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Consulting Group, Inc.

**Services** Geotechnical Engineering Study

**Project** Proposed Nerradscali Subdivision

**Location** Sacramento, California

**Client** Mr. Darren Brown

**Project No.** 05-22016G

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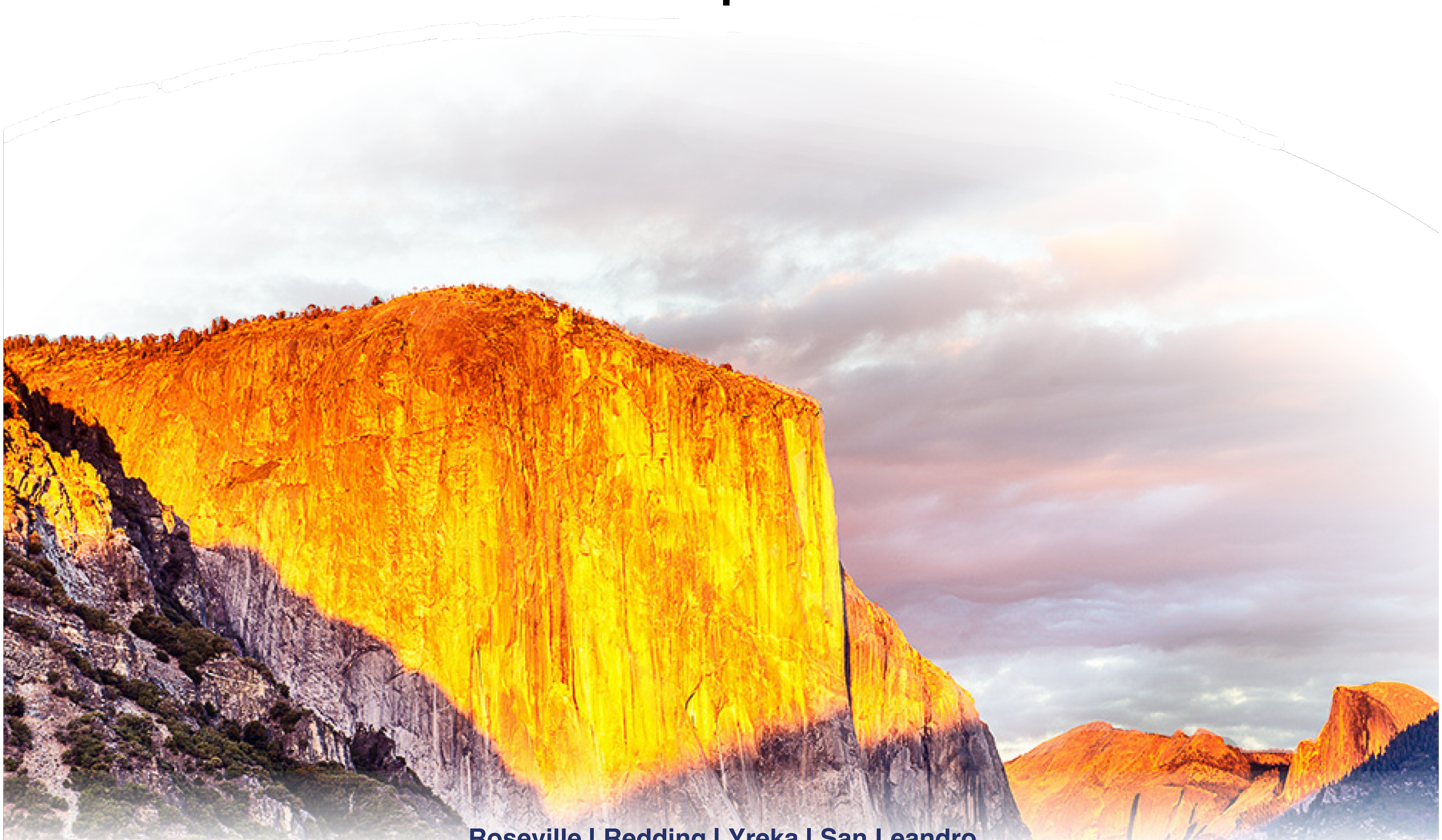

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A Report Prepared for:

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**GEOTECHNICAL ENGINEERING STUDY**
**PROPOSED NERRADSCALI SUBDIVISION**
**905 NORTH AVENUE**
**SACRAMENTO, CALIFORNIA 95838**

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**PROPOSED NERRADSCALI SUBDIVISION**
**905 NORTH AVENUE**
**SACRAMENTO, CALIFORNIA 95838**

## INTRODUCTION

### PURPOSE AND SCOPE OF STUDY

This report presents the results of our Geotechnical Engineering Study for the proposed improvements to be designed and constructed on the above referenced subject site (refer to the Location Plan, Figure 1, Appendix A). The purpose of the study is to evaluate the general conditions of the earth materials at the site to provide conclusions and recommendations related to the geotechnical and geological aspects of the project as discussed in our proposal / agreement of February 9, 2022, and executed February 10, 2022.

The scope of our work included a site reconnaissance, review of client provided and readily available published documents (including aerial images, topographic maps, and nearby groundwater levels), exploring and sampling the general subsurface earth and groundwater conditions, performing soil mechanics laboratory tests, assessing potential for geological hazards (including liquefaction and expansive soil conditions), performing geotechnical analysis, and making recommendations for earthwork, foundation design, lateral resistance, floor slab-on-grade support, and on-site pavements.

The attached Appendices contain further information including graphic presentations (Site Vicinity Map and Map of Explorations - Appendix A); field exploration procedures and logs of subsurface explorations (Appendix B); laboratory testing and procedures used (Appendix C); Guide Specifications for Earthwork (Appendix D); and SEAOC/OSHPD U.S. Seismic Design Maps (Appendix E).

### PROJECT LOCATION

The project is proposed on a 1.32+/- acre residential parcel (APN: 237-020-009-200). The subject site is bounded by North Avenue to the south, residential properties to the east and west, and City of Sacramento easement and I-80 to the North.

## PROPOSED PROJECT INFORMATION

In preparing this report we reviewed the grading plan by RFE Engineering, Inc. January 24, 2022, "On-Site Improvement Plans" (Sheet No. C6), and reviewed Google Earth aerial photography (5/14/2021) related to the subject site. Based on the referenced plan and information provided by the client, the proposed project consists of the design and construction of one (1) single-family residential home with a footprint area of 1,700 +/- square feet, four (4) half plex's with footprints of 1,150+/- square feet and two (2) half plex's with footprints of 1,280 +/- square feet. A stormwater detention pond is proposed in the northeastern portion of the site. The proposed improvements also include landscaping, concrete driveways, asphalt driving aisles, paved parking area and on-site concrete sidewalks.

# FINDINGS

## SITE HISTORICAL BACKGROUND

Google Earth aerial images dating back to May 1993 indicate the site and surrounding properties appeared as described in the Site Description section below and Project Location section above.

## SITE DESCRIPTION

During our site visit, the subject site was relatively flat lying with minor surface elevation changes. The eastern portion of the parcel was vacant and covered with volunteer grasses. A dense cluster of trees was in the northeastern portion of the site as well as metal scraps and various other debris. A single-story residential home enclosed by a wooden fence was in the southwestern portion of the parcel. In the northeastern corner of the site was a tower supporting southerly trending high tension electric lines. Two concrete slabs were in the northwestern portion of the site. Overall drainage of the subject site trended generally to the north toward a canal.

## GEOLOGY AND SEISMICITY

The site is located within California's Great Valley Geomorphic Province, a geologically young, large, flat-lying alluvial plain in the central portion of California. The Province is 40 to 60 miles (60 to 100 km) wide and stretches approximately 450 miles (720 km) from north-northwest to south-southeast, inland from and parallel to the Pacific Ocean Coast Ranges to the west and Sierra Nevada Mountains to the east. The

Great Valley has been filled with hundreds to thousands of feet of eroded sediments, ranging in age from Pleistocene to Holocene.

Based on our review of readily available published geologic literature/maps (CGS "Preliminary Geologic Map of the Sacramento 30' X 60' Quadrangle, California", 2011; scale 1:100,000) the site is mapped to be underlain by Quaternary-aged Fan Deposits (Map Symbol: Qf). The total thickness of the formation was not determined and is beyond the scope of this study. The native earth materials discovered in the explorations are considered to be consistent with the mapped earth materials.

## EARTH MATERIAL CONDITIONS

As shown on the Exploratory Logs (Appendix B), the subsurface earth material conditions were generally consistent throughout the site. The uppermost soils encountered to a depth of approximately 1½ feet below existing ground surface (begs) consisted of medium stiff, moist, dark brown, Sandy SILT, with occasional Gravel (Unified Soil Classification: ML). Underlying the silt was discovered stiff to very stiff, moist, light brown and dark brown, Sandy Silty CLAY (CL) to varying depths between 2½ to 3 feet begs. The earth materials encountered below the upper soil to a depth of approximately 13 feet begs consisted of very stiff and hard, moist, light brown with orange mottles and red-brown, Sandy SILT (ML). The earth materials encountered below this layer consisted of dense, moist, dark brown to brown, SAND (SP) to a depth of approximately 19 feet begs. Underlying the sand layer was found hard, moist, light brown, Sandy SILT (ML) to the maximum explored depth of approximately 21½ feet begs.

Since the earth material profile is generalized, the reader is advised to consult the Explorations Logs contained in Appendix B, if the earth material conditions at a specific depth and location are desired. The logs contain a more detailed earth material description regarding color, earth material type, and Unified Soil Classification System (USCS) symbol.

Earth material conditions cannot be fully determined by surface and subsurface explorations and earth material sampling. Hence, unexpected earth material conditions might be encountered during construction. If earth material conditions are encountered during construction which vary from earth materials encountered during the investigation, then appropriate recommendations will be needed during construction. Therefore, we suggest a contingency fund for additional expenditures that might have to be made due to unforeseen conditions.

## PERCOLATION TESTING

One percolation test boring was drilled with a 4-inch outer-diameter continuous flight helical solid stem auger (SSA) powered by a truck mounted drill rig to the approximate depth indicated in the table below within the proposed detention pond. The approximate depth of the percolation boring was selected per the referenced grading plans. Please refer the attached “Exploration Location Map – Figure 2” for approximate location of the percolation test.

The outer wall of the boring was scored to reduce the effects of smearing. Approximately six (6)-inches of clean gravel was added to the bottom of the test hole. In the test boring a 2-inch inner diameter (ID) PVC slotted pipe was installed into the hole on top of the gravel. Clean gravel was placed in the annular space between the boring wall and pipe.

The boring was filled with water to the presoak level to let the soils presoak before performing the test. Following the presoak time water was adjusted in each hole to at least 12 inches above the bottom of the boring. The drop in water level was measured at specific time intervals until a steady rate of drop in water level was obtained when at least three consecutive readings were within 10 percent from each other. Pre-adjusted percolation rate was determined by dividing the drop in water level over the time required for the drop in water level. The infiltration rate was determined using the percolation rate divided by a Conversion Factor. The test results are shown on Table 1, below.

TABLE 1. RESULTS OF PERCOLATION TEST

| PERCOLATION TEST NO. | BORING DEPTH (ft) | BORING DIAMETER (in) | STEADY FLOW PERCOLATION RATE (in/hr) | CALCULATED INFILTRATION RATE (in/hr) | TESTED SOIL DESCRIPTION |
|---|---|---|---|---|---|
| P-1 | 6 | 4.0 | 0.12 | 0.02 | Sandy SILT |

The infiltration rate (per the test method referenced above) of the soils shown on the above table could be used by the General Civil Engineer as preliminary infiltration rates of the soils at the location and depth indicated. A safety factor was not applied to these values. Once the basins have been constructed, we suggest the infiltration rates be confirmed by double ring infiltrometer tests in the soil exposed in the bottoms of the basins.

### GROUNDWATER CONDITIONS

Observations of groundwater conditions were made during and just after drilling the exploratory borings. Free groundwater was not encountered in any of the subsurface explorations.

## CONCLUSIONS AND DISCUSSIONS

### SITE SUITABILITY AND GEOTECHNICAL CONSIDERATIONS

From a geotechnical standpoint, the site is considered suitable for the proposed construction provided the conclusions and recommendations presented in this report are incorporated into the design and construction of the project. Geotechnical considerations that were evaluated by our office include disturbed soils due to historic agriculture usage and loose topsoil, which are discussed in the following sections of this report.

### BEARING CAPABILITY

Field and laboratory tests show that the affirmed undisturbed, native earth materials encountered at the exploration locations are considered competent for support of the proposed construction. The upper loose / soft soils and any disturbed soils (including undocumented fill, materials disturbed/backfilled of the soils loosened due to agriculture, clearing trees, etc.) that are present at the time of construction are not considered stable and should not be utilized to directly support new structural elements. Mitigation measures for unsuitable soil conditions are discussed in the Recommendations section of this report. Mitigation measures considered include removal and replacing the disturbed and/or loose soils with engineered fill; or, foundation elements designed to extend through the unsuitable soils.

Engineered fill, composed of approved materials placed and compacted according to the following recommendations, and undisturbed native soils are considered competent for support of low to moderate loading increases.

## COMPRESSIBLE AND EXPANSIVE SOILS

Compressible materials consisting of surficial disturbed material, loose soils, undocumented fills, debris, rubble, rubbish, etc., are considered unsuitable materials for support of the proposed structures. Such materials can differentially settle. We consider that any undocumented fill encountered and disturbed and / or soft/loose soil materials in the construction areas should be removed and replaced with engineered fill, or special foundation mitigation measures designed. Overexcavated earth materials deemed suitable for re-use as engineered fill could be stockpiled. If the unsuitable materials are not removed, then special foundation systems should be designed to account for the potential settlements. In areas where unsuitable or loose, wet soils are encountered, remedial grading should be undertaken to remove the loose soils and ensure the removal of the entire disturbed soils.

Engineered fill, composed of approved granular materials placed and compacted according to those discussed in the recommendations section, below, and undisturbed native soils are considered competent for support of low to moderate loading increases anticipated for this project.

Based on visual observation and on laboratory test results performed on a representative soil sample of the underlying, relatively thin layer of clay soil (Plasticity Index (PI) of 16, percent fines of 59) we consider the expansion potential of the subsurface soils to be low.

Mitigation measures for potentially compressible soils would be to assure that native, undisturbed, granular earth materials, recompacted soil, and/or engineered fill comprised of non- to low-expansive soil is beneath the rough pad soil grade. Mitigation measures are presented in the Recommendations section below for potentially compressible soils.

## GROUNDWATER AND SEASONAL MOISTURE

As previously mentioned, free groundwater was not encountered during our subsurface investigation. However, groundwater levels could be seasonal – varying between the winter and summer months. It is our opinion that perched groundwater could have an impact on the proposed design or construction depending on the foundation system selected by designers and depths of underground structures. If wet-season construction is undertaken, then groundwater seepage into excavations is expected to be generally controllable by pumping/diversion; likewise, inflow from surface (dependent on quantity and duration of storm intensity/rainfall) is expected to be similarly controllable as temporarily necessary. **If the uppermost soils should become saturated, then this condition would likely impede or delay grading operations**.

Groundwater levels can fluctuate on a seasonal basis due to changes in precipitation, irrigation, pumping, etc. We consider groundwater levels might change based on site topography and the time our investigation was performed. Excavations below perched groundwater (if encountered) might be impacted by seepage; therefore, we recommend grading and utility excavations be performed during dry season when groundwater levels are lowest.

## SEISMIC HAZARDS

Seismic ground shaking of the earth materials underlying the site can cause ground failures, including fault rupture, liquefaction and densification, lateral spreading, landsliding, and tsunamis / seiches. The following sections discuss our conclusions / opinions regarding these conditions based on our findings and literature review.

### Fault Rupture

Fault rupture hazards are important near active faults and tend to reoccur along the surface traces of previous fault movements. The site is not located within an Alquist-Priolo Special Studies Zone. We consider the potential for fault rupture, damage from fault displacement, or fault movement directly below the site to be very low. However, the site is located within an area where shaking from earthquake generated ground motion waves should be considered likely.

### Seismic Ground Shaking

The mapped and design spectral response accelerations (refer to Appendix E) presents seismic design criteria for the subject project site obtained from the SEAOC/OSHPD Seismic Design Maps (https://seismicmaps.org) that are based on data provided by ASCE 7-16 and are for use with the 2019 California Building Code (CBC). The values for spectral response accelerations with a Risk Category of II are summarized on the following table.

| Mapped and Design Spectral Accelerations | |
|---|---|
| **Description** | **Value** |
| Site Soil Classification[1] | D |
| Seismic Design Category[2] | D |
| Site Latitude, Longitude | 38.6404947, -121.445908 |
| $S_S$ - Spectral Acceleration for a Short Period | 0.523 g |
| $S_1$ - Spectral Acceleration for a 1-Second Period | 0.242 g |
| $S_{MS}$ - $MCE_R$, 5% damped Spectral Acceleration for a Short Period | 0.722 g |
| $S_{M1}$ - $MCE_R$, Spectral Acceleration for a 1-Second Period[1] | 0.512 g |
| $S_{DS}$ - design, 5% damped, Spectral Acceleration for a Short Period | 0.481 g |
| $S_{D1}$ - design, 5% damped, Spectral Accel. for a 1-Second Period[1] | 0.341 g |
| $T_L$ | 12 |
| PGA | 0.22 |
| $PGA_M$ | 0.303 |
| $F_{PGA}$ | 1.38 |

[1] The *2019 CBC* requires an earth material profile determination extending to a depth of 100 feet for site soil classification. ACG's explorations extended to depth of about 21.5 feet begs, and Exception 2 of ASCE 7-16 Section 11.4.8 for Site Class D is used to calculate $S_{M1}$ and $S_{D1}$. [2] In general accordance with the 2019 CBC (refers to *ASCE 7-16*) Seismic Design Category is based on spectral acceleration for a 1-sec Period, short & 1-sec period response acceleration parameters ($S_1$, $S_{DS}$ & $S_{D1}$, respectively) and corresponding Risk Category. Please refer to ASCE/SEI 7-16 Section 11.4.8 for base shear (V) calculations. Please refer to Appendix E for the U.S. Seismic Design Maps.

## Liquefaction and Seismic Settlement Evaluation

Liquefaction occurs when saturated fine-grained sands and/or silts lose their physical strength temporarily during earthquake induced shaking and behave as a liquid. This is due to loss of point-to-point grain contact and transfer of normal stress to the pore water. Liquefaction potential varies with water level, soil type, material gradation, relative density, and probable intensity and duration of ground shaking. Dynamic settlement of the soils that experience liquefaction may occur after earthquake shaking has ceased.

The California Geological Survey (CGS) has designated certain areas within California as potential liquefaction hazard zones. These are areas considered at risk of liquefaction-related ground failure during a seismic event based upon mapped surficial deposits and the depth to the areal groundwater table. The project site is not currently mapped for potential liquefaction hazard by the CGS (refer to CGS website: https://www.conservation.ca.gov/cgs/earthquakes).

Subsurface exploration information indicates the site is predominately underlain by generally dense sand soils and very stiff to hard sandy silt soils to the maximum depth explored of approximately 21½ feet begs. Based on the information discussed above, it is our opinion that the potential for liquefaction at the site is very low if a seismic event should occur that might impact the site.

**Ground Lurching**

Ground lurching is a result of the rolling motion imparted to the ground surface due to seismic waves released by an earthquake that can cause cracks in weaker soils. The potential for cracking at this site is considered low due to the generally dense relative densities and hard soil consistencies.

**Earthquake Induced Landsliding**

Based on information available on the California Geological Survey (CGS) website the subject site is not currently within a State of California Seismic Hazard Zone for seismically induced landsliding. In addition, there are no steep slopes on or adjacent to the subject site. Therefore, seismically induced and/or other landslides are not considered a significant hazard at the site.

**Tsunamis and Seiche Evaluation**

The site is not located near large bodies of water and the site is located at elevation of approximately 35 feet above MSL. Based on the geometry of the site, the potential for tsunami damage or damage caused by oscillatory waves (Seiche) is considered unlikely at the site.

## ON-SITE EARTH MATERIALS SUITABILITY

On-site soils like those encountered in the test borings are generally considered suitable for re-use as engineered fill provided the materials are processed to remove excessive moisture, rubble, rubbish, oversize materials, significant organic matter, or any other substance deemed unsuitable (as determined by an ACG field representative).

## EXCAVATION CONDITIONS

It is anticipated that the soil materials at the site can be readily moved by conventional earth moving equipment to at least the maximum depth explored of approximately 21½ feet begs.

**POTENTIAL SLOPE STABILITY**

No landslides, slumps, or other indications of slope instabilities were observed in the flat-lying site area during our field investigation. We consider the potential for slope instability to be negligible.

