


December 6, 2006

TO: J. Nisbet, Olympic Region Maintenance Operations, MS-47440

FROM:  T.M. Allen / D.A. Anderson
OSC Materials Laboratory MS: 47365
Geotechnical Services Division
Fax: (360) 709-5585

SUBJECT: SR 101, C.S. 2301, Vicinity MP 338.2, DMC-101
Debris Flow Assessment and Geotechnical Recommendations

INTRODUCTION

At your request, we have conducted a geotechnical assessment at the site of a debris flow that blocked both travel lanes in the vicinity of MP 338.2 on SR 101 (Figure 1). It is our understanding from Maintenance that a debris flow originating upslope of the highway deposited approximately 400 cubic yards of soil and woody debris on the highway on November 6, 2006 (Figure 2). Maintenance attempted to reopen the outer, northbound lane on this day, but another, smaller-volume debris flow initiated from the upslope area and covered the northbound lane of the highway again. Attempts to reopen the road were abandoned at this time and a request for a thorough geotechnical assessment was made by Olympic Region Maintenance.

The site of this debris flow is not currently listed in the WSDOT - Unstable Slope Management System (USMS) database.

GEOTECHNICAL ASSESSMENT

Our geotechnical assessment consisted of two separate field visits. During our initial field visit on November 6, 2006, we took photographs of the site and determined that the inclement weather combined with the unstable slope conditions were not safe for an upslope assessment.

The following afternoon the weather cleared and we conducted a thorough reconnaissance of the site. Our assessment included taking additional photographs, interviewing Maintenance, and traversing the upper slope area.

SITE CONDITIONS AND OBSERVATIONS

The debris flow event impacted SR 101 about 100 feet north of the Sunnyside Road junction. As shown in Figure 2, SR 101 traverses along the base of steep slopes on the northern edge of

the Skokomish River flood plain. Based on our field observations and published geologic mapping in the area, the steep slopes to the west of the highway are primarily composed of interbedded alpine glacial deposits ranging from pre- to late-Wisconsinan in age (70,000 to 20,000 years ago) and Quaternary-aged (1.8 million years ago to present) landslide deposits near the base of the steep slopes (Figure 3). The area immediately east of the highway is comprised of Quaternary-aged alluvial deposits (Logan, R.L., 2003). The glacial deposits that comprise the steep slope are described by Logan as stratified sand, gravels, and cobbles with a gray to yellowish-orange appearance that includes discontinuous layers of silt, clay, and peat.

As illustrated in Figure 3, the debris flows initiated on the northern edge of an older landslide deposit, approximately 500 feet upslope of the highway in a confined channel with an average slope between 35 and 40 degrees. In Figure 4, springs can be seen emitting from the upper slope area on a silty clay layer in the slope. Upon closer examination, a number of springs were observed emitting from this geologic contact as it slightly dipped to the north.

As we field reviewed the upslope areas surrounding the debris flow initiation zone, we found two areas where the slope partially failed. These detached masses had fresh, open tension cracks, the trees were leaning backwards (uphill), and the spring-line ran behind the detached blocks. The detached blocks are approximately identified in Figures 5 and 6. We estimate the volume of the detached masses to be on the order of approximately 500 cubic yards.

DISCUSSIONS AND RECOMMENDATIONS

This memorandum presents a chronology of the short-term geotechnical input and Region decisions, and provides the Region with conceptual alternatives for possible long-term mitigation of this debris flow site.

Short-Term

The highway was closed from the debris flow events on November 6, 2006. Inclement weather and continued slope instability kept us from performing a thorough field reconnaissance until the heavy-precipitation event waned on the afternoon of November 7, 2006. During the field reconnaissance, we identified two partially detached masses in the upper slope area immediately adjacent to the recent debris flow initiation zone, so we recommended that the Region forego highway clean-up activities and maintain the current detour to allow some time for possible failure to occur. The Region maintained the roadway closure, but Maintenance decided to establish erosion control and improve site drainage on Thursday, November 9, 2006.

Another heavy-precipitation storm event occurred over the weekend and no additional upslope failures were noted through Monday, November 13, 2006. With geotechnical input, the Region decided to schedule cleanup activities for November 14, 2006 and reopen the highway in the late-afternoon with 24-hour monitoring at the site. A light plant was brought in to view the upslope area during the dark night-time hours.

