



**DEPARTMENT OF
NATURAL RESOURCES**

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October 12, 2021

TO: Sam Lake, Forester, Black Hills District, South Puget Sound Region
Jacob Gross, Engineer, Black Hills District, South Puget Sound Region

FROM: Susie Wisehart, LEG #20120267, Forest Resources Division

SUBJECT: Geologic Field Summary for the Sentinel Timber Harvest, Thurston County, Washington

This letter documents my observations of potentially unstable slopes around the Sentinel timber sale during field reconnaissance on October 29, 2020 with Dee Dee Korsikas-Fogg, State Lands Forester; Sam Lake, State Lands Forester; Susie Wisehart, State Lands Licensed Engineering Geologist (LEG) and Qualified Expert; and on November 17, 2020 by Susie Wisehart.

This letter documents my landform interpretations, the key observations that I used to make those interpretations, and the mitigation options we discussed. This letter is not intended to document the full scope of the geologic review that I conducted for this sale, nor is it intended to satisfy the requirements for a Class IV-Special Forest Practices Application. I conclude that the proposed forest management activities exclude all Forest Practices potentially unstable slopes and landforms, commonly referred to as rule-identified landforms (RILs).¹

Prior to the field visits, I conducted a remote review using Washington State Department of Natural Resources (DNR) GIS data including:

- Digital orthophotographs from 1958, 1990-2000, 2006, 2008, 2009, 2011, 2013, 2015, and 2017.
- 1-meter resolution light detection and ranging (lidar) data acquired in 2011.
- Digital 1:100,000-scale geologic map.²
- Forest Practices Landslide Inventory layer, which was not available in this area.
- Spatial timber sale data from South Puget Sound Region personnel.

Category E Rule-identified landforms: Recent shallow landslides

We field reviewed seven recent shallow failures, which meet Category E RIL criteria (Figure 1). These landslides and the mitigation options we discussed are described by unit below.

¹ WAC 222-16-050 (1)(d)(i).

² Logan, Robert L., compiler, 1987, Geologic map of the Chehalis River and Westport quadrangles, Washington: Washington Division of Geology and Earth Resources Open File Report 87-8, 16 p., 1 plate, scale 1:100,000.

Unit 1

SL-1 is approximately 45 feet wide, 4 feet thick, and 120 feet long (Figure 1, Sheet 1). I observed sword fern, exposed soil, and a lack of mature conifer. The B-1480 road below appeared to be clear of debris at the time of our visit. This landslide is bound out of the proposed harvest.

Unit 2

SL-2 and SL-3 occurred below a currently abandoned section of the C-4600 (Figure 1, Sheet 2). SL-2 is approximately 15 feet wide, 1.5 feet thick, and 40 feet long and occurred approximately 75 feet downslope of the road. We did not observe water in this failure. SL-3 is approximately 25 feet wide, 2 feet thick, and 30 feet long. This landslide delivered sediment to the stream below. I did not otherwise observe water in this landslide. SL-3 appeared to be a fill slope-related failure. These landslides have been bound out of the proposed timber harvest other than any trees removed for right-of-way above SL-3.

The road plan proposed reconstructing this stretch of the C-4600 road including the fill where SL-3 occurred. There is no culvert located here currently located or planned above these landslides.

Unit 3

SL-4 and SL-5 are fill slope failures off the currently active B-1500 road that appeared to occur from the historic 2007 rain-on-snow storm event (Figure 1, Sheet 3). SL-4 is approximately 35 feet wide, 5 feet thick, and 40 feet long. SL-5 is approximately 40 feet wide and 3 feet thick. I did not observe water in these landslides at the time of my visit. In the 2008 orthophotograph, SL-5 appears to have traveled approximately 1,600 feet downstream to and just beyond the B-1400 (Figure 2). These landslides have been bound out of the harvest. Additional leave trees are placed along the boundaries east and west of the landslides (Figure 1, Sheet 3).

I worked collaboratively with Jacob Gross, the State Lands Engineer to develop road plan mitigation measures. The road plan includes grading, shaping, and cleaning and reconstruction of ditches along the B-1500 road. The road will be moved into the slope approximately 2 to 3 feet to avoid these failures. There is no culvert currently located or planned above these failures. The forester will include a note to the contract administrator to monitor this road during wet conditions. The State Lands heavy equipment crew may complete some of this road work prior to the sale. In this case, I recommend the State Lands Forester or Engineer monitor any work in wet conditions.

