October 29, 2019

Josh Graham
Graham Custom Homes
PO Box 776338
Steamboat Springs, Colorado 80477

Re: Preliminary Geotechnical Recommendations
Proposed Bristol Residence
Lot 1, Fairway Place Subdivision
Steamboat Springs, Colorado
Western Slope Geotech Project # 19-1065

Dear Josh,

Western Slope Geotech, Inc. (WSG) has prepared this preliminary geotechnical recommendations report you requested for the proposed Bristol Residence to be constructed within Lot 1 of the Fairway Place Subdivision in Steamboat Springs, Colorado. The results of site observations and pertinent geotechnical engineering recommendations are included with this report.

PURPOSE AND SCOPE OF WORK

The purpose of this report is to describe current site conditions and proposed construction and provide preliminary geotechnical design and construction recommendations for the proposed residence and associated site improvements. WSG's scope of work included field observations of the proposed building site and the preparation of this report summarizing those observations and data and outlining our preliminary recommendations for foundation design and construction. The conclusions and recommendations outlined in this report are based on the results of field observations and WSG's experience with subsurface conditions and similar construction in the nearby area.

PROPOSED CONSTRUCTION

Based on review of available plans, WSG understands the proposed residence will generally consist of a one to two-story wood framed structure over a full depth walkout basement an attached garage. Foundations and lower level floor slabs are anticipated to bear at depths ranging from approximately 4 to 10 feet below existing site grades. A site

plan showing the proposed building site, property boundaries and topography is presented on Figure 1.

Based on review of the available plans, WSG understands that retained and unretained cuts up to 6 feet in height will be constructed at the west and south sides of the building site.

Foundation loads are expected to be relatively light, with continuous wall loads less than 3 kips per lineal foot and individual column loads less than 75 kips. If the assumed construction and loading conditions vary substantially from those assumed, WSG should be contacted to reevaluate the recommendations in this report.

Foundation loads are expected to be relatively light, with continuous wall loads less than 3 kips per lineal foot and individual column loads less than 50 kips. If the assumed construction and loading conditions vary substantially from those assumed, WSG should be contacted to reevaluate the recommendations in this report.

SITE DESCRIPTION

The project site is located east of the intersection of Steamboat Boulevard and Redwoods Drive in Steamboat Springs, Colorado. At the time of WSG's site observations, the building site was vacant and covered with approximately 12 inches of snow, therefore our observations were limited.

The proposed building site was vacant and appeared mostly undisturbed. An existing driveway/access road with cuts on the order of 3 to 6 feet in depth was present in the southern portion of the property, south of the building site.

Site vegetation appeared to consist of grass, weeds, with scattered aspen trees. Several large boulders were observed at the ground surface across the site.

Site topography appeared variable due to previous grading activities and generally sloped gently to moderately down to the west at approximately 5 percent. Based on the site plan provided, it appears that a maximum elevation difference of approximately 5 to 6 feet exists across the building site.

SUBSURFACE CONDITIONS

Based on WSG's experience with other nearby sites and our site observations, we anticipate subsurface conditions will be fairly consistent at the site and will generally consist of a layer of topsoil and organics overlying poorly sorted sandy gravel with cobbles and small to large boulders. Natural sandy gravel materials are anticipated at assumed foundation depths, and the materials are not typically moisture sensitive and well-consolidated. Based on local topography and site observations, groundwater is not anticipated within foundation excavations or site grading cuts.

Groundwater levels will vary seasonally and over time based on weather conditions, site development, irrigation practices and other hydrologic conditions. Perched and/or trapped groundwater conditions may also be encountered at times throughout the year. Perched water is commonly encountered in soils overlying less permeable soil layers and/or bedrock.

Test pits excavated during initial site work or an openhole inspection of the foundation excavation, material sampling, and testing will be summarized in a follow-up report to confirm subsurface conditions and material engineering properties.

ANALYSIS AND RECOMMENDATIONS

General

WSG believes the natural sandy gravel with cobbles and boulders will provide suitable bearing for the proposed foundations and floor slabs. Difficult excavating conditions for foundations and utilities, possible blasting of larger rock and irregular excavations are likely due to the coarse grained materials. Minor subexcavation and structural backfill of foundation and slab areas should be anticipated to produce uniform grades suitable for concrete placement. In addition, any existing fills should be removed from proposed foundation and floor slab areas as a part of site development.

