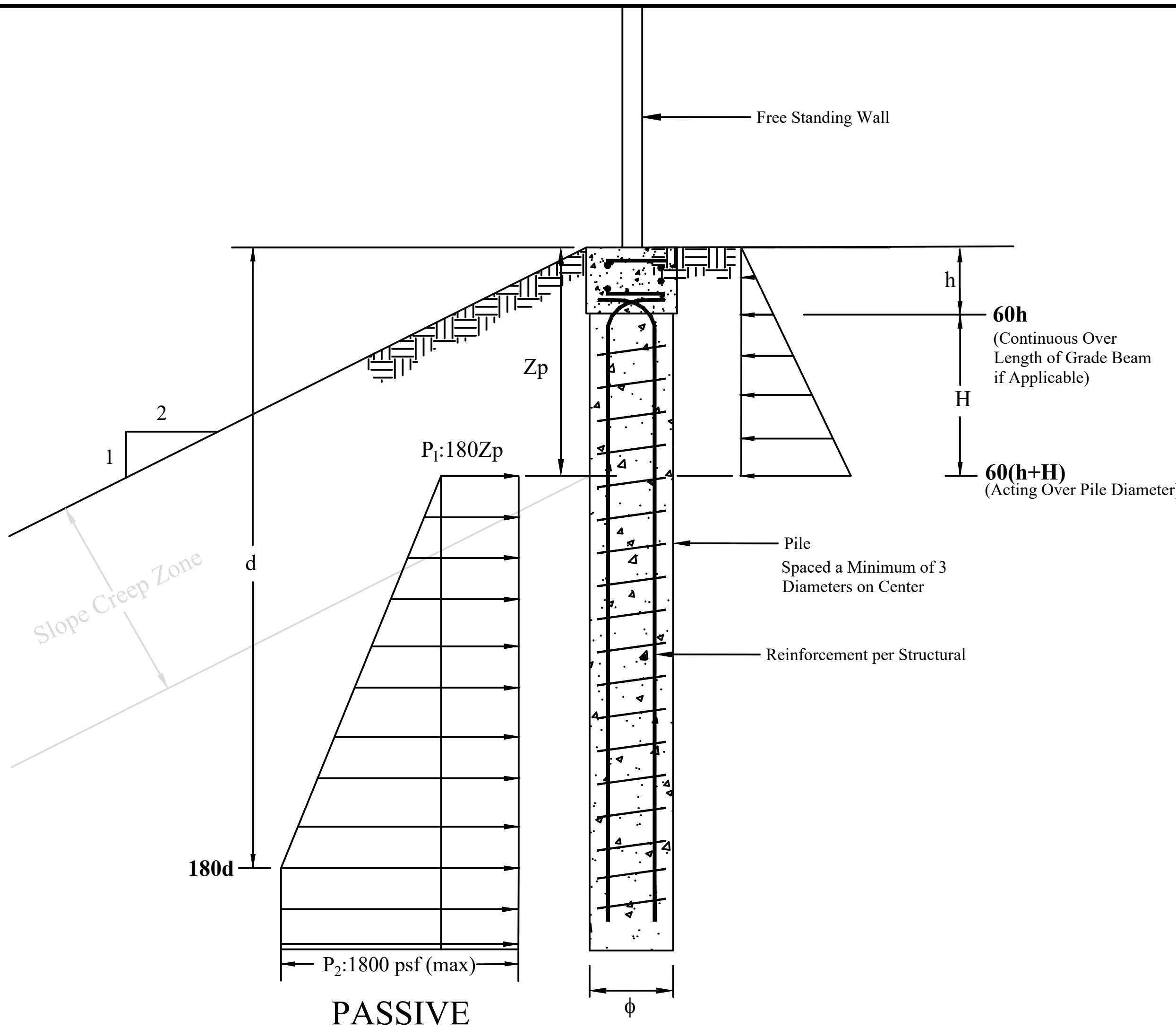
Allowable Skin Friction: 450 psf per foot depth (Neglecting Creep Zone).

| Height of Slope | Estimated Vertical Slope Creep Zone Depth (Zp) |
|---|---|
| $H_s < 4$ feet | NA |
| 4 ft $< H_s <$ 20 ft | $\frac{1}{5}$ of $H_s$ |
| $H_s \geq$ 20 ft | 4 ft |

Note: Round Zp up to nearest foot

h = Depth to Bottom of Grade Beam from Finish Grade (ft)
H = Length of Pile From Bottom Grade Beam to the Creep Zone Limit
$H_s$ = Height of Slope
ϕ = Pile Diameter (ft)
Zp = Depth of Creep Zone Below Top of Finish Grade
d = Depth Below Top of Finish Grade (ft)

| LGC Geotechnical, Inc. | FIGURE 5 Geotechnical Design Parameters for Top-of-Slope Retaining Wall | PROJECT NAME | River Road - Norco, Dallape |
|---|---|---|---|
| | | PROJECT NO. | 21250-01 |
| | | ENG. / GEOL. | TJL / BPG |
| | | SCALE | Not to Scale |
| | | DATE | January 2022 |




## ALLOWABLE LATERAL LOADS

| Lateral Earth Pressure | |
|---|---|
| A1 | 60·(H+h) psf |
| P1* | 180Zp |
| P2* | 1800 psf (max) |

* Includes Arching Factor of 2 Based on Isolated Piers Spaced a Minimum of 3 Diameters on Center

Note: Structural Engineer to Apply Suitable Factor of Safety and/or Load Factor in Design

## ALLOWABLE VERTICAL LOADS

Allowable Skin Friction: 450 psf per foot depth (Neglecting Creep Zone).

| Height of Slope | Estimated Vertical Slope Creep Zone Depth (Zp) |
|---|---|
| $H_s < 4$ feet | NA |
| 4 ft $< H_s <$ 20 ft | $\frac{1}{5}$ of $H_s$ |
| $H_s > 20$ ft | 4 ft |

h = Depth to Bottom of Grade Beam from Finish Grade (ft)
H = Length of Pile From Bottom Grade Beam to the Creep Zone Limit
$H_s$ = Height of Slope
ϕ = Pile Diameter (ft)
Zp = Depth of Creep Zone Below Top of Finish Grade
d = Depth Below Top of Grade Beam (ft)

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**FIGURE 6**
***Geotechnical Parameters for Top-of-Slope Drilled Piles***

| | |
|---|---|
| PROJECT NAME | River Road - Norco, Dallape |
| PROJECT NO. | 21250-01 |
| ENG. / GEOL. | TJL / BPG |
| SCALE | Not to Scale |
| DATE | January 2022 |

# *Appendix A*
# *References*

## *APPENDIX A*

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# *Appendix B*
# *Boring & Geotechnical Trench Logs*

# Geotechnical Boring Log Borehole HS-1

| | |
|---|---|
| **Date:** 12/3/2021 | **Drilling Company:** Cal Pac Drilling |
| **Project Name:** River Road - Norco Dallape | **Type of Rig:** Truck Mounted |
| **Project Number:** 21250-01 | **Drop:** 30" **Hole Diameter:** 8" |
| **Elevation of Top of Hole:** ~572' MSL | **Drive Weight:** 140 pounds |
| **Hole Location:** See Geotechnical Map | Page 1 of 1 |

Logged By CMP
Sampled By CMP
Checked By BPG

| Elevation (ft) | Depth (ft) | Graphic Log | Sample Number | Blow Count | Dry Density (pcf) | Moisture (%) | USCS Symbol | DESCRIPTION | Type of Test |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | B-1 | | | | | | @0' - Topsoil, dry plant debris to 6"<br>Quaternary Alluvium - Very Old (Qvoa) | EI, MD |
| 570 | | | R-1 | 4 6 13 | 109.5 | 17.8 | SM | @2.5' - Silty SAND: yellow-brown, moist, medium dense, majority medium grain sand, trace gravel to 1/4", calcite layers, porous, trace rootlets | |
| | 5 | | R-2 | 10 19 22 | 103.5 | 12.2 | | @5' - Silty Fine SAND: gray-brown, moist, dense | |
| 565 | | | R-3 | 6 10 14 | 107.1 | 8.0 | ML | @7.5' - SILT with Sand: light olive-brown, slightly moist, very stiff, sample disturbed, trace cobbles | CO |
| | 10 | | SPT-1 | 8 12 12 | | 25.4 | CL | @10' - Lean CLAY with Sand: yellow-brown, very moist, very stiff, high plasticity | |
| 560 | | | | | | | | | |
| | 15 | | R-4 | 6 18 25 | 99.3 | 8.7 | | @15' - Sandy Lean CLAY: gray-brown, slightly moist, hard, increase in medium and fine grained sand | |
| 555 | | | | | | | | | |
| | 20 | | SPT-2 | 2 3 4 | | 34.2 | | @20' - CLAY with Sand: brown, wet, stiff, porous | |
| 550 | | | | | | | | | |
| | 25 | | R-5 | 4 14 24 | 109.3 | 20.2 | | @25' - Lean CLAY: brown, very moist, hard, sample slightly disturbed | |
| 545 | | | | | | | | Total Depth = 26.5'<br>Groundwater Not Encountered<br>Backfilled with Cuttings on 12/3/2021 | |
| | 30 | | | | | | | | |

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

**SAMPLE TYPES:**
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE

GROUNDWATER TABLE

**TEST TYPES:**
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

# Geotechnical Boring Log Borehole HS-2

| | |
|---|---|
| **Date:** 12/3/2021 | **Drilling Company:** Cal Pac Drilling |
| **Project Name:** River Road - Norco, Dallape | **Type of Rig:** Truck Mounted |
| **Project Number:** 21250-01 | **Drop:** 30" **Hole Diameter:** 6" |
| **Elevation of Top of Hole:** ~573' MSL | **Drive Weight:** 140 pounds |
| **Hole Location:** See Geotechnical Map | Page 1 of 1 |

Logged By CMP
Sampled By CMP
Checked By BPG

| Elevation (ft) | Depth (ft) | Graphic Log | Sample Number | Blow Count | Dry Density (pcf) | Moisture (%) | USCS Symbol | DESCRIPTION | Type of Test |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | B-1 | | | | | | @0' - Topsoil, straw, dead plant debris to 4"<br><u>Quaternary Alluvium - Very Old (Qvoa)</u> | CR |
| 570 | | | R-1 | 4<br>4<br>4 | 100.3 | 5.0 | SM | @2.5' - Silty SAND: yellow-brown, slightly moist, loose, majority medium grained sand | |
| | 5 | | R-2 | 3<br>2<br>3 | 106.5 | 6.9 | | @5' - Silty SAND: brown, slightly moist, very loose, calcite stringers, pinhole porosity, trace rootlets | |
| 565 | | | R-3 | 9<br>19<br>21 | 108.7 | 5.0 | SP-SM | @7.5' - SAND with SILT: gray-brown, slightly moist, dense, calcite stringers, poorly graded | |
| | 10 | | SPT-1 | 7<br>10<br>8 | | 5.5 | | @10' - SAND with SILT: red-brown, slightly moist, medium dense | |
| 560 | | | | | | | | | |
| | 15 | | R-4 | 8<br>12<br>23 | 114.3 | 13.2 | ML | @15' - Sandy SILT: gray-brown, moist, very stiff | |
| 555 | | | | | | | | | |
| | 20 | | SPT-2 | 3<br>5<br>6 | | 30.2 | | @20' - Sandy SILT: brown, wet, stiff | |
| 550 | | | | | | | | | |
| | 25 | | R-5 | 9<br>16<br>21 | 112.4 | 18.9 | CL | @25' - Sandy Lean CLAY: brown, very moist, hard | |
| 545 | | | | | | | | Total Depth = 26.5'<br>Groundwater Not Encountered<br>Backfilled with Cuttings on 12/3/2021 | |
| | 30 | | | | | | | | |

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

**SAMPLE TYPES:**
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

**TEST TYPES:**
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

# Geotechnical Boring Log Borehole HS-3

| | |
|---|---|
| **Date:** 12/3/2021 | **Drilling Company:** Cal Pac Drilling |
| **Project Name:** River Road - Norco, Dallape | **Type of Rig:** Truck Mounted |
| **Project Number:** 21250-01 | **Drop:** 30" **Hole Diameter:** 8" |
| **Elevation of Top of Hole:** ~566' MSL | **Drive Weight:** 140 pounds |
| **Hole Location:** See Geotechnical Map | Page 1 of 2 |

Logged By CMP
Sampled By CMP
Checked By BPG

| Elevation (ft) | Depth (ft) | Graphic Log | Sample Number | Blow Count | Dry Density (pcf) | Moisture (%) | USCS Symbol | DESCRIPTION | Type of Test |
|---|---|---|---|---|---|---|---|---|---|
| 565 | 0 | B-1 | | | | | | <u>Artificial Fill - Undocumented</u><br>@0' - Weathered gravel, cobbles & surficial debris to 2" | |
| | | | R-1 | 5 7 7 | 103.8 | 7.1 | SM | @2.5' Silty SAND: yellow-brown, slightly moist, medium dense<br><u>Quaternary Alluvium - Very Old (Qvoa)</u> | |
| 560 | 5 | | R-2 | 8 20 32 | 97.3 | 18.2 | ML | @5' - Sandy SILT: light yellow-brown, very moist, hard, chalky | |
| | | | R-3 | 12 19 22 | 113.3 | 5.4 | SM | @7.5' - Silty SAND: gray-brown, slightly moist, dense, slight increase in coarse grained sand | |
| 555 | 10 | | SPT-1 | 10 12 11 | | 10.6 | | @10' - Silty SAND: olive-brown, moist, medium dense, majority fine grained sand, trace calcite | -#200 |
| 550 | 15 | | R-4 | 5 12 15 | 105.0 | 13.3 | SW-SM | @15 - SAND with SILT: gray-brown, moist medium dense, well-graded | |
| 545 | 20 | | SPT-2 | 3 5 6 | | 32.7 | CH | @20' - Fat CLAY: pale brown, wet, stiff, high plasticity | AL |
| 540 | 25 | | R-5 | 9 15 21 | 116.6 | 16.5 | SC | @25' - Clayey SAND: brown, moist, medium dense, mottled with iron oxide deposits | -#200 |
| | 30 | | | | | | | | |

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**SAMPLE TYPES:**
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- ▽ GROUNDWATER TABLE

**TEST TYPES:**
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

# Geotechnical Boring Log Borehole HS-3

| | |
|---|---|
| **Date:** 12/3/2021 | **Drilling Company:** Cal Pac Drilling |
| **Project Name:** River Road - Norco, Dallape | **Type of Rig:** Truck Mounted |
| **Project Number:** 21250-01 | **Drop:** 30" **Hole Diameter:** 8" |
| **Elevation of Top of Hole:** ~566' MSL | **Drive Weight:** 140 pounds |
| **Hole Location:** See Geotechnical Map |  |

Logged By CMP
Sampled By CMP
Checked By BPG

| Elevation (ft) | Depth (ft) | Graphic Log | Sample Number | Blow Count | Dry Density (pcf) | Moisture (%) | USCS Symbol | DESCRIPTION | Type of Test |
|---|---|---|---|---|---|---|---|---|---|
| 535 | 30 | | SPT-3 | 8 13 23 | | 12.7 | SC | @30' - Clayey SAND: brown, slightly moist to moist, dense | |
| 530 | 35 | | R-6 | 9 15 28 | 111.3 | 19.0 | SM | @35' - Silty SAND: gray-brown, wet, dense | |
| 525 | 40 | | SPT-4 | 7 10 10 | | 17.9 | | @40' - Silty SAND: gray-brown, wet, medium dense, well graded | -#200 |
| | | ▼ | | | | | | @43' - Groundwater | |
| 520 | 45 | | R-7 | 8 13 16 | 115.8 | 17.3 | ML | @45' - Sandy SILT: olive-gray, very moist, very stiff, increase in coarse grained sand, visible free-water on sampler | -#200 |
| 515 | 50 | | SPT-5 | 11 38 50/6" | | 13.7 | SP-SM | @50' - Poorly Graded SAND with SILT: light brown, moist, very dense, iron-oxide deposit, decrease in moisture @50.5', highly weathered decomposed granitics at sample tip | |
| 510 | 55 | | | | | | | Total Depth = 51.5'<br>Groundwater Encountered at Approximately 523' MSL<br>Backfilled with Cuttings on 12/3/2021 | |
| | 60 | | | | | | | | |

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**SAMPLE TYPES:**
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- ▽ GROUNDWATER TABLE

