ICICLE CREEK ENGINEERS

Report of Geotechnical Services
Potentially Unstable Slopes and Landforms Evaluation
Hokanson Proposed Harvest Area (Unit 1 and Unit 2)
SW¼ Section 18, Township 34 North, Range 10 East
Rockport Area, Skagit County, Washington

November 22, 2024
ICE File No. 1319-007

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Prepared For:
Nielsen Brothers Inc.

Prepared By:
Icicle Creek Engineers, Inc.

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1.0 INTRODUCTION

This report presents the results of Icicle Creek Engineers' (ICE's) geotechnical services for an evaluation of Potentially Unstable Slopes and Landforms associated with the Hokanson Proposed Harvest Area (PHA; Unit 1 and Unit 2). The Hokanson PHA is owned by Nielsen Brothers Inc. (NBI) and is located in the southwest quarter of Section 18, Township 34 North, Range 10 East, Willamette Meridian, about 3.8 miles south-southeast of the community of Rockport. The location of the Hokanson PHA (Unit 1 and Unit 2) relative to nearby physical features is shown on the Vicinity Map, Figure 1. Unit 1 and Unit 2 are shown on the proposed Forest Practices Activity Maps (Unit 1 and Unit 2), Figures 2 and 3.

This report was prepared by Brian R. Beaman, PE, LEG, LHG of ICE. Mr. Beaman is a "Qualified Expert" (Washington State Department of Natural Resources - DNR Qualified Experts List, Engineering Geologist License No. 671) as described in WAC 222-10-030(5) SEPA Policies for Potentially Unstable Slopes and Landforms. Mr. Beaman is also licensed by the State of Washington as a Professional Engineer (PE), Engineering Geologist (LEG) and Hydrogeologist (LHG).

Sam Petska, Forester with NBI and Mr. Beaman completed a field review of the Hokanson PHA (Unit 1 and Unit 2) on July 9 and 11, 2024 as shown on the Field Review Route Map, Figure 4.

2.0 BACKGROUND INFORMATION

ICE reviewed the following information as part of this evaluation:

- Aspect Consulting (Aspect), June 24, 2024, *Preliminary Slope Evaluation Assessment, Project No. AS240329, Phase 1*, prepared for Alex Gray, Sauk River Estates, 11 pages.

- DNR, April 12, 2024 (received date), May 10, 2024 (approval date), Forest Practices Application/Notification No. 2819353, Hokanson Property, Unit 1, 18 pages.
- DNR, April 12, 2024 (received date), May 10, 2024 (approval date), Forest Practices Application/Notification No. 2819352, Gibson Property, Unit 2, 18 pages.
- DNR, August 21, 2023, *Chapter 222-10 WAC, State Environmental Policy Act Guidelines.*
- DNR, August 21, 2023, *Chapter 222-16 Washington Administrative Code (WAC), Definitions.*
- DNR, February 22, 2021, *Chapter 222-30 WAC, Timber Harvesting.*
- DNR, May 2016, *Forest Practices Board Manual, Section 16, Guidelines for Evaluating Potentially Unstable Slopes and Landforms*, 84 pages.
- DNR, Forest Practices Application Mapping Tool (FPAMT), https://fpamt.dnr.wa.gov/.
- DNR, Geologic Information Portal, regional geologic mapping and landslide compilations and inventory, http://www.dnr.wa.gov/geologyportal.
- DNR, GIS Data, Open Data, Climatology, http://data-wadnr.opendata.arcgis.com/.
- DNR, Geology GIS Data and Databases and Landslide Compilation/Inventory, https://www.dnr.wa.gov/programs-and-services/geology/publications-and-data/gis-data-and-databases.
- DNR, Washington LiDAR Portal, Light Detection and Ranging (LiDAR) Digital Terrain Model (DTM) raw data and hillshade image downloads, North Puget 2017 acquisition, http://lidarportal.dnr.wa.gov/.
- Environmental Systems Research Institute (Esri) ArcGIS version 10.6.0.8321, used to process the LiDAR raw DTM data for 2-, 5-, and 10-foot topographic contour intervals and slope inclination (45-, 55-, 70- and 100-percent grade).
- Google Earth, aerial photographs dated July 20, 2003, September 25, 2011 and July 25, 2019.
- NBI, April 11, 2024, *Forest Practices Activity Map, Township 34 North Range 10E, Section 18* (Unit 1).
- NBI, March 11, 2024, *Forest Practices Activity Map, Township 34 North Range 10E, Section 18* (Unit 2).
- US Forest Service (USFS), January 19, 1996, *Sauk Watershed Analysis*, 688 pages.
- US Geological Survey (USGS), 2002, *Geologic Map of the Sauk River 30- by 60-Minute Quadrangle, Washington*, Geologic Investigations Series I-2592.
- USGS EarthExplorer, http://earthexplorer.usgs.gov/, aerial photographs dated August 14, 1953, August 3, 1963 and August 10, 1972.
- Washington State Department of Ecology (Ecology), Washington State Well Report Viewer, https://appswr.ecology.wa.gov/wellconstruction/map/WCLSWebMap/default.aspx.

We understand that the Forest Practices Applications (FPAs) for the Hokanson PHA (Unit 1 and Unit 2) were previously submitted as a Class III FPA by NBI (April 12, 2024) and approved by the DNR (May 10, 2024.

We understand that concerns over the timber harvest proposal have been raised by some of the property owners within the Sauk River Estates development, which is, in part, downgradient from the proposed harvest areas. These concerns are partially summarized in a preliminary report that was completed by Aspect dated June 24, 2024 regarding "*the potential impacts of timber harvest and forest practice activities on potentially unstable portions of the Site*." The Aspect report was completed based on a *"desktop slope stability assessment"*; no field review was completed by Aspect. Aspect's report indicated that based on their desktop review *"areas of bedrock hollows occur throughout the Site"* and *"bedrock exposures at the Site have the potential to be "dip slopes"… Dip slope bedrock exposures are potentially unstable due to the orientation of planes of weakness."*

Aspect also indicated a *"potential landslide area"* within the lower, central part of Unit 2 that *"has the appearance of a rotational landslide"* and that the *"toe of this feature is steeper than 65 percent, qualifying as a rule-identified landform per WAC 222-16-050(1)(d)(i)*."

The Aspect report concluded that the proposed forest practice activities *"may impact the water quality of the wells that the residents rely on."*

Although the FPA for the Hokanson PHA (Unit 1 and Unit 2) was approved by the DNR, an appeal was filed with the Pollution Control Hearings Board (PCHB) that is scheduled in April 2025.

3.0 HOKANSON PHA (UNIT 1 AND UNIT 2) DESCRIPTION

We understand that the Hokanson PHA (Unit 1 and Unit 2) will be primarily harvested as a clear-cut of mature conifer and occasional deciduous trees as shown on Figures 2 and 3. We expect most of the trees will be harvested using tower/cable methods by yarding downhill to a landing in a nearly level area at the base of the hillside. We understand that the upper area of bedrock cliffs will likely not be harvested, but the mid-slope bedrock cliff area may be harvested where mature trees can be safely cut and felled. Shovel/ground methods may be used in the less steep areas in the lower hillside area.

4.0 REGULATORY CONSIDERATIONS

4.1 WAC 222-16-050

From a regulatory perspective, Potentially Unstable Slopes and Landforms are referred to as "Rule-Identified Landforms" or "RILs." RILs are described by DNR (from WAC 222-16-050) as follows:

(A) Inner gorges, convergent headwalls, or bedrock hollows with slopes steeper than thirty-five degrees (seventy percent);

(B) Toes of deep-seated landslides, with slopes steeper than thirty-three degrees (sixty-five percent);

(C) Groundwater recharge areas for glacial deep-seated landslides;

(D) Outer edges of meander bends along valley walls or high terraces of an unconfined meandering stream; or

(E) Any areas containing features indicating the presence of potential slope instability which cumulatively indicate the presence of unstable slopes.

4.2 DNR FOREST PRACTICES BOARD MANUAL GUIDANCE

This evaluation was completed in general accordance with Section 16 of the DNR (May 2016) Forest Practices Board Manual (Board Manual), which provides guidance for identifying, delineating and characterizing RILs. The Board Manual indicates that timber harvest or other forest practices within or around RILs may trigger additional analysis by a Qualified Expert (DNR, May 2016, pages 16-43 to 16-46).

As will be described in more detail later in this report, the regulatory format requires landforms that not only fall under one of the five definitions of RILs but must also be shown to cause a moderate to high risk of potential impacts to a public resource or affect public safety. In this case, the Hokanson PHA (Unit 1 and Unit 2) was evaluated as lacking landforms that are defined as a RIL. From a Potentially Unstable Slopes and Landforms perspective, if no RILs are identified, then the FPA would be approved which occurred for this FPA.

Of concern for this FPA is that the bedrock cliffs that occur within or around Unit 1 and Unit 2 may result in a "rockfall hazard." Rockfall hazards are not described in detail in the Board Manual. The term "rockfall" occurs four times in the Board Manual and is described as *"Rock falls and complex rock slides are dominant in the steep bedrock slopes in the North Cascades"* (DNR, May 2016, page 16-85). Rockfalls are also mentioned twice on page 16-6 as a "Landslide Classification" (Table 1) and also a statement indicating that *"Landslides are described by terms referring to the type of material and method of movement (rock fall, debris flow, and so forth)."*

5.0 PUBLIC RESOURCES AND PUBLIC SAFETY

The purpose of this report is to evaluate Potentially Unstable Slopes and Landforms for the Hokanson PHA (Unit 1 and Unit 2) and the risk level (low, moderate or high) for potential impacts related to adjoining property damage and/or public safety issues as a result of the proposed forest practices. For a Class III FPA, it is not always necessary to provide a report prepared by a DNR "Qualified Expert." However, sometimes additional geological information (subject to this report) is a benefit to provide NBI, the DNR and other stakeholders with information that summarizes topographic, geologic and geomorphic processes that are active, or were active, within a specific area proposed for tree harvest along with mitigations, including "avoidance" (no harvest in specific areas) to reduce the risk level.

No typed streams occur within Hokanson PHA (Unit 1 and Unit 2). A seasonally and intermittently wet low gradient swale (prehistoric stream) parallels the base of the hillside as shown on Figure 4.

The Hokanson PHA (Unit 1 and Unit 2) is upgradient from part of Sauk River Estates (a residential community), State Route 530 and the Sauk River. The Sauk River is located about 700 to 1,100 feet southwest of the Hokanson PHA (Unit 1 and Unit 2). Based on our review of the DNR FPAMT, the Sauk River is typed as a Shoreline of the State. The Sauk River is also listed on the National Wild and Scenic Rivers System that was created by the US Congress in 1968.

Because no typed streams occur within the Hokanson PHA (Unit 1 and Unit 2), no delivery of sediment is expected in the form of traditional shallow, rapid landslides (referred to as debris slides, debris flows or earth flows). However, because of the presence of bedrock cliffs within Unit 1 and upgradient of Unit 2, there is the potential for rockfall that could runout and cause potential impacts related to public resources and/or public safety. Evaluating the risk of this potential for rockfall is the primary subject matter of this report.

It should be noted that the Aspect report (June 24, 2024) did not conclude that rockfall hazards are a concern. In our opinion, based on our desktop review, any proposed harvest site that contains bedrock cliffs upgradient from public resources or that may affect public safety requires additional site specific field review of rockfall potential.

6.0 SITE CONDITIONS

6.1 GENERAL

As previously described, Mr. Petska and Mr. Beaman completed a field review of the Hokanson PHA (Unit 1 and Unit 2) on July 9 and 11, 2024; the route of the field reviews are shown on Figure 4. The weather during the site visits was clear and warm/hot, with the temperature in the 70s to mid 80s.

The surficial geologic conditions (unweathered soils/bedrock that underlie the weathered horizon) and Potentially Unstable Slopes and Landforms were evaluated based on regional geologic mapping by the USGS (2002), geologic and landslide mapping by the DNR (Geologic Information Portal), Watershed Analysis by the USFS (January 19, 1996), review of historical aerial photographs dating back to 1953 (USGS Earth Explorer and Google Earth), review of LiDAR imagery (DNR, Washington LiDAR Portal), topographic contours and slope mapping (DNR/Esri, ArcGIS) and field review of the Hokanson PHA (Unit 1 and Unit 2).

Mr. Petska had the cut-line flagged prior to our field review; flagging included the property line and two localized areas of potentially unstable slopes in the lower hillside area of Unit 1.

6.2 GEOGRAPHIC AND TOPOGRAPHIC SETTING

The Hokanson PHA is located within a generally southwest facing hillside overlooking the Sauk River valley. As previously described, parts of Sauk River Estates border the southwest side of the Hokanson PHA (Unit 1 and Unit 2). The west, north and east sides of the Hokanson PHA (Unit 1 and Unit 2) are bordered by similar timberlands that are managed for forest resources by other land managers. Based on our review of the Climatology GIS files available from the DNR (Open Data, Climatology), the Hokanson PHA is within a Rain-Dominated Precipitation Zone.

Based on DTM based data (DNR, North Puget 2017 acquisition), we used Esri ArcGIS 10.6 to process topographic contours at 1-, 5- and 10-foot intervals within and around the Hokanson PHA (Unit 1 and Unit 2). Based on this topographic data, the ground surface is about Elevation 275 feet at the toe of the hillside where it intersects with the nearly level terrace of the Sauk River floodplain area. The upper part of Hokanson PHA (including the upper bedrock cliff area where no harvest is planned) extends to about Elevation 1,740 feet near the northeast corner of Unit 1.

