CTL|THOMPSON
Founded in 1971

SOILS AND FOUNDATION INVESTIGATION

PROPOSED APARTMENTS – 601 ZEREX STREET
LOT C, FOREST MEADOWS SOLAR COMMUNITY
76718 US HIGHWAY 40
FRASER, COLORADO

Prepared for:

SKI & BOARD BROKER, LLC
PO Box 30
Winter Park, Colorado 80482

Attention:

Clark Lipscomb

Project No. SU02566.000-120

October 29, 2024

CTL|Thompson, Inc.
Denver, Fort Collins, Colorado Springs, Glenwood Springs, Pueblo, Summit County – Colorado
Cheyenne, Wyoming and Bozeman, Montana

Table of Contents

SCOPE OF WORK

This report presents the results of our Soils and Foundation Investigation for the Proposed Apartments on Lot C, Tract C of Resub C within Forest Meadows Solar Community located in Fraser, Colorado. We conducted this investigation to evaluate subsurface conditions at the site and provide geotechnical engineering recommendations for the proposed multi-family apartment complex. Our report was prepared from data developed during our field exploration, engineering analysis, and experience. This report includes a description of the subsurface conditions observed in three exploratory pits and presents geotechnical engineering recommendations for design and construction of apartment foundation, floor systems, and details influenced by the subsoils. The scope was described in a Service Agreement (SU-24-0077) dated July 5, 2024.

Recommendations contained in this report were developed based on our understanding of the planned construction. Detailed plans were not provided at the time of this report. Once building plans are completed, we should review to determine whether our recommendations and design criteria are appropriate. If plans differ significantly from the descriptions contained in the report, we should be informed so that we can 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 the exploratory pits consisted of about 1 to 2 feet of existing fill underlain by up to 2 feet of clayey sand to sandy clay, followed by native silty to sandy, gravel and cobbles to the maximum depth explored of about 8 feet. Water seepage was observed in Test Pit (TP-1) at a depth of about 6 feet. We did not observe water seepage in the other two pits.

2. The apartment structures can be constructed on footing foundations supported by the undisturbed, native sand and gravel OR moisture conditioned, properly compacted structural fill. We encountered a combination of up to 4 feet of existing fill and clay soil. <u>The existing fill and clay soil are not suitable to support the proposed apartment structures</u>. We anticipate that excavations for the new apartment structures will result in native sand and gravel being the predominant soil at anticipated foundation elevations; however, if they do not, subexcavation of existing soils will be required to provide a uni-

form, dense subgrade for the proposed structures. Subexcavation of the existing fill or clay soil below slabs-on-grade should be performed to improve performance. Design and construction criteria are presented in the report. It is critical that we observe the excavation to check whether conditions are as anticipated, prior to placing footings, and observe and test the placement of any structural fill.

3. Surface drainage should be designed to provide for rapid removal of surface water away from the apartment structures.

4. 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 the owner 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 at 601 Zerex Street (601 US Hwy 40) within the Forest Meadows Solar Community as shown on Figure 1. The property consists of existing retail and warehouse space on the western portion with associated driveway and parking. The parcel is bordered by Zerex Street to the north and east, existing commercial developments to the west and southeast, and vacant, undeveloped land to the south. The undeveloped land contains a seasonal tributary to Elk Creek, which is approximately 600 feet west of the parcel. Based on review of historical images from Google Earth, the site has been developed since 1985. In 2019, the existing structure to the west was improved with an addition. The ground surface across the site is relatively flat due to previous development. The ground surface is partially paved with asphalt that is in relatively poor condition, and the remainder is cleared, unvegetated storage space.

PROPOSED CONSTRUCTION

Detailed plans were not available at the time of this report. Preliminary layout and conceptual plans shows the proposed apartment complex will consist of two separate structures connected with corridors between them. The structures will have surface parking. One structure will be four-stories tall with eight apartment units and the second will be three-stories tall with nine apartment units. We do not anticipate below grade construction. We anticipate the lower level will be slab-on-grade. We anticipate wood frame construction will be used above grade with cast-in-place concrete foundation below grade. Alternative foundations may be considered including crawl-space construction. We anticipate required excavations could be on the order of 4 feet for foundations. We anticipate cut and fill depths to achieve final proposed grade will be minimal, less than 5 feet. Foundation loads are expected to be about 1 to 3 kips per linear foot of foundation wall, with maximum column loads of 40 kips or less. Once building plans have been fully developed, we should be contacted to re-evaluate our recommendations.