**TEST TYPES:**
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

# Geotechnical Boring Log Borehole HS-4

| | |
|---|---|
| **Date:** 12/3/2021 | **Drilling Company:** Cal Pac Drilling |
| **Project Name:** River Road - Norco, Dallape | **Type of Rig:** Truck Mounted |
| **Project Number:** 21250-01 | **Drop:** 30" **Hole Diameter:** 8" |
| **Elevation of Top of Hole:** ~574' MSL | **Drive Weight:** 140 pounds |
| **Hole Location:** See Geotechnical Map | Page 1 of 1 |

Logged By CMP
Sampled By CMP
Checked By BPG

| Elevation (ft) | Depth (ft) | Graphic Log | Sample Number | Blow Count | Dry Density (pcf) | Moisture (%) | USCS Symbol | DESCRIPTION | Type of Test |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | B-1 | | | | | | @0' - Topsoil, plant debris to 8" | |
| | | | | | | | | Quaternary Alluvium - Very Old (Qvoa) | |
| 570 | | | R-1 | 22 26 31 | 117.1 | 3.8 | SP | @2.5 - SAND with cobbles and gravel, brown, dry, dense, poorly graded, approximately 20% cobbles and gravels | |
| | 5 | | R-2 | 22 32 43 | 125.0 | 3.1 | SP-SM | @5' - SAND with SILT: brown, dry, very dense, poorly graded | |
| 565 | | | R-3 | 16 24 32 | 110.7 | 5.9 | | @7.5' - SAND: brown, slightly moist, dense, poorly graded | |
| | 10 | | SPT-1 | 13 19 22 | | 6.0 | SW-SM | @10' - SAND: brown, slightly moist, very dense, well graded | |
| 560 | 15 | | R-4 | 14 35 32 | 109.6 | 6.0 | SW-SM | @15' - SAND with SILT: brown, slightly moist, very dense, well graded | |
| 555 | 20 | | SPT-2 | 4 8 29 | | 27.9 | SM | @20' - Silty SAND: olive-brown, wet, dense, at sampler tip SAND with Silt, light brown, poorly graded, observed in sampler | |
| 550 | 25 | | R-5 | 22 50/6" | 107.6 | 6.3 | | @25' - Silty SAND, brown, slightly moist, very dense | |
| 545 | 30 | | | | | | | Total Depth = 26.5'<br>Groundwater Not Encountered<br>Backfilled with Cuttings on 12/3/2021 | |

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**SAMPLE TYPES:**
B BULK SAMPLE
R RING SAMPLE (CA Modified Sampler)
G GRAB SAMPLE
SPT STANDARD PENETRATION TEST SAMPLE

GROUNDWATER TABLE

**TEST TYPES:**
DS DIRECT SHEAR
MD MAXIMUM DENSITY
SA SIEVE ANALYSIS
S&H SIEVE AND HYDROMETER
EI EXPANSION INDEX
CN CONSOLIDATION
CR CORROSION
AL ATTERBERG LIMITS
CO COLLAPSE/SWELL
RV R-VALUE
-#200 % PASSING # 200 SIEVE

# Geotechnical Boring Log Borehole I-1

| | |
|---|---|
| **Date:** 12/3/2021 | **Drilling Company:** Cal Pac Drilling |
| **Project Name:** River Road - Norco, Dallape | **Type of Rig:** Truck Mounted |
| **Project Number:** 21250-01 | **Drop:** 30" **Hole Diameter:** 8" |
| **Elevation of Top of Hole:** ~571' MSL | **Drive Weight:** 140 pounds |
| **Hole Location:** See Geotechnical Map | Page 1 of 1 |

Logged By CMP
Sampled By CMP
Checked By BPG

| Elevation (ft) | Depth (ft) | Graphic Log | Sample Number | Blow Count | Dry Density (pcf) | Moisture (%) | USCS Symbol | DESCRIPTION | Type of Test |
|---|---|---|---|---|---|---|---|---|---|
| 570 | 0 | | | | | | | @0' - Topsoil and dried plant debris to 8" | |
| | | | | | | | | Quaternary Alluvium - Very Old (Qvoa) | |
| | | | R-1 | 4 6 7 | 119.5 | 5.6 | SM | @2.5' - Silty SAND: brown, slightly moist, medium dense | |
| 565 | 5 | | | | | | | Total Depth = 5.2'<br>Groundwater Not Encountered<br>3" Perforated Pipe Surrounded by Gravel Installed on 12/3/2021<br>Backfilled with Cuttings on 12/6/2021 | |
| 560 | 10 | | | | | | | | |
| 555 | 15 | | | | | | | | |
| 550 | 20 | | | | | | | | |
| 545 | 25 | | | | | | | | |
| | 30 | | | | | | | | |

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**SAMPLE TYPES:**
B BULK SAMPLE
R RING SAMPLE (CA Modified Sampler)
G GRAB SAMPLE
SPT STANDARD PENETRATION TEST SAMPLE

GROUNDWATER TABLE

**TEST TYPES:**
DS DIRECT SHEAR
MD MAXIMUM DENSITY
SA SIEVE ANALYSIS
S&H SIEVE AND HYDROMETER
EI EXPANSION INDEX
CN CONSOLIDATION
CR CORROSION
AL ATTERBERG LIMITS
CO COLLAPSE/SWELL
RV R-VALUE
-#200 % PASSING # 200 SIEVE

# Geotechnical Boring Log Borehole I-2

| | |
|---|---|
| **Date:** 12/3/2021 | **Drilling Company:** Cal Pac Drilling |
| **Project Name:** River Road - Norco, Dallape | **Type of Rig:** Truck Mounted |
| **Project Number:** 21250-01 | **Drop:** 30" **Hole Diameter:** 8" |
| **Elevation of Top of Hole:** ~572' MSL | **Drive Weight:** 140 pounds |
| **Hole Location:** See Geotechnical Map | Page 1 of 1 |

Logged By CMP
Sampled By CMP
Checked By BPG

| Elevation (ft) | Depth (ft) | Graphic Log | Sample Number | Blow Count | Dry Density (pcf) | Moisture (%) | USCS Symbol | DESCRIPTION | Type of Test |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | @0' - Topsoil and dried plant debris to 8" | |
| 570 | | | | | | | | <u>Quaternary Alluvium - Very Old (Qvoa)</u> | |
| | | | R-1 | 15 14 21 | 114.2 | 3.1 | SM | @2.5' - Silty SAND: brown, dry, medium dense | |
| | 5 | | | | | | | Total Depth = 5'<br>Groundwater Not Encountered<br>3" Perforated Pipe Surrounded by Gravel Installed on 12/3/2021<br>Backfilled with Cuttings on 12/6/2021 | |
| 565 | | | | | | | | | |
| | 10 | | | | | | | | |
| 560 | | | | | | | | | |
| | 15 | | | | | | | | |
| 555 | | | | | | | | | |
| | 20 | | | | | | | | |
| 550 | | | | | | | | | |
| | 25 | | | | | | | | |
| 545 | | | | | | | | | |
| | 30 | | | | | | | | |

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THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

**SAMPLE TYPES:**
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- ▽ GROUNDWATER TABLE

**TEST TYPES:**
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

# Geotechnical Boring Log Borehole I-3

| | |
|---|---|
| **Date:** 12/3/2021 | **Drilling Company:** Cal Pac Drilling |
| **Project Name:** River Road - Norco, Dallape | **Type of Rig:** Truck Mounted |
| **Project Number:** 21250-01 | **Drop:** 30" **Hole Diameter:** 8" |
| **Elevation of Top of Hole:** ~567' MSL | **Drive Weight:** 140 pounds |
| **Hole Location:** See Geotechnical Map | Page 1 of 1 |

Logged By CMP
Sampled By CMP
Checked By BPG

| Elevation (ft) | Depth (ft) | Graphic Log | Sample Number | Blow Count | Dry Density (pcf) | Moisture (%) | USCS Symbol | DESCRIPTION | Type of Test |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | @0' - Topsoil and dried plant debris to 8" | |
| 565 | | | | | | | | Quaternary Alluvium - Very Old (Qvoa) | |
| | | | R-1 | 6 6 11 | 113.9 | 15.7 | SC-SM | @2.5' - Clayey SAND with SILT: brown, moist, medium dense, trace rootlets, calcite stringers | |
| | 5 | | R-2 | 6 5 7 | 113.0 | 2.2 | SW | @5' - SAND with SILT: brown, dry, medium dense, well graded | |
| 560 | | | R-3 | 4 7 11 | 109.0 | 1.9 | SP | @7.5' - SAND: yellow-brown, dry, medium dense, poorly graded | CO |
| | 10 | | | | | | | | |
| 555 | | | | | | | | Total Depth = 11'<br>Groundwater Not Encountered<br>3" Perforated Pipe Surrounded by Gravel Installed on 12/3/2021<br>Backfilled with Cuttings on 12/6/2021 | |
| | 15 | | | | | | | | |
| 550 | | | | | | | | | |
| | 20 | | | | | | | | |
| 545 | | | | | | | | | |
| | 25 | | | | | | | | |
| 540 | | | | | | | | | |
| | 30 | | | | | | | | |

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**SAMPLE TYPES:**

| | |
|---|---|
| B | BULK SAMPLE |
| R | RING SAMPLE (CA Modified Sampler) |
| G | GRAB SAMPLE |
| SPT | STANDARD PENETRATION TEST SAMPLE |
| ∇ | GROUNDWATER TABLE |

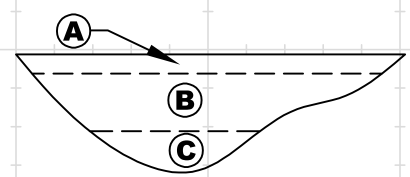
**TEST TYPES:**

| | |
|---|---|
| DS | DIRECT SHEAR |
| MD | MAXIMUM DENSITY |
| SA | SIEVE ANALYSIS |
| S&H | SIEVE AND HYDROMETER |
| EI | EXPANSION INDEX |
| CN | CONSOLIDATION |
| CR | CORROSION |
| AL | ATTERBERG LIMITS |
| CO | COLLAPSE/SWELL |
| RV | R-VALUE |
| -#200 | % PASSING # 200 SIEVE |

| | | |
|---|---|---|
| **Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-1** |
| **Project Number: 21250-01** | **Date: 12/1/2021** | **Engineering Properties:** |
| **Equipment: Backhoe** | **Location: See Geotechnical Map** | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | **Topsoil/Organics**<br>@ 0 to 0.5' - Silty SAND: gray brown, dry, loose, desiccated, many rootlets and organics, manure smell, distinct contact to cleaner soils below | | SM | O-1 @ 0.5' | | |
| | B | **Quaternary Alluvium**<br>@ 0.5 to 2' - Silty Fine SAND to Fine Sandy SILT: light to medium brown, dense to stiff, slightly moist, slightly friable at top, less so with depth, some root hairs and pinhole porosity | Qvoa | SM/ML | O-2 @ 1.5' | | |
| | C | @ 2 to 3' - Silty Fine SAND with trace of CLAY: medium brown, slightly moist, dense, more cohesive | | | O-3 @ 2.5'<br>O-4 @ 3.0' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 566' MSL** **Surface Slope: 0 deg.** **Trend: N45E**



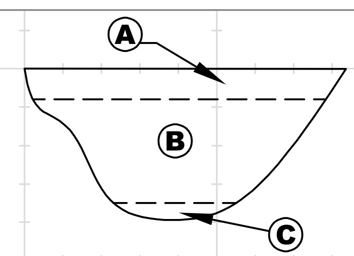

Total Depth: 3'
Groundwater: None
Backfilled: 12/01/21

scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-2 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/1/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | | <u>Topsoil/Organics</u> | | | | | |
| | A | @ 0 to 10" - Sandy SILT to Silty SAND: black brown, dry, loose, desiccated, manure smell, mostly organics/manure, roots, distinct contact to cleaner soils below | | SM/ML | O-1 @ 0.5' | | |
| | | <u>Quaternary Alluvium</u> | Qvoa | | | | |
| | B | @ 10" to 3.5' - Silty Fine SAND with trace CLAY: brown with some light gray and darker brown mottling, slightly moist, medium dense to very dense | | SM | O-2 @ 1.5'<br>O-3 @ 2.5' | | |
| | C | @ 3.5' to 4' - Gravelly SAND: light brown to medium brown, slightly moist, dense, moderately indurated | | | O-4 @ 3.5' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 567' MSL** **Surface Slope: 0 deg.** **Trend: N45E**




Total Depth: 4'
Groundwater: None
Backfilled: 12/01/21

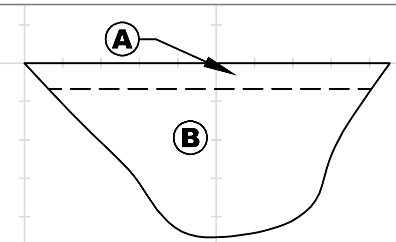
scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-3 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/1/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

LGC Geotechnical, Inc.

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | <u>Topsoil/Organics</u><br>@ 0 to 8" - Sandy SILT to Silty SAND: black to brown and gray, dry, loose, desiccated, some roots, native soils tilled in | | SM/ML | O-1 @ 0.5' | | |
| | B | <u>Quaternary Alluvium</u><br>@ 8" to 4' - Clayey Silty SAND: reddish brown with little dark gray mottle, slightly moist, dense, trace of rootlets, density increases with depth<br>@ 4' to 4.5' - increase in sand, some fine gravels | Qvoa | SM | O-2 @ 1.5'<br>O-3 @ 2.5' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 571' MSL** **Surface Slope: 0 deg.** **Trend: N60E**



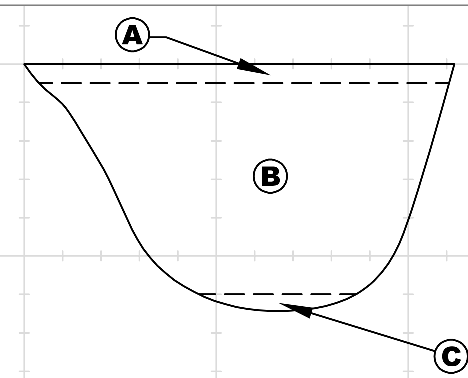

Total Depth: 4.5'
Groundwater: None
Backfilled: 12/01/21

scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-4 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/1/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | **Topsoil/Organics**<br>@ 0 to 0.5' - Sandy SILT to Silty SAND: black to gray, dry, loose, desiccated roots | | SM | O-1 @ 0.5' | | |
| | B | **Quaternary Alluvium**<br>@ 0.5' to 6' - Slightly clayey silty SAND: medium brown to reddish brown, slightly moist, medium dense to dense, density increases in depth, trace rootlets to approximately 3' deep | Qvoa | | O-2 @ 1.0'<br>O-3 @ 2.0'<br>O-4 @ 3.0' | | |
| | C | @ 6' to 6.5' - SAND: light brown, loose, slightly moist to dry, fairly clean | | | B-1 @ 6.0' to 6.5' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 572' MSL** **Surface Slope: 0 deg.** **Trend: N45E**




Total Depth: 6.5'
Groundwater: None
Backfilled: 12/01/21

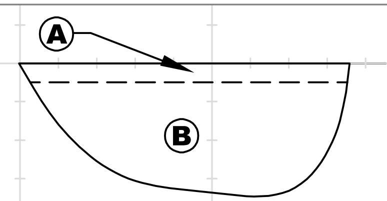
scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-5 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/1/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

LGC Geotechnical, Inc.

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | **Topsoil**<br>@ 0 to 0.5' - Sandy SILT to Silty SAND: dark gray, dry, loose, desiccated, many rootlets/roots throughout, minimal visible organics/manure | | SM/ML | O-1 @ 0.5' | | |
| | B | **Quaternary Alluvium**<br>@ 0.5 to 3.5' - Sandy SILT to Silty SAND: dry to slightly moist, dense to stiff, rootlets to 1.5', density and moisture increases with depth, some minor pinhole porosity in upper 1.5' | Qvoa | | O-2 @ 1.0'<br>O-3 @ 2.0' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 572' MSL** **Surface Slope: 0 deg.** **Trend: N25E**




Total Depth: 3.5'
Groundwater: None
Backfilled: 12/01/21

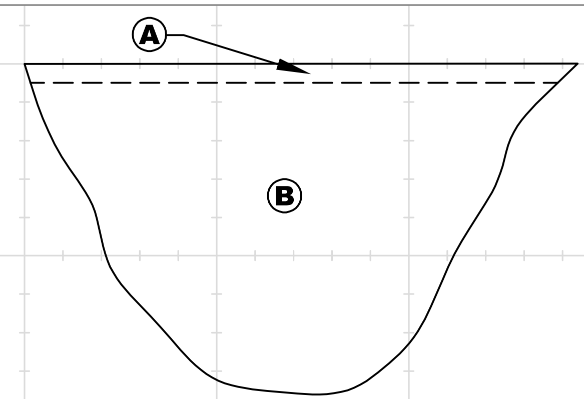
scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-6 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/1/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

LGC Geotechnical, Inc.