## RECOMMENDATIONS

Recommendations for earthwork and the design and construction of the proposed structure(s) and associated improvements follow. All recommendations could require modifications based on conditions encountered during earthworks and general construction. In addition, changes in the locations of the proposed structures and pavements could also necessitate modifications to the recommendations provided herein.

**EARTHWORK**

Earthwork specifications which may be used as a guide in the preparation of contract documents for site preparation / grading are included in Appendix D. However, recommendations in the text of this report supersede those presented in Appendix D. **The conclusions and recommendations contained in this report should be incorporated into the guide specifications.**

**Site Clearing and Stripping**

Each building pad is considered to extend laterally away from (outside of) all perimeter foundation/building edges at least five (5) feet in plan view, or to edges of any adjacent features restricting this width. The improvement areas should be stripped to sufficient depth to remove all organic laden topsoil. The actual stripping depth should be determined by our representative at the time of construction. The cleared and stripped materials should be removed from the site or stockpiled for possible use as landscape materials.

We recommend the construction areas be cleared of all obstructions or unsuitable materials, including all loose, wet, or disturbed soil, undocumented fill, rubble, rubbish, vegetation, structural elements **(includes slabs and pavements)** to be razed, and any buried utility lines to be removed. Any foundations, pavements, cisterns, septic tanks, leach fields, water wells, etcetera, that might be encountered and are to be abandoned should be removed. In addition, in areas where trees have been or will be cleared, remedial grading includes removing the entire tree root systems and the loosened soils resulting from the removal. The excavated soils could be evaluated by ACG for reuse as engineered fill. The resulting subgrades of excavation(s) should be prepared and filled to planned project subgrade level with engineered fill as discussed in the following sections.

Excavations resulting from the removal of unsuitable materials and/or loose soils should be cleared to expose firm, stable material. The surface of the resulting excavations should be scarified to a depth of 8 inches and backfilled with approved earth materials compacted to the requirements given below under subgrade preparation. Utilities that extend into the construction area and are scheduled to be abandoned should be properly capped or plugged with grout at the perimeter of the construction zone or moved as directed in the plans. It may be feasible to abandon on-site utilities in-place by filling them with grout, provided they will not interfere with future utilities or affect building foundations. The utility lines should be addressed on a case-by-case basis.

## Subgrade Preparation

Once the construction areas have been cleared, any unsuitable soils over-excavated, and any other excavations made, then subgrades that will receive engineered fill, that are to be left at existing grade, or that represent final subgrades in soil achieved by excavation should be scarified to at least 8 inches. Suitability of soils exposed in the bottom of all subgrades should be verified by an ACG special inspector during site grading. Upon favorable review, exposed soil subgrades should be scarified and recompacted (in-place) an additional 8 inches and/or prior to placing engineered fill materials to planned rough pad grade. The scarified soils should be uniformly moisture conditioned as determined by ACG's field representative based upon the compaction characteristics of the earth material (typically 1 to 4 percent over optimum) and compacted to at least 90 percent relative compaction per ASTM D 1557. The geotechnical engineer's special inspector should observe the recompacted subgrades be proof-rolled with very heavy construction equipment (e.g., loaded water truck) in order to verify subgrade earth material stability. **Inability to achieve the recommended moisture content, compaction, and/or instability of the subgrade materials is/are considered unsuitable conditions and would be used as criteria for remediation, such as the removal of loose, wet, or soft soils; or, for the need of special stabilizing measures.**

If unsuitable materials are encountered at subgrade such that they are expansive, unstable and/or proper compaction cannot be obtained, then mitigation measures would be recommended. In addition, construction equipment on saturated soils could destabilize the earth materials, sometimes to several feet of depth, which might necessitate further over excavation and/or special stabilization.

An ACG special inspector should observe and approve the subgrade soils exposed in all excavations to confirm suitable conditions have been reached and should observe and approve the scarification, moisture conditioning and recompaction of the exposed soil subgrades.

## Material for Fill

All fill materials should be inorganic, low plasticity soils free of vegetation, debris, and fragments larger than three inches in size. Pea gravel or other similar non-cementitious, poorly graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer. Imported earth materials and or earth materials from onsite borrow areas may be used as engineered fill material for general site grading, foundation backfill, foundation areas, trench backfill, slab areas, and pavement areas, provided they meet the following soil classification criteria. All fill materials from any source (on-site or off-site) to be used for engineered fill should be pre-approved by this firm and should be observed by our representative and samples obtained for laboratory classification testing at least four days prior to any materials being used for engineered fill.

| **Gradation** (ASTM C 136) | **Percent Finer by Weight** |
|---|---|
| 3” | 100 |
| No. 4 Sieve | 25 - 100 |
| No. 200 Sieve | 10 – 35 |

- Liquid Limit ........ 35 (max)
- Plasticity Index ........ 15 (max)
- Maximum expansive index (ASTM D 4829) ........ 40 (max)

**Fill Placement and Compaction**

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Materials for engineered fill should be spread and compacted in lifts not exceeding 8 inches in uncompacted thickness. Engineered fill placed at the site and subgrades requiring recompaction should be uniformly compacted to at least 90 percent relative compaction in building areas, and to at least 95 percent relative compaction in the upper 12-inches of pavement and flatwork areas, as determined by ASTM Test Designation D 1557, or to the method as might be determined by an ACG special inspector. The moisture content of engineered fill materials should be determined by ACG’s field representative based upon the compaction characteristics of the earth material (typically 1 to 4 percent over optimum). ACG should continuously observe and test the grading and earthwork operations. Such observations and tests are essential to identify field conditions that differ from those predicted by this investigation, to adjust these recommendations to actual field conditions encountered, and to verify that the grading is in overall accordance with the recommendations presented in this report and the 2019 CBC.

If construction proceeds during or shortly after the wet winter months, it may require time to dry the on-site soils since their moisture content will probably be appreciably above the optimum. In addition, if subgrade soils are wet at the time of construction, they could be rutted, loosened, or otherwise disturbed to several feet of depth by the construction equipment and require additional over-excavation and/or stabilization.

Construction occurring in later summer or early fall (after on-site earth materials becoming dry) may require substantial amounts of water to be added during earthwork operations to enable the appropriate moisture content and compaction to be achieved.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of foundations, exterior flatwork/slabs, and pavements. Construction traffic over the completed subgrade should be avoided to prevent disturbance of subgrade soils. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade consisting of engineered fill should become desiccated, saturated, or disturbed, the affected material should be removed, or these materials should be scarified, moisture conditioned, and recompacted prior to construction.

The geotechnical engineer should be retained during the earthwork construction phase of the project to continuously observe earthwork and to perform necessary tests and observations during subgrade preparation, backfilling of excavations to the completed subgrade, placement and compaction of engineered fills, proof-rolling, backfilling of utility trenches, etc.

## Utility Trench Backfill

Generally, utility trenches should be backfilled with mechanically compacted fill placed in lifts not exceeding 6 inches in uncompacted thickness. Water content of the fill material should be adjusted (typically 1 to 4 percent over optimum) during the trench backfilling operations to obtain compaction. If on-site soil or import fill material is used, then the material should be compacted to at least 90 percent relative compaction. Imported sand could also be used for bedding and shading backfill in trenches provided the sand is compacted to at least 95 percent relative compaction. **Public and private utility companies' standard plans and specifications should be adhered to when backfilling their utility trenches.** Excavations parallel with the building's footings should be in compliance with the 2019 CBC Section 1809.14 setback requirements.

Utility trenches should be plugged with lean concrete wherever the utility line passes beneath the perimeters of the structures. The plug should be at least one foot on either side of the perimeter of the building perimeter foundation and extend from the bottom of the building foundation to the bottom of the trench.

## Finish Grading and Site Drainage

We consider on-site soils to be moderately susceptible to erosion where drainage concentrations occur. Concentrated flowing water should be either dissipated or channeled to appropriate discharge facilities. Appropriate erosion control measures should be provided, where applicable, by the general civil engineer on his grading and/or winterization plan.

Positive surface gradients should be provided adjacent to the buildings and pavement areas (includes flatwork) to direct surface water away from the buildings and pavements for at least ten feet and toward suitable discharge facilities. Ponding of surface water should not be allowed adjacent to the buildings or pavements or on top of pavement. Positive drainage should be provided during construction and maintained throughout the life of the project. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Backfill against foundations, exterior walls, and in utility and sprinkler line trenches should be well compacted as previously recommended and free of all construction debris to reduce the possibility of moisture infiltration. We recommend a horizontal setback distance of at least 10 feet from the perimeter of any building and the high-water elevation of the nearest storm-water retention.

Downspouts, roof drains or scuppers should discharge into splash blocks or extensions when the ground surface beneath such features is not protected by exterior slabs or paving. Sprinkler systems should not be installed within 5 feet of foundation walls. Landscaped irrigation adjacent to the foundation system should be minimized or eliminated.

All grades must provide effective drainage away from the buildings during and after construction. Water permitted to pond next to a building can result in greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential floor slab movements, cracked slabs and walls, vapor transmission issues in interior slabs, and roof leaks. Estimated movements described in this report are based on effective drainage for the life of the structures and cannot be relied upon if effective drainage is not maintained.

Per 2019 CBC Section 1804.4, the soil ground surface should be sloped at least 5 percent (2 percent for pavement) down and away from the buildings for at least of 10 feet beyond the perimeter of the buildings or pavement. After building construction and landscaping, we recommend the Civil Engineer and/or surveyor verify final grades to document that effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary, as part of the structure's maintenance program.

## Cut and Fill Slopes

Cut/fill slopes are not anticipated. If slopes should be needed, then permanent excavation and embankment slopes up to 10 feet of height in soil should be graded at an inclination of 2 horizontal to 1 vertical (2H: 1V) or flatter. The crowns of all slopes should be constructed so that surface run-off water is not allowed to flow over the faces of the slopes. All cut slopes should be observed during grading by the Geotechnical Engineer and/or Engineering Geologist to determine if any adverse defects are present. If defects are observed, then additional study and/or recommendations would be made at that time.

For temporary excavations, the individual contractor(s) is/are responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

## Earthwork Construction Considerations

At the time of our study, moisture contents of the surface and near-surface native soils were low. Based on these moisture contents, some moisture conditioning will likely be needed for the project to make the soil compactible and suitable for use as engineered fill. The soils may need to be dried by aeration during wet weather conditions, or a chemical treatment, such as cement, lime, or kiln dust, may be needed to stabilize the soil. The soils may need more moisture and water during the dry season to make the soil compactible and suitable. Subgrade conditions may require a rock protective mat covering of exposed subgrades to limit disturbance of the site soils as well as provide a stable base for construction equipment.

Although the exposed subgrades are anticipated to be relatively stable upon initial exposure, on site soils may pump and unstable subgrade conditions could develop during general construction operations, particularly if the soils are wet and/or subjected to repetitive construction traffic. The use of light construction equipment would aid in reducing subgrade disturbance. The use of remotely operated equipment, such as a backhoe, would be beneficial to perform cuts and reduce subgrade disturbance. If unstable subgrade conditions develop, then stabilization measures will need to be employed. Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content just prior to construction of the floor slabs and pavements. Construction traffic over the completed subgrades should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed, or these materials should be scarified, moisture conditioned, and recompacted prior to floor slab and pavement construction.

We anticipate that site grading for concrete foundations, slab construction, pavements and shallow utility trenches could be performed with conventional earthmoving equipment.

**We emphasize the contractor is responsible for designing and constructing stable, temporary excavations (including utility trenches) as required to maintain stability of both the excavation sides and bottom and should be in accordance with OSHA excavation and trench safety standards.**

We recommend that the earthwork portion of this project be completed during extended periods of dry weather if possible. If earthwork is completed during the wet season (typically November through May) it may be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork may require additional mitigation measures beyond that which would be expected during the drier summer and fall months. This could include diversion of surface runoff around exposed soils and draining of ponded water on the site. Once subgrades are established, it may be necessary to protect the exposed subgrade soils from construction traffic.

## Geotechnical Engineering Earthwork Construction Observation

As previously discussed, variations in subsurface conditions are possible and may be encountered during construction. In order to permit correlation between the preliminary subsurface data obtained during this investigation and the actual subsurface conditions encountered during construction, as well as affirm substantial conformance with the plans and specifications, a representative of this firm should be present during all phases of the site earthwork to make tests and observations of the site preparation, selection of satisfactory fill materials, proof rolling, placement and compaction of controlled compacted fills, backfilling of excavations to the completed subgrade, etc. Additionally, if lime or cement treatment is needed to stabilize or dry the soil, then our representative should perform observations during mixing, remixing and compaction.

Any site earthwork performed without the presence of our representative will be entirely at the grading contractor's and/or owner's risk and no responsibility for such operations will be accepted by our firm. Sufficient notification **(at least two working days)** is necessary so that our special inspections and testing will coincide with the construction schedule.

***We emphasize the importance of ACG's presence during the observation and testing of the grading operations. ACG's observation of the subsurface soil conditions, especially under the loads imposed by construction equipment, is considered an extension of our investigation, particularly within those areas away from the subsurface explorations.***

## Guide Specifications

Earthwork guide specifications which may be used as a guide in the preparation of contract documents for site grading are included in Appendix D. **The conclusions and recommendations contained in this report should be incorporated into the guide specifications.**

## CRITERIA FOR FOUNDATION DESIGN

Based on the field and laboratory information for this study, we recommend the proposed half plexus and the residential home be supported upon isolated and/or continuous spread footings penetrate below the lowest adjacent building pad soil grade into the bearing earth materials at least 12-inches for one-story structures and 18-inches for 2- to 3-story structures. Foundation dimensions and reinforcement should be based on allowable dead plus live soil bearing values of 1,700 pounds per square foot (psf) for continuous footings of at least 15 inches in width and isolated footings at least 24 inches wide (both directions). The foundations should be supported on engineered fill and/or undisturbed, native soil. The allowable foundation bearing pressures apply to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include short duration wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

Total settlement is estimated at about 1-inch for static compression and is expected to occur the structure is built. We recommend that all footings be reinforced as designed by the structural engineer to provide structural continuity, to permit strong spanning of local irregularities and to be rigid enough to accommodate potential differential movements. Foundations should be proportioned to reduce differential foundation movement estimated at ½-inch over 20 linear feet. Proportioning based on equal total settlement is recommended; however, proportioning to relative constant dead-load pressure would reduce differential settlement between adjacent foundations.

### Lateral Resistance

Foundations placed in approved soil bearing materials (undisturbed native soil and/or engineered fill) could be designed using a coefficient of friction of 0.30 for native and/or engineered fill soils. A design passive resistance value of 275 pounds per square foot per foot (psf/ft) of depth (with a maximum value of 2,750 pounds per square foot) is recommended for native, undisturbed soil and/or engineered fill comprised of pre-approved soil. If both friction and passive pressures are combined, then the smaller value should be halved. For fine grained soils, in no case should the lateral sliding resistance exceed one-half the dead load.

The sides of the excavations for the foundations should be nearly vertical and the concrete should be placed neat against these vertical faces for the passive earth pressure values to be valid. If the loaded side is sloped or benched in the soil, and then backfilled with engineered fill, then the nominal passive pressure should be reduced to the soil frictional or adhesive resistance.

## General Foundation Considerations

ACG's geotechnical engineer or his representative should observe earth material conditions exposed in foundation excavations to confirm the adequacy for structural foundation bearing, confirm the appropriateness of these recommendations, and to allow for an opportunity to provide additional recommendations if deemed necessary. If the earth material conditions encountered differ significantly from those presented in this report, then supplemental recommendations will be required.

An important factor in soils supporting structural improvements is a change in moisture content. The recommendations herein are predicated on the soil moisture beneath and within five feet of the building perimeters, slabs and pavements being maintained in a uniform condition during and after construction. Please be advised that over watering or under watering, types of plants (trees should be at least the distance away from the improvement equal to their maximum height), altering design site drainage, etc., might be detrimental to the foundation, slabs, and/or pavements. We suggest that automatic timing devices be utilized on irrigation systems; however, provision should be made to interrupt the normal watering cycle during and following periods of rainfall. Additional foundation movements could occur if water, from any source, saturates the foundation soils; therefore, proper drainage should be provided during in the final design, during construction, and maintained for the life of the development.

Static and seismic settlement could affect various aspects of the planned development, including utilities, building entrances, sidewalks, footings, and grade beams. Design of these elements should incorporate features to mitigate the effects of the predicted settlements. Because of the anticipated settlements during an earthquake, it may be necessary to replace esthetic features, sheetrock, glazing, exterior flatwork, etc., after a major earthquake.

The foundation excavations should be clean (i.e., free of all loose slough) and maintained in a moist condition between 1 to 4 percent over optimum just prior to placing steel and concrete. The concrete for the foundation should not be placed against a dry excavation surface.

The base of all foundation excavations should be free of water, loose soil, and gravel prior to placing concrete. Concrete should be placed soon after excavating and placement of engineered fill (and lime treatment, if needed) to reduce bearing soil disturbance. Should the soils at bearing level become excessively dry, disturbed, or saturated, the affected soil should be removed prior to placing concrete. In addition, as previously described, unsuitable soils should be completely removed from any proposed construction areas prior to construction. Concrete should not be chuted against the excavation sidewalls. Concrete should be pumped or placed by means of a tremie or elephant's trunk to avoid aggregate segregation and earth contamination. Rebar reinforcement should be properly supported with proper clearances maintained during concrete placement. The concrete should be properly vibrated to mitigate formation of voids and to promote bonding of the concrete to steel reinforcing. These recommendations are predicated upon ACG's representative observing the bearing materials as well as the manner of concrete placement.

### Foundation Setback

The bottoms of utility trenches placed along the perimeter of the foundation should be above an imaginary plane that projects at a 2H:1V angle projected down from a point on the side of the footing that is 9-inches above the lowest outermost edge of the bottom of the foundation per the 2019 CBC Section 1809.14. Where trenches pass through the plane, the trench should be installed perpendicular to the face of the foundation for at least the distance of the depth of the foundation. Alternatively, the foundation could be deepened to attain the recommended setback. Foundation details under the influence of this recommendation should be forwarded along with the structural load information to the geotechnical engineer for review.

## INTERIOR FLOOR SLAB-ON-GROUND SUPPORT

On most project sites, the site mass grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade soils may be disturbed due to utility excavations, construction traffic, desiccation, rainfall, etc. As a result, the floor slab subgrade soils may not be suitable for placement of base rock and concrete and corrective action will be required.

We recommend the subgrade soil underlying the floor slab be graded per the Earthwork section, above, and then thoroughly proof rolled with a loaded tandem axle dump truck or water truck prior to final grading and placement of base rock. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the affected material as engineered fill.

A building pad comprised of ACG approved subgrade soil (graded per the criteria contained within the above "Earthwork" section) is considered suitable for support of the slabs-on-ground of the building without further treatment. The subgrade soils should be maintained at 1 to 4 percent above the compaction moisture content in the upper 12 inches. In all cases the floor slab should not be placed on a dry subgrade.

**Lightly loaded building floor slab design, thickness and reinforcement should be as designed by the structural designer for the anticipated loadings based on a modulus of subgrade soil reaction (k) estimated at 75 pounds per square inch per inch (psi/in). We recommend that slabs-on-grade should be at least 4-inches thick for light duty use. The slabs should be supported on at least 5-inches thick crushed rock or at least 5 inches of Class II aggregate base (compacted to 95% relative compaction) that is underlain by approved subgrade soils prepared per the recommendations of this report.** The exterior ground surface should be at least 6 inches below the top of the floor slab. We emphasize that all surfaces should slope to drain away from all sides of the building. Slabs subjected to heavier loads may require thicker slab sections and/or increased reinforcement.

Slabs-on-grade subject to low frequency, light vehicle traffic should be at least five inches thick, or as per the project structural engineer, and have at least a six-inch thick layer of Class 2 aggregate base (compacted to at least 95 percent relative compaction) placed beneath the slabs. If elastic design is utilized for designing slabs-on-grade founded on at least a six-inch thick layer of Class 2 aggregate base compacted to at least 95 percent relative compaction, then the design k value may be increased to 125 pci. The modulus was provided based on the slab being supported on 6 inches or more of compacted aggregate base and estimates obtained from NAVFAC 7.1 design charts. This value is for a small, loaded area (1 sq. foot or less) such as for small truck wheel loads or point loads and should be adjusted for larger loaded areas. Slabs subjected to heavier loads may require thicker slab sections and/or increased reinforcement. The slabs should be separated from the foundations supporting the structures to allow for differential movements between the two elements. We suggest the structural designer consider slab reinforcement consist of at least #3 reinforcing bars placed on maximum 24-inch centers at mid-slab height.

