United States Department of the Interior

U.S. GEOLOGICAL SURVEY

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Friday, December 12, 2014

Bob McLaurin
Town of Jackson
PO Box 1687
150 East Pearl Avenue
Jackson, WY 83001

Dear Mr. McLaurin:

At the invitation of the Wyoming State Geologist, Tom Drean, we, Rex Baum and Jonathan Godt, visited the site of the Budge Drive landslide on November 18, 2014. The purpose of the visit was to observe the landslide and review geological and geotechnical data collected so far by the Town of Jackson and its consultants and to identify any significant hazards not yet recognized or addressed by ongoing investigations. Mr. Wallace Ulrich and Mr. Jason Rolfe led us on a tour of the site during the morning of Nov. 18. Mr. Ulrich provided electronic copies of documents describing results of investigations of the landslide by Landslide Technology[1] and by others; extensometer measurements made by Dr. Roger Bilham (Univ. of Colorado, Boulder); images of ground-based InSAR data collected by IDS Corporation; and displacement surveys, maps, and photographic images of the site. After making field observations we returned to our hotel for the afternoon to review the electronic data and reports in light of our observations. At the end of the day, we shared our observations and concerns about the site with Mr. Ulrich and Mr. Rolfe. As a result of our site visit and review of the data, we offer the following observations:

1. Based on our site visit and review of reports by Landslide Technology (2014a, 2014b) and other information, one potential slide scenario has not yet been analyzed. This scenario involves the potential failure of a small (perhaps 13,000–14,000 yd^3) secondary slide that includes most of the highly fractured eastern half of the currently active Budge Drive landslide.

2. The Budge Drive landslide mass is currently pervasively fractured and dilated, particularly at the steep face of the slide, which coincides approximately with the cut slope remaining from previous quarry operations at the site. Fracturing and dilation is present throughout the slide mass and along the entire face; however, fracturing is most intense in the east part of the slide. Dilated earth material such as this has the propensity to collapse and move rapidly, as demonstrated at other landslides (Fleming and others, 1989) and at the USGS experimental debris-flow flume

[1] Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

(Iverson and others, 2000). Other landslides, such as the Ferguson rock slide in northern California (Harp and others, 2008), showed potential for very rapid, catastrophic movement during episodes when parts of the slide accelerated following rainstorms, but the landslide subsequently stopped moving during drier times without failing catastrophically. Nevertheless, the possibility of rapid catastrophic collapse and outward movement remains whether induced by prolonged periods of wet weather, earthquake shaking, or other causes.

3. Based on observations of other landslides and the potential volume (13,000 yd^3) a secondary landslide calving off the steep face of the Budge Drive landslide could move about 300 to 400 ft, or perhaps farther. Volume is a primary factor in determining travel distance (Legros, 2002). Our travel-distance estimates are based on area-volume relationships for debris flows and rock avalanches determined by Griswold and Iverson (2007). Two possible inundation areas are depicted in Figure 1: one scenario assumes that the landslide deposit fills or overruns the current Walgreens building (red hachured area) and the other scenario assumes that the moving material flows around the building (yellow hachured area). The section of the small building to the east of the Walgreens within the yellow hachured area coincides approximately with the covered parking area of that building, which is open on the side facing the current Budge Drive landslide and therefore not likely to deflect moving landslide debris.

4. The ongoing movement of the Budge Drive landslide may be increasing the potential for the secondary landslide scenario described above, by continuing to dilate the slide mass and steepen the landslide face. According to a summary of measurements recorded by extensometers at the site (Bilham, 2014), movement and spreading of the slide mass was still ongoing at the time of our field visit on Nov. 18.

5. The potential for very rapid movement of the eastern section is likely greater during snowmelt, but we cannot rule out the possibility of rapid movement at other times. Some remedial measures considered by the engineers from Landslide Technology for the purpose of improving the stability of the active Budge Drive slide mass, particularly those that reduce the load at the top of the landslide face or provide additional support for the face, might help reduce the potential for the secondary landslide scenario we have described above.

6. Reliable early warning for the secondary landslide scenario described above is probably not practical due to the short travel distances involved, the potential for rapid movement, and the lack of suitable decision criteria. Nevertheless, continuous InSAR or robotic total station monitoring might provide some added insight to the changing stability of the slide face. Instrumentation would need to be positioned in close enough proximity to the face to provide detailed observations across the face.

7. Assessing the probability of the secondary landslide scenario described above is difficult. We are unaware of any local historical or geological evidence for rapid, catastrophic movement of the particular materials exposed at the surface or revealed in boreholes (Landslide Technology, 2014b) at the site. However, stability analysis taking account of the fractured and dilated nature of the landslide mass, likely failure modes, and possible triggering conditions may help assess the likelihood of this scenario. For example, fracturing has greatly reduced the bulk cohesive strength of materials at the steep face of the landslide mass. Sliding, toppling, or other modes of motion seem possible. Earthquake shaking or elevated groundwater conditions (including water-filled cracks) resulting from snowmelt or rain, and over steepening of the steep landslide face due to continued movement are possible triggering conditions. We cannot rule out the possibility that the dilated mass could move rapidly without any apparent trigger.

Please feel free to contact us with questions about our observations or if we can be of further assistance in this matter.

Sincerely,

Jonathan W. Godt, Ph.D.
Coordinator, Landslide Hazards Program

Rex L. Baum, Ph.D.
Supervisory Research Geologist

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Figure 1. Map showing approximate extent of deposits from potential secondary landslide. (Orthophoto image of active landslide area courtesy of Jason Rolfe, of Tributary Environmental, Jackson, Wyoming)