3026927

Engineering Geologic Risk Assessment

Conk Timber Sale

January 8, 2024

Prepared for:

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1.0 INTRODUCTION

This report documents potentially unstable landforms in and around the Conk timber harvest (proposed harvest) to supplement the Forest Practices Application (FPA) to the Washington State Department of Natural Resources (DNR) (Figure 1). We provide this information to describe the slope stability risk assessment conducted for this proposed harvest (Figure 2). This report is intended to satisfy the requirements of a Class-IV-Special FPA.

Washington's Forest Practices rules define potentially unstable landforms, commonly referred to as rule-identified landforms (RIL),[1] for purposes of classifying and reviewing FPAs and regulating in those areas. We identified two topographic groundwater recharge areas (GWRA) to dormant-indistinct glacial deep-seated landslides (DSL-1, DSL-2) in and around Unit 9.

Timber harvest is proposed in the topographic groundwater recharge area to dormant-indistinct glacial deep-seated landslide DSL-2 in Unit 9 (Figure 4, Sheet 1 & 2). In our opinion, timber harvest in the topographic groundwater recharge area to DSL-2 is the Class IV-Special trigger for this FPA. In addition, road maintenance within the road prism is proposed on the existing E352423E road in the GWRA to DSL-2. No forest management activities are proposed in the GWRA to DSL-1.

Rule-identified landforms around the management area include inner gorges, bedrock hollows, and topographic GWRAs for glacial DSLs. The foresters identified and excluded bedrock hollows and inner gorges from the proposed management area. Bedrock hollows and inner gorges are documented in the Appendix D form attached to the FPA.

2.0 SCOPE OF SERVICES

Greg Morrow (LEG #19110652) and Zach Click (LEG #19115083) prepared this report. Greg is a licensed engineering geologist (LEG) and a "qualified expert" (QE) for timberland slope stability evaluations, as designated by the DNR. Zach is a licensed engineering geologist (Appendix A). Greg Morrow performed the landslide risk assessment for this report. Greg and Zach collaboratively prepared this report.

The scope of services included:

- Review of DNR GIS data including:

[1] WAC 222-16-050 (1)(d)(i)

- Digital orthophotographs: 1990-2000, 2004, 2005, 2006, 2009, 2011, 2013, 2015, 2017, 2019, 2020, 2021-2022
- Historic Aerial Photographs: 1952, 1953, 1954, 1985
- 1-meter resolution 2015 light detection and ranging (LiDAR) derivatives
  - Bare earth hill shade, slope percent, topographic contours, vegetation height, synthetic drainage paths
- 1:100,000-scale geologic mapping (Figure 3)[2]

- Field reconnaissance on:
  - May 23rd and 24th, 2023 - Greg Morrow (LEG, QE), Susie Wisehart (LEG, QE), Steven Hanson (Forester)
- Pre-application review with DNR Forest Practices on:
  - September 28, 2023 – Greg Morrow (LEG, QE), Zach Click (LEG), Steven Hanson (Forester), Jake Townsend (Unit Forester), Kyle Buckmiller (Forest Practices Forester) Esten King (LG) (Forest Practices Geologist)
- Preparation of this report

3.0 SITE AND PROJECT DESCRIPTION

The proposed Conk timber sale is located on gentle to steep glacial and bedrock slopes southwest of Conconully, Washington. Managed forestlands surround the proposed harvest area in the West Fork Salmon Creek and Lower Salmon Creek Watershed Administrative Units (WAU) (Figure 1).

The timber sale consists of fifteen variable retention harvest (VRH) units. Road access primarily uses existing grades. DNR plans approximately .5 miles of new road construction.

