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A LEIGHTON GROUP COMPANY

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Project No. 12828.001

Highpointe Communities, Inc.
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Irvine, California 92618

Attention: Mr. Timothy D. England
Senior Vice President

**Subject: Geotechnical Due Diligence Report**
**Proposed 87-Acre 146-Lot Canyon Ranch Residential Development**
**South of Barton Road and West of San Timoteo Creek**
**Cities of Redlands and Loma Linda**
**San Bernardino County, California**

## INTRODUCTION

In accordance with your authorization, Leighton and Associates, Inc. (Leighton) is pleased to submit this report documenting the findings of our due diligence geotechnical desktop study, relating the subject 87-acre property to a planned 146-lot single family residential development. The property lies within the incorporated city boundaries of both Redlands and Loma Linda, County of San Bernardino, California (the site).

The purpose of our study has been to assess site geotechnical conditions and geologic hazards, based on a review of readily available published literature and a site reconnaissance. It has also been to identify geotechnical constraints to grading and construction of the current conceptual site plan, a 200-scale exhibit prepared by Mayer Creative, titled *Canyon Ranch Conceptual Site Plan*, dated June 29, 2020.

No subsurface investigation, laboratory testing or data-based engineering analyses were performed as part of our study. For verification, a supplemental design-level geotechnical subsurface exploration of the site will be required, including soil sampling, testing and engineering analyses.

The findings of our study indicate the most significant anticipated geotechnical constraints to site development include a potential for dynamic and seismically-induced settlement of very young axial-valley alluvium deposits, strong ground-shaking resulting from large nearby earthquakes. Other potential hazards of anticipated lower impact could include liquefaction along the west site margin, and the stability of offsite adjacent slopes along the west and east site margins. We expect these hazards can be adequately mitigated through implementation of conventional remedial grading and observance of structural setbacks.

Based on our findings, we consider development of the currently conceptualized project to be feasible from a geotechnical viewpoint. Due to the limited due diligence scope of our services, and present absence of any direct subsurface data, laboratory testing, or engineering analyses, our conclusions and recommendation are considered preliminary. Accordingly, this report should be used only for the purposes of preliminary project planning, budgeting, and decision-making for property acquisition.

## SCOPE OF WORK

The scope of our desktop study included performance of the following tasks:

- **Background Review:** A review of readily available published geotechnical and geologic reports/maps, geologic hazard overlay maps, and historical aerial photographs and topographic maps available on-line and within our in-house library. A list of the review documents is presented in Appendix A, *References*.
- **Geologic Reconnaissance:** A field reconnaissance conducted to observe general site conditions and review accessible soil and bedrock outcrops. The reconnaissance was conducted by a Certified Engineering Geologist (CEG) employed by our firm.
- **Geologic Hazards Assessment:** Preliminary assessment of identified geologic hazards and their potential impact(s) to the project, including active faulting, seismicity. Review of potential landslides, seismic-induced surface fault rupture, ground shaking, liquefaction, soil settlement, and tsunamis, seiches and flooding hazards.
- **Seismic Analysis:** Seismic design parameters were determined for the site using an assumed Site Class "D", and the 2019 version of the California Building Code. A summary of resultant seismic design coefficients is provided in Table 1.

- **Report Preparation:** Preparation of this due diligence report summarizing surface and subsurface geologic conditions, geologic hazards, anticipated groundwater, and preliminary engineering properties of soil and bedrock. Findings and conclusions of our study are presented along with preliminary recommendations for remedial earthwork grading, conventional foundations, slab-on-grade flooring and pavement design.

## SITE HISTORY

No review documents revealed any evidence of significant past site grading. The site has been utilized for agricultural purposes (orange grove production/farming) since at least 1931. While those operations are now abandoned, evidence remains as rows of tree stumps, wind turbine towers, irrigation standpipes, smudge pots, and aboveground tanks. Also present on the site are several vertical concrete standpipes used for field irrigation. It is likely a vast network of related shallow piping remains buried on the site.

## SITE DESCRIPTION

The subject property boundaries form an irregular shape that encompass approximately 84 total acres. The property is situated within the eastern portion of San Timoteo Canyon, a broad northwesterly oriented valley used historically for citrus (orange tree) farming. The site occupies an ancient flat-lying river plain within the eastern portion of the valley, directly east of San Timoteo Creek. The creek consists of a linear northwesterly oriented ephemeral wash that transects the central portion of the valley. It accommodates periodic storm runoff discharged from nearby hills to the southeast. Site elevations exist at around 1,240 feet above mean sea level. Existing vegetation includes intermittent trees and tumbleweed shrubs. The above features are depicted along with the site boundaries on attached Figure 1, *Site Location Map*.

Modern-day San Timoteo Creek has entrenched approximately 23 vertical feet lower than the ancient terrace surface. Creek banks appear to have been graded (cut) to form slope ratios of around 2:1 (horiz:vert). Within the bed of the creek is a series of earthen detention dams intended to minimize floodwater energy, and temporarily impound waters to facilitate groundwater recharge through surface infiltration. Bank-to-bank flooding apparently occurs during significant storm events.

For descriptive purposes we divide the site into three contiguous north, east and west segments. A summary of these areas is presented below. Their general locations can be discerned on Figure 2, Site *Conceptual Plan*.

The western site area is triangular in shape, bounded by vacant land to the south, San Timoteo Creek channel on the west, a Korean Church facility, ranch house, and other vacant land on the north, and Nevada Street and San Timoteo Canyon Road on the east. A total of 76 lots are planned in this area. Abandoned on-site ranch house and other improvements exist along Nevada Street, including a water well. The ranch homes likely utilized a septic system for on-site sewage disposal. Associated buried septic tanks and piping likely remain buried in close proximity to the former dwellings. Crossing the northwest corner of this area is a north-south oriented row of electrical towers/poles.

The northern site area is rectangular in shape, and somewhat isolated from other areas of the property, within the city of Loma Linda. A total of 36 lots are planned in this area. The area is bounded by New Jersey Street on the west, Barton Road on the north, San Timoteo Canyon Road on the east, and Bermudez Street on the south. The afore-mentioned Korean Church facility and an existing ranch house occupy parcels offsite to the south of Bermudez Street. A small encampment of vagrants occupies the northern site boundary. Beyond the north property boundary are various residential and commercial developments. Beyond San Timoteo Canyon Road is a series of existing residential homes.

The eastern site area is triangular shape, and lies within the city of Redlands. A total of 34 new lots are planned. San Timoteo Canyon Road forms the south and west boundaries of this area. The east boundary represents the east margin of the regional river terrace, and east geographic boundary of the overall San Timoteo Canyon/valley. Abutting the east property boundary is the toe of an older elevated stream bank, having a moderate ratio and ascending height of approximately 60 feet. A string of existing homes occupies the top of bank area offsite. The bank is interrupted by two narrow easterly ascending tributary canyons, oriented generally perpendicular to the property boundary. The property boundaries extend up into the southern-most tributary canyon, where a number of proposed lots are planned. A row of power poles exists along the southern portion of the east site margin, where evidence of intermediate stream terraces also exists.

## PROPOSED DEVELOPMENT

The Site Conceptual Plan (Figure 2) denotes the project will include 146 residential homes, internal streets and local open spaces. We assume new homes will be supported by conventional spread-footings with slab-on-grade floors and wood-framed construction. We anticipate appurtenant elements will include concrete driveways and flatwork, asphalt-paved streets, and on- and off-site underground utilities. We expect the development does not include any subterranean elements. The site plan shows no designated areas of storm water infiltration. If a WQMP system is planned, field percolation testing to determine rates of soil infiltration would need to be obtained to support design.

We anticipate building pad and street construction will be accomplished through conventional remedial earthwork (grading), involving minor cuts and fills to establish finish surfaces at/or near existing grades. We assume that the site will balance and require no import of off-site earth materials. We have provided preliminary grading and foundation design recommendations in this report, which will require confirmation through supplemental field exploration, laboratory testing and engineering analysis by completion of a future design-level geotechnical study. Structural loads for buildings are presently unknown. We assume a maximum column load of 45 kips and maximum wall load of 2.5 kips per lineal foot are generally applicable for the relatively light residential structural loads.

## FINDINGS

### Regional Geology

The site lies within the southeasterly area of the San Bernardino Valley (SBV), a large regional-scale valley representing a small portion of the greater Peninsular Ranges Geomorphic Province of Southern California. Prominent abruptly ascending mountain ranges surround the SBV, including the San Gabriel (SG) Mountains on the northwest, San Bernardino (SB) Mountains on the north and east, and a range of low lying hills on the south. The location of the site relative to the above features is depicted on Figure 3, *Site Geology Map*.

Development of the SB and SG mountain ranges, and the SBV basin, result from global-scale opposing/relative movement between the North American and Pacific tectonic plates. This plate boundary is manifest as the San Andreas Fault Zone (SAFZ), which follows a generally narrow northwesterly transect along the foot of the SB Mountains. The currently recognized active strand of the SAFZ lies approximately 6.24 miles northeast of the project site. Right-lateral offset accommodated by the SAFZ has resulted in the juxtaposition of significantly different rock types within the SB Mountains northeast of the fault zone and the SG Mountains southwest of the fault zone. An overview of these and other fault zones within the SBV area are shown on Figure 4, *Regional Fault and Historic Seismicity Map*.

The range of low-lying hills south of the site represent the general northwest contiguous extension of the San Jacinto Mountains. The hills are moderately elevated, smoothly to deeply eroded, and locally referred to as The Badlands. The Badlands, have been uplifted by dextral right-lateral offset and along the San Bernardino Valley Section of the San Jacinto Fault Zone (SJFZ). The SJFZ is similar to the SAFZ in earthquake history, movement, and seismic potential. It is one of a handful of major fault zones in southern California, comprising the overall San Andreas system of faults. The nearest strand of the SJFZ lies approximately 1.0 mile southwest of the site. The presence of the SBV, between the SAFZ and SJFZ, represents a major tectonically down-dropped structural depression or sediment-sink, referred to as the Perris Structural Block.

Several thousand feet of sediments have infilled central areas of the SBV basin, derived from erosion of the adjacent uplifted mountain ranges. In general, the sediments are relatively thinner along valley margins. The transport of sediments into the valley occurs via large alluvial fans associated with major past and present rivers. These include Lytle and Cajon Creek washes at the northwest margin of the SBV. Another significant sediment source is from the presently active Santa Ana River (SAR), which exits the SB Mountains near the northeastern edge of the SBV, and flows in a west-southwesterly direction across the SBV. The SAR is located approximately 2.84 miles northwest of the site at its nearest location.

## Site Geology

The site surface is underlain by a deposit of middle-Holocene age sediments, young axial-valley alluvium (map-unit Qya3), typically composed of loose, alternating lenses of unconsolidated sandy gravel (USGS, 2003). The thickness of the Qya3 deposits is anticipated to be the order of 20 to 40 feet thick, and likely underlain by very old axial-valley deposits of middle to early Pleistocene age (map-unit Qvoa3). The Qvoa3 unit consists of a similar lithology to the Qvya3 unit, but of a greater density and possessing a lower susceptibility of liquefaction based on its relative age. The Qvoa3 unit outcrops within the cut banks bordering the site on the east. The composite thickness of the alluvial units is likely greater than hundred feet.