Unit 4

SL-6 is a fill slope failure off the currently active B-1000 road (Figure 1, Sheet 4). SL-6 is approximately 4 feet wide, 1 foot deep, 7 feet long, and did not appear to deliver sediment to the stream below. Although dry at the time of my visit, I observed a subtle depression and rilling in the road grade. I interpret this to be from water flowing down the B-1000/B-1500 Y-intersection, across the B-1000, over this fill.

SL-7 is another fill slope failure off the B-1000 road (Figure 1, Sheet 4). SL-7 is approximately 20 feet wide, 5 feet deep, and 75 feet long. This failure occurred at a culvert outlet and a second initiation occurred downslope where a Type 5/NS stream initiates approximately 15 feet below the fill. Approximately 4 to 5 trees will be cut above SL-7 to allow for safe operational space while reconstructing the fill. Below these upper right-of-way trees, the landslide initiation and runout area below the existing fill is protected with a non-tradeable leave tree area.

I worked collaboratively with Jacob Gross, the State Lands Engineer to develop road plan mitigation measures along this stretch of the B-1500 and B-1000. The road plan includes ditching, re-grading, and adding an extra cross-drain on the B-1500 to reduce water running down to the Y-intersection above SL-6 (Figure 1, Sheet 4). The State Lands heavy equipment crew may complete some of this work prior to the sale. In this case, I recommend the State Lands Forester or Engineer monitor any work in wet conditions.

Above SL-7, the road plan includes reconstructing the fill and replacing the pipe with a 24-inch diameter, 50-foot long pipe above SL-7. The reconstructed fill will be comprised of rip rap and topped with quarry spalls. The rip rap will serve as an energy dissipater at the culvert outlet, reducing the likelihood of future fill slope failures. The grade above will become a landing area for the unit. The ditch area here contains the Type 5/NS stream that appears to go subsurface below the road and initiates again approximately 15 feet below the fill slope. Installing the new pipe at a steeper angle will help identify the subsurface water and capture this stream thereby helping prevent saturation of the road prism. The timber sale includes logging restrictions to dry seasons to help protect the Type 5/NS stream.

Non-rule-identified, bedrock deep-seated landslides

I verified one relict, bedrock deep-seated landslide in and around Unit 1 (DSL-1, Figure 1, Sheet 1). My observations included:

- Planar to convergent, well vegetated headscarp.
- Vague, but distinguishable margins.
- Distinct break in slope from foot to toe of DSL. Bottom of toe was difficult to distinguish in the field.
- An approximately 1,000-foot stretch toe slopes 65 percent and steeper on DSL-1 (Figure 1, Sheet 1). These slopes are considered rule-identified landforms and they have been bound out of the proposed harvest.
- Rolling, smooth topography.
- Straight mature conifer and upright old growth stumps.
- Reddish brown sandy silt to silty sand soil and subangular gravel in float (Crescent basalt bedrock-derived soil and bedrock clasts).

I also verified one dormant-indistinct deep-seated landslide west of Unit 1 (DSL-2, Figure 1, Sheet 1). My observations include:

- Broadly convergent bowl-shape.
- Smooth, vegetated headscarp.
- Lateral margins and divergent toe.
- Relatively old alder on body where the ground appears to be wetter. Straight mature conifer on toe.
- Lack of old growth stumps.
- Lack of evidence of recent movement such as tension cracks, sag ponds, or pistol-butted trees.
- Reddish brown sandy silt to silty sand soil and subangular gravel in float (Crescent basalt bedrock and bedrock-derived soil).

Because I interpret these deep-seated landslides as dormant-indistinct to relict and bedrock, they are not considered rule-identified landforms. Unit 1 overlaps the upper portion of DSL-1 and excludes the

toe slopes 65 percent and steeper. Unit 1 overlaps the bottom portion of DSL-2 and a leave tree area is located on the upper portion of the landslide.

Inner gorges

There are inner gorge slopes on stream side slopes 70 percent and steeper around the proposed harvest units (Figure 1). These are captured within riparian management zones or bound out of the harvest.