4.0 GEOLOGIC AND GEOMORPHIC SETTING

We reviewed the Omak 1:100,000-scale Quadrangle by Gulick and Korosec, 1990, and the Orville 1:100,000-scale Quadrangle by Stoffel, 1990, geologic maps (Figure 3). The published geologic maps indicate that the proposed harvest areas are underlain by Cretaceous-aged granodiorite (Kigd(c) and Kigd(cm)) bedrock of the western mélange belt. The geologic maps also detail several faults in the project vicinity. However, these faults are mapped outside of the proposed harvest areas and were not observed in the field.

[2] Stoffel, Keith L., compiler, 1990, Geologic map of the Oroville 1:100,000 quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 90-11, 58 p., 1 plate.

The bedrock is capped with Quaternary-aged glacial outwash (Qgo) and glacial drift (Qgd) deposits. During the Pleistocene, the Okanogan lobe of the Cordilleran ice sheet scoured the Okanogan and Methow Valleys, and deposited localized veneers of glacial sediments including glacial till, outwash, drift, and lacustrine deposits over bedrock.

In the field, we observed the following geologic units and generalized stratigraphy (Figure 3, Figure 4):

- Colluvium – angular colluvium deposits below cliffs of granodiorite, rounded alluvium in stream channels and on alluvial fans
- Landslide debris – unsorted, unstratified, dense to loose, silty, gravelly sand, reworked from glacial till or drift parent material
- Glacial till – dense to very dense, tan to brown, very silty, gravelly sand with a concrete like diamict structure, unsorted, unstratified, and low permeability . We interpreted mapped glacial drift deposits as glacial till in the areas explored during our field review
- Cretaceous-aged granodiorite – observable in outcrops and cliffs

We observed localized glacial deposits and bedrock exposures or bedrock-derived colluvium in the proposed harvest area. In and around Unit 9, we observed the area is capped with dense glacial till. We also observed landslides in glacial till above South Fork Salmon Creek. Our surficial geologic unit observations are shown on Figure 4.

We used the Washington Geology Survey (WGS) Landslide inventory, Forest Practices landslide inventory (LSI) and hazard zonation (LHZ) databases to screen the sale area for published landslide information. There are no WGS, LSI, or LHZ data available for the proposed harvest area.

5.0 HISTORIC AERIAL IMAGERY

We reviewed historic orthophotographs and aerial photographs to assess past land use and evaluate landscape changes in the proposed harvest area. Figures 5 through 10 include a representative sample of the imagery we reviewed.

The 1954 aerial photograph shows watershed-scale harvest with extensive soil disturbance from roads, skid trails, landings, and yarding scars. Continued large-scale harvest activity around the proposed management area is visible between the 1990-2000 and 2021-2022 orthophotographs (Figures 7-10).

Between the 2013 and 2015 orthophotographs, we observed timber harvest in the area of Units 9, 10, and 15. Landslides DSL-1, DSL-2, and their GWRAs appear harvested.

The road upslope of DSL-1 (USFS OW 4200000), the road which intersects the body of DSL-1 (Peacock Mountain Road), and the roads up and downslope of DSL-2 (E352423E and E352426E) are visible in the 1954 photograph and through the photo record. We did not observe offsets of these roads in the aerial imagery or in the field.

We did not observe evidence of glacial DSL activity in the reviewed imagery. The topography appears to be generally the same through the photo record. Additionally, we did not observe evidence of shallow landslides in site vicinity in the aerial imagery record. Please note that not all landslide activity is visible in historical imagery due to limitations in image resolution, timing, and sun angle.

6.0 GLACIAL DEEP-SEATED LANDSLIDES

In this section, we describe two glacial deep-seated landslides (DSL) downslope from Unit 9. The landslides discussed in this section are located on a glacial terrace composed of dense glacial till in the South Fork Salmon Creek watershed.

