GEOTECHNICAL ENGINEERING STUDY
FOR
NATOMA SENIOR APARTMENTS
E Natoma Street
Folsom, California

Project No. E21442.000
December 2021

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ESTABLISHED 1984

YOUNGDAHL
CONSULTING GROUP, INC.
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1234 Glenhaven Court, El Dorado Hills, CA 95762
4300 Anthony Court, Unit D, Rocklin, CA 95677
ph 916.933.0633 fx 916.933.6482
www.youngdahl.net

Vintage Housing Development, Inc.
369 San Miguel Drive, Suite 135
Newport Beach, California 92660

Project No. E21442.000
3 December 2021

Attention: Mr. Carl Dominguez

Subject: **NATOMA SENIOR APARTMENTS**
E Natoma Street, Folsom, California
GEOTECHNICAL ENGINEERING STUDY

References:
1. Architectural Site Plan for Natoma Senior Apartments, prepared by StK :a, undated.
2. ALTA/NSPS Land Title Survey, prepared by TSD Engineering, Inc., dated 14 December 2020 (Job No. 401-002).
3. Proposal and Executed Contract for Natoma Senior Apartments, prepared by Youngdahl Consulting Group, Inc., dated 20 October 2021.

Dear Mr. Dominguez:

In accordance with your authorization, Youngdahl Consulting Group, Inc. has prepared this geotechnical engineering study for the project site located along E Natoma 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 3 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, improvement 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.

12/3/21

Kyle J. Martinez, P.E.
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
KYLE J. MARTINEZ
No. 80666
CIVIL
STATE OF CALIFORNIA

Distribution: PDF to Client

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GEOTECHNICAL ENGINEERING STUDY
FOR
NATOMA SENIOR APARTMENTS

1.0 INTRODUCTION

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

Project Understanding

We understand that the proposed project will consist of the construction of an apartment complex within the undeveloped 4.7-acre parcel southwest of the intersection of E Natoma Street and Cimmaron Circle in Folsom, California. The planned development will include the construction of a three-story, 108,000 square-foot, irregular shaped apartment building. For the purposes of this proposal, we assume that the building will be of wood-frame construction, and supported by conventional shallow foundations and slab-on-grade floors. The site is moderately sloping within the planned building footprint, with elevation differences of roughly 20 feet. It is anticipated that development will likely include fills of native and imported materials on the order of 20 feet or less and relatively shallow cuts to generate the proposed building pad and promote positive site drainage. Additional improvements will include asphalt and concrete drive and parking areas, pedestrian flatwork, underground utilities, sitework retaining walls, and drive access from E Natoma Street. No grading plans were provided at the time of this report.

Background

Based upon our limited aerial review, the site has remained undeveloped since 1952. 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 on the southeast side of E Natoma Street in Folsom, California and is bounded by E Natoma Street to the northwest and existing residential subdivisions to the northeast and south. A paved pedestrian path is present between the site and the subdivision to the west and south, along with transformer towers and overhead power lines. Seasonal drainage paths are present extending from the east to the southwest along the northern property boundary. Topography at the site generally consists of the highest elevation at the southeast corner, and slopes down in various directions. The existing slopes within the site are generally 2H:1V (Horizontal:Vertical) or flatter. Vegetation throughout the project generally consisted of seasonal grasses and trees.

Subsurface Conditions

Our field study included a site reconnaissance by a representative of our firm followed by a subsurface exploration program conducted on 5 November 2021. The exploration program included the excavation of eight 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.

Subsurface soil conditions at the project site primarily consisted of sands, silts, and clays overlying weathered bedrock. The site was generally observed to be surfaced with sand and silt layers in a medium dense/stiff condition, that were present to depths of 1 to 2.5 feet below existing grade. The surface soils in Test Pit TP-8 were observed to consist of clays in a stiff condition. Underlying the surface materials in Tet Pits TP-1 through TP-7, clay layers in a medium to very stiff condition were encountered. The clays were primarily present in layer thicknesses between approximately 0.5 feet to 1 foot. However, in Test Pits TP-1 and TP-8, 3-feet thick clay layers were encountered. Additionally, no clays were observed in Test Pit TP-6. Bedrock at the site was generally first encountered at approximately 1.5 to 4 feet below the ground surface and was observed to be in completely to slightly weathered and soft to very hard conditions.

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-10, 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-2 @ 0-1.5’	Φ = 33.8°, c = 0 psf (90%RC)
Maximum Dry Density	ASTM D1557	TP-2 @ 0-1.5’	γ_{max} = 132.6 pcf, ω_{opt} = 9.7%
Resistance Value	ASTM CTM 301	TP-2 @ 0-1.5’	12
Expansion Index	ASTM D4829	TP-1 @ 3’	EI = 40 (Low)
Corrosivity Suite	CA DOT Tests 417, 422 and 643	See Soil Corrosivity Section	
Asbestos Content	EPA 600/R-93/116, CARB 435	See Naturally Occurring Asbestos Section (Section 4.0)	

Soil Expansion Potential

Plastic materials (clay soils) were encountered in relatively thin layers. An expansion index test was performed on a sample of the clay, which resulted in a value of 40 (low expansion). 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. Due to the configuration of the proposed construction, the anticipated grading, and the grading recommendations provided in this report, we do not anticipate that special design considerations for expansive soils 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. 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.

Soil Corrosivity

A corrosivity testing suite consisting of soil pH, resistivity, sulfate, and chloride content tests were performed on selected soil samples collected during our site exploration. We are not corrosion specialists and recommend that the results be evaluated by a qualified corrosion expert. The laboratory test results (provided by Sunland Analytical) are provided in Appendix B and are summarized in Table 2, below.

Table 2: Corrosivity Summary

Location	Depth (ft)	Soil pH	Minimum Resistivity ohm-cm (x1000)	Chloride (ppm)	Sulfate (ppm)	Caltrans Environment	ACI Environment
TP-2	0 – 1.5	5.66	2.41	5.2	14.8	Non-Corrosive	S0 (Not a Concern)
TP-7	3 – 5	5.51	2.95	3.2	7.2	Non-Corrosive	S0 (Not a Concern)

According to Caltrans Corrosion Guidelines Version 3.0, March 2018, the test results appear to indicate a non-corrosive environment. According to the 2019 California Building Code Section 1904.1 and ACI 318-14 Table 19.3.1.1, the test results indicate the onsite soils have a negligible potential for sulfide attack of concrete. Accordingly, Type I/II Portland cement is appropriate for use in concrete construction. A certified corrosion engineer should be consulted to review the above tests and site conditions in order to develop specific mitigation recommendations if metallic pipes or structural elements are designed to be in contact with or buried in soil.

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

According to the Geologic Map of the Sacramento Quadrangle, California (D.L. Wagner, et al., 1981), this portion of the foothills and project site is underlain by Copper Hill Volcanic rocks.

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 identified as being in an area moderately likely to contain NOA.

The Sacramento Metropolitan Air Quality Management District (SMAQMD) is the lead agency for regulating NOA in Sacramento County, and has implemented the construction Air Toxic Control Measure (ATCM) (CCR Section 93015) for projects in Folsom. Following release of the generalized geologic map of eastern Sacramento County by the California Geologic Survey in 2006, the SMAQMD established a policy of applying the construction ATCM (CCR Section 93105) to all areas identified on the map as being underlain by rocks moderately likely to contain NOA.

Trace levels of asbestos (less than 0.25% as measured by California Air Resources Board Test Method 435) are not uncommon in the Folsom area north of US Highway 50. Two representative samples were obtained during our exploration and sent to EMSL Analytical, Inc. for testing; NOA was not detected within these samples. However, for planning purposes, implementation of SMAQMD regulations should be anticipated during project development.

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 38.683340, -121.158594 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	0.176g
	Table 11.8-1	Site Coefficient F_{PGA}	1.224
	Equation 11.8-1	$PGA_M = F_{PGA}$ PGA	0.215g
2019 CBC	Figure 1613.2.1(1)	Short-Period MCE at 0.2s, S_S	0.413g
	Figure 1613.2.1(2)	1.0s Period MCE, S_1	0.212g
	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, $S_{MS} = F_a S_s$	0.537g
	Equation 16-37	Adjusted MCE Spectral Response Parameters, $S_{M1} = F_v S_1$	0.318g
	Equation 16-38	Design Spectral Acceleration Parameters, $S_{DS} = \frac{2}{3} S_{MS}$	0.358g
	Equation 16-39	Design Spectral Acceleration Parameters, $S_{D1} = \frac{2}{3} S_{M1}$	0.212g
	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.

Geotechnical Considerations for Development

The proposed structure is relatively long, irregular in shape, and anticipated to be supported by variable thicknesses of soil and/or bedrock. Due to these features, the primary geotechnical concern associated with the planned development is the potential for excessive differential settlement, which can stress and damage foundations and other structural and architectural elements. Generally, foundations constructed within the planned cut areas of the building pad would bear within relatively thin sections of native soils and/or bedrock, which have a relatively low potential for settlement. However, foundations constructed within the planned fill areas could bear within significantly thicker sections of fill (up to 20 feet thick), which have a much higher potential for settlement. To reduce the potential for excessive differential settlement, it is recommended that all foundations be constructed within sufficient thicknesses of properly compacted engineered fill. This can be achieved by overexcavating cut and shallow fill areas a minimum of 5 feet below finished pad grade and replacing the material with engineered fill compacted to a minimum relative compaction of 95 percent. Additionally, any clays removed during overexcavation operations should be blended with non-expansive materials prior to placement as engineered fill. This is further discussed within Section 6.0 of this report.

Additional 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. Grading operations on the site are expected to involve excavation of keyways and benches, as well as cuts and fills that will require specific recommendations for their construction. These recommendations are provided in Section 6.0 of this report.

6.0 SITE GRADING AND EARTHWORK IMPROVEMENTS

Excavation Characteristics

The recent exploratory test pits were excavated using a John Deere 410F backhoe equipped with a 24-inch-wide bucket. The degree of difficulty encountered in excavating our test pits is an indication of the effort that will be required for excavation during construction. The John Deere 410F backhoe was able to excavate between approximately 2 and 7.5 feet into bedrock materials before meeting practical refusal.

The bedrock materials can likely be excavated to depths of several feet using dozers equipped with rippers. We expect that the upper, weathered portion of the rock, will require use of a Caterpillar D9 equipped with a single or multiple shank rippers, or similar equipment. We anticipate that a ripper equipped D9 can penetrate at least as deep as our test pits at most locations with moderate effort. Blasting cannot be ruled out in areas of resistant rock.

Where hard rock cuts in fractured rock are proposed, the orientation and direction of ripping will likely play a large role in the rippability of the material. When hard rock is encountered, we should be contacted to provide additional recommendations prior to performing an alternative such as blasting.

Utility trenches will likely encounter hard rock excavation conditions, especially in cut areas. Utility contractors should be prepared to use special rock trenching equipment such as large excavators (Komatsu PC400 or CAT 345 or equivalent). Blasting to achieve utility line grades, especially in planned cut areas, cannot be precluded. Water inflow into any excavation approaching the hard rock surface is likely to be experienced in all but the driest summer and fall months. Pre-ripping during mass grading may be beneficial and should be discussed with the Geotechnical Engineer prior to, or during site grading.

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 site drainage controls, dust control, clearing and stripping, overexcavation and compaction of cut and shallow fill areas, clay mitigation, and exposed grade compaction considerations. The following paragraphs state our geotechnical comments and recommendations concerning site preparation.

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. The implementation of stormwater controls is the purview of the grading contractor.

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) and ATCM requirements. 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.**

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 Compaction of Cut and Shallow Fill Areas
Based upon the site topography and the Reference 1 plan, we anticipate that up to 20 feet of fill will be required to develop the western portion of the building pad, with relatively thin fills and/or shallow cuts within the remaining portions of the pad. To reduce the potential for excessive differential settlement, as discussed in Section 5.0 of this report, it is recommended that the building foundations be constructed entirely within properly compacted engineered fill. Therefore, we recommend that the uppermost 5 feet below finish pad grade within, and extending a minimum of 5 feet beyond the foundation footprint, should consist entirely of engineered fill. As a result, portions of the building pad scheduled to receive cuts or shallow fills should be overexcavated as necessary below existing grade to a minimum of 5 feet below finish pad grade.

Clay Mitigation
Potentially expansive clays should be mixed thoroughly with less expansive on-site materials (silts, sands, and gravels) to create a low to non-expansive blended soil prior to use as engineered fill. Clay soils should not be present in concentration within the uppermost 5 feet of the building envelope, either vertically or laterally. We anticipate that the above overexcavation recommendation will sufficiently remove clays from near proximity to the foundations. Proper disposition of clays on site should be observed and documented by a representative of Youngdahl Consulting Group, Inc.