Another heavy precipitation event occurred from Friday, November 17 through Sunday, November 19, 2006. No additional upslope failures were noted through November 20, 2006. With more geotechnical input, the Region decided to scale back monitoring of the site to more frequent patrols in the area during heavy-precipitation events until slope conditions changed.

It is our understanding, from speaking with local Maintenance personnel, that no additional material has failed from the upslope area to-date.

Long-Term Considerations and Recommendations

We recommend that the Region rate this unstable slope and enter the appropriate information into the USMS database for programming prioritization and possible P3-Unstable Slope funding.

Poor equipment access and right-of-way constraints on the steep slopes to the west of the highway and a large wetland immediately east of the highway limits the possible alternatives for mitigating this unstable slope. Based on these constraints, we believe removal of the detached masses in the upslope area or construction of a debris flow containment structure adjacent to the highway should be considered for long-term mitigation at this site.

Alternative A:

We recommend that removal of the detached masses be accomplished from the side and above the debris flow source area. Pioneering and excavating immediately below the detached masses in Figures 5 and 6 should not be planned or undertaken. This mitigation option will require access agreements with adjacent property owners since we would be working outside of our right-of-way.

Alternative B:

The other alternative would be to construct a debris flow containment structure similar to those shown in Figures 7 and 8. It appears that a containment structure can be placed within our right-of-way across the debris flow chute. We estimate that the structure will need to be about 75 feet long to contain future debris flow events. The structure should be designed to contain a 500 cubic yard debris flow event.

Figure 7 shows a soldier-pile wall with wood-lagging that was constructed for the SR 101 MP 322.3 Vicinity Slide repair. Contract 5764 or Contract 5894 should be used to estimate the costs associated with this type of structure. The debris flow fence shown in Figure 8 was constructed for the SR 4 Germany Creek Rockfall and Debris Flow Mitigation project. Contract C6414 should be used to estimate the costs associated with this type of structure.

REFERENCES

Logan, R.L., 2003. Geologic Map of the Shelton 1:100,000 Quadrangle, Washington. Washington Division of Geology and Earth Sciences Open File Report 2003-15.

If you have questions regarding the information presented in this memorandum, then please contact Doug Anderson at (360) 709-5427 or Steve Lowell at (360) 709-5460.

TMA:daa

cc: Bryan Dias, Olympic Region Materials, MS 47440
Joyce Komac, Port Orchard Maintenance, WB-18
Larry Deemer, Hood Canal Maintenance, WB-18

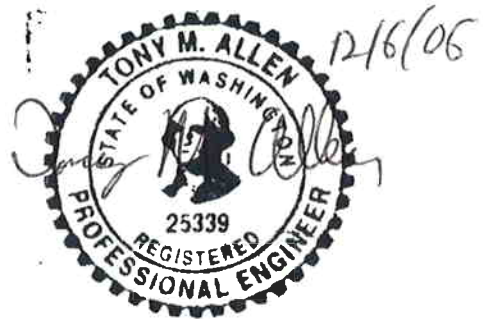


Prepared by:
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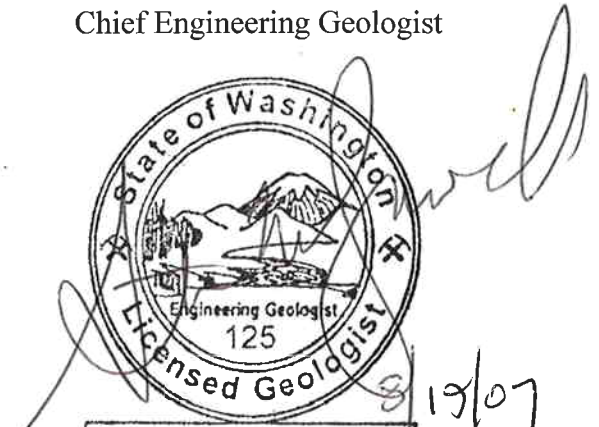
DOUGLAS A. ANDERSON

Agency Approving Authority:
TONY M. ALLEN, P.E.
State Geotechnical Engineer



EXPIRES 07-01-07

Technical Review By:
STEVEN M. LOWELL, L.E.G.
Chief Engineering Geologist



STEVE M LOWELL



Figure 2. A photo taken looking north on SR 101 on November 6, 2006. Approximately 400 cubic yards of material was deposited by a debris flow on SR 101, resulting in the closure of both lanes near Sunnyside Road.