## Surface Water

The site lies within the boundaries of the San Timoteo Canyon watershed, which encompasses the broad valley and upland areas within nearby The Badlands. The main conductor of surface water is San Timoteo Wash, a major canyon collecting runoff from the northeastern side of The Badlands. This creek is a tributary of the regionally significant Santa Ana River that crosses the SBV several miles north of the site. Additional contributions of runoff onto the site would be from the two tributary canyons along the east site margin. Based on existing topography, surface water likely flows from east to west across the site.

## Groundwater

While the SAR serves as the most significant source of aquifer recharge within the SBV, San Timoteo Wash serves as the main source of groundwater in the site area. The aquifer nearest the surface within the SBV is likely unconfined within deposits of alluvium. A historical groundwater map reviewed as part of our study shows interpreted groundwater depths beneath the site between the dates of 1973 and 1975 (Carson & Matti, 1985). An excerpt of this map is presented as Figure 6, Depth to *Groundwater Map 1975-1979*. The map indicates the depth to groundwater beneath the property was on the order of 100 feet during that period of time.

Although historical groundwater maps indicate a groundwater depth of around 100 feet beneath the site, it is considered possible that repetitive heavy storm events, generating high volumes of flow and ponded water within Timoteo Canyon Wash, may lead to a temporarily elevated groundwater condition beneath the western site margins. It is likely the depth to such groundwater would be no higher than the bed of the wash, or around 23 feet beneath the subject site, and that depths would rapidly increase/deepen with increasing distances away from the creek.

Based on the above, we do not anticipate that groundwater would pose any constraints to earthwork grading or long-term performance of site improvements. However, if groundwater does periodically increase in height along the western site margin, to depths generally shallower than 50 feet, it could increase the susceptibility of liquefaction in this area. This condition will need to be evaluated as part of a future design-level geotechnical investigation.

Our review of the State-maintained GeoTracker website (https://geotracker.waterboards.ca.gov/map) revealed no case files for the subject site, nor any sites within the surrounding area.

## Infiltration

The loose sandy gravel soils composing underlying Holocene age alluvium on the site are likely supportive of percolation rates favorable for use for on-site infiltration. Field percolation tests will need to be performed at specific BMP locations, at depths beyond planned remedial grading (fill placement), in order to verify this condition, and determine infiltration rates for WQMP system design.

## Regional Faulting

Given the close proximity of southern California to the North American / Pacific plate boundary, the seismic effects of moderate to significant earthquakes are generally widespread across the area. Hundreds of minor earthquakes (magnitude 1.0 to 2.9) occur annually within the San Bernardino Valley, along major active fault zones. In the site vicinity, these earthquakes occur along the northwest-trending SAF and SJFZ (see Figures 3 and 4). These fault systems currently accommodate up to approximately 55 millimeters per year (mm/yr) of slip, ranking among the most active in all of southern California. Since the recording of seismic events in the mid-18$^{th}$ century, at least 6 major earthquakes have occurred along the San Jacinto Fault Zone (Blake, 2000a).

The on-line Interactive Fault Map published by the United States Geological Survey (USGS, 2006), indicates the San Bernardino Valley Section of the San Jacinto Fault Zone is the nearest active fault, located approximately 1.0 mile southwest of the site. The SJFZ is zoned under the Alquist-Priolo Act, and contains several northwest oriented paralleling stands. Movement exhibits a dextral right-lateral sense with a common right-stepping pattern of offset. The last rupture/offset along this fault section is considered to have occurred during latest Quaternary time, or sometime during the past 15 thousand years.

Other major faults in the region include the Sierra Madre Fault zone along the southern foot of the SG Mountains, the Elsinore Fault bordering the north edge of the Santa Ana Mountains, and the Homestead Valley Fault Zone within the Eastern California Shear Zone, approximately 15.72 miles northwest, 23.94 miles southwest, and 45.77 miles east-northeast of the site, respectively. A map depicting the location of fault and historic seismic activity is presented as Figure 4, *Regional Fault and Historic Seismicity Map*.

## Local Faulting

No active faults are mapped as transecting the site or directly adjacent areas. There are however several mapped faults in the area northeast of the SJFZ, exhibiting orientations sub-parallel and parallel to the SJFZ (USGS, 2003; CGS, 2003). While these faults are not AP-zoned faults, and are generally considered less active than the SJFZ, we opine that they are still capable of accommodating a degree of co-seismic offset during major earthquakes along the SJFZ, if not their own earthquakes. One of these "secondary" faults is the Crafton Hills Fault Zone, situated approximately 0.75 miles southwest of the site (USGS, 2003). The same zone is referred to on CGS maps as the Live Oak Canyon Fault Zone (CGS, 2003). Another is the Banning Fault mapped approximately 0.4 miles northeast of the site (CGS, 2003). The locations of these faults are shown on Figure 3, *Site Geology Map*.

## GEOLOGIC HAZARDS

Our assessment of geologic hazards and their impacts to the project was based in part on a review of San Bernardino County Geologic Hazard Overlay Maps (SB General Plan, 1989). A map depicting liquefaction and landslide hazards is presented on Figure 5, *Geologic Hazard Map*.

### Ground Shaking

The principal geologic hazard affecting the site is considered to be strong ground shaking generated by large nearby earthquakes. The intensity of shaking generally depends upon the magnitude of an earthquake, the distance to from the source or epicenter, and response characteristics of site soils.

Related to ground shaking are additional secondary hazards such as ground lurching and ground fissuring. Ground lurching is the abrupt swaying of the ground surface. Ground fissuring refers to as minor cracks in surface soils. While the effect of ground lurching cannot be mitigated, the potential for ground fissuring can be significantly reduced by rough grading.

Project design should incorporate all applicable building codes, standards and seismic design parameters to reduce seismic risk, per CGS Special Publication 117A, Chapter 2 (CGS, 2008). Through compliance with these regulatory requirements and the utilization of appropriate seismic design parameters selected by the design professionals, potential effects relating to seismic shaking can be reduced.

### Settlement

Seismically induced settlement consists of dynamic settlement of unsaturated soil (above groundwater) and liquefaction-induced settlement (below groundwater). These types of settlement occur primarily within low density sandy soils due to reductions in volume during and shortly after an earthquake event. Although groundwater is anticipated to be on the order of 100 feet beneath a majority of the site, it could occur temporarily as an elevated condition along San Timoteo Creek. So, while the site is not defined by the County of San Bernardino as occurring within an area of expected liquefaction, the potential for seismically induced settlement is remotely possible, and would need to be evaluated during future geotechnical exploration. Seismically induced settlement could be a project constraint that would need to be mitigated as part of rough grading earthwork.

**Slope Stability and Structural Setbacks**

The presence of the cut bank along the western site margin may pose a potential constraint to adjacent lot development, from the perspective of slope stability and erosional scour potential. Analysis of slope stability and erosional scour will need to be performed as part of future site investigation. It is possible that structural setbacks may need to be established for improvements nearest the top of the cut bank.

**Liquefaction & Lateral Spreading**

San Bernardino County Geologic Hazard Overlay Map EHFH C indicates the site is not located within an area of liquefaction susceptibility (SB County, 2009). The potential for liquefaction. The most recent available groundwater data pertinent to the site is from 1979, indicating a depth of around 100 feet. If this depth is representative of present conditions, it would preclude the potential occurrence of liquefaction on the site. However, as San Timoteo Creek is the site of periodic water impoundment and lateral migration beneath the site, the potential presence of shallow groundwater and potential liquefaction cannot be precluded at this time.

Lateral spreading is a phenomenon triggered by liquefaction. Conditions required for its occurrence must include a continuous unconstrained liquefiable zone in the subsurface, gently sloping structure upon which movement can occur, and an adjacent or nearby free face or open topographic area able to accommodate lateral movement. Conditions along the western site margin are such that the occurrence of this hazard is remotely possible.

Groundwater conditions along the western site margin will need to be evaluated as part of future site geotechnical explorations. Its presence or absence will generally determine the potential for liquefaction and lateral spreading hazards on the site. Based on present hydrogeological and geologic information, we opine that the potential for these hazards is low.

## Landsliding

The CGS on-line landslide inventory map shows no specific landslides on the site or in adjacent offsite areas (CGS, 2020). They indicate the slopes abutting the east site margin have a moderate to high landslide susceptibility, based on rock strength. The SB County land Use Plan General Plan Geologic Hazard Overlay Map (FH31 C / Redlands) indicates these offsite slopes have a low to moderate landslide susceptibility (SC County, 2009). Leighton observed no evidence of significant landslides in this area during our field reconnaissance. Nor did we observe such conditions on any historical aerial photographs. We do not expect the occurrence of landslides to pose a significant constraint to development of the site.

## Surface Fault Rupture

The proposed development is not located within the boundaries of an active Earthquake Fault Zone, as designated by the State of California or County of San Bernardino. Nor did our review identify the mapped trace(s) of any inactive faults on the site, or trending toward the site. Given the above, the surface fault rupture potential on the site is considered to be very low to nil.

## Tsunamis and Seiches

Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. Based on the absence of an enclosed water body near the site and the inland site location, seiche and tsunami risks are considered negligible.

## Flooding and Dam Inundation

According to a Federal Emergency Management Agency (FEMA) flood insurance rate map (FEMA, 2008), the project site is located within a flood hazard area identified as "Zone X", defined as an area of minimal flood hazard. As shown on Figure 7, *Flood Hazard Zone Map*, the site is **not** located within a 100-year or 500-year flood hazard zone.

Earthquake-induced flooding can be caused by failure of dams or other water-retaining structures as a result of earthquakes. As shown on Figure 8, *Dam Inundation Map*, the site is **not** mapped within a dam inundation zone. Therefore, the risk of seismically-induced flooding due to dam failure is considered low.

## SEISMIC DESIGN PARAMETERS

In order to reduce the effects of strong ground shaking generated by regional seismic events, seismic design should be performed in accordance with the current 2019 CBC. The CBC seismic design parameters listed in Table 1 below should be considered for the seismic analysis of the subject site. These parameters are based on a Default site class of "D", as site-specific subsurface data is yet to be directly confirmed. We anticipate these values will likely be reduced once appropriate subsurface data is obtained.

**2019 CBC Seismic Design Parameters**

| **2019 CBC Parameters (CBC or ASCE 7-16 reference)** | **Value 2019 CBC** |
|---|---|
| Site Latitude and Longitude: 34.0432, -117.2188 | |
| Site Class Definition (1613A.2.2, ASCE 7-16 Ch 20) | D (default) |
| Mapped Spectral Response Acceleration at 0.2s Period (1613A.2.1), $S_s$ | 2.135 g |
| Mapped Spectral Response Acceleration at 1s Period (1613A.2.1), $S_1$ | 0.85 g |
| Short Period Site Coefficient at 0.2s Period (T1613A.2.3(1)), $F_a$ | 1.2 |
| Long Period Site Coefficient at 1s Period (T1613A.2.3(2)), $F_v$ | 1.7 |
| Adjusted Spectral Response Acceleration at 0.2s Period (1613A.2.3), $S_{MS}$ | 2.562 g |
| Adjusted Spectral Response Acceleration at 1s Period (1613A.2.3), $S_{M1}$ | 1.445 g |
| Design Spectral Response Acceleration at 0.2s Period (1613A.2.4), $S_{DS}$ | 1.708 g |
| Design Spectral Response Acceleration at 1s Period (1613A.2.4), $S_{D1}$ | 0.963 g |
| Mapped $MCE_G$ peak ground acceleration (11.8.3.2, Fig 22-9 to 13), $PGA$ | 0.901 |
| Site Coefficient for Mapped $MCE_G$ $PGA$ (11.8.3.2), $F_{PGA}$ | 1.2 |
| Peak Ground Acceleration (1803A.5.12; 11.8.3.2), $PGA_M$ | 1.081 g |

The project structural engineer should review the seismic parameters. Site-specific seismic ground motion analysis can be performed in future studies upon request.

## PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

### General Discussion

Based on the findings of our study we consider development of the currently conceptualized project to be feasible from a geotechnical viewpoint. Due to the limited due diligence scope of our services, an absence of direct subsurface data, laboratory testing, or engineering analyses, our conclusions and recommendation are considered preliminary. Accordingly, this report should be used only for the purposes of preliminary project planning, budgeting, and decision-making for property acquisition. Our conclusions and recommendations are subject to change depending upon the findings of future design-level subsurface geotechnical investigations, and actual foundation and grading plans.

Presently, we consider the more significant constraints to site development may include settlement of the very young axial-valley alluvium deposits, the potential for strong ground-shaking generated by large nearby earthquakes, and stability of the cut bank slope along San Timoteo Creek. These hazards can be mitigated through implementation of conventional grading, and establishment of possible structural setbacks. In the case of the setbacks, we do not anticipate such would prohibit construction of residential structures on the planned western lots, provided their footprints lie within the eastern portion of the lots.

### Remedial Grading

For planning purposes, earthwork should be performed in accordance with the General Earthwork and Grading Specifications presented in Appendix B, and the following preliminary recommendations below. The recommendations are general grading specifications provided for typical grading projects, and not all may not be applicable to the subject project.

Over-excavation and re-compaction of natural compressible alluvial deposits will be required as part of remedial grading. For budgeting purposes at this due diligence stage, we assume removals may extend to a depth of 5 feet below existing grades, or, deep enough to provide at least 3 feet of engineered fill below the bottom of planned foundation elements, whichever is deepest. Deeper removals may be required depending on the findings of future site explorations, to mitigate seismic settlement and/or establish stable deposits for fill placement. We recommend removal depths extend to competent formational material, and extend horizontally a minimum of 5 feet from the outside edge of footings (including columns connecting to buildings), or, a distance equal to the depth of over-excavation below the footings, whichever is further. Removal and re-compaction of any existing fills will also be required, if present. The depth of existing fill removals is presently undetermined. We anticipate such may be limited to a few feet locally, and possibly deeper within the axis of the eastern tributary canyon. We anticipate design grades will be prepared in close vertical proximity to those currently existing, and that earthwork may closely balance.

Prior to grading, the site should be cleared of surface and subsurface obstructions, heavy vegetation, root balls and boulders. Roots and debris should be disposed of offsite. Septic tanks, seepage pits, or wells, should be abandoned in accordance with the County of San Bernardino Department of Health Services guidelines.

**Structural Fills**

The onsite soils should be generally suitable for re-use as compacted fill, provided they are free of oversize rock, debris and organic matter. Fills placed within 10 feet of finish pad grades or slope faces should contain no rocks over 12 inches in maximum dimension.

Fill soils should be placed at a minimum of 90 percent relative compaction (based on ASTM D1557) and at or slightly above optimum moisture content.

Placement and compaction of fill should be performed in accordance with local grading ordinances under the observation and testing of the geotechnical consultant.

Placement and compaction of fill should be performed in accordance with jurisdiction requirements under the fulltime observation and testing of the geotechnical consultant.

**Shrinkage and Subsidence**

We opine that where orange groves formerly existed, the practice of repeated flooding to irrigate the groves has promoted a certain degree of hydro-consolidation in the soils, helping minimize their settlement potential. However, the native on-site soils should still be expected to experience a moderate reduction in volume, or shrinkage, as a result of remedial grading. Based on our experience with similar materials, a shrinkage volume of around 15 percent and subsidence of 0.2 feet should be anticipated for planning purposes; these are only preliminary, and are anticipated to be updated based on results of future geotechnical exploration.

**Oversized Material**

While not typical to this region, the alluvial nature of the sediments beneath the site may contain local concentrations of larger boulders or cobbles unsuitable for use as engineered fill. We found no evidence of such in exposed outcrops in the area. Any rock or rock fragments greater than 12 inches in largest dimension would be considered oversized. Oversized materials encountered during grading, if present, will require special handling and/or special placement in within fills. Recommendations to handle oversized material are not provided at this time.

**Import Soils**

If import soils are needed to establish the site design elevations, it should be granular in nature, relatively free of organic material, have an expansion index less than 21 (per ASTM Test Method D4829), and have a low corrosion impact to the proposed improvements. Import soils at potential borrow sites should be evaluated by the geotechnical consultant prior to being imported to the site.

**Trench Excavation and Backfill**

Utility trenches should be backfilled with compacted fill in accordance with the *Standard Specifications for Public Works Construction*, ("Greenbook"), 2018 Edition. Fill material should be placed in lifts not exceeding 8 inches in uncompacted thickness and should be compacted to at least 90 percent relative compaction (ASTM D1557).

Contractors should be advised that sandy soils (such as fills generated from the onsite alluvium) could make excavations particularly unsafe. All safety precautions should be properly implemented at all times. In addition, excavations at or near the toe of slopes and/or parallel to slopes may be highly unstable due to the increased driving force and load on the trench wall. Spoil piles from the excavation(s) and construction equipment should be kept away from the sides of the trenches. Leighton does not consult in the area of safety engineering.

**Slope Stability**

The natural slopes ascending from proposed lots within the southeast tributary canyon, and the cut-bank slope descending from the western site boundary, will require engineering analyses to evaluate conditions of existing gross and surficial stability. We do not anticipate the slopes will require buttressing or stabilization, however, only the results of mapping and slope stability analyses can determine such requirements. Setbacks may be required.

**Settlement**

Settlement of onsite fill materials is expected to occur during and within 90 days following fill placement. However, following the placement of fill and construction of structures, additional settlement may occur due to: (a) new footing/foundation loads, (b) compression within the fill due to the effects of landscaping irrigation, (c) compression of the left-in-place alluvial soils, and (d) dynamic settlements below the removal depths. The settlements below are general estimates/guidelines and should be further verified based on actual structural loads/footing size and additional subsurface investigation performed for individual buildings.

**Dynamic Settlement**

The earth materials onsite may undergo significant earthquake-induced settlement during the design seismic event. To reduce the effects and magnitude of the earthquake-induced settlements, remedial grading is likely to be recommended.

**Flooding**

It is likely a drainage culvert will be installed within the axis of the tributary canyon at the southeaster site margin, and extend beneath proposed lots in this area. Where planned lots intersect with the up-canyon end of the canyon, it is possible a debris wall structure may be required to protect against flooding.

**Preliminary Foundation Design Parameters**

Our recommendations below are provided as minimum and do not supersede applicable building codes or requirements of the project structural engineer. Grading and foundation plans should be reviewed to confirm foundation design parameters provided below.

**Footing Setback**

We recommend a minimum horizontal setback distance from the face of slopes for all structural footings (retaining and decorative walls, building footings, etc.). This distance is measured from the outside bottom edge of the footing horizontally to the slope face (or to the face of a retaining wall) and should be a minimum of H/2, where H is the slope height (in feet). The setback should not be less than 7 feet and need not be greater than 10 feet for manufactured fill slopes and 20 feet for tall natural descending slopes.

Note that the soils within the structural setback area possess poor lateral stability and improvements (such as retaining walls, sidewalks, fences, pools, pavements, etc.) constructed within this setback area may be subject to lateral movement and/or differential settlement. Potential distress to such improvements may be mitigated by providing a deepened footing or a pier and grade-beam foundation system to support the improvement. The deepened footing should meet the setback as described above.

## Infiltration Recommendations

We anticipate the deposits of native Holocene alluvium will support use of an on-site infiltration system for storm water runoff disposal. Field percolation testing should be performed at the location(s) of proposed basin(s) to confirm infiltration rates and the feasibility of infiltration system use.

## CLOSURE

We appreciate the opportunity to provide our services for this review. If you have any questions, please contact this office at your convenience.

Respectfully submitted,

LEIGHTON AND ASSOCIATES, INC.

Jeff L. Hull, CEG 2056
Associate Geologist

Jason D. Hertzberg, GE 2711
Principal Engineer

JLH/JDH/gv

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Figure 2 – Site Conceptual Plan
Figure 3 - Site Geology Map
Figure 4 – Regional Fault and Historic Seismicity Map
Figure 5 – Geologic Hazard Map
Figure 6 – Depth to Groundwater Map 1975-1979
Figure 7 – Flood Hazard Zone Map
Figure 8 – Dam Inundation Map

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Appendix A – References
Appendix B – General Earthwork and Grading Specifications

Distribution: (1) electronic copy


| Project: 12828.001 | Eng/Geol: JH |
|---|---|
| Scale:1 " = 3,000 ' | Date: August 2020 |

Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton
Author: Leighton Geomatics (kmanchikanti)

# SITE LOCATION MAP

Canyon Ranch Geotechcnial Due Diligence
Highpointe Communities, Inc., San Timoteo Canyon,
City of Redlands and Loma Linda, California

