**GEOTECHNICAL ENGINEERING STUDY**
**FOR**
**SUTTER STREET (512)**

512 Sutter Street
Folsom, California

Project No. E22213.000
June 2022

YOUNGDAHL
ESTABLISHED 1984

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Project No. E22213.000
30 June 2022

Attention: Mr. Ziad Alaywan

Subject: **SUTTER STREET (512)**
512 Sutter Street, Folsom, California
*GEOTECHNICAL ENGINEERING STUDY*

References:
1. Parking Exhibit for APN 070-0062-015, prepared by RFE Engineering, Inc., dated 6 April 2022.
2. Proposal and Executed Contract for 512 Sutter Street, prepared by Youngdahl Consulting Group, Inc., dated 13 May 2022.

Dear Mr. Alaywan:

In accordance with your authorization, Youngdahl Consulting Group, Inc. has prepared this geotechnical engineering study for the project site located 512 Sutter Street in Folsom, California. The purpose of this study was to prepare a site-specific geotechnical report that can be incorporated into design of the proposed site. To complete this task, our firm completed a subsurface exploration, laboratory testing, and prepared this report in accordance with the Reference 2 proposal and contract.

Based upon our observations, the geotechnical aspects of the site appear to be suitable for support of the proposed structures provided the recommendations presented in this report are incorporated into design and construction. Geotechnical conditions associated with the site development are anticipated to include processing exposed grades for preparation to receive engineered fills, excavations into bedrock, the placement of engineered fills, improvements for drainage controls, and the construction of foundations and pavements.

Due to the non-uniform nature of soils, other geotechnical issues may become more apparent during grading operations which are not listed above. The descriptions, findings, conclusions, and recommendations provided in this report are formulated as a whole; specific conclusions or recommendations should not be derived or used out of context. Please review the limitations and uniformity of conditions section of this report.

This report has been prepared for the exclusive use of the addressee of this report and their consultants, for specific application to this project, in accordance with generally accepted geotechnical engineering practice. Should you have any questions or require additional information, please contact our office at your convenience.

Very truly yours,
Youngdahl Consulting Group, Inc.

Ian Kitamura

Ian T. Kitamura
Staff Engineer

Reviewed By:

REGISTERED PROFESSIONAL ENGINEER
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6-30-22

Distribution: PDF to Client

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**GEOTECHNICAL ENGINEERING STUDY**
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## 1.0 INTRODUCTION

This report presents the results of our geotechnical engineering study performed for the proposed improvements planned to be constructed at 512 Sutter Street in Folsom, California. The vicinity map provided on Figure A-1, Appendix A shows the approximate project location.

### Project Understanding

We understand that proposed development will consist of the construction of an at-grade parking lot on a 0.16-acre lot located at 512 Sutter Street in Folsom, California. We further understand that future development at the site may consist of a multi-level residential building. Based on the Reference 1 Plan, the site slopes at varying gradients; therefore, development will likely include cuts and fills on the order of 5 feet or less to generate the proposed parking lot grade and promote positive site drainage. Additional site improvements will include a planter, an elevator lift, site retaining walls, and pedestrian flatwork.

### Background

Based upon a limited review of aerial imagery from Google Earth, the site has remained relatively unchanged since 1993. A set of raised garden beds appear to have been constructed southeast of the center of the site between September 2019 and October 2020.

If studies or plans pertaining to the site exist and are not cited as a reference in this report, we should be afforded the opportunity to review and modify our conclusions and recommendations as necessary.

### Purpose and Scope

Youngdahl Consulting Group, Inc. has prepared this report to provide geotechnical engineering recommendations and considerations for incorporation into the design and development of the site. The following scope of services were developed and performed for preparation of this report:

- A review of geotechnical and geologic data available to us at the time of our study;
- A field study consisting of a site reconnaissance, followed by an exploratory test pit program to observe and characterize the subsurface conditions;
- Laboratory testing on representative samples collected during our field study;
- Evaluation of the data and information obtained from our field study, laboratory testing, and literature review for geotechnical conditions;
- Development of geotechnical recommendations regarding earthwork construction including, site preparation and grading, excavation characteristics, soil moisture conditions, engineered fill criteria, slope configuration and grading, underground improvements, and drainage;
- Development of geotechnical design criteria for code-based seismicity, foundations, slabs on grade, retaining walls, and pavements;
- Preparation of this report summarizing our findings, conclusions, and recommendations regarding the above-described information.

## 2.0 SITE CONDITIONS

The following section describes our findings regarding the site conditions that we observed during our site reconnaissance and subsequent subsurface exploration.

### Surface Observations

The project site is located at 512 Sutter Street in Folsom, California. The site is bounded by Sutter Street to the southeast, single-family residences to the northeast, Canal Street to the northwest, and a concrete masonry unit (CMU) wall to the southwest. Topography at the site slopes down from Sutter Street to the northwest at varying gradients, with a maximum gradient of approximately 3.5H:1V (Horizontal:Vertical). Vegetation at the site consists of trees and short seasonal grasses. Raised garden beds, stone mounds, other gardening items were located in the southeast side of the lot. A small retaining wall and picnic table are located near the center of the site. Two concrete blocks were visible near the center of the site embedded into the site soils with the tops approximately flush with the ground surface.

### Subsurface Conditions

Our field study included a site reconnaissance by a representative of our firm followed by a subsurface exploration program conducted on 23 May 2022. The exploration program included the excavation of three exploratory test pits under the direction of our representative at the approximate locations shown on Figure A-2, Appendix A. A description of the field exploration program is provided in Appendix A.

The observed soil conditions generally consisted of sandy silts and sandy clays overlying bedrock. The sandy silts were generally observed to be in a medium stiff and slightly moist condition. Clay was encountered in test pits TP-1 and TP-3 from depths of 1 feet to 2½ feet. The clays were generally observed to be in medium stiff to very stiff and moist condition. Underlying the site soils was bedrock in a completely to highly weathered, and moderately hard condition, to a maximum depth explored of approximately 3½ feet below the ground surface. The bedrock in test pits TP-1 and TP-3 was observed to contain clay filled fractures. Essential excavation refusal (less than 6-inches penetration in 5 minutes) was encountered in the test pits at the base of the bedrock depths noted on the test pit logs.

A more detailed description of the subsurface conditions encountered during our subsurface exploration is presented graphically on the "Exploratory Test Pit Logs", Figures A-3 through A-5, Appendix A. These logs show a graphic interpretation of the subsurface profile, and the location and depths at which samples were collected.

### Groundwater Conditions

A permanent groundwater table was not encountered at the project site and is expected to be relatively deep with no impact to the development of the site.

Due to the shallow depth and low permeability of the underlying rock, perched water is common to the area and could be encountered during grading operations. The presence of perched water can vary because of many factors such as, the proximity to rock, topographic elevations, and the presence of utility trenches. Some evidence of past repeated exposure to subsurface water may include black staining, clay deposits, and surface markings indicating previous seepage. Based on our experience in the area, water may be perched on the bedrock horizon found beneath the site and could vary through the year with higher concentrations during or following precipitation.

## 3.0 GEOTECHNICAL SOIL CHARACTERISTICS

The geotechnical soil characteristics presented in this section of the report are based on laboratory testing and observations of samples collected from subsurface soils.

### Laboratory Testing

Laboratory testing of the collected samples was directed towards determining the physical and engineering properties of the soil underlying the site. The results of the tests performed for this project are presented in Appendix B. In summary, the following tests were performed for the preparation of this report:

**Table 1: Laboratory Tests**

| Laboratory Test | Test Standard | Summary of Results | |
|---|---|---|---|
| Direct Shear | ASTM D3080 | TP-3 @ 1' | $\Phi$ = 29.5°, c = 421 psf (90%RC) |
| Maximum Dry Density | ASTM D1557 | TP-3 @ 1' | DD = 113.9 pcf, MC = 14.2% |
| Resistance Value | ASTM CTM 301 | TP-3 @ 1' | R = 23 |

### Soil Expansion Potential

Plastic materials (clay soils) were encountered in relatively thin layers. The majority of remaining materials encountered in our explorations were generally non-plastic (rock, sand, and non-plastic silt). The non-plastic materials are generally considered to be non-expansive. In concentrated amounts, the clay could cause distress to concrete slab-on-grade floors and foundations if present in the upper 3 feet of structural improvement areas. However, we do not anticipate that expansive soil mitigation measures will be required for the design or construction of the proposed improvements provided the plastic materials are adequately blended with the non-plastic site soils prior to use as engineered fill during the site grading procedures. Depending on the proposed grading plans and cuts or fills where clay is concentrated, some focused excavations of the clay may be required. If necessary, recommendations can be made based on our observations at the time of construction should additional expansive soils be encountered at the project site.

## 4.0 GEOLOGY AND SEISMICITY

The geologic portion of this report includes a review of geologic data pertinent to the site based on an interpretation of our observations of the surface exposures and our observations in our exploratory test pits.

### Geologic Conditions

The project site is situated along the eastern edge of Sacramento County, at the base of the foothills of the Sierra Nevada geomorphic province. Tectonic building during the late Triassic and much of the Jurassic period resulted from oceanic and island masses subducting under or accreting onto the continental land mass and thereby caused extensive mountain formation. At the same time, large amounts of soil and rock were eroded off the mountains and deposited in the adjoining deep marine basins, which today comprise the Great Valley sedimentary beds and includes the greater Sacramento area flatlands.

According to the Preliminary Geologic Map of The Sacramento 30' x 60' Quadrangle, California (Guitierrez, 2011), the site is underlain by Laguna Formation deposits (Pl). These deposits typically consist of cobble gravel, sand, and minor silt of mixed metamorphic, granitic, and volcanic sources. However, directly adjacent to the property, the northern vicinity is mapped as Rocklin Pluton (Kr), which is more consistent with our subsurface observations. These rocks typically consist of light gray silicic quartz diorite. According to this geologic map, a sharp transition occurs near the northern boundary of the property. Based on our subsurface exploration, this suggests that two dominant lithologies may be encountered during grading operations.

**Naturally Occurring Asbestos**

Asbestos is classified by the EPA as a known human carcinogen. Naturally occurring asbestos (NOA) has been identified as a potential health hazard. According to the map of Relative Likelihood for the Presence of Naturally Occurring Asbestos in Eastern Sacramento County (C.T. Higgins, et. al, 2006), the project site is not identified as being in an area likely to contain NOA.

**Seismicity**

Our evaluation of seismicity for the project site included reviewing existing fault maps and obtaining seismic design parameters from the USGS online calculators and databases. For the purpose of this study, we used a latitude and longitude of 38.679023, -121.174865 to identify the project site.

Alquist-Priolo Regulatory Faults

Based upon the records currently available from the California Department of Conservation, the project site is not located within an Alquist-Priolo Regulatory Review Zone and there are no known faults located at the subject site. We do not anticipate special design or construction requirements for faulting at this project site.

Code Based Seismic Criteria

Based upon the subsurface conditions encountered during our study and our experience in the area, the site should be classified as Site Class C. The final choice of design parameters, however, remains the purview of the project structural engineer.

**Table 3: Seismic Design Parameters***

| Reference | | Seismic Parameter | Recommended Value |
|---|---|---|---|
| ASCE 7-16 | Table 20.3-1 | Site Class | C |
| | Figure 22-7 | Maximum Considered Earthquake Geometric Mean (MCEC) PGA | 0.177g |
| | Table 11.8-1 | Site Coefficient $F_{PGA}$ | 1.223 |
| | Equation 11.8-1 | $PGA_M = F_{PGA}$ PGA | 0.216g |
| 2019 CBC | Figure 1613.2.1(1) | Short-Period MCE at 0.2s, $S_S$ | 0.415g |
| | Figure 1613.2.1(2) | 1.0s Period MCE, $S_1$ | 0.213g |
| | Table 1613.2.3(1) | Site Coefficient, $F_a$ | 1.300 |
| | Table 1613.2.3(2) | Site Coefficient, $F_v$ | 1.500 |
| | Equation 16-36 | Adjusted MCE Spectral Response Parameters, $S_{MS} = F_aS_s$ | 0.540g |
| | Equation 16-37 | Adjusted MCE Spectral Response Parameters, $S_{M1} = F_vS_1$ | 0.319g |
| | Equation 16-38 | Design Spectral Acceleration Parameters, $S_{DS} = ⅔S_{MS}$ | 0.360g |
| | Equation 16-39 | Design Spectral Acceleration Parameters, $S_{D1} = ⅔S_{M1}$ | 0.213g |
| | Table 1613.2.5(1) | Seismic Design Category (Short Period), Occupancy I to III | C |
| | Table 1613.2.5(1) | Seismic Design Category (Short Period), Occupancy IV | D |
| | Table 1613.2.5(2) | Seismic Design Category (1-Sec Period), Occupancy I to IV | D |

*Based on the online calculator available at https://earthquake.usgs.gov/ws/designmaps/

**Earthquake Induced Liquefaction, Settlement, and Surface Rupture Potential**

Liquefaction is the sudden loss of soil shear strength and sudden increase in porewater pressure caused by shear strains, as could result from an earthquake. Research has shown that saturated, loose to medium-dense sands with a silt content less than about 25 percent and located within the top 40 feet are most susceptible to liquefaction and surface rupture/lateral spreading.

Due to the absence of permanently elevated groundwater table, the relatively low seismicity of the area, and the relatively shallow depth to rock, the potential for seismically induced damage due to liquefaction, surface ruptures, and settlement is considered low. For the above-mentioned reasons, mitigation for these potential hazards is not considered necessary for the development of this project.