6.3 SLOPE MAPPING

Based on DTM data (DNR, North Puget 2017 acquisition) we used Esri ArcGIS 10.6 to process the location of slopes that exceed 45-, 50-, 70-, and 100-percent grade within and around the Hokanson PHA (Unit 1 and Unit 2) as shown on the Slope Map, Figure 5. Slope inclinations were reviewed by field measurements for accuracy.

6.4 LiDAR IMAGE REVIEW

Based on our review of the LiDAR Image, Figure 6, the bedrock cliff areas are distinctive. Below the bedrock cliff areas are evenly contoured, planar to divergent slopes typical of Talus accumulation, especially the large cone-shaped feature in the west part of Unit 1. Other evenly spaced contours across the mid to lower hillside areas of Unit 1 and Unit 2 appear to be coalescing Talus slopes from variously oriented bedrock cliffs upslope from the Talus accumulations. The floodplain area of the Sauk River is nearly featureless with subtle arcuate-shape features, referred in this report as “streamlining”, that can be suggestive of historic and/or prehistoric fluvial processes.

6.5 GEOLOGIC SETTING

The surficial geologic conditions were evaluated based on regional geologic mapping by the USGS (2002), landslide Inventory mapping (DNR, Geologic Information Portal; USFS, January 19, 1996) followed by ICE review of historical aerial photographs (USGS Earth Explorer and Google Earth) and LiDAR DTM data (DNR, Washington LiDAR Portal), water well logs (Ecology) and field review (by foot traverse) of the Hokanson PHA (Unit 1 and Unit 2) and accessible adjacent areas.

Based on regional geologic mapping by the USGS (2002) and our site observations, the Sauk River valley floor is underlain by Younger Alluvium with some higher terraces of Older Alluvium (the Older Alluvium was mapped by ICE). The southwest facing hillside is underlain by Shuksan Greenschist bedrock as shown on the Geologic Map, Figure 7 (modified by ICE based on detailed topographic data and field observations). The following is a description of these geologic units from the USGS (2002) and as mapped/described by ICE.

Younger Alluvium (Qyal) – Holocene age (less than 11,700 years old) moderately sorted deposits of cobble gravel to pebbly sand along rivers and streams; gradational with Talus deposits.

Older Alluvium (Qoal) – Expected to be similar to Younger Alluvium in texture; deposited by the Sauk River when it was at a higher base level; mapped by ICE based on detailed topographic data (Figure 5), field observations and LiDAR image review (Figure 6).

Based on our review of water well logs from Ecology, we found nine water well logs (well logs) within the Sauk River Estates area of which three had defined addresses to increase confidence in location. According to the three well logs, each of the three were completed to a depth of 36 to 37 feet. The soil conditions are described on the well logs as "topsoil, sandy loam" or "silt" to a depth of 6 to 12 feet underlain by "sand and gravel" and water (where encountered) to the completion depth. Well testing indicated pumping rates of 10 gallons per minute (gpm) for two of the wells and 30 gpm for the third well. These subsurface soil and groundwater conditions described on the well logs are consistent with flood overbank deposits (the topsoil, silt, sandy loam) underlain by alluvium (sand and gravel with water). As a note, well logs are highly interpretative because of the drilling methods and oversight. However, the subsurface conditions described on the well logs are consistent Younger Alluvium/Older Alluvium.

Shuksan Greenschist (Easton Metamorphic Suite) (Kes) – Middle to Late Jurassic (174 to 145 million years old) bedrock which originated as an ocean floor basalt that was subsequently "metamorphosed" during the early Cretaceous (145 to 100 million years ago) under high heat and pressure to create a predominately fine-grained sodic actinolite-bearing greenschist.

The alignment of the edge of the Shuksan Thrust Plate in this area is aligned with the Sauk River valley (USGS, 2002). A margin of a thrust plate is often characterized by high fractured rock and is likely the reason (being susceptible to water erosion) for the alignment of the Sauk River in this area.

Lahars –"Lahars" or volcanic mudflow events (Holocene to Pleistocene age) off of Glacier Peak are locally exposed within the Sauk River valley floor. Lahar Deposits typically consist of an unstratified diamicton (mixture) of clay, silt, sand, gravel, cobbles and boulders. The nearest surface exposures of Lahar Deposits have been mapped by the USGS (2002) about 1.6 miles upstream of the Hokanson PHA (Unit 1 and Unit 2) along the left bank of the Sauk River. The most recent major eruption of Glacier Peak occurred about 11,250 years ago (USGS, 2002)

6.6 GEOMORPHIC SETTING

6.6.1 Shuksan Greenschist and Shuksan Thrust Fault

The geomorphology (origin of landforms) in the Hokanson PHA area has a very long history of formation. The origin of the Shuksan Greenschist is an oceanic basalt protolith formed in the early to middle Jurassic

about 201 to 164 million years ago that was metamorphosed in the early Cretaceous about 145 to 100 million years ago as a result of plate tectonics when the ocean plate collided with the west coast of North America. The metamorphism of the basalt causes minerals within the basalt to reorient themselves and align parallel to one another, leading to the development of "foliation." Foliation can result in a "plane of weakness" that can be more prone to breaking or sliding along these surfaces. Subsequent erosion by terrestrial processes (including glaciation, volcanic eruptions, stream and river erosion) over the course of many thousands (glacial and volcanic eruptions) to millions of years form the current topography.

6.6.2 Talus Accumulation

In the area of the Hokanson PHA, prehistoric versions of the Sauk River eroded the valley to the present condition. Downcutting by the river oversteepened the valley sideslopes, forming bedrock cliffs that locally failed resulting in the accumulation of rock fragments (Talus) over the course of time (measured in tens of thousands to millions of years). These erosional processes are evident in the Talus slopes observed on the LiDAR image (Figure 6), and during our field review. Our interpretation of the areas of Talus accumulation is shown on Figure 7. The accumulation of Talus across most of the Hokanson PHA (Unit 1 and Unit 2) is the dominant geomorphic process that has formed the slopes that descend to the valley floor.

The Talus slope within Unit 1 contains a "skid trail" that was likely used to move cut logs down the hillside during the original logging. The skid trail was cut into the hillside by sidecasting the cut material onto the downhill slope, which provides, as described later in this report, a "performance indicator" of the Talus slope.

6.6.3 Sauk River Valley Floor

The Sauk River valley floor is about 1,000- to 1,900-feet wide in the area of the Hokanson PHA (Unit 1 and Unit 2). As previously described, the nearly level terraces that border the Sauk River are relatively smooth with subtle "streamlining" suggestive of deposition and prehistoric channel locations consistent with Younger/Older Alluvium and fluvial processes. Much of the fluvial streamlining appears to be muted by long-term surface erosion (especially the Older Alluvium) and more recent modifications for road and building lot earthwork.

Two remnant high alluvial terraces occur at the base of the hillside in the south parts of Unit 1 and Unit 2. These high terraces (underlain by Older Alluvium) are nearly level to gently sloping and are approximately 30 to 35 feet higher than the adjacent valley floor.

6.6.4 Landslides

DNR and USFS Landslide Inventories – According to regional geologic mapping by the USGS (2002) and landslide inventories by the DNR (Geologic Information Portal), no landslides are present within or around the Hokanson PHA (Unit 1 and Unit 2). We also reviewed an older document by the USFS (Sauk Watershed Analysis, January 19, 1996) that does not indicate the presence of mass wasting deposits (translational events, debris avalanches, debris flows or torrents, rotational landslides, slumps or dam-break floods) within or around the Hokanson PHA (Unit 1 and Unit 2). However, based on the relatively small scale mapping and lack of unstable slope polygons in this general area of the Sauk River watershed, the mapping by the USFS (January 19, 1996) may have not been completed in the Hokanson PHA (Unit 1 and Unit 2). Regardless, we expect that the USGS (2002) and DNR (Geologic Information Portal) mapping would be

more reliable indicators of regionally-mapped landslides in this area than the USFS (January 19, 1996), of which there are none.

ICE Mapped Landslides

Based on our field observations and LiDAR image review (Figure 6), a shallow raveling landslide occurs in the south part of Unit 1 and an arcuate-shaped "bowl" landform occurs in the south part of Unit 2. These features are labeled as LS-1 and LS-2, respectively, on Figure 7.

LS-1 – LS-1 appears to be a shallow raveling failure of Talus that was caused by undercutting at the toe of the hillside by a prehistoric (measured in thousands of years) location of the Sauk River. The Talus has no cohesion, is well-drained and typically stable at slope inclinations up to 45 degrees (100-percent grade). However. undercutting the toe of the Talus by river erosion will initiate surficial raveling failure when the natural angle of repose is exceeded.

The Sauk River has long abandoned this location where the undercutting occurred, therefore the existing condition is in equilibrium based on the densely vegetated state of this landform with no visible evidence of instability. LS-1 has vague lateral margins with no internal drainage with same age, type and density of vegetation as the adjacent terrain. LS-1 is a relict surficial landform and is not subject to future movement in the near term (assumed to be 140 years) based on the lack of a triggering mechanism (river undercutting).

LS-2 – LS-2 is characterized by a bowl-shaped landform in Talus that is apparent in the LiDAR Image (Figure 6). During our field review, we observed the "bowl area" to be uniformly sloped with sidewalls inclined at more than 70-percent grade. The landform is densely vegetated with mature conifer trees and light to moderately dense brush that is similar to the adjacent terrain. No streams, springs or seepage were observed within the flow-line of the landform. Similar to LS-1, LS-2 was likely triggered as a mass movement of Talus that was being undercut at the toe of the slope by a prehistoric location of the Sauk River. LS-2 is a relict surficial landform and is not subject to future movement in the near term (assumed to be 140 years) based on the lack of a triggering mechanism (river undercutting).

6.7 HISTORICAL AERIAL PHOTOGRAPH REVIEW

ICE reviewed historical aerial photographs of the Hokanson PHA (Unit 1 and Unit 2) dated August 14, 1953, August 3, 1963, August 10, 1972 (USGS Earth Explorer), July 20, 2003, September 25, 2011 and July 25, 2019 (Google Earth), as shown in Figures 8, 9 and 10. The following is a summary of surface conditions observed on these aerial photographs.

1953 Aerial Photograph – The 1953 aerial photograph (Figure 8 – fair quality) shows that the Hokanson PHA (Unit 1 and Unit 2) and local areas on all sides have been primarily clear-cut with some thinning (according to Mr. Petska, this logging occurred in the 1940s). Other areas are forested. The skid trail that currently exists within Unit 1 is faintly visible. State Route 530 is visible including the current location of the Sauk River. No visible evidence of rockfall scars (typically lighter colored areas) are visible in the bedrock cliff areas within or around Unit 1 and Unit 2. No surface evidence of slope instability is visible.

1963 Aerial Photograph – The 1963 aerial photograph (Figure 8 – fair quality) shows that the Hokanson PHA (Unit 1 and Unit 2) and adjacent areas are reforesting and overall are similar to the 1953 aerial

photograph. It appears that some road construction and lot clearing may be occurring in the Sauk River Estates. No visible evidence of rockfall scars (typically lighter colored areas) are visible in the bedrock cliff areas within or around Unit 1 and Unit 2. No surface evidence of slope instability is visible.

1972 Aerial Photograph – The 1972 aerial photograph (Figure 9 – poor quality) shows that the Hokanson PHA (Unit 1 and Unit 2) and adjacent areas continue to reforest and overall are similar to the 1963 aerial photograph. No visible evidence of rockfall scars are visible in the bedrock cliff areas within or around Unit 1 and Unit 2. No surface evidence of slope instability is visible.

2003 Aerial Photograph – The 2003 aerial photograph (Figure 9 – good quality) shows that the Hokanson PHA (Unit 1 and Unit 2) and adjacent areas continue to reforest. Recent clear-cuts are visible in the upland area generally east of Unit 1. Based on the vegetative cover, it appears that the area west of Unit 1 had been clear-cut, likely in the late 1970s or 1980s as the regrowth of trees is visible. The skid trail within Unit 1 is not visible but probably masked by canopy closure of maturing trees. Residential structures are faintly visible within the area of Sauk River Estates and possibly because of the slightly higher quality aerial photograph. No visible evidence of rockfall scars are visible in the bedrock cliff areas within or around Unit 1 and Unit 2. No surface evidence of slope instability is visible.

2011 Aerial Photograph – The 2011 aerial photograph (Figure 10 – good quality) shows that the Hokanson PHA (Unit 1 and Unit 2) and adjacent areas including the more recent clear-cuts to the east continue to reforest. The skid trail within Unit 1 is not visible but probably masked by canopy closure of maturing trees. Many residential structures are visible within the area of Sauk River Estates. No visible evidence of rockfall scars are visible in the bedrock cliff areas within or around Unit 1 and Unit 2. No surface evidence of slope instability is visible.

2019 Aerial Photograph – The 2019 aerial photograph (Figure 10 – very good quality) shows that the Hokanson PHA (Unit 1 and Unit 2) and adjacent areas including the clear-cuts to the east and west continue to reforest. The skid trail within Unit 1 is not visible but is probably masked by canopy closure of maturing trees. Because of the higher quality and color condition of this aerial photograph, the bedrock cliffs are visible in the mid to upper parts of Unit 1. An open Talus slope is visible in the upper northwest part of Unit 1. No visible evidence of rockfall scars are visible in the bedrock cliff areas within or around Unit 1 and Unit 2. No surface evidence of slope instability is visible.