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.

Table 4: Recommended Relative Compaction

Fill Materials	Relative Compaction	Method
Engineered Fill, Building Areas	95 percent	ASTM D1557
Engineered Fill, General	90 percent	ASTM D1557
Utility Trench Backfill*	90 percent	ASTM D1557
Subgrade	95 percent	ASTM D1557
Aggregate Baserock Grade	95 percent	ASTM D1557
Asphalt Concrete Pavement	92 to 96 percent	ASTM D2041 or CTM 309

* Unless otherwise noted by the governing agency.

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 evaluated 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	≥ 33° when compacted
Resistance “R” Value	CTM 301	≥ 12
Plasticity Index	ASTM D4318	< 12
Expansion Index	ASTM D4829	≤ 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.

Underground Improvements

Trench Excavation

Trenches or excavations in soil should be shored or sloped back in accordance with current OSHA regulations prior to persons entering them. Where clay rind in combination with moist conditions is encountered in fractured bedrock, the project engineering geologist should be consulted for appropriate mitigation measures. The potential use of a shield to protect workers cannot be precluded. Refer to the Excavation Characteristics section of this report for anticipated excavation conditions.

Backfill Materials
Backfill materials for utilities should conform to the requirements of the local jurisdiction. It should be realized that permeable backfill materials will likely carry water at some time in the future.

When backfilling within structural footprints, compacted low permeability materials are recommended to be used a minimum of 5 feet beyond the structural footprint to minimize moisture intrusion. If the materials are too rocky, they may need to be screened prior to backfill in order to limit pipe damage. If a permeable material is used as backfill within this zone, subdrainage mitigation may be required. In addition, grout cutoffs and/or plug and drains around all utility penetrations are useful to keep moisture out from underneath the structure.

Backfill Compaction
Backfill compaction should conform to the requirements of the local jurisdiction or to the recommendations of this report, whichever is greater. Where backfill compaction is not specified by the local jurisdiction, the backfill should be compacted to achieve the minimum relative compactions specified above.

Drainage Considerations
In developments with the potential for a perched groundwater condition (i.e., shallow bedrock), underground utilities can become collection points for subsurface water. Where this condition is encountered, we recommend plug and drains within the utility trenches (Figure C-2, Appendix C) to collect and convey water to the storm drain system or another approved outlet. Temporary dewatering measures may be necessary and could include the installation of submersible pumps and/or point wells.

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.

Foundation Capacities
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	3,000 psf	3.0
	Allowable Friction Factor*	0.40	1.5
	Allowable Passive Resistance	260 psf/ft	1.5
* Friction Factor is calculated as tan(ϕ)			

Foundation Settlement
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.

Foundation Configuration
Conventional shallow foundations should be a minimum of 18 inches wide and founded a minimum of 24 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 24 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.

Foundation Influence Line and Slope Setback
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.

Subgrade Conditions
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.

Shallow Footing / Stemwall Backfill
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.

Slab Subgrade Preparation

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.

Slab Underlayment

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.

Slab Thickness and Reinforcement

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.

Vertical Deflections
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. However, site retaining walls, not connected to or forming part of the structure, may be founded a minimum of 12 inches below lowest adjacent soil grade or to a depth that achieves a minimum horizontal clearance of 6 feet from the outside toe of the footing to the slope face, whichever requires a deeper excavation. This footing configuration may use an allowable bearing capacity of 2,000 psf (factor of safety of 3.0) with the allowable passive resistance and friction factor presented in the Shallow Conventional Foundations section above.*

Retaining Wall Lateral Pressures
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

Wall Type	Wall Slope Configuration	Equivalent Fluid Weight (pcf)	Lateral Pressure Coefficient	Earthquake Loading (plf)	
Free Cantilever	Flat	45	0.33	$4H^2$	Applied 0.6H above the base of the wall
	2H:1V	65	0.47	$15H^2$	
Restrained*	Flat	65	0.47		

* 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.

Generalized Design Values

Some software and design methods do not 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. Generally, this occurs for keyed or interlocking non-mortared walls such as segmental block (Basalite, Keystone, Allan Block, etc.) or rockery walls. 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
33°	0 psf	140 pcf	0.108g

Wall Drainage

The criteria presented above is based on fully drained conditions as detailed in the attached Figure C-3, 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

The following table provides recommended pavement sections based on an R-Value test (CTM 301) performed on a bulk sample representative of the materials expected to be exposed at subgrade. An R-Value of 12 was determined for the soils tested and was used in our design.

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 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.

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	7.0
5.0	3.0	8.5
5.5	3.0 3.5	10.5 9.5
6.0	3.0 3.5	12.5 11.5
6.5	3.5 4.0	13.0 12.0
7.0	4.0 4.5	14.0 13.0
8.0	4.5 5.0	16.5 15.5

* 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)

Due to the redistribution of materials that occurs during mass grading operations, we should review pavement subgrades to determine the appropriateness of the provided sections.

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. 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
Silty SAND	115 pci	6 inches

* Based on an R-Value of 12 as recommended above and correlated to a k-Value recommended by ACI 330R.

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.

We recommend that the rigid pavement be placed on at least 6 inches of aggregate base compacted to at least 95 percent of the maximum dry density per the ASTM D 1557 test method. 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.

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 Autos, pickups, and panel trucks only	5.0	4.5
A	10		5.5	5.0
B	25	Shopping center entrance and service lanes Bus parking areas and interior lanes Single-unit truck parking areas and interior lanes	6.0	5.5
B	300		7.0	6.0
C	100	Roadway Entrances and Exterior Lanes	7.0	6.5
C	300		7.5	6.5
C	700		7.5	7.0

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

Drainage

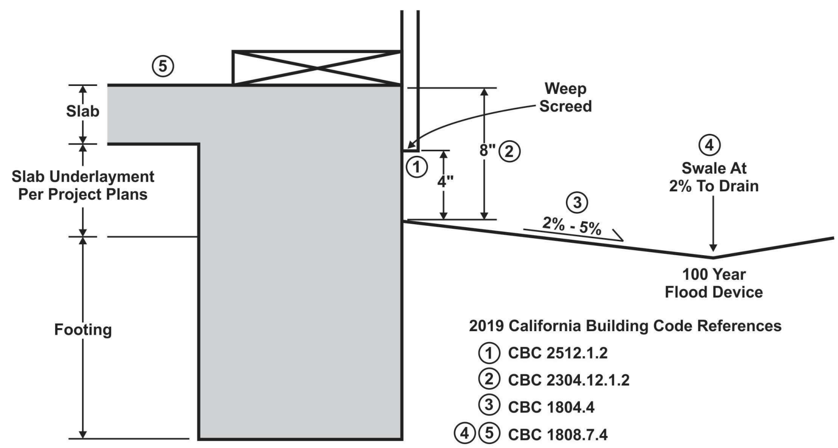
In order to maintain the engineering strength characteristics of the soil presented for use in this Geotechnical Engineering Study, maintenance of the building pad will need to be performed. This maintenance generally includes, but is not limited to, proper drainage and control of surface and subsurface 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 on the site and within the footprint of the proposed structures (potentially minimizing the transmission of moisture through these areas); grout plugs at foundation penetrations; collection and channeling of drained water from impermeable surfaces (i.e., roofs or flatwork areas); installation of subdrain/cut-off drain provisions; utilization of low flow irrigation systems; proper design and maintenance of landscaping and drainage facilities.

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.

It should be noted that due to the Americans with Disabilities Act (ADA) requirements, design and construction of alternative site drainage configurations may be necessary. In this case, design and construction of adequate drainage adjacent to foundations and slabs are essential to preserving foundation support and reducing the potential for wet slab related issues. A typical example of this condition occurs in developments where the landscape grades are situated at the same elevation as the parking areas so as to not create a drop off between the grades. This condition subsequently results in flat grades between the building, landscape area, and parking lot which do not meet building code requirements.

Building Pad Subdrain
It has been our experience that sites constructed within this area generally have an increased potential for moisture related issues related to water perched on the bedrock horizon and/or present in the fractures of the bedrock as well as moisture transmission through utility trenches. To mitigate for the potential of these issues, subdrains can be constructed in addition to the drainage provisions provided in the 2019 CBC. 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-4, Appendix C. The water collected in the subdrain pipe would be directed to an appropriate non-erosive outlet. When subdrains are constructed, 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 and lot by lot 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 may contribute to groundwater levels rising, which 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. In order to mitigate these conditions, additional drainage measures than those detailed in the California Building Code may be necessary, which could include but is not limited to, installation of subdrainage provisions.

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

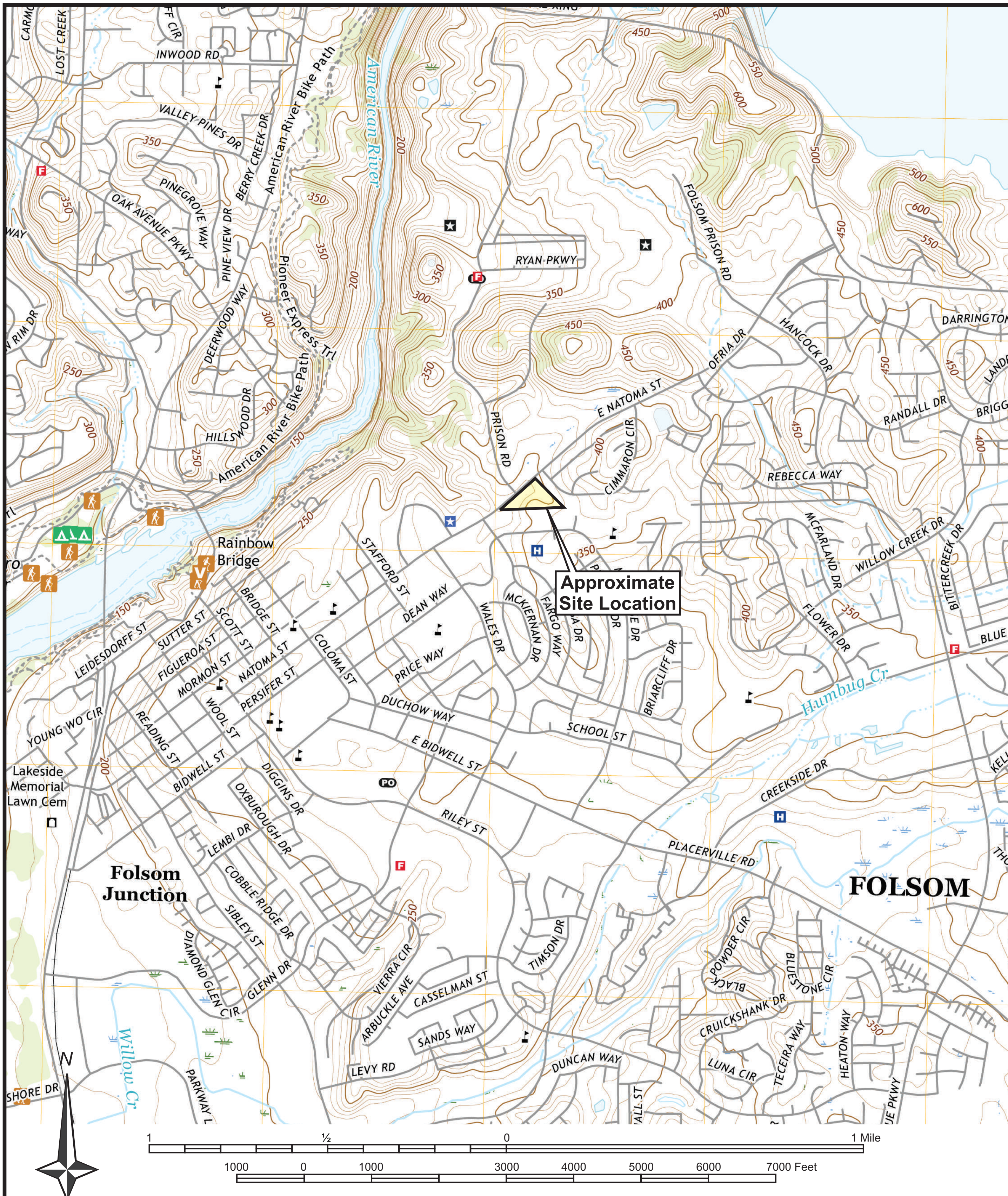
Vicinity Map
Site Plan
Exploratory Test Pit Logs
Soil Classification Chart and Log Explanation

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 5 November 2021, which included the excavation of eight 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 John Deere 410F rubber tire-mounted backhoe equipped with a 24-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-10, 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 2018*

