August 30, 2018 Project 25998

Mr. Ethan C. Wessel
Tennen Studio
4702 East Indian School Road
Phoenix, Arizona, 85018

RE: EXECUTIVE SUMMARY LETTER FOR THE GEOTECHNICAL INVESTIGATION REPORT, ROCK CUT SLOPE ANALYSIS, AND BOULDER STABILITY ANALYSIS
HBL - A PROPOSED CUSTOM HILLSIDE RESIDENCE
APN 169-04-007
7550 NORTH HUMMINGBIRD LANE
PARADISE VALLEY, ARIZONA 85253

Mr. Wessel:

At the request of the Town of Paradise Valley, this firm is submitting an Executive Summary Letter in regard to the Geotechnical Investigation Report, Rock Cut Slope Analysis, and Boulder Stability Analysis, prepared by this firm and dated July 30, 2018, which have been submitted for the above listed project.

Three main components, as a portion of the PV Hillside Safety Plan, were included in the study. A full seismic refraction hillside geotechnical study, an existing rock cut slope stability analysis, and a boulder stability analysis. Excerpts from each of these studies are presented below:

Geotechnical Investigation

The site is situated on hillside terrain that has undergone past excavation efforts. Currently the site is occupied by a residential structure, a garage structure, and an asphalt driveway. The existing house was constructed on a wedge of fill that ranges in thickness from 0.0 to approximately 8.0 feet (based on visual observations and seismic survey data). The wedge of fill is thinnest on the west side of the pad and thickens to the east.

Portions of the new home will bear on footings that bear on the subsurface rock layer, resulting from an approximately 8 feet deep cut. For such footings, where rock is encountered, the following listing may be used in the design of shallow spread and continuous footings:

Foundation Embedment Depth (ft) - as defined herein	Average Depth of Occurrence Below Existing Grade	Bearing Stratum	Allowable Soil Bearing Capacity
Bearing at the surface of Layer 2, with a minimum footing thickness of 1.0 feet	Below 3.4 feet	Layer 2	4500 PSF
Socketed 1.0 feet into layer 2	Below 3.4 feet	Layer 2	5250 PSF

Where the above condition is not applicable, and the proposed finished grade will match that of the existing, the following recommendations will apply:

It is recommended that all surface-level foundations and isolated exterior foundations bearing on engineered fill be embedded a minimum of 1.5 feet below the lowest adjacent finish pad grade within 5.0 feet of proposed exterior walls. Please refer to the following table for the acceptable allowable soil bearing capacity condition. The column labeled Bearing Stratum refers to the soil layer that the footing pad rests on. For all construction, 2.0 feet and 1.33 feet are recommended as the minimum width of spread and continuous footings, respectively. The following tabulations may be used in the design of shallow spread (column) and continuous (wall) foundations for the proposed structures.

Foundation Embedment Depth	Bearing Stratum	Allowable Soil Bearing Capacity[3]
1.5 feet	Bearing within a zone of recompacted soil that is slightly greater than 2.5 feet in thickness	2000 PSF

Following foundation excavation creation, it should be noted that the on-site site soils will need to be recompacted through hand-tamping efforts, following the completion of the foundation excavation. This is necessary because of the inability of the site soils to maintain stability while withstanding the adverse effects of backhoe teeth. Hence the need for hand-tamping to regain soil bearing. Therefore, the bottom of the footing excavations must be hand-tamped to eliminate the probable adverse effects of the disturbance due to the backhoe. Prior to the placement of reinforcing steel, the base of all foundation excavations must be compacted with a “jumping jack” or plate tamper, resulting in compaction of the foundation bearing soils to a depth of 6.0 inches. The final compaction must be to at least 95% of the ASTM D698 maximum density. Some degree of moisture processing may be required to facilitate proper compaction, although no moisture specification will apply.

This firm considers the existing spread fill, used to build the existing pad, to be uncontrolled and uncompacted (undocumented). Demolition activities will extend the problematic soils to approximately 2.5 feet, which may be roughly 1.0 feet below the base of the footings for the new structure. Therefore, we recommend that the uppermost 2.5 feet of the existing spread fill or site native soils (measured from the upper fill level) be removed and recompacted through reconditioning. The 2.5 feet zone of excavation and recompaction should reach across the entire building envelope. All final compaction shall be as specified in the Geotechnical Investigation Report. The scarification and compaction requirement apply to cut situations as well as fill situations. As such, the base of the zone of subexcavation must be scarified, moisture processed and compacted as indicated herein.

Double reinforcement shall be required for all surface-level foundations within a very specific zone / area that is governed by the location of the transition from cut to fill. Foundation double reinforcement must involve the entire length of footings downslope from the hinge point and extend at least 10 feet upslope form the hinge point. Refer to the Geotechnical Investigation Report for an illustration that depicts the natural slope, and the resulting location of what is termed herein as the “hinge point” between the cut and fill zones. The Site Plan in Section II of the report shows the approximate location of the cut-fill transition line, “hinge point.” Double reinforcement for footings should include four No. 5 bars, two near the bottom (tension side) and two near the top (compression side) of the footing (double reinforcement-equal distribution of steel on each side of the neutral axis).