We identified the glacial DSLs using LiDAR and field observations. We classified the DSLs using definitions by Cruden and Varnes[3] and activity levels using Keaton and DeGraff,[4] as modified by the Washington Forest Practices Board Manual.[5]

6.1 Glacial Deep-Seated Landslide (DSL-1)

Landslide DSL-1 is an approximately 2.6-acre, rotational-translational, dormant-indistinct glacial DSL located between Unit 9 and Unit 15. The topographic groundwater recharge area (GWRA) upslope of DSL-1 is approximately 5.5-acres. DSL-1 and its topographic GWRA are excluded from the proposed management boundaries.

During our field review we observed soils in and around DSL-1 are relatively thin glacial till deposits over granodiorite bedrock. Based on the presence of low-permeability glacial till over bedrock upslope of the landslide, we delineated an approximately 5.5-acre topographic groundwater recharge area (GWRA).

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[3] D.M. Cruden and D.J Varnes, *Landslide Types and Processes, in Landslides Investigation and Mitigation Special Report 247* (Transportation and Research Board, National Research Council, 1996), p. 36-75.

[4] J. R. Keaton and J. V. DeGraff, *Chapter 9 – Surface Observation and Geologic Mapping* (Landslides: Investigations and Mitigation, 1996), pp. 178 – 230.

[5] Washington Forest Practices Board Manual, *Section 16 Guidelines for Evaluating Potentially Unstable Slopes and Landforms* (Olympia: Washington Department of Natural Resources, 2016), p. 44-45.

In the field we confirmed the presence of landslide topography. We made the following field and remote observations:

- Smooth headscarp with rolling and benched topography on the landslide body.
- Mature and vertical conifer and intact old growth stumps on the landslide scarp, body and toe.
- The landslide margins have smooth transitions onto the body and the adjacent intact hillslopes.
- We observed glacial till in a localized, recent shallow landslide scarp in the landslide headscarp. The shallow landslide is located downslope of a relief culvert outlet on the USGS road upslope. The landslide deposited on the landslide head and did not deliver to a stream.
- The toe of DSL-1 is located on an outside meander bend of South Fork Salmon Creek. The creek is incising the landslide toe and adjacent inner gorge slopes. The landslide does not appear to constrict the stream. The landslide toe slopes are maintaining a similar angle compared to nearby slopes.
- We observed granodiorite bedrock in the inner gorge of South Fork Salmon Creek adjacent to the landslide toe, and on the opposite bank.
- Peacock Mountain Road crosses the landslide body. We did not observe evidence of road offsets or disturbance related to deep-seated landslide movement in the field. The road is visible in the 1954 aerial imagery (Figure 5).

Based on our observations described in this assessment, we interpret DSL-1 as a *dormant-distinct, glacial DSL*.

Landslide DSL-1 and its topographic GWRA are excluded from the proposed management area. Therefore, it is our opinion that this proposal has a low likelihood of causing landslide reactivation that could deliver sediment and debris to South Fork Salmon Creek.

6.2 Glacial Deep-Seated Landslide (DSL-2)

Landslide DSL-2 is an approximately 0.4-acre, dormant-indistinct, rotational-translational glacial DSL located southeast of the Unit 9 boundary. The topographic GWRA upslope of DSL-2 is approximately 24-acres. Approximately 11-acres of the topographic GWRA is within the proposed harvest area of Unit 9, corresponding to about 45% of the total topographic GWRA (Figure 4, Sheet 1, Sheet 2).

DSL-2 is located upslope of South Fork Salmon Creek within an area of mapped glacial drift and granodiorite. However, during our field review we observed soils in and around Unit 9 and DSL-2 are relatively thin glacial till deposits over granodiorite bedrock. Based on the presence of low-permeability glacial till over bedrock upslope of the landslide, we delineated the 24-acre topographic groundwater recharge area (GWRA).