Foundations

Based on the anticipated subsurface conditions and WSG's experience, we recommend the proposed residence be supported by continuous spread footing and isolated pad foundations bearing on natural, undisturbed sandy gravel and/or structural fill and designed and constructed as outlined below:

1. WSG recommends foundation footings be placed on undisturbed sandy gravel or structural fill and designed using a maximum net allowable soil bearing pressure of 2,500 psf.

2. Where footing areas are over-excavated due to removal of boulders or existing fill materials, resulting voids should be filled with approved, non-expansive structural fill materials. WSG recommends 1-1/2 inch screened rock be placed and compacted in 6 to 12-inch loose lifts and uniformly compacted to at least 80% of the maximum relative density (ASTM D4253/4254). Structural fill should be limited to 2 feet or less, otherwise foundation walls should be extended to meet undisturbed soils or bedrock. Screened rock fills greater than 12 inches in depth should be wrapped with filter fabric (Mirafi 140N or equivalent) and should extend out from the edge of footings at a 1(H) to 1(V) or flatter slope configuration.

3. Loose disturbed soils exposed at footing grades should either be removed, or moisture conditioned to near optimum moisture content and compacted to at least 98% of the maximum standard Proctor density as determined by ASTM D698. All footing areas should be compacted with a mechanical compactor prior to placement of forms.

4. Footings exposed to freezing or frost conditions should be designed with adequate soil cover to prevent freezing. A cover depth of 48 inches is recognized by the local building authority as the minimum value for frost protection.

5. WSG recommends continuous footings have a minimum width of 12 inches and isolated pad foundations have a minimum width of 24 inches in order to facilitate construction and reduce the potential for development of eccentrically loaded conditions.

6. Foundation walls and grade beams should be designed to span an unsupported distance of 10 feet or the distance between pads.

7. Foundation resistance to lateral loads can be developed by passive pressure against footings and walls and sliding resistance between footings and floor slabs and the underlying soils. WSG recommends passive pressures be computed using an equivalent fluid pressure value of 300 pcf and friction resistance be calculated using a coefficient of friction of 0.35 times structural dead loads. The

recommended passive equivalent fluid pressure value and coefficient of friction do not include a factor of safety.

8. Boulders were observed at the ground surface at various locations throughout the site. Foundation excavations should be feasible using conventional heavy-duty excavating equipment; however, difficult excavating conditions should be anticipated. The use of blasting or other rock-breaking techniques are likely to facilitate the removal of larger boulders.

9. WSG must be retained to observe foundation excavations to verify the subsurface conditions are consistent with those assumed.

WSG estimates settlement of footing foundations designed and constructed as outlined above and resulting from the assumed structural loads would be on the order of 1 inch or less. Differential settlement could approach the amount of total settlement estimated above.

Interior Building Floor Slabs

WSG assumes slab-on-grade construction is preferred for the residence lower level and garage. Based on the results of the subsurface and laboratory exploration, WSG believes slab-on-grade construction can be used for finished living areas and the garage, provided the design and construction precautions outlined below are observed.

1. Existing fill materials and/or topsoil should be removed from beneath all proposed slab areas. Underslab subgrade (natural soils or fill) areas should be graded to drain to the building perimeter to prevent the accumulation of water.

2. Cobbles and boulders greater than 6-inches in diameter should be removed within 6 inches of slab grade to reduce the potential for point-loading of the slab, which could lead to distress and cracking.

3. Underslab fill materials should consist of either approved Low Volume Change (LVC) soils or imported non-expansive materials and compacted to at least 95% of the maximum standard Proctor density within 2% of optimum moisture content (ASTM D698). The on-site sandy gravel matrix material should be suitable for use beneath floor slabs but will likely require processing and moisture conditioning prior to use.

4. Floor slabs should be underlain by a minimum 6-inch layer of free draining gravel. The gravel layer will help provide uniform support and aid in underslab drainage.

5. Floor slabs should be constructed with control joints located a maximum of 12 feet on center to control natural, unavoidable cracking associated with concrete shrinkage that commonly occurs during curing. Control joint locations should be carefully selected to intersect slab intrusions and other locations where shrinkage cracking is common.

