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November 4, 2015

Summit Powder Mountain
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IGES Project No. 01628-008

Subject: Response to Additional Review Comments - Geology
Geotechnical Investigation
The Ridge Nests Development
Powder Mountain Resort
Weber and Cache Counties, Utah

Ms. Milner:

As requested, IGES has prepared the following response to additional review comments regarding the referenced geotechnical report and first review response dated September 23, 2015 for the Ridge Nests development, part of the larger Powder Mountain Resort expansion project in Weber County, Utah. The review comments to be addressed were prepared by Simon Associates LLC (SA) in a letter dated October 14, 2015; the latest comments by SA are in regard to the review response by IGES (2015c), which was prepared in response to SA's first geologic review letter (SA, 2015a) that was regarding the original geotechnical report by IGES (2015a).

The review letter by SA was intended to address Lot 13; however, in consideration that the comments by SA could also be applicable to several other lots, it is the intention of IGES to address the comments with respect to the entire Ridge Nests development. For convenience, the review comments will be presented first, followed by our response.

Comment No. 1

"*The September 23, 2015, IGES response letter did not describe the properties of the bedding and/or jointing for incorporation into the slope stability analyses, e.g., properties such as, strike and dip, degree of fracturing (generally controlled by the number of joints in a given direction), persistence of jointing, spacing of jointing, roughness of joint surface, open and/or closed joints, joint coatings and infillings, etc.*

Should the Weber County Consulting Geotechnical Engineer consider the properties of bedding, joints, and/or fractures pertinent in regards to slope stability analyses presented in the September 23, 2015 IGES response letter, SA recommends Weber County request documentation of the bedding, joint, and/or fracture properties, and incorporation of the geologic data in the slope stability analyses."

Response to Comment No. 1

IGES did describe the strike and dip of the bedding and jointing in the September 23, 2015 response letter; IGES noted bedding near the subject site was oriented (strike) about N24°W and dip (inclination from the horizontal) at 25°NE. The bedrock was found to have blocky jointing, with the two major sets being orthogonal to one another. One joint set was parallel to the bedding, and the other was perpendicular to the bedding, dipping steeply to the southwest. The joint set parallel to the bedding has the same strike and dip orientation as the bedding, while the other major joint set perpendicular to the first has a strike of approximately N24°W and a dip of approximately 65°SW.

In response to the comment, the following additional details are provided: bedrock was found to be largely moderately fractured (distance between fractures ~0.5-1.0 feet) to little fractured (distance between fractures ~1.0-4.0 feet), with localized areas of intense fracturing (distance between fractures ~0.05-0.1 feet). Joint spacing was largely found to be a product of the lithology. The finer-grained dolomite lithologies were more thinly bedded, and therefore had a smaller distance (approximately 1 to 4 inches) between bedding plane joints. These lithologies also tended to fracture into rectangular blocks generally between 4 and 18 inches in length and width, and contained both bedding-confined and through-going fractures (Photo 1). Coarser-grained dolomite lithologies were more thickly bedded to massive, with bedding plane joints separated by between 6 inches to as much as several feet. These lithologies tended to fracture into rectangular blocks with highly variable dimensions, ranging in width and length from between a couple inches to several feet, though larger blocks (with dimensions of several feet x several feet x several feet) were most common (Photo 2). Most fracturing associated with the coarser-grained dolomite lithologies consisted of large through-going fractures.

Nearly all of the joints encountered in the field investigation were open, had slightly rough to rough surfaces, and did not contain a secondary mineralization, except rare calcite infilling in places. No slickensides were observed on any joint surface. Joint apertures varied from between a few millimeters to a couple inches in width. Joints with smaller apertures tended to be devoid of any sort of fill, while the larger aperture joints were often filled with soil. In the cases of the two identified faults, reddish gray silty gouge was found to be the fill material.

Photo 1. Finer-grained dolomite lithology, exhibiting thinner beds and blocky jointing.