**Floor Slab Moisture Penetration Resistance**

***We are not experts regarding measures for mitigating (or preventing) moisture intrusion into building's first floor slab(s)-on-grade. If such should be desired, then an expert regarding moisture intrusion should be consulted.***

We suggest the following measures for mitigating (not preventing) moisture intrusion into moisture sensitive interior floor slab(s). The floor slabs should be underlain by a 4-inch-thick layer of crushed washed rock which is intended to serve as a capillary mitigating moisture break and to provide uniform slab support. Gradation of this material should be such that 100 percent will pass a 1-inch sieve and 0 to 5 percent passes the No. 4 sieve. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder. At a minimum, we recommend in areas where it is desired to reduce floor dampness where moisture-sensitive coverings are anticipated, construction should have a suitable waterproof vapor retarder (at least 15 mils thick polyethylene vapor retarder sheeting, Raven Industries "VaporBlock 15, Stego Industries 15 mil "StegoWrap" or W.R. Meadows Sealtight 15 mil "Perminator") incorporated into the floor slab design. The water vapor retarder should be decay resistant material complying with ASTM E96 not exceeding 0.04 perms, ASTM E154 and ASTM E1745 Class A. The vapor barrier should be placed between the concrete slab and the compacted granular aggregate subbase material. The water vapor retarder (vapor barrier) should be installed in accordance with ASTM Specification E 1643-94 or the manufacturer's recommendations, whichever is more stringent. If maximum two inches of clean sand should be placed above the vapor retarder (not recommended), then we recommend a moisture barrier be placed against the outer face of the perimeter foundation. Please note that the sand can be a conduit for water beneath the slab. In addition, the sand can form boils/pockets in the slab concrete. If proposed floor areas or coverings are considered especially sensitive to moisture emissions, additional recommendations from a specialty consultant should be obtained. If desired, further resistance to moisture vapor intrusion could be achieved with proper curing of the concrete, adding a sealant to the mix (e.g., Moxie), having a mix design with low slump (e.g., 2 to 4 inches), low water/cement ratio (we suggest not greater than 0.48), and high strength (we suggest at least 3000 psi).

The structural engineer/Architect and slab-on-grade floor installation contractor should refer to ACI 302 and ACI 360 for procedures and cautions regarding the use and placement of a vapor barrier. In areas of exposed concrete, control joints should be saw-cut into the slab after concrete placement in accordance with ACI Design Manual, Section 302.1R-37 8.3.12 (tooled control joints are not recommended). To control the width of cracking, continuous slab reinforcement should be considered in exposed concrete slabs.

Positive separations and/or isolation joints should be provided between slabs and all foundations, columns, or utility lines to allow independent movement. Interior trench backfill placed beneath slabs should be compacted in accordance with recommendations outlined in the Earthwork section of this report and Appendix D. Other design and construction considerations, as outlined in the ACI Design Manual, Section 302.1R are recommended.

## EXTERIOR FLATWORK

We recommend exterior concrete flatwork subject to only pedestrian traffic be at least 4 inches thick and underlain by at least 5 inches of Class II aggregate base by approved subgrade soils prepared per the "Earthwork" recommendations section of this report.

To reduce the potential for distress to exterior flatwork that might be caused by differential movement of subgrade soils, we recommend that such flatwork be installed with crack-control joints at appropriate spacing as designed by the project architect. Flatwork, which should be installed with crack control joints, includes driveways, sidewalks, and architectural features. All subgrades should be prepared according to the recommendations in the Earthwork section before placing concrete. Positive drainage should be established and maintained adjacent to all flatwork.

## PAVEMENT SECTION ALTERNATIVES

**The R-value test result by exudation at 300 psi is 19 for Sandy Silt subgrade soil that was obtained from R-1 location shown in Figure 2 - Explorations Map.** Based on the R-value indicated and the Traffic indices (T.I.'s) indicated below, pavement section alternatives for the on-site pavement were evaluated per the CalTrans "Highway Design Manual" (HDM). A factor of safety per CalTrans HDM was **not** applied for on-site pavements. The Traffic Index selected for the final pavement design should be based upon the CalTrans "Highway Design Manual" - latest revision and/or edition - including consideration of the vehicular traffic anticipated, number of repetitions, etc., - as determined by your general civil engineer or per regulatory agency requirements. Estimated pavement sections for light (T.I. = 5; e.g., daily cars and pickups, weekly light delivery trucks, occasional fire trucks up to 40 tons, etc.) to medium duty vehicles (T.I. = 6 to 7; e.g., weekly garbage trucks, construction equipment, etc.) are summarized on the following table:

| DESIGN TRAFFIC INDEX | RECOMMENDED PAVEMENT SECTION ALTERNATIVES Inches (Feet) | | | |
|---|---|---|---|---|
| | Asphalt Concrete (AC) (Type B) | Aggregate Base (AB) (Class 2*) | Jointed Portland Cement Concrete** | Aggregate Base (Class 2*) |
| 5.0 | 2" (0.15')<br>2.5" (0.2') | 10" (0.85')<br>8" (0.65') | 5" (0.4') | 6" (0.5') |
| 6.0 | 2.5" (0.2')<br>3" (0.25) | 12" (1.0')<br>11" (0.9') | 6" (0.6') | 7" (0.6') |
| 7.0 | 3" (0.25')<br>4" (0.35') | 14" (1.15')<br>12" (1.0') | 6" (0.6') | 8" (0.65') |

(* Caltrans Class 2 aggregate base (AB). ** Portland Cement Concrete (PCC) should have a modulus of rupture of at least 625 psi)

The above sections should be used for preliminary design and planning purposes only. We recommend representative subgrade sample(s) be obtained and "R" Value test(s) be performed on actual earth materials exposed once pavement areas have been pioneered. These additional test results may then be used to evaluate pavement sections for construction. It is possible that significant variations in pavement sections (vs. those listed above) could result if the resulting test(s) is/are different than that used for this study.

The preliminary sections above should be reviewed and approved by the owner, the civil engineer, and the governing authorities prior to construction. In addition, other recommendations for the stated traffic indices are available, if needed. The total thickness of most sections would closely approximate those given. Thinner sections than those recommended could result in increased maintenance and/or shorter pavement life. If desired, please contact this office for further analysis.

Asphalt concrete paved areas should be designed, constructed, and maintained in accordance with, for example, the recommendations of the Asphalt Institute, CalTrans Highway Design Manual, or other widely recognized authority. Concrete paved areas should be designed and constructed in accordance with the recommendations of the American Concrete Institute, CalTrans Highway Design Manual, or other widely recognized authority, particularly regarding thickened edges, joints, and drainage.

Materials and compaction requirements within the structural sections should conform to the applicable provisions of the CalTrans Standard Specifications (latest edition) including at least 95 percent relative compaction of at least the uppermost twelve inches of subgrade earth materials. Asphalt concrete pavement should conform to the specifications of Type A or B per section 39, and aggregate base should conform to the specifications of Class II per Section 26 of the referenced specifications.

Concrete pavements could be reinforced with nominal rebar, such as at least #4 bars spaced no greater than 24 inches, on center, both ways, placed at above mid-slab height, but with proper concrete cover, as designed by the pavement engineer or structural engineer. If concrete pavements are to be unreinforced, then we suggest the designer use expansion/contraction and/or construction joints spaced no greater than 24 times the pavement thickness, both ways, in nearly square patterns, and detailed in general accordance with ACI Guidelines. Doweling of concrete pavements at critical pathways is also recommended.

We recommend that reinforced concrete pads be provided for truck pad areas in front of and beneath trash receptacles as determined by the structural designer. The trash collection trucks should be parked on the rigid concrete pavement when the trash receptacles are lifted. The concrete pads should be at least 6 inches thick and properly reinforced. Thickened edges should be used along outside edges of concrete pavements. Edge thickness should be at least 2 inches thicker than concrete pavement thickness and taper to the actual concrete pavement thickness 36 inches inward from the edge. Integral curbs may be used in lieu of thickened edges.

The above pavement section alternatives were estimated on the basis that a comparable soil type with R-value indicated above would constitute the final subgrade of the pavement. We emphasize that ACG should be retained to observe and test final subgrade soil(s) exposed to affirm that the soil is comparable to that indicated above. Where differing earth materials are encountered, they should be tested to affirm that they will also provide the same or better support for pavement sections like those recommended above for preliminary design.

Adequate drainage systems should be provided to prevent both surface and subsurface saturation of the subgrade soils. As a design option, a subdrain system beneath and along the edges of the pavements might be considered. The purpose of the system would be to mitigate saturation and loss of strength/stability of the subgrade soils. Subdrains should be especially considered beneath valley drains, if utilized for the project. As an alternate to edge drains (especially around landscape planters), barrier curbing that extends to at least four inches into the soil subgrade below the bottom of the aggregate base layer could be considered to limit infiltration of water beneath the adjacent pavement. Drainage inlets should be perforated (weep holes installed) at the level of the aggregate base layer. A layer of geotextile fabric should be placed on the outside of the drain inlet over the weep holes to reduce the potential for migration or piping of fines through the holes.

Base course or pavement materials should not be placed when the subgrade surface is wet. Surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade.

### Pavement Construction Considerations

On most project sites, the site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrades may become disturbed due to utility excavations, construction traffic, rainfall, etc. As a result, the pavement subgrade may not be suitable for placement of aggregate base and pavement. We recommend the area underlying the pavement be rough graded and proof-rolled prior to placement of aggregate base material. Particular attention should be paid to high traffic areas and utility trenches that were backfilled. Areas where disturbance has occurred and materials are unsuitable, they should be removed and replaced with compacted structural fill.

The aggregate base should be uniformly moisture-conditioned and compacted to at least 95 percent relative compaction (modified proctor) in accordance with this report. Base course or pavement materials should not be placed when the surface is wet. Surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade.

Minimizing subgrade saturation is an important factor in maintaining subgrade strength. Water allowed to pond on or adjacent to pavements could saturate the subgrade and cause premature pavement deterioration. The pavement should be sloped to provide rapid surface drainage, and positive surface drainage should be maintained away from the edge of the paved areas. Design alternatives which could reduce the risk of subgrade saturation and improve long-term pavement performance include crowning the pavement subgrades to drain toward the edges, rather than to the center of the pavement areas; and installing surface drains next to any areas where surface water could pond. Properly designed and constructed subsurface drainage will reduce the time subgrade soils are saturated and can also improve subgrade strength and performance. In areas where there will be irrigation adjacent to pavements, we recommend the owner consider installing perimeter drains for the pavements.

Preventative maintenance should be planned and provided for through an on-going pavement management program to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment.

**SUBDRAINAGE**

Subdrains might be needed to control subsurface water that might become perched in top and/or fill soils. Each case should be evaluated by the Geotechnical Engineer so that he/she could make appropriate mitigation recommendations.

## LIMITATIONS

This report contains statements regarding opinions, conclusions, and recommendations, all of which involve certain risks and uncertainties. These statements are often, but are not always, made through the use of words or phrases such as “anticipates”, “intends”, “estimates”, “plans”, “expects”, “we believe”, “we consider”, “it is our opinion”, “mitigation or mitigate”, “suggest”, “may be”, “expected”, “predicated”, “advised”, and similar words or phrases, or future or conditional verbs such as “will”, “would”, “should”, “potential”, “can continue”, “could”, “may”, or similar expressions. Actual results may differ significantly from the expectations contained in the statements. Among the factors that may result in differences are the inherent uncertainties associated with earth material conditions, groundwater, project development activities, regulatory requirements, and changes in the planned development.

The analysis and recommendations submitted in this report are based in part upon the data from the exploratory borings at the indicated locations and in part on information provided by the client. The nature and extent of subsurface variations between the test borings across the site (or due to the modifying effects of weather and/or man) may not become evident until further exploration or during construction. If variations then appear evident, then the conclusions, opinions, and recommendations in this report shall be considered invalid, unless the variations are reviewed and the conclusions, opinions, and recommendations are modified or approved in writing.

This report was prepared to assist the client in the evaluation of the site and to assist the architect and/or engineer in the design of the improvements. This firm should be provided the opportunity for a general review of final plans and specifications to determine that the recommendations of this report have been properly interpreted and implemented in the plans and specifications.

If there are any significant changes in the project as described herein, then the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and conclusions and recommendations modified or verified in writing.

This report is issued for the client's use only. In addition, it is his responsibility to ensure that the information and recommendations contained herein are called to the attention of the designer for the project; and, that necessary steps are taken to implement the recommendations during construction.

The findings in this report were developed on the date(s) indicated. Changes in the conditions of the property can occur with the passage of time, whether they are due to natural processes or the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control. Therefore, this report and the findings on which it is based are subject to our review at the onset of and during construction, or within two years, whichever first occurs.

The scope of services of this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria, etc.) assessment of the site or identification or prevention of pollutants, hazardous materials, or any other adverse conditions. If the owner is concerned about the potential of such contamination or pollution, other studies should be undertaken.

No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. If any changes in the nature, design, or location of the project as outlined in this report are planned, the conclusion and recommendations contained in this report shall not be considered valid unless ACG reviews the changes, and either verifies or modifies the conclusions of this report in writing.

This report is applicable only for the project and site studied and should not be used for design and/or construction on any other site.

We appreciate this opportunity to be of service on this project. If you have any questions regarding this report, then please do not hesitate to contact us.

## REFERENCES

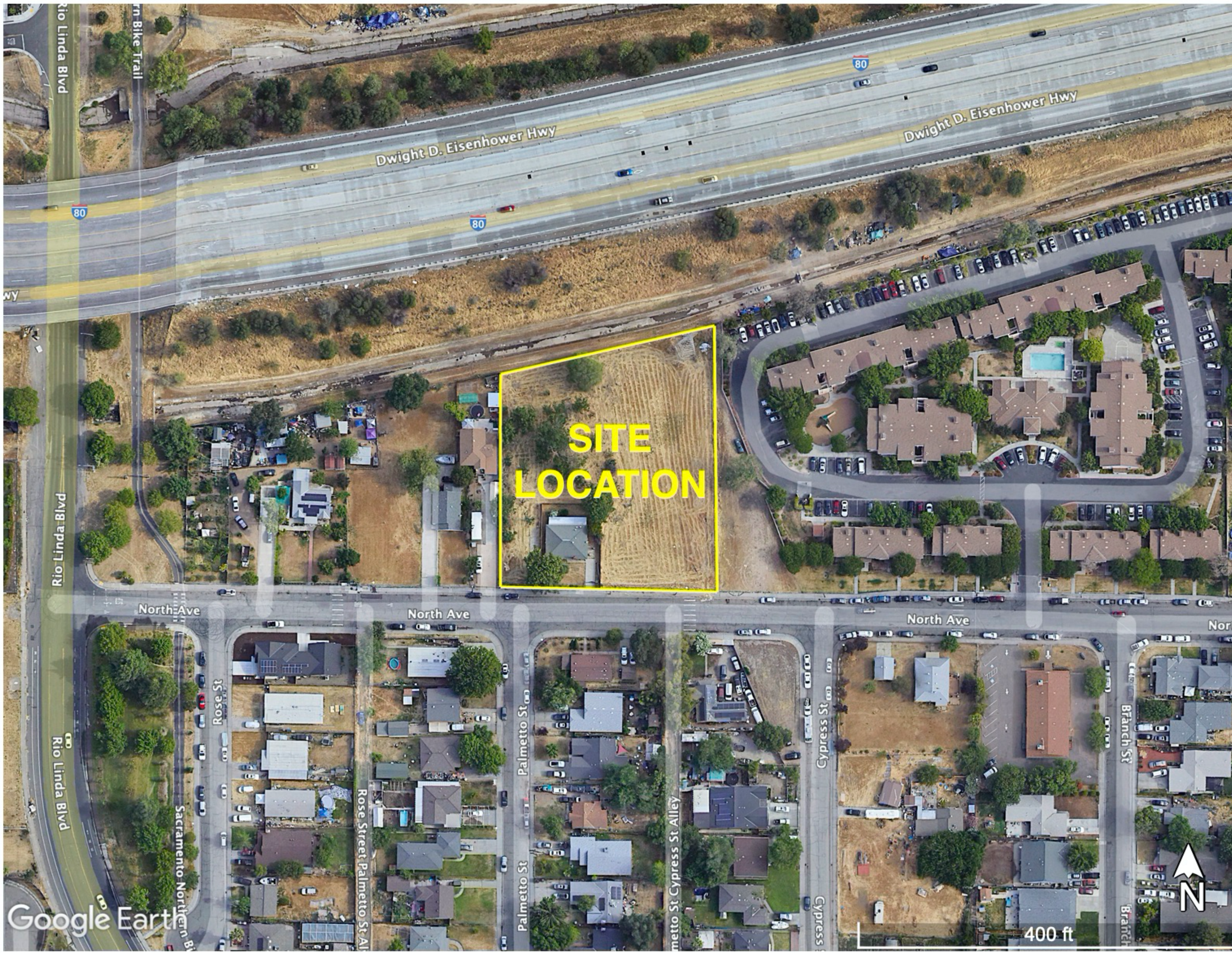
1. American Society for Civil Engineers, 2016 “Minimum Design Loads for Buildings and Other Structures,” ASCE/SEI 7-16.
2. ASTM, “Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort,” Volume 04.08
3. California Building Code, 2019, “California Code of Regulations, Title 24, Part 2, Volume 2 of 2,” California Building Standards Commission, published by ICBO.
4. CGS “Preliminary Geologic Map of the Sacramento 30’ x 60’ Quadrangle, California”, 2011, scale 1:100,000. Compilation and Digital Preparation by Carlos I. Gutierrez.
5. CGS website (https://www.conservation.ca.gov/cgs/earthquakes) for Regulatory Maps, Reports and GIS data that includes Earthquake Fault Zones, Landslide and Liquefaction Zones.
6. Hart, Earl W., Revised 1994, "Fault-Rupture Hazard Zones in California, Alquist Priolo, Special Studies Zones Act of 1972,” California Division of Mines and Geology, Special Publication 42.
7. Jennings, Charles W. and Bryant, William A., 2010, “Fault Activity Map of California” (scale 1: 750,000) published by CGS, Geologic Data Map No. 6.
8. SEAOC/OSHPD U.S. Seismic Hazard Maps (reference ASCE/SEI 7-16, 2018 International Building Code/2019 California Building Code).
9. RFE Engineering, Inc., “On-Site Improvement Plans” (Sheet No. C6), dated January 24, 2022.
10. Google Earth Aerial Photography of the Subject Site.

## APPENDICES

# APPENDIX A

**VICINITY MAP**

**EXPLORATIONS MAP**

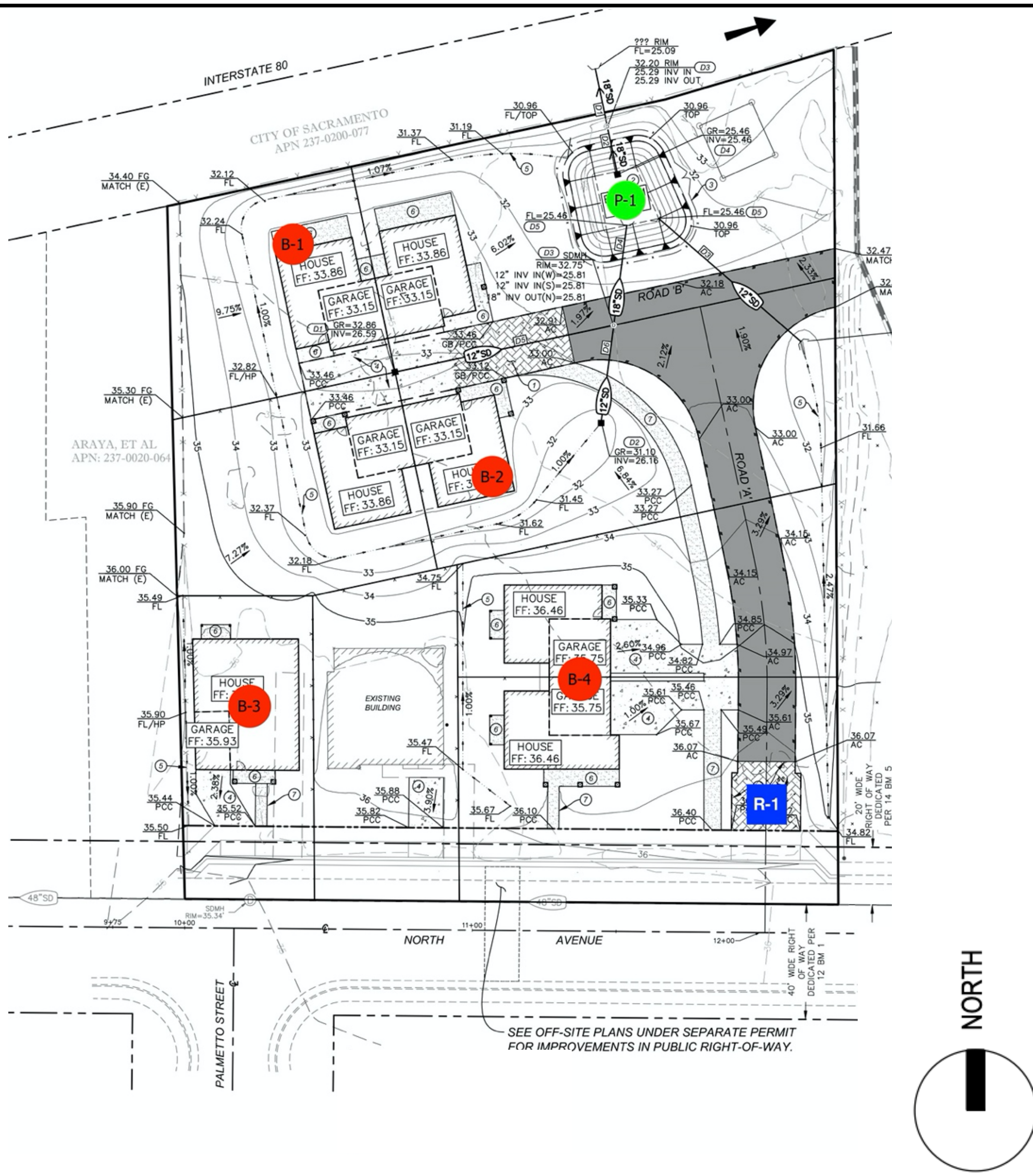



**NOTES:**

Location of site (designated by yellow border) is approximate.