**Static and Seismically Induced Slope Instability**
The existing slopes on the project site were observed to have adequate vegetation on the slope face, appropriate drainage away from the slope face, and no apparent tension cracks or slump blocks in the slope face or at the head of the slope. Additionally, due to the absence of permanently elevated groundwater table, the relatively low seismicity of the area, and the relatively shallow depth to bedrock, the potential for seismically induced slope instability for the existing slopes is considered low.

## 5.0 DISCUSSION AND CONCLUSIONS

Based upon the results of our field explorations, findings, and analysis described above, it is our opinion that construction of the proposed improvements is feasible from a geotechnical standpoint, provided the recommendations contained in this report are incorporated into the design plans, specifications, and implemented during construction. The native soils, once processed and compacted as recommended below, may be considered "engineered" and suitable for support of the planned improvements.

**Geotechnical Considerations for Development**
The project site is generally comprised of a thin layer of soils over shallow rock which is considered suitable for support of the proposed improvements. Generally, issues associated with development on similar sites are associated with the excavation of shallow rock and the presence of seepage at the soil to rock contact.

Based on the configuration presented in the Reference 1 plans, it appears that the proposed building will likely be below the road and be supported by native soils or rock and engineered fills on the order of 5 feet. For these conditions, we have included the comments below. The geotechnical recommendations for this project are presented in the following sections.

- Buildings constructed below the road elevation may be more subject to seepage and poor drainage. Special attention should be given to configuring the landscaping to drain away from the foundation and how underground utilities are configured to prevent water migrating through the trench becoming impounded against the foundation. The installation of a subdrain along the building is anticipated to provide increased protection against unwanted water conditions.
- Due to the strength of rock, it may be difficult to excavate utilities. Consideration may be given to pre-excavating utility alignments during the building pad grading when larger equipment could be used and there is more site access. Some sites with shallow rock overexcavate the rock approximately 2 feet from finish grade during grading to improve landscape performance and later utility installations.

## 6.0 SITE GRADING AND EARTHWORK IMPROVEMENTS

**Excavation Characteristics**
The recent exploratory test pits were excavated using a CAT 303.5E2 Mini Excavator equipped with an 18-inch-wide bucket. The uppermost site soils are anticipated to be excavatable with conventional earthwork equipment, such as a backhoe or mini-excavator. Excavations will

become increasingly difficult below depths of 2 feet due to the underlying rock condition and can limit production of backhoes and smaller dozers.

Due to mobility restrictions of large dozer equipment typically used for grading with shallow bedrock conditions, large excavators such as Komatsu PC400 or CAT 345 (or equivalent) equipped with special rock excavation/trenching equipment may be more appropriate for excavations on single lot residential development. As such, contractors should be equipped with equipment of suitable size to perform the site excavations.

Where hard rock cuts in fractured rock are proposed, the orientation and direction of excavation/ripping will likely play a large role in the rippability of the material. Blasting cannot be ruled out in areas of resistant rock. When hard rock is encountered, we should be contacted to provide additional recommendations prior to performing an alternative such as blasting. Water inflow into any excavation approaching the hard rock surface is likely to be experienced in all but the driest summer and fall months.

**Soil Moisture Considerations**
The compaction of soil to a desired relative compaction is dependent on conditioning the soil to a target range of moisture content. Moisture contents that are excessively dry or wet could limit the ability of the contractor to compact soils to the requirements for engineered fill. When dry, moisture should be added to the soil and the soils blended to improve consistency. Wet soil will need to be dried to become compactable. Generally, this includes blending and working the soil to avoid trapping moisture below a dryer surficial crust. Other options are available to reduce the time involved but typically have higher costs and require more evaluation prior to implementation.

The largest contributor to excessive soil moisture is generally precipitation and seepage during the rainy season. In recognition of this, we suggest that consideration be given to the seasonal limitations and costs of winter grading operations on the site. Special attention should be given regarding the drainage of the project site. If the project is expected to work through the wet season, the contractor should install appropriate temporary drainage systems at the construction site and should minimize traffic over exposed subgrades due to the moisture-sensitive nature of the on-site soils. During wet weather operations, the soil should be graded to drain and should be sealed by rubber tire rolling to minimize water infiltration.

**Site Preparation**
Preparation of the project site should involve demolition, site drainage controls, dust control, clearing and stripping, overexcavation and compaction of any loose native soils, and exposed grade compaction considerations. The following paragraphs state our geotechnical comments and recommendations concerning site preparation.

Our recommendations are based on limited windows into the subsurface and interpretations thereof; therefore, a representative of our firm should be present during site clearing operations to identify the location and depth of potential fills or loose soils, some of which may not have been found during our evaluation. We should also be present to observe removal of deleterious materials, and to identify any existing site conditions which may require mitigation or further recommendations prior to site development.

<u>Demolition</u>
As part of the demolition operation, any unwanted foundation, structural improvement, or site improvement elements (including underground utilities) should be exhumed and removed from the site. In addition, any underground storage tanks, abandoned wells or other utilities not

intended for reuse should be removed or backfilled in accordance with the appropriate regulations.

Concrete and asphalt separated from the other debris, and adequately broken down in particle size, may be mixed thoroughly with soil and placed as engineered fill as described below. If this option is exercised, a representative from our firm should be contacted to observe the adequacy of grading operations associated with the breaking and mixing of these elements.

Site Drainage Controls
We recommend that initial site preparation involve intercepting and diverting any potential sources of surface or near-surface water within the construction zones. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and methods used by the contractor, final decisions regarding drainage systems are best made in the field at the time of construction. All drainage and/or water diversion performed for the site should be in accordance with the Clean Water Act and applicable Storm Water Pollution Prevention Plan.

Dust Control
Dust control provisions should be provided for as required by the local jurisdiction's grading ordinance (i.e. water truck or other adequate water supply during grading). Dust control is the purview of the grading contractor.

Clearing and Stripping of Organic Materials
Clearing and stripping operations should include the removal of all organic laden materials including trees, bushes, root balls, root systems, and any soft or loose soil generated by the removal operations. Short or mowed dry grasses may be pulverized and lost within fill materials provided no concentrated pockets of organics result. It is the responsibility of the grading contractor to remove excess organics from the fill materials. **No more than 2 percent of organic material, by weight, should be allowed within the fill materials at any given location.** Preserved trees may require tree root protection which should be addressed on an individual basis by a qualified arborist.

Our recommendations are based on limited windows into the surface and interpretations thereof; therefore, a representative of our firm should be present during site clearing operations to identify the location and depth of potential fills or loose soils, some of which may not have been found during our evaluation. We should also be present to observe removal of deleterious materials, and to identify any existing site conditions which may require mitigation or further recommendations prior to site development.

Overexcavation and Recompaction of Undocumented Fills/Loose/Soft Native Soils
Following general site clearing, any undocumented fills and any existing loose/soft soils within the development footprint should be overexcavated down to firm native materials and backfilled with engineered fill as detailed in the engineered fill section below. Any depressions extending below final grade resulting from the removal of fill materials or other deleterious materials should be properly prepared as discussed below and backfilled with engineered fill.

Exposed Grade Compaction
Exposed soil grades following initial site preparation activities and overexcavation operations should be scarified to a minimum depth of 8 inches and compacted to the requirements for engineered fill. Generally, where rock conditions are exposed, no scarification should be necessary; however, these surfaces should be moisture conditioned and compacted to mitigate

disturbance resulting from site preparation. Prior to placing fill, the exposed grades should be in a firm and unyielding state. Any localized zones of soft or pumping soils observed within the exposed grade should either be scarified and recompacted or be overexcavated and replaced with engineered fill as detailed in the engineered fill section below.

**Engineered Fill Criteria**
All materials placed as fills on the site should be placed as “Engineered Fill" which is observed, tested, and compacted as described in the following paragraphs.

Suitability of Onsite Materials
We expect that soil generated from excavations on the site, excluding deleterious material, may be used as engineered fill provided the material does not exceed 8 inches in maximum dimension. The contractor should either dispose of excess materials to an offsite location or mechanically reduce rocks to less than 8 inches.

Fill Placement and Compaction
Engineered fills should be placed in thin horizontal lifts not to exceed 8 inches in uncompacted thickness. If the contractor can achieve the recommended relative compaction using thicker lifts, the method may be judged acceptable based on field verification by a representative of our firm using standard density testing procedures. Lightweight compaction equipment may require thinner lifts to achieve the recommended relative compaction. Fills should have a maximum particle size of 8 inches unless approved by our firm.

The relative compaction of engineered fills is based on the maximum density and optimum moisture determined through the ASTM D1557 test method. We recommend that the engineered fills be placed at a minimum relative compaction of 90 percent. Depending on the moisture condition of the soils, the engineered fills may require moisture conditioning to be within a suitable compaction range.

Our firm should be requested for consultation, observation, and testing for the earthwork operations prior to the placement of any fills. Fill soil compaction should be evaluated by means of in-place density tests performed during fill placement so that adequacy of soil compaction efforts may be determined as earthwork progresses.

Import Materials
The recommendations presented in this report are based on the assumption that the import materials will be similar to the materials present at the project site. High quality materials are preferred for import; however, these materials can be more dependent on source availability. Import material should be approved by our firm prior to transporting it to the project site.

Material for this project should consist of a material with the geotechnical characteristics presented below. If these requirements are not met, additional testing and evaluation may be necessary to determine the appropriate design parameters for foundations, pavement, and other improvements.

**Table 5: Select Import Criteria**

| Behavior Property | Reference Document | Recommendation |
|---|---|---|
| Direct Shear Strength | ASTM D3080 | ≥ 30° when compacted |
| Resistance "R" Value | CTM 301 | ≥ 20 |
| Sieve Analysis | ASTM D1140 | Not more than 30% Passing the No. 200 sieve |
| Maximum Aggregate Size | ASTM D1140 | ≤ 6" |

**Slope Configuration and Grading**
Generally, a cut slope orientation of 2H:1V (Horizontal:Vertical) is considered stable with the material types encountered on the site. A fill slope constructed at the same orientation is considered stable if compacted to the engineered fill recommendations as stated in the recommendations section of this report. All slopes should have appropriate drainage and vegetation measures to minimize erosion of slope soils.

Placement of Fills on Slopes
Placement of fill material on natural slopes should be stabilized by means of keyways and benches. Where the slope of the original ground equals or exceeds 5H:1V, a keyway should be constructed at the base of the fill. The keyway should consist of a trench excavated to a depth of at least 2 feet into firm, competent materials. The keyway trench should be at least 10 feet wide or as designated by our firm based on the conditions at the time of construction. Benches should be cut into the original slope as the filling operation proceeds. Each bench should consist of a level surface excavated at least 6 feet horizontally into firm soils or 4 feet horizontally into rock. The rise between successive benches should not exceed 36 inches. The need for subdrainage should be evaluated at the time of construction. Refer to Figure C-1 in Appendix C for typical keyway and bench construction.

Slope Face Compaction
All slope fills should be laterally overbuilt and cut back such that the required compaction is achieved at the proposed finish slope face. As a less preferable alternative, the slope face could be track walked or compacted with a wheel. If this second alternative is used, additional slope maintenance may be necessary.

Slope Drainage
Surface drainage should not be allowed to flow uncontrolled over any slope face. Adequate surface drainage control should be designed by the project civil engineer in accordance with the latest applicable edition of the CBC. All slopes should have appropriate drainage and vegetation measures to minimize erosion of slope soils.

## 7.0 DESIGN RECOMMENDATIONS
The contents of this section include recommendations for foundations, slabs-on-grade, retaining walls, pavements, and drainage.

**Shallow Conventional Foundations**
Shallow conventional foundation systems are considered suitable for construction of the planned improvements, provided that the site is prepared in accordance with the recommendations discussed in Section 6.0 of this report.

The provided values do not constitute a structural design of foundations which should be performed by the structural engineer. In addition to the provided recommendations, foundation design and construction should conform to applicable sections of the 2019 California Building Code.

<u>Foundation Capacities</u>
The foundation bearing and lateral capacities are presented in the table below. The allowable bearing capacity is for support of dead plus live loads based on the foundation configuration presented in this report. The allowable capacity may be increased by 1/3 for short-term wind and seismic loads. Lateral forces on structures may be resisted by passive pressure acting against the sides of shallow footings and/or friction between the foundation bearing material and the bottom of the footing. Section 1806.3 of the 2019 CBC allows for the combination of the friction factor and passive resistance value to lateral resistance. Consideration should be given to ignoring passive resistance where soils could be disturbed later or within 6 feet horizontally of the slope face.

**Table 6: Foundation Capacities**

| Soil Type | Design Condition | Design Value | Applied Factor of Safety |
|---|---|---|---|
| Engineered Fill | Allowable Bearing Capacity | 2,000 psf | 3.0 |
| | Allowable Friction Factor* | 0.38 | 1.5 |
| | Allowable Passive Resistance | 215 psf/ft | 1.5 |
| * Friction Factor is calculated as tan(ϕ) | | | |

<u>Foundation Settlement</u>
A total settlement of less than 1 inch is anticipated; a differential settlement of 0.75 inches in 25 feet is anticipated where foundations are bearing on like materials. The settlement criteria are based upon the grading recommendations provided in this report and the assumption that foundations will be sized and loaded in accordance with the recommendations in this report.

<u>Foundation Configuration</u>
Conventional shallow foundations should be a minimum of 12 inches wide and founded a minimum of 18 inches below the lowest adjacent soil grade. Isolated pad foundations should be a minimum of 24 inches square in plan dimension and founded a minimum of 18 inches below lowest adjacent soil grade.

Foundation reinforcement should be provided by the structural engineer. The reinforcement schedule should account for typical construction issues such as load consideration, concrete cracking, and the presence of isolated irregularities. At a minimum, we recommend that continuous footing foundations be reinforced with four No. 4 reinforcing bars, two located near the bottom of the footing and two near the top of the stem wall.