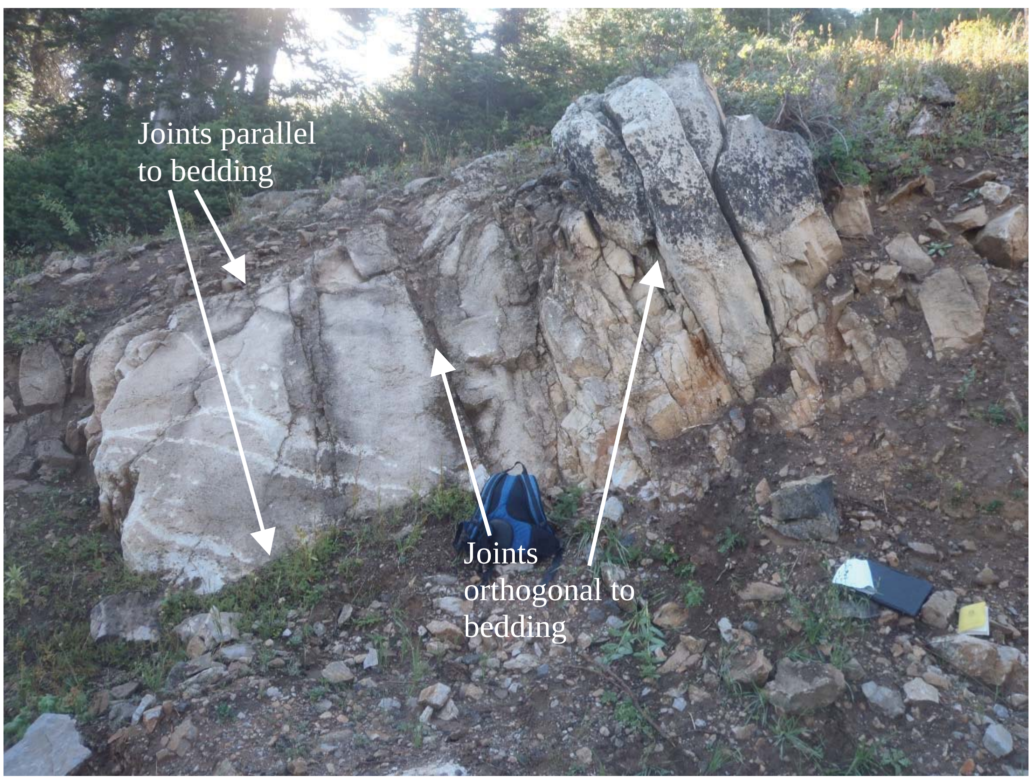

Photo 2. Coarser-grained dolomite lithology, exhibiting thicker beds and wider jointing.

The preceding bedrock characteristics were discussed between the engineering geologist and the geotechnical engineer and were taken into consideration in development of the subsurface model, geologic cross section, and subsequent slope stability analysis.

Comment No. 2

"*SA recommends Weber County request IGES provide definitions for "inactive" fault, "drastic deformation," and "ancient geologic past". Without definitions, applicability of the above factors to determine timing of surface-fault-rupture are difficult to evaluate. However, regardless of the definitions, SA considers several of the factors not to be applicable in regards to timing of surface-fault-rupture. For instance:*

a. "The fault extends up to, but not through, the overlying profile." *Without the age of the overlying soil profile, the statement is unsubstantiated.*

b. "Abundant vegetation is present above the fault trace, and is not offset or disturbed in any way." *Without an age of the vegetation, the statement is unsubstantiated.*

c. "The fact that the footwall block shows such drastic deformation not seen elsewhere on the property suggests that the displacement happened in the ancient geologic past, and subsequent geomorphic processes have returned the bedrock block back to stable topographic conditions across the fault trace." *In regards to determining timing of surface-fault rupture, SA is not aware of any paleoseismic studies correlating:*

i. "…*drastic deformation*" to displacement occurring in the "ancient geologic past."
ii. *The use of* "…subsequent geomorphic processes…[returning] bedrock blocks back to stable topographic conditions across a fault trace.""

Additionally, SA recommends Weber County suggest IGES consider the following, long established standard of practice, methods for evaluating the potential for surface-fault-rupture along the documented faults:

a. *"Review of aerial photographs and surface observations to identify any fault-related geomorphic features indicative of past surface faulting at or near the property (e.g., fault scarps, vegetation lineaments, gullies, vegetation/soil contrasts, aligned springs and seeps, sag ponds, aligned or disrupted drainages, faceted spurs, grabens, and/or displaced landforms such as terraces, shorelines, geologic units, etc.).*

b. *"The USGS Quaternary Fault and Fold Database of the United States. (http://earthquake.usgs.gov/hazards/qfaults)."*

Response to Comment No. 2

In the context of the IGES submitted letter on September 23, 2015, the following definitions are to be used in association with the terms or phrases in question:

- *Inactive fault*: a fault in which displacement of greater than 4 inches has not been observed to have occurred along one or more of its traces within Holocene time (~11,000 years ago-present). (Weber County Wiki for Natural Hazards Overlay Districts, Chapter 38-3).
- *Drastic deformation*: deformation that is anomalous to the existing geologic framework.
- *Ancient geologic past*: relating to the past in terms of millions of years, as opposed to thousands of years.

With regards to the timing of surface-fault-rupture, it should be noted that three of the four factors identified by IGES to demonstrate that the faults are inactive faults are to be taken as individual pieces of evidence that collectively indicate fault inactivity. Each piece of data provides geologic support for the cumulative conclusion that the faults are inactive, and are discussed individually below.

SA comments: "*Without the age of the overlying soil profile, the statement is unsubstantiated*."