Source for base map: Imagery from Google Earth 2022©.

| | | |
|---|---|---|
| **ALLERION CONSULTING GROUP, INC.**<br>1050 Melody Lane, Suite 160<br>Roseville, CA 95678<br>Phone: 916-742-5096 | **VICINITY MAP**<br>**Proposed Nerradscali Subdivision**<br>**905 North Avenue**<br>**Sacramento, California** | **ACG JOB NO.**<br>05-22016G<br>**DATE**<br>03/23/2022<br>**FIGURE**<br>1 |




**LEGEND:**

- B-x – Approximate Location and Number of Boring
- P-x – Approximate Location and Number of Percolation Test
- R-1 – Approximate Location of R-value Sample

**NOTES:**

Source for base map: RFE Engineering, Inc., "On-Site Improvement Plans" (Sheet No. C6), dated January 24, 2022.

**ALLERION CONSULTING GROUP, INC.**
1050 Melody Lane, Suite 160
Roseville, CA 95678
Phone: 916-742-5096

## EXPLORATIONS MAP

**Proposed Nerradscali Subdivision**
**905 North Avenue**
**Sacramento, California**

| | |
|---|---|
| ACG JOB NO. | 05-22016G |
| DATE | 03/23/2022 |
| FIGURE | 2 |

# APPENDIX B

## FIELD EXPLORATION METHODS

## LOGS OF SUBSURFACE EXPLORATIONS

Allerion
Consulting Group, Inc.

**FIELD EXPLORATION METHODS**

Field exploration included a general geotechnical engineering reconnaissance within the study area, as well as the excavation of subsurface explorations at approximate locations shown on the Explorations Map, Figure 2, Appendix A. Locations of explorations were determined in the field by estimating from the existing site features shown on an aerial photo. The exploration locations should only be considered accurate to the degree implied by the means and methods used to define them. The explorations were accomplished, and the soil logging and sampling performed by, a Staff Geologist and/or Engineer under the direct supervision of a California licensed Geotechnical Engineer. The explorations were conducted to determine the geometry and geotechnical characteristics of subsurface geologic deposits at the site.

The exploratory borings were advanced with a 4-inch outer-diameter continuous flight helical solid stem augers (SSA) powered by a truck mounted drill rig. Relatively undisturbed soil samples were recovered from the borings at selected intervals by either a 1.4-inch SPT (standard penetration) or 2-inch inner-diameter samplers (Modified California) advanced with an automatic hammer driving a 140 lb. hammer freely falling 30 inches (standard 350-foot/lb. striking force). The number of blows of the hammer required to drive the samplers each 6-inch to 18-inch interval of each drive is denoted as the penetration resistance or "blow count" and provides a field estimate of soil consistency/relative density. Blow counts shown on the logs have not been corrected/converted. Selected undisturbed samples were retained in moisture-proof containers for laboratory testing and reference. Bulk soil samples were recovered directly from excavation cuttings and placed in sealed plastic sample bag(s).

Soils were logged in the field by the Staff Geologist or Engineer and were field classified based on inspection of samples and auger cuttings per the Unified Soil Classification System (ASTM D2487) by color, gradation, texture, type, etc. Groundwater observations were made in the explorations during and after drilling. Exploration log prepared for the exploration provides soil descriptions and field estimated depths. The exploration logs are included in this Appendix B which also contains the Explorations Log Legend. This log includes visual classifications of the materials encountered during drilling as well as the field engineer's interpretation of the subsurface conditions. Final exploration logs included with this report represents the geotechnical engineer's interpretation of the field logs.

Samples of the subsurface soil earth materials were obtained from the exploratory borings for use in laboratory testing to further determine the soil's engineering properties and geotechnical design parameters to be used for future site improvements. The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Bulk soil samples were recovered directly from excavation cuttings and placed in a plastic sample bag. Soil samples were then transported to ACG's soil mechanics laboratory for further testing. Field descriptions within the exploration logs have been modified, where appropriate, to reflect laboratory test results. Upon completion of drilling the test borings were backfilled from final test boring depth up to original ground surface with soil cuttings.

Project: **Proposed Nerradscali Subdivision**

Project Location: **Sacramento, CA**

Project Number: **05-22016G**

# Log of Boring B-1



| | | | | | |
|---|---|---|---|---|---|
| Date(s) Drilled | **2/23/2022** | Logged By | **CH** | Checked By | **MK** |
| Drilling Method | **Solid Stem Auger (SSA)** | Drill Bit Size/Type | **4" SSA** | Total Depth of Borehole | **11.5 feet begs** |
| Drill Rig Type | **CME 45** | Drilling Contractor | **Cal-Nev Geo Exploration** | Approximate Surface Elevation | **35 feet above MSL** |
| Groundwater Level and Date Measured | **Not Encountered** | Sampling Method(s) | **Modified California, SPT** | Hammer Data | **140 lb., 30", Auto** |
| Borehole Backfill | **Soil Cuttings** | Location | **See Explorations Map** | | |

| Apprx. Elevation (feet) | Apprx. Depth (feet) | Sample Type | Sample Number | Sampling Resistance, blows/6 inches | Material Type (USCS) | Graphic Log | MATERIAL DESCRIPTION | Recovery (percent) | Water Content, % | Dry Unit Weight, pcf | Percent Fines | LL, % | PI, % | Remarks and Other Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 0 | | | | ML | | Medium Stiff, Moist, Dark Brown, Fine Sandy SILT | | | | | | | |
| | | | | | CL | | Very Stiff, Moist, Light Brown, Fine Sandy Silty CLAY | | | | | | | |
| | | | 1 | 6<br>8<br>31 | | | | | 16.5 | 106 | | | | |
| | | | | | ML | | Hard, Moist, Light Brown, Fine Sandy SILT | | | | | | | |
| 30 | 5 | | 2 | 50/6" | | | | | | | | | | |
| | | | | | | | Red-Brown with Rock Fragments | | | | | | | |
| | | | | | | | Light Brown | | | | | | | |
| 25 | 10 | | | | | | | | | | | | | |
| | | | 3 | 16<br>36<br>50/6" | | | | | | | | | | |
| | | | | | | | Boring was completed at a depth of approximately 11.5 feet begs. Free groundwater was not encountered during or after the drilling. Boring was backfilled with soil cuttings. | | | | | | | |
| 20 | 15 | | | | | | | | | | | | | |
| 15 | 20 | | | | | | | | | | | | | |
| 10 | 25 | | | | | | | | | | | | | |
| 5 | 30 | | | | | | | | | | | | | |

/Volumes/Ace Quality Control/ACE Projects/ALLERION Projects/2022/Geotechnical /05-22016G Nerradscali Subdivision, Sacramento/Boring Logs/Field Worksheet Logs.bg4[Allerion-30.tpl]

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| | |
|---|---|
| Project: **Proposed Nerradscali Subdivision** | # Log of Boring B-2 |
| Project Location: **Sacramento, CA** | **Sheet 1 of 1** |
| Project Number: **05-22016G** | |

| | | |
|---|---|---|
| Date(s) Drilled **2/23/2022** | Logged By **CH** | Checked By **MK** |
| Drilling Method **Solid Stem Auger (SSA)** | Drill Bit Size/Type **4" SSA** | Total Depth of Borehole **11.5 feet begs** |
| Drill Rig Type **CME 45** | Drilling Contractor **Cal-Nev Geo Exploration** | Approximate Surface Elevation **34 feet above MSL** |
| Groundwater Level and Date Measured **Not Encountered** | Sampling Method(s) **Modified California, SPT** | Hammer Data **140 lb., 30", Auto** |
| Borehole Backfill **Soil Cuttings** | Location **See Explorations Map** | |

| Apprx. Elevation (feet) | Apprx. Depth (feet) | Sample Type | Sample Number | Sampling Resistance, blows/6 inches | Material Type (USCS) | Graphic Log | MATERIAL DESCRIPTION | Recovery (percent) | Water Content, % | Dry Unit Weight, pcf | Percent Fines | LL, % | PI, % | Remarks and Other Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 0 | | | | ML | | Medium Stiff, Moist, Dark Brown, Fine Sandy SILT | | | | | | | |
| | | | | | CL | | Very Stiff, Moist, Dark Brown, Fine Sandy Silty CLAY | | | | | | | |
| | | | 1 | 28<br>50\1" | ML | | Hard, Moist, Dark Brown, Fine Sandy SILT<br>Light Brown | | 18.4 | | 59 | 38 | 16 | |
| 29 | 5 | | 2 | 16<br>32<br>42 | | | Light Brown with Orange Mottles | | | | | | | |
| 24 | 10 | | 3 | 34<br>50/1" | | | Light Brown, No Mottles | | | | | | | |
| | | | | | SP | | Dense, Moist, Dark Brown to Brown, Fine to Medium SAND | | | | | | | |
| 19 | 15 | | 4 | 11<br>15<br>20 | | | | | 8.3 | | | | | |
| | | | | | ML | | Hard, Moist, Light Brown, Fine Sandy SILT | | | | | | | |
| 14 | 20 | | 5 | 14<br>25<br>50\6" | | | | | | | | | | |
| | | | | | | | Boring was completed at a depth of approximately 21.5 feet begs. Free groundwater was not encountered during or after the drilling. Boring was backfilled with soil cuttings. | | | | | | | |
| 9 | 25 | | | | | | | | | | | | | |
| 4 | 30 | | | | | | | | | | | | | |

/Volumes/Ace Quality Control/ACE Projects/ALLERION Projects/2022/Geotechnical /05-22016G Nerradscali Subdivision, Sacramento/Boring Logs/Field Worksheet Logs.bg4[Allerion-30.tpl]

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# Log of Boring B-3

**Sheet 1 of 1**

Project: **Proposed Nerradscali Subdivision**
Project Location: **Sacramento, CA**
Project Number: **05-22016G**

| | | |
|---|---|---|
| Date(s) Drilled: **2/23/2022** | Logged By: **CH** | Checked By: **MK** |
| Drilling Method: **Solid Stem Auger (SSA)** | Drill Bit Size/Type: **4" SSA** | Total Depth of Borehole: **21.5 feet begs** |
| Drill Rig Type: **CME 45** | Drilling Contractor: **Cal-Nev Geo Exploration** | Approximate Surface Elevation: **37 feet above MSL** |
| Groundwater Level and Date Measured: **Not Encountered** | Sampling Method(s): **Modified California, SPT** | Hammer Data: **140 lb., 30", Auto** |
| Borehole Backfill: **Soil Cuttings** | Location: **See Explorations Map** | |

| Apprx. Elevation (feet) | Apprx. Depth (feet) | Sample Type | Sample Number | Sampling Resistance, blows/6 inches | Material Type (USCS) | Graphic Log | MATERIAL DESCRIPTION | Recovery (percent) | Water Content, % | Dry Unit Weight, pcf | Percent Fines | LL, % | PI, % | Remarks and Other Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37 | 0 | | | | ML | | Medium Stiff, Moist, Dark Brown, Fine Sandy SILT with Gravel | | | | | | | |
| | | | 1 | 2<br>3<br>17 | | | Very Stiff, Light Brown with Orange Mottles, Fine Sandy SILT | | 12.7 | | 50 | | | |
| 32 | 5 | | 2 | 26<br>43<br>50\6" | | | Hard, No Mottles | | 24 | 95 | | | | |
| | | | | | | | Light Brown with White Streaks | | | | | | | |
| | | | | | | | Light Brown with Orange Mottles | | | | | | | |
| 27 | 10 | | 3 | 11<br>19<br>30 | | | | | | | | | | |
| | | | | | | | Boring was completed at a depth of approximately 11.5 feet begs. Free groundwater was not encountered during or after the drilling. Boring was backfilled with soil cuttings. | | | | | | | |
| 22 | 15 | | | | | | | | | | | | | |
| 17 | 20 | | | | | | | | | | | | | |
| 12 | 25 | | | | | | | | | | | | | |
| 7 | 30 | | | | | | | | | | | | | |

Project: **Proposed Nerradscali Subdivision**
Project Location: **Sacramento, CA**
Project Number: **05-22016G**

# Log of Boring B-4

**Sheet 1 of 1**

| | | | | | |
|---|---|---|---|---|---|
| Date(s) Drilled | **2/23/2022** | Logged By | **CH** | Checked By | **MK** |
| Drilling Method | **Solid Stem Auger (SSA)** | Drill Bit Size/Type | **4" SSA** | Total Depth of Borehole | **11 feet begs** |
| Drill Rig Type | **CME 45** | Drilling Contractor | **Cal-Nev Geo Exploration** | Approximate Surface Elevation | **36 feet above MSL** |
| Groundwater Level and Date Measured | **Not Encountered** | Sampling Method(s) | **Modified California, SPT** | Hammer Data | **140 lb., 30", Auto** |
| Borehole Backfill | **Soil Cuttings** | Location | **See Explorations Map** | | |

| Apprx. Elevation (feet) | Apprx. Depth (feet) | Sample Type | Sample Number | Sampling Resistance, blows/6 inches | Material Type (USCS) | Graphic Log | MATERIAL DESCRIPTION | Recovery (percent) | Water Content, % | Dry Unit Weight, pcf | Percent Fines | LL, % | PI, % | Remarks and Other Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 0 | | | | ML | | Medium Stiff, Moist, Dark Brown, Fine Sandy SILT | | | | | | | |
| | | | | | CL | | Stiff, Moist, light brown, Fine Sandy Silty CLAY | | | | | | | |
| | | | 1 | 6<br>50\6" | ML | | Hard, Moist, Light Brown, Fine Sandy SILT | | 16.1 | 101 | | | | |
| 31 | 5 | | 2 | 10<br>9<br>15 | | | Very Stiff, Light Brown with Orange Mottles | | | | | | | |
| 26 | 10 | | 3 | 16<br>50/6" | | | Hard, Light Brown No Mottles | | | | | | | |
| | | | | | | | Boring was completed at a depth of approximately 11 feet begs. Free groundwater was not encountered during or after the drilling. Boring was backfilled with soil cuttings. | | | | | | | |
| 21 | 15 | | | | | | | | | | | | | |
| 16 | 20 | | | | | | | | | | | | | |
| 11 | 25 | | | | | | | | | | | | | |
| 6 | 30 | | | | | | | | | | | | | |

/Volumes/Ace Quality Control/ACE Projects/ALLERION Projects/2022/Geotechnical /05-22016G Nerradscali Subdivision, Sacramento/Boring Logs/Field Worksheet Logs.bg4[Allerion-30.tpl]

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Project: **Proposed Nerradscali Subdivision**
Project Location: **Sacramento, CA**
Project Number: **05-22016G**

# Key to Log of Boring
**Sheet 1 of 1**

| Apprx. Elevation (feet) | Apprx. Depth (feet) | Sample Type | Sample Number | Sampling Resistance, blows/6 inches | Material Type (USCS) | Graphic Log | MATERIAL DESCRIPTION | Recovery (percent) | Water Content, % | Dry Unit Weight, pcf | Percent Fines | LL, % | PI, % | Remarks and Other Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

**COLUMN DESCRIPTIONS**

1 Apprx. Elevation (feet): Approximate Elevation (MSL, feet).
2 Apprx. Depth (feet): Approximate Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 Sampling Resistance, blows/6 inches: Number of blows to advance driven sampler 6 inches (or distance shown) beyond seating interval using the hammer identified on the boring log.
6 Material Type (USCS): Type of material encountered per USCS.
7 Graphic Log: Graphic depiction of the subsurface material encountered.
8 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9 Recovery (percent): Percent Recovery
10 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
11 Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
12 Percent Fines: The percent fines (soil passing the No. 200 Sieve) in the sample. WA indicates a Wash Sieve, SA indicates a Sieve Analysis.
13 LL, %: Liquid Limit, expressed as a water content.
14 PI, %: Plasticity Index, expressed as a water content.
15 Remarks and Other Tests : Comments and observations regarding drilling or sampling made by driller or field personnel.

**FIELD AND LABORATORY TEST ABBREVIATIONS**

CHEM: Chemical tests to assess constituents
COMP: Compaction test (Proctor)
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

**MATERIAL GRAPHIC SYMBOLS**

Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)

SILT, SILT w/SAND, SANDY SILT (ML)

Poorly graded SAND (SP)

**TYPICAL SAMPLER GRAPHIC SYMBOLS**

Bulk Sample

3-inch-OD California Modified w/ 2.38-inch-ID Stainless Steel Tube

2.5-inch-OD Modified California w/ 1.91-inch-ID stainless steel tube

2-inch-OD split spoon (SPT)

**OTHER GRAPHIC SYMBOLS**

Water level (at time of drilling, ATD)

Water level (after waiting)

Minor change in material properties within a stratum

Inferred/gradational contact between strata

?  Queried contact between strata

**GENERAL NOTES**

1: Soil classifications are based on the Unified Soil Classification System (USCS). Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

# APPENDIX C

## LABORATORY TESTING

## LABORATORY TESTING

Samples retrieved during the field exploration were taken to the soil mechanics laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) described in Appendix B. An applicable laboratory testing program was formulated for classification testing and to determine engineering properties of the subsurface earth materials. The field descriptions were confirmed or modified based on the test results.

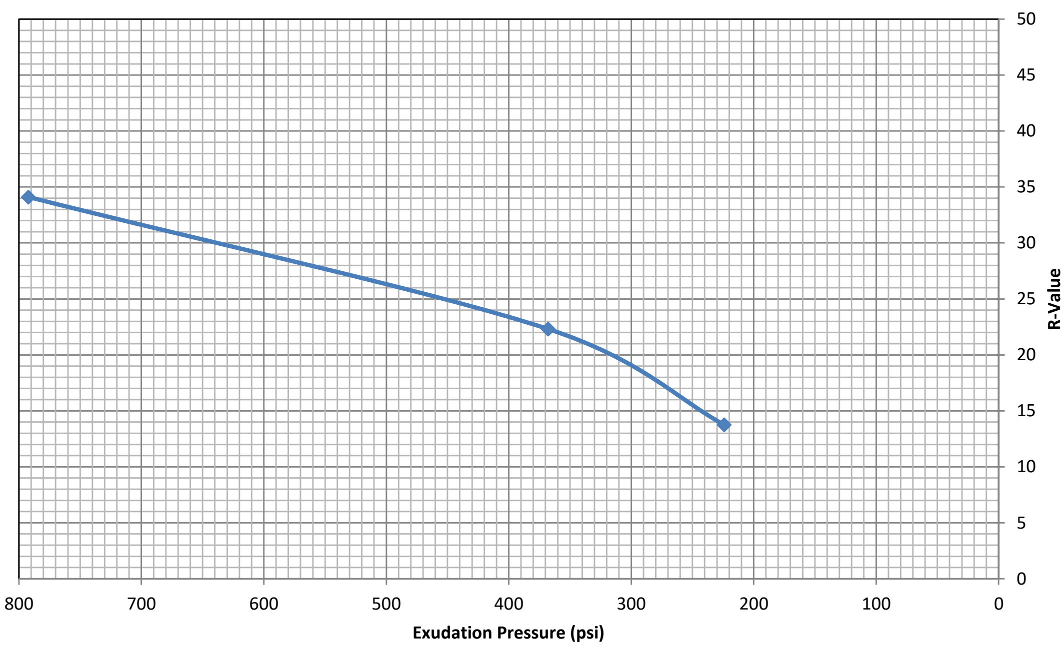
Soil mechanics laboratory tests were performed on soil samples recovered from the explorations to further determine the physical and engineering properties of the soils. These tests included R-value test (CTM 301), gradation (ASTM D422), dry density (ASTM D 2937), Atterberg limits (ASTM D 4318) and natural moisture content (ASTM D 2216). The results of these tests are shown on the Exploration Log at the depth that each sample was recovered. The R-value test results are attached. The laboratory test results were used for the geotechnical engineering analyses, and the development of engineering, earthwork, and construction recommendations.