SUBSURFACE CONDITIONS

Subsurface conditions were investigated by observing three exploratory test pits excavated at the approximate locations shown on Figure 2. Subsurface conditions observed in the pits were logged by our representative who obtained samples of the soils during excavation. Graphic logs of the soils observed in the pits are shown on Figure 3.

Subsurface conditions observed in the exploratory pits consisted of about 1 to 2 feet of existing fill underlain by up to 2 feet of clayey sand to sandy clay, followed by native silty to sandy, gravel and cobbles to the maximum depth explored of about 8 feet. Bedrock was not encountered to a maximum explored depth of 8 feet below existing ground surface. Cobbles and boulders encountered were subrounded river rock and typically 6 to 12 inches in diameter. The largest boulders encountered were approximately 30 inches in diameter. Groundwater seepage was observed in TP-1 at a depth of approximately 6 feet. We did not observe seepage in the other two test pits. 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. Laboratory testing included sieve analysis (full gradation and No. 200 sieve analysis), Atterberg limits and water-soluble sulfates. Laboratory test results are summarized on Table I.

GEOLOGY

We reviewed the following geologic mapping showing the site:

- Geologic Map of the Fraser 7.5-Minute Quadrangle, Grand County, Colorado (SI Map 3130, Version 1.0), by Ralph R. Shroba, Bruce Bryant, Karl S. Kellogg, Paul K. Theobald, and Theodore R. Brandt with the U.S. Geological Survey, 2010.

The site is mapped as gravelly stream-terrace alluvium from the late Pleistocene era. Our field investigation and observations at the site support the mapping. We did not observe geologic constraints on this site that would inhibit the planned construction.

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, the owner must assume responsibility for maintaining structures and use appropriate practices regarding drainage and landscaping.

SITE EARTHWORK

We anticipate excavation of the soils can be accomplished using conventional, heavy duty excavating equipment. Hard cobbles and boulders should be expected. Some boulders will be large, at least 30 inches in diameter. A hydraulic hammer chisel (excavator attachment) or similar device may be required to split large boulders. Sides of excavations need to be sloped to meet local, state and federal safety regulations. We anticipate the sand and gravel 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. Some sloughing of the excavation face may occur as the soils dry out. Contractors are required to identify the soils encountered and ensure that applicable standards are met. Contractors are responsible for site safety and maintenance of the work site.

Groundwater was observed in on of the test pits, as noted in **SUBSURFACE CONDITIONS**. Water seepage may be encountered during deep excavations for utilities and potentially during foundation excavations. The footing areas should be protected from any seepage and precipitation. Developers should plan for the potential of seepage.

We recommend that contingent planning for shallow trenches and sumps be considered, especially if excavations are planned during seasonal runoff as groundwater levels may fluctuate and rise. Planning for the excavation should include trenches that are 1 to 2 feet below footing subgrade elevation. Excavations should be sloped to a gravity discharge or to a temporary sump where water can be removed by pumping, if necessary. It is very important that an excavation dewatering plan be in place prior to excavation. If the footing subgrade soils are exposed without proper drainage and become softened due to equipment traffic, subexcavation and replacement may be required. This process can be costly. We can provide additional recommendations at the time of construction.

Existing Fill

Existing fill was observed in the test pits, as noted in **SUBSURFACE CONDITIONS**. Fill depths encountered in our test pits are approximate, and actual fill depths may be deeper than we observed. We have not been provided with compaction records for this fill and deem this fill unsuitable to support new construction and the proposed development. In addition, clay soils are also not suitable for foundation support. Existing, undocumented fill and clay soils should be removed prior to placement of new improvements, including structural fill, on the site. Foundation elements, slabs-on-grade, and auxiliary structures should not be placed on existing fill or clay soils.

Sub-Excavation

Due to the historical use of this site and existing fill and clay soils encountered in our investigation, variable bearing conditions may be exposed during excavation for foundations. If these conditions are encountered, foundation footing elevations may need to be adjusted in order to bear footings on native gravel soils. An alternative to this adjustment can be subexcavation of existing fill and clay soils and replacement with structural fill as described below to provide uniform, dense bearing conditions. Please note that the depth of structural fill below footings would need to be the same for all foundations. Under no circumstance should footings be placed on both structural fill and native gravel.