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000 / **December 2021**	**VICINITY MAP** / **Natoma Senior Apartments** Folsom, California	**FIGURE** **A-1**

REFERENCE: *Architectural Site Plan, Natoma Senior Apartments, STK, Sheet A-1.01, Dated September 2021; Overlaid onto Google Earth, Aerial Dated Dated 6/3/2021*

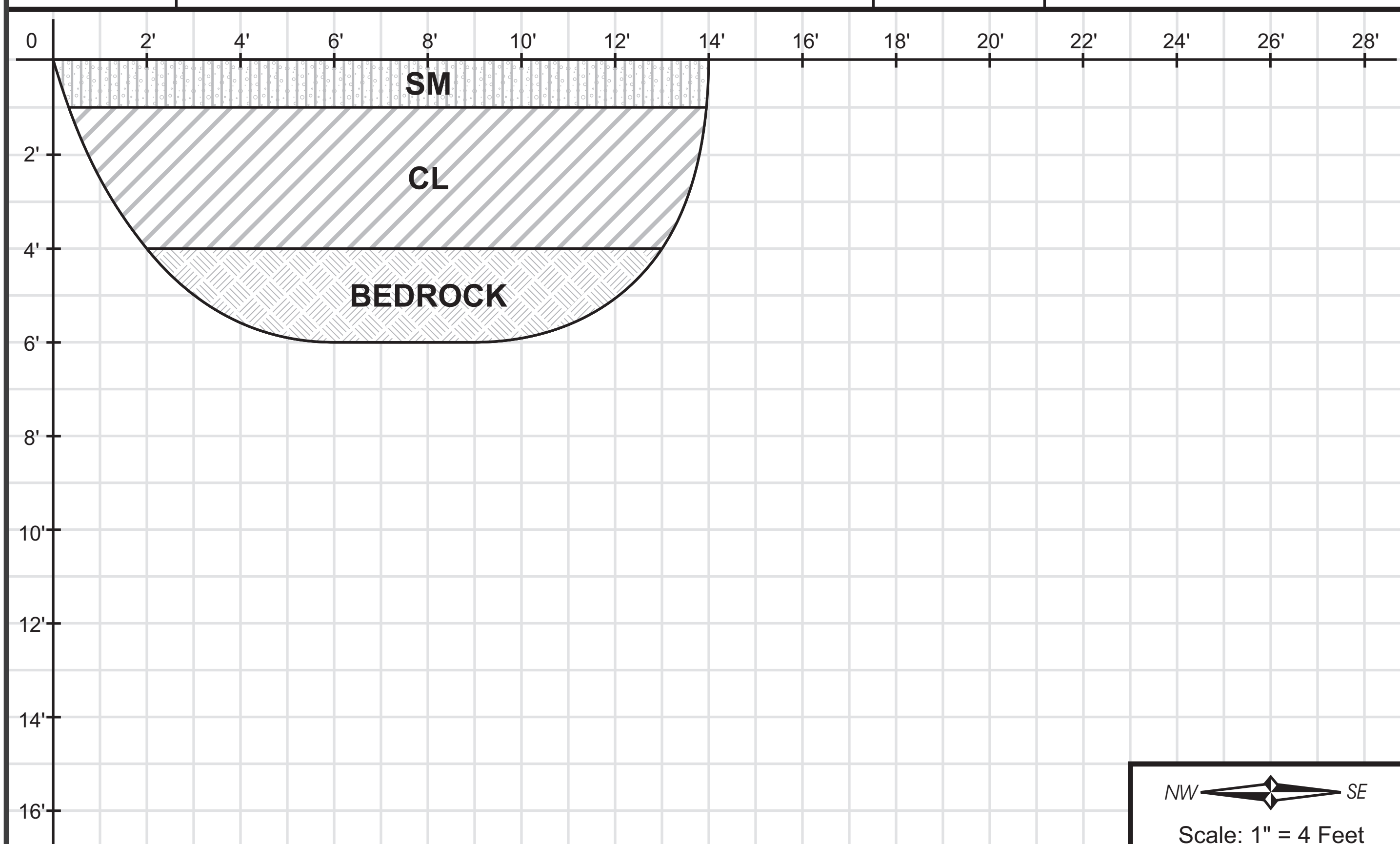
0 50 100 200

Approximate Scale: 1" = 100'

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000	**SITE PLAN**	**FIGURE**
	December 2021	**Natoma Senior Apartments** Folsom, California	**A-2**

Logged By: **FJS**	Date: **5 November 2021**	Lat / Lon: **N 38.683092° / W 121.157646°**		Pit No. **TP-1**
Equipment: **John Deere 410F with 24" Bucket**		Pit Orientation: **170°**	Elevation: **~**	

Depth (Feet)	Geotechnical Description & Unified Soil Classification	Sample	Tests & Comments
@ 0' - 1'	Yellow brown and olive silty **SAND (SM)** with trace clay, angular, medium dense, moist, with rock fragments		
@ 1' - 4'	Brown sandy **CLAY (CL)**, medium stiff, moist	**TP-1** @ 3'	
@ 4' - 6'	Olive yellow and blue grey metavolcanic **BEDROCK**, highly to moderately weathered, moderately soft, slightly moist		
@ 6'	*Grades moderately hard*		
	Test pit terminated at 6' No free groundwater encountered No caving noted		

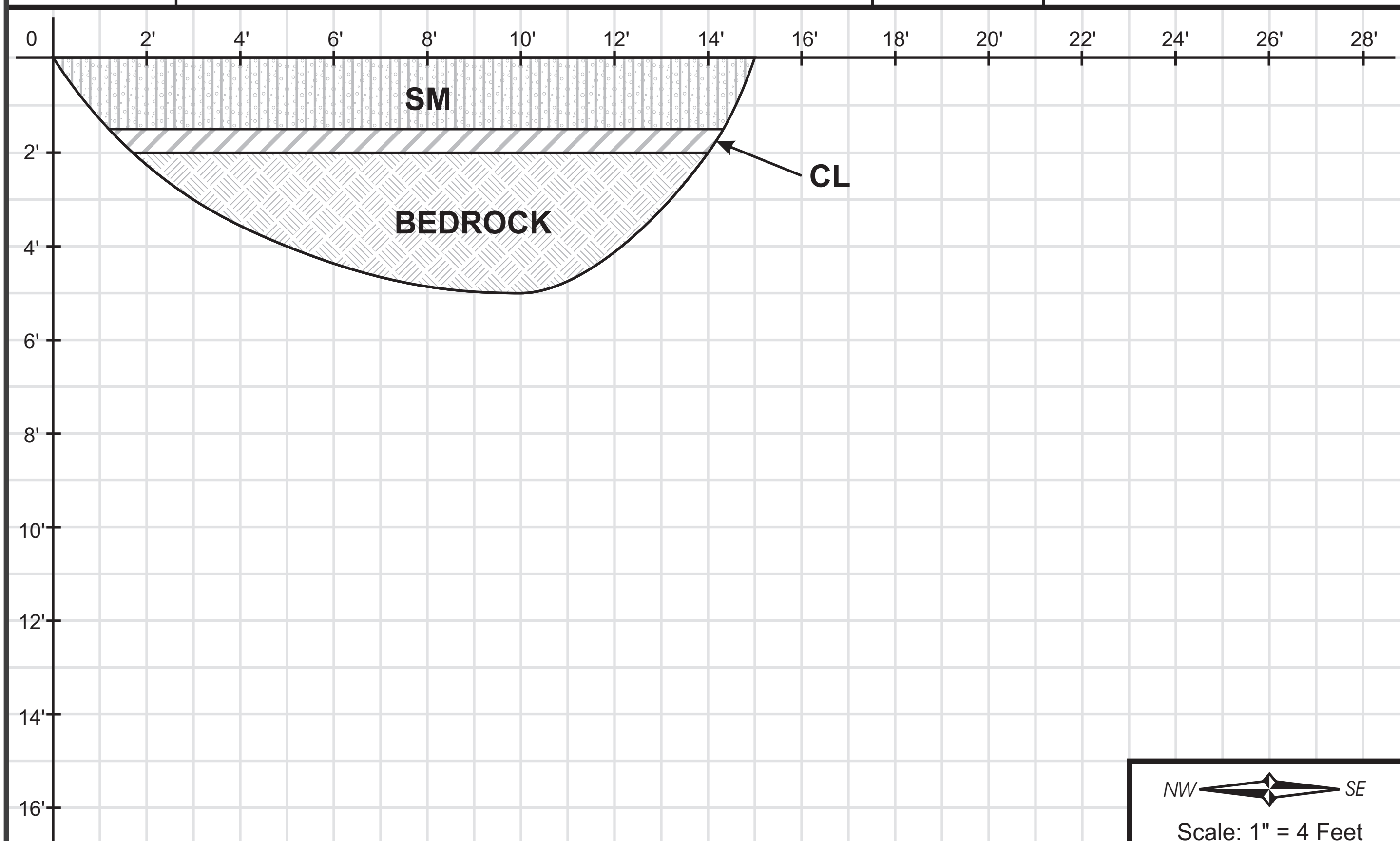


Note: The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at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

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000	**EXPLORATORY TEST PIT LOG**	**FIGURE**
	December 2021	**Natoma Senior Apartments** Folsom, California	**A-3**

Logged By: **FJS**	Date: **5 November 2021**	Lat / Lon: **N 38.683479° / W 121.157955°**		Pit No. **TP-2**
Equipment: **John Deere 410F with 24" Bucket**		Pit Orientation: **215°**	Elevation: **~**	

Depth (Feet)	Geotechnical Description & Unified Soil Classification	Sample	Tests & Comments
@ 0' - 1.5'	Brown silty **SAND (SM)** with clay and trace gravel, medium dense, moist	**TP-2** @ 0-1.5'	
@ 1.5' - 2'	Brown sandy **CLAY (CL)**, high plasticity, stiff, moist		
@ 2' - 3'	Olive yellow and yellow brown metavolcanic **BEDROCK**, completely to highly weathered, moderately soft		
@ 3' - 5'	*Grades hard*		
	Test pit terminated at 5' (practical refusal) No free groundwater encountered No caving noted		

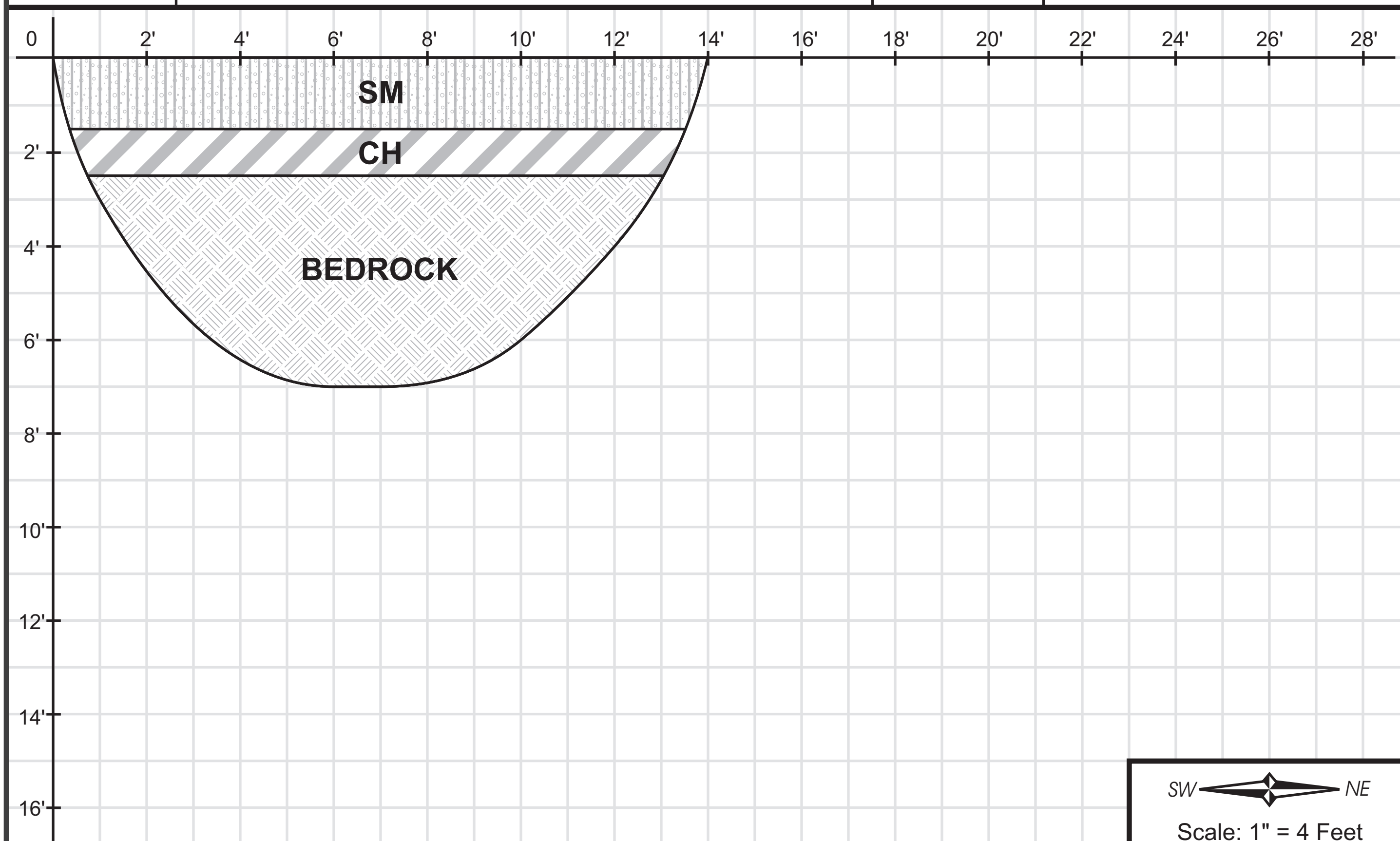


Note: The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at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