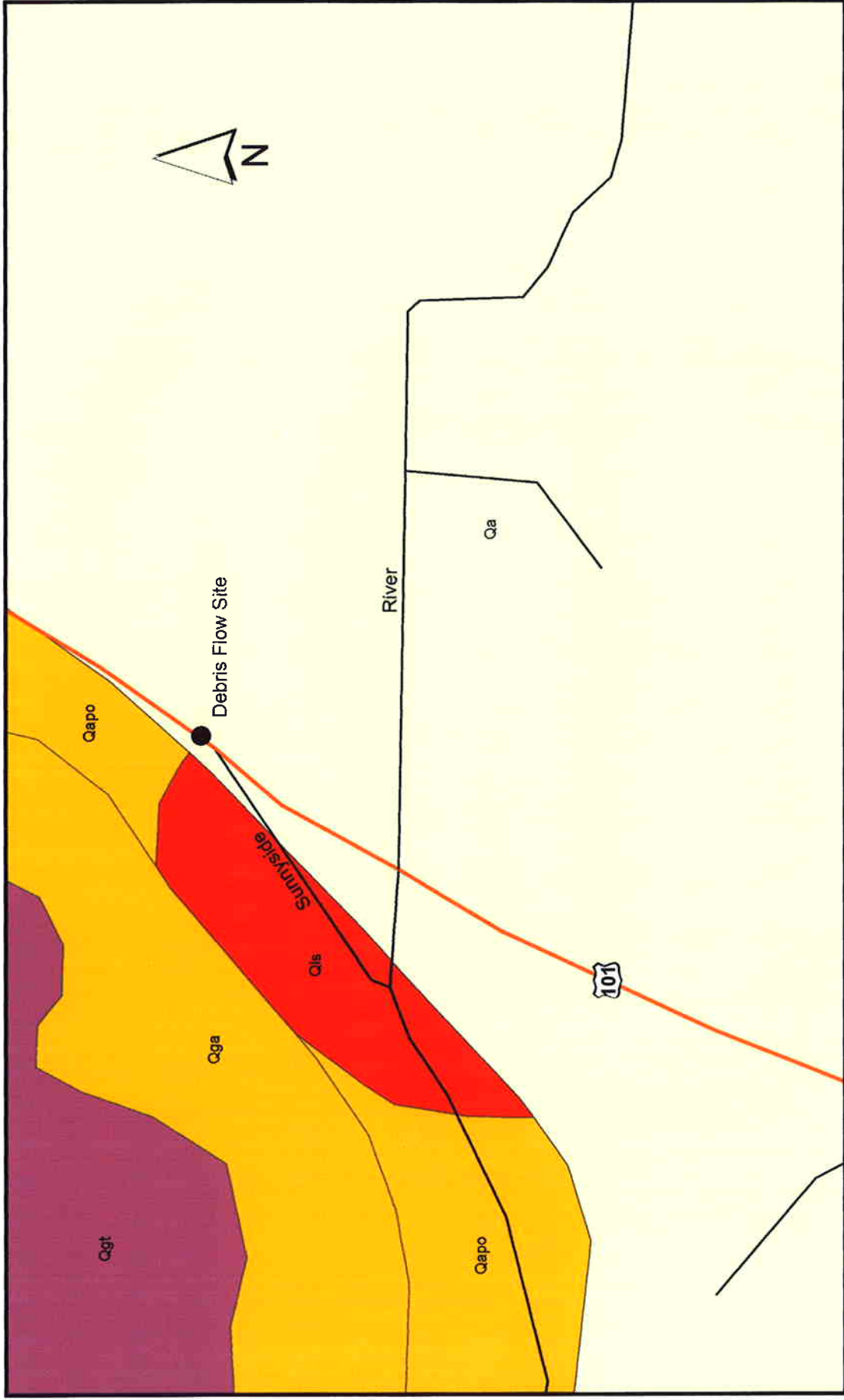


Figure 3

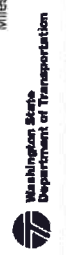
**SR 101 Vicinity MP 338.2
Debris Flow Site**