6.8 FIELD REVIEW OBSERVATIONS

6.8.1 General

Mr. Petska and Mr. Beaman completed field reviews of the Hokanson PHA (Unit 1 and Unit 2) and accessible surrounding areas on July 9 and 11, 2024. The weather during our field review was sunny with temperatures in the 70s and mid 80s. The weather preceding our field review was seasonably warm and dry. The route of our field reviews (foot traverse) is shown on Figure 4 including key Observation Points (OP-1 through OP-84).

Observation Points	Observations
OP-1	3 by 4 foot boulder and second smaller boulder. Appear to have been moved (lack of moss) to this location that appears to be former logging landing area
OP-2	Foliation strike N75W, dip 23 degrees NNE

OP-3	Base of bedrock cliff
OP-4	Foliation strike N75W, dip 20 degrees NNE
OP-5	Moss and duff covered Talus
OP-6	Several boulders 4 by 4 foot to 6 by 6 foot; Talus
OP-7	Same as OP-6
OP-8	Same as OP-6
OP-9	Steep area; vegetated Talus
OP-10	Fewer boulders in this area
OP-11	Many relatively large boulders on this topographic bench
OP-12	Extensive vegetated Talus slope
OP-13	House sized boulder on Talus slope
OP-14	Vegetated Talus slope
OP-15	A fresh appearing boulder about 2 by 3 foot
OP-16	Vegetated Talus field; many cedar trees
OP-17	Wide swale; scattered boulders throughout; dry, forested, stable
OP-18	Toe area of hillside; 2 large boulders
OP-19	Toe area of hillside; 1 large boulder
OP-20	6 by 6 foot boulder on terrace area
OP-21	More random sized boulders on terrace area
OP-22	Old road grade
OP-23	Distinctive swale; dry but may be wet in the winter/early spring
OP-24	6 by 6 foot boulder on nearly level terrace area; may be a runout boulder
OP-25	Distinctive swale; dry but may be wet in the winter/early spring
OP-26	Possible logging tower (landing) location
OP-27	3 by 3 foot boulder at the toe of hillside
OP-28	6 by 8 foot boulder at the toe of the hillside
OP-29	1 foot diameter boulder on hillside area
OP-30	10 by 8 foot moss covered boulder
OP-31	Talus in skid trail cut slope and large boulder below skid trail
OP-32	20 by 20 foot boulder
OP-33	Intact rock overlain by Talus colluvium; foliation strike N75W, dip 23 degrees NNE
OP-34	Vegetated talus; notably smaller in diameter compared to lower on the hillside
OP-35	25 foot diameter boulder
OP-36	Moss covered Talus slope
OP-37	Same as OP-36
OP-38	Talus slope typically 3 foot in diameter
OP-39	Very large conifer tree on sloping bench about 2.5 to 3 feet in diameter
OP-40	Overlook at the top of bedrock cliffs
OP-41	Moss covered Talus 3 foot diameter
OP-42	Base of large bedrock cliff
OP-43	Foliation strike N70W, dip 14 degrees NNE
OP-44	Foliation strike N75W, dip 20 degrees NNE
OP-45	Widely-spaced, near vertical joint sets
OP-46	Foliation strike N70W, dip 26 degrees NNE
OP-47	Vertical face of bedrock cliff appears to be a joint surface
OP-48	Foliation strike N75W, dip 20 degrees NNE
OP-49	Foliation strike N75W, dip 26 degrees NNE
OP-50	Moss covered Talus, baseball to basketball size
OP-51	Convergent slope at the base of bedrock cliff, appears to be created by the Talus slope seam
OP-52	Forested and mossy covered Talus slope; basketball sized boulders
OP-53	Open Talus slope, partially moss covered; baseball to basketball sized boulders
OP-54	Talus at skid trail crossing; road surface about 50 percent intact
OP-55	Moss covered Talus
OP-56	Moss covered Talus
OP-57	Moss covered Talus; basketball sized boulders
OP-58	2 by 1.5 foot rock lodged against a tree
OP-59	Bedrock cliffs
OP-60	Foliation strike N80W, dip 26 degrees NNE
OP-61	Very tight vertical joint about 6 feet apart
OP-62	Moss covered bedrock cliffs
OP-63	Joint plane is near vertical and about 6 feet apart
OP-64	Foliation strike N80W, dip 28 degrees NNE

OP-65	Vertically oriented joints
OP-66	Forested Talus
OP-67	Moss covered Talus
OP-68	Forested Talus, relatively large boulders 4 to 5 feet in diameter
OP-69	Foliation strike N75W, dip 18 degrees NNE
OP-70	Foliation strike N75W, dip 21 degrees NNE
OP-71	Foliation strike N75W, dip 21 degrees NNE
OP-72	Moss covered Talus
OP-73	Rock outcrop on ridgeline
OP-74	Foliation strike N75W, dip 29 degrees NNE
OP-75	Foliation strike N75W, dip 25 degrees NNE; talus is large
OP-76	Foliation strike N75W, dip 23 degrees NNE; isolated bedrock cliff
OP-77	Forested and moss covered Talus
OP-78	Bedrock cliff area
OP-79	Foliation strike N75W, dip 25 degrees NNE
OP-80	Bedrock headwall, dry
OP-81	Widely convergent swale, dry, forested, stable
OP-82	Same as OP-81
OP-83	Wide boulder field above the house-size boulder observed at OP-13
OP-84	Boulder field (Talus slope) continuous

6.8.2 Rockfall Hazards

General – Based on our review of the geologic conditions (Figure 7) and the LiDAR image/topography (Figure 6), our primary concern in planning a field review was to focus on rockfall hazards given the accumulation of Talus that appears to have shaped the ground surface downslope of bedrock cliff areas. We also reviewed the general hillside area bordering the Sauk River, especially to the south, and observed (using regional LiDAR coverage from the DNR) that these Talus slopes are relatively common. Talus slopes are certainly not unusual in eastern Washington where there are no or few trees; the basalt cliffs and Talus slopes are easy to observe below the basalt cliffs that line the Columbia River. While the Hokanson PHA (Unit 1 and Unit 2) does not have the same geologic conditions as these areas in eastern Washington, the Shuksan Greenschist is a known "cliff former" with foliation and jointing that result in rockfall that forms similar Talus slopes below the bedrock cliff areas. The primary difference between these two geographic areas is that the relatively cool and wet conditions of western Washington allow the Talus slopes to be masked by the vegetation, especially if rockfall from the bedrock cliff areas is not active.

The evaluation of rockfall hazards in the Hokanson PHA (Unit 1 and Unit 2) are directly related to the following existing conditions.

- Orientation of Shuksan Greenschist foliation (metamorphic bedding) and joint sets (tectonic fracturing) (kinematic indicator).
- Damage to trees that are impacted by rockfall (activity indicator).
- Growth (or lack thereof) of moss and lichen on Talus surfaces or in bedrock cliff areas that indicate the Talus or bedrock cliffs have been stable for many years or decades (activity indicator).
- The overall regrowth of mature forest across the Talus slopes (activity indicator).
- Condition of skid trails that traverse the Talus slope in Unit 1 (activity and performance indicator).
- Presence of precariously detached blocks of bedrock on the hillside (activity indicator).
- Previous logging methods where trees were harvested using harvest practices that were not necessarily planned to reduce the risk of "causing" rockfall (performance indicator).
- History/prehistory of rockfall runout at the base of the Talus slope that would be evidenced by isolated boulders that have "run out" past the toe of the Talus slope onto the nearly level Sauk River floodplain (performance and activity indicator).

The runout condition of rockfall from the Hokanson PHA is the primary hazard related to Sauk River Estates (public safety), State Route 530 (public safety and property damage) and the Sauk River (public resource).

Details on these existing conditions are presented in the following sections.

Shuksan Greenschist Foliation and Joint Sets – Foliation (metamorphic bedding) of the Shuksan Greenschist was measured at N70W to N80W with a dip of 14 to 29 degrees down to the north-northeast at 17 OP locations listed in section **6.8.1** of this report. This is a "favorable" structure as the dip is into the hillside rather than away or parallel to topographic slope that is associated with "dip slope" type rock instability conditions. We also observed various joint sets (tectonic fracturing) with most being near vertical with random spacing. We observed that the most common potential intact rock failures in the bedrock cliff areas could result from undermining (creating overhangs); these overhangs can be susceptible to toppling failures.

Tree Damage – During our field review we did not observe any trunks scars at the base of trees that would be caused by rockfall. We observed only one location where it appeared that a 2 foot by 1.5 foot boulder lodged against the base of a tree (OP-58; located adjacent to the upper bedrock cliff). The lack of tree damage is a strong indicator the rockfalls are infrequent; likely measured in decades.

Moss and Lichen Growth – The ground surface is generally mantled with topsoil and vegetated with ferns and other indigenous brush (especially in the lower hillside area). Relatively large areas of accumulated Talus are present at the surface in the mid to upper hillside area that is covered in the thick mat of moss. Isolated blocks of bedrock on the surface are typically tabular in shape and have developed patches of moss and lichen over most of the rock surfaces. The presence of a developed topsoil, moss and lichen are strong indicators that rockfall is infrequent, likely measured in decades.

Forest Regrowth – The general area of Talus slopes have successfully reforested with mature conifer trees which is an indicator that the Talus slope has stabilized.

Abandoned Skid Trails (Unit 1 and Unit 2) – Man-made factors include an abandoned skid trail that climbs in a series of four traverses across the large Talus slope within the Hokanson PHA (Unit 1) that allows for observation of loss or covering of the prism of the skid trail (a performance indicator) that would suggest recent (the skid trail is faintly evident on the 1953 aerial photograph) rockfall activity. Other skid trails occur within the hillside area of the Hokanson PHA (Unit 2). This type of road/trail construction typically results in a near vertical cut on the uphill side and loose fill pushed out onto the downhill side. Under current forest practices for road construction, this skid trail could be constructed, but only if all excavated material was removed (no sidecast fill) where the natural hillside is more than 65-percent grade.

During our field review, we observed the abandoned skid trail to be constructed by cutting into the hillside and sidecasting excavated soil on to the downhill side. We also observed that the road prism (cut, road surface and sidecast fill slope) is substantially intact. This condition is a favorable performance indicator of general hillside stability and likely explained by the well-drained condition of the Talus and angularity of the rock fragments that provide additional stability.

Detached Blocks of Bedrock – As previously described, detached blocks of bedrock (prehistoric rockfall) are scattered across the hillside; one being about the size of a small house (OP-13). However, the entire Talus slope is a product of rockfall. Because of the age of the bedrock in this area, aging of the detached blocks of bedrock (rockfall) is likely measured in thousands, if not tens of thousands of years and likely occurred during seismic activity related to large subduction zone earthquakes or volcanic eruptions of Glacier Peak or Mt. Baker.

Previous Logging Methods – Based on our review of historical aerial photographs and information provided by Mr. Petska, this hillside was previously logging in the 1940s and was also the likely time period that the abandoned skid trail was constructed. We expect that the method of logging did not consider rockfall as a hazard with falling/skidding trees and excavation for the skid trail that intentionally pushed rocks of various sizes onto the hillside. We expect that the proposed forest practices will strongly consider minimizing ground disturbance and avoiding dislodging detached boulders that are scattered across the hillside.

Rockfall Runout – As part of our evaluation, we were particularly interested in rockfall that had run out onto the Sauk River valley terrace that is underlain by more recent soil deposits with the Younger Alluvium and Older Alluvium (less than 11,700 years old). Our field review observed a single boulder on this terrace (OP-20) along with two other boulders at OP-27 and OP-28. The boulder at OP-20 appears to be an actual runout boulder, whereas the other two boulders appear to be related to previous logging where these boulders may have been transported by equipment. Assuming these boulders are all rockfall related, the runout appears to be effectively slowed upon encountering the natural swale and low berm at the base of the hillside. As previously described, these rockfall occurrences are infrequent and likely occurred sometime during the past 11,700 years.

6.8.3 Rule Identified Landforms (RILs)

Based on our review of available information and field review, no RILs occur within the Hokanson PHA (Unit 1 and Unit 2).

7.0 HOKANSON PHA (UNIT 1 AND UNIT 2) CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

General – The surficial geologic conditions (unweathered bedrock and soils that underlie the weathered horizon) and Potentially Unstable Slopes and Landforms were evaluated based on regional geologic mapping by the USGS (2002), geologic and landslide inventory mapping by the DNR (Geologic Information Portal), Watershed Analysis by the USFS (January 19, 1996), review of historical aerial photographs dating back to 1953 (USGS EarthExplorer and Google Earth), review of LiDAR imagery (DNR Washington LiDAR Portal), topographic contours and slope mapping (DNR/ESRI, ArcGIS) and field review of the Hokanson PHA (Unit 1 and Unit 2).

Rockfall Risk and RILs Evaluation – Our evaluation of Potentially Unstable Slopes and Landforms is focused on potential rockfall hazards. Based on our evaluation (described in the previous paragraph), we conclude that the risk of rockfall from bedrock cliff areas that occur in the upper and mid-slope parts of Unit 1 and upslope of Unit 2 is low. We also conclude that the risk of rockfall that could runout to Sauk River Estates, State Route 530 and the Sauk River is low.