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000 **December 2021**	**EXPLORATORY TEST PIT LOG** **Natoma Senior Apartments** Folsom, California	**FIGURE A-4**

Logged By: **STR**	Date: **5 November 2021**	Lat / Lon: **N 38.683822° / W 121.158541°**		Pit No. **TP-3**
Equipment: **John Deere 410F with 24" Bucket**		Pit Orientation: **35°**	Elevation: **~**	

Depth (Feet)	Geotechnical Description & Unified Soil Classification	Sample	Tests & Comments
@ 0' - 1.5'	Brown silty **SAND (SM)** with clay, dense, moist to wet, with rock fragments		
@ 1.5' - 2.5'	Yellow brown **CLAY (CH)**, stiff, moist, with rock fragments		
@ 2.5' - 4'	Olive yellow and olive metavolcanic **BEDROCK**, completely weathered, soft to moderately soft, slightly moist to moist		
@ 4' - 7'	*Grades moderately hard*		
@ 5' - 7'	*Grades highly weathered*		
@ 7'	*Grades moderately weathered, hard*		
	Test pit terminated at 7' (practical refusal) No free groundwater encountered No caving noted		

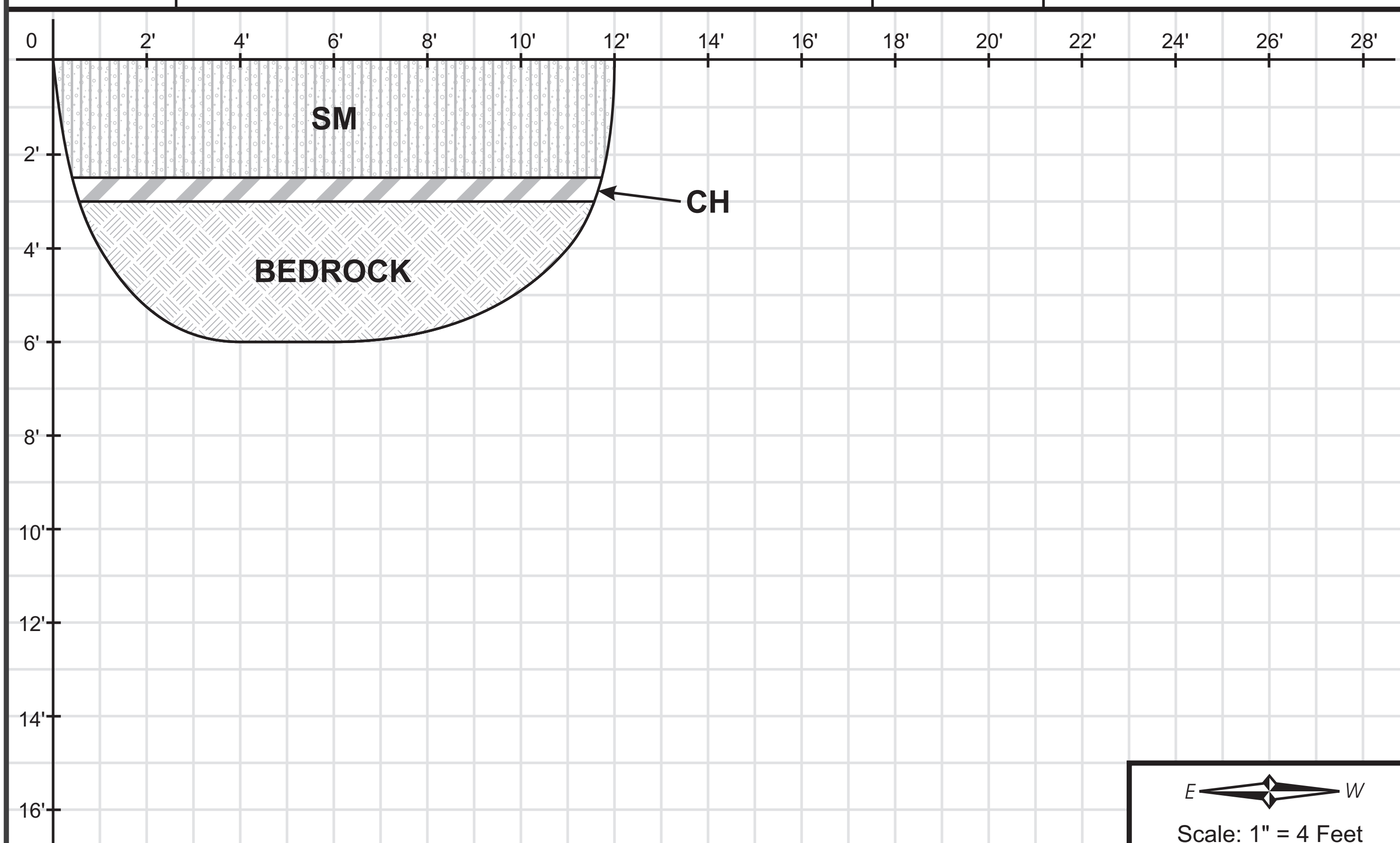


Note: The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at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

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000	**EXPLORATORY TEST PIT LOG**	FIGURE
	December 2021	**Natoma Senior Apartments** Folsom, California	**A-5**

Logged By: **STR**	Date: **5 November 2021**	Lat / Lon: **N 38.683053° / W 121.158279°**	Pit No. **TP-4**
Equipment: **John Deere 410F with 24" Bucket**		Pit Orientation: **255°** / Elevation: **~**	

Depth (Feet)	Geotechnical Description & Unified Soil Classification	Sample	Tests & Comments
@ 0' - 2.5'	Brown silty medium **SAND (SM)** with clay, medium dense to dense, moist		
@ 2.5' - 3'	Yellow brown **CLAY (CH)**, very stiff, moist, with rock fragments		
@ 3' - 4'	Olive yellow and green grey metavolcanic **BEDROCK**, highly to completely weathered, soft to moderately soft		
@ 4' - 5'	*Grades highly weathered, moderately hard*		
@ 5' - 6'	*Grades moderately weathered, hard*		
	Test pit terminated at 6' (practical refusal) No free groundwater encountered No caving noted		

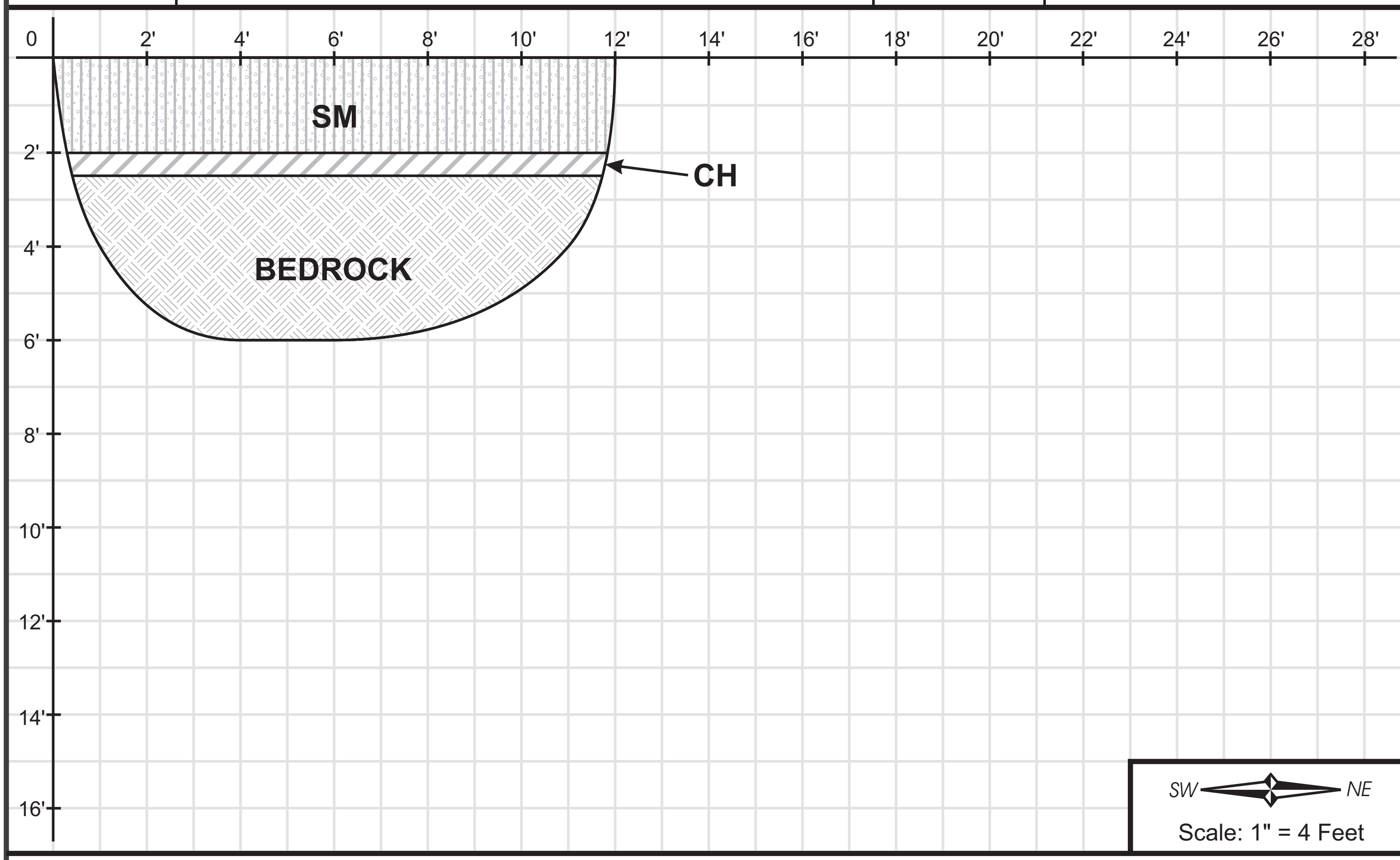


Note: The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at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

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000 **December 2021**	**EXPLORATORY TEST PIT LOG** **Natoma Senior Apartments** Folsom, California	**FIGURE A-6**

Logged By: **STR**	Date: **5 November 2021**	Lat / Lon: **N 38.682982° / W 121.159020°**		Pit No. **TP-5**
Equipment: **John Deere 410F with 24" Bucket**		Pit Orientation: **70°**	Elevation: **~**	

Depth (Feet)	Geotechnical Description & Unified Soil Classification	Sample	Tests & Comments
@ 0′ - 2′	Red brown silty **SAND (SM)**, medium dense, slightly moist		
@ 2′ - 2.5′	Red yellow sandy **CLAY (CH)**, medium stiff, slightly moist to moist		
@ 2.5′ - 4′	Olive yellow metavolcanic **BEDROCK**, highly weathered, moderately soft, slightly moist		
@ 4′ - 6′	*Grades moderately weathered, hard*		
@ 6′	*Grades moderately fractured, hard to very hard*		
	Test pit terminated at 6' (practical refusal) No free groundwater encountered No caving noted		