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | <u>Topsoil</u><br>@ 0 to 0.5' - Silty SAND to Sandy SILT: black to gray, loose dry, desiccated, many roots | | SM/ML | O-1 @ 0.5' | | |
| | B | <u>Quaternary Alluvium</u><br>@ 0.5 to 8.5' - Silty SAND to Sandy SILT: slightly moist, medium brown, medium dense, increase in density and moisture with depth | Qvoa | | O-2 @ 1.5'<br>O-3 @ 2.5'<br>B-1 @ 1-3' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 572' MSL** **Surface Slope: 0 deg.** **Trend: N5E**



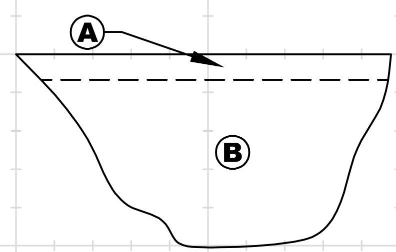

Total Depth: 8.5'
Groundwater: None
Backfilled: 12/01/21

scale: 1 in = 5 ft

| | | |
|---|---|---|
| **Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-7** |
| **Project Number: 21250-01** | **Date: 12/1/2021** | **Engineering Properties:** |
| **Equipment: Backhoe** | **Location: See Geotechnical Map** | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | **Topsoil**<br>@ 0 to 8" - Clayey SAND to Sandy CLAY: dark gray, dry, loose, desiccated, minimal organics visible, few rootlets | | SC | O-1 @ 0.5' | | |
| | B | **Quaternary Alluvium**<br>@ 8" to 5' - Silty Fine SAND: brown to red brown, slightly moist, medium dense, homogeneous appearance, slight increase in coarse sand at 2.5', increase density at 4' | Qvoa | SM/ML | O-2 @ 1.5'<br>O-3 @ 2.5' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 574' MSL** **Surface Slope: 0 deg.** **Trend: N40W**



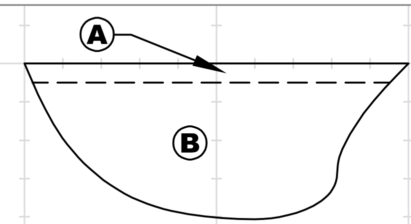

Total Depth: 5'
Groundwater: None
Backfilled: 12/01/21

scale: 1 in = 5 ft

| | | |
|---|---|---|
| **Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-8** |
| **Project Number: 21250-01** | **Date: 12/1/2021** | **Engineering Properties:** |
| **Equipment: Backhoe** | **Location: See Geotechnical Map** | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | **Topsoil**<br>@ 0 to 0.5' - Silty SAND and CLAY: gray brown, dry, loose, desiccated many roots, rootlets, little visible organics/manure | | SM/ML | O-1 @ 0.5' | | |
| | B | **Quaternary Alluvium**<br>@ 0.5 to 4' - Sandy SILT to Silty SAND: medium brown to reddish brown, dry to slightly moist (upper 1.5' dry/weathered), increase in moisture with depth, dense to very dense to 4' | Qvoa | | O-2 @ 1.5'<br>O-3 @ 2.5' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 571' MSL** **Surface Slope: 0 deg.** **Trend: N40W**



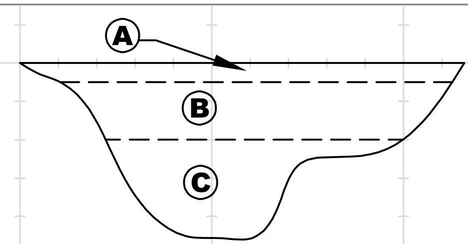

Total Depth: 4'
Groundwater: None
Backfilled: 12/01/21

scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-9 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/1/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | | **Topsoil** | | | | | |
| | A | @ 0 to 0.5' - Silty SAND to Sandy SILT: dark gray to brown, dry, loose, many roots | | SM/ML | O-1 @ 0.5' | | |
| | | **Quaternary Alluvium** | Qvoa | | | | |
| | B | @ 0.5 to 2' - Sandy SILT: light to medium brown, dry, loose to medium dense, weathered, desiccated | | | O-2 @ 1.5' | | |
| | C | @ 2' to 4.5' - Sandy SILT to Silty Fine SAND: medium brown to red brown, slightly moist, dense, probed tight | | | O-3 @ 2.5'<br>O-4 @ 3.5' | | |

GRAPHICAL REPRESENTATION BELOW: Elevation: 572' MSL Surface Slope: 0 deg. Trend: N45W




Total Depth: 4.5'
Groundwater: None
Backfilled: 12/01/21

scale: 1 in = 5 ft

| | | |
|---|---|---|
| **Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-10** |
| **Project Number: 21250-01** | **Date: 12/1/2021** | **Engineering Properties:** |
| **Equipment: Backhoe** | **Location: See Geotechnical Map** | |

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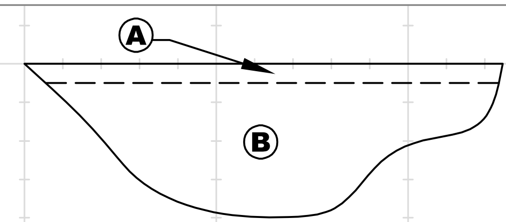
| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | **Topsoil**<br>@ 0 to 0.5' - Silty SAND to Sandy SILT: brown, dry, loose, visible organics/manure | | SM/ML | O-1 @ 0.5' | | |
| | B | **Quaternary Alluvium**<br>@ 0.5 to 4' - Silty SAND to Sandy SILT: light to medium brown, slightly moist, dense, rootlets to 3.5', probed tight at 2', drier and weathered in upper 2', increase in density and sand with depth | Qvoa | | O-2 @ 1.5'<br>O-3 @ 2.5'<br>O-4 @ 3.5'<br>B-1 @ 1-4' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 572' MSL** **Surface Slope: 0 deg.** **Trend: N40E**




Total Depth: 4'
Groundwater: None
Backfilled: 12/01/21

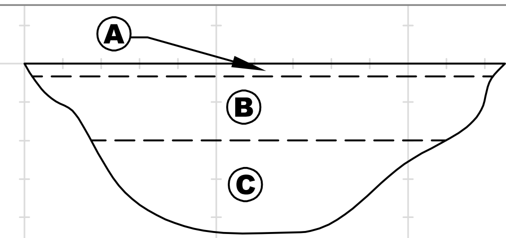
scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-11 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/1/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

LGC Geotechnical, Inc.

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | | Topsoil | | | | | |
| | A | @ 0 to 4" - Sandy SILT: gray, dry, loose, desiccated, many roots | | SM/ML | | | |
| | | Quaternary Alluvium | Qvoa | | | | |
| | B | @ 4" to 2' - Slightly Sandy SILT: medium gray to brown, dry, loose, slightly weathered and desiccated, rootlets to 2' | | | O-1 @ 0.5'<br>O-2 @ 1.5' | | |
| | C | @ 2 to 4.5' - Sandy SILT to silty fine SAND: medium brown to slightly reddish brown, slightly moist, dense, probes very tight | | | O-3 @ 2.5'<br>O-4 @ 3.5' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 567' MSL** **Surface Slope: 0 deg.** **Trend: N35E**



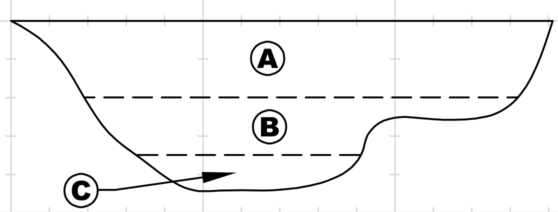

Total Depth: 4.5'
Groundwater: None
Backfilled: 12/01/21

scale: 1 in = 5 ft

| | | |
|---|---|---|
| **Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-12** |
| **Project Number: 21250-01** | **Date: 12/1/2021** | **Engineering Properties:** |
| **Equipment: Backhoe** | **Location: See Geotechnical Map** | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | | **Quaternary Alluvium** | Qvoa | | | | |
| | A | @ 0 to 2' - slightly clayey SILT: light brown, dry, medium stiff, rootlets, upper few inches includes roots from plants above @1.5' - 2" to 3" bed of white chalky silt, dry, loose | | SM/ML | O-1 @ 0.5'<br>O-2 @ 1.5' | | |
| | B | @ 2 to 3.5' - Sand and Fine GRAVEL: medium brown, dry, loose to medium dense | | | B-1 @ 2.0' - 3.5'<br>O-3 @ 2.5' | | |
| | C | @ 3.5 to 4.5' - Silty Fine SAND to Fine Sandy SILT: medium brown, slightly moist, dense to very dense, trace rootlets | | | | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 567' MSL** **Surface Slope: 0 deg.** **Trend: N35E**



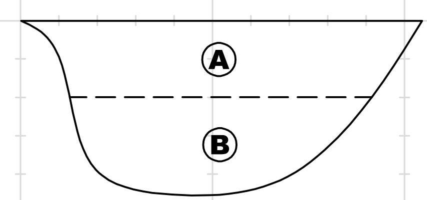

Total Depth: 4.5'
Groundwater: None
Backfilled: 12/01/21

scale: 1 in = 5 ft

| | | |
|---|---|---|
| **Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-13** |
| **Project Number: 21250-01** | **Date: 12/2/2021** | **Engineering Properties:** |
| **Equipment: Backhoe** | **Location: See Geotechnical Map** | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | | <u>Quaternary Alluvium</u> | Qvoa | | | | |
| | A | @ 0 to 2' - Sandy SILT to Silty SAND: medium brown to reddish brown, dry, loose, weathered and desiccated in upper 2', excavates somewhat blocky, roots/rootlets in upper 2', pinhole porosity throughout, trace clay | | ML | B-1 @ 0-2'<br>O-1 @ 0.5'<br>O-2 @ 1.5' | | |
| | B | @ 2 to 4.5' - Increase in sand content to Silty SAND: red brown, slightly moist, dense, trace clay, trace pinhole porosity, trace rootlets, density increases with depth, very dense, difficult excavating with backhoe @ 4.5' | | SM | | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 573' MSL** **Surface Slope: 0 deg.** **Trend: N20W**



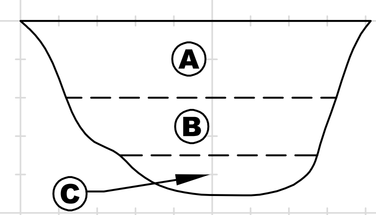

Total Depth: 4.5'
Groundwater: None
Backfilled: 12/02/21

scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-14 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/2/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | | Quaternary Alluvium | Qvoa | | | | |
| | A | @ 0 to 2' - Silty SAND with Clay: red brown, dry to slightly moist, medium dense, weathered, fractured, desiccated, some rootlets | | SM | | | |
| | B | @ 2 to 3.5' - similar to above, less weathered, increase in moisture and density | | | | | |
| | | @ 3.5 to 4' - increase in density to very dense, some white caliche staining, along healed fractures, few light gray cobbles, well rounded, some coarse sand | | | | | |
| | C | @ 4 to 4.5' - SAND with gravel, medium brown, slightly moist, very dense, gravels to 2" diameter, rounded, moderately indurated, difficult excavating | | | | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 574' MSL** **Surface Slope: 0 deg.** **Trend: N15E**




Total Depth: 4.5'
Groundwater: None
Backfilled: 12/02/21

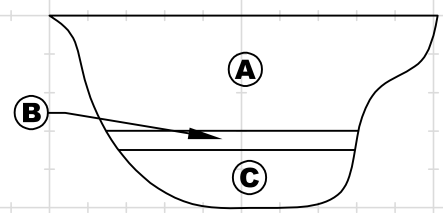
scale: 1 in = 5 ft

| | | |
|---|---|---|
| **Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-15** |
| **Project Number: 21250-01** | **Date: 12/2/2021** | **Engineering Properties:** |
| **Equipment: Backhoe** | **Location: See Geotechnical Map** | |

LGC Geotechnical, Inc.

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | **Artificial Fill - Undocumented**<br>@ 0 to 3' - Sandy SILT to Silty SAND: light brown, dry to slightly moist, medium dense, weathered/desiccated, few clasts of well-cemented siltstone, few rounded cobbles to 3" across, wood debris at base of unit | Afu | SM/ML | B-1 @ 0 to 3.0' | | |
| | B | **Topsoil**<br>@ 3 to 3.5' - Silty SAND to Sandy SILT: red brown, loose dry, many rootlets, weathered | | | | | |
| | C | **Quaternary Alluvium**<br>@ 3.5 to 5' - Silty Fine SAND with trace Clay: red brown, slightly moist, dense, difficult excavating at 5' | Qvoa | SM | | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 568' MSL** **Surface Slope: 0 deg.** **Trend: N20E**



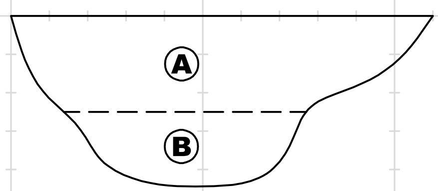

Total Depth: 5'
Groundwater: None
Backfilled: 12/02/21

scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-16 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/2/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | Artificial Fill - Undocumented<br>@ 0 to 2.5' - Silty SAND to Sandy Silt: red brown to gray and light brown mottled, slightly moist, medium dense, angular gravels throughout, asphalt and some granitics, trace clay, visible lifts including 4" gravel lift near surface and at 2' | Afu | SM/ML | B-1 @ 0 to 2.5' | | |
| | B | Quaternary Alluvium<br>@ 2.5 to 4.5' - Silty Fine SAND: red brown, slightly moist, dense, difficult excavating, some pinhole porosity, trace root hairs, trace clay | Qvoa | SM | | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 565' MSL** **Surface Slope: 0 deg.** **Trend: N25E**




Total Depth: 4.5'
Groundwater: None
Backfilled: 12/02/21

scale: 1 in = 5 ft

**Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-17**

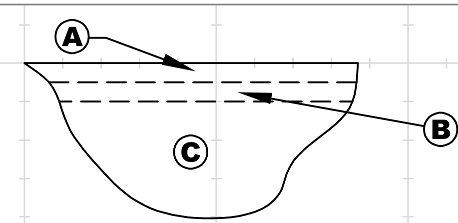
**Project Number: 21250-01** | **Date: 12/2/2021** | **Engineering Properties:**

**Equipment: Backhoe** | **Location: See Geotechnical Map**

LGC Geotechnical, Inc.

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | | Artificial Fill - Undocumented | Afu | | | | |
| | A | @ 0 to 0.5' - Silty SAND to Sandy SILT: light brown, loose, dry, many gravels | | SM/ML | O-1 @ 0.5' | | |
| | | Quaternary Alluvium | Qvoa | | | | |
| | B | @ 0.5 to 1' - Silty SAND: red brown, dry to slightly moist, medium dense, weathered, slightly desiccated, slightly clayey | | SM | O-2 @ 1.5' | | |
| | C | @ 1 to 4' - Increase in moisture and density, decrease in silt with depth, difficult excavating at 4' | | | | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 573' MSL** **Surface Slope: 0 deg.** **Trend: N35E**



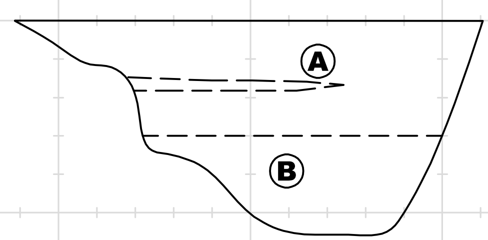

Total Depth: 4'
Groundwater: None
Backfilled: 12/02/21

scale: 1 in = 5 ft

| Project Name: River Road, Norco - Dallape | Logged By: BPG | Trench No.: TP-18 |
|---|---|---|
| Project Number: 21250-01 | Date: 12/2/2021 | Engineering Properties: |
| Equipment: Backhoe | Location: See Geotechnical Map | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | | <u>Artificial Fill - Undocumented</u> | Afu | | | | |
| | A | @ 0 to 3' - Silty SAND with Gravel: red brown, dry, loose to medium dense, many gravels, lense or lift of vegetation approximately 3" thick @1.5' (non-continuous) | | SM | | | |
| | | <u>Quaternary Alluvium</u> | Qvoa | | | | |
| | B | @ 3 to 5.5' - Silty SAND: red brown, slightly moist, dense, increase in moisture and density with depth, difficult excavating at 5.5', some pinhole porosity and root hairs | | | | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 571' MSL** **Surface Slope: 0 deg.** **Trend: N30W**



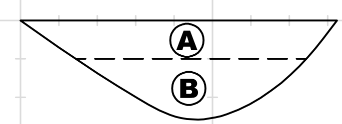

Total Depth: 5.5'
Groundwater: None
Backfilled: 12/02/21

scale: 1 in = 5 ft

| | | |
|---|---|---|
| **Project Name: River Road, Norco - Dallape** | **Logged By: BPG** | **Trench No.: TP-19** |
| **Project Number: 21250-01** | **Date: 12/2/2021** | **Engineering Properties:** |
| **Equipment: Backhoe** | **Location: See Geotechnical Map** | |

| Geologic Attitudes | Unit | SOIL DESCRIPTION: | GEOLOGIC UNIT | USCS | SAMPLE No | MOISTURE (%) | DRY DENSITY (PCF) |
|---|---|---|---|---|---|---|---|
| | A | <u>Quaternary Alluvium</u><br>@ 0 to 1' - Silty SAND: red brown, dry, loose, weathered, desiccated, many roots, rootlets, pinhole porosity | Qvoa | SM/ML | O-1 @ 0.5' | | |
| | B | @ 1 to 2.5' - Silty SAND: red brown, dry, loose, weathered, desiccated, many roots, rootlets, increase in moisture and density, excavated hard/blocky, increase in sand @2.5', some pinhole porosity | | | O-2 @ 1.5' | | |

**GRAPHICAL REPRESENTATION BELOW:** **Elevation: 572' MSL** **Surface Slope: 0 deg.** **Trend: N40W**




Total Depth: 2.5'
Groundwater: None
Backfilled: 12/02/21

scale: 1 in = 5 ft

# *Appendix C*
# *Laboratory Test Results*

## ***APPENDIX C***

## ***Laboratory Test Results***

The laboratory testing program was directed towards providing quantitative data relating to the relevant engineering properties of the site soils. Samples considered representative of site conditions were tested in general accordance with American Society for Testing and Materials (ASTM) procedure and/or California Test Methods (CTM), where applicable. The following summary is a brief outline of the test type and a table summarizing the test results.

