CTL | THOMPSON INCORPORATED

SOILS AND FOUNDATION INVESTIGATION
LOT 9
INDIAN MOUNTAIN
FILING NO. 6
58 WA BUN WAY
PARK COUNTY, COLORADO

Prepared For:

Tim Horne and Patsy Verhoeven
P.O. Box 8226
Aspen, Colorado 81612

Project No. SU01097-120

May 26, 2015

1790 Airport Road, Unit 2, Breckenridge, Colorado 80424
Telephone: 970-453-2047 www.ctlthompson.com

TABLE OF CONTENTS

SCOPE

This report presents the results of our soils and foundation investigation for the proposed residence at Lot 9, Indian Mountain, Filing No. 6 in Park County, Colorado. We conducted this investigation to evaluate subsurface conditions at the site and provide geotechnical engineering recommendations for the proposed residence. Our report was prepared from data developed during our field exploration, engineering analysis, and experience with similar conditions. This report includes a description of the subsurface conditions observed in our exploratory pits and presents geotechnical engineering recommendations for design and construction of the residence foundations, floor systems, and details influenced by the subsoils. The scope was described in our Service Agreement (SU 15-0113) dated April 6, 2015.

Recommendations contained in this report were developed based on our understanding of the planned construction. If plans differ significantly from the descriptions contained in the report, we should be informed so that we determine whether our recommendations and design criteria are appropriate. A summary of our conclusions is presented below.

SUMMARY OF CONCLUSIONS

1. Subsurface conditions observed in our exploratory pits consisted of approximately 6 to 18 inches of "topsoil" underlain by clayey sand and sandy gravel soils with cobles, to the maximum depth explored of 12 feet below existing grade. Groundwater was not encountered in the pits at the time of excavation.

2. We expect excavations for the new residence will expose natural clayey sand and/or gravel at anticipated foundation elevations. All topsoil should be removed beneath footing and slab areas. The residence can be constructed on footing foundations. Design and construction criteria are presented in the report. It is critical that we observe the excavation prior to placing footings to verify conditions are as anticipated.

3. We judge the subsoils are non-expansive. Slab-on-grade floors may be used.

4. Surface drainage should be designed to provide for rapid removal of surface water away from the building.

5. The design and construction criteria for foundations and floor systems in this report were compiled with the expectation that all other recommendations presented related to surface and subsurface drainage, landscaping irrigation, backfill compaction, etc. will be incorporated into the project and that home owners will maintain the structure, use prudent irrigation practices and maintain surface drainage. It is critical that all recommendations in this report are followed.

SITE CONDITIONS

The site is located southeast of the Wa Bun Way cul-de-sac near the intersection of Gitche Goone Lane and Wa Bun Way (see Figure 1). The property is bordered to the north by Wa Bun Way and occupied residential Lot 10 and by vacant lots to the east, south, and west. The property is currently vacant. The lot sits in a gulch with slopes aspects ranging from east to south to southwest. The gulch drains to the southeast. Slopes on the site range from 8 to 18 percent. Vegetation consists of coniferous and aspen trees, brush, and grass. The trees are closely spaced on the west side of the site and prevented our access to the southwest corner of the proposed structure.

PROPOSED CONSTRUCTION

The completed plans for the proposed construction are not available at the time of this report. As we understand it, the residence will be a two story metal Quonset structure with a garage and partial living space on the lower level. The lower level floors will either be a standard slab-on-grade construction with separate footings or a mono-pour thickened slab on grade. Additional recommendations can be provided, upon request, if thickened slab construction is used. The finished floor elevation is expected to be approximately 9526 feet USGS. Maximum foundation excavations on the order of 5 feet are anticipated for the northwest corner of the structure. The southeast portion of the residence will most likely be placed on fill. Interior wood frame construction will be used above grade with cast-in-place concrete stem walls below grade. Foundation loads are expected to be about 1,000 to 3,000 pounds per linear foot of foundation wall, with maximum column loads of 40 kips or less.

SUBSURFACE CONDITIONS

Subsurface conditions were investigated by excavation of two exploratory pits at the approximate locations shown on Figure 2. Subsurface conditions observed in the pits were logged by our field engineer who obtained samples of the soils during excavation. Graphic logs of the soils observed in the pits are shown on Figure 3.