In the field we confirmed the presence of landslide topography. We made the following field and remote observations:

- Vague headscarp intersected by the existing E352423E road. The existing road crosses the landslide scarp and head. Headscarp is difficult to discern in the field, and appears to have been modified by a road cut and filling from historic road construction. We did not observe evidence of road offsets or disturbance related to deep-seated landslide movement (Figure 4, Sheet 2).
- Smooth benched to rolling slopes on the landslide body.
- Lateral margins transition smoothly onto the head and body.
- The landslide margins, body, and toe of the are vegetated with vertical mature timber and intact old growth stumps.
- We observed a flat terrace surface separating the landslide toe from the stream. The toe of the landslide does not extend into the stream. The terrace surface is approximately 10 feet wide and is 1 to 4 feet above the stream channel elevation. The terrace is vegetated with trees and brush and has thick forest duff (Figure 4, Sheet 2).
- We did not observe springs, seeps, or streams on the landslide body, or streams flowing from upland area in Unit 9 into DSL-2.

Based on our observations described in this assessment, we interpret DSL-2 as a *dormant-indistinct, glacial DSL*.

As stated above, the existing E352423E road alignment crosses the headscarp and body of DSL-2. The headscarp is difficult to discern and the original landslide topography was likely altered by historic road construction. In the field, we did not observe evidence of road offsets or disturbance related to deep-seated landslide movement. The road is poorly outsloped and rutted and captures surface water. The road interrupts the natural surface water flow pathways from the GWRA in Unit 9 and diverts surface water to the north, away from DSL-2.

We communicated our observations to the forester and engineer, and the DNR proposes to improve the existing road drainage to divert surface water captured by the road away from DSL-2. The proposed road improvements include a ditchline and drainage dip to be constructed

at Station 15+35 along road E352423E. The new ditch line and drainage dip will effectively capture and convey surface water away from DSL-2, diverting surface flow from Unit 9 away from DSL-2, discharging onto the forest floor. We mapped the locations of the proposed road drainage improvements on Figure 4, Sheet 2.

Based on our field observations, the glacial terrace is capped with dense, low-permeability glacial till over bedrock. The delineated GWRA on Figure 4 assumes all surface drainage from the upland in Unit 9 is contributing to DSL-2. However, the proposed ditch line and dip are designed to capture and divert surface water runoff from Unit 9 and the existing road in the GWRA away from DSL-2. Therefore, we anticipate the proposed road improvements will significantly reduce surface water contributions from Unit 9 to DSL-2, especially during rainstorms and where infiltration rates are less than precipitation throughfall rates. Figure 4, Sheet 2 shows the ditch line and dip will divert an additional approximately 24 acres (about 99% of the total GWRA) of surface drainage away from DSL-2.

Based on our assessment, the toe of DSL-2 does not extend into the creek and appears to be buttressed or buried by a flat, vegetated terrace. We did not observe springs, seeps, or streams on the landslide body or headscarp, or streams flowing into DSL-2 from the upland area in Unit 9. Therefore, we interpret that there is a low-likelihood that DSL-2 would deliver sediment to the stream.

DSL-2 appears to have been dormant for a long period of time. We did not observe evidence that past watershed-scale harvest or road construction on and around DSL-2 or its GWRA caused landslide initiation or reactivation in the aerial photograph record. Harvest operations are limited to removing timber in approximately 45% of the GWRA to DSL-2. Furthermore, the proposed road drainage improvements are designed to divert approximately 99% of surface water in the GWRA from Unit 9 away from DSL-2.

The low-likelihood of sediment delivery, lack of evidence of historic landslide movement, the limited removal of 45% of the forest stand in the GWRA, and the diversion of surface water away from DSL-2 are the basis of our opinion that the proposed harvest has a low probability of influencing slope stability or posing a risk of sediment delivery. It is our opinion that there is a low likelihood of the proposed forest management causing or contributing to movement on DSL-2.

7.0 FOREST PRACTICES RULES STATEMENTS

The following are the required Forest Practices Rule statements addressing WAC 222-10-030 (1) (*a,b,c*). These responses are based on the data and discussion presented above.