Perimeter Drainage Systems

WSG recommends a perimeter drainage system be installed at the building perimeter to enhance site drainage, help reduce the potential for development of hydrostatic pressures behind the below-grade walls and reduce the potential for water infiltration beneath footings and into underslab. If groundwater is encountered beneath floor slab areas during excavation, WSG recommends an underdrain system be placed beneath the entire lower level.

A perimeter drainage system should generally consist of a 4-inch perforated PVC drainpipe covered by a minimum of twelve (12) inches of free-draining gravel and covered with filter fabric (Mirafi 140N or equivalent) to prevent intrusion of fines. The high point of the drainpipe should be placed at approximate footing grade around the exterior of the lower level perimeter foundation walls, constructed with a minimum 1% slope and discharge to a daylighted outfall. Minimum burial depths of 24 inches are acceptable for at-grade floor slab areas. If groundwater is encountered within underslab areas during excavation or is suspected beneath interior slab areas, an underdrain system is recommended. An underdrain system would generally consist of both 4-inch perforated and solid PVC transmission pipes beneath the structure lower levels and on approximate 10-foot centers. WSG can provide underdrain and perimeter drainage system design and details upon request and after building plans are available.

Lateral Earth Pressures and Foundation Backfill

Lateral Earth Pressures: Foundation walls should be designed to resist lateral pressures associated with foundation backfill materials and existing site soils. Materials affecting lateral pressures are located within the area extending from the base of the foundation wall

upward at an approximate 1(H) to 1(V) angle. Recommended lateral earth pressure design values to be used in foundation wall design are provided in Table A shown below. All values presented assume drained conditions (no hydrostatic loads) and sufficient wall rotation is achieved for activation of active earth pressure conditions.

Table A

Design Pressure Condition	Equivalent Fluid Pressure (pcf)
Active	45
At-Rest	55
Passive	300

Variables that affect active lateral earth pressures include but are not limited to the classification and swell potential of the backfill soils, backfill compaction and geometry, wetting of the backfill soils, surcharge loads and point loads developed in the backfill materials. The recommended equivalent fluid pressure values do not include a factor of safety or an allowance for hydrostatic loading. Use of expansive soil backfill, excessive compaction of the wall backfill or surcharge loads placed adjacent to the foundation walls can add to the lateral earth pressures causing the equivalent fluid pressure values used in design to be exceeded.

Foundation Backfill: Backfill placed adjacent to below-grade walls should consist of LVC potential materials and relatively impervious soils free from organic matter, debris and other objectionable materials. The anticipated on-site natural sandy gravel should be suitable for use as wall backfill but may require processing and moisture conditioning prior to placement. WSG recommends foundation backfill soils be uniformly placed in maximum 9-inch loose lifts, moisture conditioned to within +/-2% of optimum moisture content and compacted to at least 95% of the maximum standard Proctor dry density (ASTM D698).

Foundation wall backfill operations should be conducted only after proper bracing and support is provided. Structural engineer approval is recommended. Excessive lateral stresses resulting in displacement, distress and damage to foundation walls can occur when insufficient bracing is in place or heavy mechanical compaction equipment is used.

Soilogic recommends compaction of unbalanced foundation wall backfill soils be completed using light mechanical or hand compaction equipment.

Exterior Flatwork

Any existing topsoil and vegetation and existing fill should be stripped from proposed flatwork areas prior to fill or concrete placement. WSG recommends the exposed subgrade be scarified to a depth of 6-inches, moisture conditioned to within ±2% of optimum moisture content and compacted to at least 95% of the maximum standard Proctor density. WSG recommends fill supporting flatwork consist of approved granular materials or imported LVC fill materials uniformly placed in 9-inch loose lifts, moisture conditioned and compacted to the values indicated above with a limited risk of post-construction movement. The on-site sandy gravel soils could be used as fill beneath exterior flatwork.

Subgrade soils expected to receive exterior flatwork concrete should be evaluated closely evaluated immediately prior to concrete placement. If areas of disturbed, wet and softened, or dry subgrade soils are encountered at that time, reworking of those materials or removal/ replacement procedures may be required.