Though the age of the soil profile overlying the faults is unknown, the presence of undisturbed soil provides a lower limit for most recent displacement along the fault traces. Soil formation can take hundreds to thousands of years to develop. Taking the conservative estimate of 100 years per inch of topsoil development (NRCS)[1], and the fact that 3.5 feet of soil were encountered in TP-1, provides a lower limit of at least 3,600 years since last displacement along the faults.

SA comments: "*Without the age of the vegetation, the statement is unsubstantiated*."

IGES concedes to the reviewer that offset of individual trees or other flora is generally not applicable for timing of fault movement. However, no alignment, pattern, or offset of vegetation was observed either in the site visit or apparent in Google Earth imagery. This suggests a lack of surficial expression of the fault traces.

SA comments: "*In regards to determining timing of surface-fault-rupture, SA is not aware of any paleoseismic studies correlating*:

iii. "*…drastic deformation" to displacement occurring in the* "ancient geologic past."
iv. *The use o*f "…subsequent geomorphic processes…[returning] bedrock blocks back to stable topographic conditions across a fault trace.""

The drastic deformation identified in this specific instance is such that there is no synchronous relationship between the event that caused the deformation and the current geologic setting for this particular area. In other words, the deformation noted on the footwall block of one of the faults, in steeply dipping to the southeast, is completely out of place from any other geologic data present at the location and is localized (e.g., restricted to the fault block). Because this deformation has no apparent relationship with any of the other geologic data present, the logical conclusion is that the event that caused the deformation (movement along the fault) occurred in

[1] http://www.nrcs.usda.gov/wps/portal/nrcs/detail/wa/soils/?cid=nrcs144p2_036333

the "ancient geologic past," otherwise similar geologic data would be present in the area, e.g. geomorphic expression of the fault.

Given that the deformation is associated with a fault trace, it is therefore to be understood that the deformation was the product of at least one but likely multiple major seismic events. Such seismic events are likely to have resulted in the production of a fault scarp exposed at the surface, but currently no such scarp is present and there are gentle topographic conditions across the fault trace. These stable topographic conditions would have subsequently been produced by geomorphic processes that would have slowly eroded away the fault scarp, leaving the existing gentle topography encountered today.

Additionally, it should be noted that the faults in question are passing through very hard bedrock comprised of dolomite, and not unconsolidated sediment. Had these faults been active during Holocene time (with a minimum of 4 inches of displacement) the activity would have produced a bedrock fault scarp exhibiting at least 4 inches of displacement. This dolomitic bedrock is very resistant to weathering and erosion as evidenced by its cliff-forming character, and its presence at the top of the ridges found in the surrounding areas. Whereas it may be likely that 4+ inches of unconsolidated material offset by a fault may be removed by weathering and erosion processes during Holocene time, it is conversely highly unlikely that 4+ inches of hard bedrock fault scarp would be removed over this same time interval, especially given the climatic conditions at the site compared to weathering rates found in industrial environments (Gauri et al., 1992). The absence of a fault scarp under these conditions, therefore, is evidence that there has not been surface-fault-rupture with greater than 4 inches of displacement during Holocene time.

SA Comment regarding *"Review of aerial photographs and surface observations to identify any fault-related geomorphic features indicative of past surface faulting at or near the property (e.g., fault scarps, vegetation lineaments, gullies, vegetation/soil contrasts, aligned springs and seeps, sag ponds, aligned or disrupted drainages, faceted spurs, grabens, and/or displaced landforms such as terraces, shorelines, geologic units, etc.)."*

IGES is unaware of any paleoseismic studies that pertain to similar geologic conditions as found in this investigation, but rather the conclusion of fault inactivity is by way of taking all of the geologic data collectively through the application of the geological principles of cross-cutting relationships and uniformitarianism.

Regarding the additional recommendations from SA, IGES reviewed aerial photographs, conducting surface observations, and reviewing the USGS Quaternary Fault and Fold Database of the United States prior to the submittal of the September 23, 2015 letter; regrettably, this information was not incorporated into our response. Prior to undertaking the fieldwork for this investigation, IGES reviewed the Western GeoLogic report for the area (Western GeoLogic, 2012), in which aerial photographs were analyzed and no faults were identified. Additionally, the USGS Quaternary Fault and Fold Database of the United States was reviewed, with the closest fault to the area of investigation being approximately 2.5 miles to the southwest. IGES also analyzed current and historic Google Earth imagery for the area, and did not identify any surficial features relating to faulting in the area. Finally, surface observations were made during the field investigation, and no surficial expression of the faults were found except in the road cut north of the planned development.

Closure

We appreciate the opportunity to provide you with our services. If you have any questions please contact the undersigned at your convenience (801) 748-4044.

Respectfully Submitted,
IGES, Inc.

Reviewed by:

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Engineering Geologist

Attachments:

References

References

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