> ***(a)*** *The likelihood that the proposed forest practices will cause movement on the potentially unstable slopes or landforms, or contribute to further movement of a potentially unstable slope or landform.*

Glacial deep-seated landslide DSL-2 appears to have been dormant for a long time period, and we did not find evidence that previous road construction or clear-cut harvests on and around the landslide and its topographic GWRA caused landslide initiation or reactivation. About 45% of the topographic GWRA (11 acres) to DSL-2 is proposed for variable retention harvest. Additionally, the proposed road drainage improvements are designed to divert approximately 99% of surface water contributions from the GWRA to DSL-2. Therefore, it is our opinion that the proposal has a low likelihood of causing or contributing to an increase in landslide movement.

> ***(b)*** *The likelihood of delivery of sediment or debris to a public resource, or in a manner that would threaten public safety:*

Glacial deep-seated landslide DSL-2 appears to have been dormant for a long time period, and we did not find evidence that previous road construction or clear-cut harvests on and around the landslide and its topographic GWRA caused landslide initiation or reactivation. The toe of DSL-2 does not extend into the creek and appears to be buttressed or buried by a flat, vegetated terrace. We did not observe springs, seeps, or streams on the landslide body or headscarp, or streams flowing into DSL-2 from the upland area in Unit 9. Therefore, it is our opinion that this proposal has a low likelihood of contributing to landslide reactivation that could deliver sediment and debris to public resources or threaten public safety.

> ***(c)*** *Any possible mitigation for the identified hazards and risks:*

The proposed timber harvest is limited to approximately 45% of the topographic GWRA of DSL-2. The proposed road drainage improvements are designed to reduce approximately 99% of surface water contributions from the GWRA to DSL-2.

8.0 ASSESSMENT LIMITATIONS

This report documents potentially unstable landforms in and around the proposed Conk timber sale to supplement the FPA to the Washington State Department of Natural Resources (DNR). We provide this information to describe the slope stability risk assessment conducted for this proposed harvest. This report is intended to satisfy the requirements of a Class IV-Special FPA. Mitigation recommendations presented in this report were developed collaboratively with DNR region staff. While forest management activities inherently involve risk, the mitigations presented in this report are intended to reduce adverse impacts to slope stability due to the proposed construction and abandonment activities.

The conclusions presented in this report 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 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 memorandum. 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 accepted practices in the field of engineering geology in the region at the time of this memorandum. 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 report for any activities other than those evaluated for the proposed Conk timber sale. If any changes in the proposed timber sale or road plan are formulated or carried out differently in the field than what was evaluated, the 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.