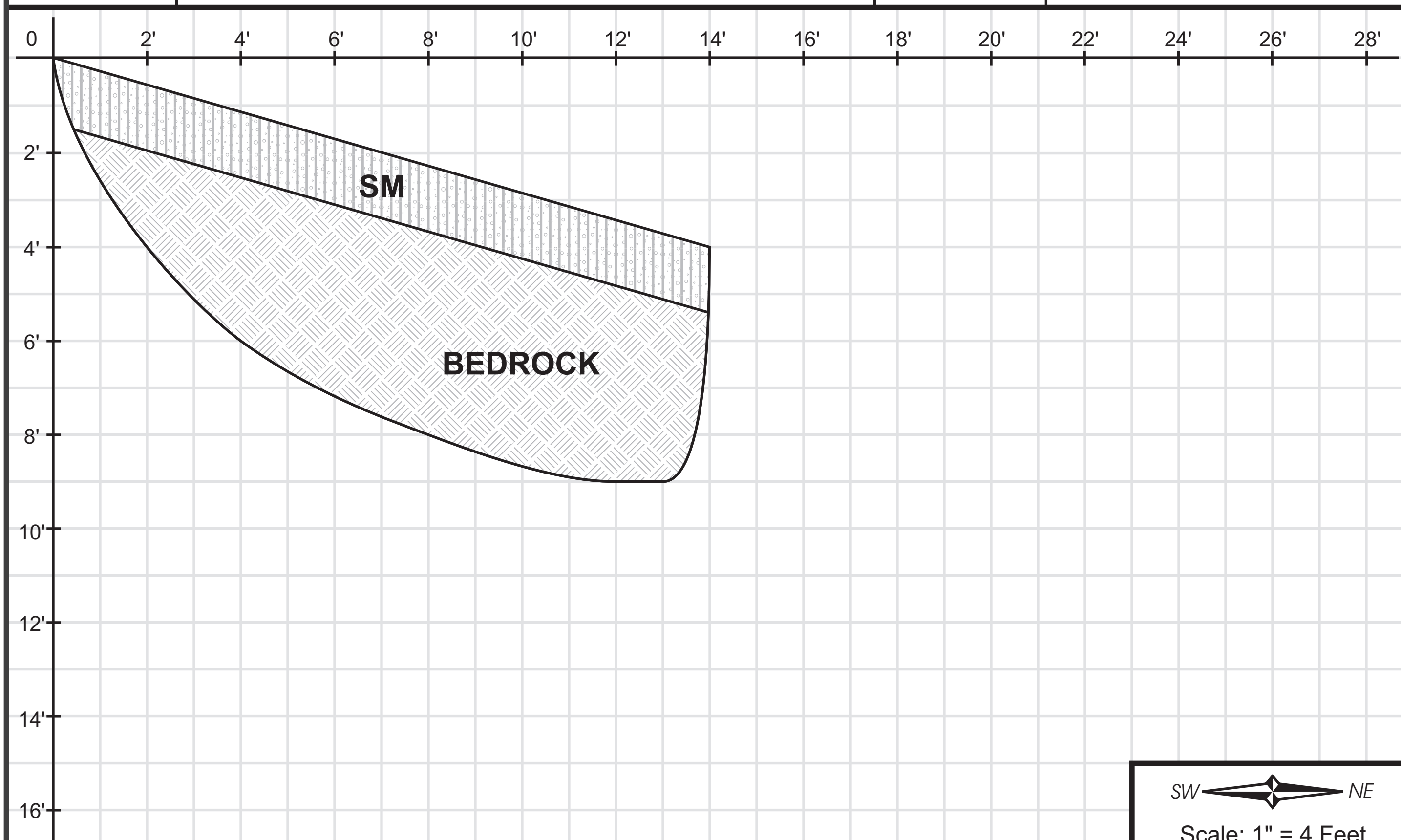


Note: The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at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

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000	**EXPLORATORY TEST PIT LOG**	**FIGURE**
	December 2021	**Natoma Senior Apartments** Folsom, California	**A-7**

Logged By: **STR**	Date: **5 November 2021**	Lat / Lon: **N 38.682982° / W 121.159160°**		Pit No. **TP-6**
Equipment: **John Deere 410F with 24" Bucket**		Pit Orientation: **310°**	Elevation: **~**	

Depth (Feet)	Geotechnical Description & Unified Soil Classification	Sample	Tests & Comments
@ 0' - 1.5'	Red brown silty **SAND (SM)**, medium dense, moist		
@ 1.5' - 9'	Brown and blue grey metavolcanic **BEDROCK**, moderately weathered, moderately hard to hard		
@ 9'	*Grades hard*		
	Test pit terminated at 9' (practical refusal) No free groundwater encountered No caving noted		

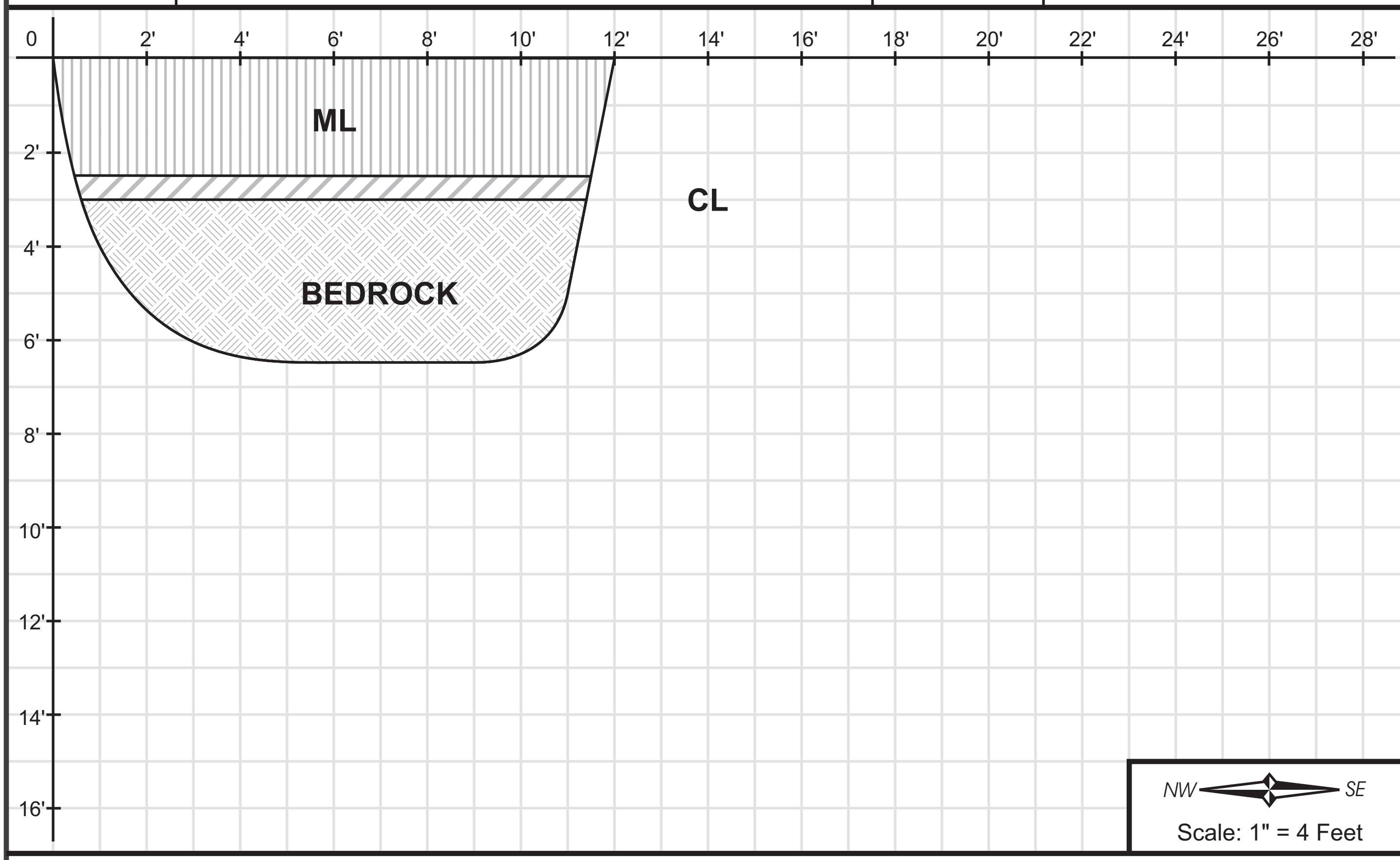


Note: The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at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

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000	**EXPLORATORY TEST PIT LOG**	FIGURE
	December 2021	**Natoma Senior Apartments** Folsom, California	**A-8**

Logged By: **STR**	Date: **5 November 2021**	Lat / Lon: **N 38.683236° / W 121.158701°**		Pit No. **TP-7**
Equipment: **John Deere 410F with 24" Bucket**		Pit Orientation: **150°**	Elevation: **~**	

Depth (Feet)	Geotechnical Description & Unified Soil Classification	Sample	Tests & Comments
@ 0' - 2.5'	Red brown sandy **SILT (ML)** with clay, medium stiff, slightly moist		
@ 2.5' - 3'	Red brown **CLAY (CL)**, stiff to medium stiff, slightly moist, with bedrock fragments		
@ 3' - 4'	Olive yellow metavolcanic **BEDROCK**, slightly weathered, moderately hard, slightly moist	**TP-7** @ 3-5'	
@ 4' - 6.5'	*Grades light brown grey and blue grey, moderately fractured, hard*		
	Test pit terminated at 6.5' (practical refusal) No free groundwater encountered No caving noted		

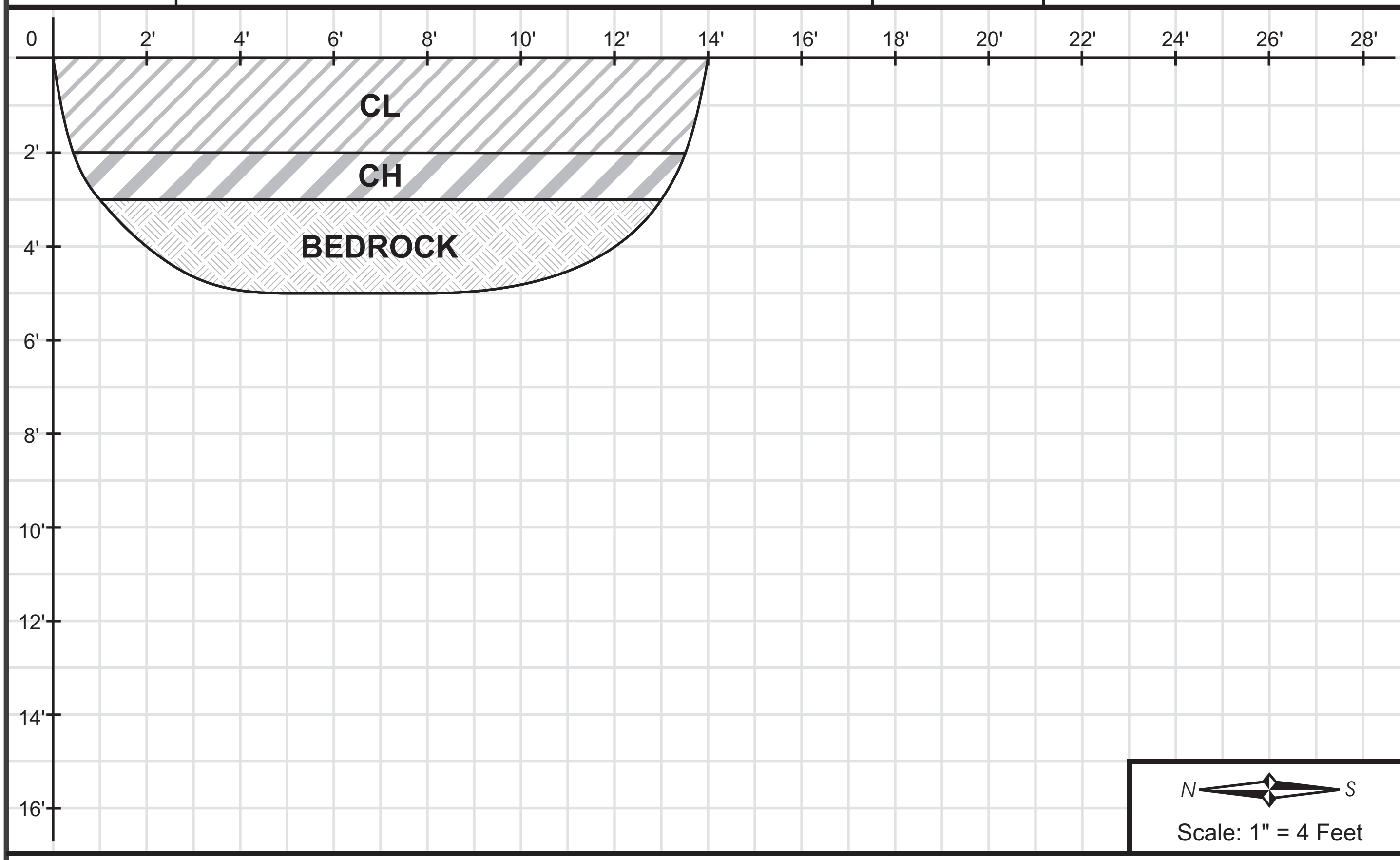


Note: The test pit log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at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

YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000 **December 2021**	**EXPLORATORY TEST PIT LOG** **Natoma Senior Apartments** Folsom, California	**FIGURE A-9**

Logged By: **STR**	Date: **5 November 2021**	Lat / Lon: **N 38.683491° / W 121.158374°**	Pit No. **TP-8**
Equipment: **John Deere 410F with 24" Bucket**		Pit Orientation: **180°** / Elevation: **~**	

Depth (Feet)	Geotechnical Description & Unified Soil Classification	Sample	Tests & Comments
@ 0' - 2'	Red brown sandy **CLAY (CL)** with silt, stiff, slightly moist	**TP-8** @ 1-2'	
@ 2' - 3'	Brown **CLAY (CH)** with gravel, very stiff, slightly moist to moist, with bedrock fragments	**TP-8** @ 2-3'	
@ 3' - 4'	Olive yellow metavolcanic **BEDROCK**, slightly weathered, moderately hard, slightly moist		
@ 4' - 6.5'	*Grades light brown grey and blue grey, moderately fractured, hard*		
	Test pit terminated at 6.5' (practical refusal) No free groundwater encountered 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.