A 5-inch (full) thick floor slab for the building should incorporate No. 4 reinforcing steel at 24 inches on center, each way, chaired, tied (100 percent) and tied to the footing steel. The final design for reinforcement should be completed by a registered structural engineer.

Rock Cut Slope Analysis

The main cut is located on the western edge of the site. The rocks associated with this cut slope are predominantly highly to moderately weathered and fractured Quartz-Muscovite-Schist that contains different magnitudes of foliation. Quartz veins and a mafic intrusion are also present. The most predominant discontinuity along the western and eastern 1/3 of the slope is foliation, and the most common discontinuities along the central 1/3 of the slope are conjugate fractures. Typically, the dip of the foliation is consistent throughout.

At this time, we understand that the preferred method of slope remediation would involve laying the slope back to conform to a 2.5:1 (horizontal:vertical) ratio for the upper soil portion of the slope, and a 1:1.5 (horizontal:vertical) ratio for the lower rock portion of the slope. Without treatment of the slope face, and in anticipation of the accumulation of detritus at the toe of the slope, an established buffer zone must be incorporated into the design and construction according to the following table:

Vertical Rock Cut-Slope Height (feet)	Horizontal Rock-Fall Impact Zone Distance (feet)
5	2.5
10	5
15	7.5
20	10

As an alternate to laying the slope back and implementing an appropriate building setback, the following recommendations will apply:

An in-situ, with an applied site-specific seismic force, analysis indicates a potential for sliding. As the factor of safety was determined to be less than 1.5, remedial actions such as bolting must be employed. In order to stabilize the slope and guard against a potential slope failure, rock bolting must be employed. With rock bolting, the Factor of Safety will increase above 2, with that Factor of Safety applicable only to the natural slope above the bolted portion. We recommend a bolt pattern of two rows of (6 feet by 6 feet) across the slope. All measurements will be made along the slope face in a linear fashion. Both the upper and lower row of bolts will have 20-feet long bolts. We recommend the use of a 3-inch minimum diameter core hole. The annular space must be grouted a minimum of 60% of the total length of the bolt (i.e. 12’). Final locations to be marked on-site by Vann Engineering, Inc. Tecco mesh should begin 6 feet upslope from the slope crest, and extend down slope to the toe of the cut slope.

Boulder Stability Analysis

The following table summarizes the results of the 3 boulder simulations. An "X" indicates that the boulder did not meet both of the design criteria and will require stabilization.

Boulder ID	In Situ	Seismic Shaking		Base Erosion	Stabilization Required
	(Sliding)	(Sliding)	(Toppling)	(Sliding)	
B-1	-	-	-	X	**Yes**
B-2	-	-	-	X	**Yes**
B-3	-	-	-	-	-
B-4	-	-	-	-	-
B-5	X	X	-	X	**Yes**
B-6	-	-	-	X	**Yes**
B-7	X	X	-	X	**Yes**
B-8	-	X	-	X	**Yes**
B-9	X	X	-	X	**Yes**
B-10	-	-	-	-	-
B-11	X	X	-	X	**Yes**
B-12	-	-	-	-	-
B-13	-	X	-	X	**Yes**

The voids between the boulders (B-1, B-2, B-5, B-6, B-7, B-8, B-9, B-11, and B-13). and the underlying slope/pedestal should be filled with 4000 psi non-shrink grout (ASTM C1107). Any smaller boulders wedged between the subject boulders and the underlying rock mass should be encompassed within the grout as well. On the downhill side of the boulder, the top soil should be removed so that the grout makes clean contact with the underlying rock. The grout should be formed on the downhill side of the boulder to create a buttress. Refer to the Boulder Mitigation Protocol detail sheet in Section II of the Geotechnical Investigation Report.

The location of each boulder to be stabilized must be confirmed by this firm prior to grouting.

Furthermore, any smaller boulders or rock fragments (without a dimension greater than 3.0 feet) which sit atop other boulders should be removed, as depicted in the figure below. The stability of such boulders/rock fragments was not directly evaluated in this study; however, it is the opinion of this firm that such scenario presents a high potential for movement.

All exposed concrete should be finished with faux rock, on equivalent textured paint. If the faux rock is mixed into the concrete design, the minimum compressive strength of the mix must still meet the requirements set forth herein.

It must be noted that the reports and the recommendations are predicated on three reports serving in congress; 1) the Geotechnical Investigation Report dated July 30, 2018, 2) the Boulder Stability Evaluation dated July 30, 2018, and 3) the Rock Cut Slope Stability Analysis dated July 30, 2018. This report is, therefore, a portion of the overall study of the site. Because of the uniqueness of each report, the contents are constrained to separate submittals. Notwithstanding, all three reports will work together. All three reports are identified by the Project Number 25998.

Neither Vann Engineering, Inc. nor their agents or employees shall be jointly, severally or individually liable to the client or owner in excess of the compensation to be paid for our work, by any reason of any act or omission, including breach of contract or negligence not amounting to willful or intentional wrong.

Respectfully submitted,

VANN ENGINEERING, INC.

Registered Professional Engineer (Geological)
CERTIFICATE NO.
15206
JEFFRY D.
VANN
Date Signed 8/30/18
ARIZONA, U.S.A.
Expires 09/30/19

Jeffry D. Vann, MS PE D.GE F.ASCE
Principal Engineer

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