CONSTRUCTION TESTING SERVICES

# Resistance "R" Value by Stabilometer

Test Performed in General Accordance with
☑ CT 301
☐ ASTM D 2844-07

| | | | |
|---|---|---|---|
| **Project Name:** | Nerradscali Subdivision | **CTS Job No.** | 18291 |
| **Project Location:** | Sacramento, CA | **Client:** | ACE Quality Control |
| **Date Sampled:** | 2/23/2022 | **Sample Location:** | 905 North Ave |
| **Date Tested:** | 2/28/2022 | **Lab Log In:** | 240494 |
| **Sampled by:** | Client | **Source:** | N/A |
| **Tested by:** | James Bridges | **Description:** | Silty Sand |




| Specimen | Dry Density (pcf) | Moisture Content %) | Exudation Pressure (psi) | Corrected R Value | Expansion Pressure (psf) |
|---|---|---|---|---|---|
| A | 114.0 | 13.5 | 792 | 34 | 128 |
| B | 114.1 | 14.6 | 368 | 22 | 66 |
| C | 113.8 | 15.7 | 224 | 14 | <1 |

**R-Value at 300 psi** **19**

***Limitations:***
*The materials tested was sampled and/or transported to our laboratory by parties other than CTS personnel. This report therefore makes no representation of whether the sample tested was representative of the subject material. Testing was performed in accordance with the applicable test methods by qualified personnel. Pursuant to applicable building codes and/or specifications, the results presented in this report are for the items listed herein and for the exclusive use of the Client and the registered design professional in responsible charge. The results apply only to the samples tested and are not to be considered as a guarantee or warranty, express or implied. In the event changes to the specifications (and/or materials) were made and not communicated to CTS, then CTS assumes no responsibility for the accuracy of pass/fail statements (meets/did not meet), if provided*

Reviewed by: Amy Reeves, EIT
Title: Staff Engineer
Date: 3/2/2022

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# APPENDIX D

## GUIDE SPECIFICATIONS FOR EARTHWORK

## GUIDE SPECIFICATIONS FOR EARTHWORK

A. General Description

1. This item shall consist of all clearing and grubbing, removal of existing obstructions, preparation of the land to be filled, filling the land, spreading, compaction and control of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades and slopes as shown on the accepted plans.

2. The Geotechnical Engineer is not responsible for determining line, grade elevations or slope gradients. The property owner or his representative shall designate the party that will be responsible for those items of work.

B. Geotechnical Report

1. The Geotechnical Report has been prepared for this project by Allerion Consulting Group (ACG), Roseville, California, (916-742-5096). This report was for design purposes only and may not be sufficient to prepare an accurate bid. A copy of the report is available for review at **ACG's** office.

2. Contents of these guide specifications shall be integrated with the Geotechnical Report of which they are a part and shall not be used as a self-contained document. Where a conflict occurs between these guide specifications and the conclusions and recommendations contained in the report, then the conclusions and recommendations shall take precedence and these guide specifications adjusted accordingly.

C. Site Preparation

1. Clearing Area(s) to be Filled: All trees, brush, logs, rubbish, and other debris shall be removed and disposed of to leave the areas that have been disturbed with a neat appearance. Underground structures shall be removed or may be crushed in place upon approval by the Geotechnical Engineer. Excavations and depressions resulting from the removal of the above items shall be cleaned out to firm undisturbed soil and backfilled with suitable materials in accordance with the specifications contained herein. Stockpiles of clean soil may be reused as filled material provided the soil is free of significant vegetation, debris, rubble, and rubbish and is approved by the Geotechnical Engineer.

2. Surfaces upon which fill is to be placed, as well as subgrades of structure pad(s) left at existing grade, shall have all organic material removed; or, with permission of the Geotechnical Engineer, closes cut and remove vegetation and thoroughly disc and blend the remaining nominal organics into the upper soil. Discing must be thorough enough so that no concentrations of organics remain, which may require re-discing or cross-discing several times.

3. Organic laden material removed per paragraph C.2. above, may be used as fill in landscaped areas provided that the material shall not extend closer than ten (10) feet to any structure, shall not exceed two (2) feet in thickness or be used where the material could, in the opinion of the Geotechnical Engineer, create a slope stability problem, and shall be compacted to at least eighty-two (82) percent relative compaction per ASTM Test Designation D 1557. Alternatively, the organic laden material may be hauled off-site and suitably disposed of.

4. Upon completion of the organic removal, exposed surface shall be plowed or scarified to a depth of at least six (6) inches, and until the surface is free from ruts, hummocks, or other uneven features which would tend to prevent uniform compaction by the equipment to be used. Where vegetation has been close cut and removed and remaining organics blended with the upper soil, further scarifying may not be necessary. Where fills are to be placed on hill slopes, scarifying shall be to depths adequate to provide bond between fill and fill foundation. Where considered necessary by the Geotechnical Engineer, (typically where the slope ratio of the original ground is steeper than five (5) horizontal to one (1) vertical), the ground surface shall be stepped or benched to achieve this bond. Vertical dimension of the required benches shall be as determined by the Geotechnical Engineer, based upon location, degree, and condition of the hill slope.

5. After the foundation for the fill has been cleared and scarified, it shall be disced or bladed until it is uniform and free from large clods, uniformly moisture conditioned to the range specified by the Geotechnical Engineer, and compacted to not less than [refer to report -- if not recommended, use 90] percent of maximum dry density as determined by ASTM D 1557, or to such other density as may be determined appropriate for the materials and conditions and acceptable to the Geotechnical Engineer and the owner or his representative.

D. <u>Fill Materials</u>

1. Materials for fill shall consist of material approved by the Geotechnical Engineer.

2. The materials used for fill shall be free from organic matter and other deleterious substances and shall not contain rocks, clods, lumps, or cobbles exceeding four (4) inches in greatest dimension with not more than fifteen (15) percent larger than two and one-half (2-1/2) inches.

3. Imported materials to be used for fill shall be non-expansive [typically, have a plasticity index not exceeding twelve (12)], shall be of maximum one (1) inch size, and shall be tested and approved by the Geotechnical Engineer prior to commencement of grading and before being imported to the site.

4. The Contractor shall notify the Geotechnical Engineer at least four (4) working days in advance of the Contractor's intention to import soil; shall designate the borrow area; and, shall permit the Geotechnical Engineer to sample the borrow area for the purposes of examining the material and performing the appropriate tests to evaluate the quality and compaction characteristics of the soil. Compaction requirements for the material shall be based upon the characteristics of the material as determined by the Geotechnical Engineer.

E. <u>Placement of Fill</u>

1. The selected fill material shall be placed in level, uniform layers (lifts) which, when compacted, shall not exceed six (6) inches in thickness. Water shall be added to the fill, or the fill allowed to dry as necessary to obtain fill moisture content at which compaction as specified can be achieved. Each layer shall be thoroughly mixed during the spreading to obtain uniformity of moisture in each layer.

2. The fill material shall be compacted within the appropriate moisture content range (typically optimum to slightly above the optimum) as determined by the Geotechnical Engineer for the soil(s) being used.

3. Each layer of fill shall be compacted to not less than [refer to report; if not recommended, use 90] percent of maximum dry density as determined by ASTM Test Designation D 1557. Compaction equipment shall be of such design that it will be able to compact the fill to the specified density. Compaction shall be accomplished while the fill material is within the specified moisture content range. Compaction of each layer shall be continuous over its entire area and the compaction equipment shall make sufficient trips to ensure that the required density has been obtained. No ponding or jetting is permitted.

4. If work has been interrupted for any reason, the Geotechnical Engineer shall be notified by the contractor at least two (2) working days prior to the intended resumption of grading.

F. <u>Geotechnical Engineer</u>

1. Owner is retaining Geotechnical Engineer to make observations and tests to determine general compliance with Plans and Specifications, to verify expected or unexpected variations in subsurface conditions, and to give assistance in appropriate decisions. Cost of Geotechnical Engineer will be borne by the Owner, except costs incurred for re-tests and/or re-observations caused by failure of the Contractor to meet specified requirements will be paid by the Owner and back charged to Contractor.

G. <u>Observation and Testing</u>

1. Field density tests shall be made by the Geotechnical Engineer or his representative of the compaction of each layer of fill. Density tests shall be taken in the compacted material below any surfaces disturbed by the construction equipment. When these tests indicate that the density of any layer of fill or portion thereof is below the required density or moisture content, the particular layer or portion shall be reworked until the required density or moisture content has been obtained.

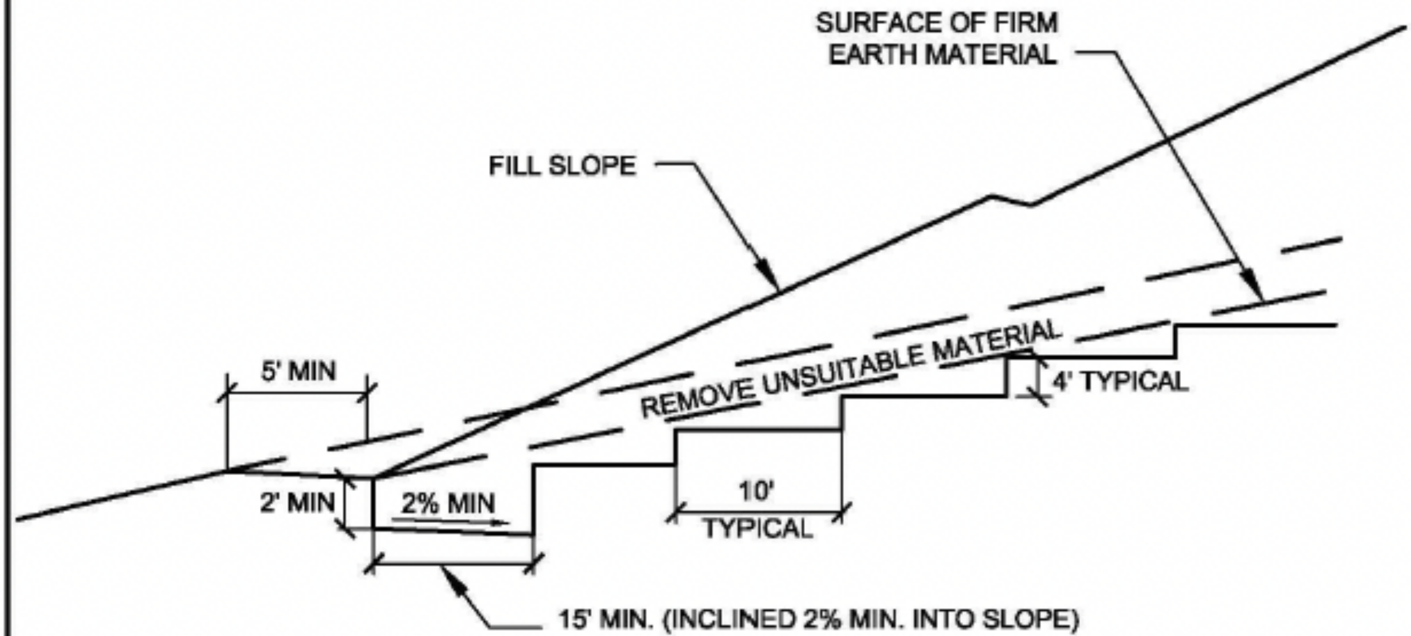
2. All aspects of the site earthwork shall be observed and tested as deemed necessary by the Geotechnical Engineer or his representative so that he can render a professional opinion of the completed fill for substantial compliance with plans and specifications and design concepts. The grading contractor shall give the Geotechnical Engineer at least two (2) working days' notice prior to beginning any site earthwork to allow proper scheduling of the work.

H. <u>Seasonal Limits</u>

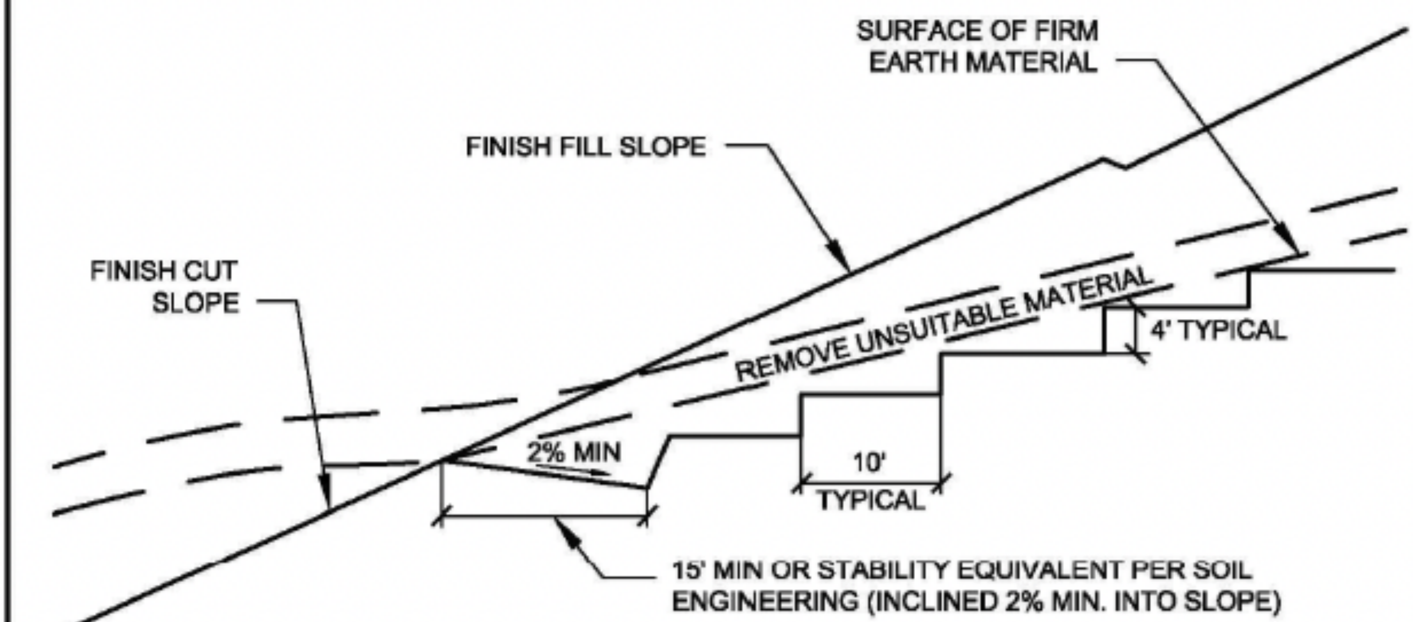
1. No fill material shall be placed, spread, or compacted during unfavorable weather conditions. When work is interrupted by heavy rain, fill operations shall not be resumed until the Geotechnical Engineer or his representative indicates that the moisture content and density of the previously placed fill are as specified.

GRADING DETAILS
(On following pages)

## BENCHING FILL OVER NATURAL

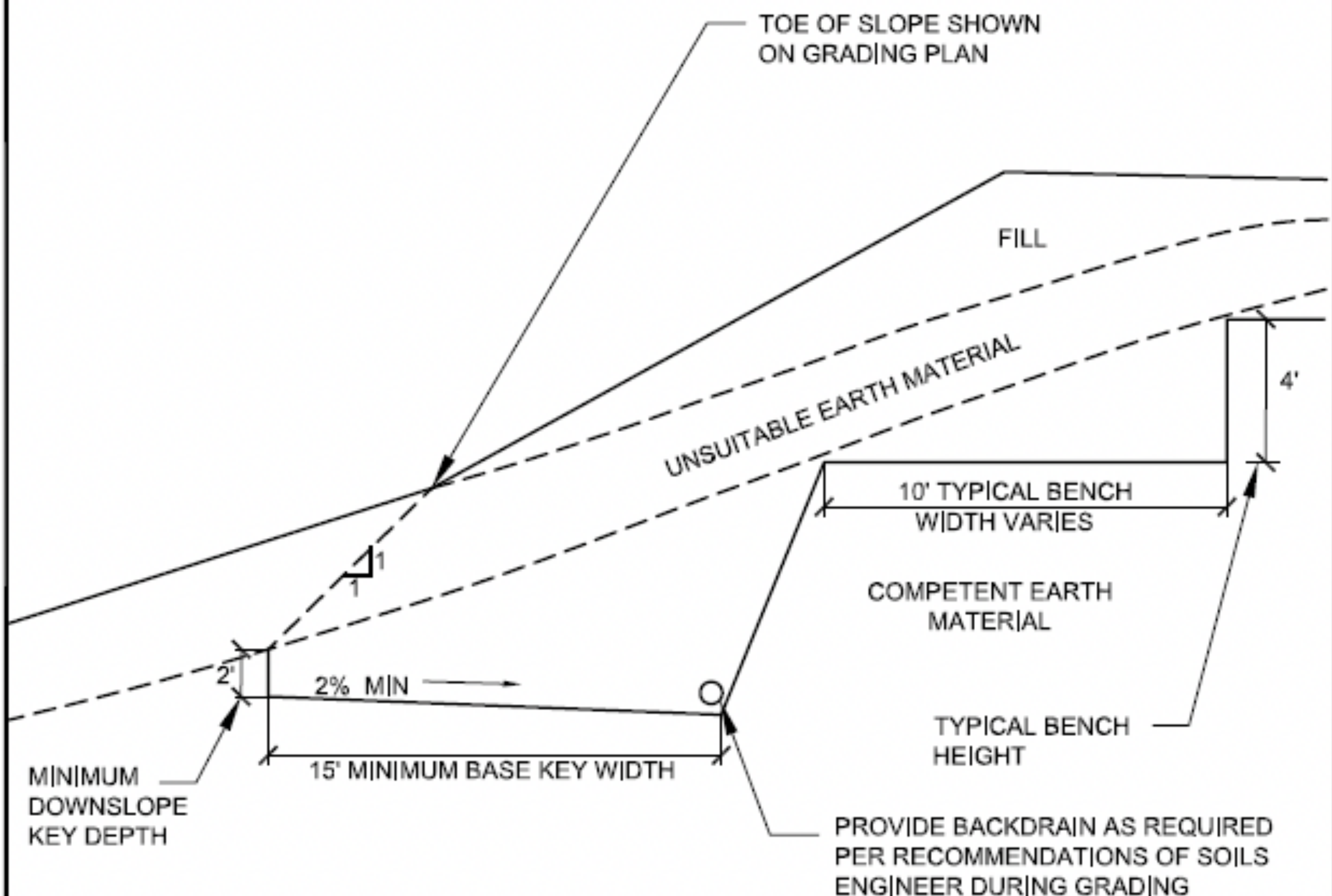



## BENCHING FILL OVER CUT




NOT TO SCALE

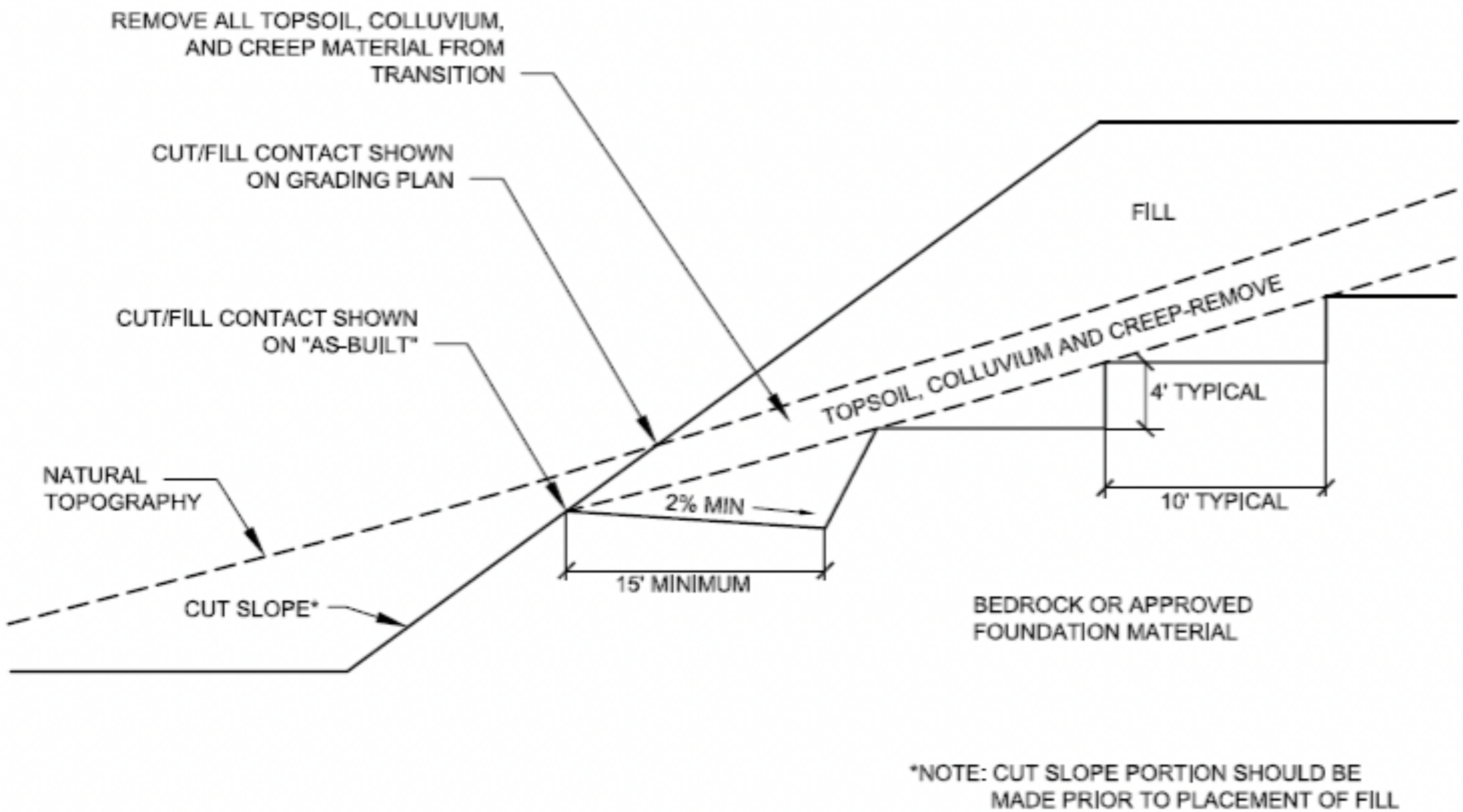
# BENCHING FOR COMPACTED FILL DETAIL




WHERE NATURAL SLOPE GRADIENT IS 5:1 OR LESS, BENCHING IS NOT NECESSARY. FILL IS NOT TO BE PLACED ON COMPRESSIBLE OR UNSUITABLE MATERIAL.