Moisture and Density Determination Tests: Moisture content (ASTM D2216) and dry density determinations (ASTM D2937) were performed on driven samples obtained from the test borings. The results of these tests are presented in the boring logs. Where applicable, only moisture content was determined from undisturbed or disturbed samples.

Grain Size Distribution/Fines Content: Representative samples were dried, weighed, and soaked in water until individual soil particles were separated (per ASTM D421) and then washed on a No. 200 sieve (ASTM D1140). Where applicable, the portion retained on the No. 200 sieve was dried and then sieved on a U.S. Standard brass sieve set in accordance with ASTM D6913 (sieve).

| Sample Location | Description | % Passing # 200 Sieve |
|---|---|---|
| HS-3, SPT-1 @ 10’ | Olive Brown Silty Sand | 38.5 |
| HS-3, R-5 @ 25’ | Brown Sandy Lean Clay | 65.5 |
| HS-3, SPT-4 @ 40’ | Gray Silty Sand | 43.8 |
| HS-3, R-7 @ 45’ | Olive Gray Sandy Silt | 50.9 |

Atterberg Limits: The liquid and plastic limits (“Atterberg Limits”) were determined per ASTM D4318 for engineering classification of fine-grained material and presented in the table below. The USCS soil classification indicated in the table below is based on the portion of sample passing the No. 40 sieve and may not necessarily be representative of the entire sample. The plot is provided in this Appendix.

| Sample Location | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) | USCS Soil Classification |
|---|---|---|---|---|
| HS-3 @ 20 ft | 66 | 27 | 39 | CL |

Collapse/Swell Potential: Two collapse tests were performed per ASTM D4546. A sample (2.4 inches in diameter and 1-inch in height) was placed in a consolidometer and loaded to the approximate in-situ effective stress. The curve is presented in this Appendix.

Maximum Density Tests: The maximum dry density and optimum moisture content of a typical material was determined in accordance with ASTM D1557. The result of this test is presented in the table below:

| **Sample Location** | **Sample Description** | **Maximum Dry Density (pcf)** | **Optimum Moisture Content (%)** |
|---|---|---|---|
| HS-1 @ 0-5 ft | Brown Silty Sand | 117.0 | 12.0 |

Expansion Index: The expansion potential of selected representative samples was evaluated by the Expansion Index Test per ASTM D4829.

| **Sample Location** | **Expansion Index** | **Expansion Potential*** |
|---|---|---|
| HS-1 @ 0-5 ft | 24 | Low |

* Per ASTM D4829

Soluble Sulfates: The soluble sulfate content of a select sample was determined by standard geochemical methods (CTM 417). The test result is presented in the table below.

| **Sample Location** | **Sulfate Content, ppm** |
|---|---|
| HS-2 @ 0-5 ft | 156 |

Chloride Content: Chloride content was tested per CTM 422. The results are presented below.

| **Sample Location** | **Chloride Content, ppm** |
|---|---|
| HS-2 @ 0-5 ft | 960 |

Organic Matter Content of Soils: Organic matter content tests were performed in general accordance with ASTM D 2974 (Test Methods A & C). The results are presented in attached Table 7.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. | HS-1 | HS-1 | HS-1 | HS-1 | HS-1 | HS-2 | HS-2 | HS-2 |
| Sample No. | R-1 | R-2 | R-3 | R-4 | R-5 | R-1 | R-2 | R-3 |
| Depth (ft.) | 2.5 | 5.0 | 7.5 | 15.0 | 25.0 | 2.5 | 5.0 | 7.5 |
| Sample Type | Ring | Ring | Ring | Ring | Ring | Ring | Ring | Ring |
| Soil Identification | Brown silty sand (SM) | Brown silty sand (SM) | Light olive brown silt with sand (ML)s | Grayish brown lean clay (CL) | Brown lean clay (CL) | Brown silty sand (SM) | Brown silty sand (SM) | Grayish brown poorly-graded sand with silt (SP-SM), loose |
| Pocket Penetrometer (tons/$ft^2$) | >4.50 | >4.50 | 4.00/>4.50 | 4.00 | >4.50 | 3.50 | 3.50 | <0.25 |
| Weight Soil + Rings / Tube (g) | 1197.3 | 1104.3 | 917.4 | 1045.7 | 1011.7 | 1026.6 | 906.8 | 1089.7 |
| Weight of Rings / Tube (g) | 266.4 | 266.4 | 222.0 | 266.4 | 222.0 | 266.4 | 222.0 | 266.4 |
| Average Length (in.) | 6.00 | 6.00 | 5.00 | 6.00 | 5.00 | 6.00 | 5.00 | 6.00 |
| Average Diameter (in.) | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 |
| Wet. Wt. of Soil + Cont. (g) | 238.6 | 216.8 | 181.2 | 210.5 | 212.5 | 228.0 | 241.2 | 258.3 |
| Dry Wt. of Soil + Cont. (g) | 213.4 | 199.5 | 172.1 | 197.7 | 186.5 | 219.9 | 229.6 | 248.9 |
| Weight of Container (g) | 72.1 | 57.5 | 58.2 | 51.2 | 57.8 | 58.9 | 62.6 | 60.1 |
| Container No. | | | | | | | | |
| **Wet Density** | 129.0 | 116.1 | 115.7 | 108.0 | 131.4 | 105.4 | 113.9 | 114.1 |
| **Moisture Content (%)** | **17.8** | **12.2** | **8.0** | **8.7** | **20.2** | **5.0** | **6.9** | **5.0** |
| **Dry Density (pcf)** | **109.5** | **103.5** | **107.1** | **99.3** | **109.3** | **100.3** | **106.5** | **108.7** |
| **Degree of Saturation (%)** | 89.3 | 52.4 | 37.6 | 33.9 | 100.5 | 20.0 | 32.2 | 24.4 |

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**MOISTURE & DENSITY of SOILS**

**ASTM D 2216 & ASTM D 2937**

Project Name: River Rd - Norco
Project No.: 21250-01
Tested By: SF/GB Date: 12/15/21

| Boring No. | HS-2 | HS-2 | HS-3 | HS-3 | HS-3 | HS-3 | HS-3 | HS-3 |
|---|---|---|---|---|---|---|---|---|
| Sample No. | R-4 | R-5 | R-1 | R-2 | R-3 | R-4 | R-5 | R-6 |
| Depth (ft.) | 15.0 | 25.0 | 2.5 | 5.0 | 7.5 | 15.0 | 25.0 | 35.0 |
| Sample Type | Ring | Ring | Ring | Ring | Ring | Ring | Ring | Ring |
| Soil Identification | Brown silt (ML) | Brown sandy lean clay s(CL) | Brown silty sand (SM) | Light brown silt (ML) | Light brown silty sand (SM) | Grayish brown well-graded sand with silt (SW-SM) | Brown clayey sand (SC) | Grayish brown silty sand (SM) |
| Pocket Penetrometer (tons/ft$^2$) | >4.50 | >4.50 | >4.50 | >4.50 | >4.50 | >4.50 | >4.50 | >4.50 |
| Weight Soil + Rings / Tube (g) | 1200.1 | 1025.4 | 1068.1 | 1096.0 | 1127.8 | 1124.5 | 1038.9 | 1222.0 |
| Weight of Rings / Tube (g) | 266.4 | 222.0 | 266.4 | 266.4 | 266.4 | 266.4 | 222.0 | 266.4 |
| Average Length (in.) | 6.00 | 5.00 | 6.00 | 6.00 | 6.00 | 6.00 | 5.00 | 6.00 |
| Average Diameter (in.) | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 |
| Wet. Wt. of Soil + Cont. (g) | 230.5 | 213.3 | 203.4 | 214.7 | 212.3 | 210.3 | 1066.1 | 219.1 |
| Dry Wt. of Soil + Cont. (g) | 210.3 | 189.8 | 193.8 | 190.4 | 203.4 | 192.4 | 930.4 | 193.2 |
| Weight of Container (g) | 57.6 | 65.7 | 57.7 | 56.8 | 37.4 | 57.6 | 107.7 | 56.7 |
| Container No. | | | | | | | | |
| **Wet Density** | 129.4 | 133.6 | 111.1 | 115.0 | 119.4 | 118.9 | 135.9 | 132.5 |
| **Moisture Content (%)** | **13.2** | **18.9** | **7.1** | **18.2** | **5.4** | **13.3** | **16.5** | **19.0** |
| **Dry Density (pcf)** | **114.3** | **112.4** | **103.8** | **97.3** | **113.3** | **105.0** | **116.6** | **111.3** |
| **Degree of Saturation (%)** | 75.2 | 102.2 | 30.5 | 67.0 | 29.7 | 59.2 | 100.0 | 99.7 |

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**MOISTURE & DENSITY of SOILS**

**ASTM D 2216 & ASTM D 2937**

Project Name: River Rd - Norco
Project No.: 21250-01
Tested By: S. Felter Date: 12/15/21

*M&D HS-1, HS-2, HS-3, HS-4, I-1, I-2, I-3*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring No. | HS-3 | HS-4 | HS-4 | HS-4 | HS-4 | HS-4 | I-1 | I-2 |
| Sample No. | R-7 | R-1 | R-2 | R-3 | R-4 | R-5 | R-1 | R-1 |
| Depth (ft.) | 45.0 | 2.5 | 5.0 | 7.5 | 15.0 | 25.0 | 3.0 | 3.0 |
| Sample Type | Ring | Ring | Ring | Ring | Ring | Ring | Ring | Ring |
| Soil Identification | Olive gray sandy silt s(ML) | Brown poorly-graded sand (SP), loose | Brown poorly-graded sand with silt (SP-SM) | Brown poorly-graded sand with silt (SP-SM) | Brown well-graded sand with silt (SW-SM) | Brown silty sand (SM) | Brown silty sand (SM) | Brown silty sand (SM) |
| Pocket Penetrometer (tons/ft$^2$) | >4.50 | <0.25 | >4.50 | >4.50 | >4.50 | 4.50 | 4.00 | >4.50 |
| Weight Soil + Rings / Tube (g) | 1246.3 | 1142.9 | 1195.6 | 1111.8 | 1104.3 | 1091.2 | 1176.7 | 1115.8 |
| Weight of Rings / Tube (g) | 266.4 | 266.4 | 266.4 | 266.4 | 266.4 | 266.4 | 266.4 | 266.4 |
| Average Length (in.) | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 |
| Average Diameter (in.) | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 | 2.415 |
| Wet. Wt. of Soil + Cont. (g) | 1090.3 | 270.3 | 234.4 | 226.1 | 230.5 | 224.4 | 228.0 | 230.5 |
| Dry Wt. of Soil + Cont. (g) | 945.4 | 262.6 | 228.5 | 216.8 | 221.9 | 214.5 | 219.7 | 225.3 |
| Weight of Container (g) | 108.1 | 58.7 | 36.7 | 58.2 | 77.4 | 57.1 | 71.8 | 57.4 |
| Container No. | | | | | | | | |
| **Wet Density** | 135.8 | 121.5 | 128.8 | 117.2 | 116.1 | 114.3 | 126.2 | 117.7 |
| **Moisture Content (%)** | **17.3** | **3.8** | **3.1** | **5.9** | **6.0** | **6.3** | **5.6** | **3.1** |
| **Dry Density (pcf)** | **115.8** | **117.1** | **125.0** | **110.7** | **109.6** | **107.6** | **119.5** | **114.2** |
| **Degree of Saturation (%)** | 102.5 | 23.2 | 23.8 | 30.3 | 29.9 | 29.9 | 36.9 | 17.6 |

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**MOISTURE & DENSITY of SOILS**

**ASTM D 2216 & ASTM D 2937**

Project Name: River Rd - Norco

Project No.: 21250-01

Tested By: S. Felter Date: 12/15/21

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Boring No. | I-3 | I-3 | I-3 | | | | | | |
| Sample No. | R-1 | R-2 | R-3 | | | | | | |
| Depth (ft.) | 2.5 | 5.0 | 7.5 | | | | | | |
| Sample Type | Ring | Ring | Ring | | | | | | |
| Soil Identification | Brown silty, clayey sand (SC-SM) | Brown well-graded sand (SW) | Yellowish brown poorly-graded sand (SP) | | | | | | |
| Pocket Penetrometer (tons/$ft^2$) | >4.50 | 3.25 | 0.50/1.00 | | | | | | |
| Weight Soil + Rings / Tube (g) | 1216.9 | 916.8 | 1067.6 | | | | | | |
| Weight of Rings / Tube (g) | 266.4 | 222.0 | 266.4 | | | | | | |
| Average Length (in.) | 6.00 | 5.00 | 6.00 | | | | | | |
| Average Diameter (in.) | 2.415 | 2.415 | 2.415 | | | | | | |
| Wet. Wt. of Soil + Cont. (g) | 233.7 | 273.6 | 208.7 | | | | | | |
| Dry Wt. of Soil + Cont. (g) | 209.6 | 268.8 | 205.9 | | | | | | |
| Weight of Container (g) | 55.7 | 54.4 | 60.9 | | | | | | |
| Container No. | | | | | | | | | |
| **Wet Density** | 131.7 | 115.6 | 111.1 | | | | | | |
| **Moisture Content (%)** | **15.7** | **2.2** | **1.9** | | | | | | |
| **Dry Density (pcf)** | **113.9** | **113.0** | **109.0** | | | | | | |
| **Degree of Saturation (%)** | 88.1 | 12.3 | 9.5 | | | | | | |

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**MOISTURE & DENSITY of SOILS**

**ASTM D 2216 & ASTM D 2937**

Project Name: River Rd - Norco
Project No.: 21250-01
Tested By: SF/GB Date: 12/16/21

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# MOISTURE CONTENT
## ASTM D 2216