We found about 6 to 18 inches of “topsoil” underlain by clayey sand and sandy gravel soils with cobbles, to the maximum depth explored of 12 feet below existing grade. The gravel soils may consist of weather/decomposed granite with depth. No free water was observed in the pits at the time of excavation. The soils were generally slightly moist to moist and medium dense to very dense with depth. The pits were backfilled after excavation operations were completed.

Samples obtained in the field were returned to our laboratory where field classifications were checked and samples were selected for pertinent testing. Results of gradation testing conducted on samples of the sand soils and gravel soils are shown on Figures 4 through 7. Laboratory test results are also summarized in table 1.

GEOLOGIC HAZARDS

We reviewed geologic mapping showing the site. The mapping was by D.G. Wyant and Fred Barker with U.S. Geologic Survey (Map GQ-1343). The mapping was completed in 1976. The site is mapped as Precambrian aged granite. No geologic hazards are identified on the mapping. Our field investigation and observation at the site confirm the mapping.

Covering the ground with houses, streets, driveways, patios, etc., coupled with lawn irrigation and changing drainage patterns, leads to an increase in subsurface moisture conditions. As a result, some soil movement is inevitable. It is critical that all recommendations in this report are followed to increase the chances that the foundations and slabs-on-grade will perform satisfactorily. After construction, owners must assume responsibility for maintaining structures and use appropriate practices regarding drainage and landscaping. We did not observe geologic constraints on this site that would inhibit the planned construction.

SITE EARTHWORK

Our subsurface information indicates that excavations for the foundation will be in the natural sand and/or gravel soils. We should observe the excavation to confirm whether subsurface conditions are as anticipated.

We anticipate excavation of the soils can be accomplished using conventional, heavy duty excavating equipment. Sides of excavations need to be sloped to meet local, state and federal safety regulations. The soils will likely classify as Type C soils based on OSHA standards governing excavations. Temporary slopes deeper than 4 feet that are not retained should be no steeper than 1.5 to 1 (horizontal to vertical) in Type C soils. Cobbles and some boulders will be encountered. Contractors should identify the soils encountered and ensure that applicable standards are met. Contractors are responsible for site safety and maintenance of the work site.

The footing areas should be protected from any seepage (if encountered) and precipitation through the use of shallow trenches and sumps. Excavations should be sloped to a gravity discharge or to a temporary sump where water can be removed by pumping, if necessary.

Structural Fill

Structural fill may be required to backfill excavations resulting from the removal of existing cobbles and boulders and backfill under the downhill side of the structure. The on-site sand soil and gravel soil, free of organic matter, debris, and rocks larger than 6 inches in diameter, can be used as structural fill. Gravel soils are preferred. Care should be taken during fill placement so the larger rocks do not become nested or grouped together. If required, import fill should consist of a CDOT Class 6 aggregate base course or similar soil. Lean-mix concrete (flowable fill) could also be used to fill voids.

Structural fill below foundations should be placed in loose lifts of 8 inches thick or less, moisture conditioned to within 2 percent of optimum moisture content, and compacted to at least 98 percent of ASTM D 698 maximum dry density. Fill beneath slabs should be placed in a similar manner and compacted to at least 95 percent for slabs separated from footings or 98 percent if a thickened slab is used. Moisture content and density of structural fill should be checked by a representative of our firm during placement.

FOUNDATIONS

The residence can be constructed on footing foundations supported by the natural sand and/or gravel soils or compacted structural fill. Loose and disturbed soils should be removed or compacted. Structural fill should meet the criteria in the Structural Fill section. Our representative should be called to observe conditions exposed in the completed foundation excavations to confirm whether the exposed soils are as anticipated and suitable for support of the foundation as designed. Structural fill should be tested for proper moisture content and density during placement.

1. The proposed residence can be supported by footing foundations supported on the undisturbed, natural sand and/or gravel soil or compacted fill. Soils loosened during the forming process for the footings should be removed or re-compacted prior to placing concrete. All topsoil must be completely removed beneath footing and floor slab areas.