<u>Foundation Influence Line and Slope Setback</u>
All footings should be founded below an imaginary 2H:1V plane projected up from the bottoms of adjacent footings and/or parallel utility trenches, or to a depth that achieves a minimum horizontal clearance of 6 feet from the outside toe of the footings to the slope face, whichever requires a deeper excavation.

<u>Subgrade Conditions</u>
Footings should never be cast atop soft, loose, organic, slough, debris, nor atop subgrades covered by ice or standing water. A representative of our firm should be retained to observe all

subgrades during footing excavations and prior to concrete placement so that a determination as to the adequacy of subgrade preparation can be made.

<u>Shallow Footing / Stemwall Backfill</u>
All footing/stemwall backfill soil should be compacted to the criteria for engineered fill as recommended in Section 6.0 of this report.

**Slab-on-Grade Construction**
It is our opinion that soil-supported slab-on-grade floors could be used for the main floor of the structure, contingent on proper subgrade preparation. Often the geotechnical issues regarding the use of slab-on-grade floors include proper soil support and subgrade preparation, proper transfer of loads through the slab underlayment materials to the subgrade soils, and the anticipated presence or absence of moisture at or above the subgrade level. We offer the following comments and recommendations concerning support of slab-on-grade floors. The slab design (concrete mix design, curing procedures, reinforcement, joint spacing, moisture protection, and underlayment materials) is the purview of the project Structural Engineer.

<u>Slab Subgrade Preparation</u>
All subgrades proposed to support slab-on-grade floors should be prepared and compacted to the requirements of engineered fill as discussed in Section 6.0 of this report.

<u>Slab Underlayment</u>
As a minimum for slab support conditions, the slab should be underlain by a minimum 4-inch thick crushed rock layer that is covered by a minimum 10-mil thick moisture retarding plastic membrane. The membrane may only be functional when it is above the vapor sources. The bottom of the crushed rock layer should be above the exterior grade to act as a capillary break and not a reservoir, unless it is provided with an underdrain system. The slab design and underlayment should be in accordance with ASTM E1643 and E1745.

An optional 1-inch blotter sand layer placed above the plastic membrane, is sometimes used to aid in curing of the concrete. Although historically common, this blotter layer is not currently included in slabs designed according to the 2019 Green Building Code. When omitted, special wet curing procedures will be necessary. If installed, the blotter layer can become a reservoir for excessive moisture if inclement weather occurs prior to pouring the slab, excessive water collects in it from the concrete pour, or an external source of water enters above or bypasses the membrane.

Our experience has shown that vapor transmission through concrete is controlled through proper concrete mix design. As such, proper control of moisture vapor transmission should be considered in the design of the slab as provided by the project architect, structural or civil engineer. It should be noted that placement of the recommended plastic membrane, proper mix design, and proper slab underlayment and detailing per ASTM E1643 and E1745 will not provide a waterproof condition. If a waterproof condition is desired, we recommend that a waterproofing expert be consulted for slab design.

<u>Slab Thickness and Reinforcement</u>
Geotechnical reports have historically provided minimums for slab thickness and reinforcement for general crack control. The concrete mix design and construction practices can additionally have a large impact on concrete crack control. All concrete should be anticipated to crack. As such, these minimums should not be considered to be standalone items to address crack control, but are suggested to be considered in the slab design methodology.

In order to help control the growth of cracks in interior concrete from becoming significant, we suggest the following minimums. Interior concrete slabs-on-grade not subject to heavy loads, should be a minimum of 4-inches thick and reinforced. A minimum of No. 3 deformed reinforcing bars placed at 18 inches on center both ways, at the center of the structural section is suggested. Joint spacing should be provided by the structural engineer. Troweled joints recovered with paste during finishing or “wet sawn” joints should be considered every 10 feet on center. Expansion joint felt should be provided to separate floating slabs from foundations and at least at every third joint. Cracks will tend to occur at recurrent corners, curved or triangular areas and at points of fixity. Trim bars can be utilized at right angle to the predicted crack extending 40 bar diameters past the predicted crack on each side.

<u>Vertical Deflections</u>
Soil-supported slab-on-grade floors can deflect downward when vertical loads are applied, due to elastic compression of the subgrade. For preliminary design of concrete floors, a modulus of subgrade reaction of k = 115 psi per inch would be applicable for engineered fills.

**Exterior Flatwork**
Exterior concrete flatwork is recommended to have a 4-inch thick rock cushion. This could consist of vibroplate compacted crushed rock or compacted ¾-inch aggregate baserock. If exterior flatwork concrete is against the floor slab edge without a moisture separator it may transfer moisture to the floor slab. Expansion joint felt should be provided to separate exterior flatwork from foundations and at least at every third joint. Contraction / groove joints should be provided to a depth of at least 1/4 of the slab thickness and at a spacing of less than 30 times the slab thickness for unreinforced flatwork, dividing the slab into nearly square sections. Cracks will tend to occur at recurrent corners, curved or triangular areas and at points of fixity. Trim bars can be utilized at right angle to the predicted crack extending 40 bar diameters past the predicted crack on each side.

**Retaining Walls**
Our design recommendations and comments regarding retaining walls for the project site are discussed below. *Retaining wall foundations should be designed in accordance with the Shallow Conventional Foundations section above*

<u>Retaining Wall Lateral Pressures</u>
Based on our observations and testing, the retaining wall should be designed to resist lateral pressure exerted from a soil media having an equivalent fluid weight provided in the table below. The values presented below are not factored and are for conditions when firm native soil or engineered fill is used within the zone behind the wall defined as twice the height of the retaining wall. Additionally, the values do not account for the friction of the backfill on the retaining wall which may or may not be present depending on the wall materials and construction.

The lateral pressures presented in the table below include recommendations for earthquake loading which is required for structures to be designed in Seismic Design Categories D, E, or F per Section 1803.5.12.1 of the 2019 California Building Code. The lateral pressures presented have been calculated using the Mononobe-Okabe Method derived from Wood (1973) and modified by Whitman et al. (1991). The values are intended to be used as the multiplier for uniformly distributed loads and the parameter “H” is the total height of the wall including the footing but excluding any key, if used.

**Table 7: Retaining Wall Pressures**

<table>
<tr><th>Wall Type</th><th>Wall Slope Configuration</th><th>Equivalent Fluid Weight (pcf)</th><th>Lateral Pressure Coefficient</th><th colspan="2">Earthquake Loading (plf)</th></tr>
<tr><td rowspan="2">Free Cantilever</td><td>Flat</td><td>40</td><td>0.33</td><td>$3H^2$</td><td rowspan="3">Applied 0.6H above the base of the wall</td></tr>
<tr><td>2H:1V</td><td>65</td><td>0.52</td><td rowspan="2">$13H^2$</td></tr>
<tr><td>Restrained*</td><td>Flat</td><td>60</td><td>0.50</td></tr>
</table>

* Restrained conditions shall be defined as walls which are structurally connected to prevent flexible yielding, or rigid wall configurations (i.e. walls with numerous turning points) which prevent the yielding necessary to reduce the driving pressures from an at-rest state to an active state.

Design Values for Dry Stacked Walls

Dry stacked walls do not generally use the equivalent fluid weight method presented above; instead they use design soil properties for a given soil condition such as the internal friction angle, cohesion, and bulk unit weight. The walls could include keyed or interlocking non-mortared walls such as segmental block (Basalite, Keystone, Allan Block, etc.), rockery walls, or specialty designs for proprietary systems. When this occurs, the following soil parameters would be applicable for design with the onsite native materials in a firm condition or for engineered fills. The seismic coefficient is considered to be ½ of the adjusted peak ground acceleration for the site conditions is given in Section 4.0 of this report. Some software allows for the extension of the Mononobe-Okabe Method beyond the conventional limitations and, if the method is applied, could calculate seismic values significantly higher than those provided by the multiplier method provided above.

**Table 8: Generalized Design Parameters**

| Internal Angle of Friction | Cohesion | Bulk Unit Weight | Seismic Coefficient, Kh |
|---|---|---|---|
| 30° | 50 psf | 120 pcf | 0.108g |

Wall Drainage

The criteria presented above is based on fully drained conditions as detailed in the attached Figure C-2, Appendix C. For these conditions, we recommend that a blanket of filter material be placed behind all proposed walls. Permeable materials are specified in Section 68 of the California Department of Transportation Standard Specifications, current edition. The filter material should conform to Class 1, Type B permeable material in combination with a filter fabric to separate the open graded gravel/rock from the surrounding soils. Generally, a clean ¾ inch crushed rock should be acceptable. Consistent with Caltrans Standards, when Class 2 permeable materials are used, the filter fabric may be omitted unless otherwise designed.

The blanket of filter material should be a minimum of 12-inches thick and should extend from the bottom of the wall to within 12 inches of the ground surface. The top 12 inches of wall backfill should consist of a compacted soil cap. A filter fabric having specifications equal to or greater than those for Mirafi 140N should be placed between the gravel filter material and the surrounding soils to reduce the potential for infiltration of soil into the gravel. A 4-inch diameter drain pipe should be installed near the bottom of the filter blanket with perforations facing down. The drainpipe should be underlain by at least 4 inches of filter-type material. An adequate gradient should be provided along the top of the foundation to discharge water that collects behind the retaining wall to a controlled discharge system.

The configuration of a long retaining wall generally does not allow for a positive drainage gradient within the perforated drain pipe behind the wall since the wall footing is generally flat with no gradient for drainage. Where this condition is present, to maintain a positive drainage behind the walls, we recommend that the wall drains be provided with a discharge to an appropriate non-erosive outlet a maximum of 50 feet on center. **In addition, if the wall drain outlets are temporarily stubbed out in front of the walls for future connection during construction, it is imperative that the outlets be routed into the tight pipe area drainage system and not buried and rendered ineffective.**

**Asphalt Concrete Pavement Design**

We understand that asphalt pavements will be used for the associated roadways. The following comments and recommendations are given for pavement design and construction purposes. All pavement construction and materials used should conform to applicable sections of the latest edition of the California Department of Transportation Standard Specifications.

Subgrade Compaction

The asphalt concrete pavement section should be constructed to achieve the minimum relative compactions specified in Section 6.0 of this report. Deviation from the following table should be reviewed by the governing agency when the pavements are to be constructed within their right-of-way. Final acceptance of the constructed pavement section is the purview of the governing agency or owner of the site.

Subgrade Stability

All subgrades and aggregate base should be proof-rolled with a full water truck or equivalent immediately before paving, in order to evaluate their condition. If unstable subgrade conditions are observed, these areas should be overexcavated down to firm materials and the resulting excavation backfilled with suitable materials for compaction (i.e., drier native soils or aggregate base). Areas displaying significant instability may require geotextile stabilization fabric within the overexcavated area, followed by placement of aggregate base. Final determination of any required overexcavation depth and stabilization fabric should be based on the conditions observed during subgrade preparation.

Design Criteria

Critical features that govern the durability of a pavement section include the stability of the subgrade; the presence or absence of moisture, free water, and organics; the fines content of the subgrade soils; the traffic volume; and the frequency of use by heavy vehicles. Soil conditions can be defined by a soil resistance value, or “R-Value,” and traffic conditions can be defined by a Traffic Index (TI).

Design Values

Critical features that govern the durability of a pavement section include the stability of the subgrade; the presence or absence of moisture, free water, and organics; the fines content of the subgrade soils; the traffic volume; and the frequency of use by heavy vehicles. Soil conditions can be defined by a soil resistance value, or “R-Value,” and traffic conditions can be defined by a Traffic Index (TI).

Laboratory testing was performed on a bulk sample considered to be representative of the materials expected to be exposed at subgrade. An R-value of 23 was determined for the sandy SILT tested. However, to account for the variability of materials and expansion pressures developed during laboratory testing, an R-value of 20 was used for pavement design purposes.

Design values provided are based upon properly drained subgrade conditions. Although the R-Value design to some degree accounts for wet soil conditions, proper surface and landscape drainage design is integral in performance of adjacent street sections with respect to stability and degradation of the asphalt. If clay soils are encountered and cannot be sufficiently blended with non-expansive soils, we should review pavement subgrades to determine the appropriateness of the provided sections, and provide additional pavement design recommendations as field conditions dictate. Even minor clay constituents will greatly reduce the design R-Value.

Section Thickness
The recommended design thicknesses presented in the following table were calculated in accordance with the methods presented in the Sixth Edition of the California Department of Transportation Highway Design Manual. A varying range of traffic indices are provided for use by the project Civil Engineer for roadway design.

**Table 9: Asphalt Pavement Section Recommendations**

| Design Traffic Indices | Alternative Pavement Sections (Inches) | |
|---|---|---|
| | Asphalt Concrete * | Aggregate Base ** |
| 4.5 | 3.0 | 4.5 |
| 5.0 | 3.0 | 7.5 |
| 5.5 | 3.0<br>3.5 | 9.0<br>8.0 |
| 6.0 | 3.0<br>3.5 | 10.5<br>9.5 |
| 6.5 | 3.5<br>4.0 | 11.5<br>10.5 |
| 7.0 | 4.0<br>4.5 | 12.0<br>11.0 |
| 8.0 | 4.5<br>5.0 | 14.5<br>13.5 |

* Asphalt Concrete: must meet specifications for Caltrans Hot Mix Asphalt Concrete
** Aggregate Base: must meet specifications for Caltrans Class II Aggregate Base (R-Value = minimum 78)

**Portland Cement Concrete Pavement Design**
We understand that Portland cement concrete pavements may be considered for various aspects of exterior paving for the site. The American Concrete Institute (ACI) Concrete Pavement Design method (ACI 330R-08) was used for design of the exterior concrete (rigid) pavements at the site.