Figure 1

Leighton

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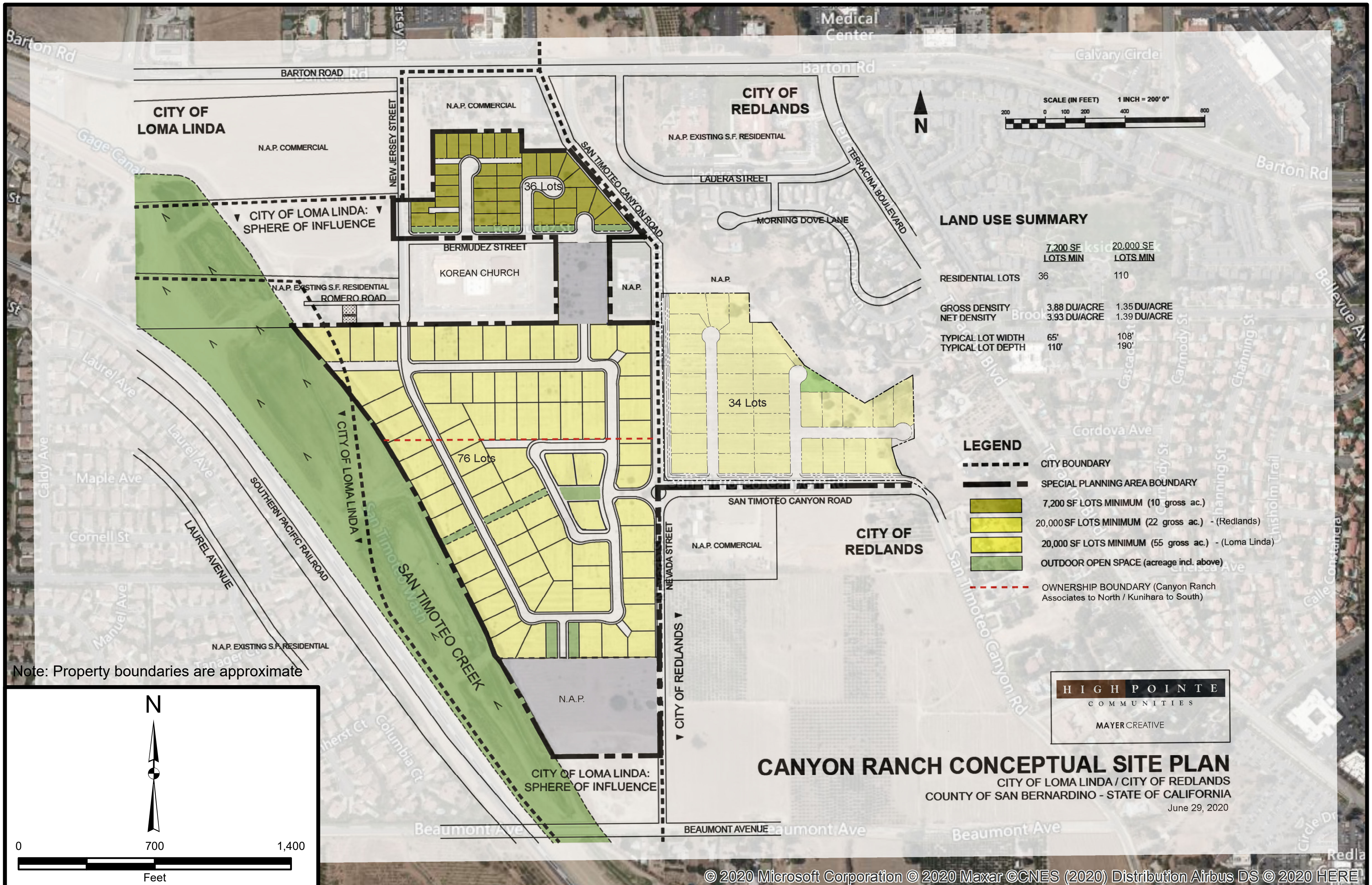


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Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton
Author: Leighton Geomatics (kmanchikanti)

# SITE CONCEPTUAL PLAN

Canyon Ranch Geotechcnial Due Diligence
Highpointe Communities, Inc., San Timoteo Canyon,
City of Redlands and Loma Linda, California

Figure 2

Leighton

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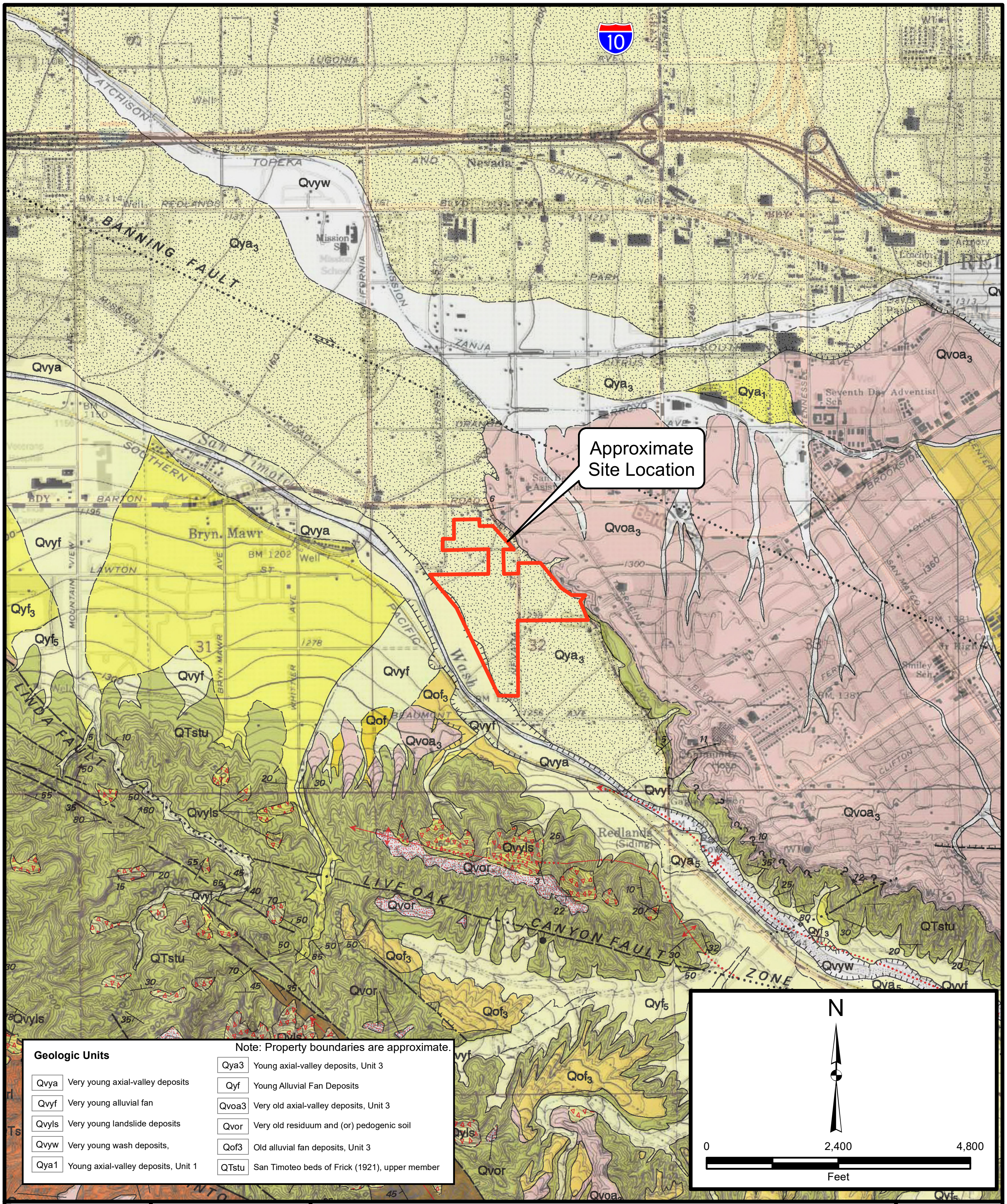


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Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton; USGS Geology 2003
Author: (kmanchikanti)

# SITE GEOLOGY MAP

Canyon Ranch Geotechcnial Due Diligence
Highpointe Communities, Inc., San Timoteo Canyon,
City of Redlands and Loma Linda, California

Figure 3

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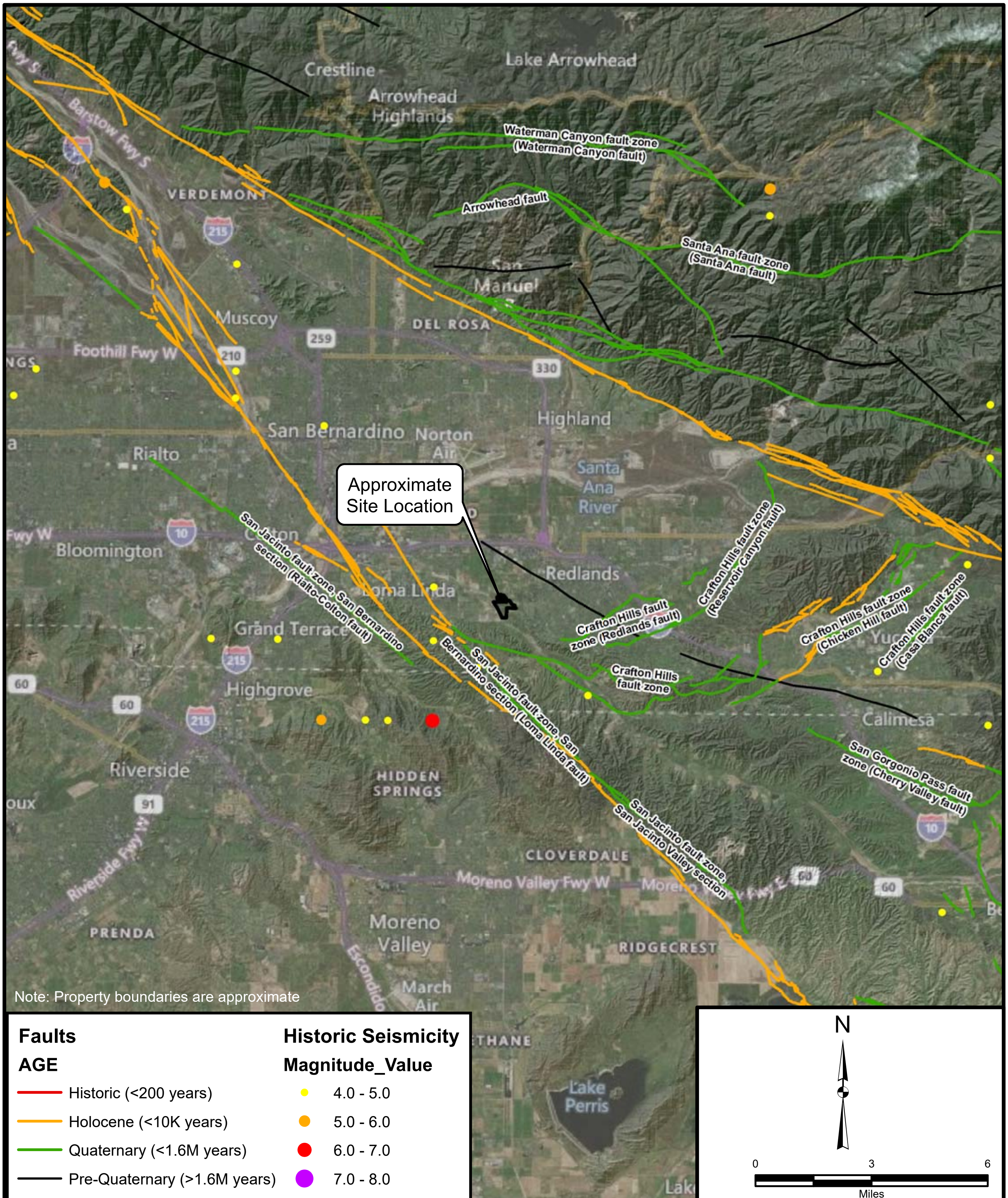


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| Project: 12828.001 | Eng/Geol: JH | **REGIONAL FAULT AND HISTORIC SEISMICITY MAP** | Figure 4 |
| Scale:1 " = 3 miles | Date: August 2020 | Canyon Ranch Geotechcnial Due Diligence, Highpointe Communities, Inc., San Timoteo Canyon, City of Redlands and Loma Linda, California | Leighton |
| Base Map: ESRI ArcGIS Online 2020<br>Thematic Information: Leighton; CGS, USGS<br>Author: (kmanchikanti) | | | |