Subexcavation of the existing fill and clay soils and replacement with structural fill should also be performed for slabs-on-grade. Subexcavation should include removal of all existing fill including existing building materials, concrete, clay soils, and organic material in the area of the building footprint prior to placement of structural fill. The resulting excavation should be flat, level and equal depth below the slab elevation. A representative of our firm should observe the excavation to confirm all fill has been removed prior to placement of structural fill. Additional discussion of slab-on-grade construction is included within this report. As an alternative, crawl-space construction, and a structurally supported lower level can be considered. We can provide additional recommendations if necessary.

Structural Fill

Structural fill will be necessary for slabs-on-grade and potentially below foundations. Groundwater conditions at the site must be considered and planned for prior to removal of unsuitable soils. The existing fill and on-site native soils, free of organic matter, construction debris and rocks larger than 6 inches in diameter, can be used as structural fill. 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 CDOT 5 or 6 aggregate base course or similar soil. If groundwater is encountered in excavations, it will likely be necessary to place clean stone fill. We should provide additional recommendations at the time of constructions. Structural fill should have no rocks larger than 6 inches. We can evaluate potential fill materials upon request. Lean-mix concrete (flowable fill) can also be used to fill voids.

Prior to placing any structural fill, all topsoil, existing fill, and clay soil must be removed. The native gravel subgrade should be scarified, moisture conditioned and compacted with a vibratory padfoot or sheepsfoot roller. Structural fill placed beneath the building footprint should be placed in thin loose lifts, moisture conditioned to within +/-2 percent of optimum moisture content and compacted to at least 98 percent of ASTM D 698 maximum dry density.

Structural fill placed outside the building footprint should be placed in thin loose lifts, moisture conditioned to within +/-2 percent of optimum moisture content and compacted to at least 95 percent of ASTM D 698 maximum dry density. Moisture content and density of structural fill should be tested by a representative of our firm during placement.

FOUNDATIONS

The residence can be supported on footing foundations on the undisturbed, native sand and gravel soils or properly compacted structural fill. All existing fill and clay soils should be removed beneath footings and slabs. Prior to concrete placement, the footing areas should be moistened and compacted to provide a flat and level subgrade. Loose and disturbed soils should be removed or compacted. Structural fill, if required, should be tested by our representative and meet the criteria in Structural Fill. Our representative should observe conditions exposed in the completed foundation excavation to confirm whether the exposed soils are as anticipated and suitable for support of the foundation. If subexcavation and replacement of soils beneath footings is necessary, our representative should observe the subexcavation bottom prior to fill placement.

1. Soils loosened during the forming process for the footings should be removed or compacted prior to placing concrete. Lean concrete may also be used to fill depressions resulting from the removal of boulders.

2. Footings can be sized using a maximum allowable soil pressure of 3,000 psf. We expect settlement of footings will be approximately 1 inch or less. Settlement of foundations that bear on both structural fill or native soils could be differential and should be avoided. Differential settlement of up to ½-inch should be considered in the design.

3. To resist lateral loads, a coefficient of friction of 0.45 can be used for concrete in contact with soil.

4. 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.

5. 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.

6. The soils under exterior footings should be protected from freezing. We recommend the bottom of footings be constructed at a depth of at least 42 inches below finished exterior grade.

SLABS-ON-GRADE

We anticipate a slab-on-grade main level and garage floor is desired. Based on our laboratory test data and experience, we judge slab-on-grade construction supported by the undisturbed, native sand and gravel OR properly placed granular structural fill will have a low risk of damaging differential movement. All topsoil, existing fill, and clay soils must be removed beneath slabs. 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 that allow free vertical movement of the slabs.

2. Underslab plumbing should be pressure tested for leaks before the slabs are constructed. Plumbing and utilities that pass through slabs should be isolated from the slabs with sleeves and provided with flexible couplings.

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

4. We recommend a 4-inch layer of clean gravel be placed beneath the slabs to provide a flat, uniform subgrade. This material should consist of minus 2-inch aggregate with at least 50% retained on the No. 4 sieve and less than 2% passing the No. 200 sieve. Due to potential shallow groundwater, we recommend considering an under-slab drain. Under-slab drains typically utilize gravity outfalls which may not be possible on this site. We can provide additional recommendations for drain system layout upon request.