The results of this evaluation, including rockfall hazard areas and rockfall runout areas, are shown on the Potentially Unstable Slopes and Landforms Map, Figure 11. Based on the age of the terrace deposits, the rocks that ran-out onto the terrace surface may be as much as 11,700 years old and were contained within the lime-green shaded area shown on Figure 11. The risk of future rockfall past the green-shaded area is considered low, based on our full evaluation.

RILs – No defined RILs exist within the Hokanson PHA (Unit 1 and Unit 2) such as Bedrock Hollow, Inner Gorge, Toes of Deep-Seated Landslides, Groundwater Recharge Areas for Glacial Deep-Seated Landslides or Outer Edges of Meander Bends

Based on this evaluation and review, it is our opinion that the proposed Forest Practices for the Hokanson PHA (Unit 1 and Unit 2) can be successfully/safely completed **provided that recommendations to mitigate rockfall and runout are implemented**. The harvest area within the Hokanson PHA (Unit 1 and Unit 2) should be replanted as soon as practical.

Response to Aspect June 24, 2024 Report – As previously described, Aspect completed a *"desktop slope stability assessment"* with no field review. Aspect's report indicated that based on their desktop review *"areas of bedrock hollows occur throughout the Site"* along with *"bedrock exposures at the Site have the potential to be "dip slopes"… Dip slope bedrock exposures are potentially unstable due to the orientation of planes of weakness."*

Aspect also indicated a *"potential landslide area"* within the lower, central part of Unit 2 that *"has the appearance of a rotational landslide"* and that the *"toe of this feature is steeper than 65 percent, qualifying as a rule-identified landform per WAC 222-16-050(1)(d)(i)*." We agree there may be a shallow raveling landslide in this area based on LiDAR image, topographic and field review, however in our opinion, the type and mechanism of failure is different and does not trigger a WAC 222-16-150 regulated landform. The desktop review is a valuable step in planning and targeting specific areas of a proposed harvest unit for field review to better assess Potentially Unstable Slopes and Landforms which often results in a revision of the desktop review interpretation.

The Aspect report concluded that the proposed forest practice activities *"may impact the water quality of the wells that the residents rely on."*

We presume that the Aspect June 24, 2024 report is considered "preliminary" based on labeling the report as a "desktop slope stability analysis" that is often completed to target a field review strategy. We incorporated the preliminary conclusions provided in the Aspect report and planned our field review to address these concerns along with other factors that guided ICE's evaluation. ICE's response to Aspect's preliminary conclusions are as follows:

ICE response to *"areas of bedrock hollows occur throughout the Site"* – We concur that, based on desktop review, there are topographic landforms that exhibit convergency with slopes that are inclined more than 70-percent grade and are over 10 feet in height scattered (relatively infrequently) across the site, including the LS-2 landform observed by ICE. However, during field review by ICE we observed these areas to be dry, typically with intact bedrock or underlain by Talus. LS-1 and LS-2 were likely triggered by undercutting of the toe of the Talus slope by an ancient location of the Sauk River when it was at a higher

base level. These areas were observed to be dry during field review (no streams, springs or seepage) and are typically forested with no change in vegetation within or around the landforms. No sediment delivery or public safety concerns were present. We concluded that no bedrock hollows (RILs) occur within the Hokanson PHA (Unit 1 and Unit 2).

ICE response to "*Dip slope bedrock exposures are potentially unstable due to the orientation of planes of weakness*" – Based on our review of the regional geologic map we observed that Aspect likely used a bedrock foliation measurement by the USGS (2002) that is located almost ½ mile east-southeast of Unit 2. There are also two other USGS foliation measurements in this same area that conflict with the one used by Aspect. Variation in structure attitude of the Shuksan Greenschist is not unusual considering the tectonic history of this formation.

During our field reviews, we were able to obtain numerous measurements of foliation and found the measurements to be relatively consistent (rather than variable) with a strike ranging from about N70W to N80W with a dip of 14 to 29 degrees down to the north-northeast. This is a "favorable" structure as the dip is into the hillside rather than away or parallel to topographic slope that is associated with "dip slope" type rock instability. We also observed various joint sets with most being near vertical with random spacing.

We observed that the most common intact rock failures in the bedrock cliff areas were caused by undermining (creating overhangs); these overhangs can be susceptible to toppling failures, although these failures appeared to be infrequent. During our field review we completely traversed the base of the upper bedrock cliff (OP-42 to OP-52) and the mid-slope bedrock cliff area (OP-59 to OP-65, OP-69 to OP-76 and OP-78 and OP-79 and observed mature trees at the base of these bedrock cliff areas with no scars caused by rockfall; this is a favorable indicator that rockfall from the bedrock cliffs is infrequent (essentially no rockfall during the life cycle of these mature trees).

ICE response to ***"potential landslide area"*** **within the lower, central part of Unit 2 that** ***"has the appearance of a rotational landslide"*** **and that the** ***"toe of this feature is steeper than 65 percent, qualifying as a rule-identified landform per WAC 222-16-050(1)(d)(i)"*** – Based on our field review (surface observations) and knowledge of the subsurface conditions (Talus accumulation), it is not likely that a rotational landslide exists at this location. Based on our field review, we concluded that a shallow raveling landslide (LS-1) that is relict occurs in the south part of the Hokanson PHA (Unit 1) as shown on Figure 7.

ICE response to *"may impact the water quality of the wells that the residents rely on"* – The DNR (May 2016) Board Manual Section 16 does not provide guidance related to the evaluation of potential impacts to water wells. Water well and groundwater quality issues related to forest practices are also not specifically regulated by WAC 222. As a practical matter, it is important to consider other factors that relate to proposed forest practices that may cause potential impacts to downgradient users related to groundwater quality and quantity. At the location of the Hokanson PHA (Unit 1 and Unit 2), considering the laterally confined conditions of the Sauk River valley, we expect that the primary recharge to water wells in this area is directly by the Sauk River. We expect that groundwater moves rapidly through the floodplain terrace Younger Alluvium deposits which is favorable from a water quantity and quality perspective.

While there may be some groundwater that drains to the Sauk River valley by open, connected fractures in the bedrock, we expect that this contribution is very small and is rapidly incorporated into the Sauk River aquifer.

It is commonly accepted that when trees are removed from an area, more precipitation will infiltrate into the ground (increasing water quantity) as a result of the loss of evapotranspiration, at least until the new stand of trees regrow and the evapotranspiration rate is restored (typically a 15 to 20 year time frame).

7.2 RECOMMENDATIONS

The following are our recommendations for rockfall mitigation related to the Hokanson PHA (Unit 1 and Unit 2).

- Limited tree harvest should occur in the terrace area, including that needed for road access and landing. The existing trees are effective barriers to slow and stop rockfall. Select conifer trees may be cut on a "tree-by-tree" basis, including "high stumping" following field review by ICE of tree position and rockfall runout risk assessment.
- ICE should be provided with a detailed access and landing plan including clearing limits for review and comment prior to construction. As currently planned, the landing as proposed at OP-26 is a preferred location.
- We are aware of several detached boulders resting on top of the Talus in the hillside areas of Unit 1 and Unit 2. Timber falling and yarding will need to be planned so as to not displace these boulders. ICE should be involved for periodic field review during the timber falling and yarding process to evaluate the stability of these detached boulders and provide recommendations, including no harvest, to maintain the current stability of these detached boulders.
- Timber falling and removal in general should be closely monitored including alerting the fallers that tree cutting needs to be completed to minimize ground disturbance and rockfall.
- To the extent that it does not create a fire hazard, logging slash can be stacked to form a barrier on the south side of the where the current landing is planned.
- Where downhill logging is used, reasonable care shall be taken to lift the leading end of the log to minimize downhill movement of slash and soils (per WAC 222-30-060 (6) (b)).

8.0 USE OF THIS REPORT

We have prepared this report for use by Nielsen Brothers Inc. This report is not applicable to other locations or for other purposes. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

There are always risks related to slope stability issues in mountainous areas. These areas are naturally active geologically with respect to mass wasting, erosional and sedimentation processes exacerbated by other factors such as earthquakes, extreme precipitation events and climate change. This risk related to slope stability issues can be reduced using currently accepted and prescribed methods, but the risk cannot be eliminated. Proper logging methods, including road construction/decommissioning, drainage and erosion control, before and after logging, are key to reducing risks of slope instability.

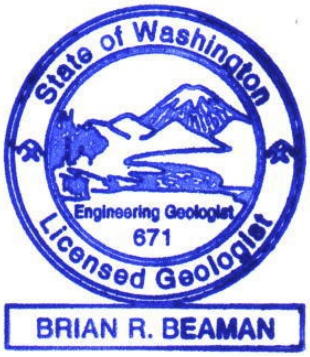
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time this report was prepared. No warranty, express or implied, should be understood.

****

We trust this report meets your present needs. Please contact us with any questions.

Yours very truly,
Icicle Creek Engineers, Inc.

Kathy S. Killman, LEG
Principal Engineering Geologist



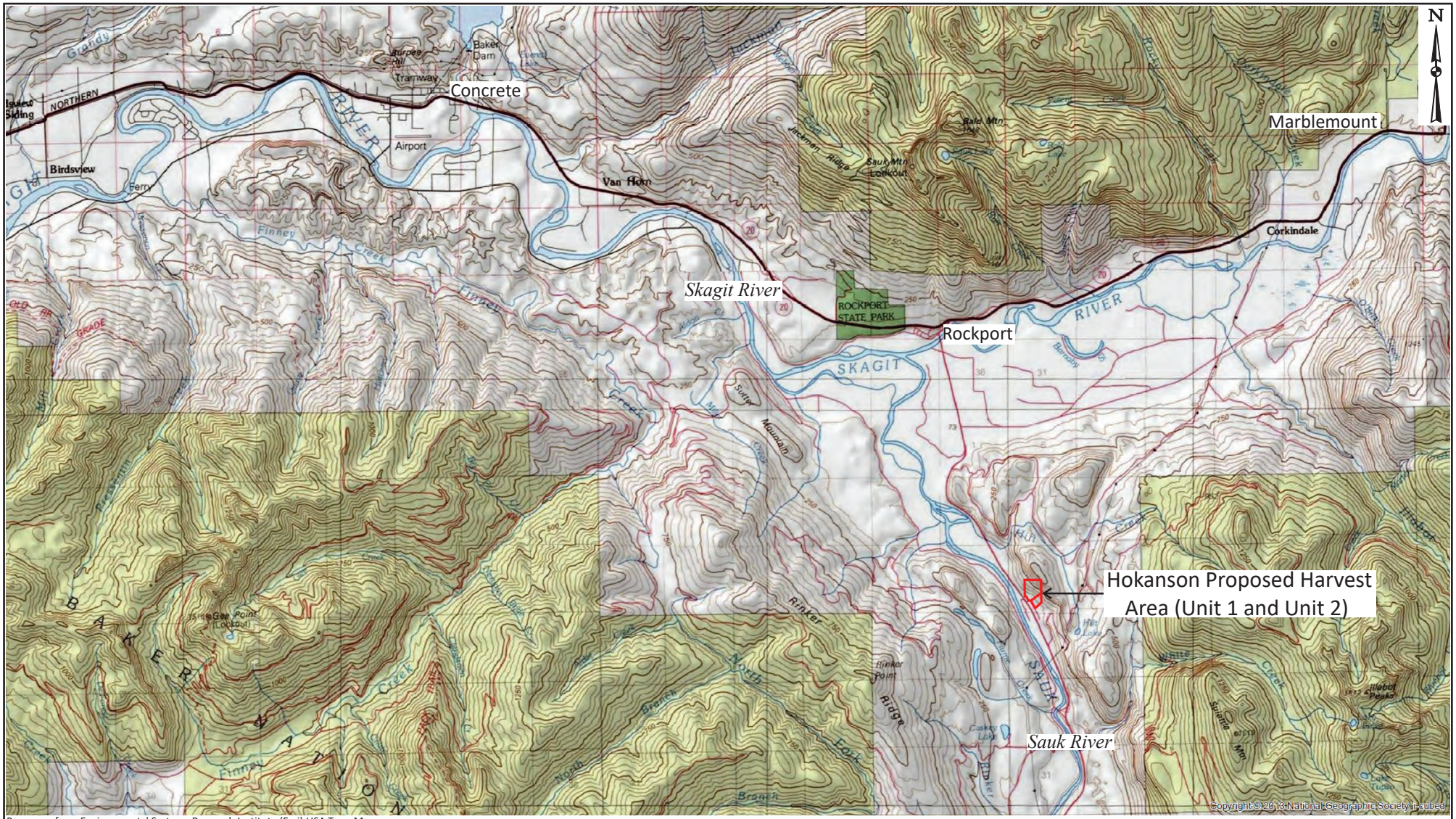
Brian R. Beaman, PE, LEG, LHG
Principal Engineer/Geologist/Hydrogeologist

Attachments: Vicinity Map – Figure 1
Forest Practices Activity Map – Unit 1 - Figure 2
Forest Practices Activity Map – Unit 2 – Figure 3
Field Review Route Map – Figure 4
Slope Map – Figure 5
LiDAR Image – Figure 6
Geologic Map – Figure 7
1953 and 1963 Aerial Photographs – Figure 8
1972 and 2003 Aerial Photographs – Figure 9
2011 and 2019 Aerial Photographs – Figure 10
Potentially Unstable Slopes and Landforms Map – Figure 11