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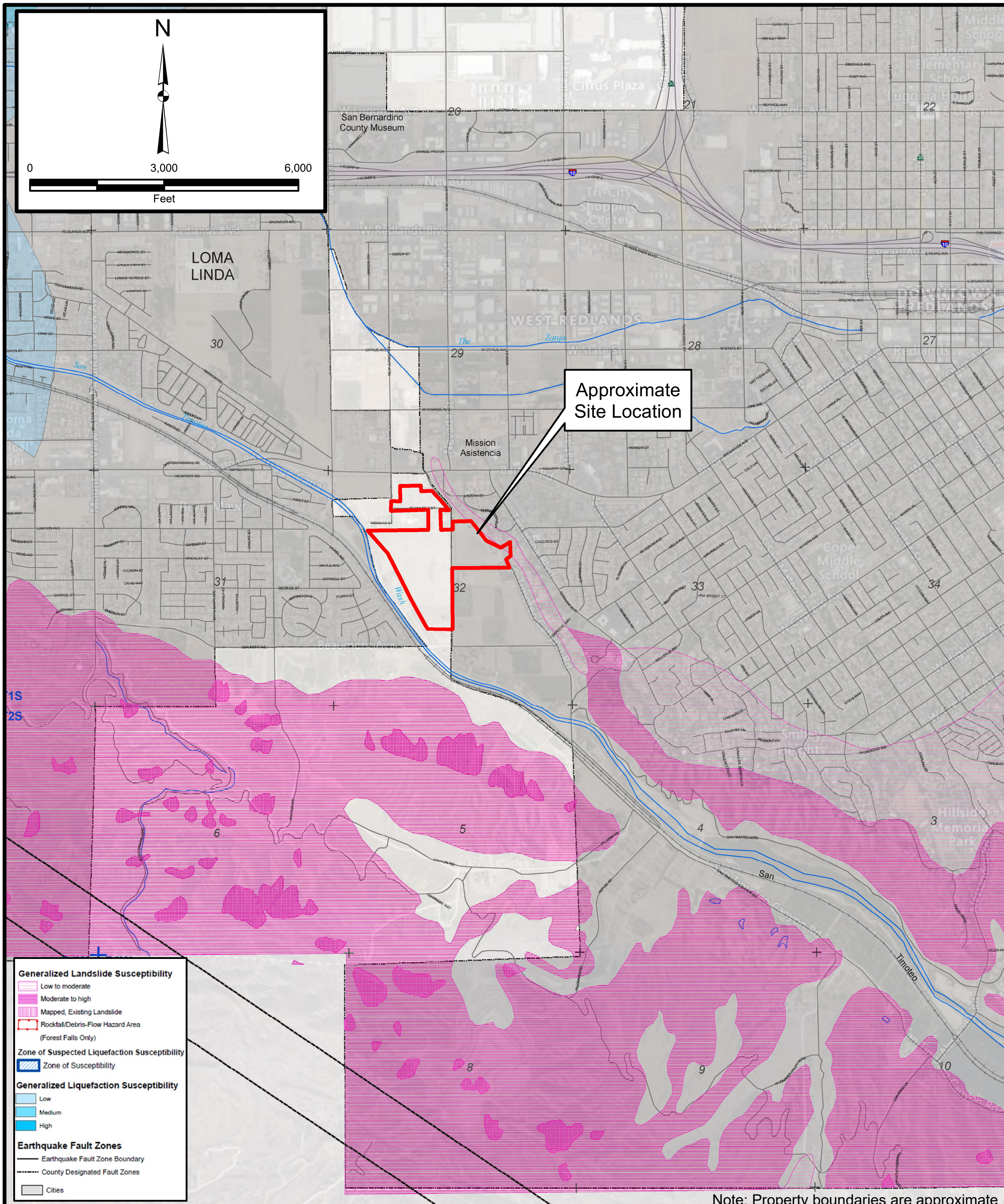


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Base Map: ESRI ArcGIS Online 2020,
Thematic Information: Leighton, CGS
Author: Leighton Geomatics (kmanchikanti)

# GEOLOGIC HAZARD MAP

**Canyon Ranch Geotechcnial Due Diligence**
**Highpointe Communities, Inc., San Timoteo Canyon,**
**City of Redlands and Loma Linda, California**

Figure 5

Leighton

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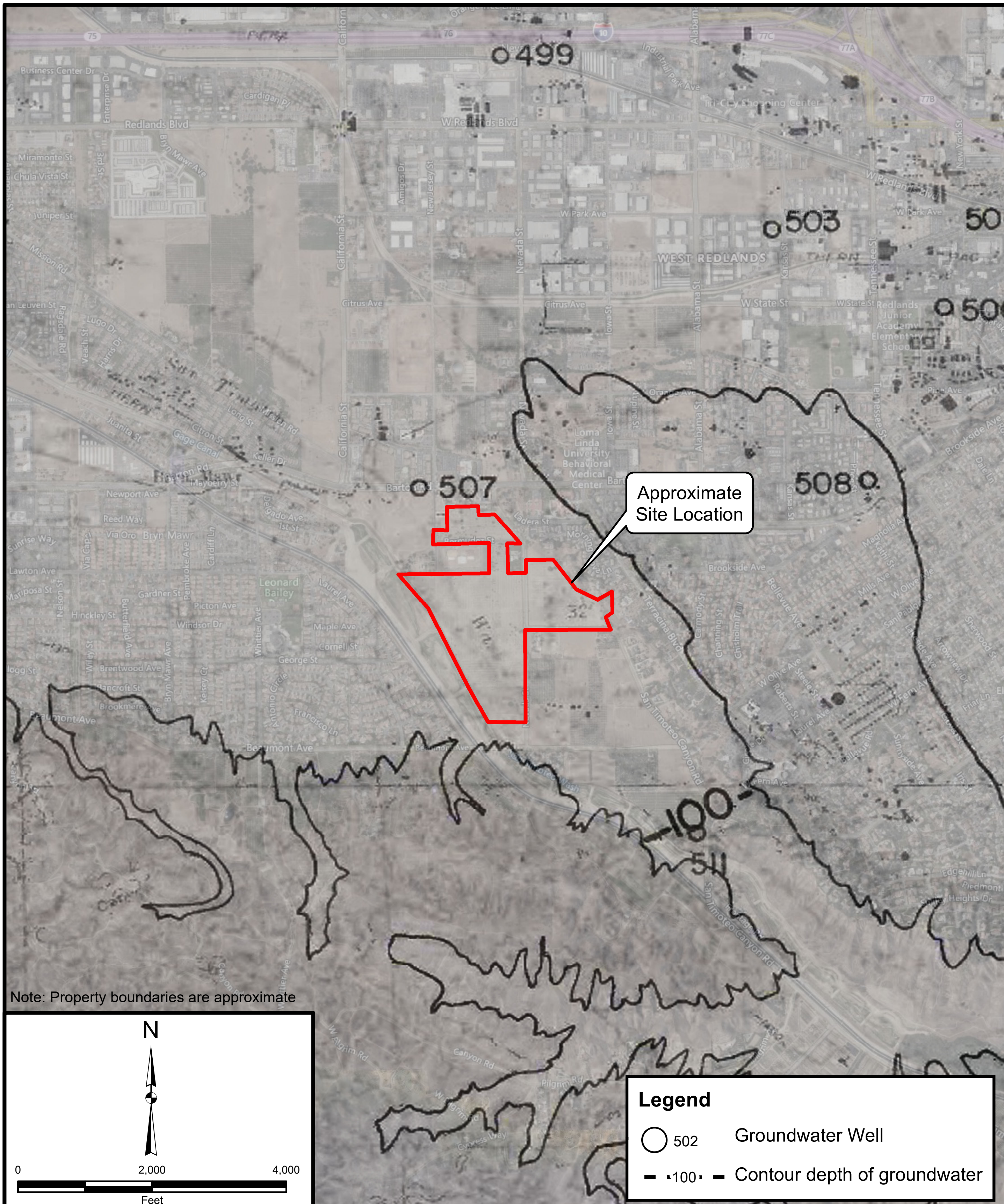


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Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton, Carson and Matti, 1985
Author: Leighton Geomatics (kmanchikanti)

# DEPTH TO GROUNDWATER MAP 1975-1979

Canyon Ranch Geotechcnial Due Diligence, Highpointe Communities, Inc., San Timoteo Canyon, City of Redlands and Loma Linda, California

Figure 6

Leighton

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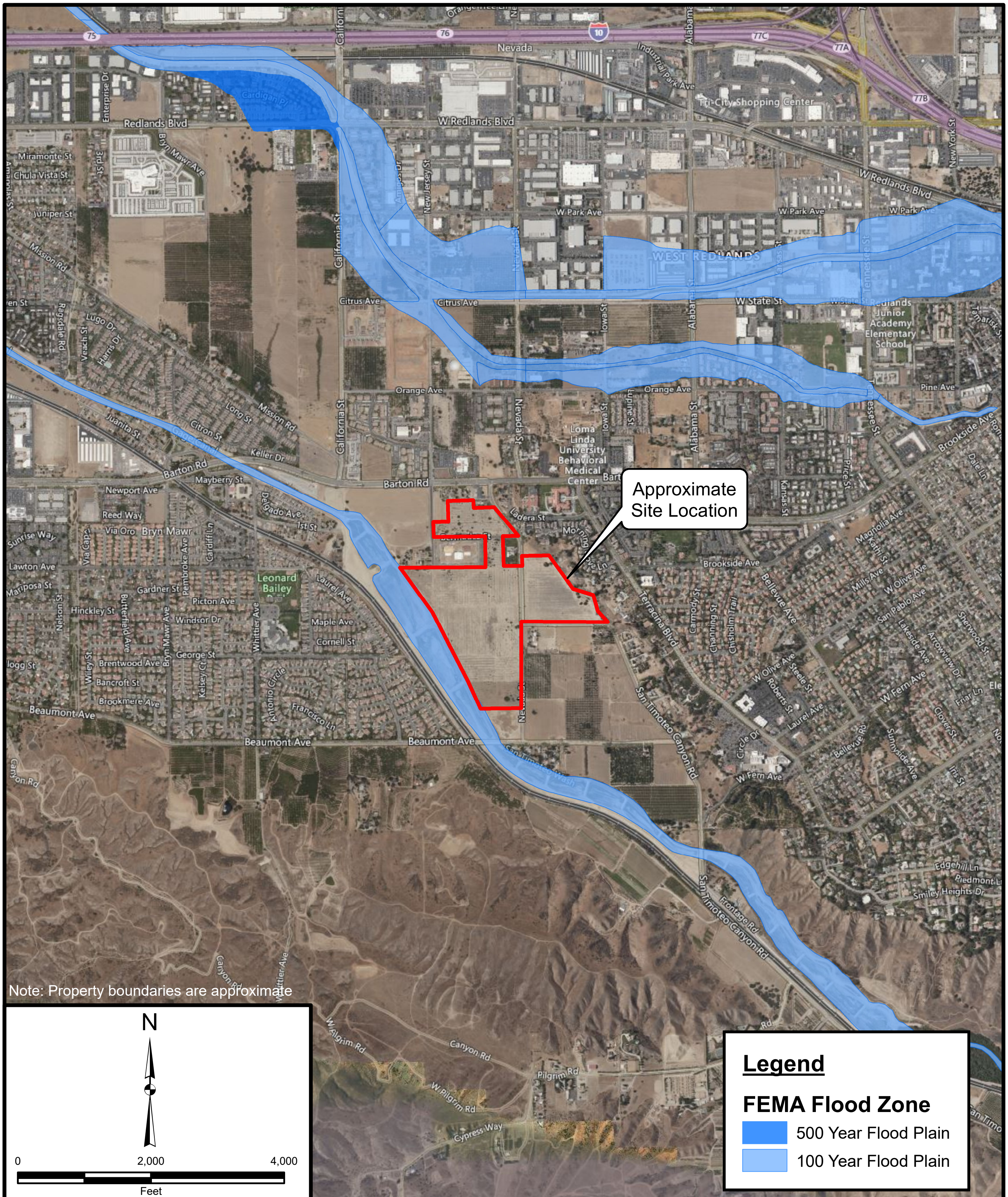


| Project: 12828.001 | Eng/Geol: JH |
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Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton, FEMA
Author: Leighton Geomatics (kmanchikanti)