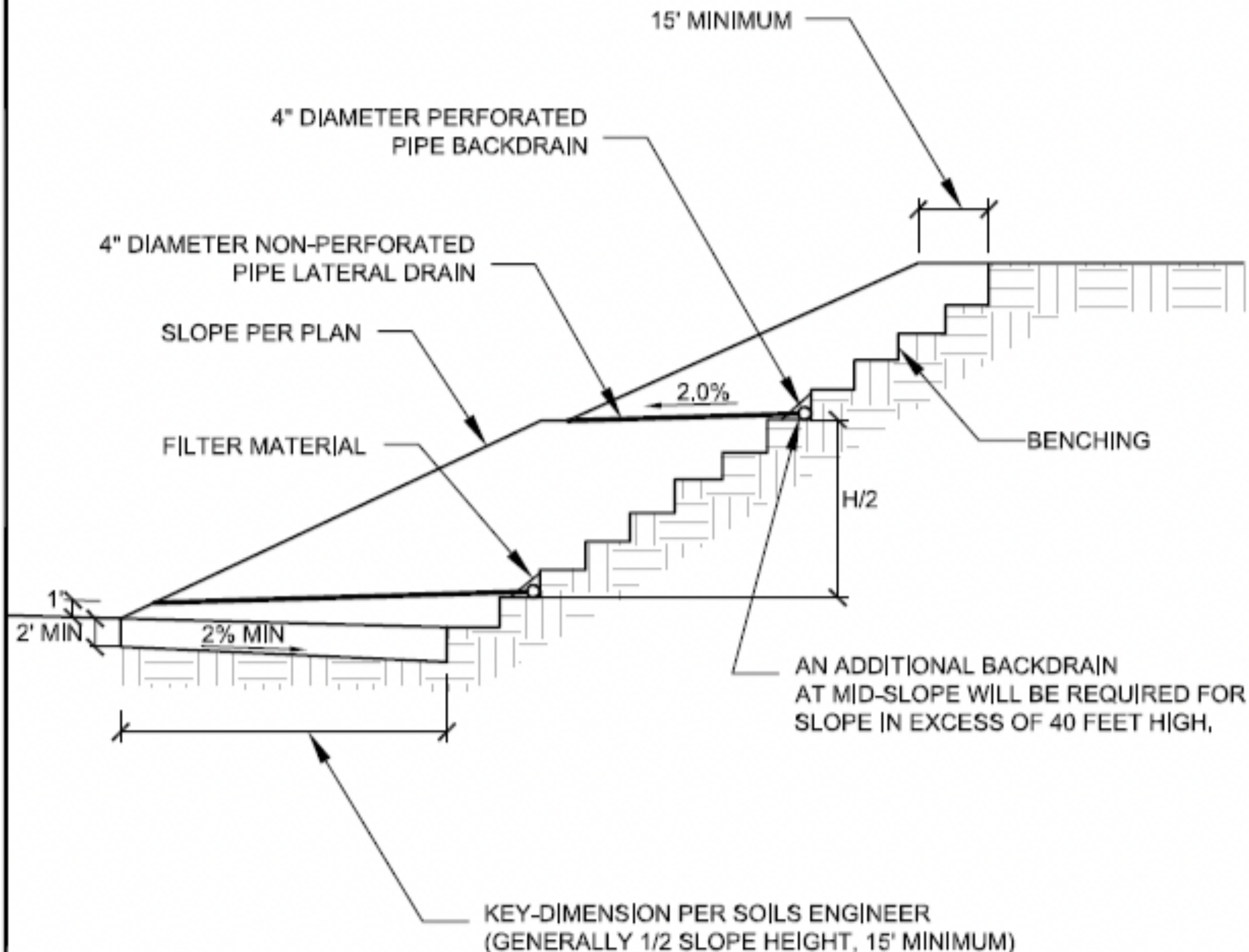
NOT TO SCALE

# FILL SLOPE ABOVE NATURAL GROUND DETAIL




NOT TO SCALE

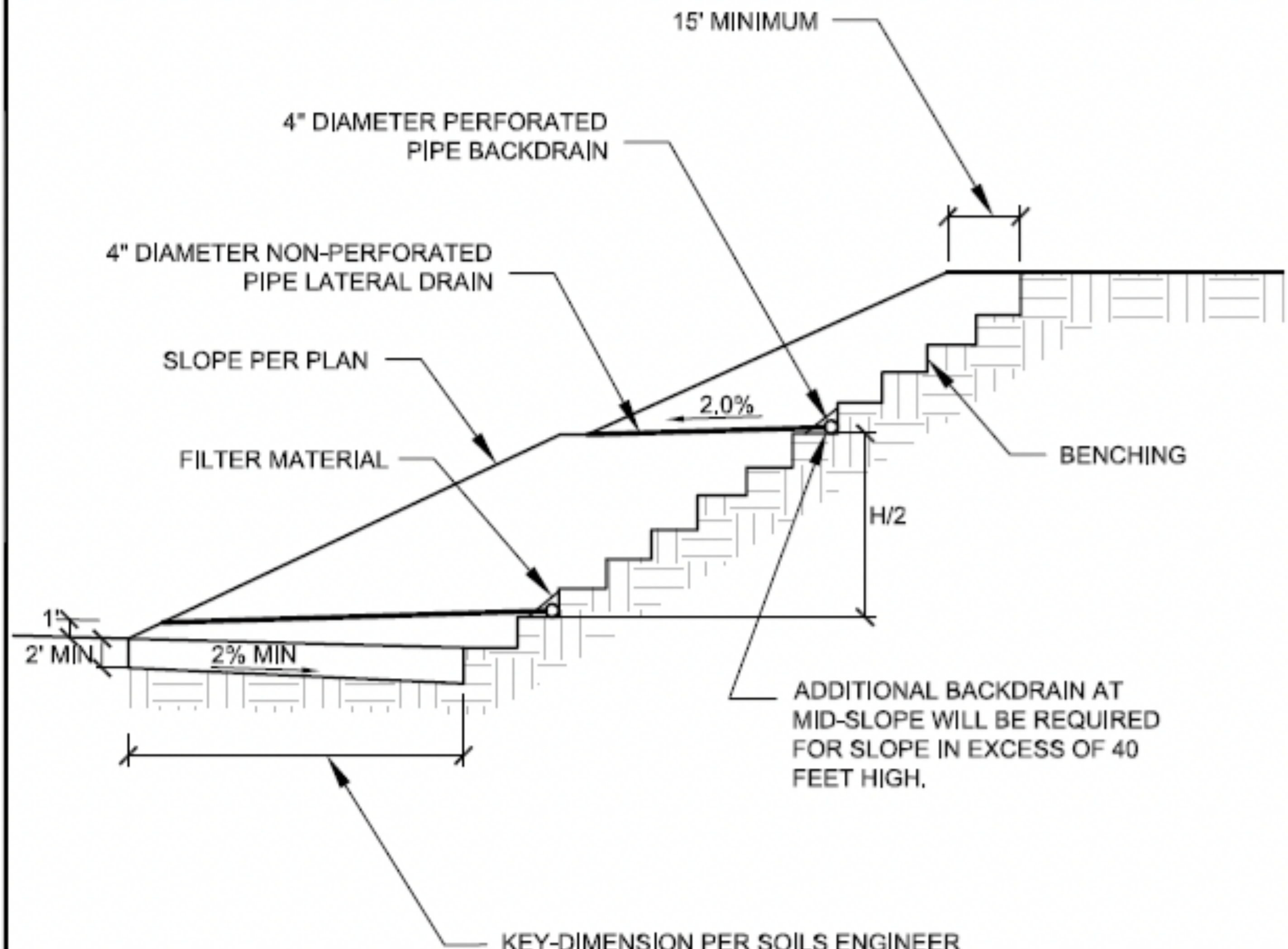
# FILL SLOPE ABOVE CUT SLOPE DETAIL




DIMENSIONS ARE MINIMUM RECOMMENDED

NOT TO SCALE

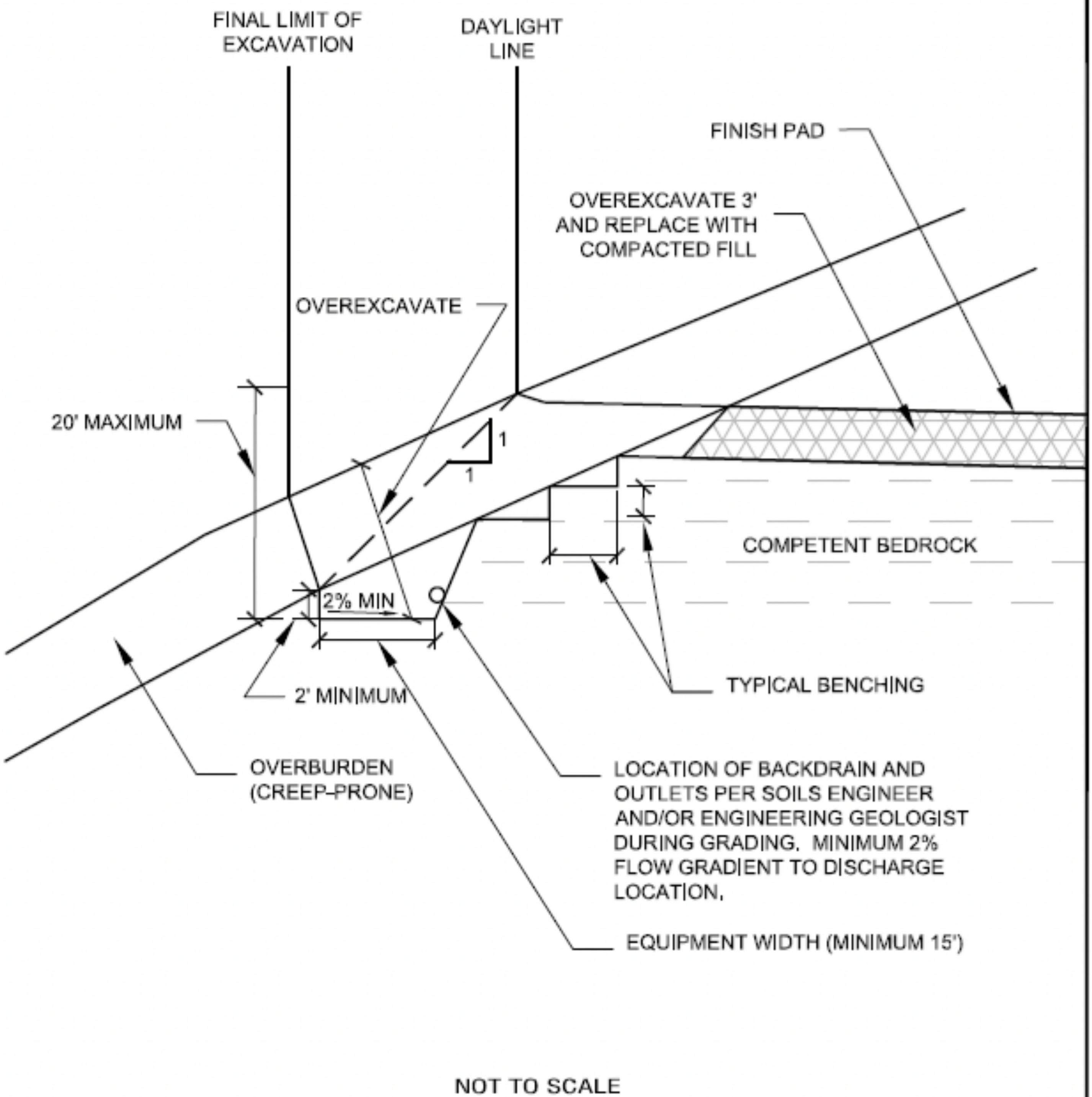
# TYPICAL SLOPE STABILIZATION FILL DETAIL