DMC-101
Date: November 2006

Geologic Units

- Alluvial Deposits (Qa)
- Alpine Glacial Deposits (Qga; Qapo)
- Glacial Till Deposit (Qgt)
- Landslide Deposit (Qls)

Data Source: Logan, P.L., 2002, Geologic Map of the Shewton
1:100,000 Quadrangle, Washington, WDGER-CFR 2003-15.
Produced by -dca



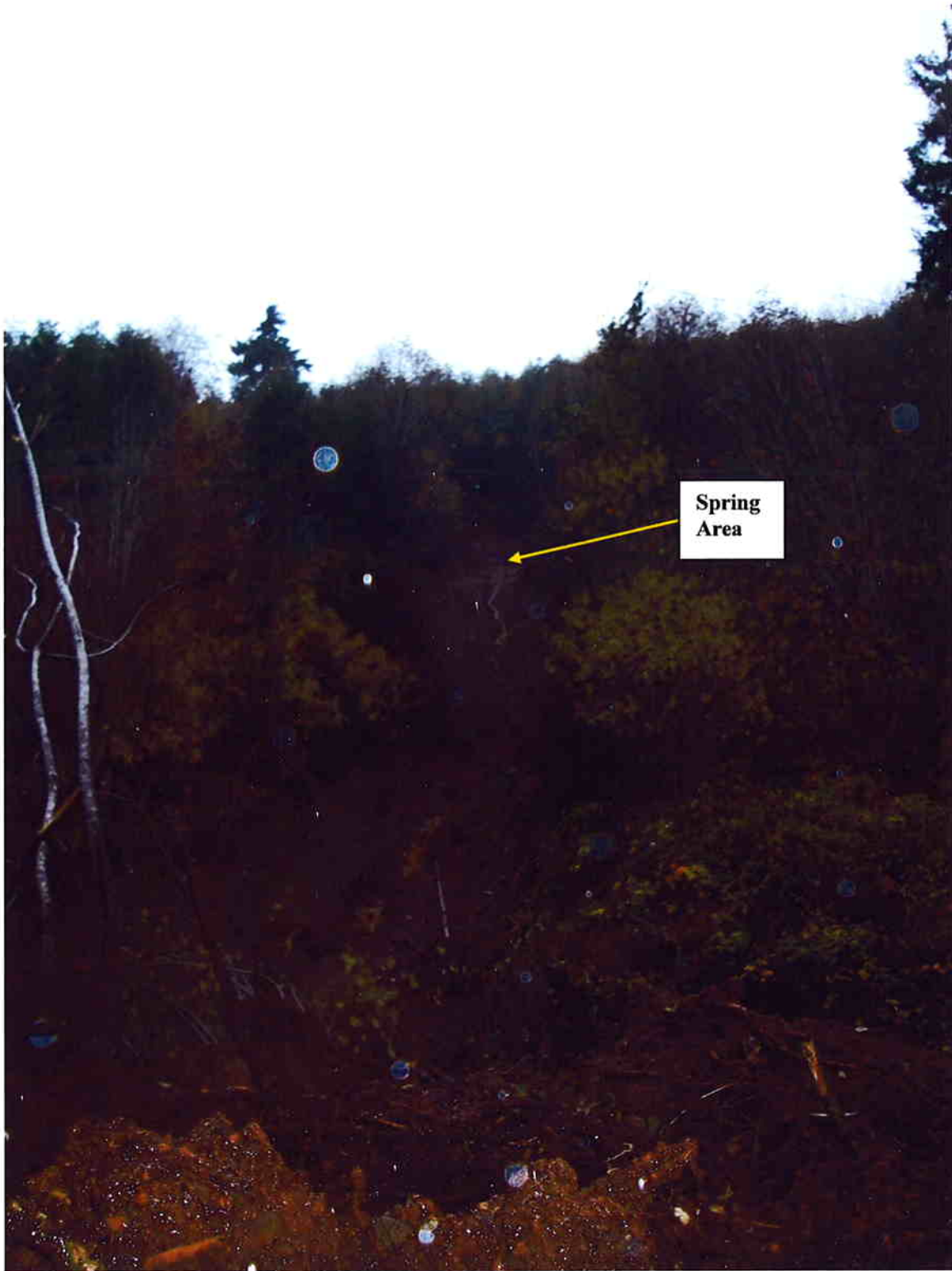


Figure 4. A photo taken from SR 101 looking at the initiation area and the path of the debris flow. Notice the springs emitting from the upper slope area.