Project Name: River Rd - Norco
Project No.: 21250-01

Tested By: S. Felter
Date: 12/15/21
Checked By: J. Ward
Date: 01/06/22

| Boring No. | HS-1 | HS-1 | HS-2 | HS-2 | HS-3 |
|---|---|---|---|---|---|
| Sample No. | SP-1 | SP-2 | SP-1 | SP-2 | SP-1 |
| Depth (ft) | 10.0 | 20.0 | 10.0 | 20.0 | 10.0 |
| Sample Type | SPT | SPT | SPT | SPT | SPT |
| Sample Description | Olive brown lean clay (CL) | Olive brown lean clay (CL) | Brown well-graded sand with silt (SW-SM) | Brown silt (ML) | Olive brown silty sand (SM) |
| Wt. wet soil + container (g) | 230.4 | 233.2 | 320.8 | 224.6 | 817.9 |
| Wt. dry soil + container (g) | 196.0 | 192.2 | 306.8 | 188.1 | 749.9 |
| Weight of container (g) | 60.3 | 72.2 | 54.3 | 67.2 | 108.1 |
| | | | | | |
| **Moisture Content (%)** | **25.4** | **34.2** | **5.5** | **30.2** | **10.6** |

| Boring No. | HS-3 | HS-3 | HS-3 | HS-3 | HS-4 |
|---|---|---|---|---|---|
| Sample No. | SP-2 | SP-3 | SP-4 | SP-5 | SP-1 |
| Depth (ft) | 20.0 | 30.0 | 40.0 | 50.0 | 10.0 |
| Sample Type | SPT | SPT | SPT | SPT | SPT |
| Sample Description | Pale brown fat clay (CH) | Brown clayey sand (SC) | Gray silty sand (SM) | Grayish brown poorly-graded sand with silt (SP-SM) | Brown well-graded sand with silt (SW-SM) |
| Wt. wet soil + container (g) | 292.4 | 336.1 | 1071.9 | 269.4 | 218.8 |
| Wt. dry soil + container (g) | 234.4 | 304.7 | 925.1 | 243.9 | 209.7 |
| Weight of container (g) | 57.1 | 57.8 | 107.2 | 58.3 | 57.7 |
| | | | | | |
| **Moisture Content (%)** | **32.7** | **12.7** | **17.9** | **13.7** | **6.0** |

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# MOISTURE CONTENT

**ASTM D 2216**

Project Name: River Rd - Norco
Project No.: 21250-01

Tested By: S. Felter
Date: 12/15/21
Checked By: J. Ward
Date: 01/06/22

| | | | | | |
|---|---|---|---|---|---|
| Boring No. | HS-4 | | | | |
| Sample No. | SP-2 | | | | |
| Depth (ft) | 20.0 | | | | |
| Sample Type | SPT | | | | |
| Sample Description | Olive brown silty sand (SM) | | | | |
| Wt. wet soil + container (g) | 243.8 | | | | |
| Wt. dry soil + container (g) | 201.8 | | | | |
| Weight of container (g) | 51.2 | | | | |
| | | | | | |
| **Moisture Content (%)** | **27.9** | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Boring No. | | | | | |
| Sample No. | | | | | |
| Depth (ft) | | | | | |
| Sample Type | | | | | |
| Sample Description | | | | | |
| Wt. wet soil + container (g) | | | | | |
| Wt. dry soil + container (g) | | | | | |
| Weight of container (g) | | | | | |
| | | | | | |
| **Moisture Content (%)** | | | | | |

# ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS
## ASTM D 4546

| | | | |
|---|---|---|---|
| Project Name: | River Rd - Norco | Tested By: | G. Bathala |
| Project No.: | 21250-01 | Checked By: | J. Ward |
| Boring No.: | HS-1 | Sample Type: | Ring |
| Sample No.: | R-3 | Depth (ft.) | 7.5 |

Date: 12/17/21
Date: 01/07/22

Sample Description: Light olive brown silt with sand (ML)s

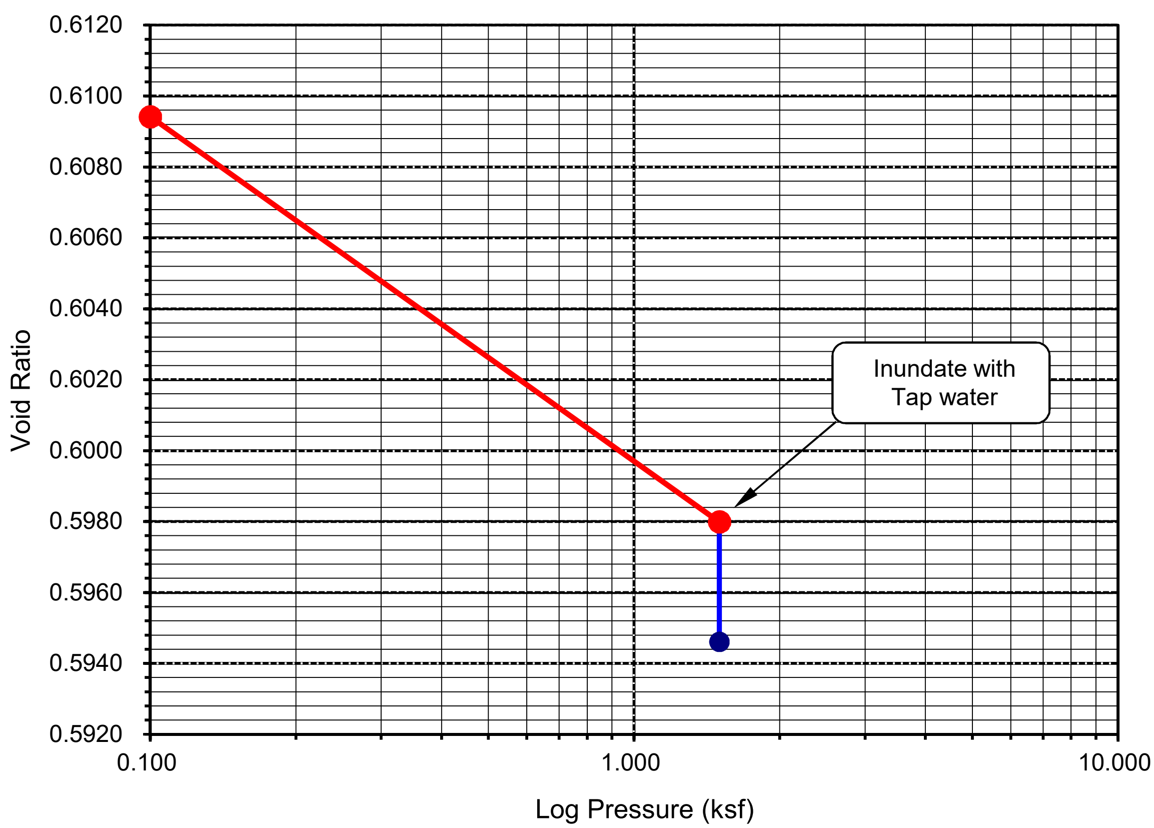
| | |
|---|---|
| Initial Dry Density (pcf): | 104.7 |
| Initial Moisture (%): | 8.00 |
| Initial Length (in.): | 1.0000 |
| Initial Dial Reading: | 0.3285 |
| Diameter(in): | 2.415 |

| | |
|---|---|
| Final Dry Density (pcf): | 105.7 |
| Final Moisture (%) : | 21.1 |
| Initial Void Ratio: | 0.6096 |
| Specific Gravity(assumed): | 2.70 |
| Initial Saturation (%) | 35.4 |

| Pressure (p) (ksf) | Final Reading (in) | Apparent Thickness (in) | Load Compliance (%) | Swell (+) Settlement (-) % of Sample Thickness | Void Ratio | Corrected Deformation (%) |
|---|---|---|---|---|---|---|
| 0.100 | 0.3284 | 0.9999 | 0.00 | -0.01 | 0.6094 | -0.01 |
| 1.500 | 0.3204 | 0.9919 | 0.09 | -0.81 | 0.5980 | -0.72 |
| H2O | 0.3183 | 0.9898 | 0.09 | -1.02 | 0.5946 | -0.93 |

**Percent Swell (+) / Settlement (-) After Inundation = -0.21**

Void Ratio - Log Pressure Curve



# ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS

## ASTM D 4546

| | | | | | |
|---|---|---|---|---|---|
| Project Name: | River Rd - Norco | Tested By: | G. Bathala | Date: | 12/17/21 |
| Project No.: | 21250-01 | Checked By: | J. Ward | Date: | 01/07/22 |
| Boring No.: | I-3 | Sample Type: | Ring | | |
| Sample No.: | R-3 | Depth (ft.) | 7.5 | | |

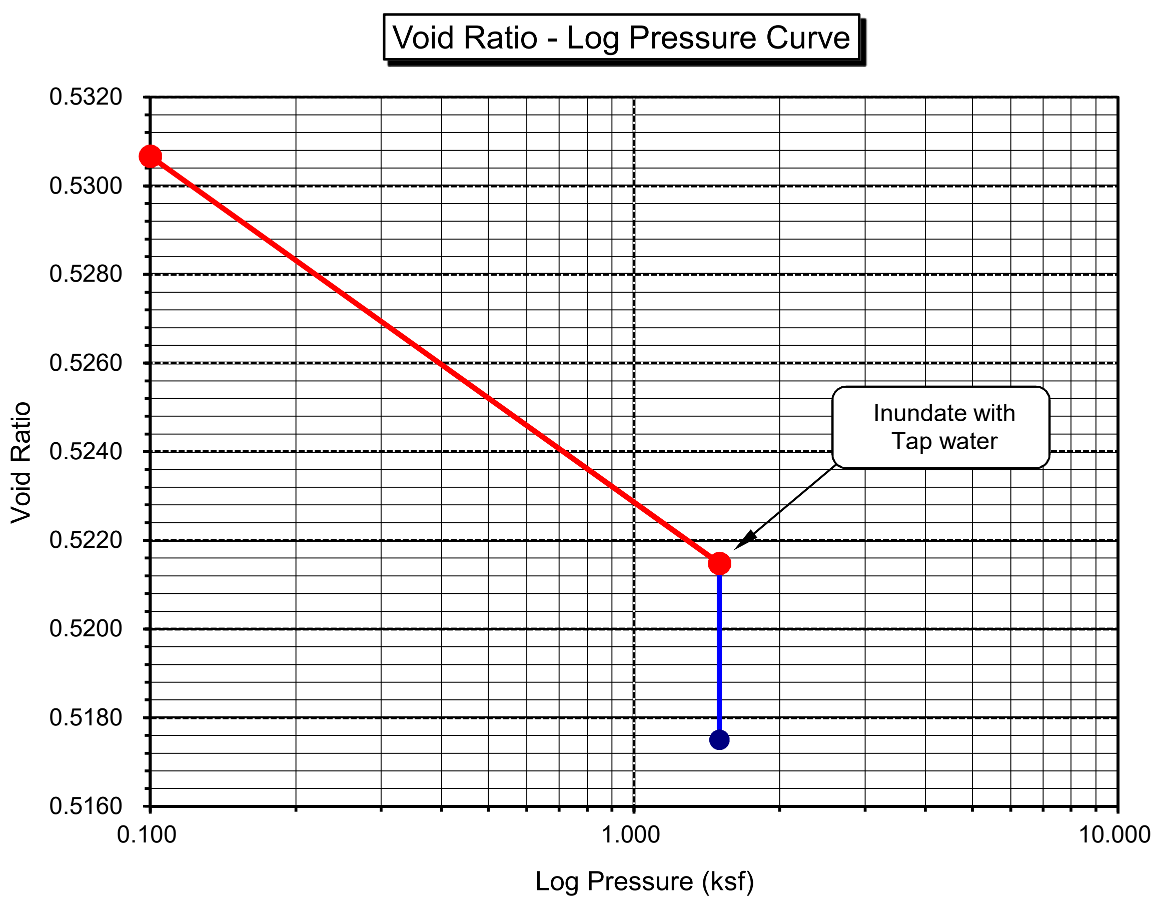
Sample Description: Yellowish brown poorly-graded sand (SP)

| | |
|---|---|
| Initial Dry Density (pcf): | 110.1 |
| Initial Moisture (%): | 1.99 |
| Initial Length (in.): | 1.0000 |
| Initial Dial Reading: | 0.3144 |
| Diameter(in): | 2.415 |

| | |
|---|---|
| Final Dry Density (pcf): | 111.1 |
| Final Moisture (%) : | 13.9 |
| Initial Void Ratio: | 0.5308 |
| Specific Gravity(assumed): | 2.70 |
| Initial Saturation (%) | 10.1 |

| Pressure (p) (ksf) | Final Reading (in) | Apparent Thickness (in) | Load Compliance (%) | Swell (+) Settlement (-) % of Sample Thickness | Void Ratio | Corrected Deformation (%) |
|---|---|---|---|---|---|---|
| 0.100 | 0.3143 | 0.9999 | 0.00 | -0.01 | 0.5307 | -0.01 |
| 1.500 | 0.3074 | 0.9930 | 0.09 | -0.70 | 0.5215 | -0.61 |
| H2O | 0.3048 | 0.9904 | 0.09 | -0.96 | 0.5175 | -0.87 |

**Percent Swell (+) / Settlement (-) After Inundation = -0.26**



| TP-1 (0.5')* | | TP-2 (0.5')* | | TP-3 (0.5')* | | TP-4 (0.5')* | |
|---|---|---|---|---|---|---|---|
| Depth (ft) | % Organics | Depth (ft) | % Organics | Depth (ft) | % Organics | Depth (ft) | % Organics |
| 0-0.5' | 11.1 | 0-0.5' | 54.4 | 0-0.5' | 60.3 | 0-0.5' | 60.9 |
| 0.5-1.5' | 0.6 | 0.5-1.5' | 1.1 | 0.5-1.5' | 1.6 | 0.5-1.5' | 1.5 |
| 1.5-2.5' | 0.5 | 1.5-2.5' | 0.7 | 1.5-2.5' | 0.9 | 1.5-2.5' | 1.3 |

| TP-5 (0.0')* | | TP-6 (0.5')* | | TP-7 (0.5')* | | TP-8 (0.5')* | |
|---|---|---|---|---|---|---|---|
| Depth (ft) | % Organics | Depth (ft) | % Organics | Depth (ft) | % Organics | Depth (ft) | % Organics |
| 0-0.5' | 1.9 | 0-0.5' | 21.5 | 0-0.5' | 10.8 | 0-0.5' | 7.7 |
| 0.5'-1.5' | 0.9 | 0.5'-1.5' | 1.0 | 0.5'-1.5' | 1.2 | 0.5'-1.5' | 1.7 |

| TP-9 (0.5')* | | TP-10 (0.5')* | | TP-11 (0.0')* | | TP-12 (0.0')* | |
|---|---|---|---|---|---|---|---|
| Depth (ft) | % Organics | Depth (ft) | % Organics | Depth (ft) | % Organics | Depth (ft) | % Organics |
| 0-0.5' | 7.8 | 0-0.5' | 11.5 | 0-0.5' | 4.1 | 0-0.5' | 2.3 |
| 0.5'-1.5' | 1.9 | 0.5'-1.5' | 1.6 | 0.5'-1.5' | 3.7 | 0.5'-1.5' | 0.8 |

| TP-13 (0.0')* | | TP-17 (0.0')* | | TP-19 (0.0')* | |
|---|---|---|---|---|---|
| Depth (ft) | % Organics | Depth (ft) | % Organics | Depth (ft) | % Organics |
| 0-0.5' | 2.0 | 0-0.5' | 1.7 | 0-0.5' | 1.6 |
| 0.5'-1.5' | 1.4 | | | | |

**Legend**

| | |
|---|---|
| **> 5%** | **"High" Organic Content "Soils" Recommended for Export from Site** |
| **2 to 5%** | **"Transitional" Soils Recommended for Mix/Blend w/ "Clean" Soils** |
| **< 2%** | **"Clean" Soils** |

**Note: (#')* Indicates Recommended Organic Export Depth in Feet. Export depth may exceed the depths highlighted boxes.**

LGC Geotechnical, Inc.

**Table 8**
**Summary of Measured Organic Content vs Depth of Sample**

| | |
|---|---|
| **Project Name** | River Rd., Norco - Dallape |
| **Project Number** | 21250-01 |
| **ENG./GEOL.** | TJL / BPG |
| **Date** | January 2022 |

# *Appendix D*
# *Infiltration Test Data*

# Infiltration Test Data Sheet

**LGC Geotechnical, Inc**
131 Calle Iglesia Suite 200, San Clemente, CA 92672 tel. (949) 369-6141

**Project Name:** River Rd - Norco- Dallape
**Project Number:** 21250-01
**Date:** 12/6/2021
**Boring Number:** I-1

| Test hole dimensions (if circular) | |
|---|---|
| Boring Depth (feet)*: | 5 |
| Boring Diameter (inches): | 8 |
| Pipe Diameter (inches): | 3 |

*measured at time of test

| Test pit dimensions (if rectangular) | |
|---|---|
| Pit Depth (feet): | |
| Pit Length (feet): | |
| Pit Breadth (feet): | |

***Pre-Test (Sandy Soil Criteria)****

| Trial No. | Start Time (24:HR) | Stop Time (24:HR) | Time Interval (min) | Initial Depth to Water (feet) | Final Depth to Water (feet) | Total Change in Water Level (feet) | Greater Than or Equal to 0.5 feet (yes/no) |
|---|---|---|---|---|---|---|---|
| 1 | 8:11 | 8:24 | 13.0 | 1.50 | 2.5 | 1 | yes |
| 2 | 8:39 | 8:50 | 11.0 | 1.4 | 2 | 0.6 | yes |

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

***Main Test Data***

| Trial No. | Start Time (24:HR) | Stop Time (24:HR) | Time Interval, $\Delta t$ (min) | Initial Depth to Water, $D_o$ (feet) | Final Depth to Water, $D_f$ (feet) | Change in Water Level, $\Delta D$ (feet) | Observed Infiltration Rate (in/hr) |
|---|---|---|---|---|---|---|---|
| 1 | 8:52 | 9:02 | 10.0 | 1.4 | 1.95 | 0.55 | 1.9 |
| 2 | 9:03 | 9:13 | 10.0 | 1.35 | 1.85 | 0.5 | 1.7 |
| 3 | 9:14 | 9:24 | 10.0 | 1.25 | 1.85 | 0.6 | 2.0 |
| 4 | 9:25 | 9:35 | 10.0 | 1.05 | 1.65 | 0.6 | 1.9 |
| 5 | 9:36 | 9:46 | 10.0 | 0.95 | 1.6 | 0.65 | 2.0 |
| 6 | 9:47 | 9:57 | 10.0 | 1.5 | 1.95 | 0.45 | 1.6 |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| | | | | | | **Observed Infiltration Rate (Does Not Include Any Factor of Safety)** | **1.6** |

***Sketch:***

***Notes:***

LGC Geotechnical, Inc.

