PRELIMINARY GEOLOGIC HAZARD EVALUATION
COPPER RIDGE VILLAGE
LOT 1, STEAMBOAT AIRPARK SUBDIVISION
GLORIA GOSSARD PARKWAY
STEAMBOAT SPRINGS, COLORADO

Prepared by

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Conclusions

NWCC believes that the construction of the proposed Copper Ridge Village residential development and associated roadways is feasible from a geotechnical standpoint, provided the recommendations in this report are followed. A discussion of geologic and geotechnical considerations related to the proposed residential development and roadway construction are outlined herein. It should be noted that this investigation is preliminary in nature with regards to the construction of the individual building sites and roadways, and detailed geotechnical investigations for the individual buildings and roadways must be performed prior to final roadway and foundation design and construction.

Purpose and Scope of Study

This report presents the results of a Preliminary Geologic Hazard Evaluation for the proposed Copper Ridge Village development to be constructed within Lot 1 of the Steamboat Airpark Subdivision, north of Gloria Gossard Parkway and southwest of the Steamboat Springs Airport in the City of Steamboat Springs, Routt County, Colorado.

This report has been prepared to summarize the data obtained and to present our preliminary conclusions and recommendations based on our current understanding of the proposed construction and development, and the subsurface conditions previously encountered in this area. A discussion of preliminary geotechnical engineering considerations, local geology and site conditions related to construction of the proposed residential development are included.

Proposed Development

It is our understanding that the proposed development will consist of the construction of seven multi-family residential structures and associated roadways and parking areas to be located north of Gloria Gossard Parkway within Lot 1 of the Steamboat Airpark Subdivision in Steamboat Springs, Colorado.

Based on the preliminary plans provided by Four Points Surveying and Engineering (FPSE), dated February 15, 2021, it appears that overlot site grading, consisting of cuts on the order of 5 to 50 feet in height will be required for construction of the proposed roadways. Fill slopes of up to approximately 30 feet in height will be required on the downhill side of the proposed roadways. Retaining walls are proposed west-southwest of the driveway and the southwest corner of Building 1 and south of the driveway and south side of Building 5.

We anticipate structure loadings from the residential structures will range from light to moderate. If loadings or conditions are significantly different from those described above, we should be notified to reevaluate the recommendations contained in this report.

Site Conditions

The property generally consists of vacant undisturbed land located in Steamboat Springs, Colorado. The property is bordered to the west and north by similar, undeveloped land, on the northeast by the Steamboat Springs Airport and other undeveloped land, on the south by the West Acres Mobile Home Park and the east-southeast by the West Acres Park Subdivision, which is an industrial/commercial subdivision.

The topography of the site is highly variable and generally consists of moderate to steeply sloping hillsides. A drainage that generally flows in a north to south direction is located in the western part of the property and the adjacent hillsides generally slope down towards the drainage.

The vegetation across the site is variable and generally consists of grasses, weeds, deciduous brush, scrub oak and scattered aspen trees.

Field Investigations

A review of previous geotechnical investigations in this area was completed to obtain general information on subsurface conditions in this part of Steamboat Springs. It should be noted that NWCC has conducted several subsurface investigations along Gloria Gossard Parkway, within the Overlook Subdivision, and at the Steamboat Springs Airport.

NWCC completed a site visit/evaluation on April 2, 2021. The existing natural slopes and drainage conditions were relatively free of snow and observed across the site.

Subsurface Conditions

The subsurface conditions encountered in previous subsurface investigations in this area are variable and generally consisted of a layer of topsoil and organic materials overlying natural clays and claystone-shale bedrock materials of the Mancos Shale Formation.

The layer of topsoil and organic materials generally ranges from 6 to 24 inches in thickness, with the thicker amounts of topsoil being encountered in the drainage areas.

Natural clays are typically encountered below the topsoil and organic materials and range from 2 to 30 feet in thickness. The natural clays are typically slightly sandy to sandy with occasional bedrock fragments, moderately to highly plastic, medium stiff to hard, moist to very moist and brown to gray in color with calcareous stringers. Samples of the natural clays encountered in this area classified as CL to CH soils in accordance with the Unified Soil Classification System (USCS).