Relative Compaction
The asphalt concrete pavement section should be constructed to achieve the minimum relative compactions specified in Section 6.0 of this report. Deviation from the following table should be reviewed by the governing agency when the pavements are to be constructed within their right-of-way. Final acceptance of the constructed pavement section is the purview of the governing agency.

Subgrade Stability
All subgrades and aggregate base should be proof-rolled with a full water truck or equivalent immediately before paving, in order to evaluate their condition.

Soil Design Parameters
The pavement thicknesses were evaluated based on the soil design parameters provided in the following table.

**Table 10: Soil Parameters**

| Subgrade Soil Description | k, Modulus of Subgrade Reaction* | Base Course |
|---|---|---|
| Sandy SILT | 115 pci | 6 inches |

* Based on an R-Value of 20 as recommended above and correlated to a k-Value recommended by ACI 330R.

Section Thickness

Based on the subgrade soil parameters shown in the above table, the recommended concrete thicknesses for various traffic descriptions are presented in the table below. The recommended thicknesses provided below assume the use of plain (non-reinforced) concrete pavements.

**Table 11: Concrete Pavement Section Recommendations**

| Category | ADTT* | Pavement Traffic Description | Thickness (inches) | |
|---|---|---|---|---|
| | | | 3000 psi** | 4000 psi** |
| A | 1 | Car parking areas and access lanes<br>Autos, pickups, and panel trucks only | 4.5 | 4.5 |
| A | 10 | | 5.0 | 5.0 |
| B | 25 | Shopping center entrance and service lanes<br>Bus parking areas and interior lanes<br>Single-unit truck parking areas and interior lanes | 6.0 | 5.5 |
| B | 300 | | 6.5 | 6.0 |
| C | 100 | Roadway Entrances and Exterior Lanes | 6.5 | 6.5 |
| C | 300 | | 7.0 | 6.5 |
| C | 700 | | 7.0 | 7.0 |

* Average Daily Truck Traffic
** 28-day concrete compressive strength

Jointing and Reinforcement

From a geotechnical perspective, contraction joints should be placed in accordance with the American Concrete Institute (ACI) recommendations which include providing a joint spacing about 30 times the slab thickness up to a maximum of 10 feet. The joint patterns should also divide the slab into nearly square panels. If increased joint spacing is desired, reinforcing steel should be installed within the pavement in accordance with ACI recommendations. Final determination of steel reinforcement configurations (if used within the pavements) remains the purview of the Project Structural Engineer.

**Drainage**

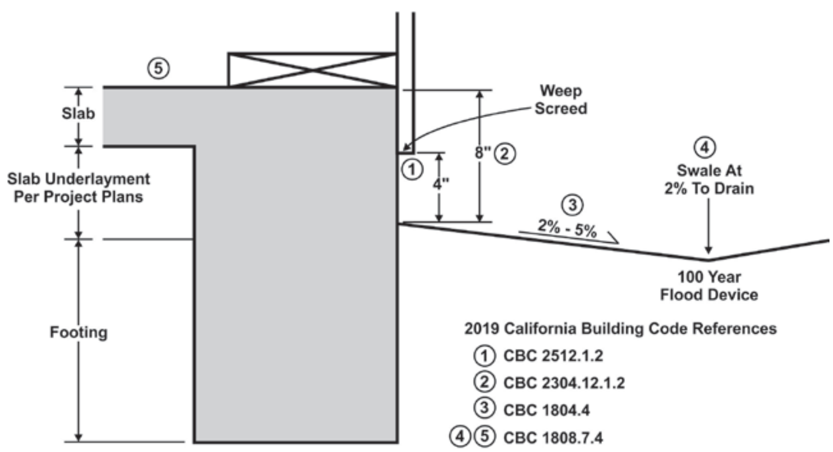
In order to maintain the engineering strength characteristics of the soil presented for use in this report, maintenance of the site will need to be performed. This maintenance generally includes, but is not limited to, proper drainage and control of surface and subsurface water which could affect structural support and fill integrity. A difficulty exists in determining which areas are prone to the negative impacts resulting from high moisture conditions due to the diverse nature of potential sources of water; some of which are outlined in the paragraph below. We suggest that measures be installed to minimize exposure to the adverse effects of moisture, but this will not guarantee that excessive moisture conditions will not affect the structure.

Some of the diverse sources of moisture could include water from landscape irrigation, annual rainfall, offsite construction activities, runoff from impermeable surfaces, collected and channeled water, and water perched in the subsurface soils on the bedrock horizon or present in fractures in the weathered bedrock. Some of these sources can be controlled through drainage features installed either by the owner or contractor. Others may not become evident until they, or the effects of the presence of excessive moisture, are visually observed on the property.

Some measures that can be employed to minimize the buildup of moisture include, but are not limited to proper backfill materials and compaction of utility trenches within the footprint of the proposed structures; grout plugs at foundation penetrations; collection and channeling of drained water from impermeable surfaces (i.e. roofs, concrete or asphalt paved areas); installation of subdrain/cut-off drain provisions; utilization of low flow irrigation systems; education to the proposed owners of proper design and maintenance of landscaping and drainage facilities that they or their landscaper installs.

Drainage Adjacent to Buildings

All grades should provide rapid removal of surface water runoff; ponding water should not be allowed on building pads or adjacent to foundations or other structural improvements (during and following construction). All soils placed against foundations during finish grading should be compacted to minimize water infiltration. Finish and landscape grading should include positive drainage away from all foundations. Section 1808.7.4 of the 2019 California Building Code (CBC) states that for graded soil sites, the top of any exterior foundation shall extend above the elevation of the street gutter at the point of discharge or the inlet of an approved drainage device a minimum of 12 inches plus 2 percent. If overland flow is not achieved adjacent to buildings, the drainage device should be designed to accept flows from a 100-year event. Grades directly adjacent to foundations should be no closer than 8 inches from the top of the slab (CBC 2304.12.1.2), and weep screeds are to be placed a minimum of 4 inches clear of soil grades and 2 inches clear of concrete or other hard surfacing (CBC 2512.1.2). From this point, surface grades should slope a minimum of 2 percent away from all foundations for at least 5 feet but preferably 10 feet, and then 2 percent along a drainage swale to the outlet (CBC 1804.4). Downspouts should be tight piped via an area drain network and discharged to an appropriate non-erosive outlet away from all foundations.




**Typical 2019 California Building Code Drainage Requirements**

The above referenced elements pertaining to drainage of the proposed structures is provided as general acknowledgement of the California Building Code requirements, restated and graphically illustrated for ease of understanding. Surface drainage design is the purview of the Project Architect/Civil Engineer. Review of drainage design and implementation adjacent to the building envelopes is recommended as performance of these improvements is crucial to the performance of the foundation and construction of rigid improvements.

Subdrainage

Reduction of potential moisture related issues could be addressed by the construction of subdrains in addition to the drainage provisions provided in the 2019 CBC. Considering that this site is down sloping from the road, a subdrain should be considered along the front of the residence to collect and redirect unwanted water from the structure.

Typical subdrain construction would include a 3 feet deep trench (or depth required to intercept the bottom of utility trenches) constructed as detailed on Figure C-3, Appendix C. The water collected in the subdrain pipe would be directed to an appropriate non-erosive outlet. We recommend that a representative from our firm be present during the subdrain installation procedures to document that the drain is installed in accordance with the observed field conditions, as well as to provide additional consultation as the conditions dictate.

As noted in the previous discussions, the moisture conditions may not manifest until after the site is developed. As such, any recommendations for the subdrain orientation and location to mitigate the moisture conditions can be provided on an as requested basis as the conditions arise.

Post Construction

All drainage related issues may not become known until after construction and landscaping are complete. Therefore, some mitigation measures may be necessary following site development. Landscape watering is typically the largest source of water infiltration into the subgrade. Given the soil conditions on site, excessive or even normal landscape watering could contribute to moisture related problems and/or cause distress to foundations and slabs, pavements, and underground utilities, as well as creating a nuisance where seepage occurs.

Low Impact Development Standards

Low Impact Development or LID standards have become a consideration for many projects in the region. LID standards are intended to address and mitigate urban storm water quality concerns. These methods include the use of Source Controls, Run-off Reduction and Treatment Controls. For the purpose of this report use of Run-off Reduction measures and some Treatment Controls may impact geotechnical recommendations for the project.

Youngdahl Consulting Group, Inc. did not perform any percolation or infiltration testing for the site as part of the Geotechnical Investigation. A review of soil survey and the data collected from test pits indicate that soils within the project are Hydrologic Soil Group D (very slow infiltration). Based on this condition, use of infiltration type LID methods (infiltration trenches, dry wells, infiltration basins, permeable pavements, etc.) should not be considered without addressing applicable geotechnical considerations/implications. As such, use of any LID measure that would require infiltration of discharge water to surfaces adjacent to structures/pavement or include infiltration type measures should be reviewed by Youngdahl Consulting Group, Inc. during the design process.

## 8.0 DESIGN REVIEW AND CONSTRUCTION MONITORING

Geotechnical engineering can be affected by natural variability of soils and, as with many projects, the contents of this report could be used and interpreted by many design professionals for the application and development of their plans. For these reasons, we recommend that our firm provide support through plan reviews and construction monitoring to aid in the production of a successful project.

### Plan Review

The design plans and specifications should be reviewed and accepted by Youngdahl Consulting Group, Inc. prior to contract bidding. A review should be performed to determine whether the recommendations contained within this report are still applicable and/or are properly interpreted and incorporated into the project plans and specifications. Modifications to the recommendations provided in this report or to the design may be necessary at the time of our review based on the proposed plans.

**Construction Monitoring**
Construction monitoring is a continuation of geotechnical engineering to confirm or enhance the findings and recommendations provided in this report. It is essential that our representative be involved with all grading activities in order for us to provide supplemental recommendations as field conditions dictate. Youngdahl Consulting Group, Inc. should be notified at least two working days before site clearing or grading operations commence, and should observe the stripping of deleterious material, overexcavation of loose/soft soils and existing fills (if present), and provide consultation, observation, and testing services to the grading contractor in the field. At a minimum, Youngdahl Consulting Group, Inc. should be retained to provide services listed in Table 12 below.

The recommendations included in this report have been based in part on assumptions about strata variations that may be tested only during earthwork. Accordingly, these recommendations should not be applied in the field unless Youngdahl Consulting Group, Inc. is retained to perform construction observation and thereby provide a complete professional geotechnical engineering service through the observational method. Youngdahl Consulting Group, Inc. cannot assume responsibility or liability for the adequacy of its recommendations when they are used in the field without Youngdahl Consulting Group, Inc. being retained to observe construction.

**Post Construction Drainage Monitoring**
Due to the elusive nature of subsurface water, the alteration of water features for development, and the introduction of new water sources, all drainage related issues may not become known until after construction and landscaping are complete. Youngdahl Consulting Group, Inc. can provide consultation services upon request that relate to proper design and installation of drainage features during and following site development.

## 9.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

1. This report has been prepared for the exclusive use of the addressee of this report for specific application to this project. The addressee may provide their consultants authorized use of this report. Youngdahl Consulting Group, Inc. has endeavored to comply with generally accepted geotechnical engineering practice common to the local area. Youngdahl Consulting Group, Inc. makes no other warranty, expressed or implied.

2. As of the present date, the findings of this report are valid for the property studied. With the passage of time, changes in the conditions of a property can occur whether they be due to natural processes or to the works of man on this or adjacent properties. Legislation or the broadening of knowledge may result in changes in applicable standards. Changes outside of our control may cause this report to be invalid, wholly or partially. Therefore, this report should not be relied upon after a period of three years without our review nor should it be used or is it applicable for any properties other than those studied.

3. Section [A] 107.3.4 of the 2019 California Building Code states that, in regard to the design professional in responsible charge, the building official shall be notified in writing by the owner if the registered design professional in responsible charge is changed or is unable to continue to perform the duties.

   WARNING: Do not apply any of this report's conclusions or recommendations if the nature, design, or location of the facilities is changed. If changes are contemplated, Youngdahl

Consulting Group, Inc. must review them to assess their impact on this report's applicability. Also note that Youngdahl Consulting Group, Inc. is not responsible for any claims, damages, or liability associated with any other party's interpretation of this report's subsurface data or reuse of this report's subsurface data or engineering analyses without the express written authorization of Youngdahl Consulting Group, Inc.

4. The analyses and recommendations contained in this report are based on limited windows into the subsurface conditions and data obtained from subsurface exploration. The methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Samples cannot be relied on to accurately reflect the strata variations that usually exist between sampling locations. Should any variations or undesirable conditions be encountered during the development of the site, Youngdahl Consulting Group, Inc. will provide supplemental recommendations as dictated by the field conditions.