Document ID: 1319007.report

Submitted via email

FIGURES



Base map from Environmental Systems Research Institute (Esri) USA Topo Maps

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Approximate Scale in Miles

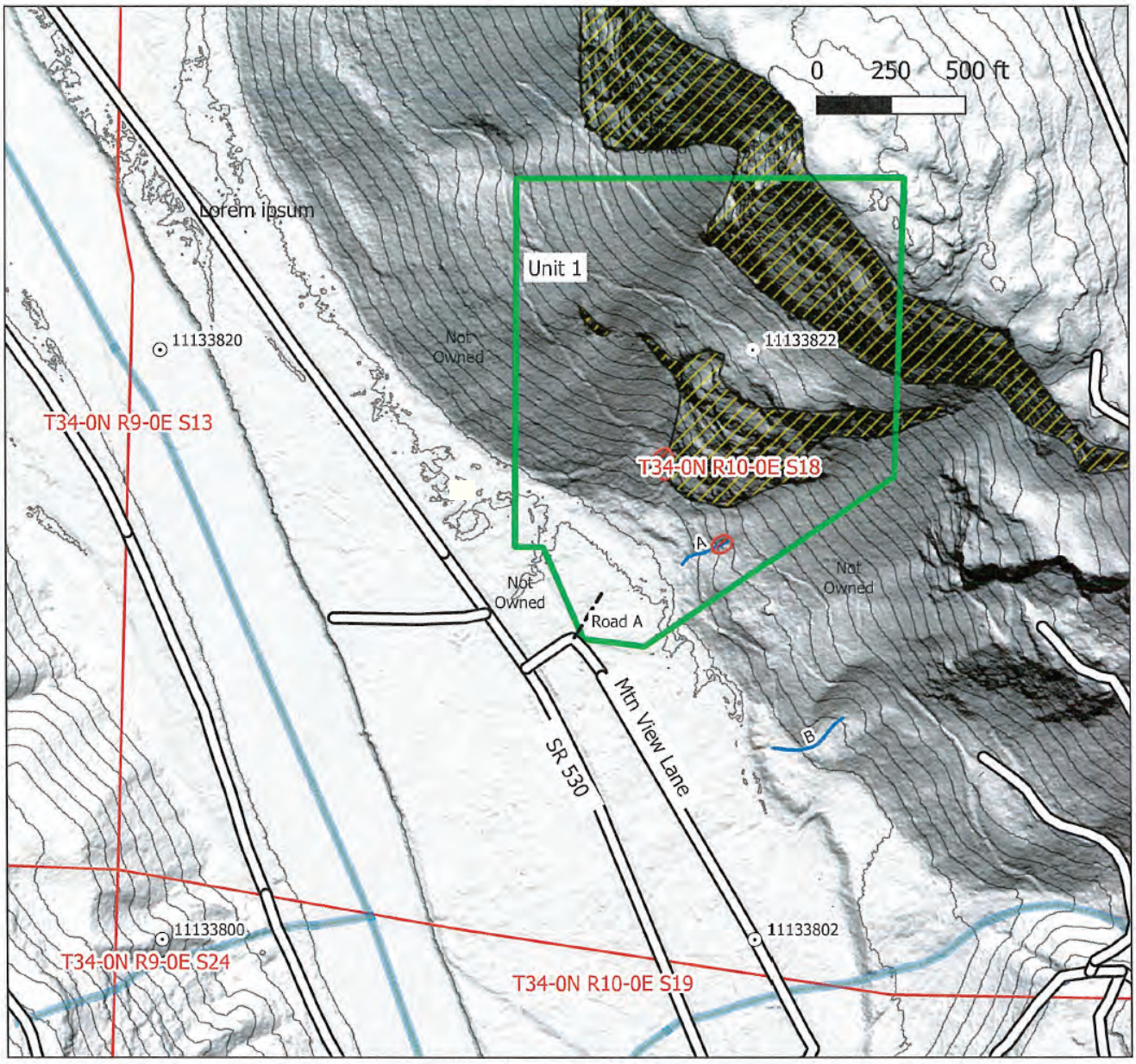
VICINITY MAP

HOKANSON PROPOSED HARVEST AREA

ICICLECREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

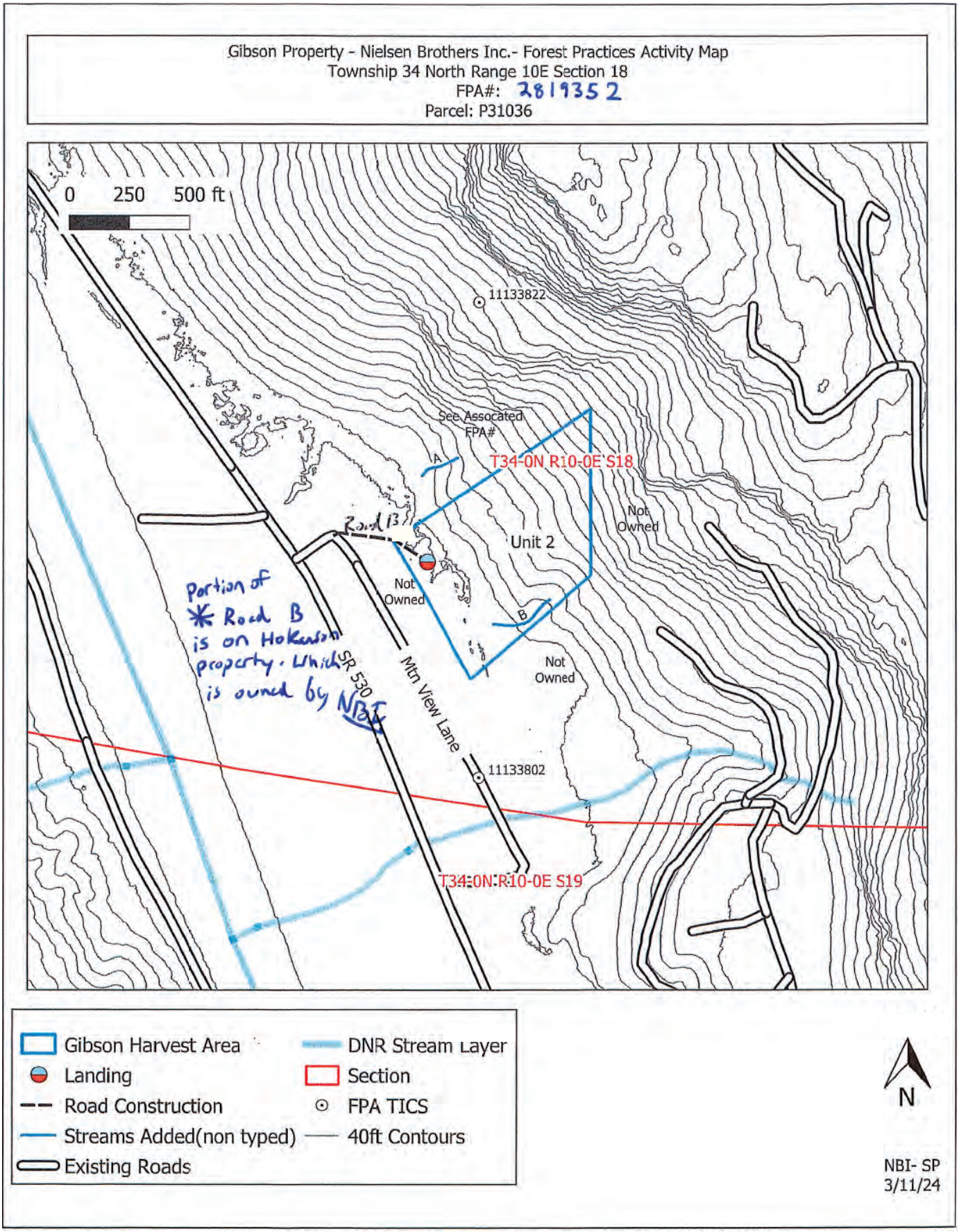
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DRAWN: BRB	Figure
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DATE: 11/22/24	

Hokanson Property - Nielsen Brothers Inc.- Forest Practices Slope Stability Activity Map
Township 34 North Range 10E Section 18
FPA#:



Forest Practices Activity Map dated April 11, 2024 provided by NBI

FOREST PRACTICES ACTIVITY MAP - UNIT 1	ICICLECREEK ENGINEERS 29335 NE 20th Street Carnation, Washington 98014 (425) 333-0093	SCALE: As Shown DESIGNED: --- DRAWN: BRB CHECKED: KSK DATE: 11/22/24	ICE FILE NO. 1319-007 Figure 2
HOKANSON PROPOSED HARVEST AREA			



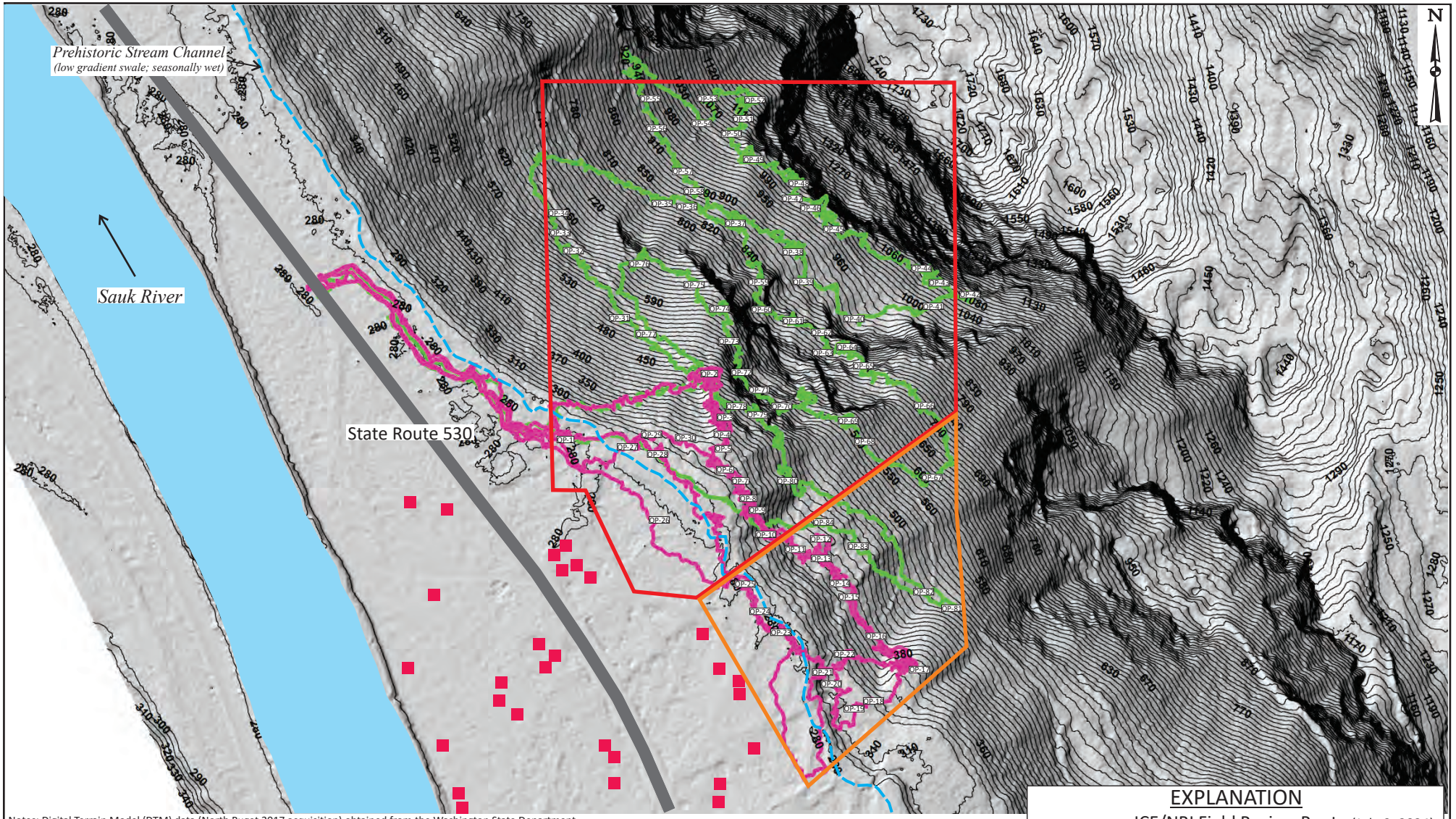
Forest Practices Activity Map dated March 11, 2024 provided by NBI

FOREST PRACTICES ACTIVITY MAP - UNIT 2

HOKANSON PROPOSED HARVEST AREA

ICICLECREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As Shown	ICE FILE NO.
DESIGNED: ---	1319-007
DRAWN: BRB	Figure
CHECKED: KSK	3
DATE: 11/22/24	



Notes: Digital Terrain Model (DTM) data (North Puget 2017 acquisition) obtained from the Washington State Department of Natural Resources, Washington LiDAR Portal (https://lidarportal.dnr.wa.gov/) processed by ICE for LiDAR image and 10-foot topographic contours using Environmental Systems Research Institute (Esri) ArcGIS 10.6.