5. The 2018 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)".

STRUCTURALLY SUPPORTED FLOORS

We do not anticipate any below grade spaces for these structures; however, crawl space construction may be considered to avoid subexcavation of the existing fill and clay soil for slab-on-grade construction. In this situation, the main level floor will be structurally supported with crawl space below. A structural floor is supported by the foundation system. Design and construction issues associated with structural floors include ventilation and lateral loads on foundation walls. Where structurally supported floors are installed over a crawl space, the required air space depends on the materials used to construct the floor. Building codes require a clear space of at least 18 inches between exposed earth and untreated wood floor components. For non-organic systems, we recommend a minimum clear space of 12 inches. This minimum clear space should be maintained between any point on the underside of the floor system (including beams, plumbing pipes and floor drain traps) and the soils.

Where structurally supported floors are used, utility connections, including water, gas, air duct, and exhaust stack connections to floor supported appliances should be capable of absorbing some deflection of the floor. Plumbing that passes through the floor should ideally be hung from the underside of the structural floor and not lain on the bottom of the excavation. This configuration may not be achievable for some parts of the installation. It is prudent to maintain the minimum clear space below all plumbing lines.

Control of humidity in crawl spaces is important for indoor air quality and performance of wood floor systems. We believe the best current practices to control humidity involve the use of a vapor retarder or vapor barrier (6 mil minimum, 10 mil for greater durability) placed on the soils below accessible subfloor areas. The vapor retarder/barrier should be sealed at joints and attached to concrete foundation elements. A positive approach to protect wood floors above crawl spaces is to install a mechanical ventilation system controlled by a humidistat in crawl space areas. When a pre-set humidity is determined, mechanical systems should activate to create airflow in the space.

FOUNDATION WALLS

Foundation walls that 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, such as in crawl spaces. 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), design for a lower “active” lateral earth pressures may be 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.

For backfill soils conforming with recommendations in the <u>Foundation Wall Backfill</u> section that are not saturated, we recommend design of below-grade building walls at this site using an equivalent fluid density of at least 50 pcf. This value assumes some deflection and minor cracking of walls may occur. If very little wall deflection is desired, design for the "at-rest” case using an equivalent fluid density of 60 pcf may be appropriate. Retaining walls that are free to rotate and allow the “active” earth pressure condition to develop can be designed using an equivalent fluid density of at least 40 pcf. 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.

Lateral loads can be resolved by evaluating passive resistance using a passive equivalent fluid density of 325 pcf for granular backfill that is compacted to the criteria in

Foundation Wall Backfill and will not be removed. The magnitude of strain required to develop passive resistance must be considered in design.

Foundation Wall Backfill

Proper placement and compaction of foundation wall backfill is important to reduce infiltration of surface water and settlement from consolidation of the backfill soils. The existing fill soils are judged unsuitable to be used as foundation wall backfill. The native sand and gravel soils and/or imported granular structural fill can be used as foundation wall backfill, provided they are free of rocks larger than 6 inches in diameter, excessive clay, organics, and debris. The upper 2 feet of fill should be a relatively impervious clay material to limit infiltration of surface water.

Backfill should be placed in loose lifts of approximately 8 inches thick or less. Thickness of backfill lifts will likely need to be reduced if there are small, confined areas of backfill, which limit the size and weight of compaction equipment. Granular backfill should be moisture-conditioned to within +/-2 percent of optimum moisture content and compacted to at least 95 percent of standard Proctor (ASTM D 698) maximum dry density. Our representative should test moisture content and density of the backfill during placement. Some settlement of the backfill should be expected even if the material is placed and compacted properly. In our experience, settlement of properly compacted granular backfill could be on the order of 0.5 to 1 percent of backfill thickness. Increasing the minimum compaction level will reduce settlement potential. However, care should be taken not to over compact the backfill or use large equipment near the wall, since this could cause excessive lateral pressure and damage or crack the wall.

SUBSURFACE DRAINAGE

We anticipate the main level of the apartment structure will be at or slightly above the existing ground surface on all sides. Foundation walls will be backfilled to approximately equal heights. There will be no retaining conditions. If structurally supported floors with crawl space construction is utilized or any below grade space or retaining conditions are proposed, we should be contacted so that we may provide recommendations for a foundation drain system. Based on our current understanding of the proposed construction, we do not believe that a foundation perimeter drain is merited at this time.

PAVEMENT SECTION THICKNESS

Existing fill and clay soil should not support new pavement. Removal of existing fill and clay soil is recommended and placement of new pavement should be on native soils OR fill placed as described in **Site Earthwork**. The native sand and gravel soils should provide good support for new pavement.

