CESARE, INC.
*Geotechnical Engineers & Construction Materials Consultants*

March 10, 2021

Mr. Michael O'Connor
Triumph Development West, LLC
12 Vail Road, Suite 700
Vail, CO 81657

Subject: Proposed Geologic Hazards Assessment
Middle Creek Housing Lot 3
Vail, Colorado
Project Number 21.5015.A

Dear Mr. O'Connor:

Cesare, Inc. (Cesare) performed a geologic hazards assessment for Triumph Development West, LLC (Client) for the proposed Middle Creek Housing in Vail, Colorado. A vicinity map of the site is shown in Exhibit 1.


**EXHIBIT 1. Vicinity Map**

## 1. SCOPE

Cesare has not visited the site at the time of this letter. A visit to verify Cesare's findings will be made

in the spring after the ground is substantially free of snow cover. This assessment addresses geologic hazards consistent with Colorado Senate Bill 35 (1972), House Bill 1041 (1974), and Eagle County land use code requirements that could impact site development.

## 2. SITE CONDITIONS

The site is located north of Interstate 70 in Vail, Colorado. The site slopes down from north to south. The site is currently a preschool known as the Children's Garden of Learning. Cesare understands that development will consist of demolishing the existing building and parking lot and replacing with a building about 55 feet by 300 feet in plan dimension. The building will be stepped to fit the slope of the site, with four stories on the uphill side and five stories on the downhill side. The lower level of the five-story section will be parking. Based on current drawings, excavations about 20 feet deep will be required for the structure. In addition to excavations, current plans indicate as much as 15 feet of fill will change existing site grades.

## 3. SITE GEOLOGY

The "Geologic map of the Vail West quadrangle, Eagle County, Colorado," by Scott, R.B., et al., USGS MF-2369, 2002, indicates that the surficial deposits at the site consist of glacial till. The bedrock at the site consists of the Minturn Formation, which is an interbedded sandstone, siltstone, and claystone.

## 4. HAZARDS ASSESSMENT

The Eagle County geohazards assessment maps do not list any hazards on the site. There are landslide and rockfall hazard areas mapped to the east, debris fans mapped to the south, and rockfall and debris flow areas to the northwest. A portion of the geologic hazards map for the area is included as Exhibit 2. Cesare reviewed a preliminary geohazards study for the site by Koechlein Consulting Engineers, Inc., dated August 23, 2001. The preliminary geohazards study includes a larger area than this letter. The preliminary geohazards study lists rockfall and debris flow hazards for the site and notes that both hazards can be mitigated. The following sections address additional hazards that may be affect the site.

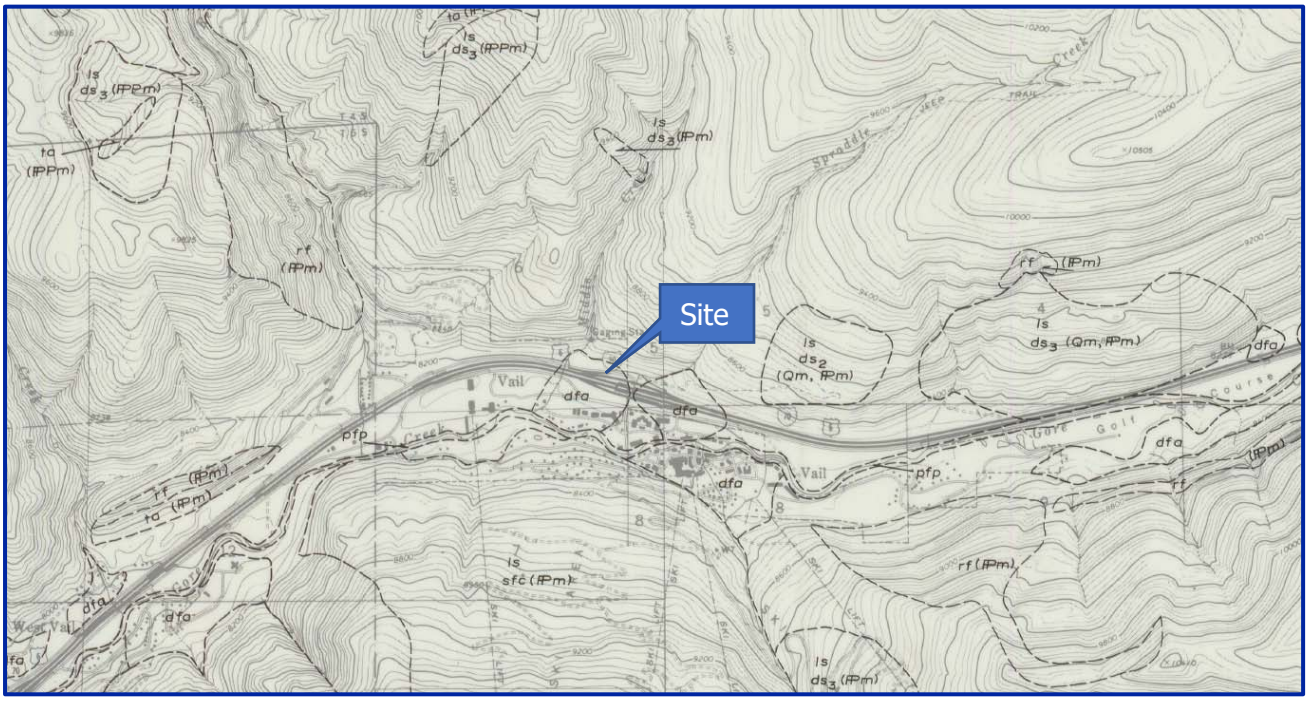


**EXHIBIT 2. Portion of Geologic Hazards Map**

## 4.1 FLOODING HAZARD ASSESSMENT

According to the Eagle County flood maps, the site is mapped as Zone X area of minimal flood hazard. Cesare opines that because of the steep sides of the valley and that the site is located well above Gore Creek, flood hazard will be minimal.