EXPLANATION

- ICE/NBI Field Review Route (July 9, 2024)
- ICE/NBI Field Review Route (July 11, 2024)
- OP-22 Observation Points (see report text)
- Existing Structures - Houses, sheds and other buildings (from 2019 aerial photograph)
- Hokanson Proposed Harvest Unit 1
- Hokanson Proposed Harvest Unit 2

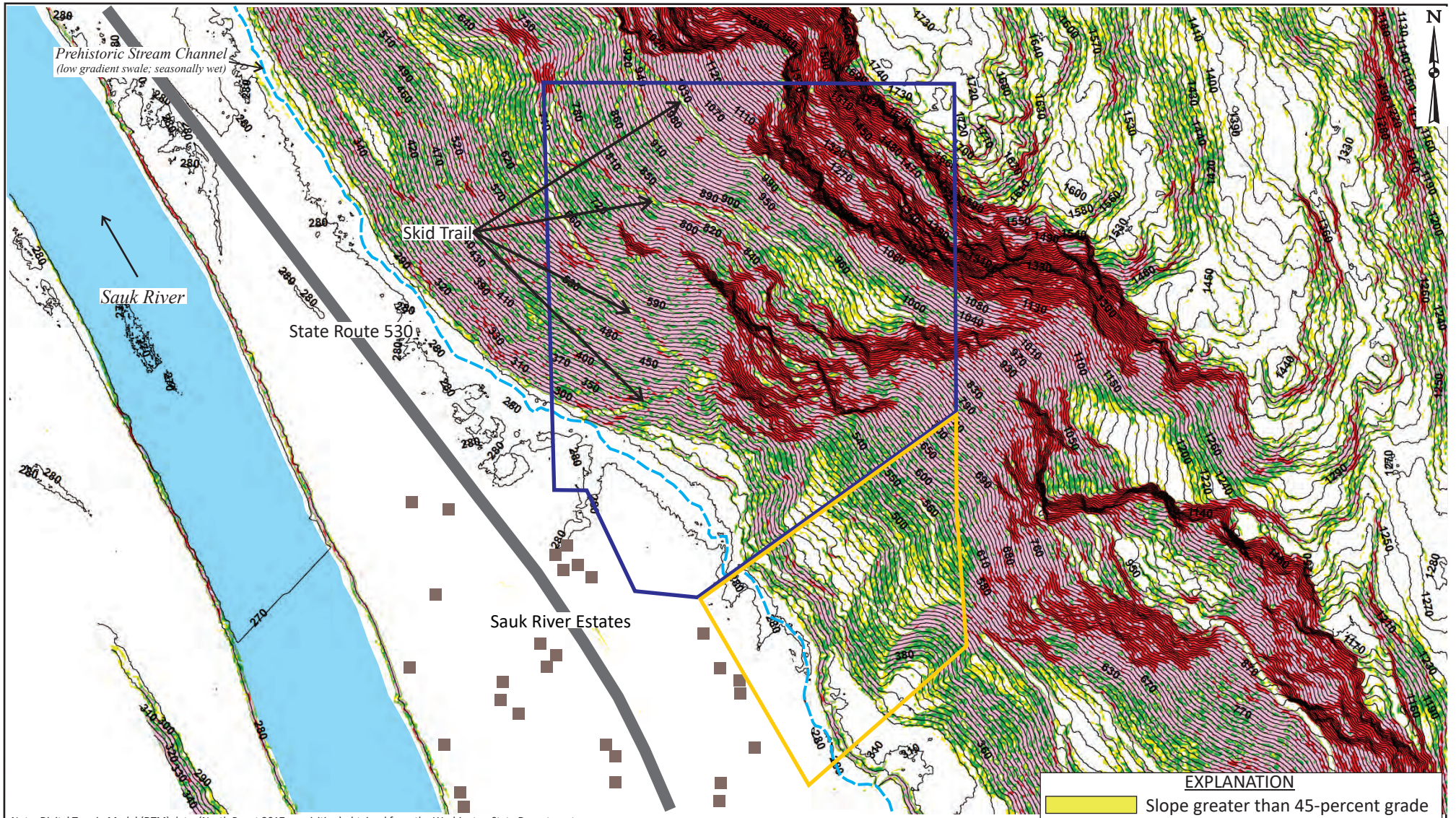
0 750 1,500
Approximate Scale in Feet

FIELD REVIEW ROUTE MAP

HOKANSON PROPOSED HARVEST AREA

ICICLE CREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As shown	ICE FILE NO.
DESIGNED: ---	1319-007
DRAWN: BRB	Figure
CHECKED: KSK	4
DATE: 11/22/24	



Note: Digital Terrain Model (DTM) data (North Puget 2017 acquisition) obtained from the Washington State Department of Natural Resources, Washington LiDAR Portal (https://lidarportal.dnr.wa.gov/) processed by ICE for 10-foot topographic contours and 45-,-55, -70 and 100-percent slope using Environmental Systems Research Institute (Esri) ArcGIS 10.6.

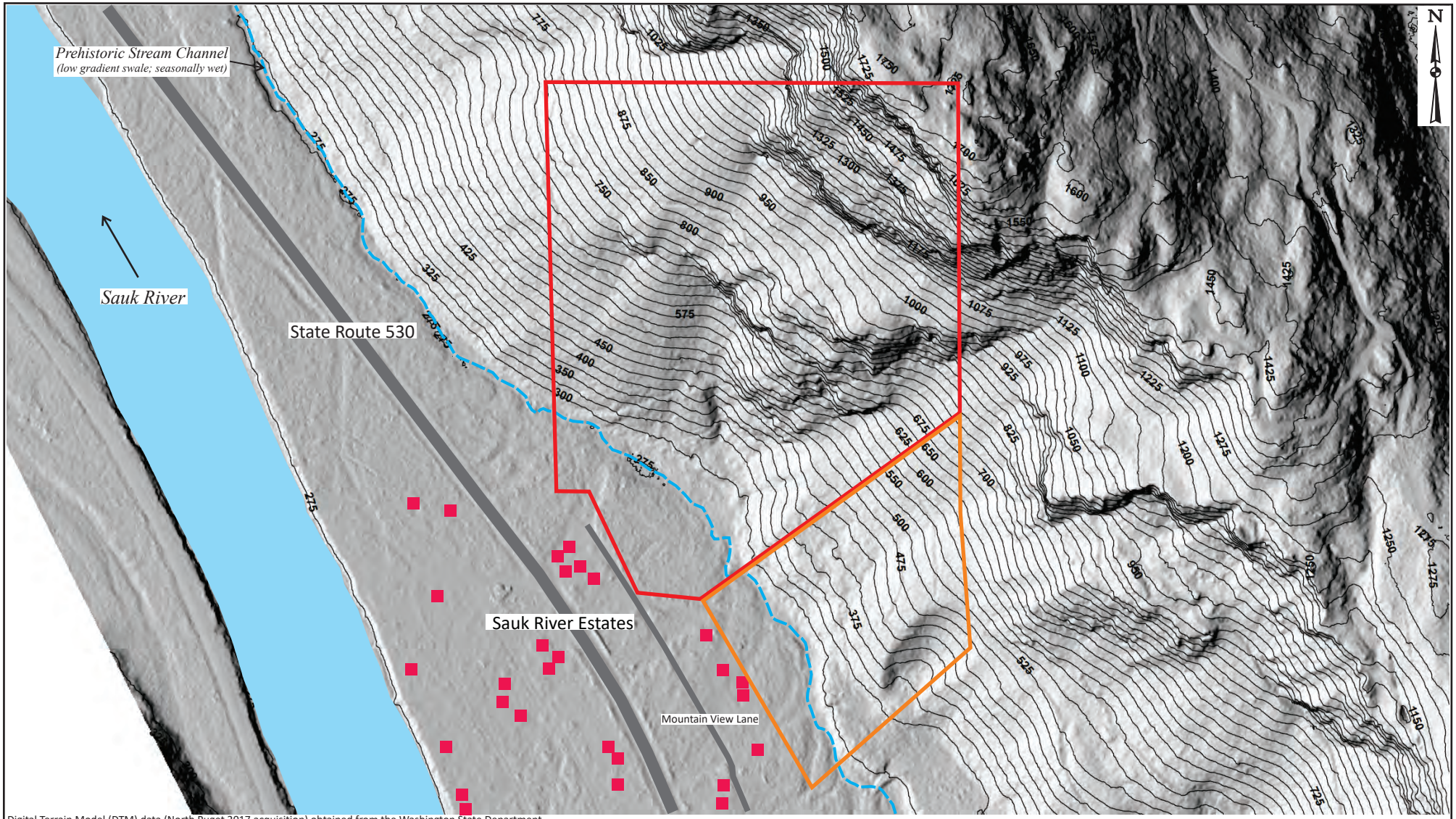
0 750 1,500
Approximate Scale in Feet

SLOPE MAP

HOKANSON PROPOSED HARVEST AREA

ICICLECREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As shown	ICE FILE NO.
DESIGNED: ---	1319-007
DRAWN: BRB	Figure
CHECKED: KSK	5
DATE: 11/22/24	



Digital Terrain Model (DTM) data (North Puget 2017 acquisition) obtained from the Washington State Department of Natural Resources, Washington LiDAR Portal (https://lidarportal.dnr.wa.gov/) processed by ICE for LiDAR image using Environmental Systems Research Institute (Esri) ArcGIS 10.6.

EXPLANATION

- Existing Structures - Houses, sheds and other buildings (from 2019 aerial photograph)
- Hokanson Proposed Harvest Unit 1
- Hokanson Proposed Harvest Unit 2

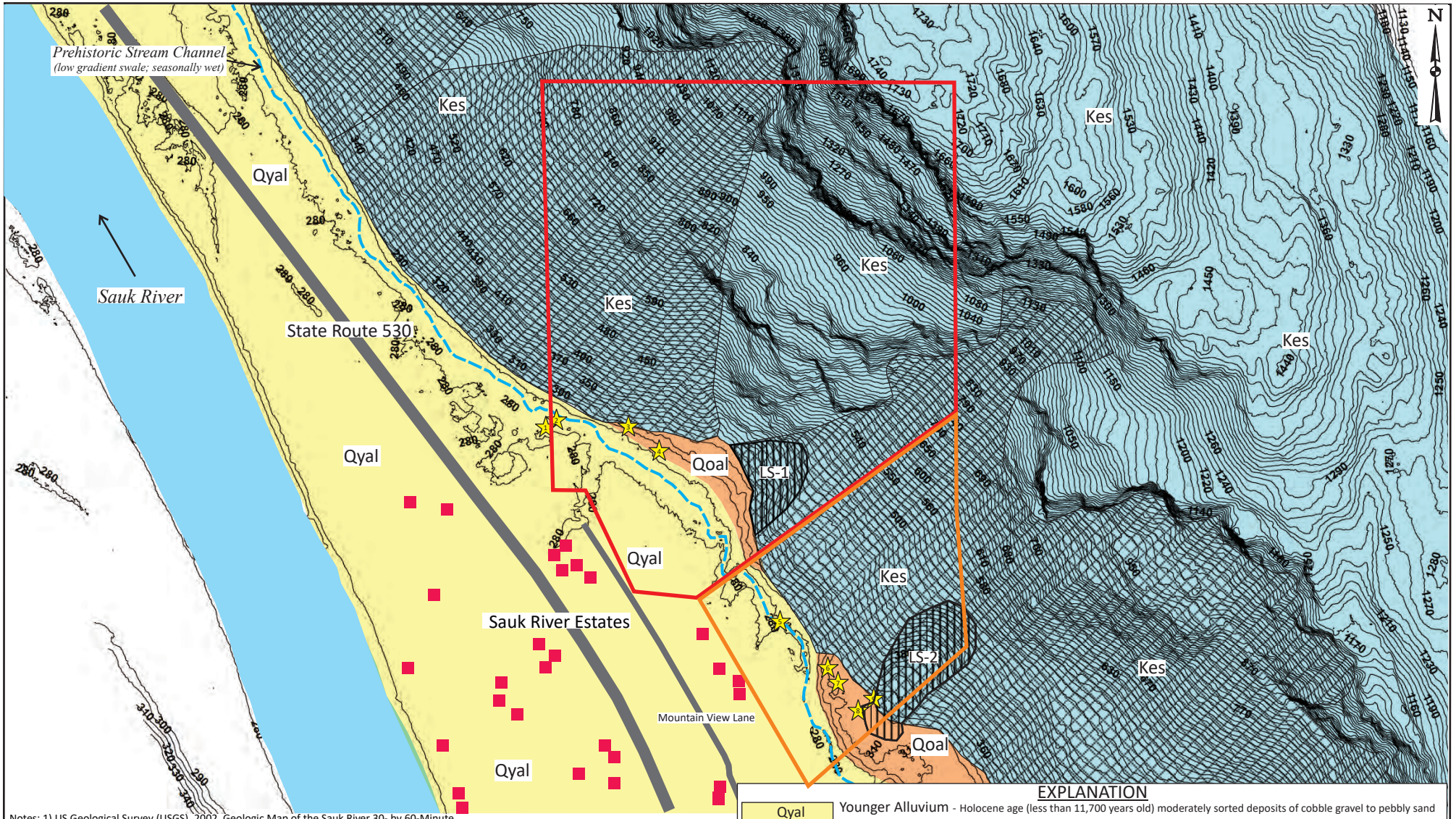
0 750 1,500
Approximate Scale in Feet

LIDAR IMAGE

HOKANSON PROPOSED HARVEST AREA

ICICLE CREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: None	ICE FILE NO.
DESIGNED: ---	1319-007
DRAWN: BRB	Figure
CHECKED: KSK	6
DATE: 11/22/24	



Notes: 1) US Geological Survey (USGS), 2002, Geologic Map of the Sauk River 30- by 60-Minute Quadrangle, Washington, Geologic Investigations Series I-2592; modified by ICE based on detailed topographic data and field observations.
2) Digital Terrain Model (DTM) data (North Puget 2017 acquisition) obtained from the Washington State Department of Natural Resources (DNR), Washington LiDAR Portal (https://lidarportal.dnr.wa.gov/) processed by ICE for 10-foot topographic contours using Environmental Systems Research Institute (Esri) ArcGIS 10.6.
3) Yellow Star indicates possible rockfall boulder that came to rest in the nearly level alluvial terrace area. Boulders 1 through 4 may have been caused by previous logging activities (skid trail construction and other activities).