Our recommendations assume a properly prepared subgrade and drained conditions. The collection and diversion of surface water away from paved areas is extremely important to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from the paved areas to limit wetting of the subgrade soils. Frost susceptible soils (soils with high levels of silt and/or clay) can be problematic if there is a free water source and heaving can occur. The onsite native gravel soils have low frost susceptibility. The onsite native clay soils have moderate to high frost susceptibility. Our recommendations for pavement section thickness are given below. Traffic for the access road and drive lanes is expected to be primarily passenger vehicles with less than 20 percent truck traffic (buses, snowplows, garage trucks, delivery trucks, fire trucks).

1. New Portland cement concrete pavement for the entrance aprons should have a minimum thickness of 7 inches over 6 inches of aggregate base course.

2. Recommended minimum asphalt pavement thickness should adhere to the Guideline for the Design and Use of Asphalt Pavements for Colorado Roadways by the Colorado Asphalt Pavement Association, Chapter Three, Table 3-7.

3. New asphalt pavement for drive lanes and parking areas should have a minimum thickness of 3 inches of asphalt over 4 inches of aggregate base course. This value assumes traffic will primarily consist of automobile and light truck (pickup) traffic with occasional heavier truck traffic such as buses, snowplows, and delivery trucks.

4. Other areas of concentrated traffic and turning movements (such as areas in front of dumpsters) should consist of at least 8 inches of Portland cement concrete over 6 inches of aggregate base course. Steel-reinforcement can be added to the pavement to lengthen design life and reduce differential movement. We believe a reasonable reinforcement section for this type of project is a single mat of No. 4 rebar at a spacing of 24 inches each way (mid height of slab).

5. These pavement thickness recommendations do not consider construction traffic loads. Consideration should be given to staging asphalt and/or concrete placement to prevent damage by excessive construction equipment loads. These thicknesses are based on the subsurface conditions encountered and our experience with similar projects in the area. We have not been provided with traffic information for the site. If traffic counts are available, we can re-evaluate our recommendations upon request.

Structural Fill, Subgrade Preparation and Aggregate Base Course

All existing fill, clay soil, building materials, structures, and pavement/concrete should be removed from new pavement areas. Due to observed existing fill depths, subexcavation for pavement areas may be 2 to 4 feet or more if additional fill is encountered. Structural fill may be required to achieve subgrade elevation following removal of existing fill. Prior to fill placement, the native soils should be scarified to a depth of 12 inches, moisture conditioned and compacted. Structural fill placed beneath pavements should consist of the onsite native sand and gravel soils devoid of vegetation, topsoil, and rocks larger than 6 inches in diameter. Existing fill can be reused as structural fill provided it meets the criteria above. If imported material is necessary, it should be as described in the **Structural** Fill section of this report. A representative of our firm should observe import or fill materials prior to placement and perform necessary laboratory testing. Alternative fill materials may be considered and will require laboratory testing to confirm. Structural fill beneath pavements should be compacted to at least 95% of the maximum Modified Proctor (ASTM D-1557) dry density at a moisture content within 2 percent of optimum.

Prior to placement of aggregate base course, the completed pavement subgrade should be proof rolled with a fully loaded tandem dump truck with a gross weight of at least 50,000 pounds. Areas that deform excessively should be removed and replaced with structural fill, if necessary, to achieve a stable subgrade prior to placing pavement materials. The depth of sub-excavation for unstable subgrade should be determined on a case-by-case basis at the time of construction. In our experience, subexcavation to depths of 1 to 2 feet may be necessary to stabilize. In some cases, typically with saturated soils, geogrid reinforcement can be used to reduce subexcavation depths.

Aggregate base course should have a minimum 'R' value of 84 and meet CDOT Class 5 or 6 gradation specifications. The aggregate base course should be compacted to at least 95% of the maximum Modified Proctor (ASTM D-1557) dry density at a moisture content within 2 percent of optimum.

Asphalt Pavement

The asphalt should consist of a mixture of aggregate, filler, and asphalt cement. The asphalt mixture should meet the Grand County or Colorado Department of Transportation (CDOT) grading requirements for an asphalt mix. The asphalt should be a batched hot mix, approved by the engineer, and placed and compacted to a density of 92% to 96% of the maximum theoretical density, determined according to Colorado Procedure 51. The asphalt should be placed in lifts not exceeding 3 inches thick or less than 1.5 inches thick. We recommend State Highway Grading SX.