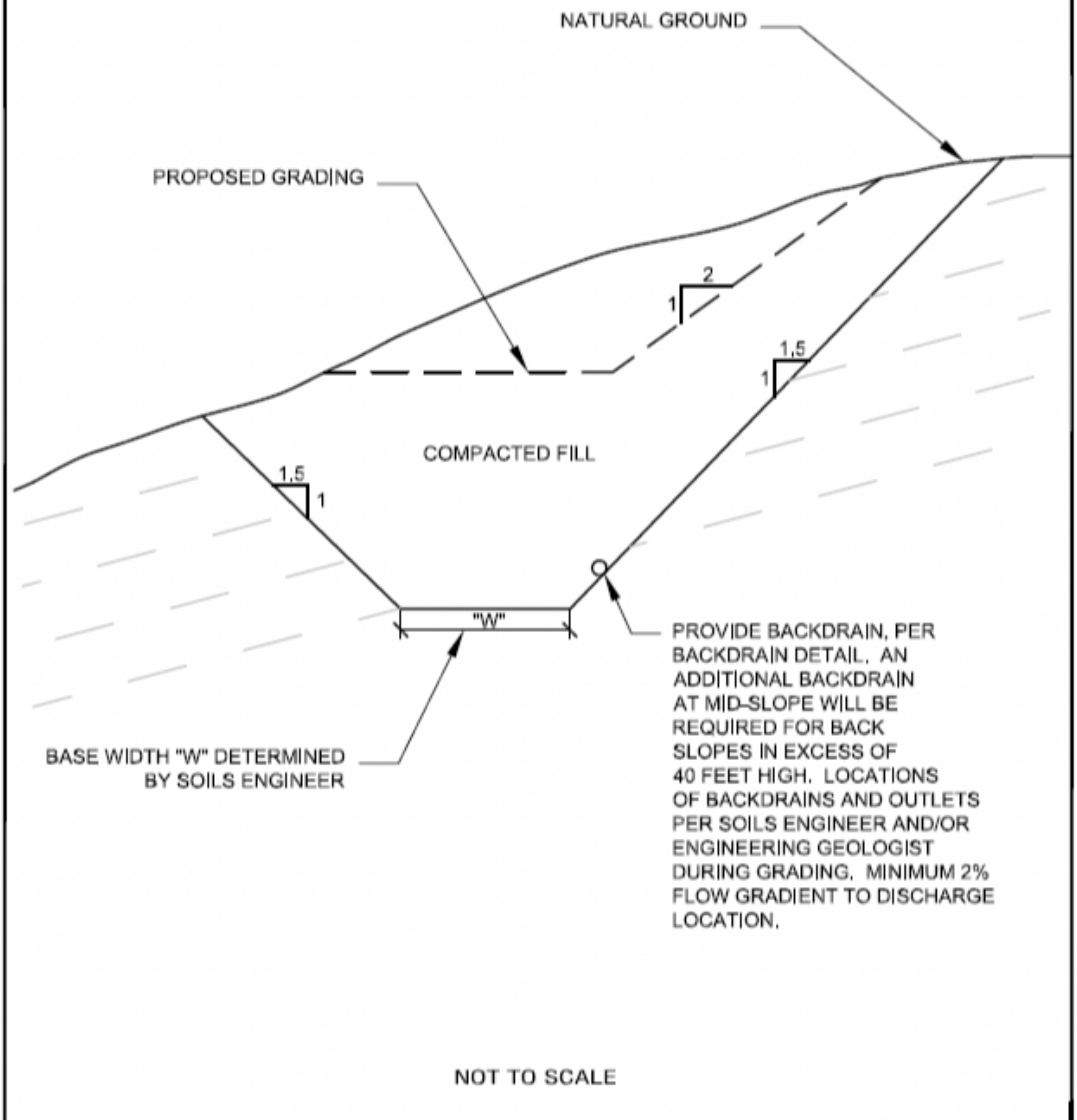

DIMENSIONS ARE MINIMUM RECOMMENDED

NOT TO SCALE

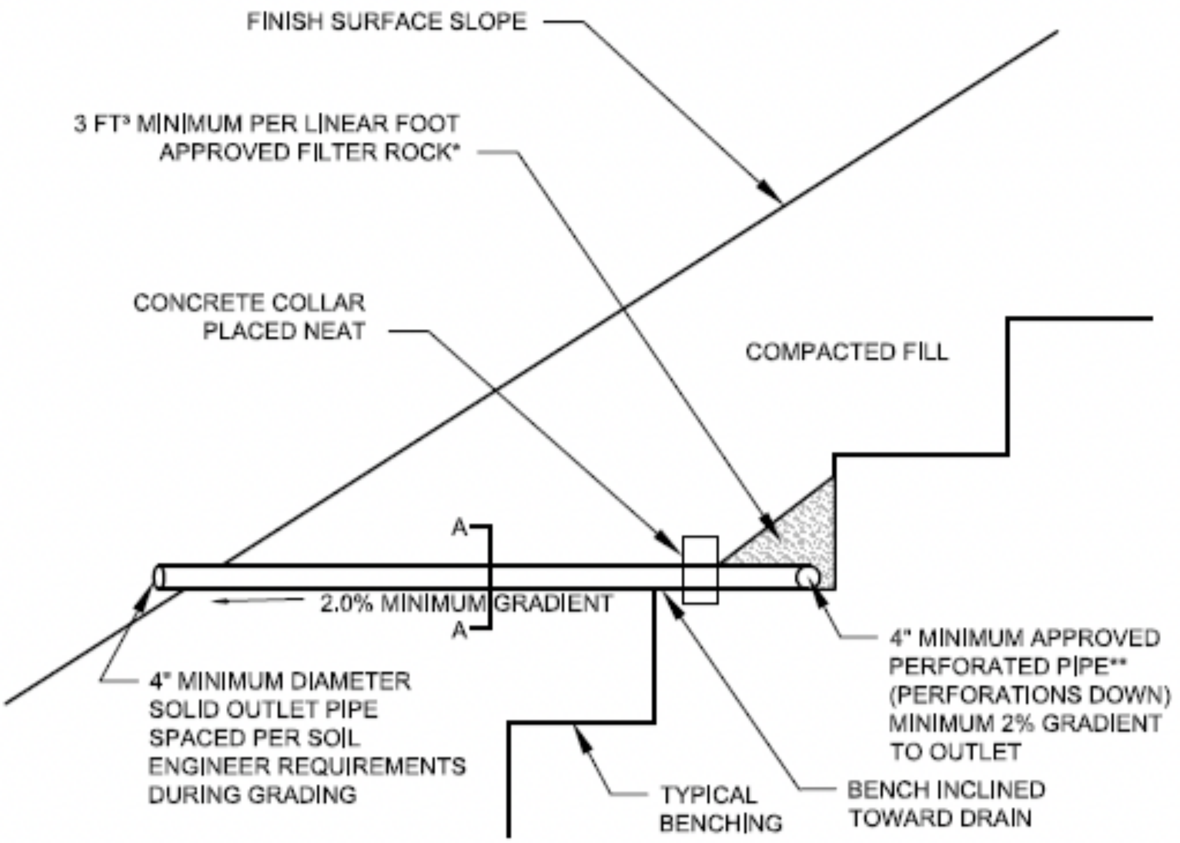
# TYPICAL BUTTRESS FILL DETAIL



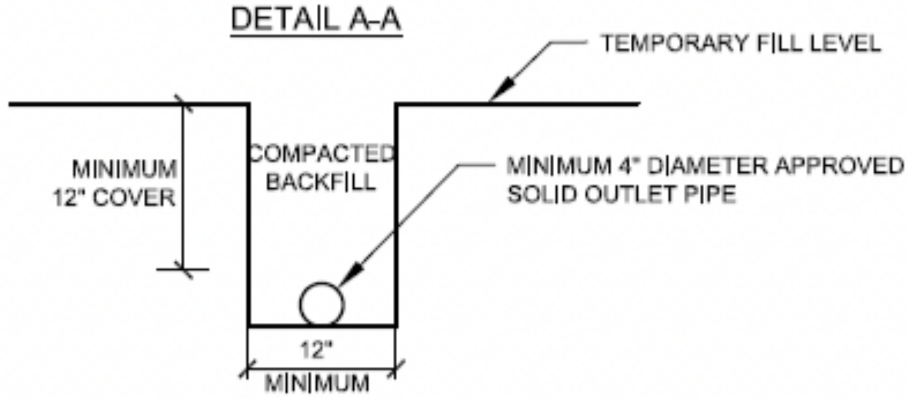

# DAYLIGHT SHEAR KEY DETAIL




# TYPICAL SHEAR KEY DETAIL




DETAIL A-A



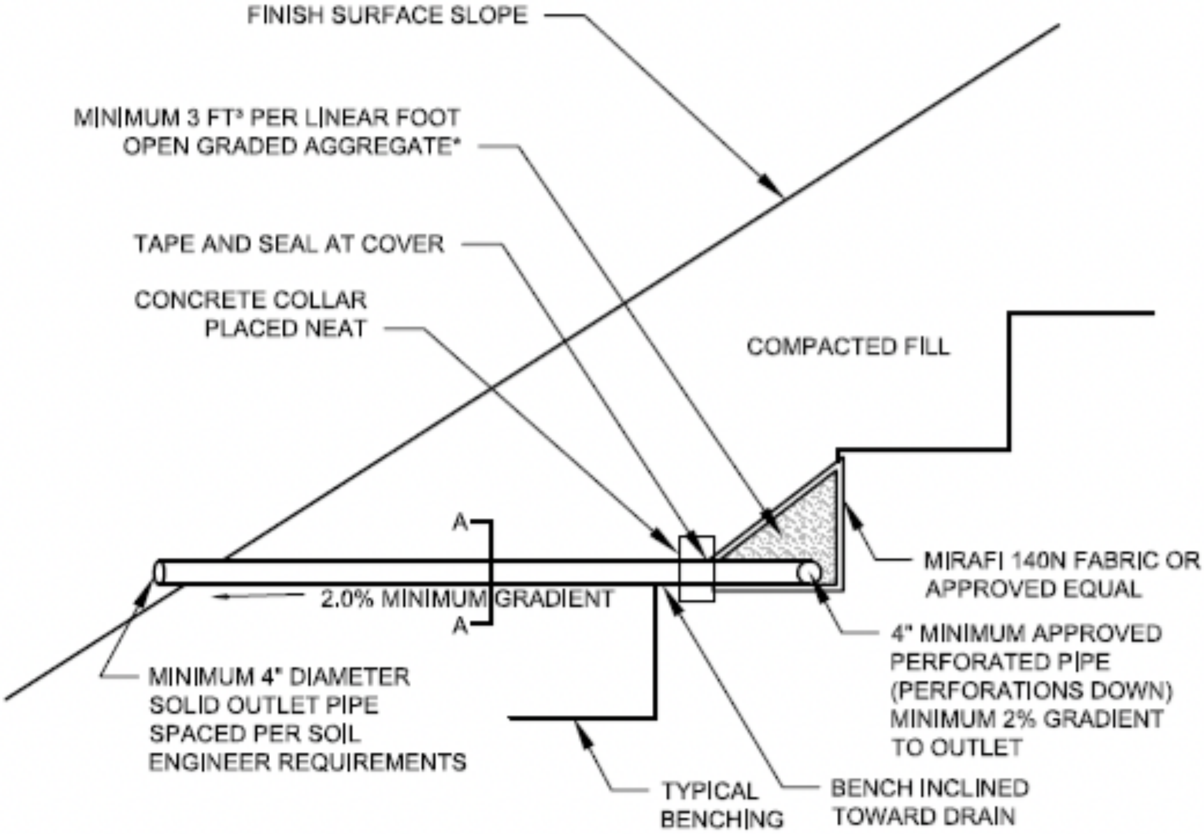

**APPROVED PIPE TYPE:
SCHEDULE 40 POLYVINYL CHLORIDE
(P.V.C.) OR APPROVED EQUAL.
MINIMUM CRUSH STRENGTH 1000 PSI

*FILTER ROCK TO MEET FOLLOWING
SPECIFICATIONS OR APPROVED EQUAL:

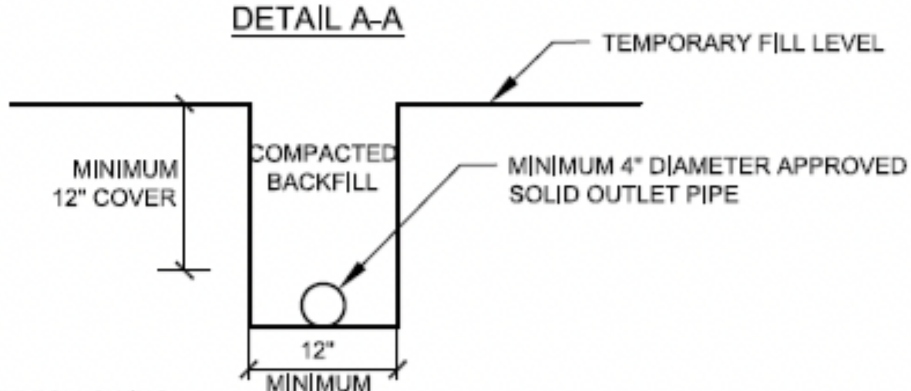
| SIEVE SIZE | PERCENTAGE PASSING |
|---|---|
| 1" | 100 |
| ¾" | 90-100 |
| ⅜" | 40-100 |
| NO. 4 | 25-40 |
| NO. 30 | 5-15 |
| NO. 50 | 0-7 |
| NO. 200 | 0-3 |

NOT TO SCALE

# TYPICAL BACKDRAIN DETAIL




## DETAIL A-A

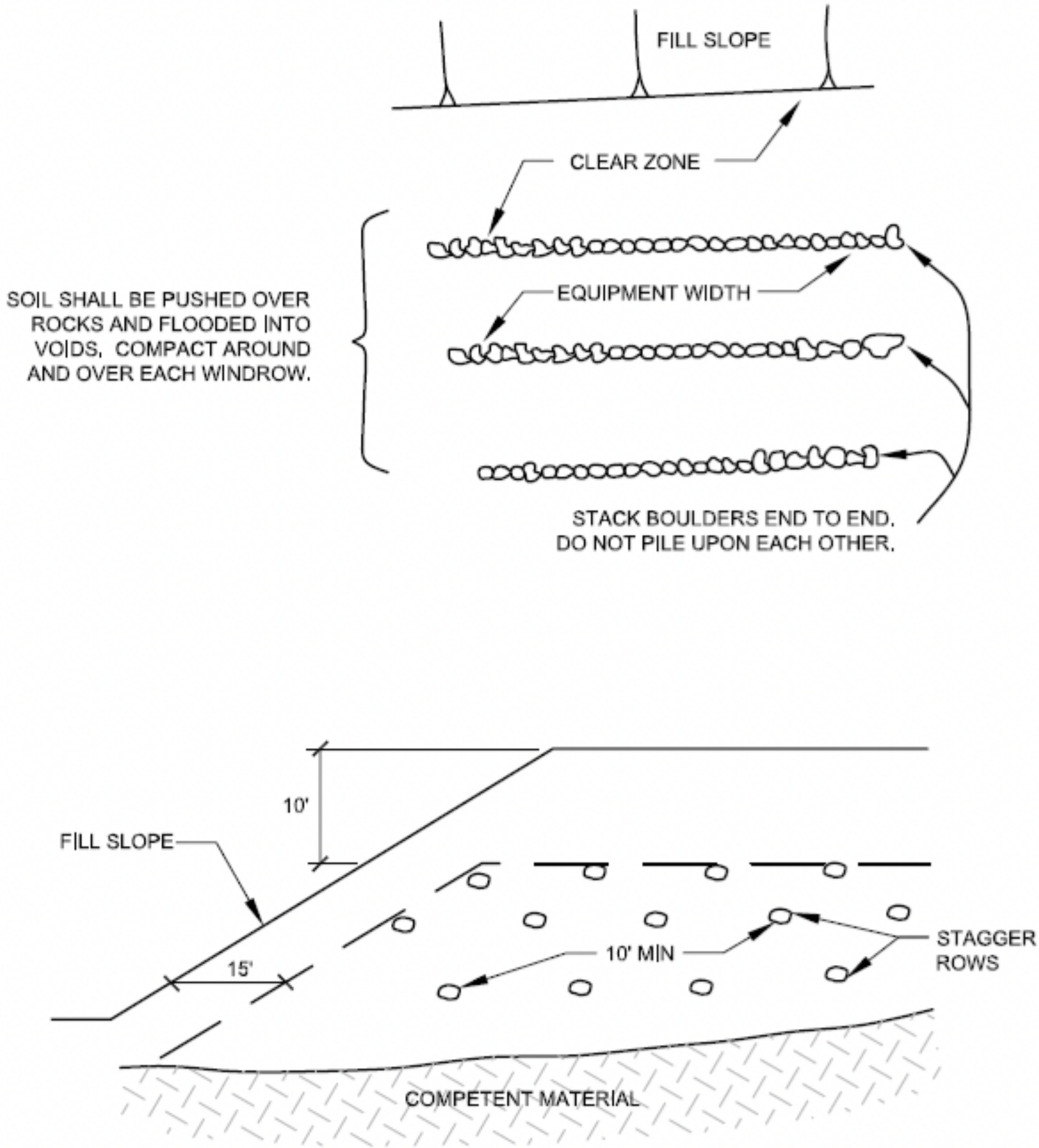



*NOTE; AGGREGATE TO MEET FOLLOWING SPECIFICATIONS OR APPROVED EQUAL:

| SIEVE SIZE | PERCENTAGE PASSING |
|---|---|
| 1 ½" | 100 |
| 1" | 5-40 |
| ¾" | 0-17 |
| ⅜" | 0-7 |
| NO. 200 | 0-3 |

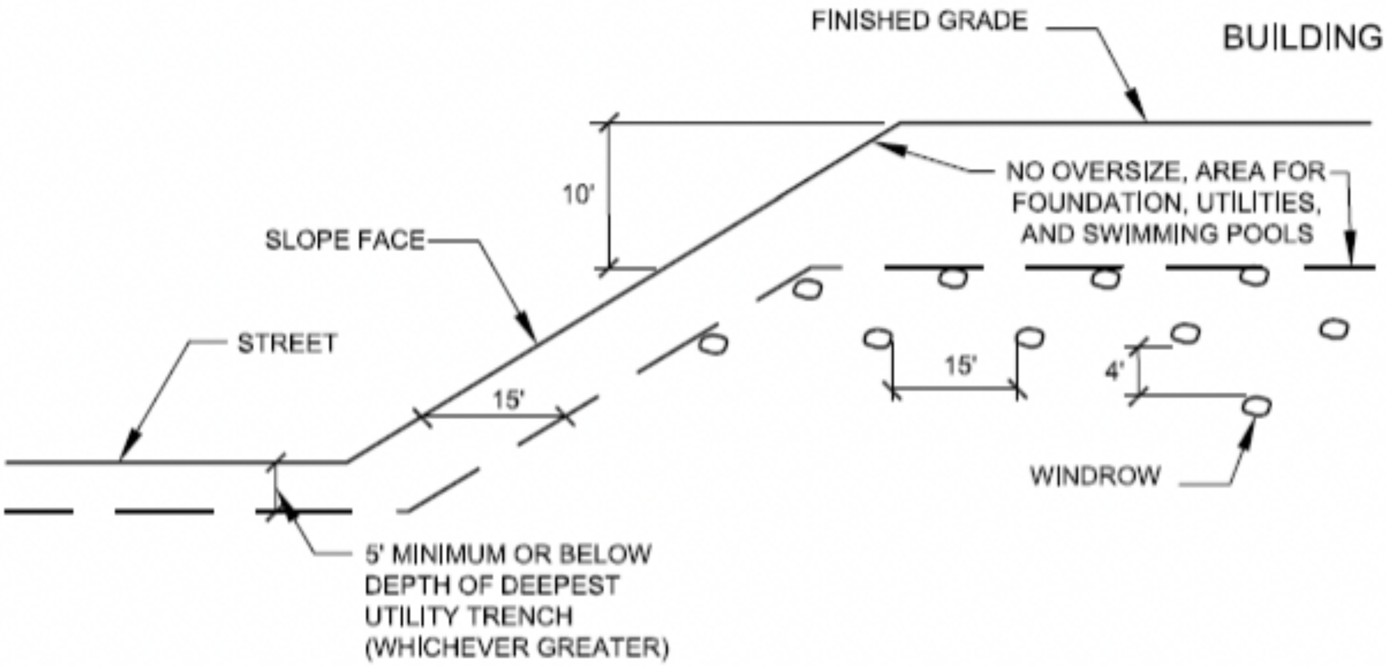
NOT TO SCALE

# BACKDRAIN DETAIL (GEOFRABIC)

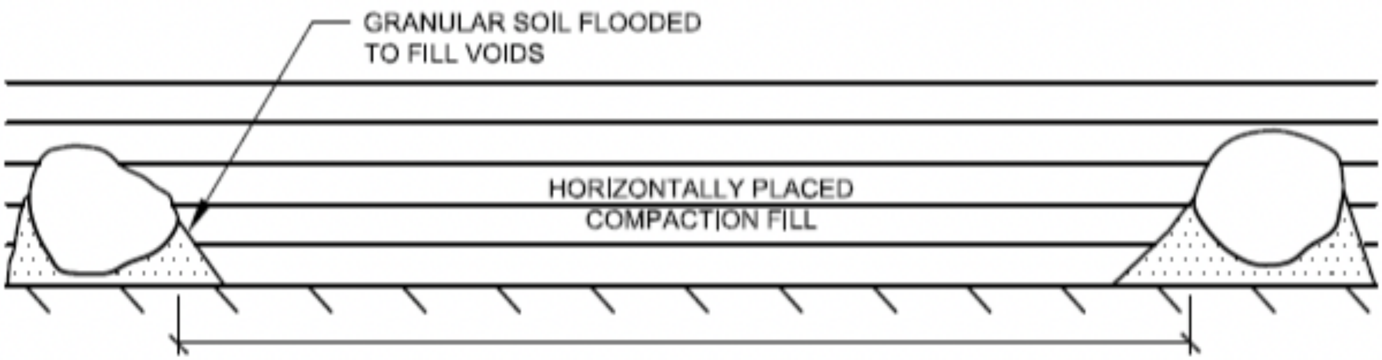



NOT TO SCALE

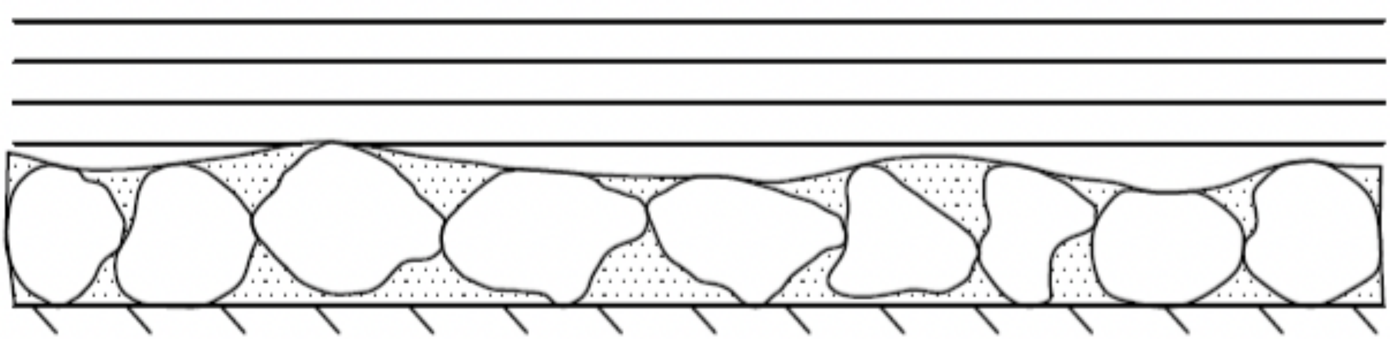
# ROCK DISPOSAL DETAIL




TYPICAL WINDROW DETAIL (EDGE VIEW)