**Table 12: Checklist of Recommended Services**

| Item Description | | Recommended | Not Anticipated |
|---|---|---|---|
| 1 | Provide foundation design parameters | Included | |
| 2 | Review grading plans and specifications | ✓ | |
| 3 | Review foundation plans and specifications | ✓ | |
| 4 | Observe and provide recommendations regarding demolition | ✓ | |
| 5 | Observe and provide recommendations regarding site stripping | ✓ | |
| 6 | Observe and provide recommendations on moisture conditioning removal, and/or recompaction of unsuitable existing soils | ✓ | |
| 7 | Observe and provide recommendations on the installation of subdrain facilities | ✓ | |
| 8 | Observe and provide testing services on fill areas and/or imported fill materials | ✓ | |
| 9 | Review as-graded plans and provide additional foundation recommendations, if necessary | ✓ | |
| 10 | Observe and provide compaction tests on storm drains, water lines and utility trenches | | ✓ |
| 11 | Observe foundation excavations and provide supplemental recommendations, if necessary, prior to placing concrete | ✓ | |
| 12 | Observe and provide moisture conditioning recommendations for foundation areas and slab-on-grade areas prior to placing concrete | | ✓ |
| 13 | Provide design parameters for retaining walls | Included | |
| 14 | Observe retaining wall drain installation | ✓ | |
| 15 | Provide finish grading and drainage recommendations | Included | |
| 16 | Provide geologic observations and recommendations for keyway excavations and cut slopes during grading | ✓ | |
| 17 | Excavate and recompact all test pits within structural areas | ✓ | |

# APPENDIX A
Field Study

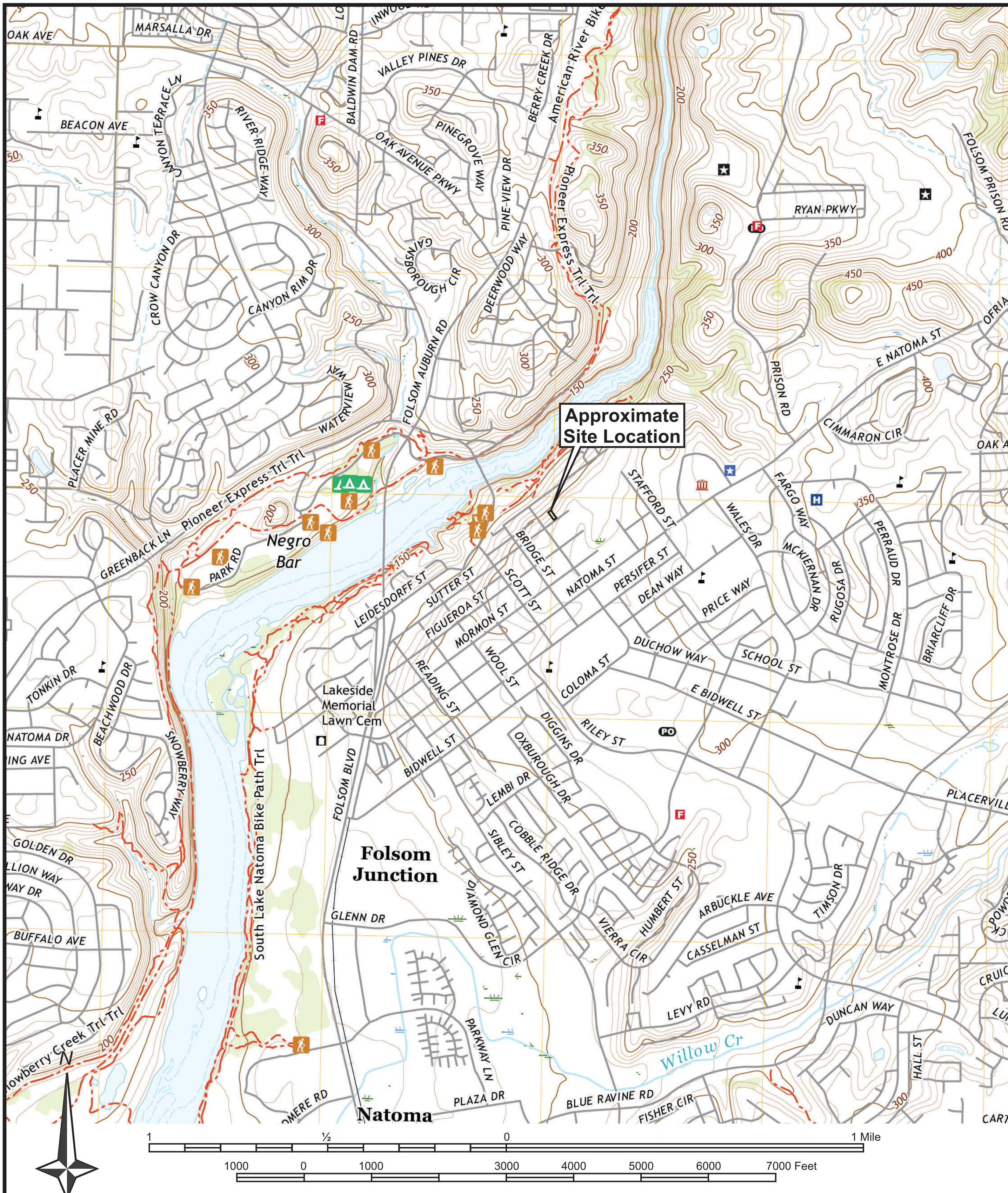
Vicinity Map
Site Plan
Exploratory Test Pit Logs
Soil Classification Chart and Log Explanation

**Introduction**
The contents of this appendix shall be integrated with the Geotechnical Engineering Study of which it is a part. They shall not be used in whole or in part as a sole source for information or recommendations regarding the subject site.

Our field study included a site reconnaissance by a Youngdahl Consulting Group, Inc. representative followed by a subsurface exploration program conducted on 23 May 2022, which included the excavation of three test pits under his direction at the approximate locations shown on Figure A-2, this Appendix. Excavation of the test pits was accomplished with a CAT 303.5E2 CR rubber track-mounted mini-excavator equipped with an 18-inch-wide bucket. The bulk and bag samples collected from the test pits were returned to our laboratory for further examination and testing.

The Exploratory Test Pit Logs describe the vertical sequence of soils and materials encountered in each test pit, based primarily on our field classifications and supported by our subsequent laboratory examination and testing. Where a soil contact was observed to be gradual, our logs indicate the average contact depth.

The soils encountered were logged during excavation and provide the basis for the "Exploratory Test Pit Logs", Figures A-3 through A-5, this Appendix. These logs show a graphic representation of the soil profile and the depths at which samples were collected.




Scale: 1:24,000

***BASE MAP REFERENCE:*** *U.S.G.S. 7.5 Minute Topographic Series, Folsom Quadrangle, Dated 2021*

| YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984 | Project No.: E22213.000<br>June 2022 | **VICINITY MAP**<br>**Sutter Street (512)**<br>Folsom, California | **FIGURE**<br>**A-1** |
|---|---|---|---|


TP-1 = Approximate Test Pit Locations

0 15 30 60

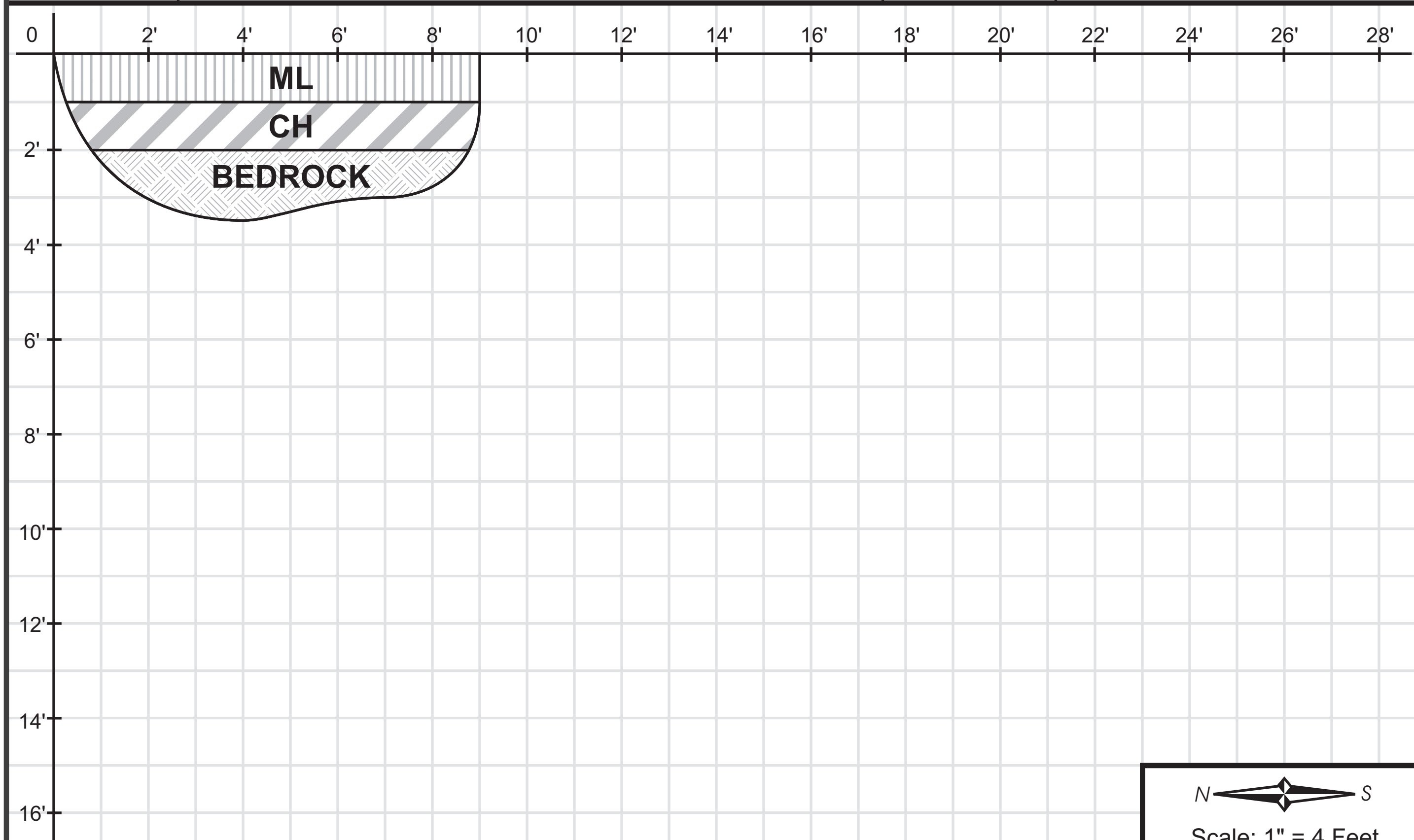
Approximate Scale: 1" = 30'

**REFERENCE:** *Parking Exhibit, 510 Sutter Street, RFE Engineering Inc., Sheet EX-1, Dated 4/6/2022; Google Earth, Aerial Data Dated 6/3/2021*

| | | | |
|---|---|---|---|
| YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984 | Project No.: E22213.000 | **SITE PLAN** | FIGURE |
| | June 2022 | **Sutter Street (512)** Folsom, California | **A-2** |

| Logged By: **ITK** | Date: **23 May 2022** | Lat / Lon: **N 38.678871° / W 121.174809°** | | Pit No. **TP-1** |
|---|---|---|---|---|
| Equipment: **CAT 303.5E2CR with 18" Bucket** | | Pit Orientation: **195°** | Elevation: **~** | |

| Depth (Feet) | Geotechnical Description & Unified Soil Classification | Sample | Tests & Comments |
|---|---|---|---|
| *@ 0' - 1'* | Brown sandy **SILT (ML)** with trace gravel, medium stiff, slightly moist, with roots | **TP-1** @ 1-1.5' | |
| *@ 1' - 2'* | Red brown sandy **CLAY (CH)** with trace cobble, medium stiff, moist | | |
| *@ 2' - 3.5'* | Red brown to blue grey **BEDROCK**, completely to highly weathered, close clay filled fractures, moderately hard, moist | | |
| | Test pit terminated at 3.5' (practical refusal)<br>No free groundwater encountered<br>No caving noted | | |



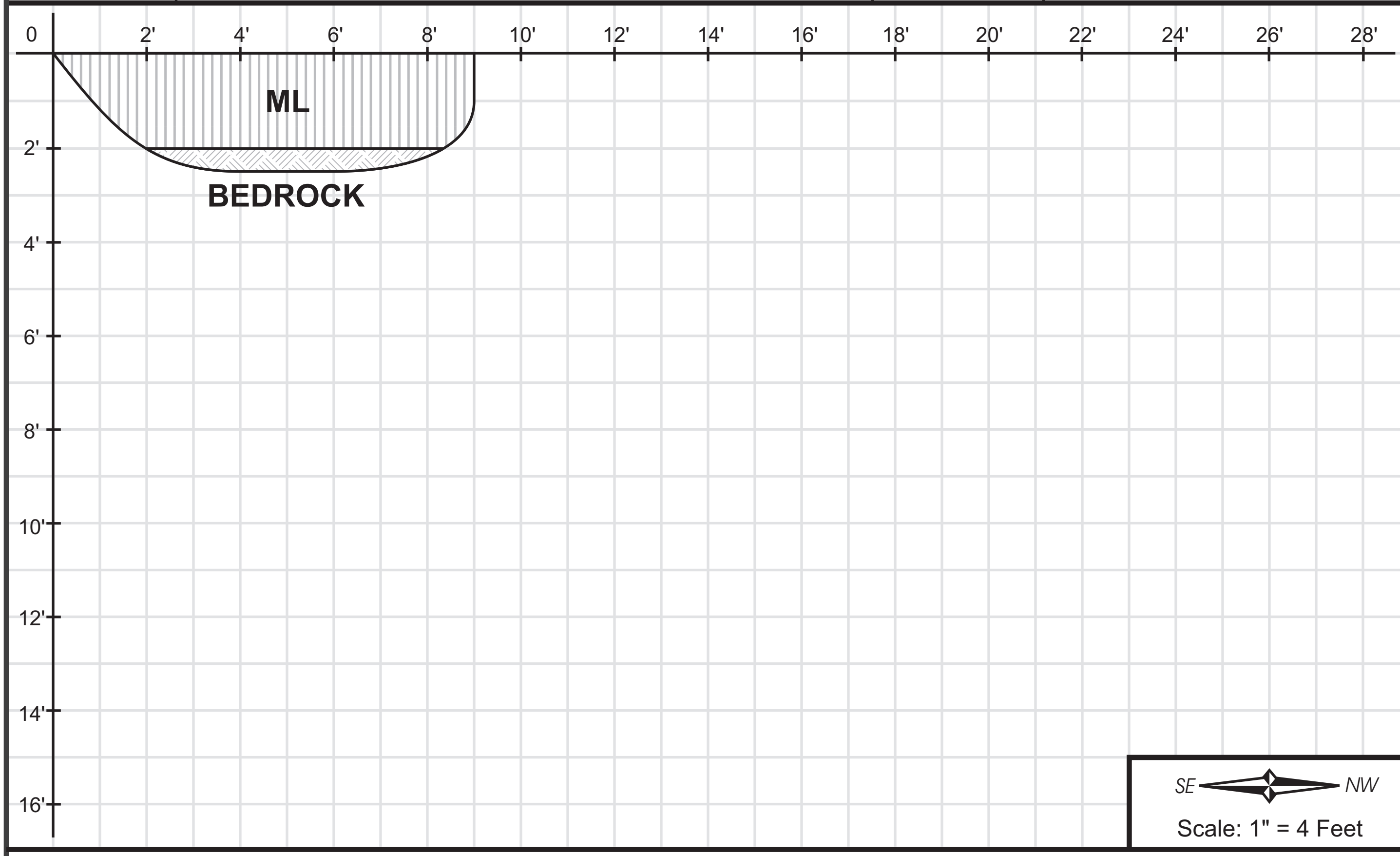

Scale: 1" = 4 Feet

**Note:** The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations, Note, too, that the passage of time may affect conditions at the sampling locations.

| YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984 | Project No.: E22213.000 | **EXPLORATORY TEST PIT LOG** | FIGURE |
|---|---|---|---|
| | **June 2022** | **Sutter Street (512)**<br>Folsom, California | **A-3** |

| Logged By: **ITK** | Date: **23 May 2022** | Lat / Lon: **N 38.679064° / W 121.174849°** | Pit No. **TP-2** |
|---|---|---|---|
| Equipment: **CAT 303.5E2CR with 18" Bucket** | | Pit Orientation: **330°** Elevation: **~** | |

| Depth (Feet) | Geotechnical Description & Unified Soil Classification | Sample | Tests & Comments |
|---|---|---|---|
| *@ 0' - 2'* | Brown sandy **SILT (ML)** with trace gravel, medium stiff, slightly moist | | |
| *@ 2' - 2.5'* | Red brown to grey **BEDROCK**, completely to highly weathered, moderately hard, slightly moist | | |
| | Test pit terminated at 2.5' (practical refusal)<br>No free groundwater encountered<br>No caving noted | | |




Scale: 1" = 4 Feet

**Note:** The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations, Note, too, that the passage of time may affect conditions at the sampling locations.

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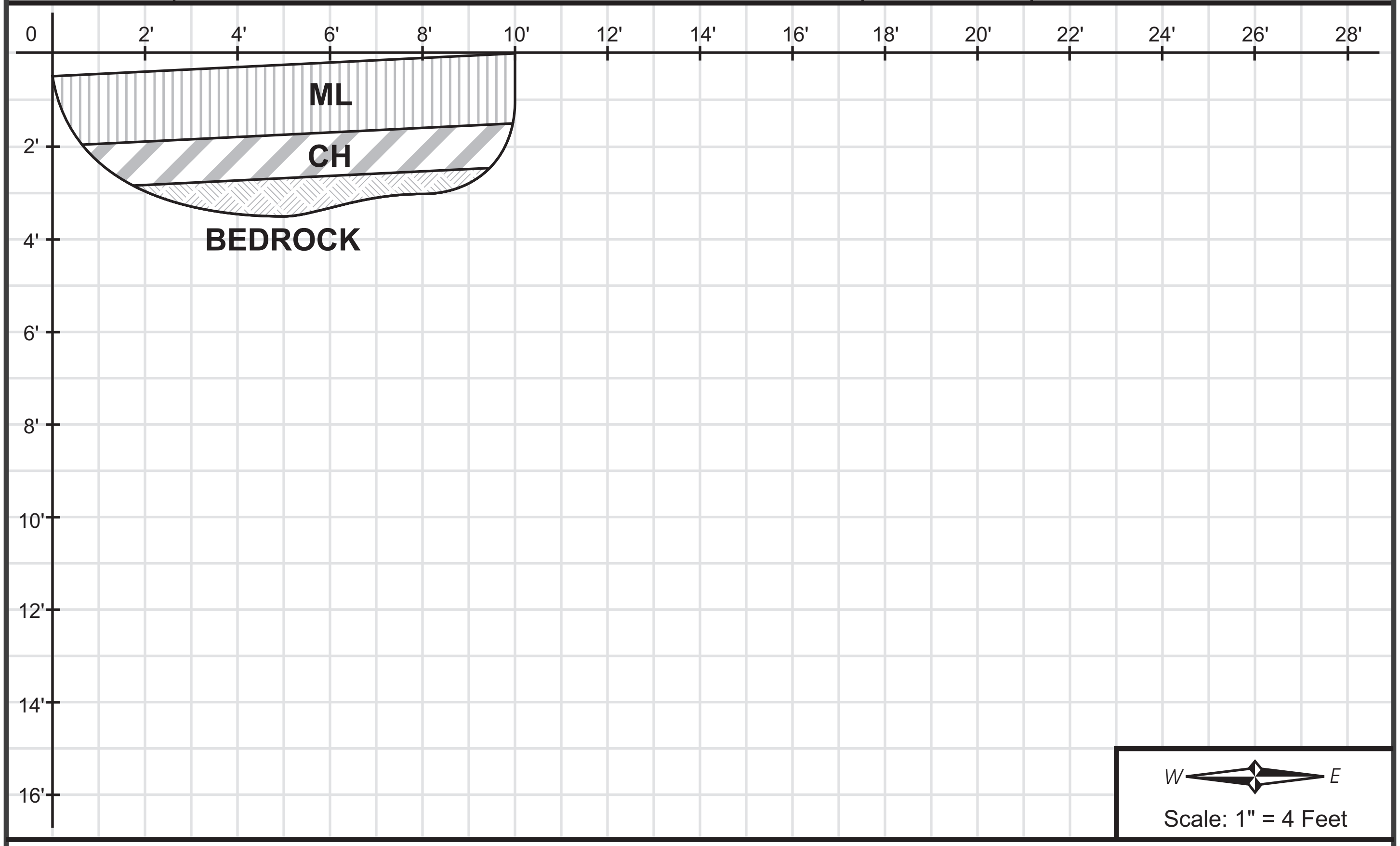
|---|---|---|---|

| Logged By: **ITK** | Date: **23 May 2022** | Lat / Lon: **N 38.679068° / W 121.17499°** | Pit No. **TP-3** |
|---|---|---|---|
| Equipment: **CAT 303.5E2CR with 18" Bucket** | | Pit Orientation: **290°** | Elevation: **~** |

| Depth (Feet) | Geotechnical Description & Unified Soil Classification | Sample | Tests & Comments |
|---|---|---|---|
| *@ 0' - 1.5'* | Brown to olive brown sandy **SILT (ML)** with gravel, medium stiff, slightly moist | **TP-3** @ 1' | **TP-3 @ 1'**<br>$\phi$ = 29.5°, c = 421 psf<br>DDmax = 113.9 pcf<br>MCopt = 14.2%<br>R-Value = 23 |
| *@ 1.5' - 2.5'* | Red brown sandy **CLAY (CH)**, medium stiff to stiff, moist | **TP-3** @ 2' | |
| *@ 2.5' - 3.5'* | Red brown to blue grey **BEDROCK**, completely to highly weathered, close clay filled fractures, moderately hard, moist | | |
| | Test pit terminated at 3.5' (practical refusal)<br>No free groundwater encountered<br>No caving noted | | |




**Note:** The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations, Note, too, that the passage of time may affect conditions at the sampling locations.

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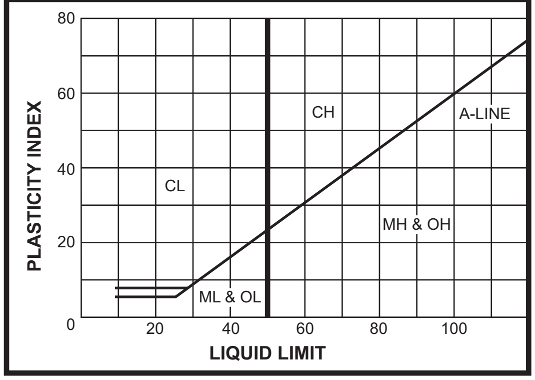
|---|---|---|---|

## UNIFIED SOIL CLASSIFICATION SYSTEMS

| MAJOR DIVISION | | | SYMBOLS | TYPICAL NAMES |
|---|---|---|---|---|
| COARSE GRAINED SOILS Over 50% > #200 sieve | GRAVELS Over 50% > #4 sieve | Clean **GRAVELS** With Little Or No Fines | GW | Well graded **GRAVELS**, **GRAVEL-SAND** mixtures |
| | | | GP | Poorly graded **GRAVELS**, **GRAVEL-SAND** mixtures |
| | | **GRAVELS** With Over 12% Fines | GM | Silty **GRAVELS**, poorly graded **GRAVEL-SAND-SILT** mixtures |
| | | | GC | Clayey **GRAVELS**, poorly graded **GRAVEL-SAND-CLAY** mixtures |
| | SANDS Over 50% < #4 sieve | Clean **SANDS** With Little Or No Fines | SW | Well graded **SANDS**, gravelly **SANDS** |
| | | | SP | Poorly graded **SANDS**, gravelly **SANDS** |
| | | **SANDS** With Over 12% Fines | SM | Silty **SANDS**, poorly graded **SAND-SILT** mixtures |
| | | | SC | Clayey **SANDS**, poorly graded **SAND-CLAY** mixtures |
| FINE GRAINED SOILS Over 50% < #200 sieve | **SILTS & CLAYS** Liquid Limit < 50 | | ML | Inorganic **SILTS**, silty or clayey fine **SANDS**, or clayey **SILTS** with plasticity |
| | | | CL | Inorganic **CLAYS** of low to medium plasticity, gravelly, sandy, or silty **CLAYS**, lean **CLAYS** |
| | | | OL | Organic **CLAYS** and organic silty **CLAYS** of low plasticity |
| | **SILTS & CLAYS** Liquid Limit > 50 | | MH | Inorganic **SILTS**, micaceous or diamacious fine sandy or silty soils, elastic **SILTS** |
| | | | CH | Inorganic **CLAYS** of high plasticity, fat **CLAYS** |
| | | | OH | Organic **CLAYS** of medium to high plasticity, organic **SILTS** |
| **HIGHLY ORGANIC CLAYS** | | | PT | PEAT & other highly organic soils |

## PLASTICITY CHART

USED FOR CLASSIFICATION OF FINE GRAINED SOILS




## SAMPLE DRIVING RECORD

| BLOWS PER FOOT | DESCRIPTION |
|---|---|
| 25 | 25 Blows drove sampler 12 inches, after initial 6 inches of seating |
| 50/7" | 50 Blows drove sampler 7 inches, after initial 6 inches of seating |
| 50/3" | 50 Blows drove sampler 3 inches during or after initial 6 inches of seating |

*Note: To avoid damage to sampling tools, driving is limited to 50 blows per 6 inches during or after seating interval.*

## SOIL GRAIN SIZE

| **U.S. STANDARD SIEVE** | 6" | | 3" | | ¾" | | 4 | | 10 | | 40 | | 200 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SOIL** | BOULDER | | COBBLE | | GRAVEL: COARSE | | GRAVEL: FINE | | SAND: COARSE | | SAND: MEDIUM | | SAND: FINE | SILT | CLAY |
| **GRAIN SIZE IN MILLIMETERS** | 150 | | 75 | | 19 | | 4.75 | | 2.0 | | .425 | | 0.075 | 0.002 | |

## KEY TO PIT & BORING SYMBOLS

Standard Penetration test

2.5" O.D. Modified California Sampler

3" O.D. Modified California Sampler

Shelby Tube Sampler

2.5" Hand Driven Liner

Bulk Sample

Water Level At Time Of Drilling

Water Level After Time Of Drilling

P Perched Water

## KEY TO PIT & BORING SYMBOLS

Joint

Foliation

Water Seepage

| | |
|---|---|
| NFWE | No Free Water Encountered |
| FWE | Free Water Encountered |
| REF | Sampling Refusal |
| DD | Dry Density (pcf) |
| MC | Moisture Content (%) |
| LL | Liquid Limit |
| PI | Plasticity Index |
| PP | Pocket Penetrometer |
| UCC | Unconfined Compression (ASTM D2166) |
| TVS | Pocket Torvane Shear |
| EI | Expansion Index (ASTM D4829) |
| Su | Undrained Shear Strength |