Concrete Pavement

All concrete should be based on a mix design established by a qualified engineer. A CDOT Class P mix is acceptable. The design mix should consist of aggregate, Portland cement, water, and additives which will meet the requirements contained in this section. The concrete should have a modulus of rupture of third point loading of 630 psi. Normally, concrete with a 28-day compressive strength of 4,000 psi will meet this requirement. Concrete should contain approximately 6 percent entrained air. Maximum allowable slump should not exceed 4 inches.

The concrete should contain joints not greater than 15 feet on centers. Joints should be sawed or formed by pre-molded filler. The joints should be at least ¼ of the slab thickness. Expansion joints should be provided at the end of each construction sequence and between the concrete slab and adjacent structures. Expansion joints, where required, should be filled with a ½-inch thick asphalt impregnated fiber. Concrete should be cured by protecting against loss of moisture, rapid temperature changes and mechanical injury for at least three days after placement.

Surface drainage is critical to the performance of pavements. Recommendations in this report are based on effective drainage for the life of the improvements and cannot be relied upon if effective drainage is not maintained. The collection and diversion of surface water away from paved areas is extremely important to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from the paved areas and prevent wetting of the subgrade soils.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentrations in one sample of less than 0.01 percent. As indicated in our tests and ACI 332-20, the sulfate exposure class is *Not Applicable* or *RS0.*

SULFATE EXPOSURE CLASSES PER ACI 332-20

Exposure Classes		Water-Soluble Sulfate (SO_4) in Soil [A] (%)
Not Applicable	RS0	< 0.10
Moderate	RS1	0.10 to 0.20
Severe	RS2	0.20 to 2.00
Very Severe	RS3	> 2.00

A) Percent sulfate by mass in soil determined by ASTM C1580.

For this level of sulfate concentration, ACI 332-20 *Code Requirements for Residential Concrete* indicates there are no cement type restrictions for sulfate resistance as indicated in the table below.

CONCRETE DESIGN REQUIREMENTS FOR SULFATE EXPOSURE PER ACI 332-20

Exposure Class	Maximum Water/ Cement Ratio	Minimum Compressive Strength (psi)	Cementitious Material Types [B]			Calcium Chloride Admixtures
			ASTM C150/ C150M	ASTM C595/ C595M	ASTM C1157/ C1157M	
RS0	N/A	2500	No Type Restrictions	No Type Restrictions	No Type Restrictions	No Restrictions
RS1	0.50	2500	II	Type with (MS) Designation	MS	No Restrictions
RS2	0.45	3000	V [C]	Type with (HS) Designation	HS	Not Permitted
RS3	0.45	3000	V + Pozzolan or Slag Cement [D]	Type with (HS) Designation plus Pozzolan or Slag Cement [E]	HS + Pozzolan or Slag Cement [E]	Not Permitted

A) Concrete compressive strength specified shall be based on 28-day tests per ASTM C39/C39M

B) Alternate combinations of cementitious materials of those listed in ACI 332-20 Table 5.4.2 shall be permitted when tested for sulfate resistance meeting the criteria in section 5.5.

C) Other available types of cement such as Type III or Type I are permitted in Exposure Classes RS1 or RS2 if the C3A contents are less than 8 or 5 percent, respectively.

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. There are instances where this slope cannot be achieved. A slope of 6 inches in the first 10 feet should be used 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 Foundation Wall Backfill. 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 (homeowner maintenance) away from the building 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. Lawn sprinklers should not discharge within 5 feet of the foundation and should be directed away from the building. Low-volume emitters can be used within 5 feet of the foundation.

4. Impervious plastic membranes should not be used to cover the ground surface immediately surrounding the building. 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. Buried downspout discharge pipes should be heated (with thermostat) during winter months to prevent freezing. Downspout extensions, splash blocks and buried outlets must be maintained by the homeowner.

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 Grand County is 5.4 pCi/L (http://county-radon.info/CO/Grand.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 this area 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 buildings 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.

CONSTRUCTION OBSERVATIONS

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.

STRUCTURAL ENGINEERING SERVICES

CTL|Thompson, Inc. is a full-service geotechnical, structural, materials, and environmental engineering firm. Our services include preparation of structural framing and foundation plans. We can also design earth retention systems. Based on our experience, CTL|T typically provides value to projects from schedule and economic standpoints, due to our combined expertise and experience with geotechnical, structural, and materials engineering. We would like the opportunity to provide proposals for structural engineering services on your future projects.