# FLOOD HAZARD ZONE MAP

Canyon Ranch Geotechcnial Due Diligence, Highpointe Communities, Inc., San Timoteo Canyon, City of Redlands and Loma Linda, California

Figure 7

Leighton

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| Project: 12828.001 | Eng/Geol: JH |
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Base Map: ESRI ArcGIS Online 2020
Thematic Information: Leighton, CA DWR, FEMA
Author: Leighton Geomatics (kmanchikanti)

# DAM INUNDATION MAP

Canyon Ranch Geotechcnial Due Diligence
Highpointe Communities, Inc., San Timoteo Canyon,
City of Redlands and Loma Linda, California

Figure 8

Leighton

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# APPENDIX A

# APPENDIX A

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# APPENDIX B

APPENDIX B
LEIGHTON AND ASSOCIATES, INC.
GENERAL EARTHWORK AND GRADING SPECIFICATIONS FOR ROUGH GRADING

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LEIGHTON AND ASSOCIATES, INC.

GENERAL EARTHWORK AND GRADING SPECIFICATIONS FOR ROUGH GRADING

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# 1.0 GENERAL

## 1.1 Intent

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

## 1.2 The Geotechnical Consultant of Record

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

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

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include natural ground after it has been cleared for receiving fill but before fill is placed, bottoms of all "remedial removal" areas, all key bottoms, and benches made on sloping ground to receive fill.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to determine the attained level of compaction.

The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

### 1.3 <u>The Earthwork Contractor</u>

The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the plans and specifications.

The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of "spreads" of work and the estimated quantities of daily earthwork contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

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

## 2.0 PREPARATION OF AREAS TO BE FILLED

### 2.1 <u>Clearing and Grubbing</u>

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

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). No fill lift shall contain more than 5 percent of organic matter. Nesting of the organic materials shall not be allowed.

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

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed.

## 2.2 Processing

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

## 2.3 Overexcavation

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

## 2.4 Benching

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

Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.

### 2.5 Evaluation/Acceptance of Fill Areas

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

## 3.0 FILL MATERIAL

### 3.1 General

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

### 3.2 Oversize

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

### 3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of Section 3.1. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