Drainage

Positive drainage is imperative for satisfactory long-term performance of the proposed structure foundations, floor slabs and associated site improvements. WSG recommends positive drainage be developed away from the structure during construction and maintained throughout the life of the site improvements. Twelve (12) inches of fall in the first 10 feet away from the building is recommended. Flatter slopes could be considered in hardscape areas. In the event that some settlement of the backfill soils occurs adjacent to the residence, the original grade and associated positive drainage outlined above should be immediately restored.

Care should be taken in the planning of landscaping to avoid features which could result in the fluctuation of the moisture content of the foundation bearing and/or flatwork subgrade soils. We recommend watering systems be placed a minimum of 5 feet away from the perimeter of the structure and be designed to discharge away from all site improvements. Gutter systems should be considered to help reduce the potential for water ponding adjacent to the residence, with the gutter downspouts, roof drains or scuppers extended to discharge a minimum of 5 feet away from structural, flatwork and pavement elements.

Water which is allowed to pond adjacent to the site improvements can result in unsatisfactory performance of those improvements over time. The use of area drain inlets and subsurface piping is recommended to aid in rapid runoff of surface water from areas of concentrated drainage and/or limited surface runoff capability.

SITE GRADING

WSG understands retained and unretained cuts up to 6 feet in height are anticipated for site development at the west and south sides of the building site. Based on the proposed construction, WSG recommends the following:

1. Unretained cuts and fills should be constructed to a 2(H) to 1(V) or flatter slope configuration. Flatter slopes are often desirable to help facilitate revegetation efforts.

2. Fill materials supporting driveways or other settlement-sensitive landscaping features should consist of either on-site materials or approved imported materials. All fills should be uniformly placed and compacted in 9-inch loose lifts to at least 95% of the maximum standard Proctor density within 2% of optimum moisture content (ASTM D698). All fills should be benched or keyed into hillsides exceeding 25 percent grade using minimum 4-foot benches.

3. Proper drainage should be provided and maintained around all cuts, fills, buildings, and driveway surfaces. Special attention should be given to channeling or routing drainage around and away from site fills and retaining structures. Excessive or uncontrolled surface and subsurface drainage could lead to erosion and poor site fill performance and/or slope failure.

4. All disturbed areas should be protected from erosion by revegetation or other appropriate methods. Areas of concentrated drainage should be protected by use of rip rap or other appropriate methods.

5. Construction safety is the sole responsibility of the contractor. The contractor is responsible for determining the appropriate OSHA slope criteria for the soils conditions encountered and implementing it during construction. The contractor shall be responsible for all means, methods, techniques, sequencing, and operations

during construction. All excavation activities should meet minimum OSHA, state or local trenching and excavation safety standards.

GENERAL COMMENTS

This report was prepared based upon WSG's experience with similar nearby sites and construction in this area. The subsurface conditions encountered may vary from those assumed. Therefore, WSG must be retained to conduct an openhole inspection on foundation excavations and any necessary testing required to quantify foundation design parameters. Modifications to the assumed design values, and therefore foundation design may be required and could result in construction delays.

Variations in subsurface conditions can occur in relatively short distances away. This report does not reflect any variations which may occur across the site or away from the test pit locations. If variations in the subsurface conditions anticipated become evident, the geotechnical engineer should be notified immediately so that further evaluation can be completed and when warranted, alternative recommendations provided.

The scope of services for this project does not include either specifically or by implication any biological or environmental assessment of the site or identification or prevention of pollutants or hazardous materials or conditions. Other studies should be completed if concerns over the potential of such contamination or pollution exist.

