MEMORANDUM

To: Laura Vaugeois – Forest Practices
Karl Wegmann - Geology

From: Bill Lingley – Geology

Date: June 18, 2004

Subject: Mass Wasting Assessment Report, Boulder River, French Creek, and Squire Creek watershed analysis – Landslide Hazard Zonation Project: Priority 1 Review

Summary

Shaw (2004) presents an important discussion of landslide hazards in the Boulder River, French Creek, and Squire Creek watershed, which has important applicability elsewhere in Washington. Although several deep-seated landslides and a few small shallow-rapid failures have been newly identified, the watershed analysis is thorough and employs the same organization currently used for Priority 2 - Landslide Hazard Zonation Project studies. Shaw documents some impacts of a large catastrophic landslide, the effects of alpine weathering processes on delivery, and a reduction in the volume of management-related delivery over time. Four large landslides in glacial sediments that appear to be moving in response to groundwater recharge are not described in detail, but Shaw rates this terrace has having moderate overall hazard consistent with my assessment. Shaw's report should be sent out for final external review.

Introduction

This memorandum has been prepared as part of the Landslide Hazard Zonation project (Vaugeois and others, 2002) and follows the protocol for Priority #1 Watershed Review developed by you (Wegmann and Vaugeois, 2003). These reviews are spot checks covering watershed analyses that are nearly complete, and primarily address State and fee lands within these watersheds.

The Boulder River, French Creek, and Squire Creek Watershed Analysis (Shaw, 2004) has been completed, except for final editing, external review, and prescriptions. The southern portion of the watershed is entirely federal ownership and therefore not included in this analysis.

Methods

Findings from the Landslide Hazard Assessment for the Boulder River, French Creek, and Squire Creek WAU were compared with mass wasting interpretations derived from DNR color photo Set NW-C-83 and DNR black and white ortho-photograph set NWH-98 covering most of the watershed and DNR color photo set NW-C-01 covering about half of the watershed. The newly identified and

modified landslides were mapped directly in ArcGIS by 'heads-up' digitizing of the landslides onto the 1998 ortho-photographs. A hillslope-shaded relief map derived from a USGS 10-meter digital elevation model (DEM) of the watershed aided in predicting areas of potential failure and in assisting with the delineation of Mass Wasting Map Units (MWMUs). Additional rule-identified unstable slopes including some inner gorges, convergent headwalls, and bedrock hollows were identified using topographic mapping (U.S. Geological Survey, 1966a-c). Following this work, I reviewed geologic mapping of the watershed (Tabor and others, 2002; Dragovich and others, 2002a, b; Dragovich and others, 2003) and compared the mass wasting map units and mapped landslides with geologic units. Garth Anderson of DNR's Northwest Region and I performed 1.5 days of fieldwork on June 14 and 15, 2004.

Key Questions

1. *Are the majority of landslides in the basin adequately identified?*

   Yes.

   Shaw (2004) identified 226 shallow rapid landslides and about 20 deep-seated failures in the entire watershed using nine photo sets acquired between 1942 and 2001. Of these, only a small percentage is present within the non-federal, northern part of the watershed. In addition, I identified 21 questionable to probable failures, twelve of which are very small and nine of which are subtle deep-seated features. (See map and attached spreadsheet.)

2. *Do the Mass Wasting Map Units (MWMUs) reflect reasonable assumptions based upon your review of the geology and landslides in the basin?*

   Yes.

   The author does a good job of delineating areas with potentially unstable slopes and assigning reasonable overall hazard ratings to each. However, there are two areas where slight modifications of the MWMUs have been recommended to the author. These are:

   a) Large landslides on the prominent terrace having an upper elevation of about 900-feet (See Lingley, 2004a, b) are currently mapped as part of Shaw's MWMU10. Four of these (I.D.s 1005, 1006, 1007, and 1010) appear to be active with freshly exposed glacial sand cropping out on steep the headscarps. The juxtaposition of this sand over poorly-permeable glacial lacustrine clay creates groundwater-recharge slope instability issues for these deep-seated landslides. For this reason, I would recommend additional explanatory text in the final watershed analysis and in descriptions of this mass wasting map unit.
   b) MWMU 10 should be expanded to cover glacial deposits north of Browns Creek and south of the Darrington town site where at least two relict landslides have formed, possibly in response to groundwater recharge in the glacial ice-margin deposits.

3. *Are the hazard ratings assigned to the Mass Wasting Map Units reinforced by the distribution of landslides as shown in the Landslide Inventory for the WAU?*

   Yes, except as note above.

Most of the study area is rated as “medium” and “Low” hazard, consistent with the low frequency of failures found below the elevation of alpine erosional processes. Shaw provides an interesting discussion of delivery, especially since her work is among the few studies that span both managed tree farms and wilderness, which has never been logged.