## 4.0 FILL PLACEMENT AND COMPACTION

### 4.1 Fill Layers

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

### 4.2 Fill Moisture Conditioning

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

### 4.3 Compaction of Fill

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

### 4.4 Compaction of Fill Slopes

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

### 4.5 Compaction Testing

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

### 4.6 <u>Frequency of Compaction Testing</u>

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

### 4.7 <u>Compaction Test Locations</u>

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

## 5.0 SUBDRAIN INSTALLATION

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

## 6.0 EXCAVATION

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

## 7.0 TRENCH BACKFILLS

### 7.1 Safety

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

### 7.2 Bedding and Backfill

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

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

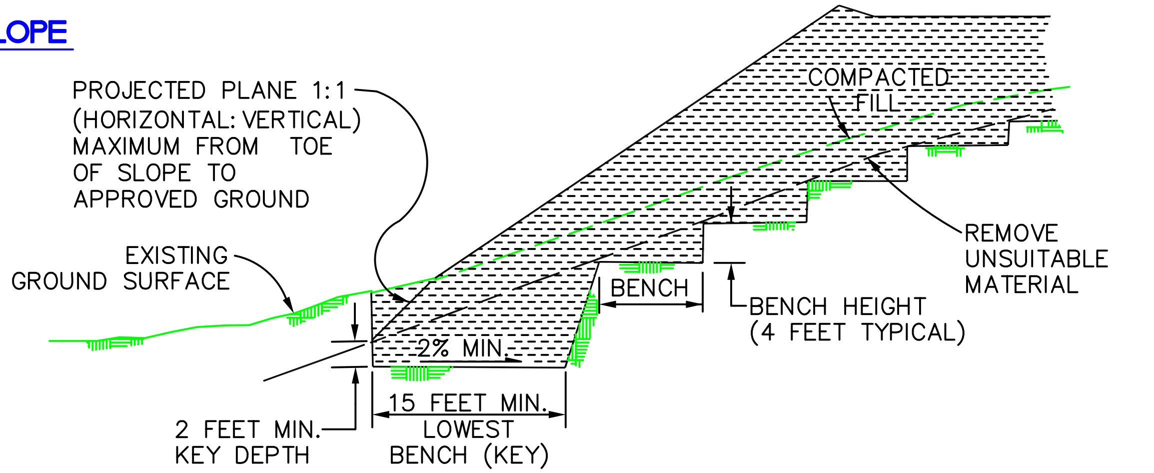
### 7.3 Lift Thickness

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

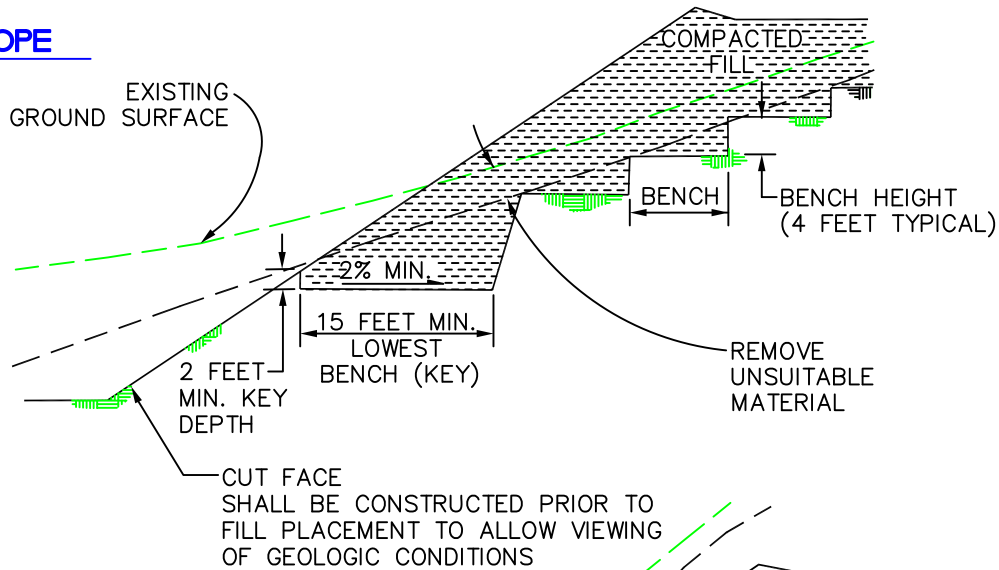
### 7.4 Observation and Testing

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

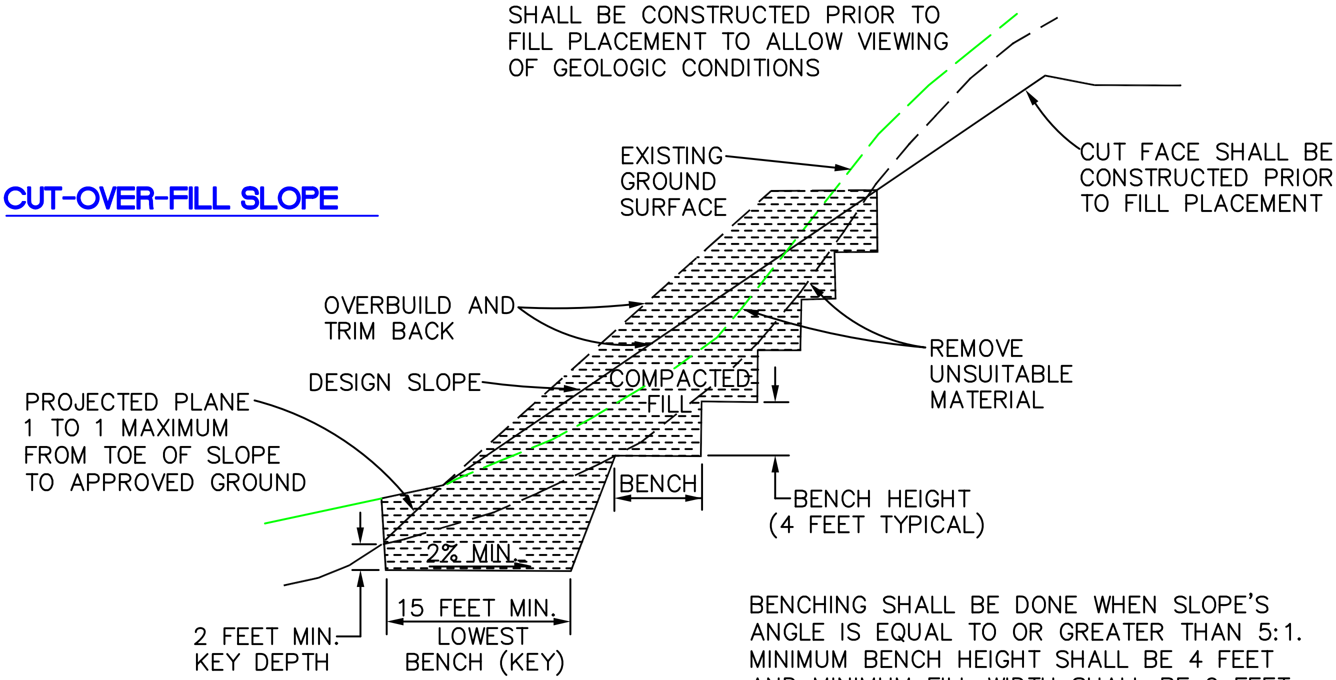
## FILL SLOPE




## FILL-OVER-CUT SLOPE

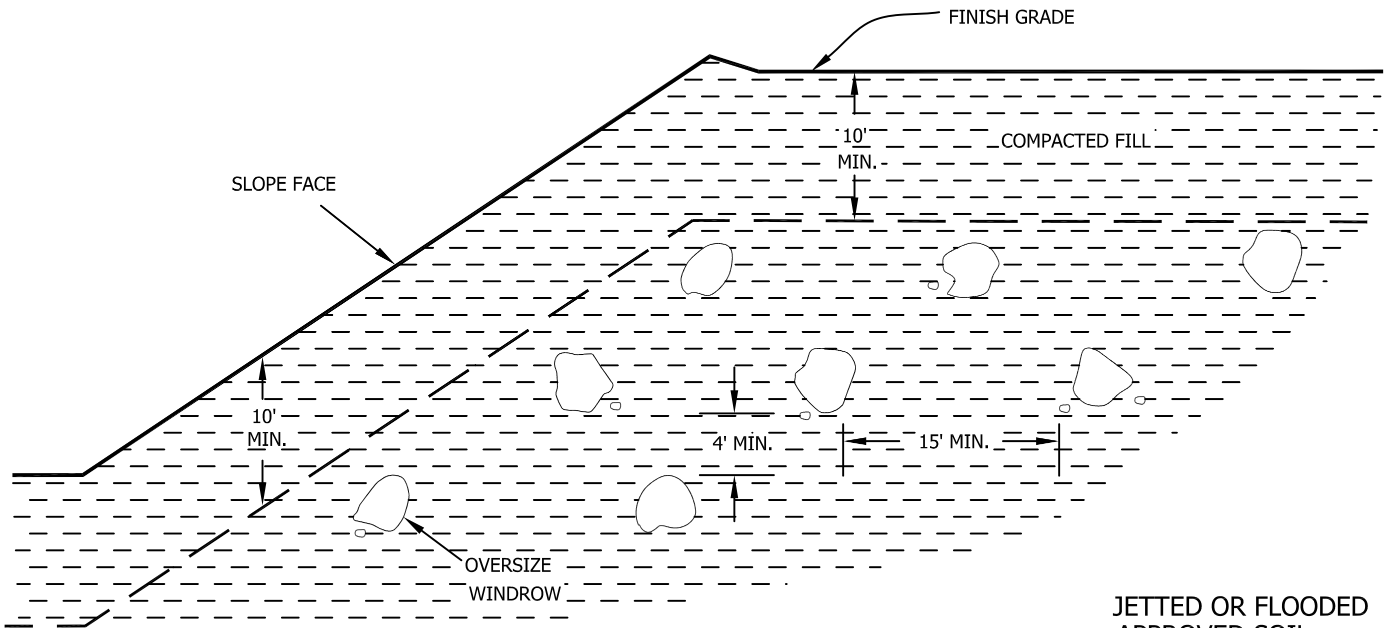



## CUT-OVER-FILL SLOPE

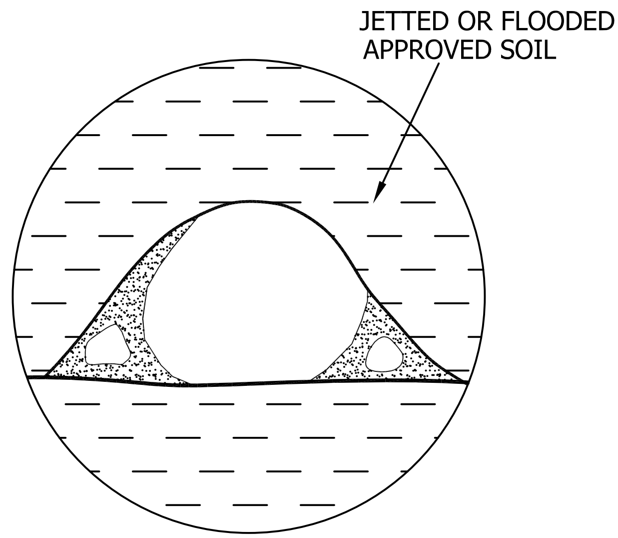



BENCHING SHALL BE DONE WHEN SLOPE'S ANGLE IS EQUAL TO OR GREATER THAN 5:1. MINIMUM BENCH HEIGHT SHALL BE 4 FEET AND MINIMUM FILL WIDTH SHALL BE 9 FEET.

| KEYING AND BENCHING | GENERAL EARTHWORK AND GRADING SPECIFICATIONS<br>STANDARD DETAILS A | Leighton |
|---|---|---|

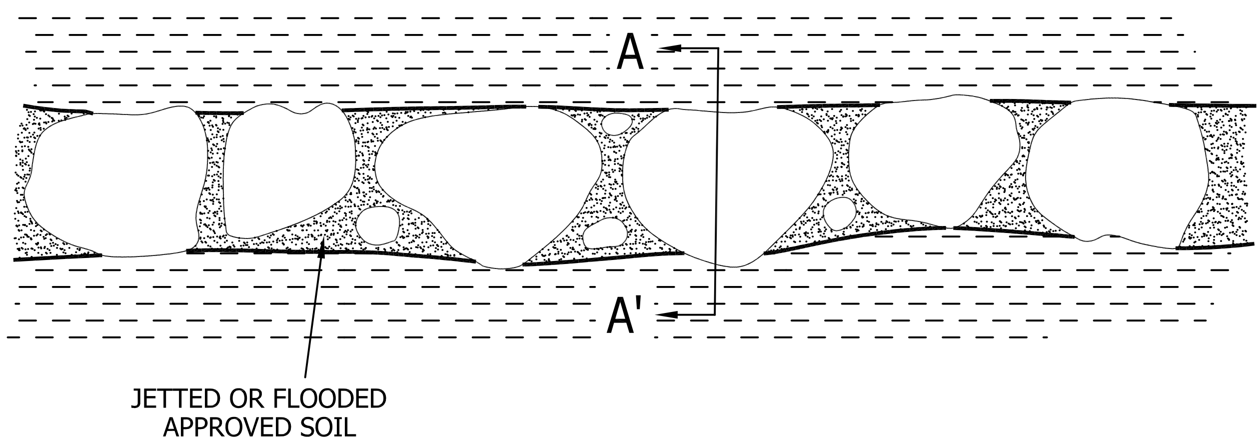



- Oversize rock is larger than 8 inches in largest dimension.
- Backfill with approved soil jetted or flooded in place to fill all the voids.
- Do not bury rock within 10 feet of finish grade.
- Windrow of buried rock shall be parallel to the finished slope face.




SECTION A-A'

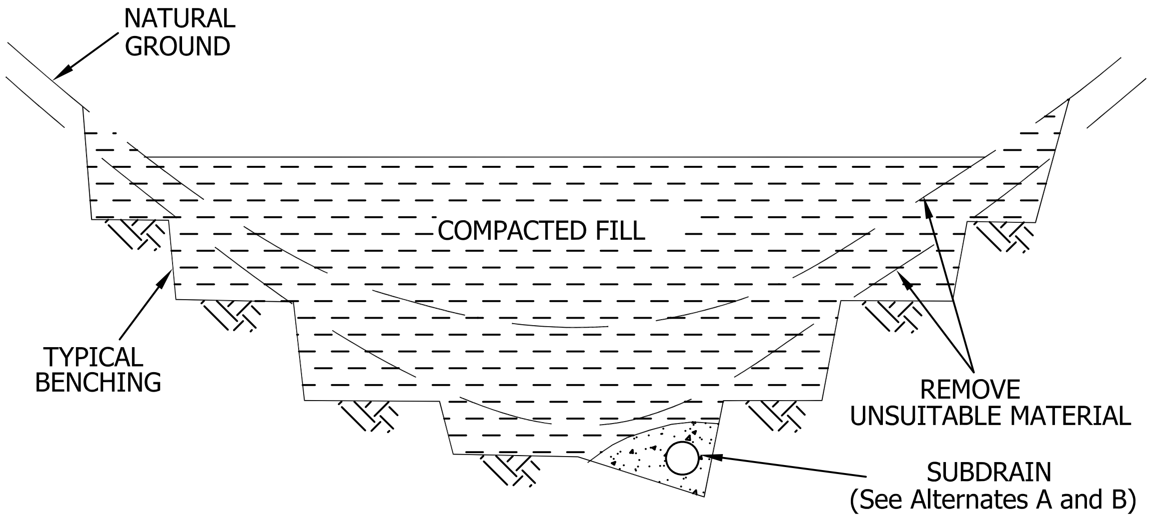
PROFILE ALONG WINDROW



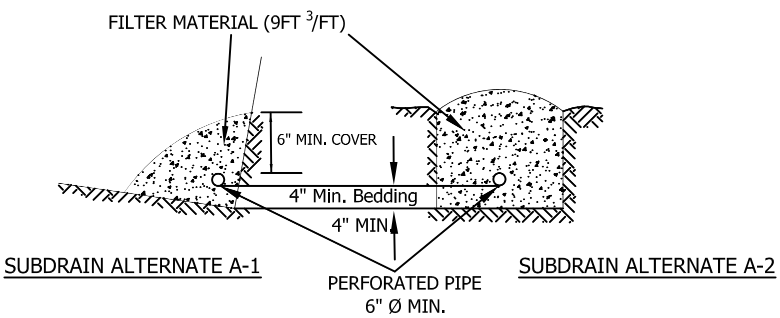

# OVERSIZE ROCK DISPOSAL

GENERAL EARTHWORK AND GRADING
SPECIFICATIONS
STANDARD DETAILS B

Leighton




## SUBDRAIN ALTERNATE A

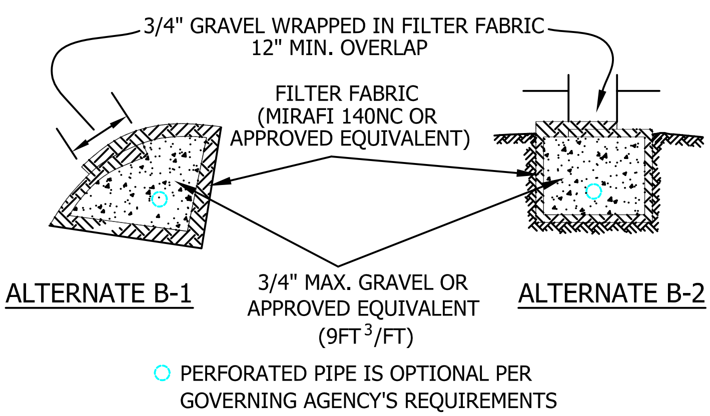



FILTER MATERIAL

FILTER MATERIAL SHALL BE CLASS 2 PERMEABLE MATERIAL PER STATE OF CALIFORNIA STANDARD SPECIFICATION, OR APPROVED ALTERNATE. CLASS 2 GRADING AS FOLLOWS:

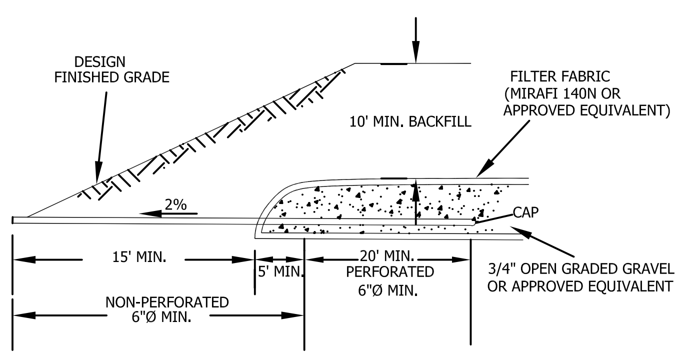
| Sieve Size | Percent Passing |
|---|---|
| 1" | 100 |
| 3/4" | 90-100 |
| 3/8" | 40-100 |
| No. 4 | 25-40 |
| No. 8 | 18-33 |
| No. 30 | 5-15 |
| No. 50 | 0-7 |
| No. 200 | 0-3 |

## SUBDRAIN ALTERNATE B




○ PERFORATED PIPE IS OPTIONAL PER GOVERNING AGENCY'S REQUIREMENTS

## DETAIL OF CANYON SUBDRAIN TERMINAL




| | | |
|---|---|---|
| CANYON SUBDRAIN | GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS C | Leighton |