Claystone-shale bedrock materials are typically encountered below the topsoil and organic materials or natural clays at depths ranging from 1 to 30 feet below the existing ground surface. The claystone-shale bedrock materials are slightly sandy to sandy, low to moderately plastic, weathered to very hard, moist to slightly moist and gray to dark gray in color. Samples of the claystone-shale bedrock materials encountered in this area generally classified as CL soils in accordance with the USCS.

The natural clays and claystone-shale bedrock materials will typically exhibit low to high swell potentials when wetted under constant loads.

Groundwater conditions are highly variable across the site. Groundwater seepage/seasonal subsurface runoff is typically encountered at the topsoil and clay or bedrock interface during spring snowmelt and heavy runoff periods. Groundwater seepage is also typically encountered in highly weathered or fractured zones of the claystone-shale bedrock. It should be noted that the groundwater conditions can be expected to fluctuate with changes in precipitation and runoff conditions across the site.

Preliminary Multi-Family Residential Construction Considerations & Recommendations

Foundations: The foundation recommendations for the proposed multi-family structures must be developed based on a site specific geotechnical investigations, due to the highly variable nature of the subsurface conditions and swell potentials of the soils and bedrock materials. The final foundation grades for the structures should be carefully considered with the underlying soil conditions in mind. Due to the swell potential of the clays and bedrock materials encountered at the site, the structures will most likely need to be founded on straight-shaft piers or helical/screw piles advanced into the underlying natural clays or bedrock materials. If soils and or bedrock materials are encountered that exhibit a low to moderate swell potential, the use of shallow foundations such as voided footings may be used.

The location, depth and consistency of the soils and bedrock materials encountered during this and previous investigations were highly variable and site specific investigations and sampling should be conducted for each structure to determine which foundation type is most appropriate and feasible.

Floor Slabs: Lightly to moderately loaded floor slabs-on-grade can be constructed at the site with varying degrees of protection from swelling subgrade materials depending on the swell potential. A layer of free draining gravel beneath the slab, separation from bearing walls and columns, control joints and subgrade overexcavation and replacement are some of the measures that should be taken to allow slab-on-grade construction. However, structural floor systems constructed over crawlspaces should be used in the areas where the swell potential is known to be moderate to very high or in areas where the client and/or structure cannot tolerate the differential floor slab movement that will occur when the moisture-sensitive soils or bedrock materials become wetted and swell or consolidate.

Underdrain Systems: Underdrain systems will be required to protect the lower levels and crawl space areas of the structures due to the presence of stiff cohesive soils and a relatively shallow, seasonal perched water table. Groundwater, localized perched or runoff water can infiltrate the foundation areas at the foundation levels. This water can be one of the primary causes of differential foundation and slab movement, especially where expansive clays and bedrock have been encountered.

Preliminary Roadway and Pavement Section Recommendations

Preliminary Site Grading Recommendations: Based on our experience with soil conditions in this area and the results of previous slope stability analyses conducted by our firm in this area, we recommend that unretained cut slopes in the topsoil and organic materials be constructed to no steeper than a 3 (Horizontal) to 1 (Vertical) slope configuration. The unretained cut slopes constructed in the overburden soils and bedrock materials should be constructed to no steeper than a 2 (Horizontal) to 1 (Vertical) slope configuration. Unretained cut slopes in competent shale bedrock materials may be cut to a 1(Horizontal) to 1(Vertical) slope configuration; however, placement of topsoil and revegetation of these slopes will be very difficult. Flatter slopes than those indicated above for the overburden soils and bedrock materials are often desirable in that they help reduce erosion and minor sloughing of newly completed cut slopes and also help revegetation efforts. The use of erosion control mats can reduce the amount of shallow sloughing in new cut slopes. Turf reinforcement mats should be considered in areas where shallow sloughing is not tolerable.

Groundwater seepage between the topsoil and overburden soil/bedrock contact zone may occur across the site in the roadway cuts during heavy runoff periods, which could be adverse to the newly constructed slopes until the vegetation is allowed to establish.