# Infiltration Test Data Sheet

**LGC Geotechnical, Inc**
131 Calle Iglesia Suite 200, San Clemente, CA 92672 tel. (949) 369-6141

**Project Name:** River Rd - Norco- Dallape
**Project Number:** 21250-01
**Date:** 12/6/2021
**Boring Number:** I-2

| Test hole dimensions (if circular) | |
|---|---|
| Boring Depth (feet)*: | 5 |
| Boring Diameter (inches): | 8 |
| Pipe Diameter (inches): | 3 |

*measured at time of test

| Test pit dimensions (if rectangular) | |
|---|---|
| Pit Depth (feet): | |
| Pit Length (feet): | |
| Pit Breadth (feet): | |

### *Pre-Test (Sandy Soil Criteria)**

| Trial No. | Start Time (24:HR) | Stop Time (24:HR) | Time Interval (min) | Initial Depth to Water (feet) | Final Depth to Water (feet) | Total Change in Water Level (feet) | Greater Than or Equal to 0.5 feet (yes/no) |
|---|---|---|---|---|---|---|---|
| 1 | 8:36 | 8:48 | 12.0 | 1.60 | 2.1 | 0.5 | yes |
| 2 | 8:49 | 9:04 | 15.0 | 1.2 | 1.75 | 0.55 | yes |

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

### *Main Test Data*

| Trial No. | Start Time (24:HR) | Stop Time (24:HR) | Time Interval, Δt (min) | Initial Depth to Water, $D_o$ (feet) | Final Depth to Water, $D_f$ (feet) | Change in Water Level, ΔD (feet) | Observed Infiltration Rate (in/hr) |
|---|---|---|---|---|---|---|---|
| 1 | 9:06 | 9:16 | 10.0 | 1.3 | 1.6 | 0.3 | 1.0 |
| 2 | 9:17 | 9:27 | 10.0 | 1.35 | 1.6 | 0.25 | 0.8 |
| 3 | 9:28 | 9:38 | 10.0 | 1.15 | 1.45 | 0.3 | 0.9 |
| 4 | 9:39 | 9:49 | 10.0 | 1.25 | 1.5 | 0.25 | 0.8 |
| 5 | 9:50 | 10:00 | 10.0 | 1.25 | 1.5 | 0.25 | 0.8 |
| 6 | 10:01 | 10:11 | 10.0 | 1.25 | 1.5 | 0.25 | 0.8 |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| | | | | | | **Observed Infiltration Rate (Does Not Include Any Factor of Safety)** | **0.8** |

***Sketch:***

***Notes:***

# Infiltration Test Data Sheet

**LGC Geotechnical, Inc**

**131 Calle Iglesia Suite 200, San Clemente, CA 92672 tel. (949) 369-6141**

**Project Name:** River Rd - Norco- Dallape
**Project Number:** 21250-01
**Date:** 12/6/2021
**Boring Number:** I-3

| Test hole dimensions (if circular) | |
|---|---|
| Boring Depth (feet)*: | 11 |
| Boring Diameter (inches): | 8 |
| Pipe Diameter (inches): | 3 |

*measured at time of test

| Test pit dimensions (if rectangular) | |
|---|---|
| Pit Depth (feet): | |
| Pit Length (feet): | |
| Pit Breadth (feet): | |

## *Pre-Test (Sandy Soil Criteria)**

| Trial No. | Start Time (24:HR) | Stop Time (24:HR) | Time Interval (min) | Initial Depth to Water (feet) | Final Depth to Water (feet) | Total Change in Water Level (feet) | Greater Than or Equal to 0.5 feet (yes/no) |
|---|---|---|---|---|---|---|---|
| 1 | 7:42 | 7:44 | 2.0 | 10.00 | 11 | 1 | yes |
| 2 | 7:45 | 7:47 | 2.0 | 9.67 | 11 | 1.33 | yes |

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

## *Main Test Data*

| Trial No. | Start Time (24:HR) | Stop Time (24:HR) | Time Interval, $\Delta t$ (min) | Initial Depth to Water, $D_o$ (feet) | Final Depth to Water, $D_f$ (feet) | Change in Water Level, $\Delta D$ (feet) | Observed Infiltration Rate (in/hr) |
|---|---|---|---|---|---|---|---|
| 1 | 10:29 | 10:31 | 2.0 | 9.6 | 11.2 | 1.6 | 125.2 |
| 2 | 10:33 | 10:35 | 2.0 | 9.7 | 10.95 | 1.25 | 89.1 |
| 3 | 10:36 | 10:38 | 2.0 | 9.35 | 10.6 | 1.25 | 62.9 |
| 4 | 10:39 | 10:41 | 2.0 | 8.7 | 10.25 | 1.55 | 55.0 |
| 5 | 10:42 | 10:44 | 2.0 | 8.5 | 10.15 | 1.65 | 53.8 |
| 6 | 10:45 | 10:47 | 2.0 | 7.75 | 9.7 | 1.95 | 47.9 |
| 7 | 10:49 | 10:51 | 2.0 | 7.75 | 9.5 | 1.75 | 41.3 |
| 8 | 10:55 | 10:57 | 2.0 | 7.3 | 9.7 | 2.4 | 54.0 |
| 9 | 11:01 | 11:03 | 2.0 | 7.3 | 9.35 | 2.05 | 43.3 |
| 10 | 11:07 | 11:09 | 2.0 | 7.3 | 9.2 | 1.9 | 39.1 |
| 11 | 11:13 | 11:15 | 2.0 | 7.3 | 9.1 | 1.8 | 36.4 |
| 12 | 11:19 | 11:21 | 2.0 | 7.2 | 9.2 | 2 | 40.4 |
| | | | | | | **Observed Infiltration Rate (Does Not Include Any Factor of Safety)** | **36.4** |

***Sketch:***

***Notes:***

LGC Geotechnical, Inc.

# *Appendix E*
# *General Earthwork and Grading Specifications for Rough Grading*

# ***General Earthwork and Grading Specifications for Rough Grading***

## ***1.0 General***

### ***1.1 Intent***

These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

### ***1.2 The Geotechnical Consultant of Record***

Prior to commencement of work, the owner shall employ a qualified Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultant shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to confirm that the attained level of compaction is being accomplished as specified. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

### ***1.3 The Earthwork Contractor***

The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the project plans and specifications. The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of “equipment” of work and the estimated quantities of daily earthwork

contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the
Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate personnel will be available for observation and testing. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified. It is the contractor's sole responsibility to provide proper fill compaction.

## *2.0 Preparation of Areas to be Filled*

### *2.1 Clearing and Grubbing*

Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed. The contractor is responsible for all hazardous waste relating to his work. The Geotechnical Consultant does not have expertise in this area. If hazardous waste is a concern, then the Client should acquire the services of a qualified environmental assessor.

### *2.2 Processing*

Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be over-excavated as specified in the following section. Scarification shall continue until soils are broken down and free of oversize material and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

### *2.3 Over-excavation*

In addition to removals and over-excavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be over-excavated to competent ground as evaluated by the Geotechnical Consultant during grading.

### *2.4 Benching*

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise over-excavated to provide a flat subgrade for the fill.

### *2.5 Evaluation/Acceptance of Fill Areas*

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

## *3.0 Fill Material*

### *3.1 General*

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

### *3.2 Oversize*

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

### 3.3 ***Import***

If importing of fill material is required for grading, proposed import material shall meet the requirements of the geotechnical consultant. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

## 4.0 ***Fill Placement and Compaction***

### 4.1 ***Fill Layers***

Approved fill material shall be placed in areas prepared to receive fill (per Section 3.0) in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

### 4.2 ***Fill Moisture Conditioning***

Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557).

### 4.3 ***Compaction of Fill***

After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

### 4.4 ***Compaction of Fill Slopes***

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557.

### 4.5 ***Compaction Testing***

Field tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

### *4.6 Frequency of Compaction Testing*

Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

### *4.7 Compaction Test Locations*

The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than 5 feet apart from potential test locations shall be provided.

## *5.0 Subdrain Installation*

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

## *6.0 Excavation*

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

## *7.0 Trench Backfills*

***7.1*** The Contractor shall follow all OHSA and Cal/OSHA requirements for safety of trench excavations.

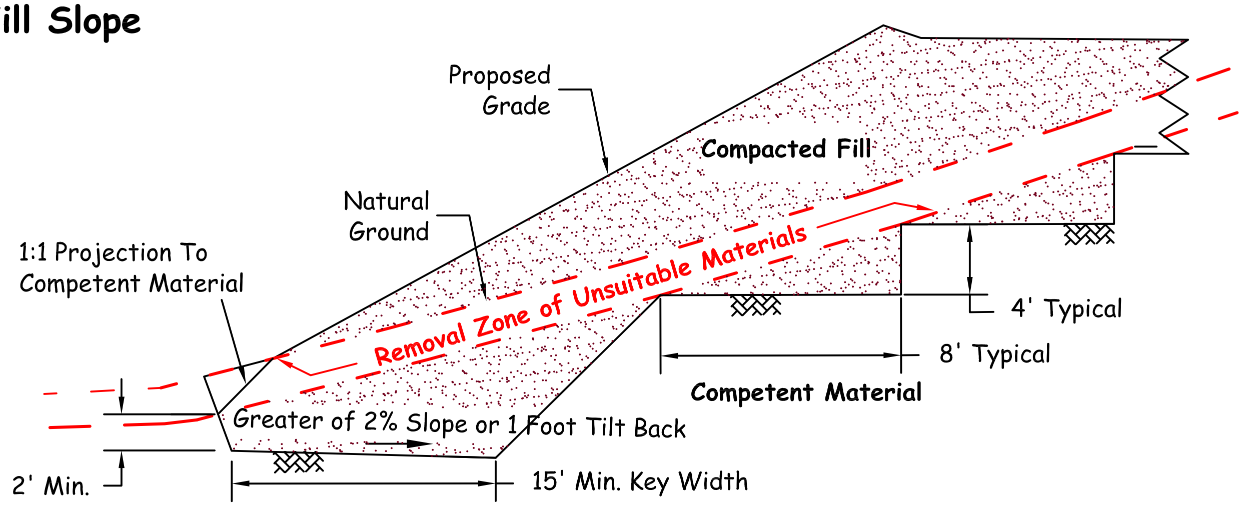
***7.2*** All bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of maximum from 1 foot above the top of the conduit to the surface.

***7.3*** The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.

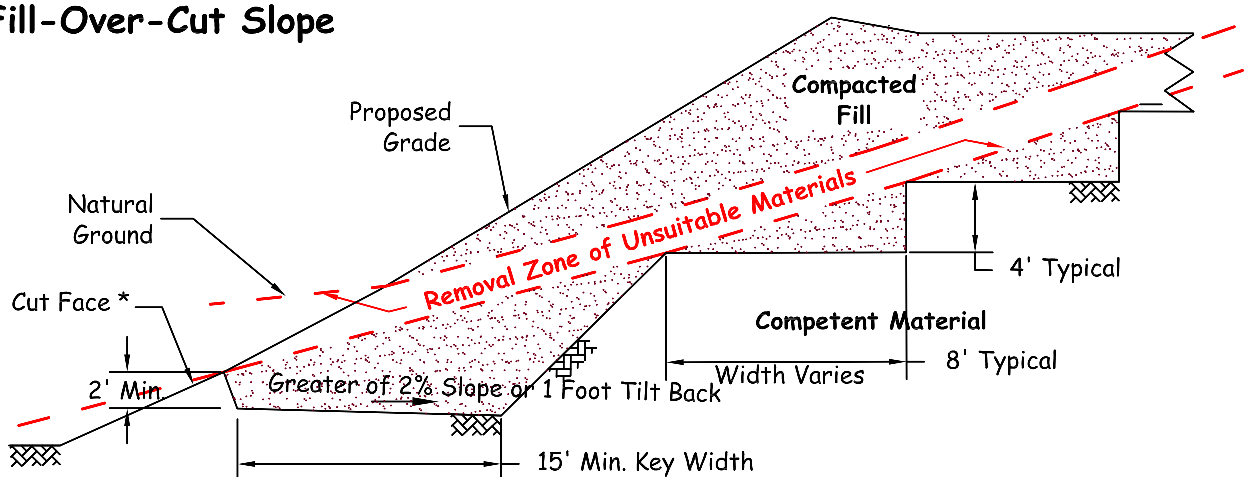
***7.4*** The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

***7.5*** Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

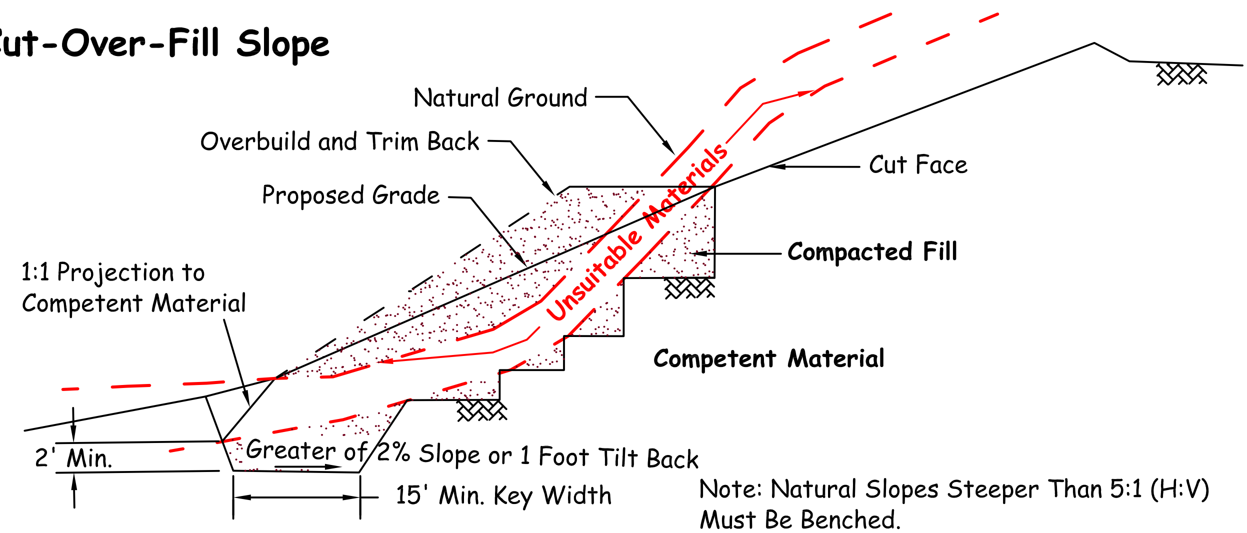
## Fill Slope




## Fill-Over-Cut Slope




## Cut-Over-Fill Slope




Note: Natural Slopes Steeper Than 5:1 (H:V) Must Be Benched.