4. *Are there landforms that seem to have a large number of landslides, but no associated Mass Wasting Map Unit?*

No.

5. *Does the text describing the Mass Wasting Map Units do an adequate job in presenting the landform / geology information that a forester using this map would need to identify the features on the ground?*

Yes.

The report is thorough, very interesting, and informative. Because of the information on the impacts of catastrophic landslides, alpine erosion processes, and harvested areas versus lands that have never been logged, this report is highly recommended to geologists and forest managers with interest in the impacts of slope stability on sediment delivery.

However, I have two suggestions that might improve the report. First, the presence of glacial lacustrine clay at the base of the prominent terrace capped with glacial poorly graded outwash sand indicates groundwater recharge hydrology may trigger/reactivate terrace margin failures. These failures are geologically identical to the Hazel landslide, a failure commonly cited as a noteworthy example of recurrent motion owing to groundwater-recharge. Because such conditions can be rule-identified unstable landforms, a description of the potential for this trigger mechanism should be addressed. Secondly, the MWMU descriptions are couched in technical geological language. While this detail will assist engineering geologists in gaining detailed knowledge of the watershed, it will probably make the text difficult for use by foresters.

6. Are there additions to the mass wasting assessment products?

Yes.

A map showing the 17 new landslides is attached. This map also shows six failures mapped by Shaw that I recommend modifying and the proposed modification to MWMU10 near Brown’s Creek. The existing landslides in the LSI coverage are also shown; these were confirmed in the field during this study. A Mass Wasting Inventory Data spreadsheet (Form A-1) is attached.

7. Is this mass wasting assessment: (1) Acceptable as is, (2) acceptable with revisions, (3) not acceptable?

The Boulder River, French Creek, and Squire Creek mass wasting assessment is acceptable with the revisions noted above. These have been forwarded to Susan Shaw.

References

Dragovich, Joe D.; Gilbertson, Lea A.; Lingley, William S., Jr.; Polenz, Michael; Glenn, Jennifer, 2002a, Geologic map of the Darrington 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2002-7, 1 sheet, scale 1:24,000.

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Lingley, W. S., Jr., 2004a *(DRAFT)* Mass Wasting Module, Level II Assessment: Jackman – Corkindale Creeks watersheds, Calawah County, Washington, Washington Department of Natural Resources, Olympia, Washington 2 maps, 10 Figs. 46 p.

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Shaw, Susan C. 2004, draft Mass Wasting Assessment Report, Boulder River, French Creek, and Squire Creek watershed analysis module, report prepared for the Stilliguamish Tribe of Indians, Stevenson. 68 p. 1 pl.

U.S. Geological Survey, 1966a, Washington Darrington quadrangle; U.S. Geological Survey Map, 1 sheet, scale 1:24,000.

U.S. Geological Survey, 1966b, Washington Fortson quadrangle; U.S. Geological Survey Map, 1 sheet, scale 1:24,000.

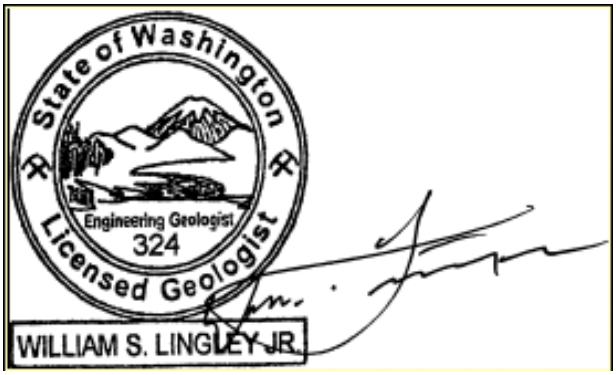
U.S. Geological Survey, 1966c, Washington Mount Higgins quadrangle; U.S. Geological Survey Map, 1 sheet, scale 1:24,000.

Tabor, R. W.; Frizzell, V. A., Jr.; Booth, D. B.; Waitt, R. B., 2000, Geologic map of the Sauk River 60-minute quadrangle, Washington: U.S. Geological Survey Geologic Investigations Series Map I-2538, 1 sheet, scale 1:100,000, with 57 p. text.

Vaugeois, Laura, Dieu, Julie, Raines, Mary, 2002, Landslide Hazard Zonation – Project status report and proposal. Draft report submitted to the Cooperative Evaluation, Monitoring, and Research Committee, Washington Department of Natural Resources, 38 p.

Wegmann, Karl, Vaugeois, Laura, 2003, written communication, July 15, 2003 -- Landslide Hazard Zonation project, protocol for priority # 1 watersheds; Department of Natural Resources, Division of Geology and Earth Resources.

Respectfully submitted,



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Nancy Sturhan – Forest Practices