2. Based on the proposed construction, soil conditions observed, and our experience, we expect settlement of footings designed and constructed as discussed will be about 1 inch or less. Placing structural fill beneath the downhill side of the building will increase the risk of differential settlement.

3. Footings can be sized using a maximum allowable soil pressure of 2,500 psf. A coefficient of sliding friction of 0.40 may be used to resist sliding.

3. Continuous wall footings should have a minimum width of at least 16 inches. Foundations for isolated columns should have minimum dimensions of 24 inches by 24 inches. Larger sizes may be required, depending upon foundation loads.

4. Grade beams and foundation walls should be well reinforced, top and bottom, to span undisclosed loose or soft soil pockets and resist lateral earth pressures. We recommend reinforcement sufficient to span an unsupported distance of at least 10 feet. Reinforcement should be designed by the structural engineer.

5. The soils under exterior footings should be protected from freezing. Typically, we recommend footings be provided with at least 40 inches of soil cover of bearing elevation. A depth of at least 24 inches below finished exterior grades is required in by Park County Building Department.

FLOOR SYSTEM AND SLABS-ON-GRADE

Slab-on-grade for the lower level is desired. Based on our laboratory test data and experience, we judge slab-on-grade construction supported by the natural sand and/or gravel or properly placed granular structural fill will have a low risk of damaging differential movement. Fill placed to attain subgrade elevations below floor slabs should be placed in accordance with the recommendations outlined in Structural Fill. We recommend the following precautions for slab-on-grade construction at this site. These precautions will not prevent movement from occurring; they tend to reduce damage if slab movement occurs.

1. Slabs should be separated from exterior walls and interior bearing members with slip joints which allow free vertical movement of the slabs (for independent footing and slab construction).

2. Underslab plumbing should be pressure tested for leaks before the slabs are constructed. Plumbing and utilities which pass through slabs should be isolated from the slabs with sleeves and provided with flexible couplings. If a furnace is supported on the slabs, a flexible plenum boot should be provided.

3. Frequent control joints should be provided, in accordance with American Concrete Institute (ACI) recommendations, to reduce problems associated with shrinkage and curling.

4. The 2012 International Residential Code (IRC R506) states that a 4-inch base course layer consisting of clean graded sand, gravel, crushed stone or crushed blast furnace slag shall be placed beneath below grade floors (unless the underlying soils are free-draining), along with a vapor retarder.

   IRC states that the vapor retarder can be omitted where approved by the building official. The merits of installation of a vapor retarder below floor slabs depend on the sensitivity of floor coverings and building use to moisture. A properly installed vapor retarder is more beneficial below concrete slab-on-grade floors where floor coverings,

painted floor surfaces, or products stored on the floor will be sensitive to moisture. The vapor retarder is most effective when concrete is placed directly on top of it, rather than placing a sand or gravel leveling course between the vapor retarder and the floor slab. Placement of concrete on the vapor retarder may increase the risk of shrinkage cracking and curling. Use of concrete with reduced shrinkage characteristics including minimized water content, maximized coarse aggregate content, and reasonably low slump will reduce the risk of shrinkage cracking and curling. Considerations and recommendations for the installation of vapor retarders below concrete slabs are outlined in Section 3.2.3 of the 2006 American Concrete Institute (ACI) Committee 302, "Guide for Concrete Floor and Slab Construction (ACI 302.R-96)".

FOUNDATION WALLS

Foundation walls which extend below-grade should be designed for lateral earth pressures where backfill is not present to about the same extent on both sides of the wall. Many factors affect the values of the design lateral earth pressure. These factors include, but are not limited to, the type, compaction, slope and drainage of the backfill, and the rigidity of the wall against rotation and deflection. For a very rigid wall where negligible or very little deflection will occur, an "at-rest" lateral earth pressure should be used in design. For walls that can deflect or rotate 0.5 to 1 percent of wall height (depending upon the backfill types), lower "active" lateral earth pressures are appropriate. Our experience indicates typical below-grade walls in residences deflect or rotate slightly under normal design loads, and that this deflection results in satisfactory wall performance. Thus, the earth pressures on the walls will likely be between the "active" and "at-rest" conditions.