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 and after construction.

LIMITATIONS

This report has been prepared for the exclusive use of Ski & Board Broker, LLC. and your design team for planning for the Proposed Apartments at 601 Zerex Street. 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 geotechnical engineering. The recommendations provided are appropriate for about three years. If the site is not developed within about three years, we should be contacted to determine if we should update this report.

Our borings were widely spaced to provide a general picture of subsurface conditions for preliminary planning of development and residential construction, which is conceptual at this time. Variations from our borings should be anticipated. We believe this investigation was conducted in a manner consistent with that level of care and skill ordinarily used by geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report or analysis of the influence of subsurface conditions on the project, please call.

CTL|THOMPSON, INC.

COLORADO LICENSED PROFESSIONAL ENGINEER SPENCER A. HRUBALA 64569

Spencer A. Hrubala, P.E.
Project Manager

Reviewed by:

Greg Crum, P.E.
Principal Engineer

cc: clark@cstoneholdings.com

Not to scale

SKI & BOARD BROKER, LLC.
601 ZEREX STREET
CTL|T PROJECT NO. SU02566.000-120

VICINITY MAP

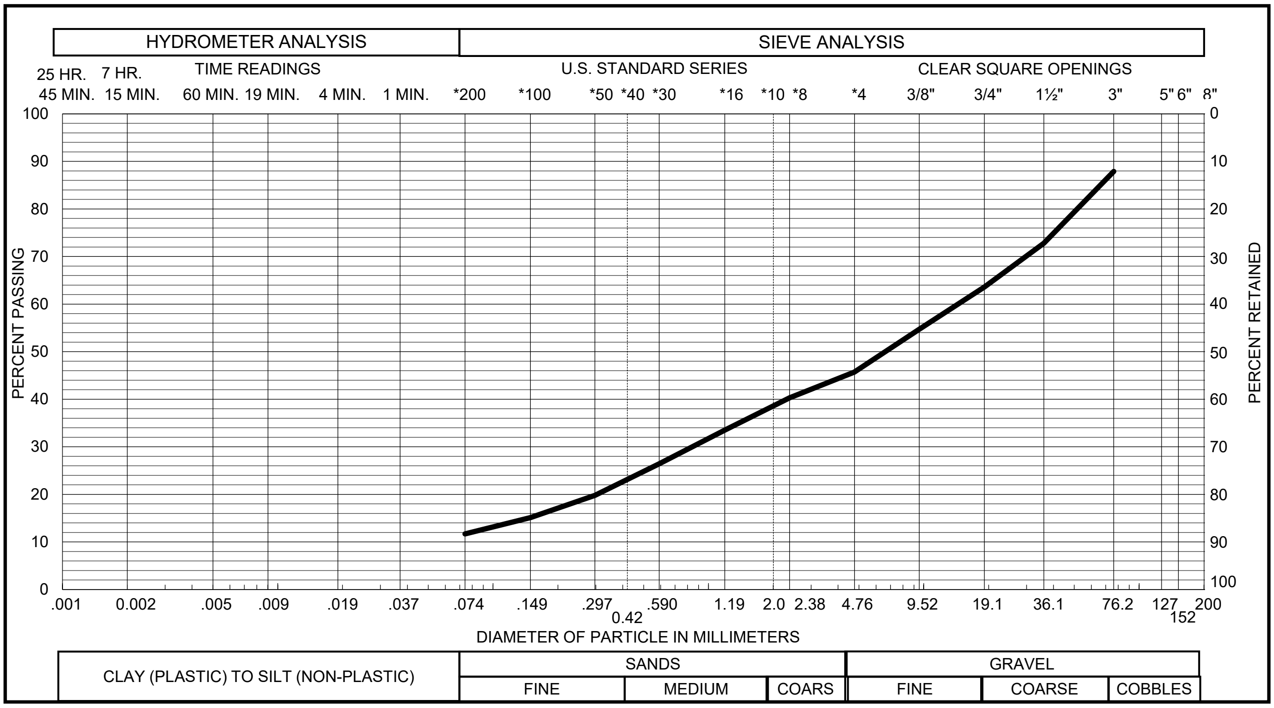
Figure 1

Scale: 1 inch = 100 feet

SKI & BOARD BROKER, LLC.
601 ZEREX STREET
CTL|T PROJECT NO. SU02566.000-120

LOCATIONS OF EXPLORATORY TEST PITS

Figure 2



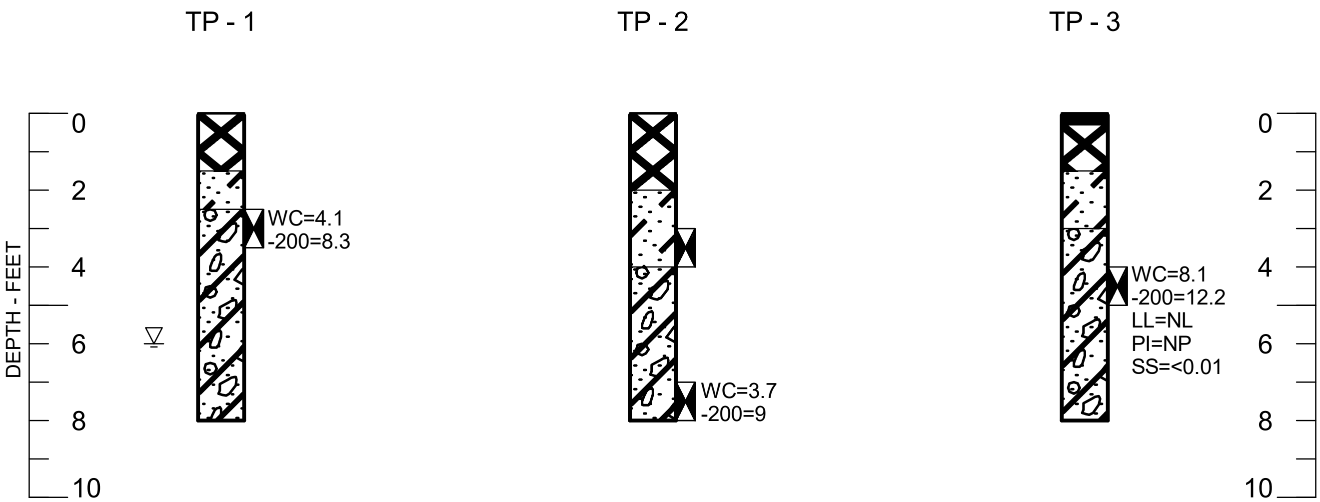