EXPLANATION

- Qyal — Younger Alluvium - Holocene age (less than 11,700 years old) moderately sorted deposits of cobble gravel to pebbly sand along rivers and streams; gradational with Talus deposits
- Qoal — Older Alluvium - Expected to be similar to Younger Alluvium in texture; deposited by the Sauk River when it was at a higher base level; mapped by ICE based on field observations and topography (Figure 4) and LiDAR image review (Figure 6)
- Kes — Shuksan Greenschist (Easton Metamorphic Suite) - Middle to Late Jurassic (174 to 145 million years old) bedrock which originated as an ocean floor basalt that was subsequently "metamorphosed" during the early Cretaceous (145 to 100 million years ago) under high heat and pressure to create a predominately fine-grained sodic actinolite-bearing greenschist; cross-hatching indicates Talus slopes (typically softball-to car-sized rock fragments); vertical line-hatching indicates **relict** surficial landslide in Talus referred to as LS-1 and LS-2 (see section **6.6.4** of the report)
- Existing Structures - Houses, sheds and other buildings (from 2019 aerial photograph)
- Rockfall Boulder (see note 3)
- Hokanson Proposed Harvest Unit 1
- Hokanson Proposed Harvest Unit 2

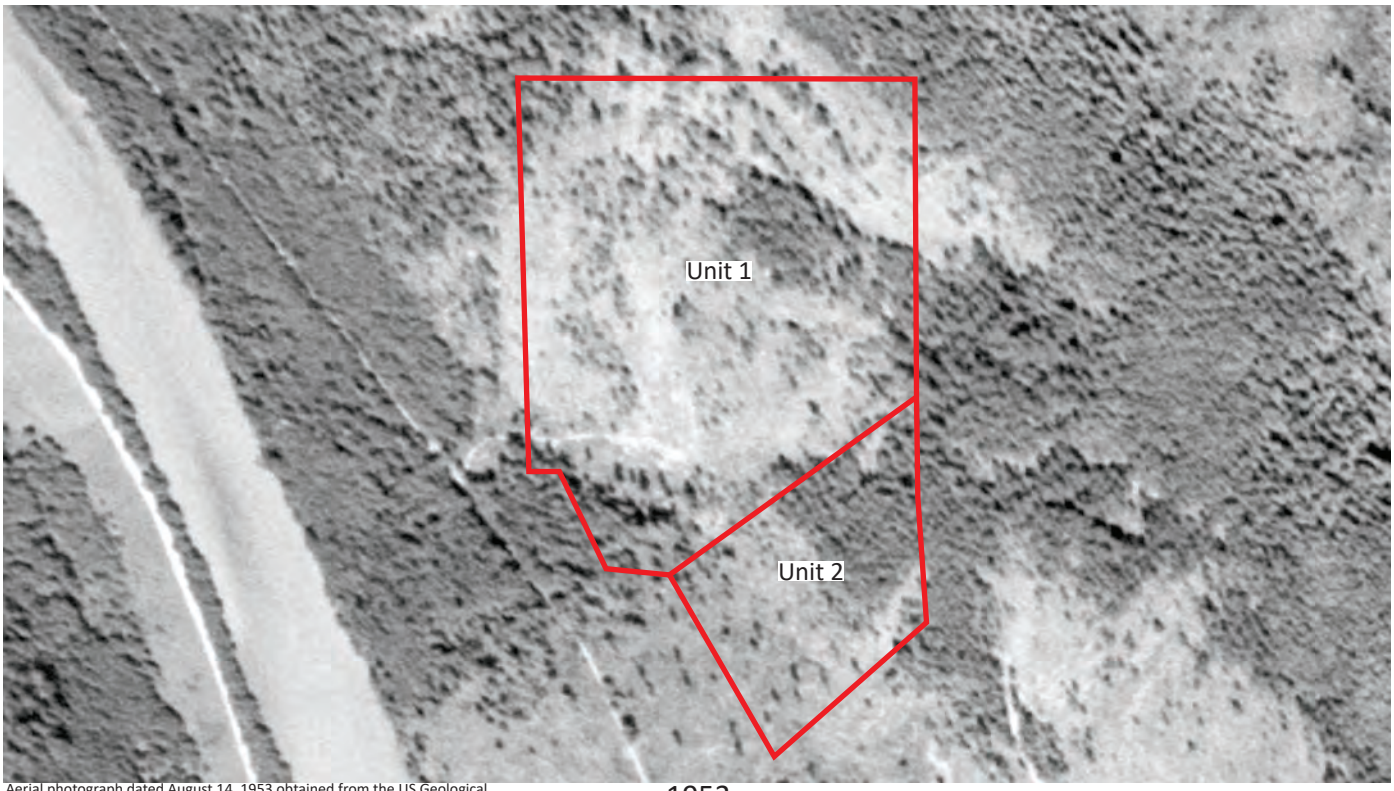
0 750 1,500
Approximate Scale in Feet

GEOLOGIC MAP

HOKANSON PROPOSED HARVEST AREA

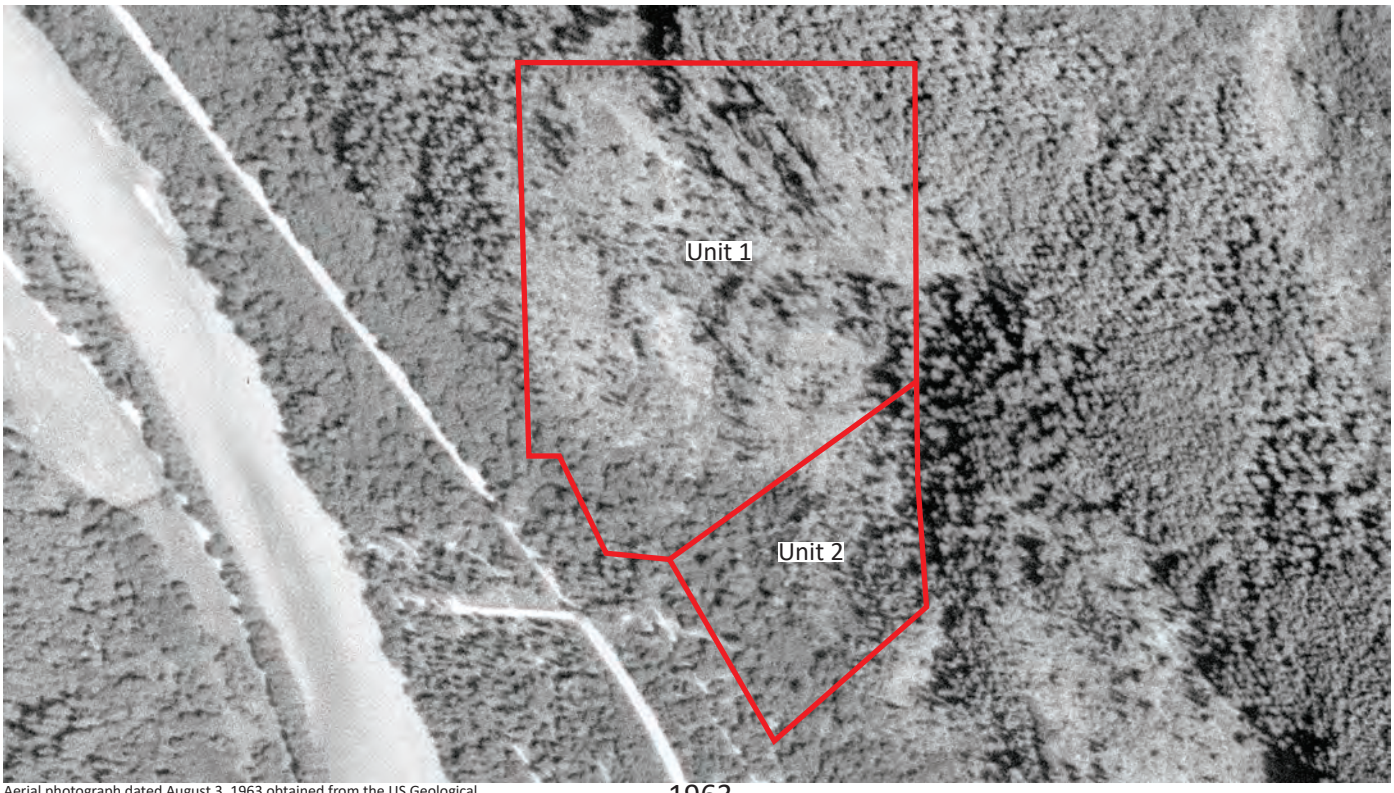
ICICLE CREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As shown	ICE FILE NO.
DESIGNED: ---	1319-007
DRAWN: BRB	Figure
CHECKED: KSK	7
DATE: 11/22/24	



Aerial photograph dated August 14, 1953 obtained from the US Geological Survey (USGS) Earth Explorer (https://earthexplorer.usgs.gov/)

1953



Aerial photograph dated August 3, 1963 obtained from the US Geological Survey (USGS) Earth Explorer (https://earthexplorer.usgs.gov/)

1963

0 1,000 2,000
Approximate Scale in Feet

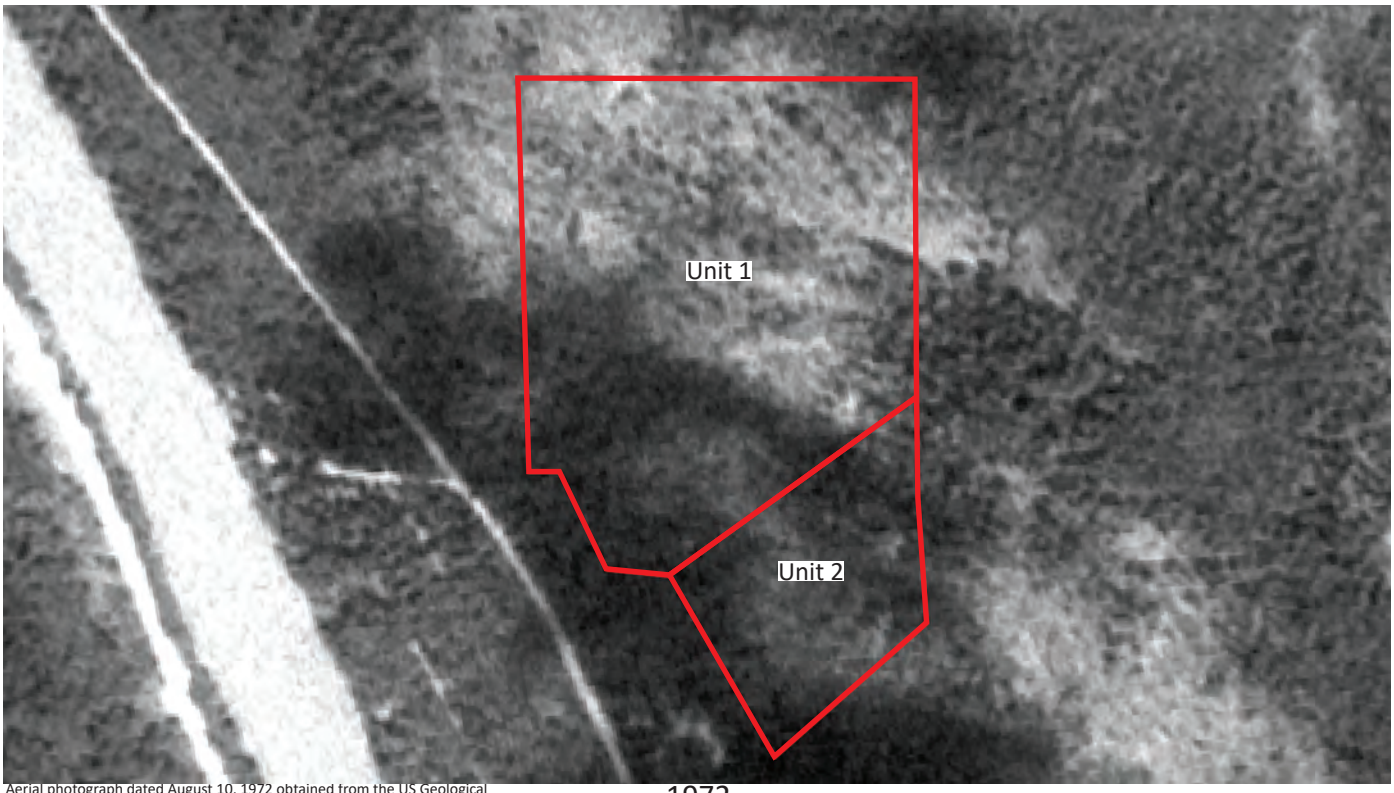
EXPLANATION
Hokanson Proposed Harvest Unit 1 and Unit 2