If seepage is encountered deeper in the overburden soils or bedrock, this seepage will significantly increase the risk of slope instability, and these areas will need to be reevaluated. Additional slope stabilization and/or drainage measures may be required in areas where groundwater seepage is encountered or if unstable materials are observed. Therefore, an engineer from this office must observe the cut slopes as they are constructed so that any potentially unstable and problem areas can be evaluated and remediated before the construction is completed.

We recommend that the unretained fill slopes be constructed to a 2 (Horizontal) to 1 (Vertical) or flatter configuration. All embankments must be properly compacted and constructed on suitable bearing soils after the topsoil and organic materials are removed. The fills should be properly benched into hillsides exceeding 4 (Horizontal) to 1 (Vertical). The on-site soils and bedrock materials, exclusive of the topsoil and organic materials, should be suitable for use in roadway embankment and utility trench backfill. These materials may require moisture conditioning (wetting or drying) to bring them to near optimum moisture content prior to placement and compaction. We recommend that common roadway embankment fill materials and utility trench backfill materials be uniformly placed and compacted in 6 to 8 inch loose lifts to at least 95 percent of the maximum standard Proctor density and within 3 percent of the

optimum moisture content determined in accordance with ASTM D-698. We also recommend that a representative of this office observe and test the fill materials as they are placed in the embankments

All of the cut and fill slopes and any other stripped areas should be protected against erosion by revegetation or other methods. Riprap or other erosion control measures will probably be required in areas of concentrated drainage and steeper slopes. We recommend that a maximum of 4 inches of topsoil and organic materials be placed over the finished cut and fill slopes to prevent sloughing/sliding of these materials off of the slope before the vegetation has been adequately established. As noted above, the use of erosion control or turf reinforcement mats will reduce the risk of near surface sloughing and minor slope failures until the vegetation is established.

Preliminary Pavement Section Recommendations: Pavement section alternatives presented below are based on anticipated soil conditions, assumed traffic loadings, pavement design procedures presented in the AASHTO Guide for Design of Pavement Structures, and our experience with similar sites and conditions in this part of Steamboat Springs. AASHTO pavement design procedures have been adopted and are used by the Colorado Department of Transportation (CDOT). NWCC has assumed the proposed pavement areas will be subjected to primarily automobiles with occasional delivery trucks and with regular trash truck service.

Based on the soil conditions encountered in the adjacent areas and our understanding of the proposed construction, it appears the materials to be encountered at proposed pavement subgrade elevations will most likely consist of fill materials or natural clays. We have assumed the fill materials and clays will generally classify as CL to CH soils in accordance with the USCS, which is the worst-case scenario. NWCC recommends the pavement areas subjected to both truck and automobile traffic, such as the main roadway through the development be constructed with a minimum of 4 inches of hot mix asphalt (HMA) overlying a minimum of 4 inches of CDOT class 6 aggregate base course (ABC) and a minimum of 8 inches of subbase aggregates (Pit Run). The pavement areas subjected to **automobiles only**, such as the parking stalls, can be paved with a minimum of 3 inches of HMS, 4 inches of CDOT class 6 aggregate base course (ABC), and a minimum of 6 inches of subbase aggregates (subbase).

NWCC recommends the areas subjected to heavy truck turning movements, such as the pads in front of the trash dumpsters or loading docks be paved with a rigid pavement section consisting of at least 8 inches of Portland cement concrete (PCC).

NWCC recommends the asphalt pavement material (HMA) consist of an approved "Superpave" mix designed by a qualified, registered engineer. The mix design should be designed using the SX gradation and mixed with PG 58-28 oil or other performance graded asphaltic materials. The mix should be produced and placed by a qualified contractor and should be compacted to between 92 and 96 percent of the maximum theoretical (Rice) density or at least 92 percent of the maximum Rice density. Quality control activities should be conducted on paving materials at the time of placement.