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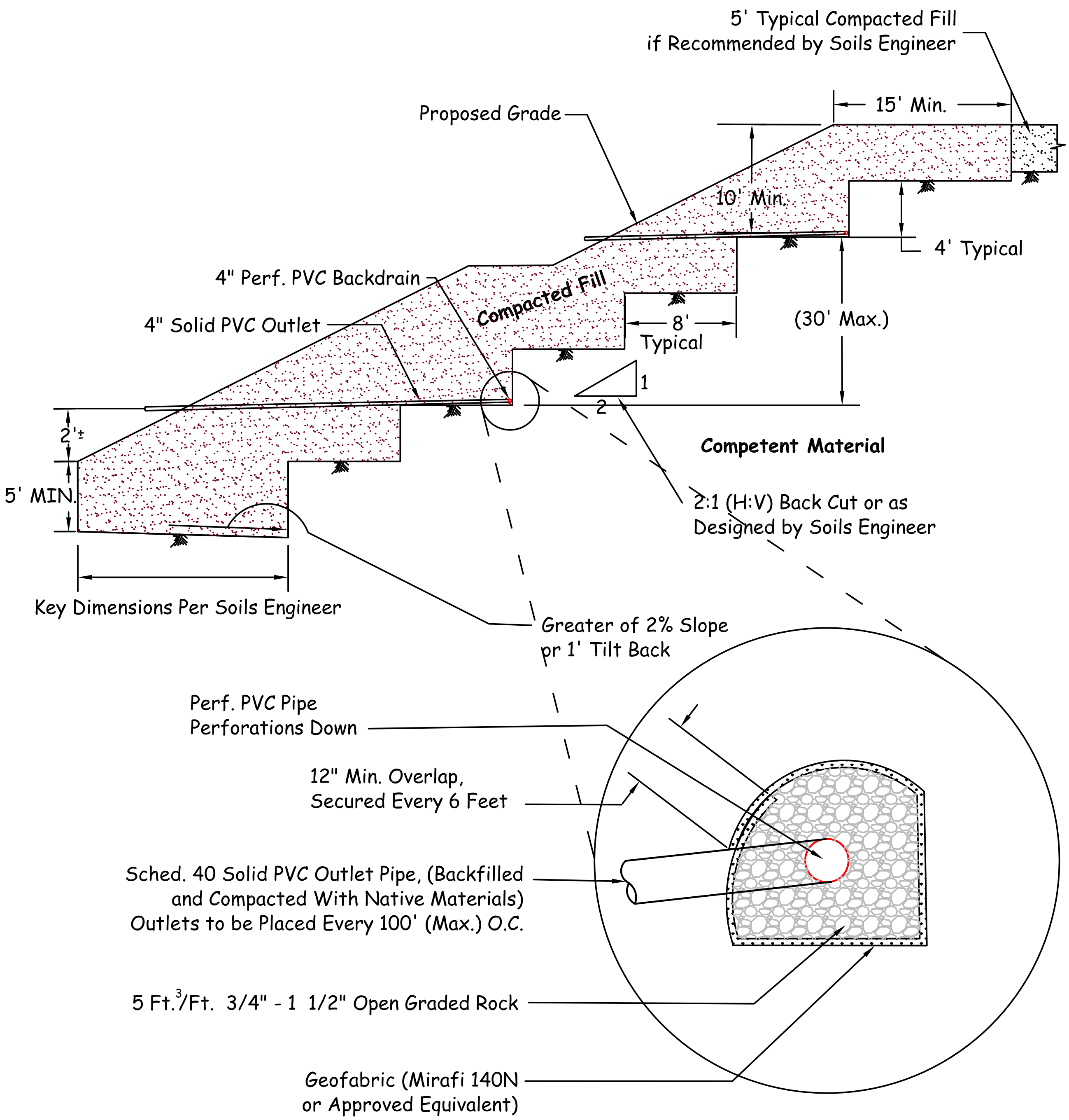
# KEYING AND BENCHING

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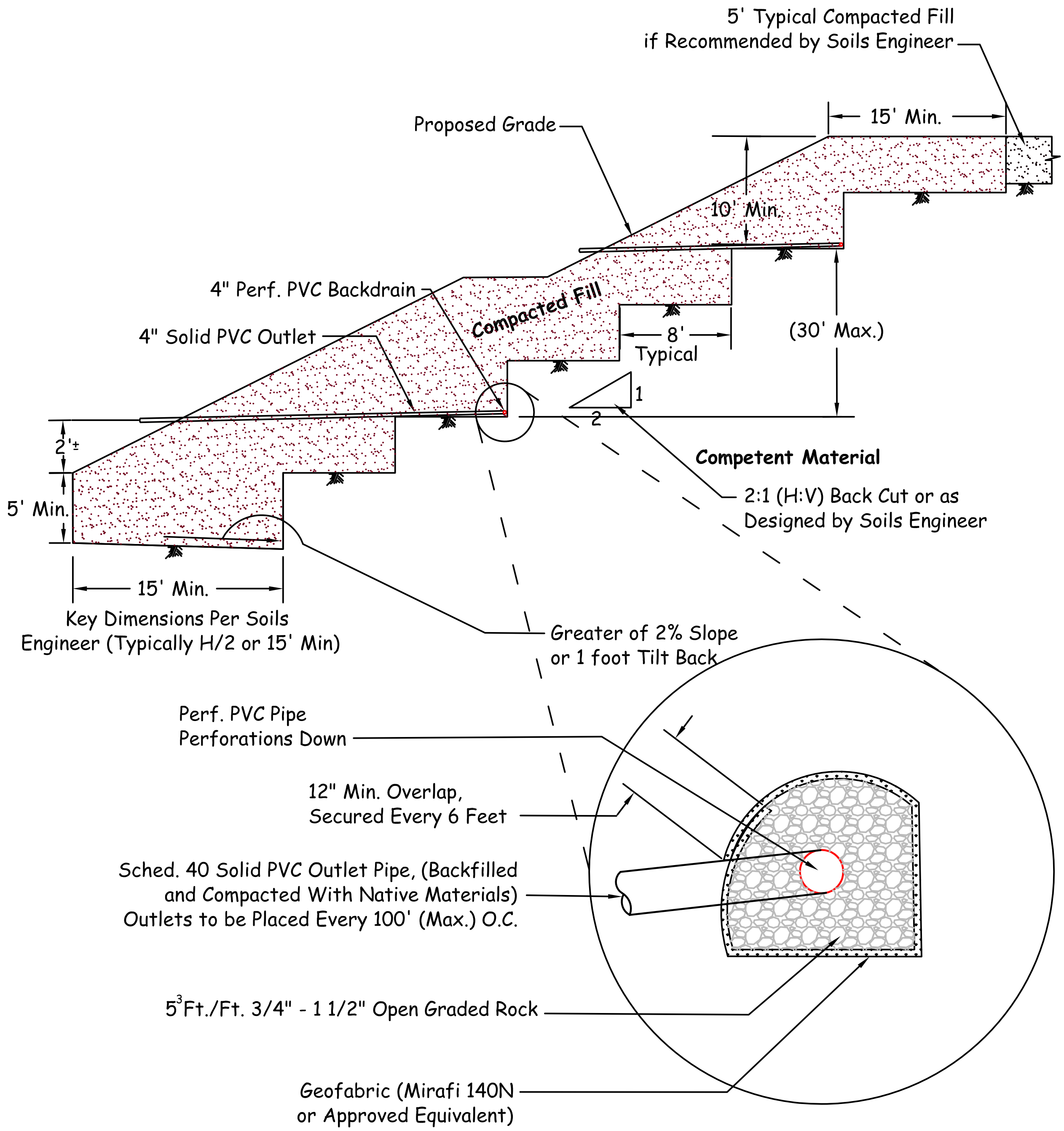
# TYPICAL BUTTRESS DETAIL

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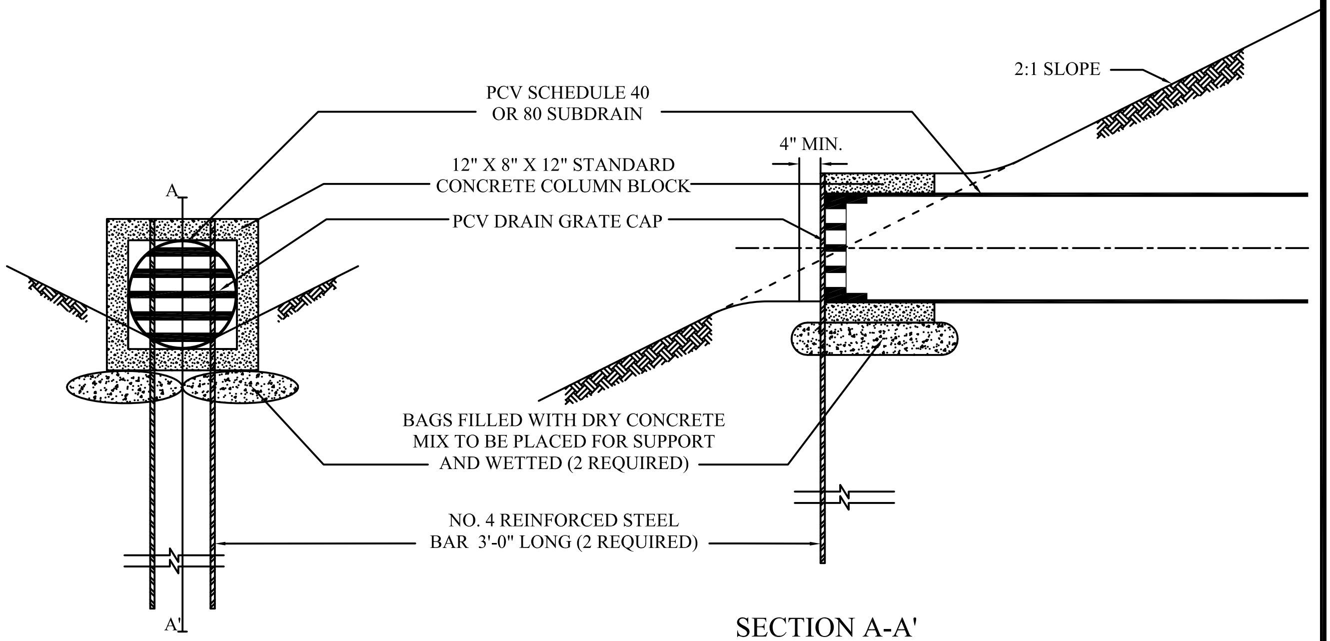
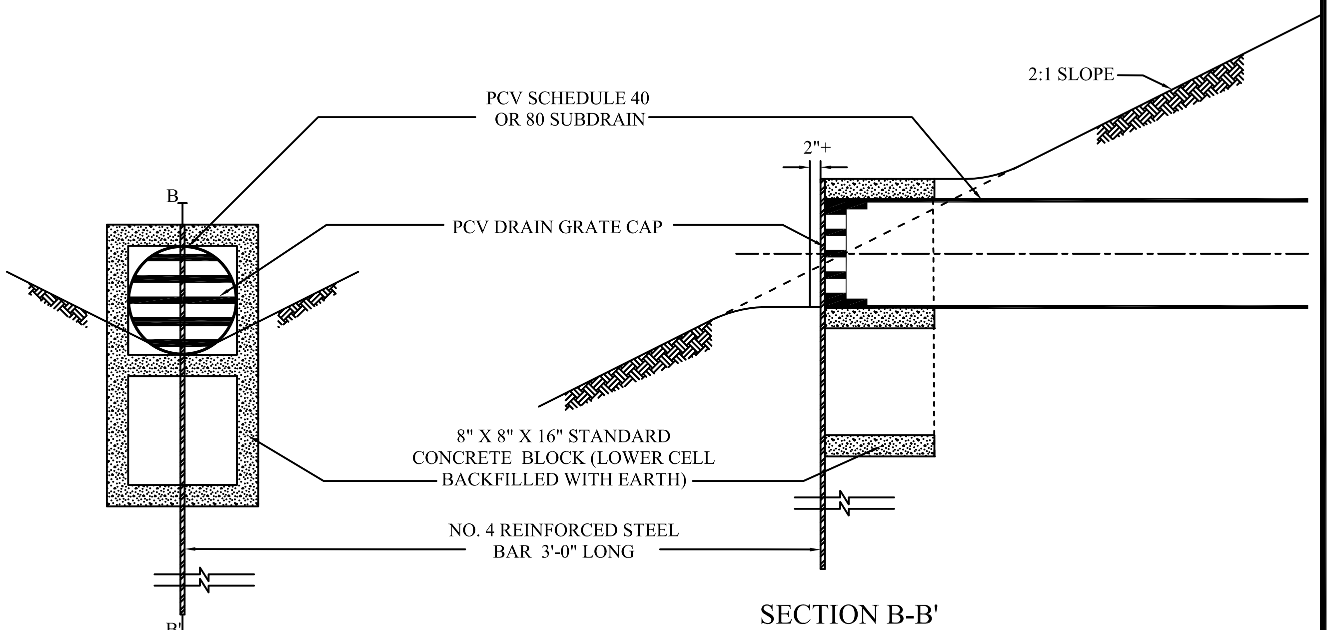
# TYPICAL STABILIZATION FILL DETAIL

# SUBDRAIN OUTLET MARKER -6" & 8" PIPE




# SUBDRAIN OUTLET MARKER -4" PIPE




NOT TO SCALE

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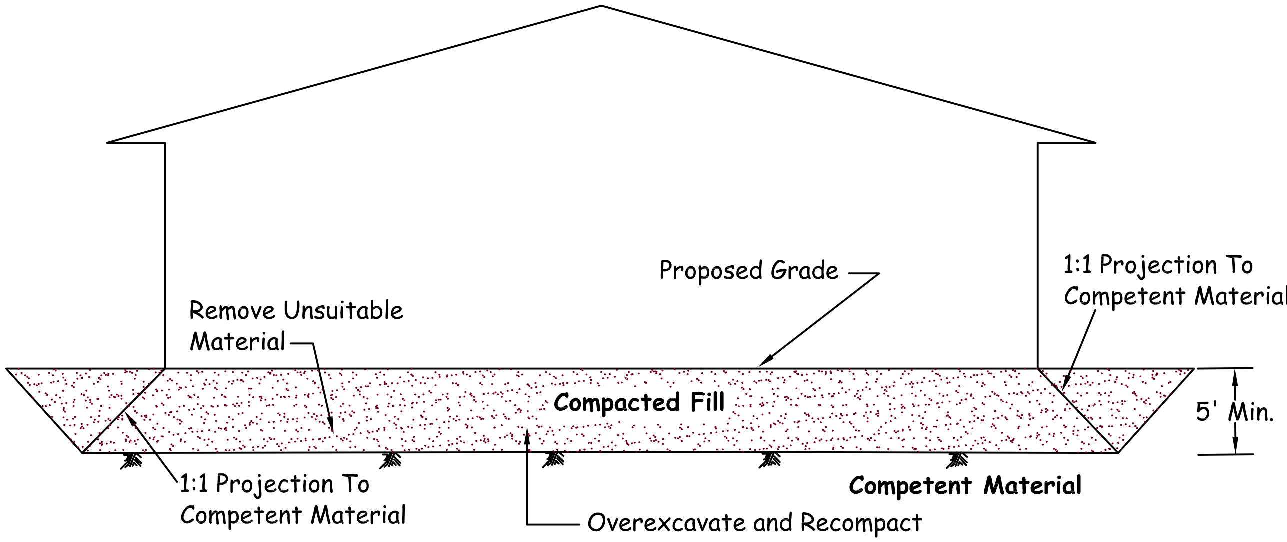
**SUBDRAIN OUTLET MARKER DETAIL**

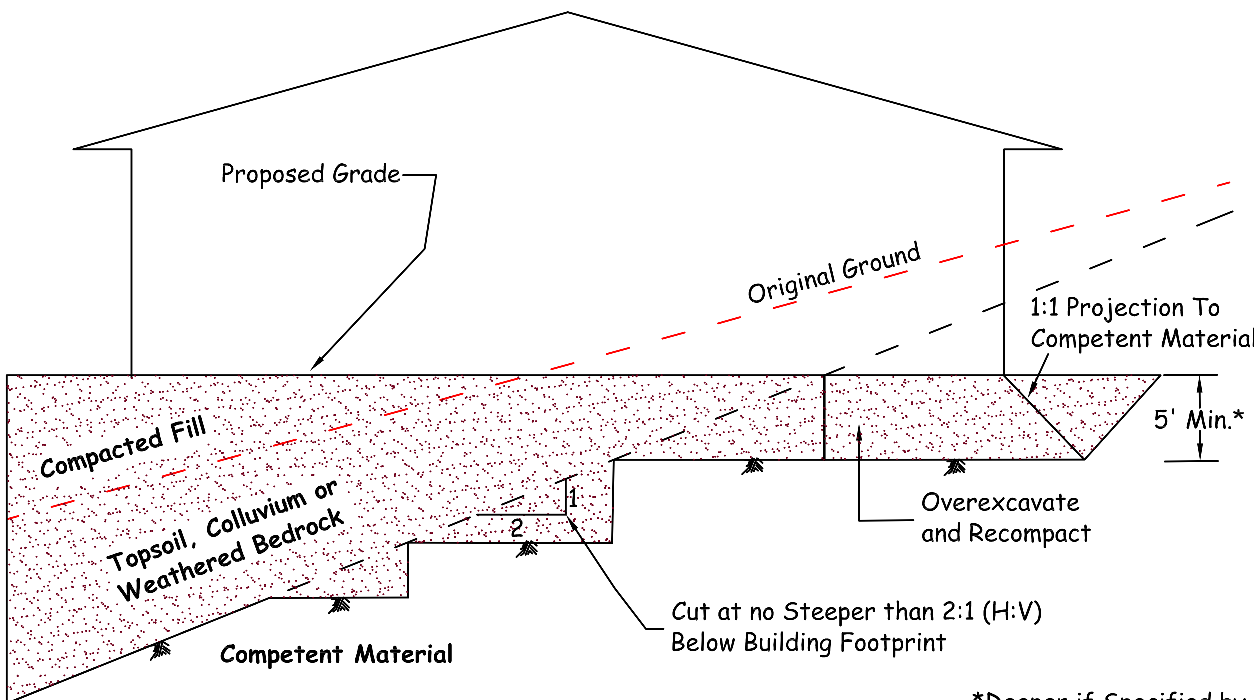
# Cut Lot
## (Exposing Unsuitable Soils at Design Grade)




Note 1: Removal Bottom Should be Graded With Minimum 2% Fall Towards Street or Other Suitable Area (as Determined by Soils Engineer) to Avoid Ponding Below Building

Note 2: Where Design Cut Lots are Excavated Entirely Into Competent Material, Overexcavation May Still be Required for Hard-Rock Conditions or for Materials With Variable Expansion Characteristics.