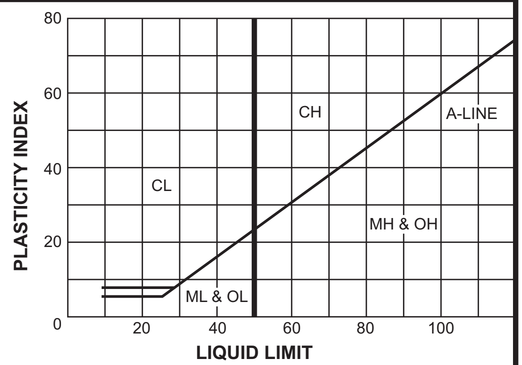
YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000 / **December 2021**	**EXPLORATORY TEST PIT LOG** **Natoma Senior Apartments** Folsom, California	**FIGURE A-10**

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

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

SOIL 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

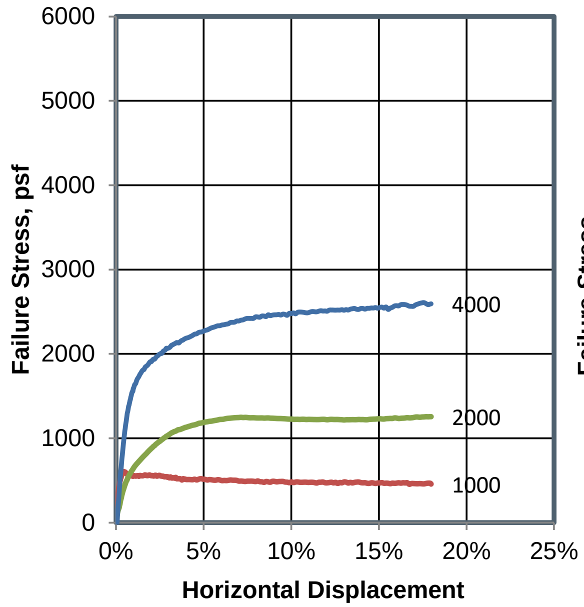
YOUNGDAHL CONSULTING GROUP, INC. ESTABLISHED 1984	Project No.: E21442.000 / December 2021	**SOIL CLASSIFICATION CHART AND LOG EXPLANATION** **Natoma Senior Apartments** Folsom, California	**FIGURE A-11**

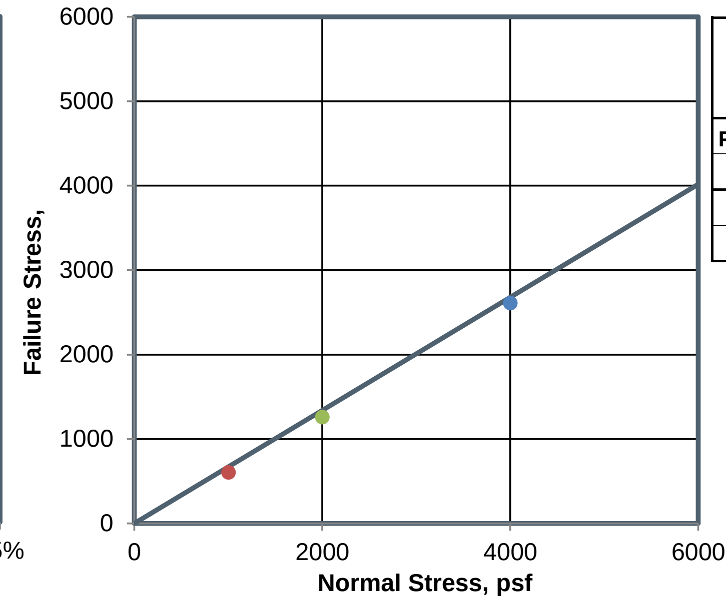
APPENDIX B

Laboratory Testing

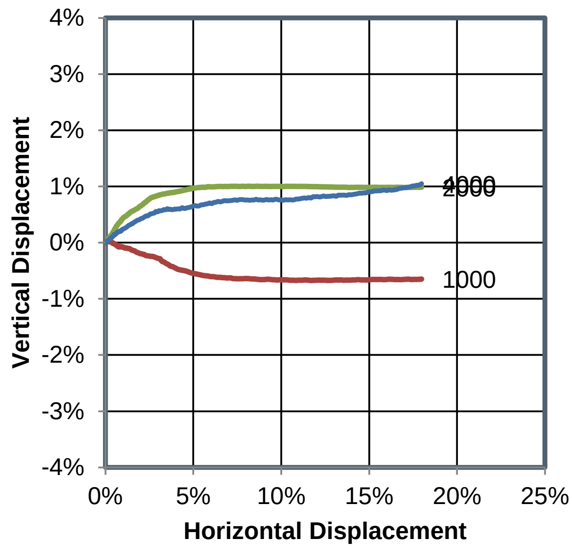
Direct Shear Test
Modified Proctor Test
Resistance Value Test
Expansion Index Test
Corrosivity Tests
NOA Tests

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





Direct Shearbox Results
Friction Angle
33.8°
Cohesion
0 psf



Test No.		1	2	3
Initial	Wet Density, pcf	130.9	130.9	130.9
	Dry Density, pcf	119.3	119.3	119.3
	Moisture Content, %	9.7	9.7	9.7
	Diameter, in	2.50	2.50	2.50
	Height, in	1.00	1.00	1.00
Pre Shear	Wet Density, pcf	146.5	153.5	144.7
	Dry Density, pcf	121.5	123.3	122.6
	Moisture Content, %*	20.6	24.5	18.0
	Diameter, in	2.50	2.50	2.50
	Height, in	0.98	0.97	0.97
Normal Stress, psf		1000	2000	4000
Failure Stress, psf		604	1256	2608
Failure Strain, %		0.46	17.94	17.57
Rate, in/min			0.001	

*Based on post shear moisture content

Sample Type: Remolded to 90% RC

Material Description: **Brown Silty SAND with Clay and trace Gravel**

Source: Curve 1

Notes: Gravel removed from test sample.

Sample No./Depth: TP-2 @ 0-1.5'	USCS Class.	Liquid Limit	Plasticity Index	% Greater than No. 4	% Less than No. 200
Date Sampled: 11/5/2021 Date Test Started: 11/16/2021				2	

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ESTABLISHED 1984
1234 Glenhaven Court, El Dorado Hills, CA 95762
ph 916.933.0633 ▪ fx 916.933.6482 ▪ www.youngdahl.net

Project: **Natoma Senior Apartments**

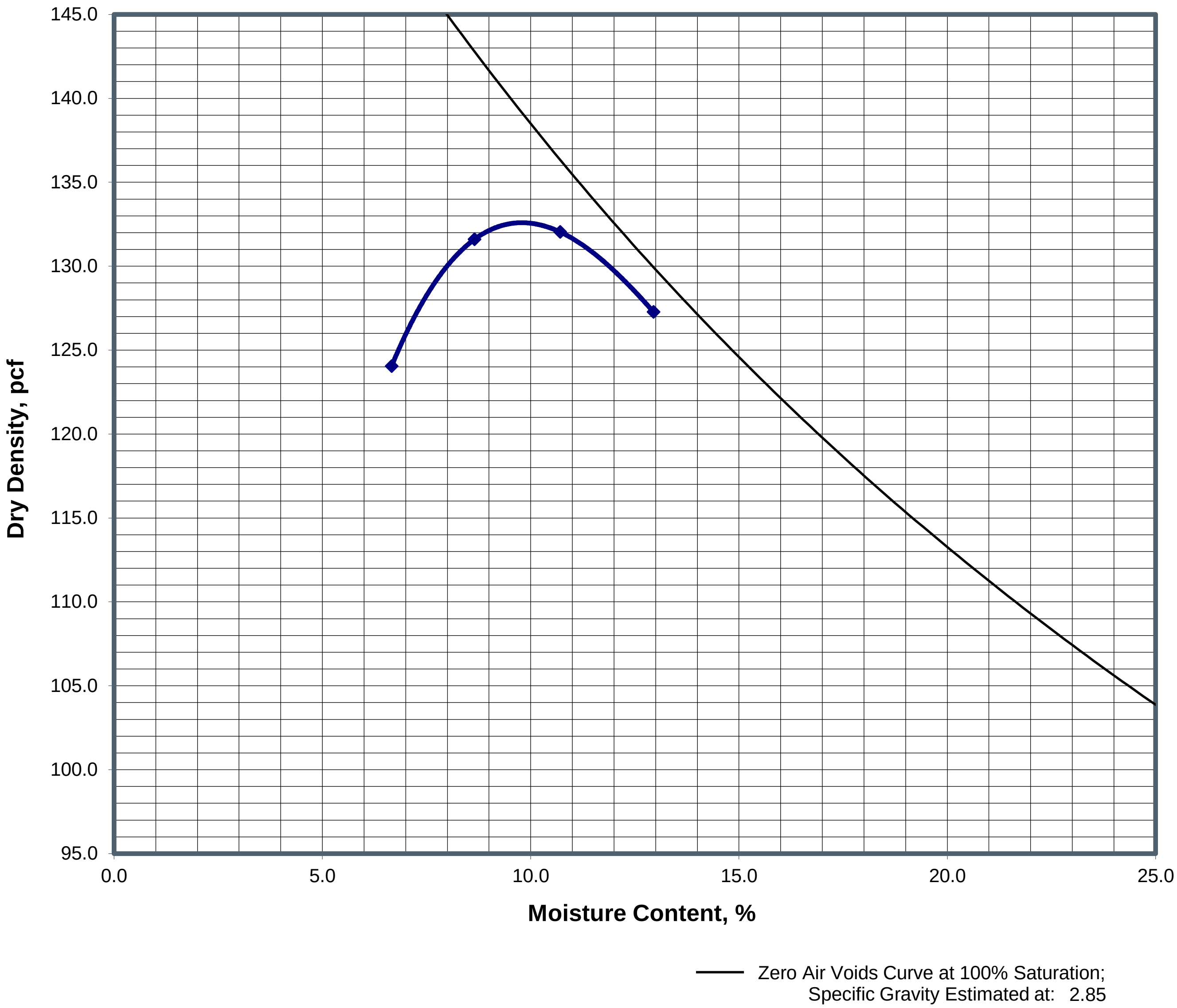
Project No.: **E21442.000**

Reviewed By: DN

Date: 11/19/2021

Figure B-1

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



Maximum Dry Density, pcf:	**132.6**	Optimum Moisture Content, %:	**9.7**

Material Description: **Brown Silty SAND with Clay and trace Gravel**

Source: TP-2 @ 0-1.5'

Notes:

Sample No./Depth:	Curve 1			USCS Class.	Liquid Limit	Plasticity Index	% Greater than No. 4 :	% Less than No. 200
Date Sampled:	11/5/2021	Date Test Started:	11/11/2021				2	