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**June 2022**

**SOIL CLASSIFICATION CHART AND LOG EXPLANATION**
**Sutter Street (512)**
Folsom, California

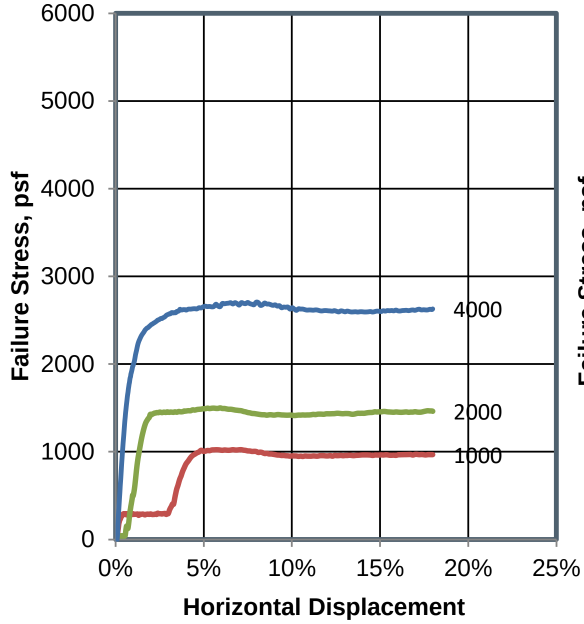
**FIGURE A-6**

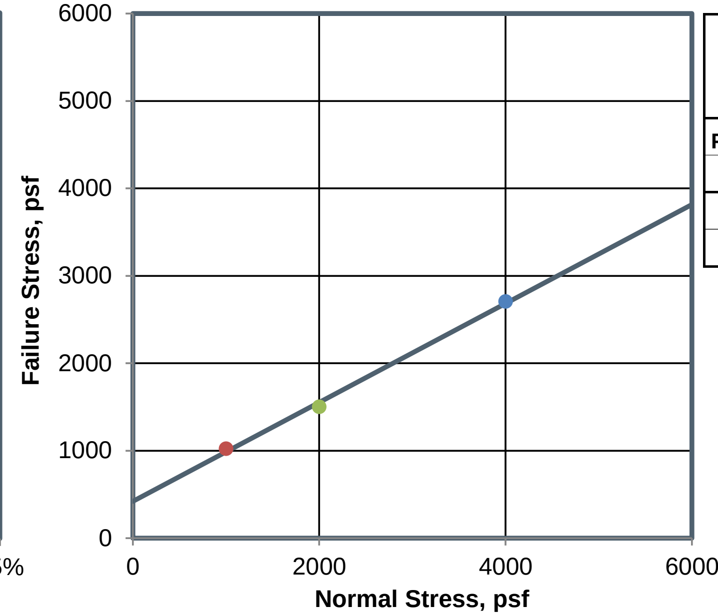
# APPENDIX B

Laboratory Testing

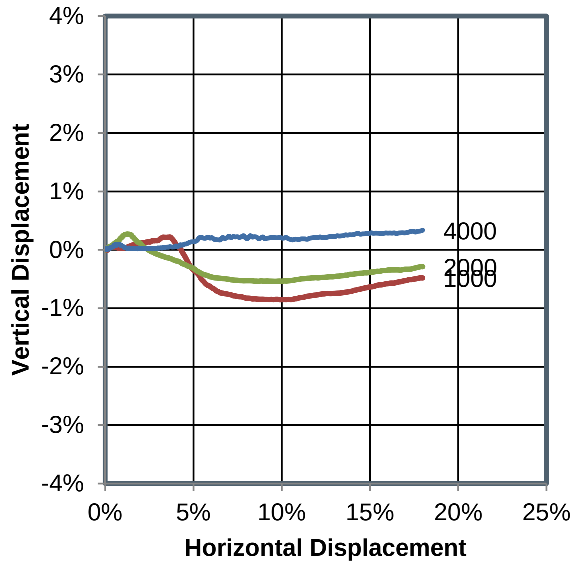
Direct Shear Test
Modified Proctor Test
Resistance Value Test

## *Direct Shear Test of Soils Under Consolidated Drained Conditions, ASTM D3080*




| Direct Shearbox Results |
|---|
| Friction Angle |
| 29.5° |
| Cohesion |
| 421 psf |




| Test No. | | 1 | 2 | 3 |
|---|---|---|---|---|
| Initial | Wet Density, pcf | 117.1 | 117.1 | 117.1 |
| | Dry Density, pcf | 102.5 | 102.5 | 102.5 |
| | Moisture Content, % | 14.2 | 14.2 | 14.2 |
| | Diameter, in | 2.50 | 2.50 | 2.50 |
| | Height, in | 1.00 | 1.00 | 1.00 |
| Pre Shear | Wet Density, pcf | 135.2 | 131.4 | 136.6 |
| | Dry Density, pcf | 106.4 | 105.5 | 107.1 |
| | Moisture Content, %* | 27.1 | 24.6 | 27.5 |
| | Diameter, in | 2.50 | 2.50 | 2.50 |
| | Height, in | 0.96 | 0.97 | 0.96 |
| Normal Stress, psf | | 1000 | 2000 | 4000 |
| Failure Stress, psf | | 1024 | 1500 | 2706 |
| Failure Strain, % | | 6.65 | 5.93 | 7.97 |
| Rate, in/min | | 0.002 | | |

*Based on post shear moisture content

| | | | | | |
|---|---|---|---|---|---|
| Sample Type: | Remolded to 90% RC | | | | |
| Material Description: | **Brown Sandy SILT with Gravel** | | | | |
| Source: | | | | | |
| Notes: | Gravel removed from test sample. | | | | |
| Sample No./Depth: TP-3 @ 1' | | USCS Class. | Liquid Limit | Plasticity Index | % Greater than No. 4 | % Less than No. 200 |
| Date Sampled: 5/23/2022 | Date Test Started: 6/3/2022 | | | | 16 | |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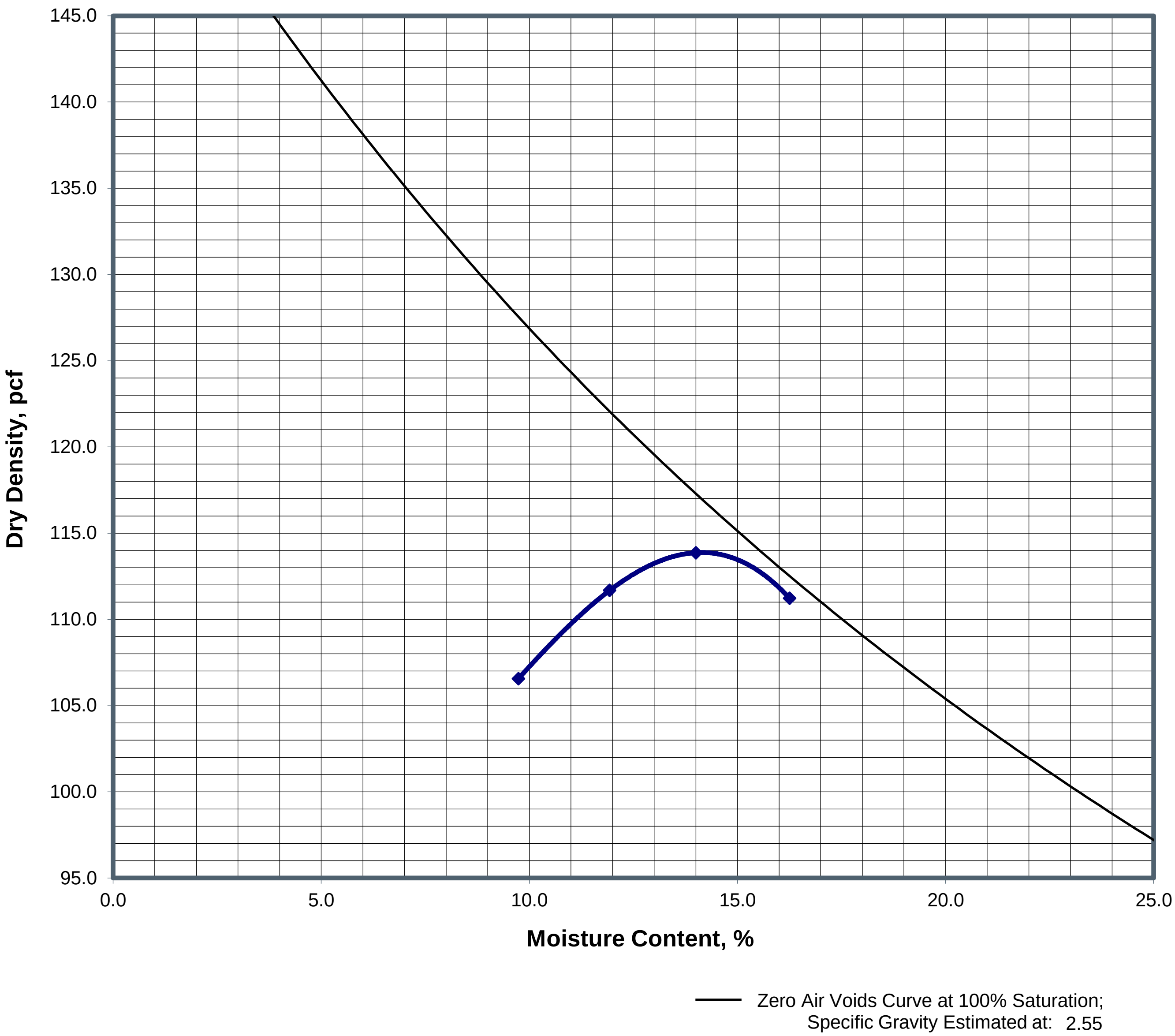
| | | | |
|---|---|---|---|
| Project: | **Sutter Street (512) GES** | | |
| Project No.: | **E22213.000** | | Figure |
| Reviewed By: DN | Date: 6/7/2022 | | **B-1** |

## *Laboratory Compaction Characteristics of Soil*
## *Using Modified Effort (56,000 lf-lbf/ft3), ASTM D1557, Method A*




| | | | |
|---|---|---|---|
| Maximum Dry Density, pcf: | **113.9** | Optimum Moisture Content, %: | **14.2** |

Material Description: **Brown Sandy SILT with Gravel**

Source:

Notes:

| Sample No./Depth: | TP-3 @ 1' | | | USCS Class. | Liquid Limit | Plasticity Index | % Greater than No. 4 : | % Less than No. 200 |
|---|---|---|---|---|---|---|---|---|
| Date Sampled: | 5/23/2022 | Date Test Started: | 5/25/2022 | | | | 16 | |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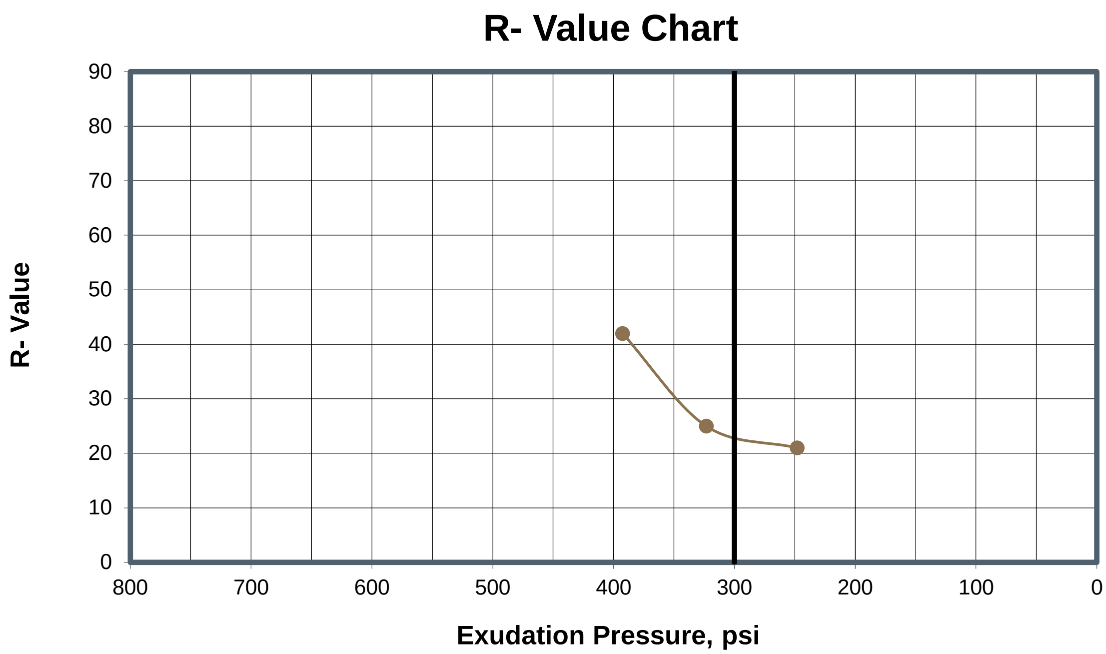
|---|---|---|---|
| Project: | **Sutter Street (512) GES** | | |
| Project No.: | **E22213.000** | | Figure |
| Reviewed By: JGR | Date: 5/27/2022 | | **B-2** |

## *Resistance "R" Value of Soil and Soil-Aggregate Mixtures, CTM 301*




| Test Specimen No.: | 1 | 2 | 3 |
|---|---|---|---|
| Moisture Content at Test, % | 15.3 | 16.4 | 17.5 |
| Dry Density at Test, pcf | 116.7 | 113.4 | 110.6 |
| Expansion Pressure, psf | 277 | 173 | 108 |
| Exudation Pressure, psi | 393 | 323 | 248 |
| Resistance "R" Value | 42 | 25 | 21 |
| "R" Value at 300 psi Exudation Pressure | | | **23** |

Material Description: **Brown Sandy SILT with Gravel**

Source:

Notes:

| Sample No./Depth: TP-3 @ 1' | | USCS Class. | Liquid Limit | Plasticity Index | % Greater than No. 4 | % Less than No. 200 |
|---|---|---|---|---|---|---|
| Date Sampled: 5/23/2022 | Date Test Started: 5/31/2022 | | | | 16 | |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|---|---|---|---|
| Project No.: | **E22213.000** | | Figure |
| Reviewed By: JLC | Date: 6/1/2022 | | **B-3** |