PROFILE VIEW

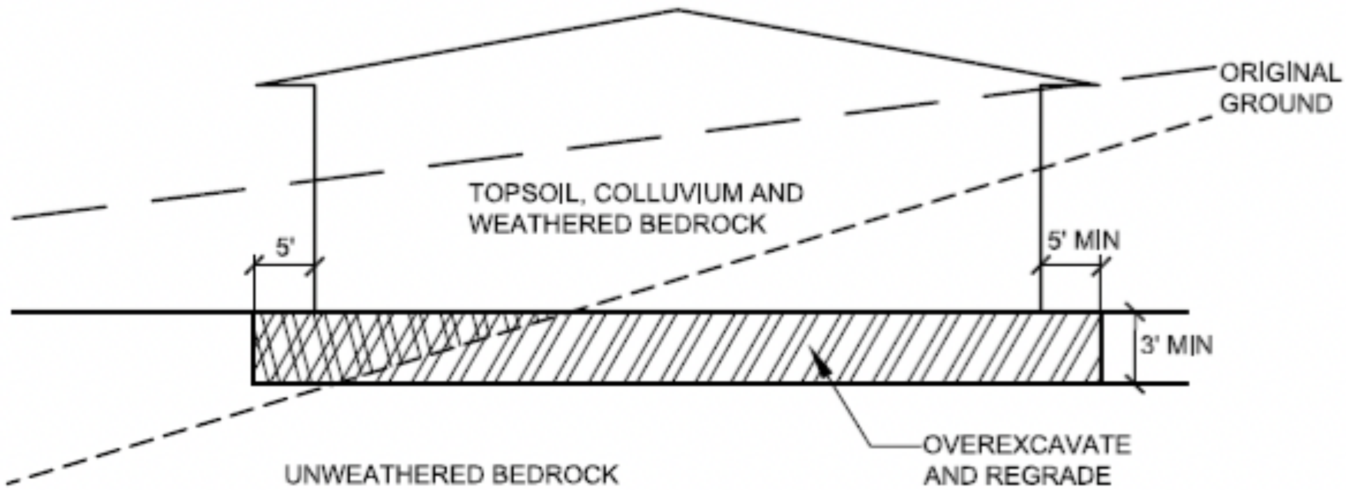


NOT TO SCALE

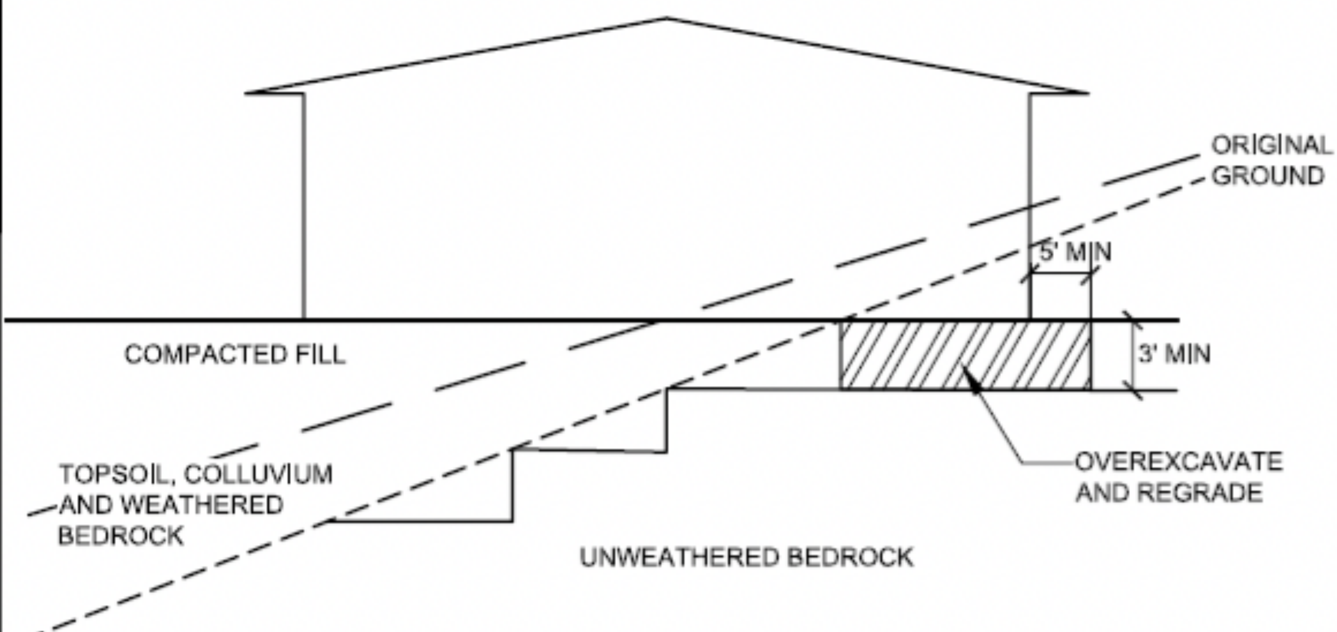
# ROCK DISPOSAL DETAIL

## GENERAL GRADING RECOMMENDATIONS

### CUT LOT

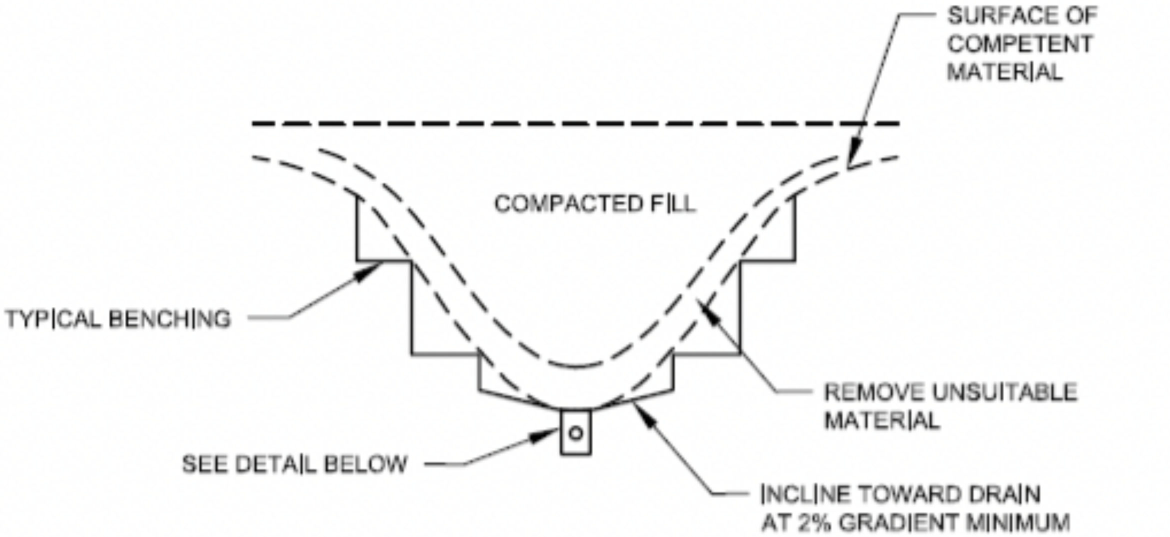



### CUT/FILL LOT (TRANSITION)

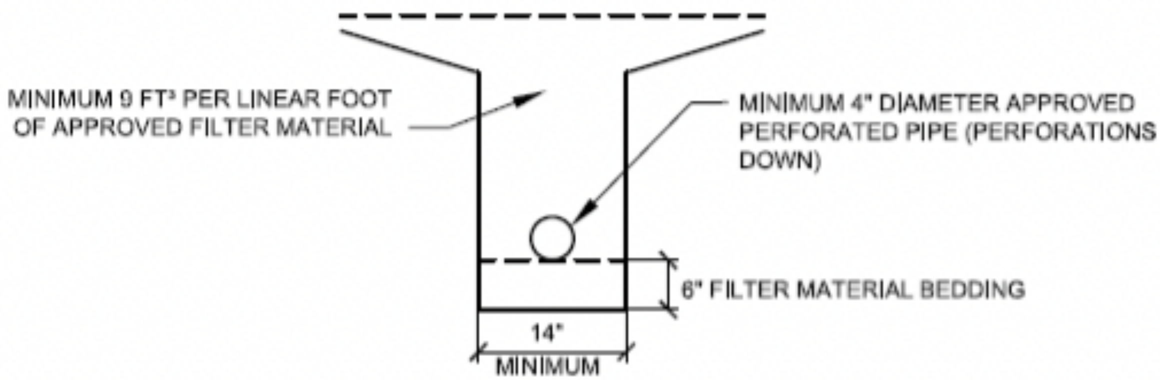



NOT TO SCALE

# TRANSITION LOT DETAIL




DETAIL




FILTER MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

| SIEVE SIZE | PERCENTAGE PASSING |
|---|---|
| 1" | 100 |
| ¾" | 90-100 |
| ⅜" | 40-100 |
| NO. 4 | 25-40 |
| NO. 30 | 18-33 |
| NO. 8 | 5-15 |
| NO. 50 | 0-7 |
| NO. 200 | 0-3 |

NOT TO SCALE

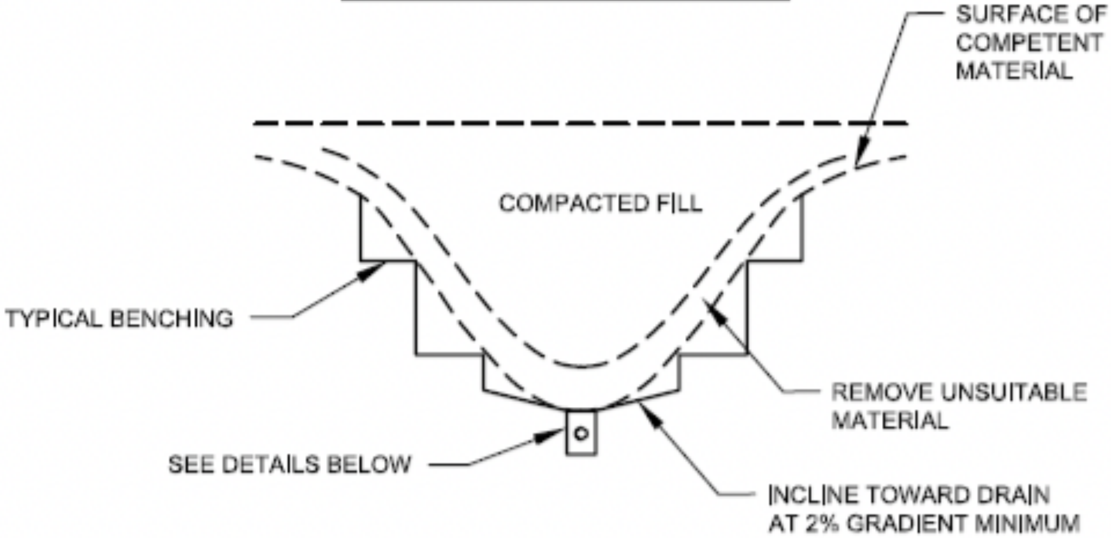
APPROVED PIPE TO BE SCHEDULE 40 POLY-VINYL-CHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 psi

PIPE DIAMETER TO MEET THE FOLLOWING CRITERIA, SUBJECT TO FIELD REVIEW BASED ON ACTUAL GEOTECHNICAL CONDITIONS ENCOUNTERED DURING GRADING

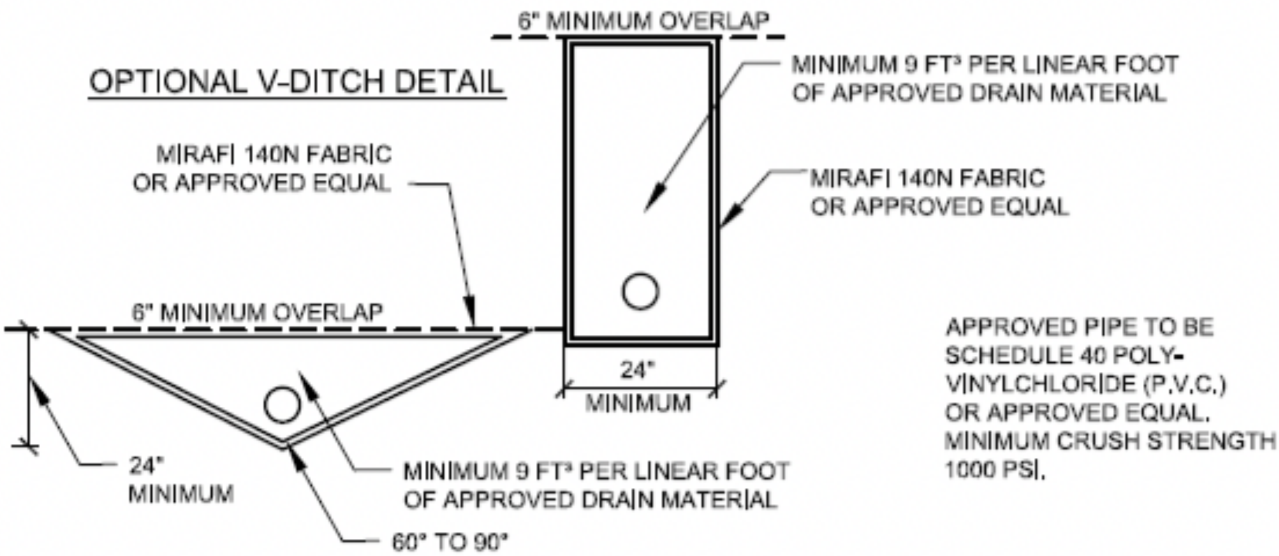
| LENGTH OF RUN | PIPE DIAMETER |
|---|---|
| INITIAL 500' | 4" |
| 500' TO 1500' | 6" |
| > 1500' | 8" |

# TYPICAL CANYON SUBDRAIN DETAIL

## CANYON SUBDRAIN DETAILS




## TRENCH DETAILS




DRAIN MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

| SIEVE SIZE | PERCENTAGE PASSING |
|---|---|
| 1 ½" | 88-100 |
| 1" | 5-40 |
| ¾" | 0-17 |
| ⅜" | 0-7 |
| NO. 200 | 0-3 |

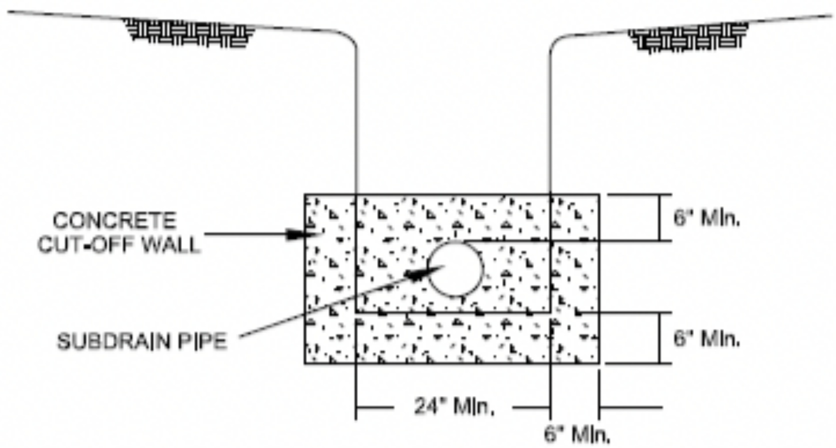
PIPE DIAMETER TO MEET THE FOLLOWING CRITERIA, SUBJECT TO FIELD REVIEW BASED ON ACTUAL GEOTECHNICAL CONDITIONS ENCOUNTERED DURING GRADING

| LENGTH OF RUN | PIPE DIAMETER |
|---|---|
| INITIAL 500' | 4" |
| 500' TO 1500' | 6" |
| > 1500' | 8" |

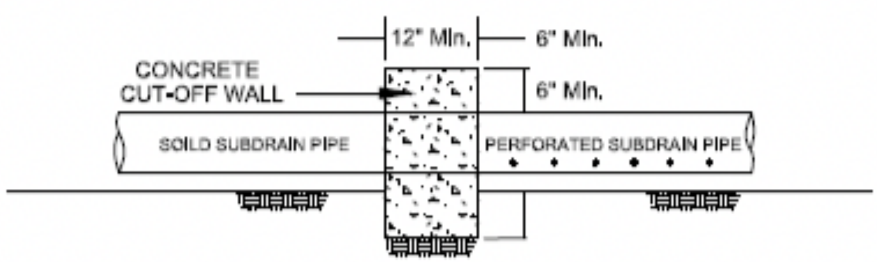
NOT TO SCALE

# GEOFABRIC SUBDRAIN

FRONT VIEW



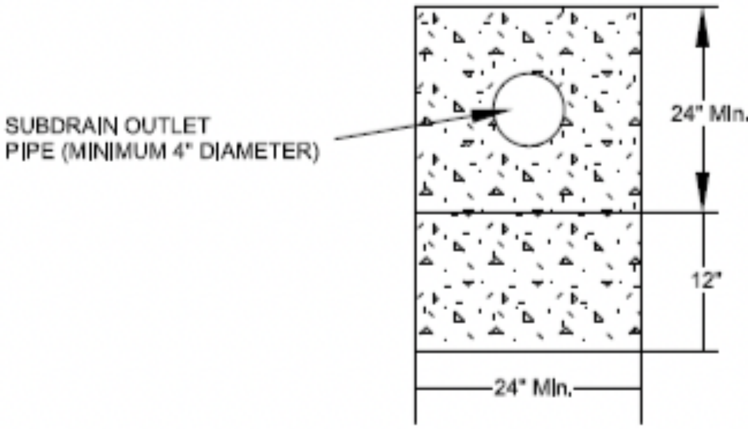

SIDE VIEW



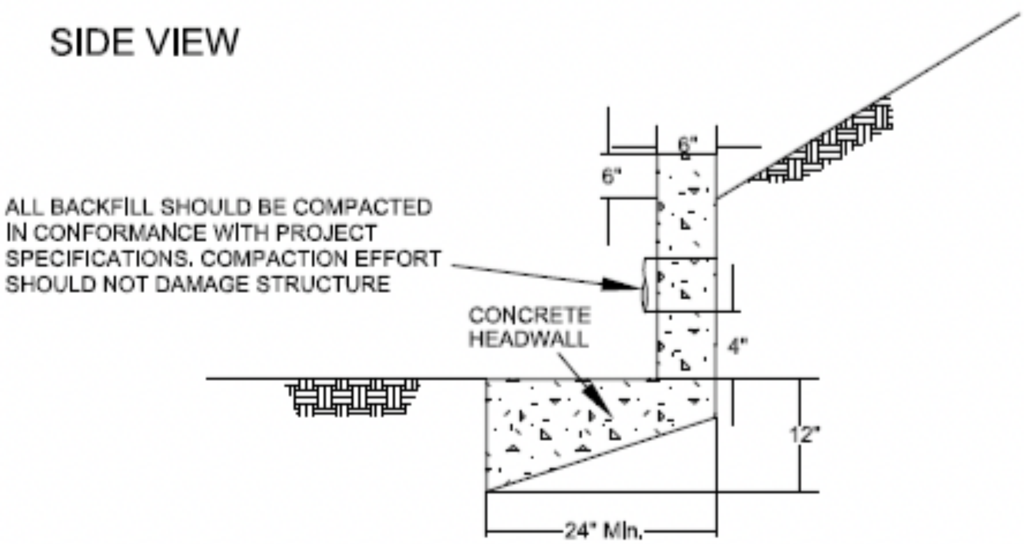

NOT TO SCALE

# RECOMMENDED SUBDRAIN CUT-OFF WALL

## FRONT VIEW




## SIDE VIEW




NOTE: HEADWALL SHOULD OUTLET AT TOE OF SLOPE OR INTO CONTROLLED SURFACE DRAINAGE DEVICE

ALL DISCHARGE SHOULD BE CONTROLLED

THIS DETAIL IS A MINIMUM DESIGN AND MAY BE MODIFIED DEPENDING UPON ENCOUNTERED CONDITIONS AND LOCAL REQUIREMENTS

NOT TO SCALE

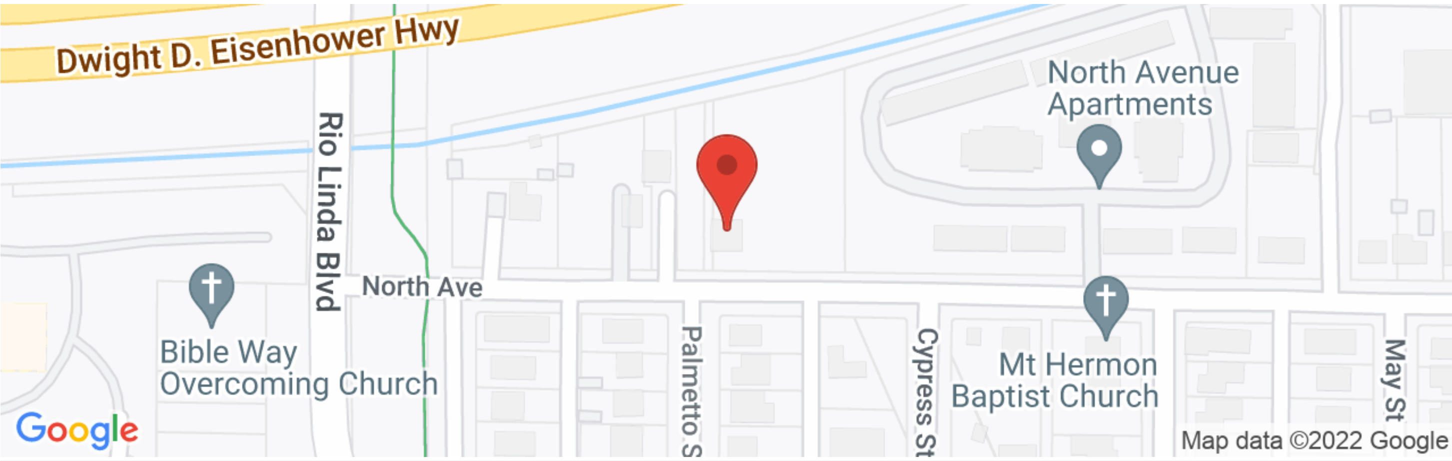
# TYPICAL SUBDRAIN OUTLET HEADWALL DETAIL

# APPENDIX E

## SEAOC/OSHPD U.S. Seismic Hazard Maps

# 905 North Ave, Sacramento, CA 95838, USA

## Latitude, Longitude: 38.6404947, -121.445908




| | |
|---|---|
| **Date** | 3/21/2022, 12:09:45 PM |
| **Design Code Reference Document** | ASCE7-16 |
| **Risk Category** | II |
| **Site Class** | D - Default (See Section 11.4.3) |

| Type | Value | Description |
|---|---|---|
| $S_S$ | 0.523 | $MCE_R$ ground motion. (for 0.2 second period) |
| $S_1$ | 0.242 | $MCE_R$ ground motion. (for 1.0s period) |
| $S_{MS}$ | 0.722 | Site-modified spectral acceleration value |
| $S_{M1}$ | null -See Section 11.4.8 | Site-modified spectral acceleration value |
| $S_{DS}$ | 0.481 | Numeric seismic design value at 0.2 second SA |
| $S_{D1}$ | null -See Section 11.4.8 | Numeric seismic design value at 1.0 second SA |

| Type | Value | Description |
|---|---|---|
| SDC | null -See Section 11.4.8 | Seismic design category |
| $F_a$ | 1.382 | Site amplification factor at 0.2 second |
| $F_v$ | null -See Section 11.4.8 | Site amplification factor at 1.0 second |
| PGA | 0.22 | $MCE_G$ peak ground acceleration |
| $F_{PGA}$ | 1.38 | Site amplification factor at PGA |
| $PGA_M$ | 0.303 | Site modified peak ground acceleration |
| $T_L$ | 12 | Long-period transition period in seconds |
| SsRT | 0.523 | Probabilistic risk-targeted ground motion. (0.2 second) |
| SsUH | 0.549 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration |
| SsD | 1.5 | Factored deterministic acceleration value. (0.2 second) |
| S1RT | 0.242 | Probabilistic risk-targeted ground motion. (1.0 second) |
| S1UH | 0.257 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration. |
| S1D | 0.6 | Factored deterministic acceleration value. (1.0 second) |
| PGAd | 0.5 | Factored deterministic acceleration value. (Peak Ground Acceleration) |
| $C_{RS}$ | 0.952 | Mapped value of the risk coefficient at short periods |
| $C_{R1}$ | 0.942 | Mapped value of the risk coefficient at a period of 1 s |

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Building Envelope | Geotechnical | Environmental | Firestop Systems