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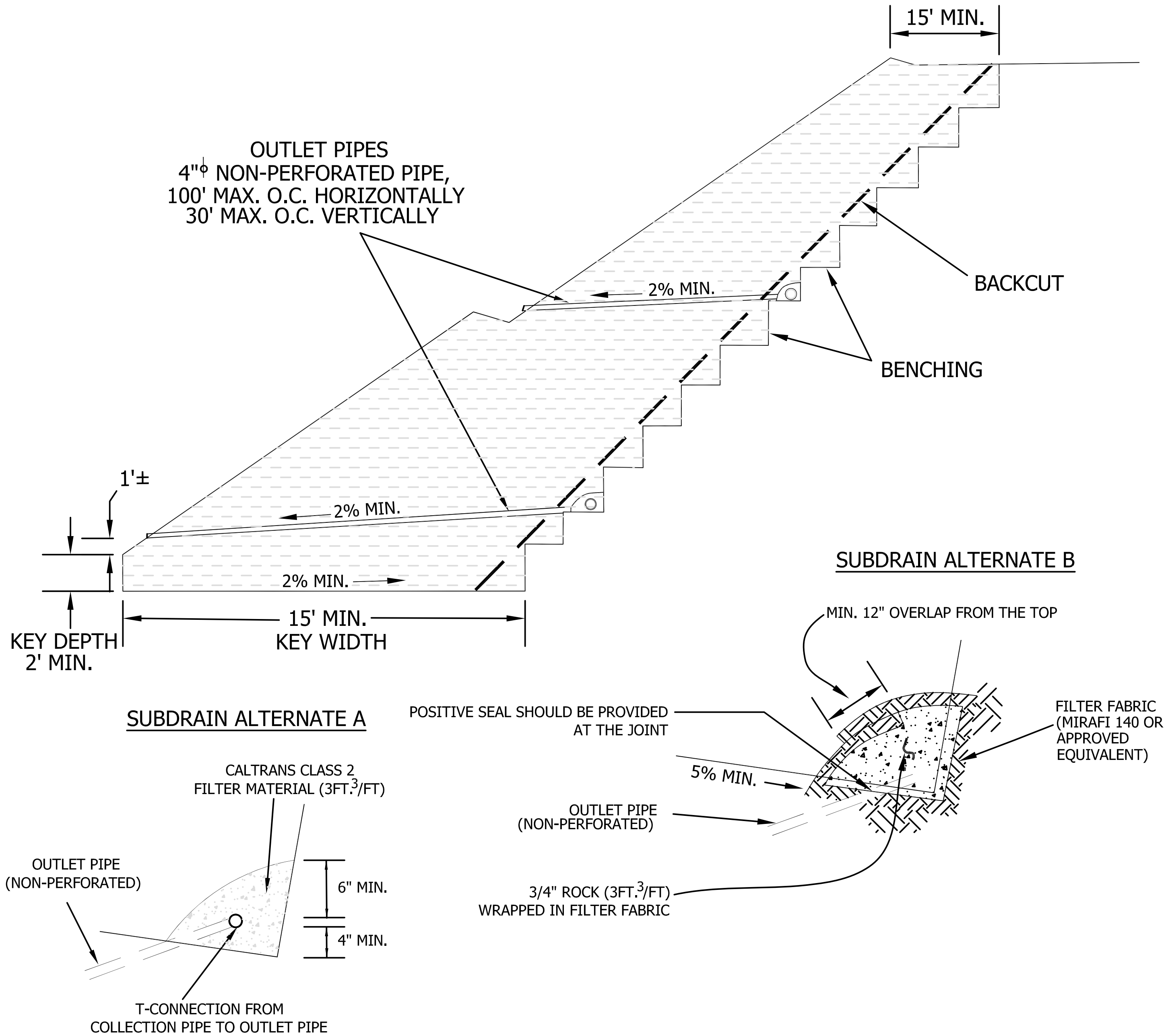


- SUBDRAIN INSTALLATION - Subdrain collector pipe shall be installed with perforations down or, unless otherwise designated by the geotechnical consultant. Outlet pipes shall be non-perforated pipe. The subdrain pipe shall have at least 8 perforations uniformly spaced per foot. Perforation shall be 1/4" to 1/2" if drilled holes are used. All subdrain pipes shall have a gradient at least 2% towards the outlet.
- SUBDRAIN PIPE - Subdrain pipe shall be ASTM D2751, ASTM D1527 (Schedule 40) or SDR 23.5 ABS pipe or ASTM D3034 (Schedule 40) or SDR 23.5 PVC pipe.
- All outlet pipe shall be placed in a trench and, after fill is placed above it, rodded to verify integrity.

| BUTTRESS OR REPLACEMENT FILL SUBDRAINS | GENERAL EARTHWORK AND GRADING SPECIFICATIONS<br>STANDARD DETAILS D | Leighton |
|---|---|---|

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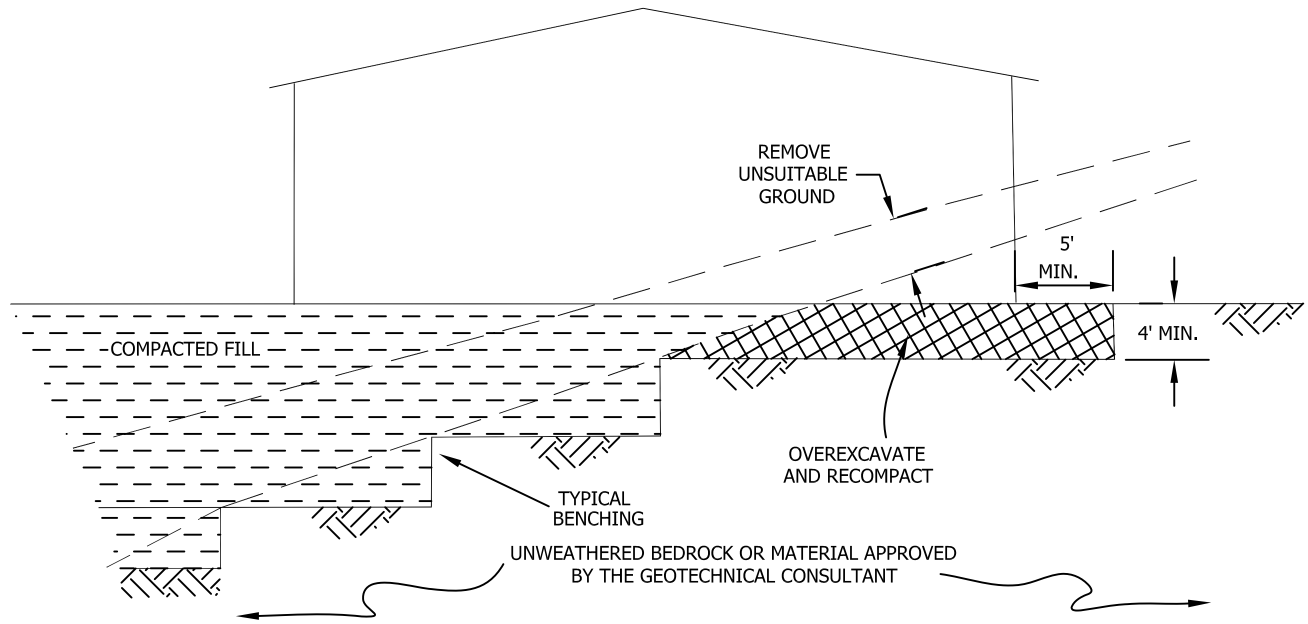
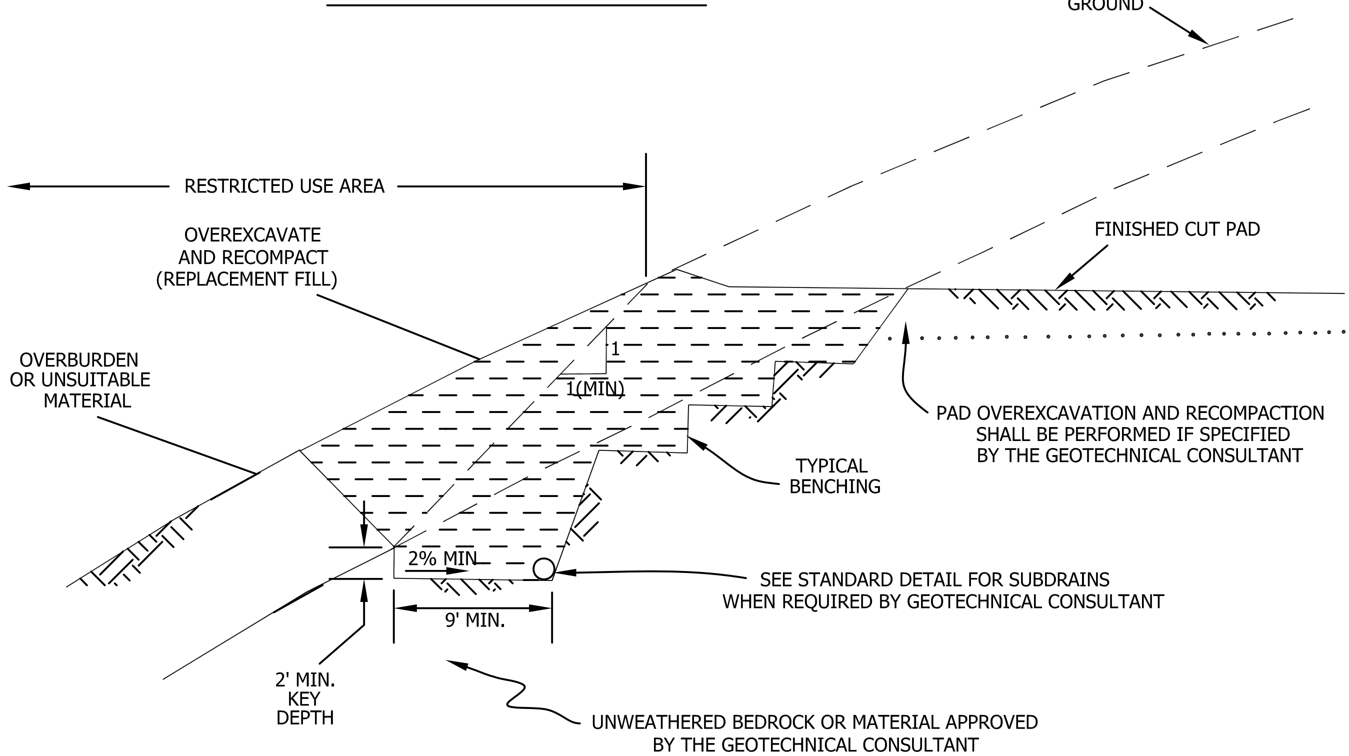
## CUT-FILL TRANSITION LOT OVEREXCAVATION




## SIDE HILL FILL FOR CUT PAD




| | | |
|---|---|---|
| TRANSITION LOT FILLS AND SIDE HILL FILLS | GENERAL EARTHWORK AND GRADING SPECIFICATIONS<br>STANDARD DETAILS E | Leighton |

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