If on-site soils are used as backfill and the backfill is not saturated, we recommend design of basement walls at this site using an equivalent fluid density of at least 45 pcf. This value assumes deflection; some minor cracking of walls may occur. If very little wall deflection is desired, a higher design value is appropriate. The structural engineer should also consider site-specific grade restrictions, the effects of large openings on the behavior of the walls, and the need for lateral bracing during backfill. Retaining walls that are free to rotate and allow active earth pressure condition to develop can be designed using an equivalent fluid density of at least 35 pcf.

Foundation Wall Backfill

Proper placement and compaction of foundation backfill is important to reduce infiltration of surface water and settlement of backfill. The natural soils can be used as backfill, provided they are free of rocks larger than about 6-inches in diameter, organics, existing building components and debris. The upper 2 feet of fill should be a relatively impervious material to limit infiltration. Backfill should be placed in loose lifts of approximately 10 inches thick or less, moisture conditioned to slightly above optimum moisture content, and compacted. Thickness of lifts will likely need to be about 6

inches if there are small confined areas of backfill, which limit the size and weight of compaction equipment. Backfill should be placed in loose lifts of approximately 8 inches thick or less, moisture conditioned to within 2 percent of optimum moisture content, and compacted. Thickness of lifts will likely need to be about 6 inches if there are small confined areas of backfill, which limit the size and weight of compaction equipment. The backfill which will support surface improvements should be compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D 698). Backfill in landscape areas should be compacted to at least 90 percent of maximum standard Proctor dry density. Moisture content and density of the backfill should be checked during placement by a representative of our firm. Observation of the compaction procedure is necessary. Testing without observation can lead to undesirable performance.

SUBSURFACE DRAINAGE

Water from snow melt, precipitation and irrigation of landscaping frequently flows through relatively permeable backfill placed adjacent to a residence, and collects on the surface of less permeable soils occurring at the bottom of basement or foundation excavations. This process can cause wet or moist basement or crawl space conditions after construction. To reduce the likelihood water pressure will develop outside foundation walls and the risk of accumulation of water at basement level, we recommend a foundation drain be provided. The drain should be installed along the entire basement perimeter and anywhere a retaining condition exists. The drain will not prevent moist conditions in basements. The drain should consist of a 4-inch diameter, perforated or slotted pipe encased in free-draining gravel, and a geocomposite drain board or clean gravel layer extending to within 2 feet of exterior grade, adjacent to the walls. The drain should lead to a positive gravity outlet or sump where water can be removed by pumping. Sump pumps and gravity outlet locations must be maintained by the home owner. A typical foundation drain detail for basement construction is presented on Figure 8.

CONCRETE

Concrete in contact with soils can be subject to sulfate attack. Superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are likely low, based on our experience in the area. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious materials ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high water tables. Concrete should have a total air content of 6 percent ± 1.5 percent. We advocate all foundation walls and grade beams in contact with the subsoils (including the inside and outside faces of garage) be damp-proofed.

SURFACE DRAINAGE

Surface drainage is critical to the performance of foundations, floor slabs and concrete flatwork. Recommendations in this report are based on effective drainage for the life of the structure and cannot be relied upon if effective drainage is not maintained. We recommend the following precautions be observed during construction and maintained at all times after construction is completed:

1. The ground surface surrounding the exterior of the building should be sloped to drain away from the building in all directions. We recommend providing a slope of at least 12 inches in the first 10 feet in landscape areas. In some cases, achieving 12 inches of slope is not feasible. In these areas, we recommend 6 inches as a minimum. We recommend a slope of at least 3 inches in the first 10 feet in paved areas. A swale should be provided around the uphill side of the building to divert surface runoff.

2. Backfill around the exterior of foundation walls should be placed as described in the Foundation Wall Backfill section. Increases in the moisture content of the backfill soils after placement often results in settlement. Settlement is most common adjacent to north facing walls. Re-establishing proper slopes (home owner maintenance) away from the buildings may be necessary.

3. Landscaping should be carefully designed to minimize irrigation. Plants used near foundation walls should be limited to those with low moisture requirements; irrigated grass should not be located within 5 feet of the foundation. Sprinklers should not discharge within 5 feet of the foundation and should be directed away from the buildings.