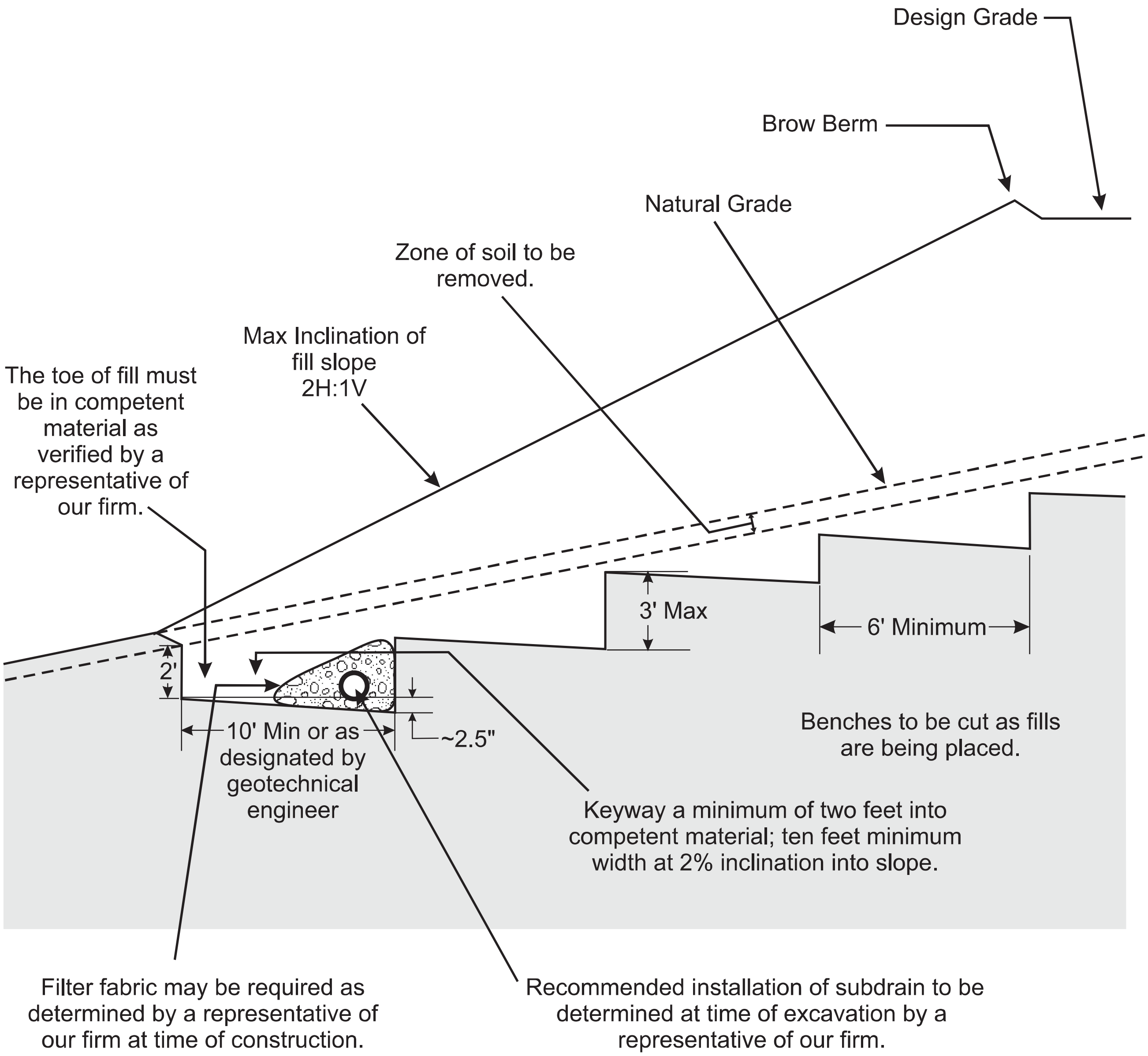
# APPENDIX C

Details

Keyway and Bench with Drain
Site Wall Drainage
Subdrain

# PLACEMENT OF FILL ON NATURAL SLOPE
**(Typical)**

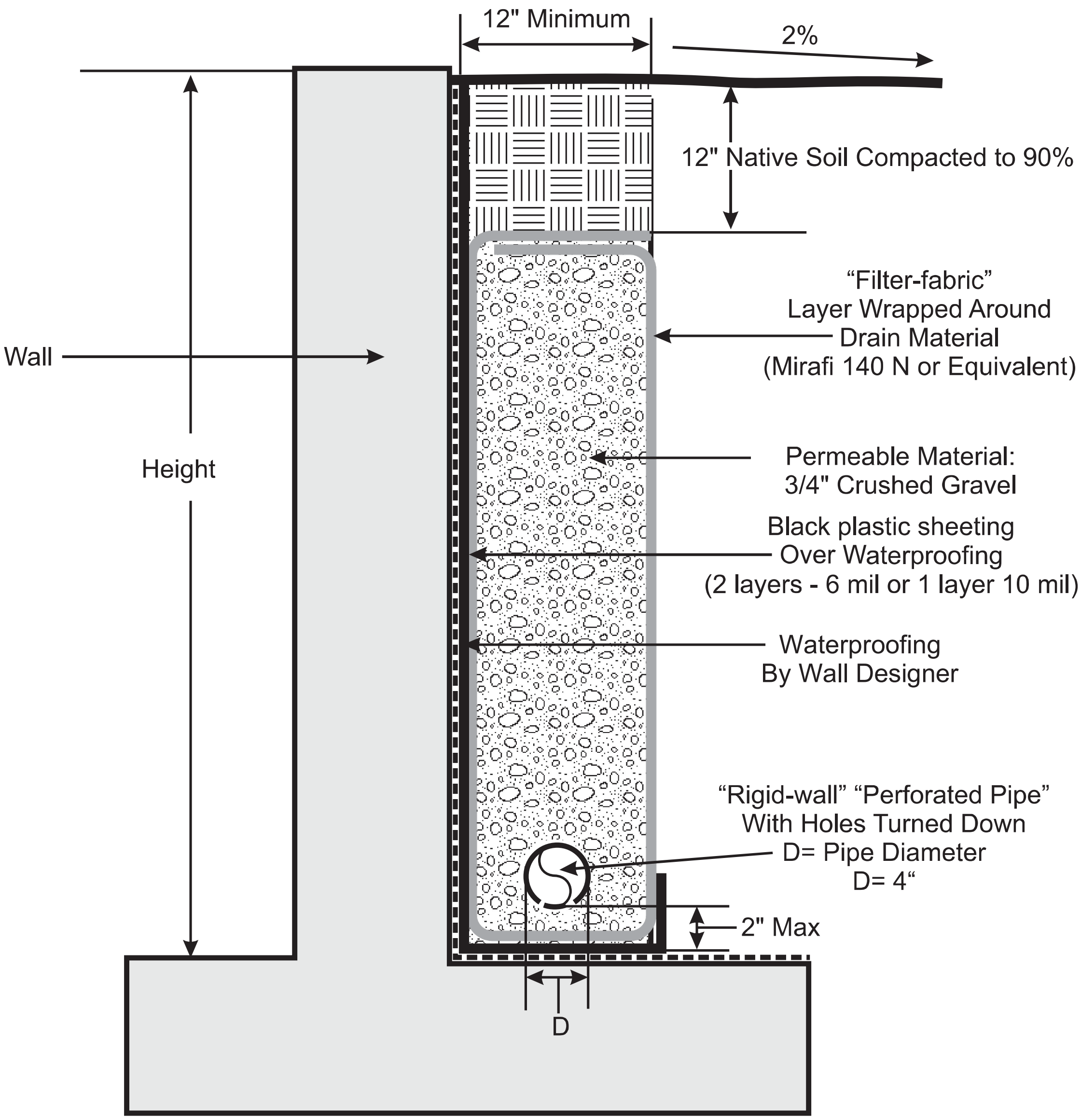
**All keyways should be observed and approved prior to placement of fill.**
*A keyway is required by CBC for fills on natural slopes of 5H:1V or steeper.*




| YOUNGDAHL CONSULTING GROUP, INC. GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS TESTING | Project No.: E22213.000 / June 2022 | **KEYWAY & BENCH WITH DRAIN** **Sutter Street (512)** Folsom, California | FIGURE **C-1** |
|---|---|---|---|

# Retaining Wall With
# "Perforated Pipe Sub-Drain"

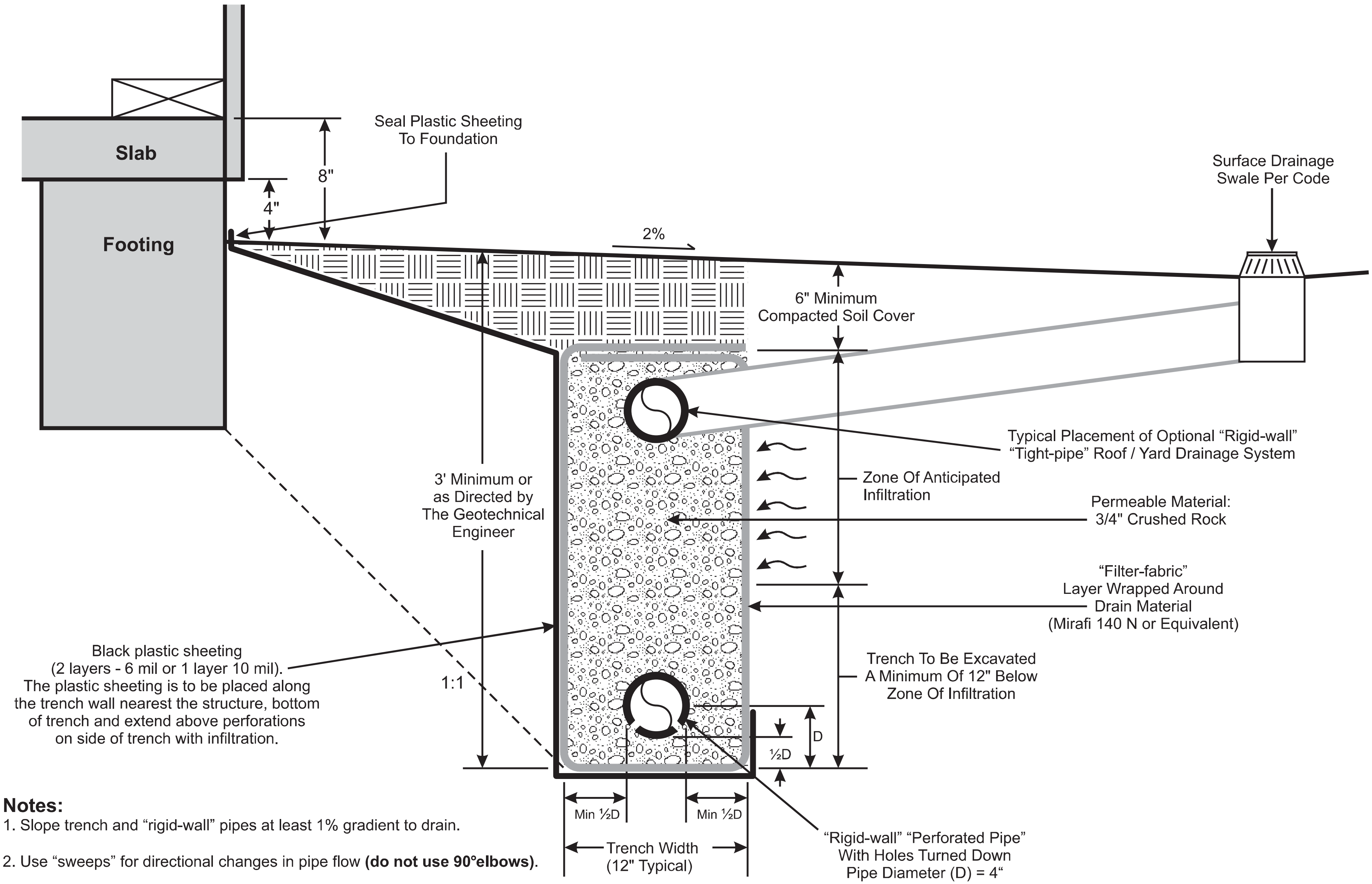
***(Typical Cross Section)***




Notes:
1. Slope footing and "rigid-wall" pipes along flow line parallel to wall at least 1% gradient to drain to an appropriate outfall area away from residence.
2. Use "sweeps" for directional changes in pipe flow **(do not use 90°elbows)**.
3. Provide periodic "clean-outs".
4. Washed clean permeable material.

***Not To Scale***

| | | | |
|---|---|---|---|
| YOUNGDAHL CONSULTING GROUP, INC.<br>GEOTECHNICAL • ENVIRONMENTAL • MATERIALS TESTING | Project No.:<br>E22213.000<br>**June 2022** | **RETAINING WALL DRAIN DETAIL**<br>**Sutter Street (512)**<br>Folsom, California | **FIGURE**<br>**C-2** |




**Notes:**

1. Slope trench and "rigid-wall" pipes at least 1% gradient to drain.
2. Use "sweeps" for directional changes in pipe flow **(do not use 90°elbows)**.
3. Provide sweeps to periodic "clean-outs".
4. Washed clean permeable material.

| | | | |
|---|---|---|---|
| YOUNGDAHL CONSULTING GROUP, INC.<br>GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS TESTING | Project No.:<br>E22213.000<br>**June 2022** | **SUB-DRAIN DETAIL**<br>**Sutter Street (512)**<br>Folsom, California | **FIGURE**<br>**C-3** |