Base course materials (ABC) should consist of a well-graded aggregate base course material that meets CDOT Class 6 ABC grading and durability requirements and the subbase should consist of well-graded aggregate materials that meet CDOT Class 2 ABC grading and durability requirements.

ABC and subbase materials should be uniformly placed and compacted in 4 to 6-inch loose lifts to at least 95 % of the maximum modified Proctor density and within +/- 2 % of the optimum moisture content as determined by ASTM D1557.

Concrete pavement materials shall be based on a mix design established by a qualified engineer. Concrete should have a minimum 28-day compressive strength of 4,500 psi, be air-entrained with approximately 6 percent air, and have a maximum water/cement ratio of 0.42. Concrete should have a maximum slump of 4 inches and should contain control joints no greater than 10 to 12 feet on center, depending on slab configurations. The depth of the control joints should be at least ¼ of the slab thickness.

Prior to placement of subgrade fill materials or subbase materials, in cut areas, NWCC recommends that all of the existing topsoil and organic materials be removed and the exposed materials be scarified, moisture conditioned and recompacted. The scarified natural clays and subgrade materials should be compacted in 6 to 8 inch lifts to at least 95 % of the maximum standard Proctor density and within +/- 2 % of the optimum moisture content as determined by ASTM D698. The finished subgrade surface, after recompaction, should also be sloped at least 1 percent to avoid ponding and to reduce the potential for wetting and expansion of the subgrade soils. The finished subgrade surface should be proof rolled with a loaded tandem dump truck or loaded water truck and any areas deflecting or rutting should be removed and or stabilized prior to placing the subbase aggregates.

The collection and diversion of surface and subsurface drainage away from the paved areas is extremely important to the satisfactory performance of the pavement. The design of the surface and subsurface drainage features should be carefully considered to remove all water from paved areas and to prevent ponding of water on and adjacent to paved areas.

Geologic Hazard Evaluation

Slope Stability: The stability of both the natural and proposed cut and fill slopes have been considered in this evaluation. Aerial photographs and information from previous investigations were also used to provide a further evaluation of the site geomorphology.

We observed evidence of historic landslide activity in the form of small surface failures and hummocky topography in the western portion of the site at the time of our recent site visit. Two small surface failures were observed on the natural hillside along the western property line. The surface failures occurred in the upper 12 inches of topsoil

materials and natural soils. The hummocky topography below the surface failures is the result of this landslide activity, in the form of small-scale slumps and debris flows within the overburden soils. These features are now obscured by erosion and are mostly subtle and difficult to delineate. A larger landslide occurred to the west of the property along the cut slope along the north side of Gloria Gossard Parkway as a result of excess groundwater seepage. This landslide was repaired/stabilized using a free draining rock/boulder buttress fill. No evidence of further movement within this failure was observed during our recent site visit.

Smaller surface failures also occurred during construction of the large cut slope in the southeast portion of the property. These surface failures were due to an excessive amount of topsoil fill placed over the newly constructed cut slopes, and the topsoil fill materials failed/slumped in the areas where groundwater seepage was observed flowing out of the bedrock materials. These surface failures were repaired by regrading and establishing vegetation. A small area was also repaired using a turf reinforcement mat.

A larger failure at the east end of this cut slope was repaired using a free draining rock/boulder buttress fill. No evidence of further movement was observed in this area during our recent site visit.

Shale bedrock of the Mancos Formation was poorly exposed along the ridgelines and upper steep slope faces that surround the site. Where exposed, the bedrock displays near horizontal to slightly dipping bedding down to the southeast on the order of 10%. The outcrops exposed in the steep slope faces form very steep slopes and are relatively stable. Small rafts of vegetation and overburden soil form small hummocks on the lower portions of these slopes.

Based on the topography and our experience with similar soil and bedrock conditions, we believe that there is generally a low risk of slope stability issues associated with the current development plan of the property. For much of the site, we believe that properly designed and constructed roadway cut and fill slopes should be safe from slope stability problems. However, the higher cut slopes along the north side of proposed development could become unstable as the result of the proposed site grading. These areas will need to be further investigated during the subsurface investigation for the proposed structures. In addition, any excavations in this portion of the site must be observed by an engineer from this office as the excavations are completed.