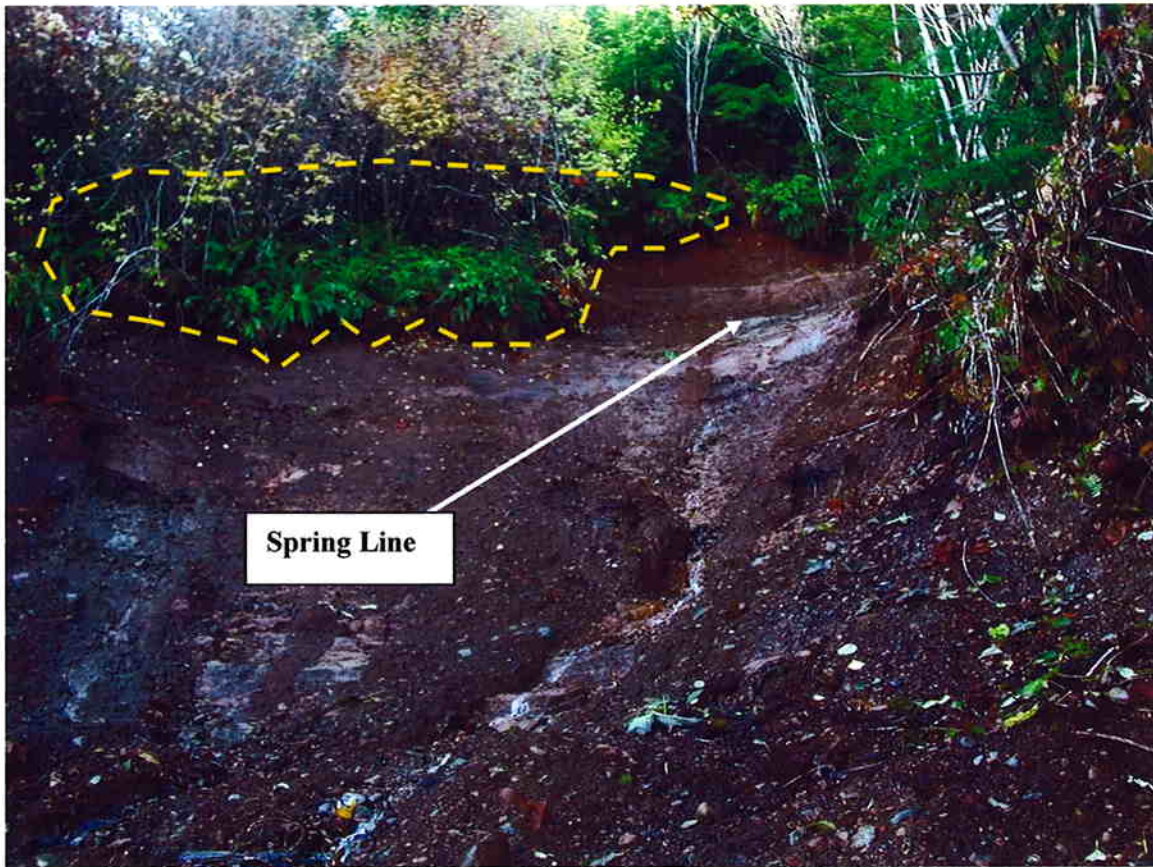


Figure 5. A photo of the detached mass to the left of the debris flow failure scar. The dashed, yellow polygon approximates the area of the southern detached mass.



Figure 6. A photo taken from the highway looking up the debris flow chute on November 14, 2006 during road clean-up activities. We have approximated the area of the northern detached mass with a dashed, yellow polygon.



Figure 7. A photo of the soldier-pile wall option for containing debris flows.



Figure 8. A photo of a typical debris flow fence constructed on SR 4.