4. Impervious plastic membranes should not be used to cover the ground surface immediately surrounding the buildings. These membranes tend to trap moisture and prevent normal evaporation from occurring. Geotextile fabrics can be used to control weed growth and allow some evaporation to occur.

5. Roof downspouts and drains should discharge well beyond the limits of all backfill. Splash blocks and/or extensions should be provided at all downspouts so water discharges onto the ground beyond the backfill. We generally recommend against burial of downspout discharge. Where it is necessary to bury downspout discharge, solid, rigid pipe should be used and it should slope to an open gravity outlet. Downspout extensions, splash blocks and buried outlets must be maintained by the home owner.

6. The design and construction criteria for foundations and floor systems were compiled with the expectation that all other recommendations presented in this report related to surface and subsurface drainage, landscaping irrigation, backfill compaction, etc. will be incorporated into the project. It is critical that all recommendations in this report are followed.

CONSTRUCTION OBSERVATIONS

This report has been prepared for the exclusive use of Tim Horne/Patsy Verhoeven and the design/construction team for the purpose of providing geotechnical design and construction criteria for

the proposed project. The information, conclusions, and recommendations presented herein are based upon consideration of many factors including, but not limited to, the type of structures proposed, the geologic setting, and the subsurface conditions encountered. The conclusions and recommendations contained in the report are not valid for use by others. Standards of practice evolve in the area of geotechnical engineering. The recommendations provided in this report are appropriate for about three years. If the proposed project is not constructed within about three years, we should be contacted to determine if we should update this report.

We recommend that CTL | Thompson, Inc. provide construction observation services to allow us the opportunity to verify whether soil conditions are consistent with those found during this investigation. If others perform these observations, they must accept responsibility to judge whether the recommendations in this report remain appropriate.

GEOTECHNICAL RISK

The concept of risk is an important aspect with any geotechnical evaluation primarily because the methods used to develop geotechnical recommendations do not comprise an exact science. We never have complete knowledge of subsurface conditions. Our analysis must be tempered with engineering judgment and experience. Therefore, the recommendations presented in any geotechnical evaluation should not be considered risk-free. Our recommendations represent our judgment of those measures that are necessary to increase the chances that the structures will perform satisfactorily. It is critical that all recommendations in this report are followed during construction. The home owner must assume responsibility for maintaining the structure and use appropriate practices regarding drainage and landscaping. Improvements performed by the owner after construction, such as finishing a basement or construction of additions, retaining walls, decks, patios, landscaping and exterior flatwork, should be completed in accordance with recommendations in this report.

RADON

Radon is a gaseous, radioactive element that comes from the radioactive decay of uranium, which is commonly found in igneous rocks. The average indoor radon level in Summit County is 9.2 pCi/L (http://county-radon.info/CO/Summit.html), which is above the recommended action level of 4 pCi/L as recommended by the Environmental Protection Agency. Testing for radon gas at the site is beyond the scope of this study. Due to the many factors that affect the radon levels in a specific building, accurate testing of radon levels is usually only possible after construction is complete. Typically, radon mitigation systems in Summit County consist of ventilation systems installed beneath lower level slabs and crawlspaces. The infrastructure for such a mitigation system can normally be installed

during construction at a relatively low cost, which is recommended. The building(s) should be tested for radon once construction is complete. If test results indicate mitigation is required, the installed system can then be used for mitigation. We are not experts in radon testing or mitigation. If the client is concerned about radon, then a professional in this special field of practice should be consulted.

LIMITATIONS

Our exploratory pits were located to provide a reasonably accurate picture of subsurface conditions. Variations in the subsurface conditions not indicated by the pits will occur. A representative of our firm should test structural fill placement and to observe the completed foundation excavation to confirm that the exposed soils are suitable for support of the footings as designed. We believe this investigation was conducted in a manner consistent with that level of care and skill ordinarily exercised by geotechnical engineers currently practicing under similar conditions in the locality of this project. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report, please call.

CTL | THOMPSON, INC.

Matthew Hopkins
Engineering Technician III

George Benecke III, P.E.
Division Manager, Summit County

MRH:GWB/cj
(2 copies)

cc: patsyfish@gmail.com
wandersonAIA@comcast.net