# Cut/Fill Transition Lot




*Deeper if Specified by Soils Engineer

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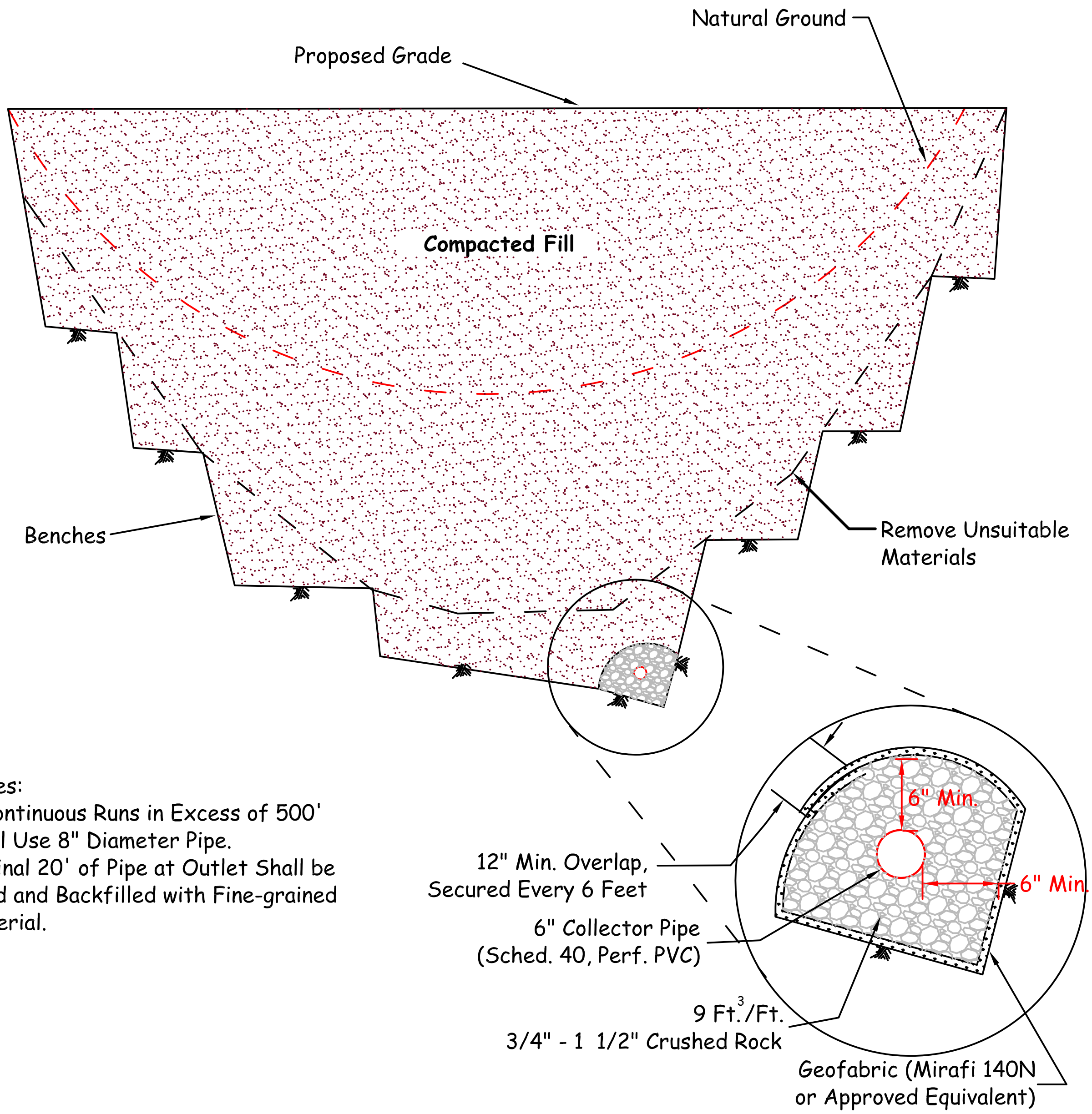
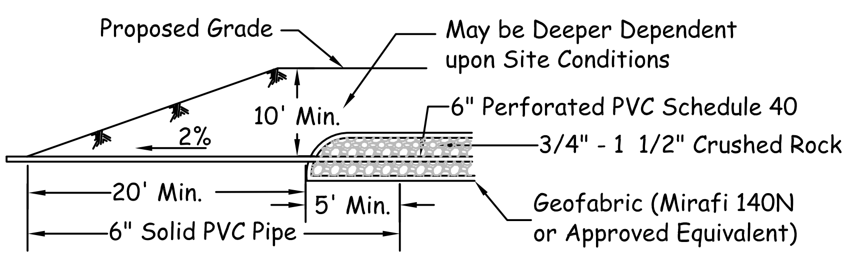
# CUT AND TRANSITION LOT OVEREXCAVATION DETAIL




Notes:
1) Continuous Runs in Excess of 500' Shall Use 8" Diameter Pipe.
2) Final 20' of Pipe at Outlet Shall be Solid and Backfilled with Fine-grained Material.

## Proposed Outlet Detail

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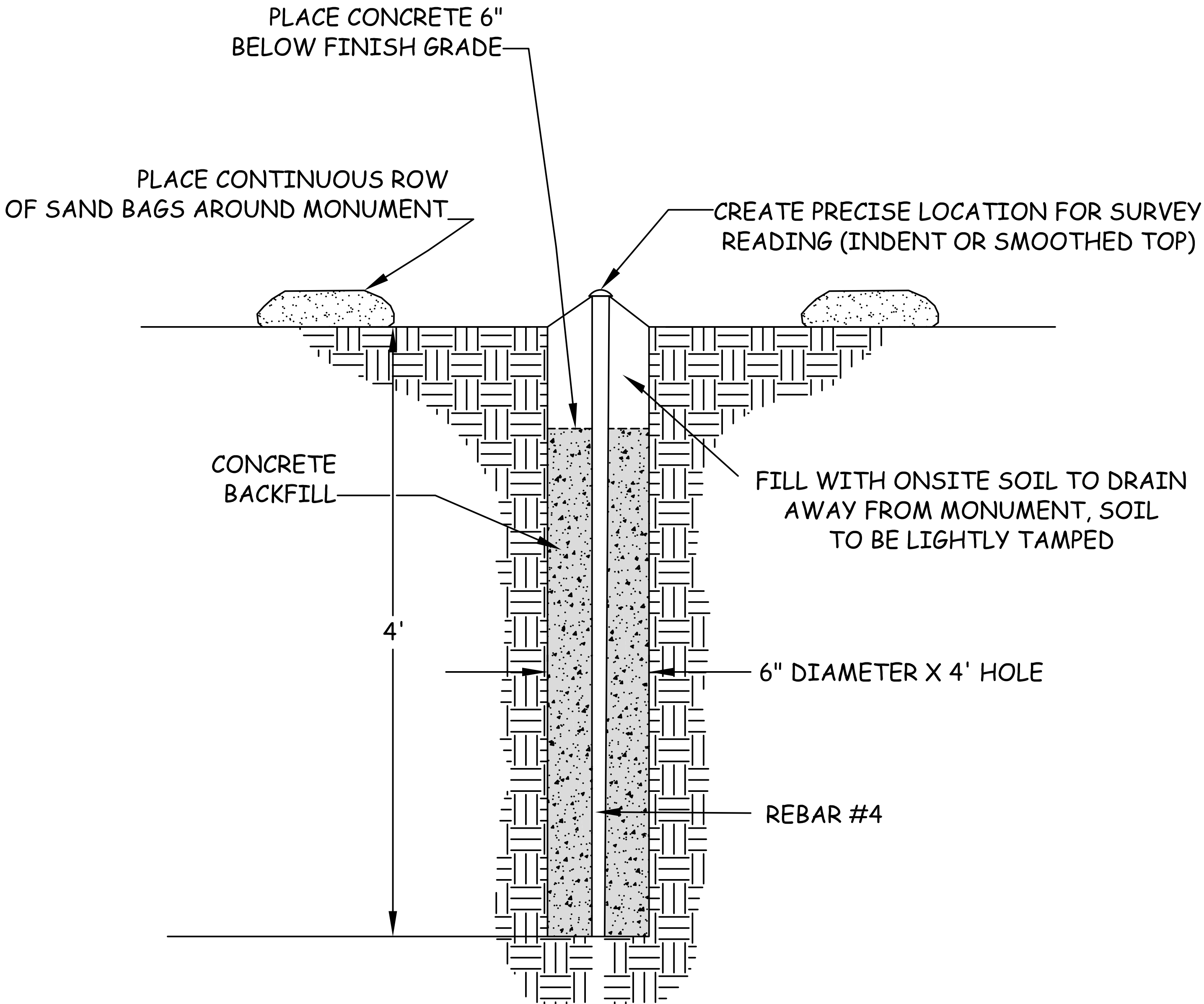
# CANYON SUBDRAINS




NO CONSTRUCTION EQUIPMENT WITHIN 25 FEET
OF ANY INSTALLED SETTLEMENT MONUMENTS

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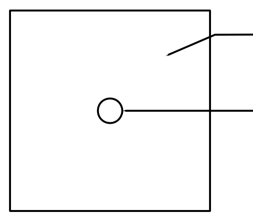
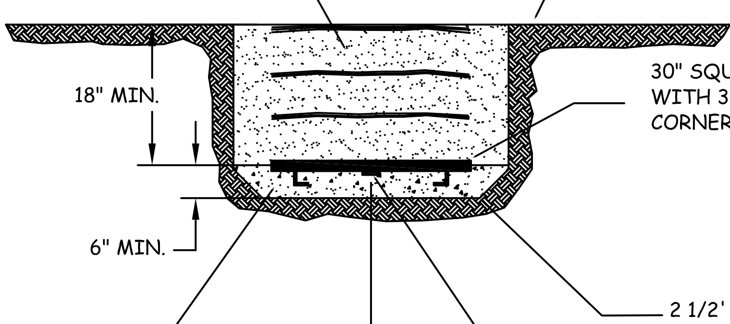
# TYPICAL SURFACE SETTLEMENT MONUMENT

TOP VIEW




1. SURVEY FOR HORIZONTAL AND VERTICAL LOCATION TO NEAREST .01 INCH PRIOR TO BACKFILL USING KNOW LOCATIONS THAT WILL REMAIN INTACT DURING THE DURATION OF THE MONITORING PROGRAM. KNOW POINTS EXPLICITELY NOT ALLOWED ARE THOSE LOCATED ON FILL OR THAT WILL BE DESTROYED DURING GRADING.
2. IN THE EVENT OF DAMAGE TO SETTLEMENT PLATE DURING GRADING, CONTRACTOR SHALL IMMEDIATELY NOTIFY THE GEOTECHNICAL ENGINEER AND SHALL BE RESPONSIBLE FOR RESTORING THE SETTLEMENT PLATES TO WORKING ORDER.
3. DRILL TO RECOVER AND ATTACH RISER PIPE.

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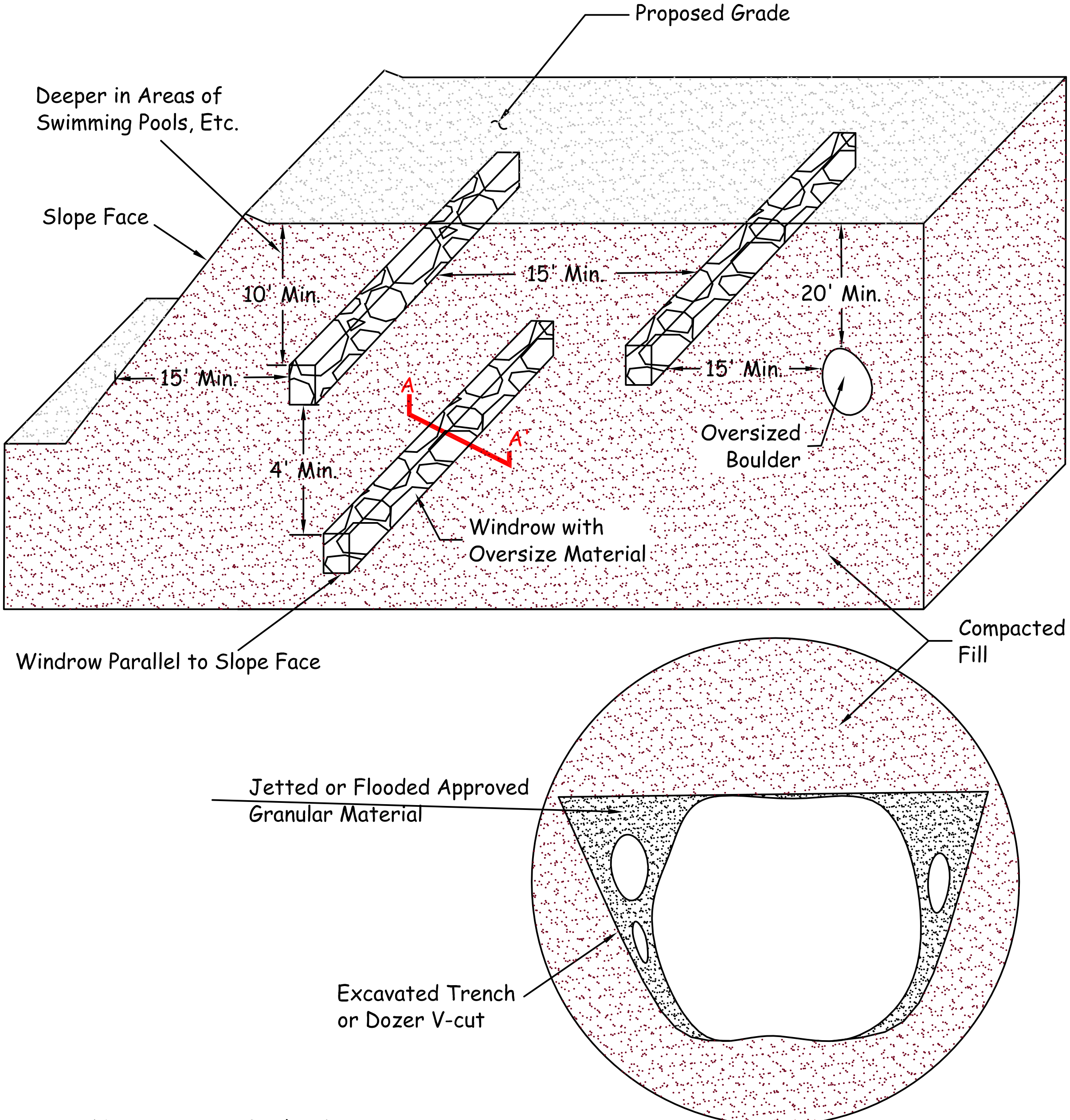
# TYPICAL SETTLEMENT PLATE AND RISER




Note: Oversize Rock is Larger than 8" in Maximum Dimension.

Section A-A'

LGC Geotechnical, Inc.

**OVERSIZE ROCK DISPOSAL DETAIL**