1953 AND 1963 AERIAL PHOTOGRAPHS

HOKANSON PROPOSED HARVEST AREA

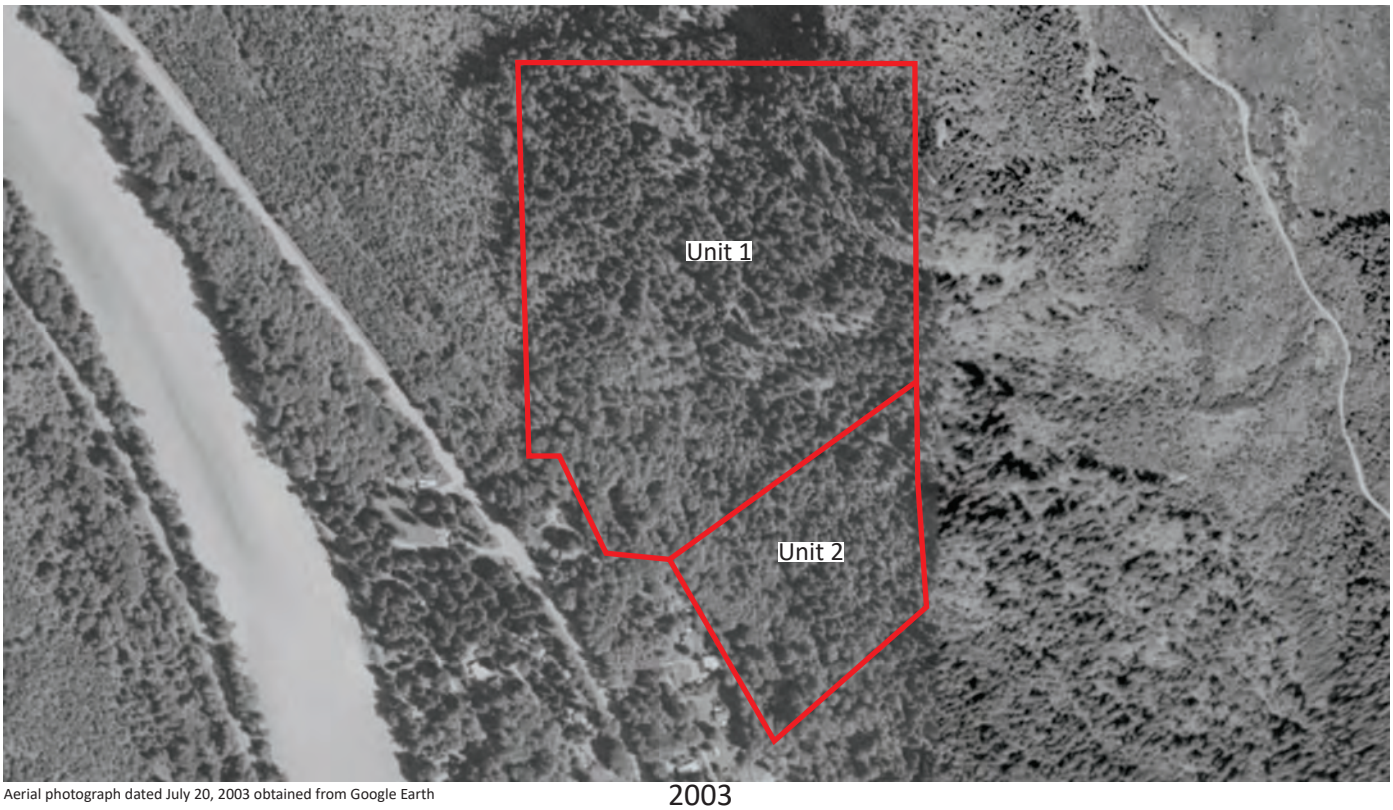
ICICLECREEK ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: As Shown	ICE FILE NO.
DESIGNED: ---	1319-007
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CHECKED: KSK	8
DATE: 11/22/24	



Aerial photograph dated August 10, 1972 obtained from the US Geological Survey (USGS) Earth Explorer (https://earthexplorer.usgs.gov/)

1972



Aerial photograph dated July 20, 2003 obtained from Google Earth

2003

0 1,000 2,000

Approximate Scale in Feet

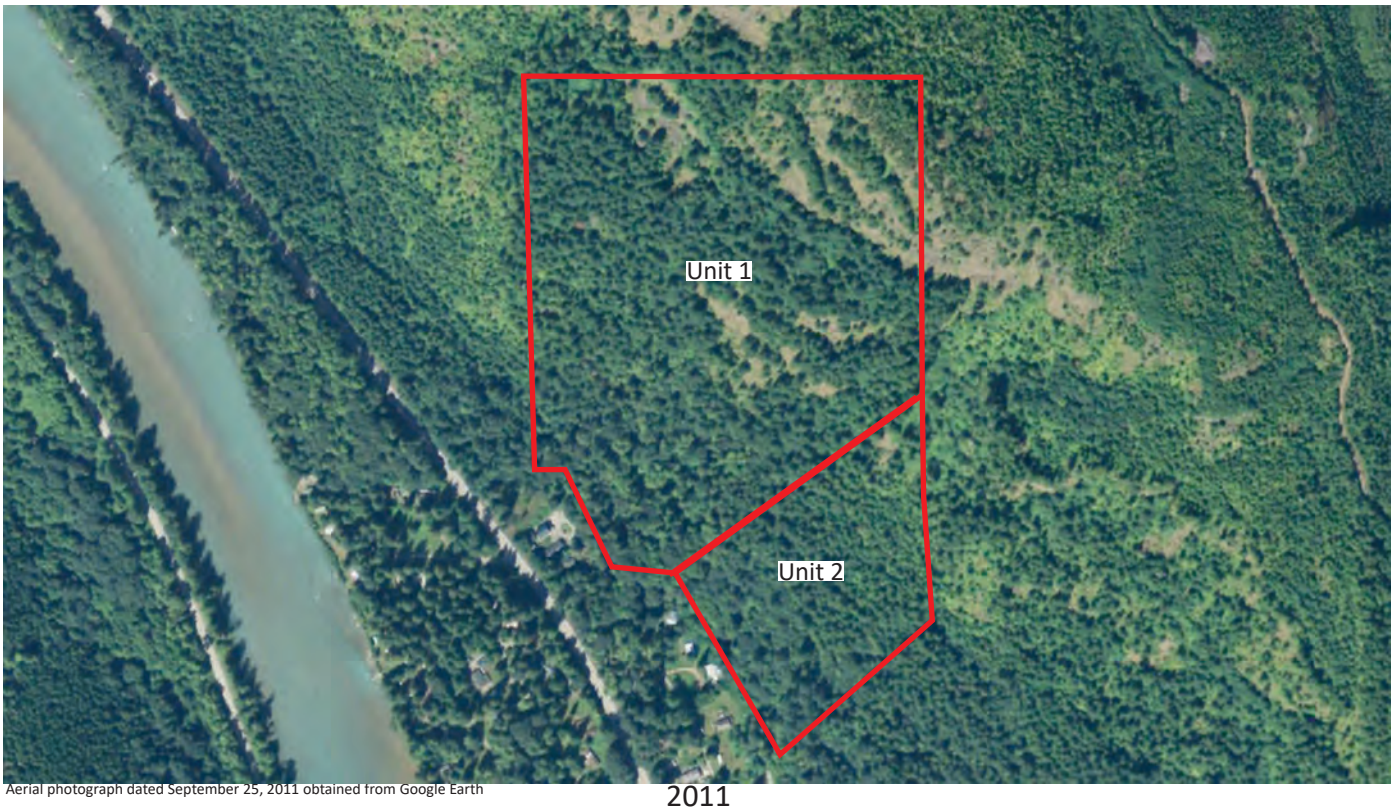
EXPLANATION

Hokanson Proposed Harvest Unit 1 and Unit 2

HOKANSON PROPOSED HARVEST AREA

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CHECKED: KSK	9
DATE: 11/22/24	



Aerial photograph dated September 25, 2011 obtained from Google Earth

2011



Aerial photograph dated July 25, 2019 obtained from Google Earth

2019

0 1,000 2,000

Approximate Scale in Feet

EXPLANATION

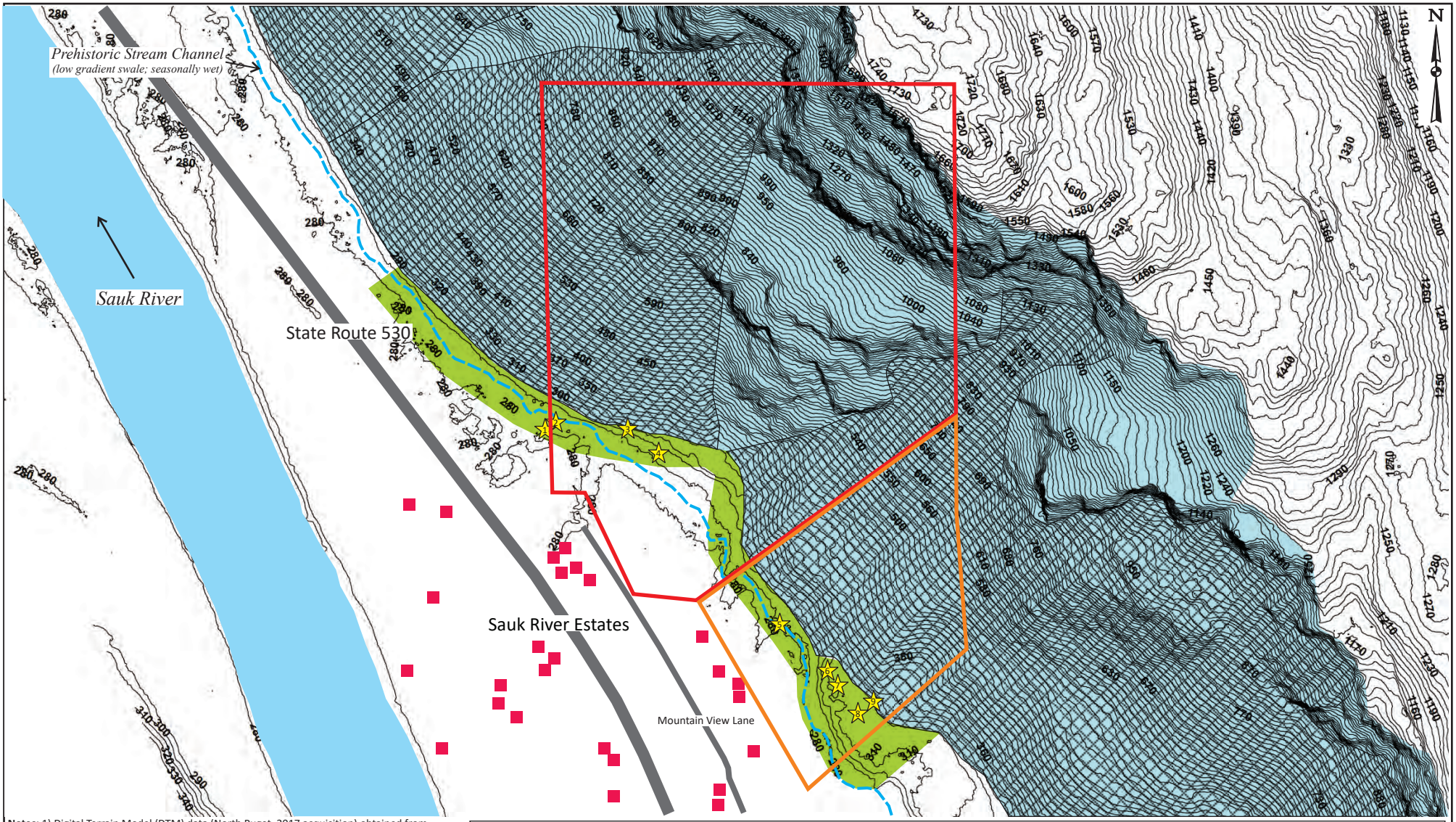
Hokanson Proposed Harvest Unit 1 and Unit 2

2011 AND 2019 AERIAL PHOTOGRAPHS

HOKANSON PROPOSED HARVEST AREA

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CHECKED: KSK	10
DATE: 11/22/24	



Notes: 1) Digital Terrain Model (DTM) data (North Puget 2017 acquisition) obtained from the Washington State Department of Natural Resources, Washington LiDAR Portal (https://lidarportal.dnr.wa.gov/); processed by ICE for 20-foot topographic contour intervals using Esri ArcGIS 10.6.

2) This evaluation was completed by ICE in general accordance with WAC 222-16-050 and Section 16 of the DNR Forest Practices Board Manual.

3) A Category E RIL is defined by WAC 222-16-050 1, d, I, E as *"Any areas containing features indicating the presence of potential slope instability which cumulatively indicate the presence of unstable slopes."*

EXPLANATION

- Rockfall Hazard Area - low risk (see report for details) Cross-hatching indicates talus slopes (typically softball- to car-sized rock fragments)
- Rockfall Runout Area - low risk (see report for details) Existing rockfall boulders that ran-out to the terrace may be several thousands of years old
- Rule-Identified Landforms (RILs) - No defined RILs exist such as Bedrock Hollow, Inner Gorge, Toes of Deep-Seated Landslides, Groundwater Recharge Areas for Glacial Deep-Seated Landslides or Outer Edges of Meander Bends occur within Unit 1 or Unit 2
- Existing Structures - Houses, sheds and other buildings (from 2019 aerial photograph)
- Rockfall Boulder
- Hokanson Proposed Harvest Unit 1
- Hokanson Proposed Harvest Unit 2

0 750 1,500
Approximate Scale in Feet

POTENTIALLY UNSTABLE SLOPES AND LANDFORMS MAP

HOKANSON PROPOSED HARVEST AREA

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DATE: 11/22/24	