Road work will remain in existing road prisms. Reconstruction of the C-4600 road will require adding fill to re-establish a crossing northeast of Unit 2 (Figure 1, Sheet 2). I confirmed in the field that the adjacent slopes are 55-65 percent steep and do not meet inner gorge criteria in the proposed crossing location. Downstream, the southwest slopes become slightly steeper and likely become an asymmetrical inner gorge. I did not observe evidence of recent debris flows through this area and large subangular cobbles appeared to armor the stream and side slopes. Therefore, I do not interpret the proposed crossing reconstruction to be crossing a rule-identified landform.

Limitations

This memorandum is intended to summarize landform interpretations in and around the proposed Sentinel timber harvest to DNR's foresters and to document licensed engineering geologist involvement in the timber sale and road plan mitigation measures. The conclusions presented in this memorandum are based on professional judgement and do not guarantee slope stability or absolute absence of risk. In addition, conclusions were developed using limited information including office-based screening tools and surficial geologic observations at the locations visited as they existed at the time of review. This review also included limited shallow hand-dug test pits and geologic exposures in the area reviewed, but does not include deeper subsurface exploration such as borehole drilling. Actual geologic conditions may differ from those presented in this report. Site conditions can change with time and additional relevant information may become available. If this occurs, geologic interpretations and recommendations may require modification. It is not possible to fully define the geologic conditions of the site based on this limited investigation; however, the work was performed using generally accepted practices in the field of engineering geology in the region at the time of this report. It is not possible to predict slope movement with certainty with the available scientific knowledge.

Do not rely on the interpretations or conclusions presented in this memorandum for any activities other than those evaluated for the proposed Sentinel timber harvest. If any changes in the proposed FPA or road plan are formulated or carried out differently in the field than what was evaluated, conclusions and recommendations shall not be considered valid unless those changes are reviewed in writing by the author. No one other than the DNR should rely on this report.

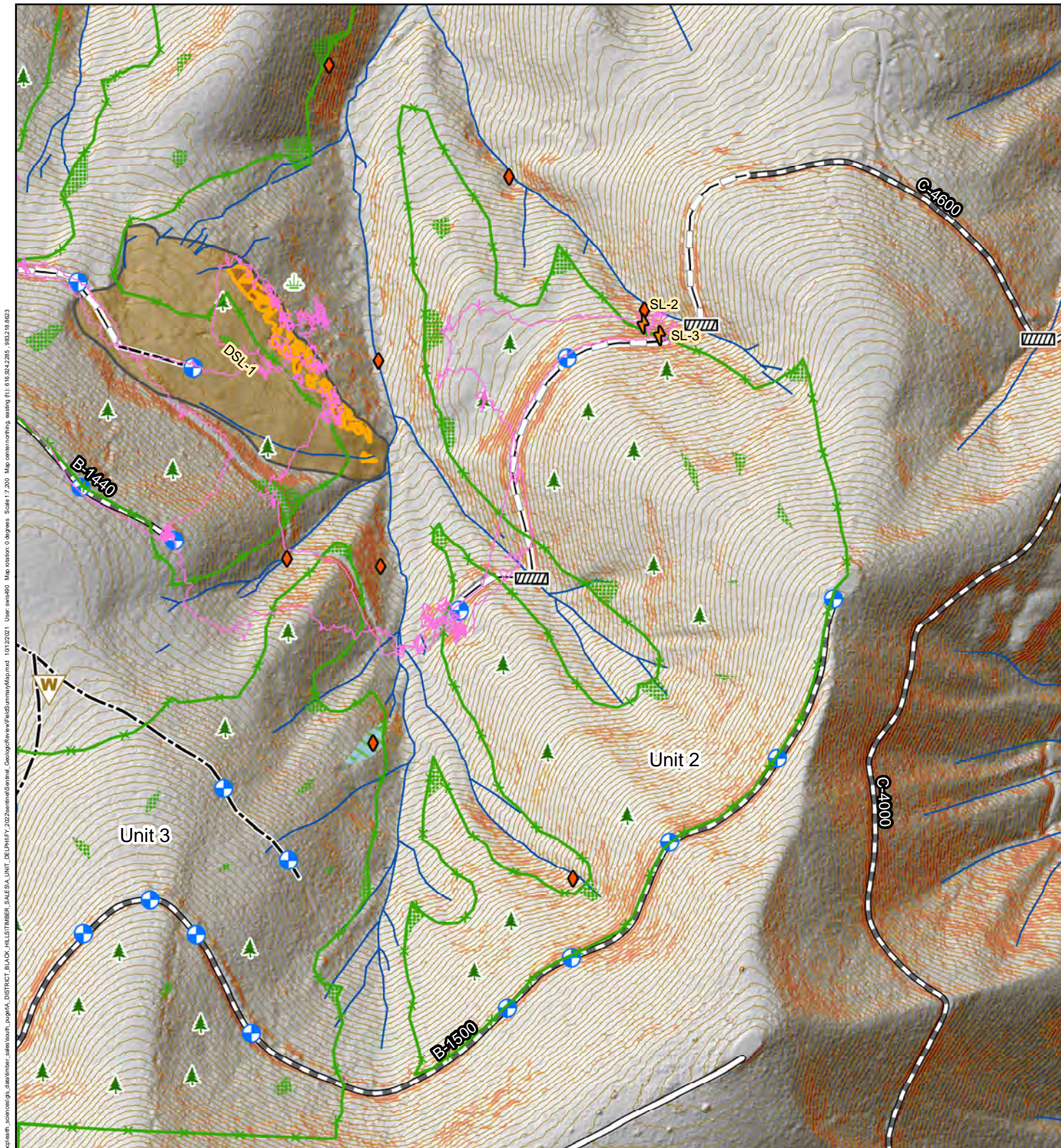
ATTACHMENTS:

Figure 1: Geologic Field Summary Map (4 sheets)

Figure 2: 2008 Orthophotograph



Susan Wisehart, LEG #20120267
State Lands Geologist
Earth Sciences Program
Forest Resources Division



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Note: 1-m Lidar acquired in 2011.

Harvest Unit Boundaries Leave Tree Area Non-tradeable Leave Tree Area Leave Tree Area < 1/4-acre Culvert Landing - Proposed	Waste Area Wetland Mgt Zone Existing Roads Optional Construction Optional Reconstruction Required Pre-Haul Maintenance	Forester-delineated streams Geologist Tracks Non-RIL bedrock deep-seated landslide Rule-identified landforms Inner gorges	Rule-identified landform Toe of DSL >65% Landslide Category E RIL: Recent shallow landslide 10-ft. contour	Slope Percent (rise over run) 0 - 64 65 - 69 70+	
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Fig. 1
Sheet 2 of 4

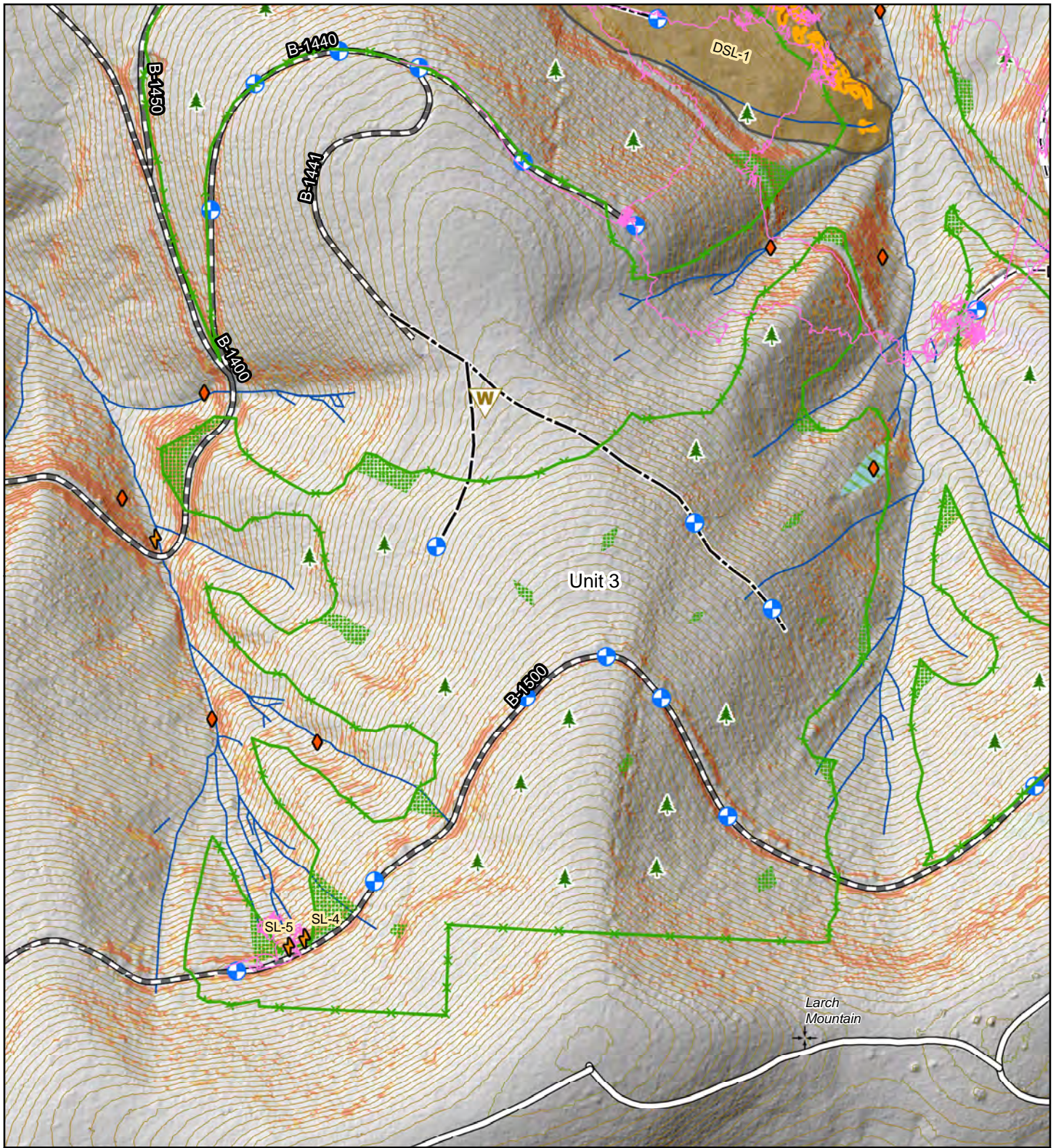
GEOLOGIC FIELD SUMMARY MAP
Sentinel

600 Ft. Scale 1:7,200

Washington State Department of Natural Resources



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Note: 1-m Lidar acquired in 2011.