Based on our review of the Routt County Geologic Hazard map, it appears that the steeper portions of the property located along the north property line and in the adjacent properties to the west and north are mapped as Potentially Unstable Slopes (PUS). This implies a previously stable slope could become unstable due to disturbance from development related activities. We recognize this hazard classification as a general, all-encompassing grouping of slopes that do not exhibit signs of instability at this time, but may have isolated steep topographical areas, or other

isolated soil and/or groundwater conditions which may be conducive to small-scale slope failures. The proposed cut slopes in this area will be further evaluated in the subsurface investigation.

Swelling Soils and Bedrock: The potential hazards from swelling materials at the site and remedial measures have been briefly discussed above. Swell-consolidation tests conducted on samples collected in previous investigations in the area indicate a variable swell potential ranging from low to high exists across the site. A site-specific Subsoil and Foundation Investigation for the proposed buildings will be required to better evaluate the potential hazard from swelling soils and bedrock materials, and to provide recommendations to reduce the risk of construction at this site on swelling materials, since the swell potential of any particular site can change erratically both in lateral and vertical extent.

Geologic Setting and Seismic Activity: The project site is situated in the Southern Rocky Mountain Province and lies one to two miles west of the west flank of the Park Range. Portions of the Park Range are also referred to as the Gore Range in this area. The Park Range Uplift has been interpreted as a product of the Laramide orogeny which probably began in early Cretaceous time and reached its peak in Paleocene time. The Park Range uplift is anticlinal in nature with a core of igneous and metamorphic rocks flanked by sedimentary rocks of Cretaceous age in the project area.

Specifically, the near surface bedrock in the project site consists of the Cretaceous Mancos Shale Formation. The Mancos Shale Formation consists of a deep marine shale deposit up to 5,000 feet in thickness. The shale is typically slightly sandy to sandy, low to moderately plastic, hard to very hard, fissile and dark gray to gray. The near surface claystone-shale beds of the Mancos Shale Formation are nearly horizontal in much of the project area.

Overlying the near surface bedrock, residual and colluvial clay soils are the products of chemical and mechanical erosion processes which continue. Some these residual and colluvial have experienced slumping, probably during a wetter climatic period than is currently being experienced.

Seismic activity in the project area is considered to be low. According to the Uniform Building Code (1997) all of Colorado is located in Zone 1. This classification implies the following seismic risk: "minor damage; distant earthquakes may cause damage to structures with fundamental periods greater than 1.0 second; corresponding to intensities V and VI on the Modified Mercalli Intensity Scale" (Algermissen, 1969). Based on the UBC definitions, levels of peak horizontal ground acceleration should not exceed 0.04g with a 90 percent probability level. Two earthquakes of significance have been recorded in Steamboat Springs since 1870. Both earthquakes, March 1895 and February 1955, corresponded to Modified Mercalli Intensities of V (Kirkham and Rogers, 1981).

Based on anticipated geologic conditions, NWCC recommends a **Soil Site Class B** designation be used for the site in accordance with Table 20.3-1 in Chapter 20 of ASCE 7.

Limitations

This report is preliminary and suitable for preliminary design and planning. This report is based on previous investigations completed on adjacent properties and the assumed soil and bedrock conditions at the site. Based on our present knowledge, there are no subsurface or geological conditions, which constitute a major hazard or would render the proposed development and roadway construction infeasible. However, additional subsurface investigations must be conducted to provide specific design criteria for the individual building foundations, slabs, retaining walls, lateral earth pressures, overlot site grading, roadway construction, slope stabilization and other soil related construction activities.

The owner must retain NWCC, Inc. to monitor the construction of the roadways and other development related site work to ensure compliance with the specifications and verify that the subsoil and groundwater conditions are similar to those assumed herein.

If there are any further questions concerning this report, or if we may be of further service, please contact this office.

Sincerely,
NWCC, INC.,

Timothy S. Travis, P.E.
Senior Project Engineer

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Reviewed by Brian D. Len, P.E.
Principal Engineer