Sample of SANDY GRAVEL, SILTY
From TEST PIT 3 FROM 3 - 4 FEET

GRAVEL 54 % SAND 34 %
SILT & CLAY 12 % LIQUID LIMIT NL
PLASTICITY INDEX NP

SKI & BOARD BROKER, LLC.
601 ZEREX STREET
CTL|T PROJECT NO. SU02566.000

Gradation Test Results

FIG. 3



LEGEND:

- ASPHALT
- FILL, CLAYEY, SAND, SOME GRAVELS AND COBBLES, MOIST, MEDIUM DENSE, DARK BROWN.
- GRAVEL, SILTY TO SANDY, MOIST TO WET, DENSE TO VERY DENSE, BROWN TO DARK BROWN (GM, GP, GP-GM).
- CLAYEY SAND TO SANDY CLAY, SOME GRAVEL AND COBBLES, BROWN TO RED (SC, CL, CH).
- DRIVE SAMPLE. THE SYMBOL INDICATES BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER INCHES.
- ∇ GROUND WATER LEVEL MEASURED AT TIME OF DRILLING.

NOTES:

1. THE BORINGS WERE DRILLED ON AUGUST 26, 2024 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A DRILL RIG.

2. WC - INDICATES MOISTURE CONTENT (%).
   LL - INDICATES LIQUID LIMIT.
   PI - INDICATES PLASTICITY INDEX.
   -200 - INDICATES PASSING NO. 200 SIEVE (%).
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT (%).

3. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.

SKI & BOARD BROKER, LLC.
601 ZEREX STREET
CTL|T PROJECT NO. SU02566.000-120

Summary Logs of Exploratory Borings

FIG. A-1

TABLE I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. SU02566.000-120

EXPLORATORY PIT	DEPTH (FEET)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	SULFATE CONC. (%)	PASSING NO. 200 SIEVE (%)	DESCRIPTION
TP-1	2.5-3.5	4.1				8.3	Sandy Gravel, Silty
TP-2	7-8	3.7				8.8	Sandy Gravel, Silty
TP-3	3-4	8.1	NL	NP	<0.01	12.2	Sandy Gravel, Silty