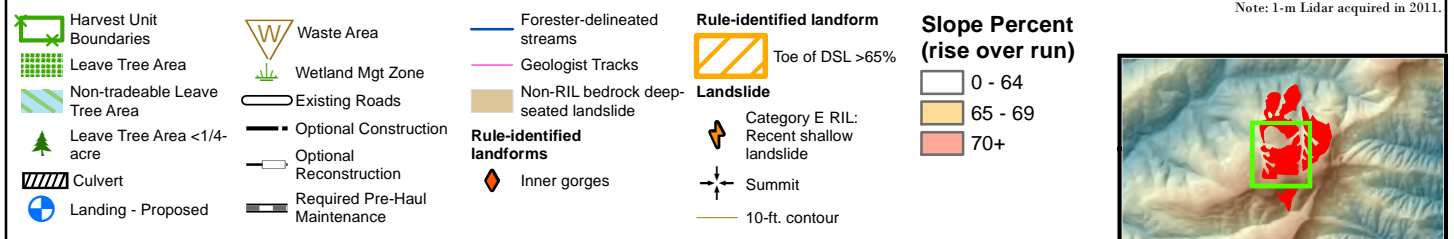


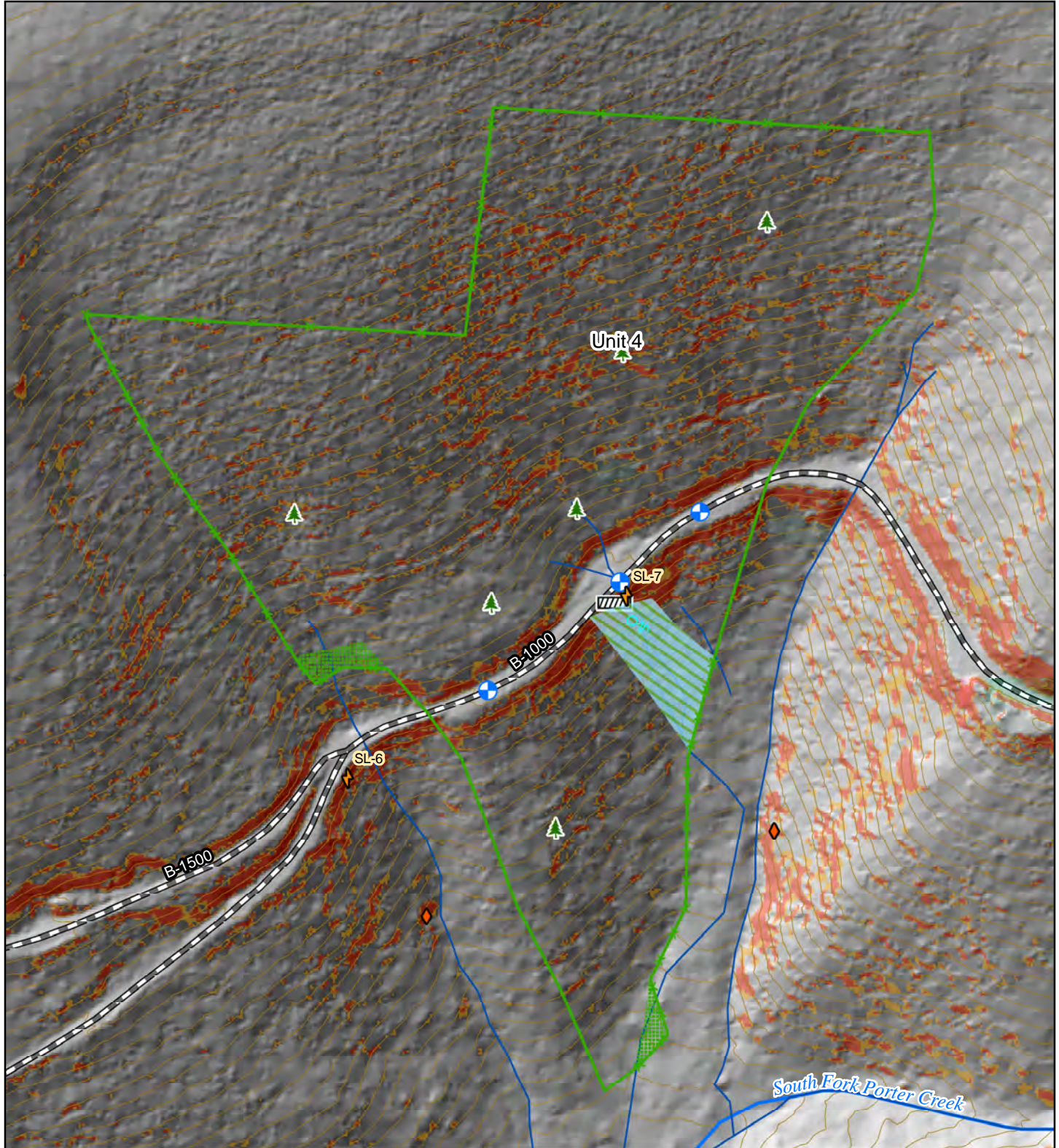
Fig. 1
Sheet 3 of 4

GEOLOGIC FIELD SUMMARY MAP
Sentinel

500 Ft. Scale 1:6,000



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Note: 1-m Lidar acquired in 2011.

<ul style="list-style-type: none"> Harvest Unit Boundaries Leave Tree Area Non-tradeable Leave Tree Area Leave Tree Area <1/4-acre Culvert 	<ul style="list-style-type: none"> Landing - Proposed Required Pre-Haul Maintenance Forester-delineated streams Rule-identified landforms Inner gorges 	Landslide <ul style="list-style-type: none"> Category E RIL: Recent shallow landslide Seepage Major Stream 10-ft. contour
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Fig. 1
Sheet 4 of 4

GEOLOGIC FIELD SUMMARY MAP
Sentinel

200 Ft.

Scale 1:2,400

Washington State Department of Natural Resources