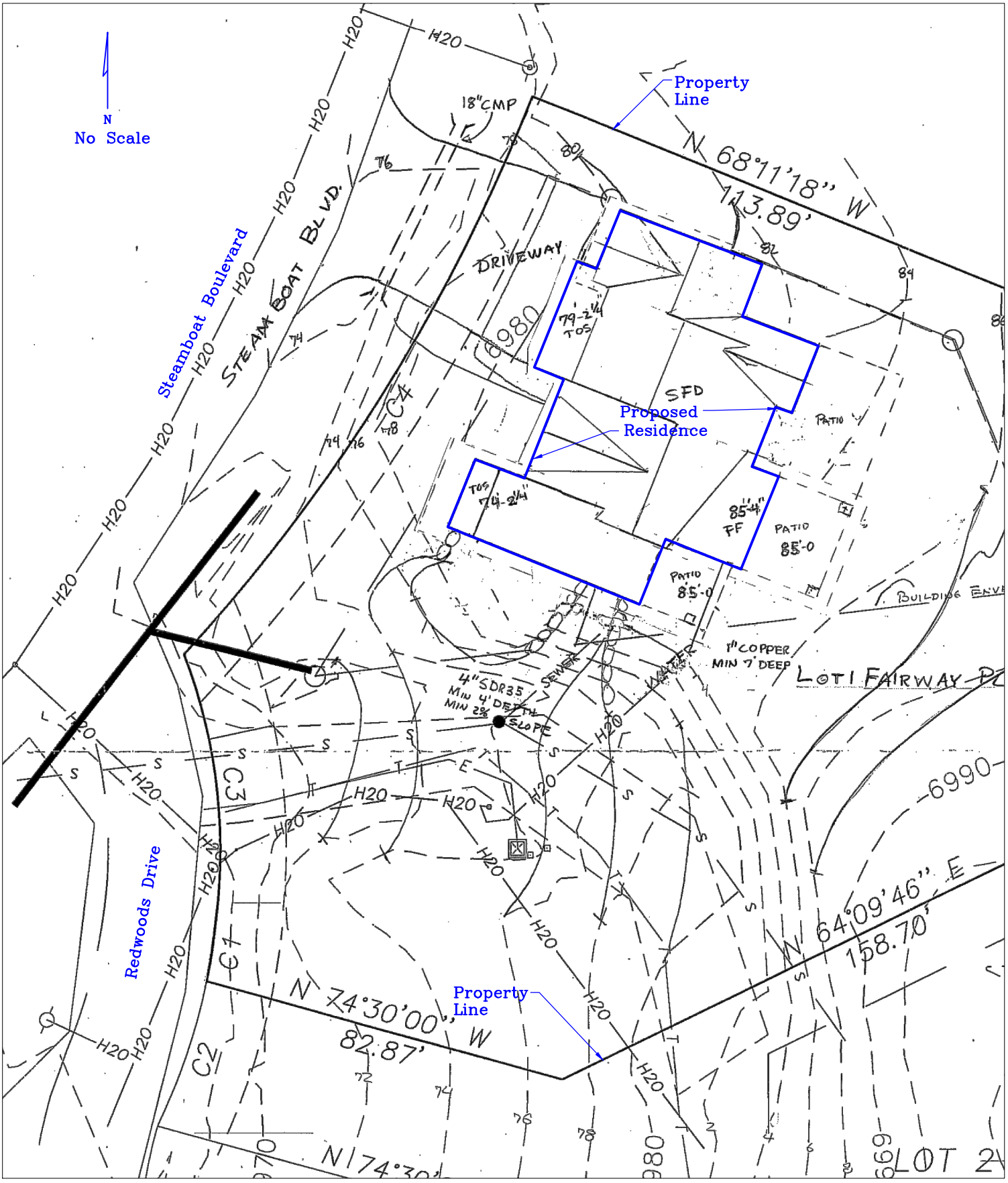
WSG should be retained to review the plans and specifications so that comments can be made regarding the interpretation and implementation of our geotechnical recommendations in the design and specifications. Soilogic should also be retained to provide testing and observation services during construction to help evaluate compliance with project plans and specifications.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with the generally accepted standard of care for the profession. No warranties express or implied, are made. The conclusions and recommendations contained in this report should not be considered valid in the event that any changes in the nature, design or location of the project as outlined in this report are planned, unless those changes are reviewed and the conclusions of this report modified and verified in writing by the geotechnical engineer.

WSG appreciates the opportunity to be of service to you on this project. If you have any questions concerning the enclosed information or if we can be of further service to you in any way, please do not hesitate to contact us.

Very Truly Yours,
Western Slope Geotech, Inc.

Harold Schlicht, P.E.
Principal Engineer



SITE PLAN

Project Name: Proposed Bristol Residence	WESTERN SLOPE GEOTECH STEAMBOAT SPRINGS COLORADO	
Location: Lot 1, Fairway Place Subdivision, Steamboat Springs, CO	Project No.: 19-1065	Drawn/Checked:HS
	Date: 10/28/19	Figure No.: 1