## 4.2 RADON

The U.S. Environmental Protection Agency map of radon zones indicates that virtually all of western Colorado, including Eagle County, is in Zone 1 (www.epa.gov/radon/zonemap.html). Although there is no known safe level of radon, Zone 1 is the zone of highest risk for exposure to radon gas (i.e., greater than 4 picocuries per Liter (PCi/l)). The Colorado Geological Survey (CGS) participated in an EPA study in 1987 and 1988 to record indoor radon levels throughout Colorado residences and compiled its results in a report that related geologic setting and building construction with radon levels (CGS 1991 Open-File Report 91-4). Residences with basements had higher levels of radon than residences built on grade on the same geologic material. The CGS is careful to state that radon potential can vary considerably within the same geologic unit due to the nonuniform distribution of uranium, secondary leaching, and the accumulation of uranium and other radioactive elements into other strata.

Based on levels of radon recorded in existing residences in the region and the presence of rock types that are known to produce radon, it is reasonable to assume that radon emissions into buildings is occurring in the Vail area. The EPA, the Colorado Department of Public Health and Environment (CDPHE) Radiation Management Division, and the National Association of Home Builders (NAHB) recommend that all new residences constructed in Zone 1 should include radon resistant features. These organizations also recommend that after the building is constructed, radon should be measured and if the results are greater than 4 pCi/L, the system should be upgraded from passive

to active (usually by installing a fan). In the EPA publication titled, "Building Radon Out: a Step-by-Step Guide on How to Build Radon-Resistant Homes" (USEPA Office of Air and Radiation EPA/402-K-01-002, April 2001), three practical and inexpensive alternatives for passive, sub-slab depressurization systems are presented; gravel with vents, perforated pipes, or soil gas collection mats. Recommendations for passive and active design and construction techniques for reducing radon gas can be found on the EPA radon website www.epa.gov/radon or the CDPHE radon website www.cdphe.state.co.us/hm/rad/radon .

### 4.4 LANDSLIDES

There are steep slopes above the site and landslides are mapped at a similar elevation along the valley. Cesare will conduct a site visit to look for physical signs of landslides, i.e., tension cracks, hummocky terrain, pistol butting of trees. At this time, Cesare is not aware of any active landslides on the site; however, construction and development of this site should include a slope stability analysis. Slope stability analysis of the site should include any excavations or fills planned for the site, as changes in grading can destabilize an otherwise stable site.

### 4.5 ROCKFALL

The Minturn and Maroon Formations include some cliff forming members that are often source areas for rockfall. There are areas of rockfall hazard mapped both east and west of the site. The site is not mapped as an area of rockfall hazard. During Cesare's site visit, after snowmelt, it will confirm if any rockfall exists at or above the site and any potential source areas.

### 4.6 AVALANCHE

Slopes north of the site are steep enough to generate an avalanche, however, no avalanche hazard is mapped on or above the site. Cesare has not observed any avalanche paths or scars on or adjacent to the site. Cesare judges the avalanche hazard at the site to be low. In Cesare's opinion, no avalanche mitigation will be necessary at the site.

### 4.7 ABANDONED MINES

No abandoned mines are known to exist below or in the vicinity of the property. Risks associated with settlement due to abandoned mines is considered nil.

### 4.8 DEBRIS FLOWS

Two debris flow fans are mapped south and southeast of the site. The debris fans sit at the mouths of Spraddle Creek and Middle Creek, downhill from the site. The Robson geohazards map explanation describes the debris fans as "*Areas of possible recurrent flooding, debris flows and hydrocompaction*". Potential for hydrocompaction of debris fan material should be evaluated in a design level geotechnical report. Hydrocompaction reduced or managed in several ways, including deep foundations, overexcavation, and managing drainage. A design level geotechnical report should include testing for collapse potential to evaluate the risk of hydrocompaction of any debris flow material on the site.

## 5. CONCLUSIONS

There are no geologic hazards in the literature reviewed by Cesare that preclude development of the site. Cesare will visit the site, after snowmelt, to verify the findings in the literature. Slope stability, and hydrocompaction should be evaluated in a design level report.

## 6. LIMITATIONS

This letter has been prepared for the exclusive use of Cesare's Client for specific application of the project discussed and has been prepared in accordance with generally accepted geologic and geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. In the event that changes in the nature, design, or location of the project as outlined in this letter are planned, the conclusions and recommendations contained in this letter shall not be considered valid unless Cesare reviews the changes and either verifies or modifies the conclusions of this letter in writing.

Please contact Cesare with any questions or comments regarding this information.

Sincerely,
CESARE, Inc.


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