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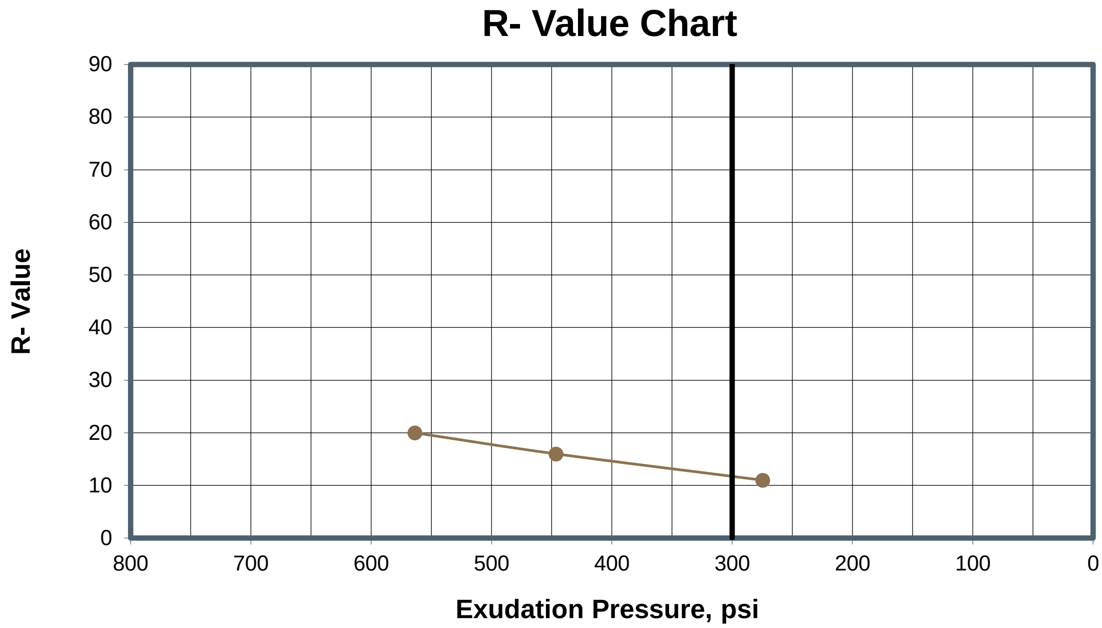
Project:	**Natoma Senior Apartments**		
Project No.:	**E21442.000**		Figure
Reviewed By: JLC	Date: 11/12/2021		B-2

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



Test Specimen No.:	1	2	3
Moisture Content at Test, %	13.4	14.5	15.6
Dry Density at Test, pcf	126.8	125.4	119.1
Expansion Pressure, psf	30	17	0
Exudation Pressure, psi	564	446	275
Resistance "R" Value	20	16	11
"R" Value at 300 psi Exudation Pressure			**12**

Material Description: **Brown Silty SAND with Clay and trace Gravel**

Source:

Notes: Gravel removed from test sample.

Sample No./Depth: TP-2 @ 0-1.5'	USCS Class.	Liquid Limit	Plasticity Index	% Greater than No. 4	% Less than No. 200
Date Sampled: 11/5/2021 Date Test Started: 11/17/2021				2	

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ESTABLISHED 1984
1234 Glenhaven Court, El Dorado Hills, CA 95762
ph 916.933.0633 ▪ fx 916.933.6482 ▪ www.youngdahl.net

Project:	**Natoma Senior Apartments**		
Project No.:	**E21442.000**		Figure
Reviewed By: JLC	Date: 11/19/2021		B-3

Expansion Index of Soils, ASTM D4829

Test Results

Expansion Index	40
Dry Density, as molded, pcf	115.9
Moisture Content, as molded, %	8.0
Final Moisture Content, %	21.4
Initial Saturation, as molded, %	48.0

Classification of Potentially Expansive Soil

Expansion Index, EI	Potential Expansion
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	High
Above 130	Very High

Material Description: **Brown Sandy CLAY**

Source:

Notes:

Sample No./Depth:	TP-1 @ 3'			USCS Class.	Liquid Limit	Plasticity Index	% Greater than No. 4	% Less than No. 200
Date Sampled:	11/5/2021	Date Test Started:	11/15/2021				2	

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ESTABLISHED 1984
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ph 916.933.0633 ▪ fx 916.933.6482 ▪ www.youngdahl.net

Project:	**Natoma Senior Apartments**		
Project No.:	**E21442.000**		Figure
Reviewed By: DN	Date: 11/19/2021		B-4

Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 11/12/2021
Date Submitted 11/09/2021

To: Jeffry Cannon
Youngdahl Consulting Group
1234 Glenhaven Ct.
El Dorado Hills, CA 95630

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : E21442.000 NATOMA SA Site ID : TP-2 @ 0-1.5.
Thank you for your business.

* For future reference to this analysis please use SUN # 86121-179465.

EVALUATION FOR SOIL CORROSION

Soil pH	5.66	
Minimum Resistivity	2.41 ohm-cm (x1000)	
Chloride	5.2 ppm	00.00052 %
Sulfate	14.8 ppm	00.00148 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422m

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 11/12/2021
Date Submitted 11/09/2021

To: Jeffry Cannon
Youngdahl Consulting Group
1234 Glenhaven Ct.
El Dorado Hills, CA 95630

From: Gene Oliphant, Ph.D. \ Randy Horney RH
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : E21442.000 NATOMA SA Site ID : TP-7 @ 3-5.
Thank you for your business.

* For future reference to this analysis please use SUN # 86121-179466.

EVALUATION FOR SOIL CORROSION

Soil pH	5.51		
Minimum Resistivity	2.95	ohm-cm (x1000)	
Chloride	3.2 ppm	00.00032	%
Sulfate	7.2 ppm	00.00072	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422m

EMSL Analytical, Inc.

464 McCormick Street San Leandro, CA 94577
Phone/Fax: (510) 895-3675 / (510) 895-3680
http://www.EMSL.com / sanleandrolab@emsl.com

EMSL Order: 092117692
Customer ID: YOUN22
Customer PO: E21442.000
Project ID:

Attention: Francisco Saldana
Youngdahl Consulting Group
1234 Glenhaven Court
El Dorado Hills, CA 95762

Phone: (916) 933-0633
Fax: (916) 933-6482
Received: 11/09/2021 9:15 AM
Analysis Date: 11/11/2021
Collected: 11/05/2021

Project: NATOMA SENIOR APARTMENTS, E21442.000

Test Report: PLM Analysis of Bulk Samples for Asbestos via EPA 600/R-93/116 Method with CARB 435 Prep (Milling) Level A for 0.25% Target Analytical Sensitivity

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
TP-2 *092117692-0001*	MULTIPLE PART COMPOSITE FROM TEST PIT NO 2	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	**None Detected**
TP-7 *092117692-0002*	MULTIPLE PART COMPOSITE FROM TEST PIT NO 7	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	**None Detected**

Analyst(s)

Adam C. Fink (2)

Cecilia Yu, Laboratory Manager
or other approved signatory

Initial report from: 11/11/2021 23:26:18

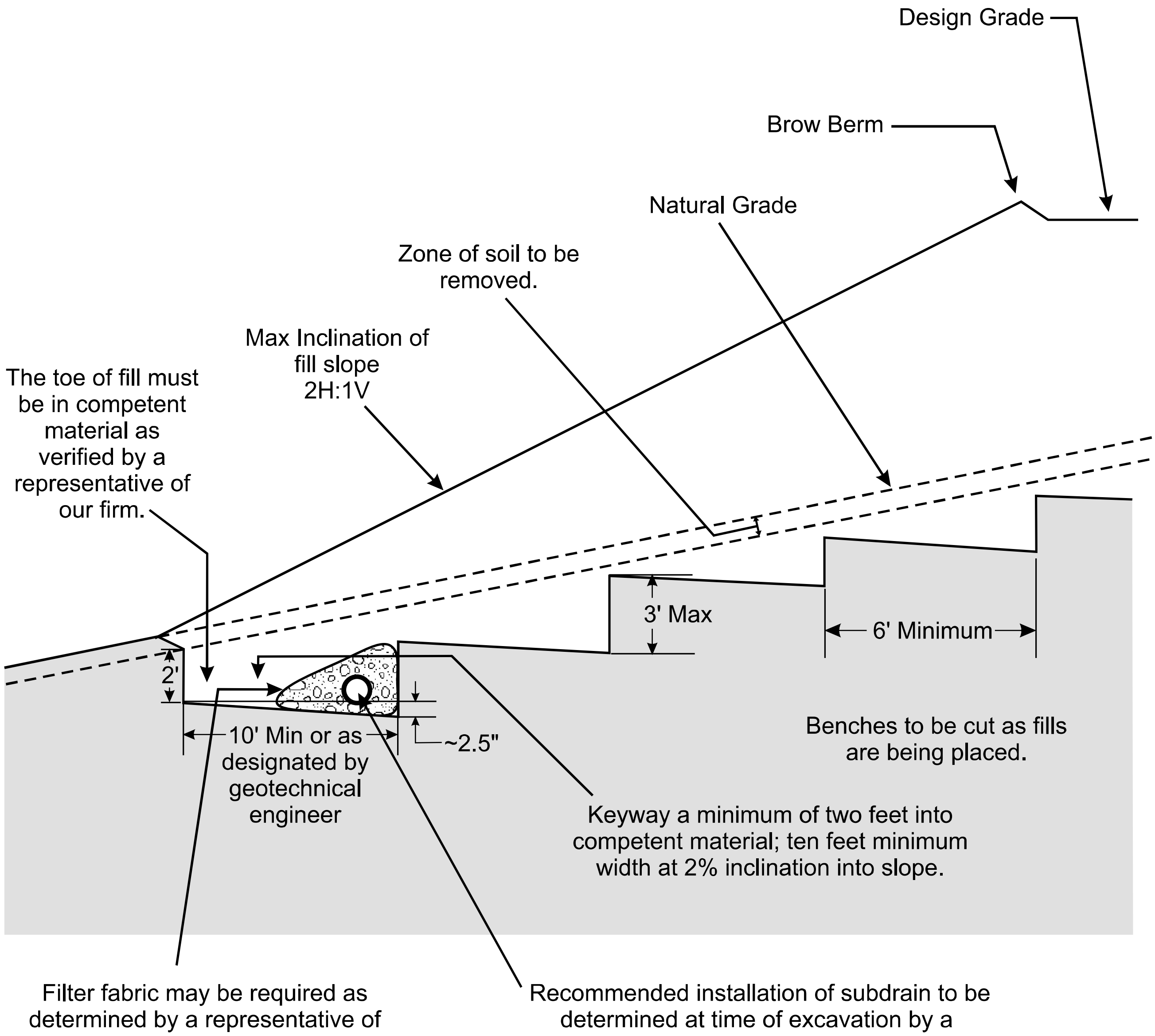
APPENDIX C

Details

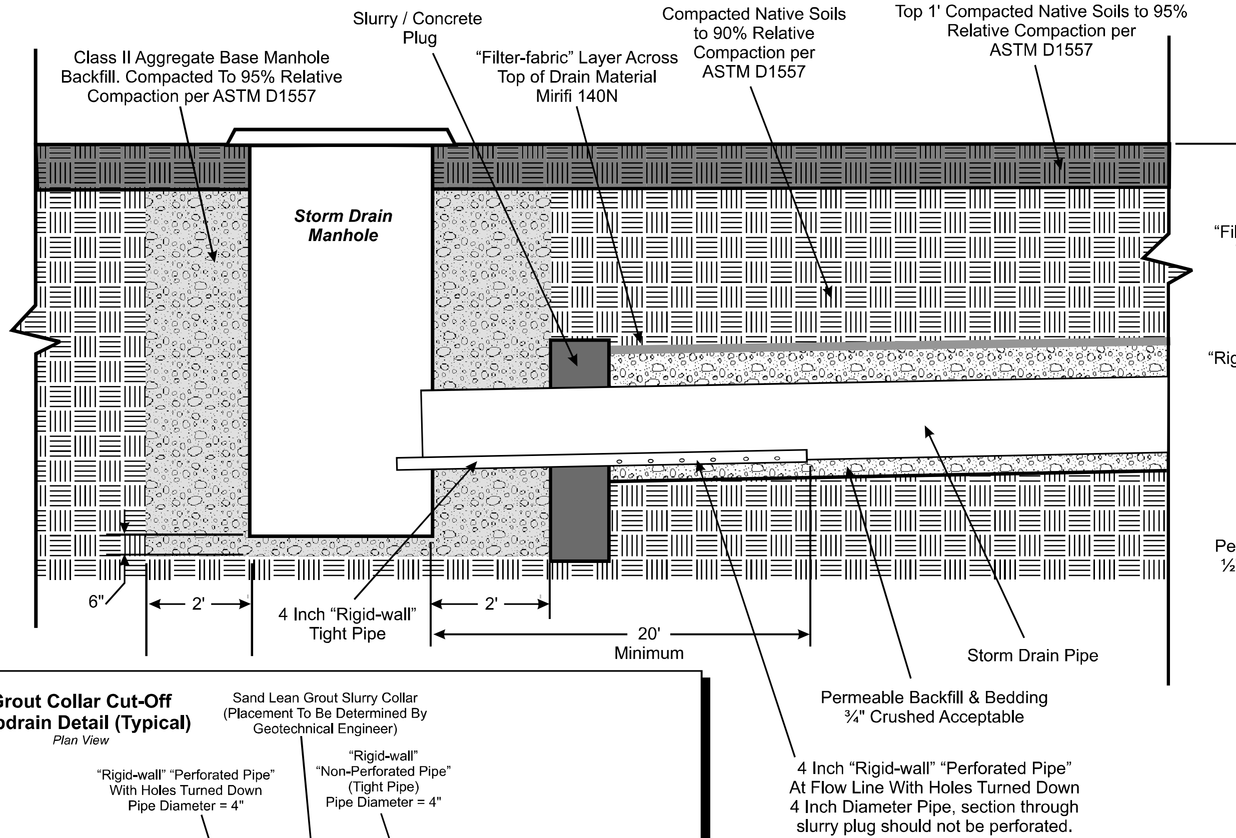
Keyway and Bench with Drain
Plug and Drain
Site Wall Drainage
Subdrain

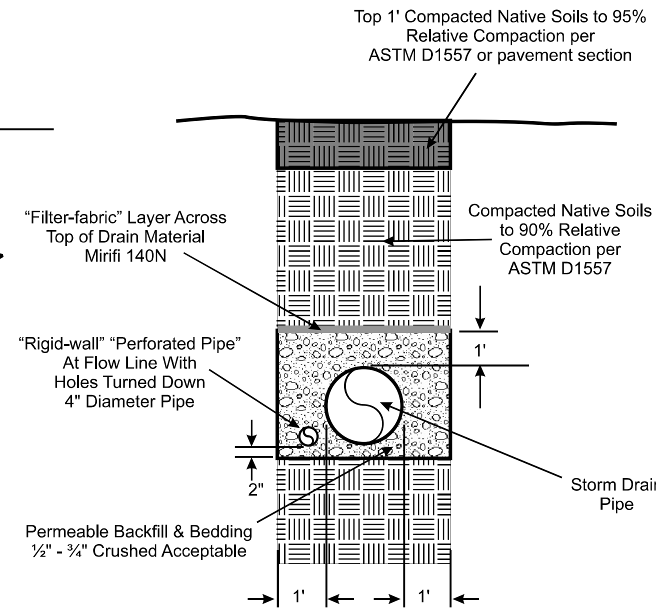
PLACEMENT OF FILL ON NATURAL SLOPE
(Typical)

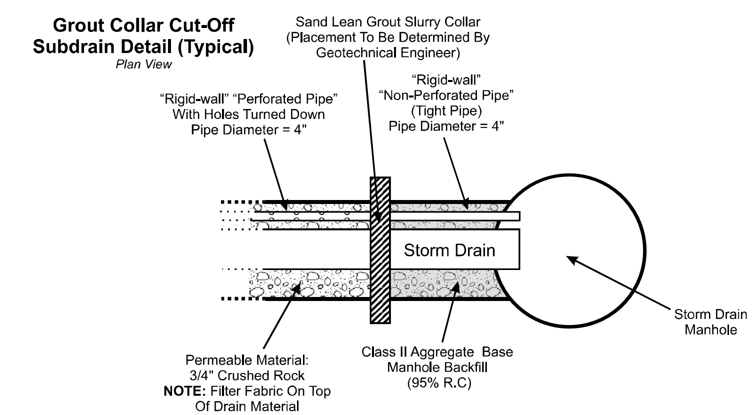
All keyways should be observed and approved prior to placement of fill.
A keyway is required by CBC for fills on natural slopes of 5H:1V or steeper.



YOUNGDAHL CONSULTING GROUP, INC. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS TESTING	Project No.: E21442.000 December 2021	**KEYWAY & BENCH WITH DRAIN** **Natoma Senior Apartments** Folsom, California	FIGURE **C-1**







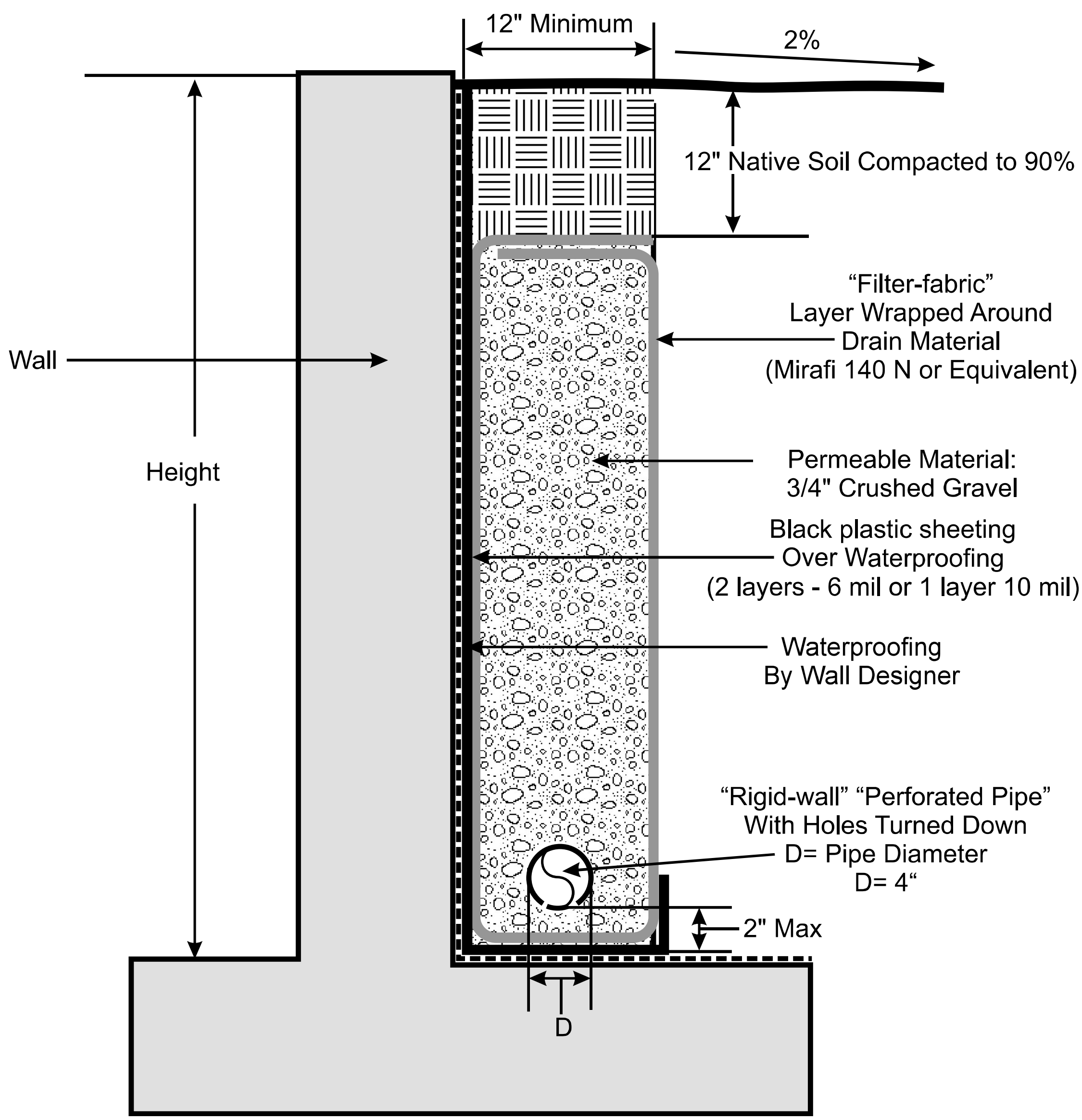
Notes: ***1. Slope trench and "rigid-wall" pipes at least 1% gradient to drain.***
2. Washed clean permeable material.
3. Slurry collar to extend into trench sidewalls and to top of pipe envelope.

Notes: *Slope trench and "rigid-wall" pipes at least 1% gradient to drain.*

YOUNGDAHL CONSULTING GROUP, INC. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS TESTING	Project No.: E21442.000 **December 2021**	**TYPICAL STORM DRAIN / SUB-DRAIN DETAIL** **Natoma Senior Apartments** Folsom, California	**FIGURE** **C-2**

Retaining Wall With
“Perforated Pipe Sub-Drain”

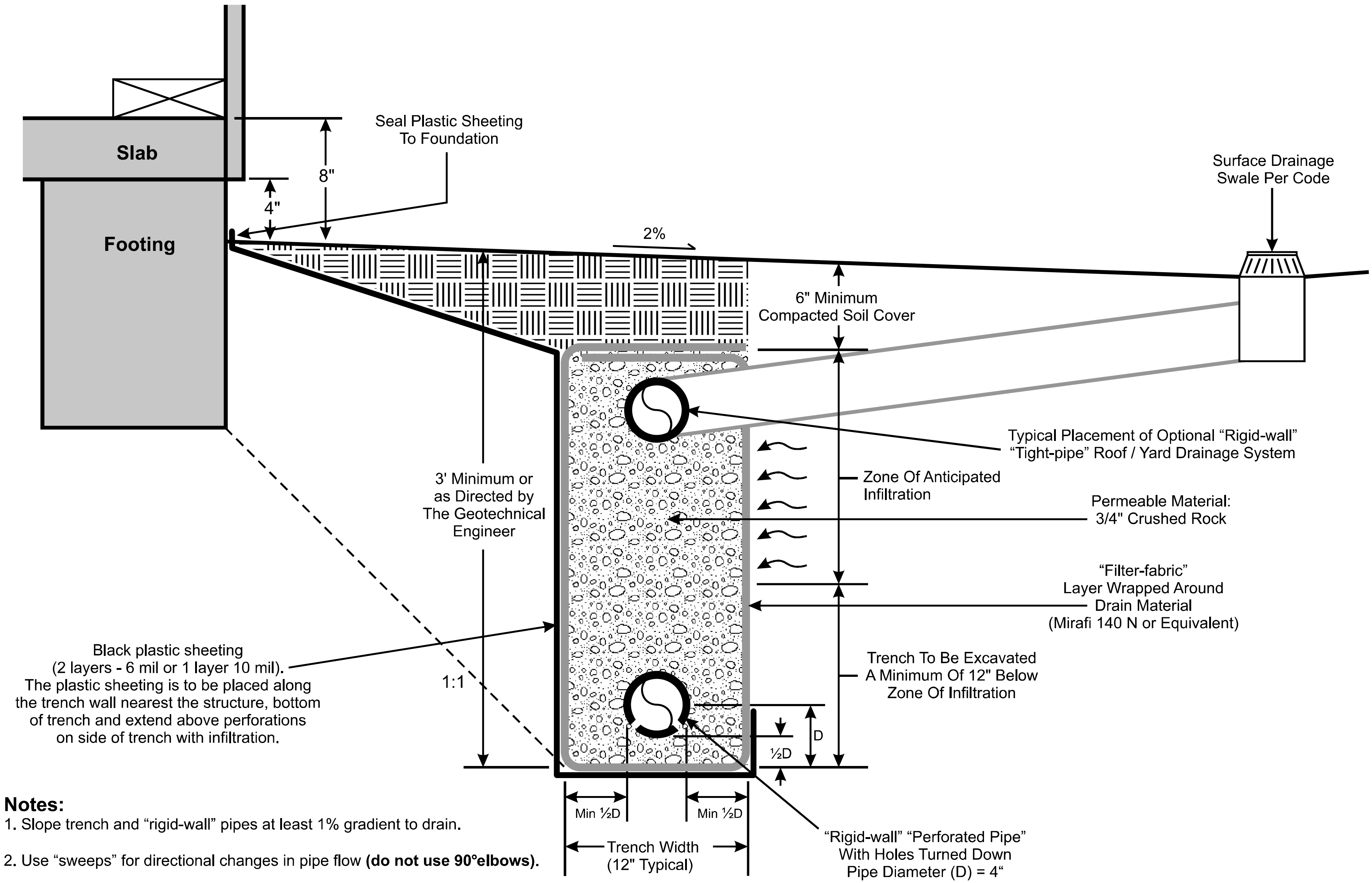
(Typical Cross Section)



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. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS TESTING	Project No.: E21442.000	**RETAINING WALL DRAIN DETAIL**	**FIGURE**
	December 2021	**Natoma Senior Apartments** Folsom, California	**C-3**



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. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS TESTING	Project No.: E21442.000 **December 2021**	**SUB-DRAIN DETAIL** **Natoma Senior Apartments** Folsom, California	**FIGURE** **C-4**