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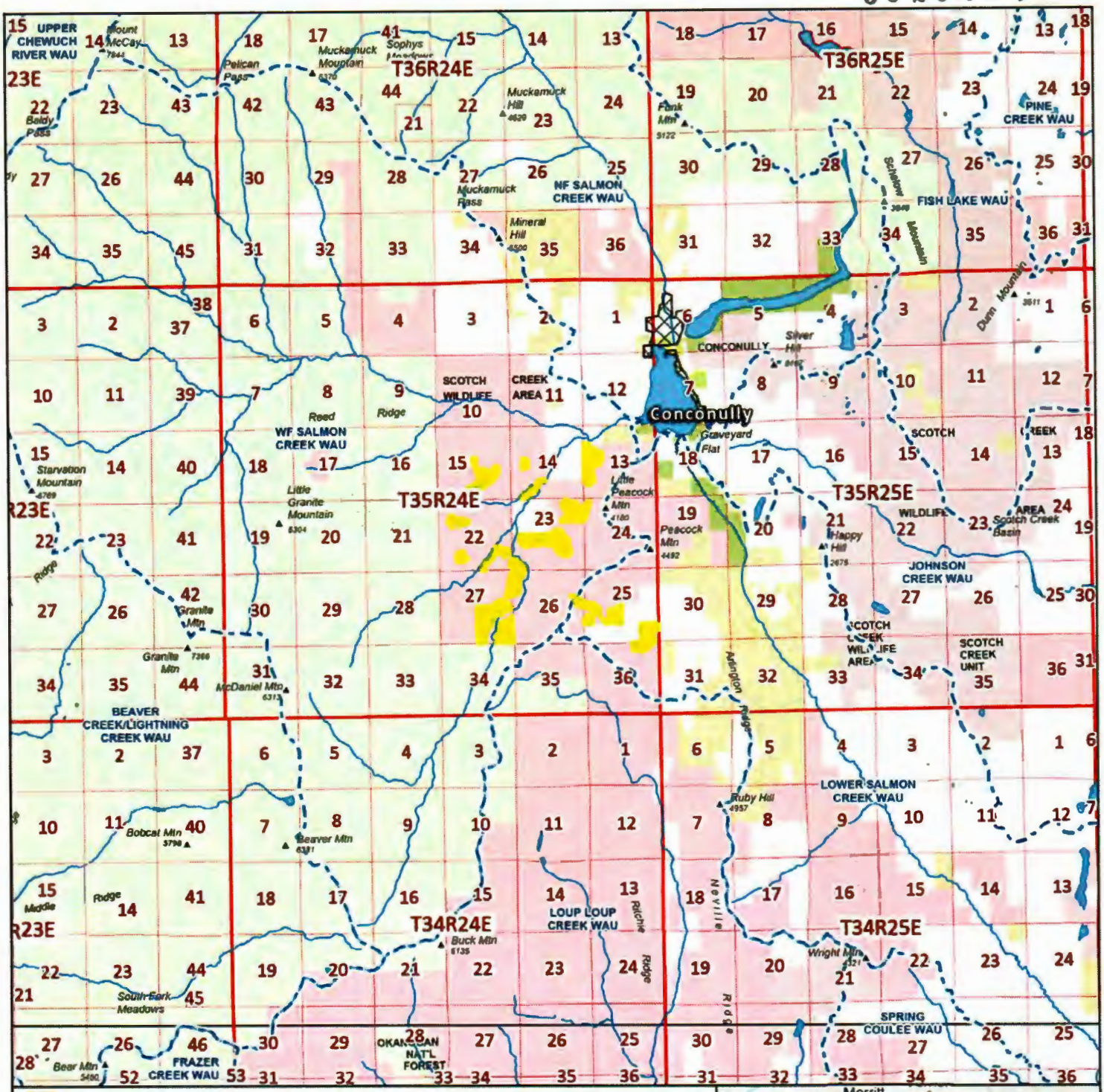
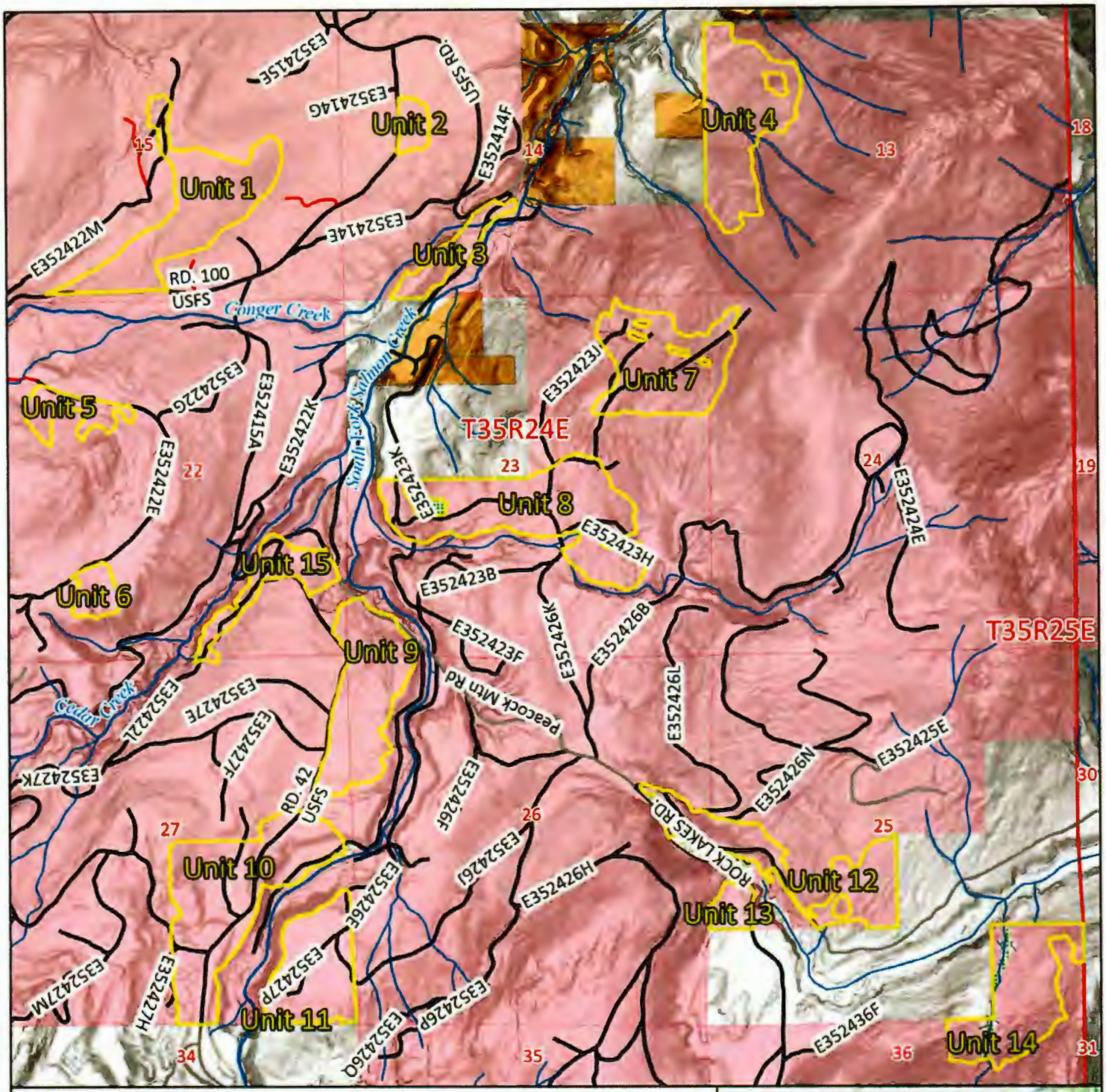


Fig. 1

VICINITY MAP

Conk Timber Sale

Washington State Department of Natural Resources



- Harvest Unit Boundary
- Leave Tree Area
- Wetland Mgt Zone
- Equipment Limitation Zone
- Forester-Delineated Stream
- County Parcels with Buildings

DNR-Managed Lands

- Granted Trust Lands
- Active roads
- Approved abandoned roads
- Non-DNR roads
- Survey - Township Lines
- Survey - Section Lines
- Major Stream

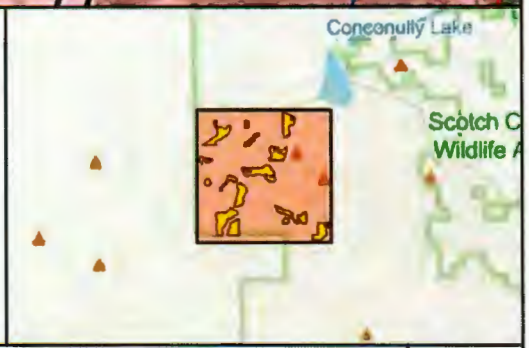


Fig. 2

SITE MAP
Conk Timber Sale

0 980 2,000 Feet
Scale: 1:24,000

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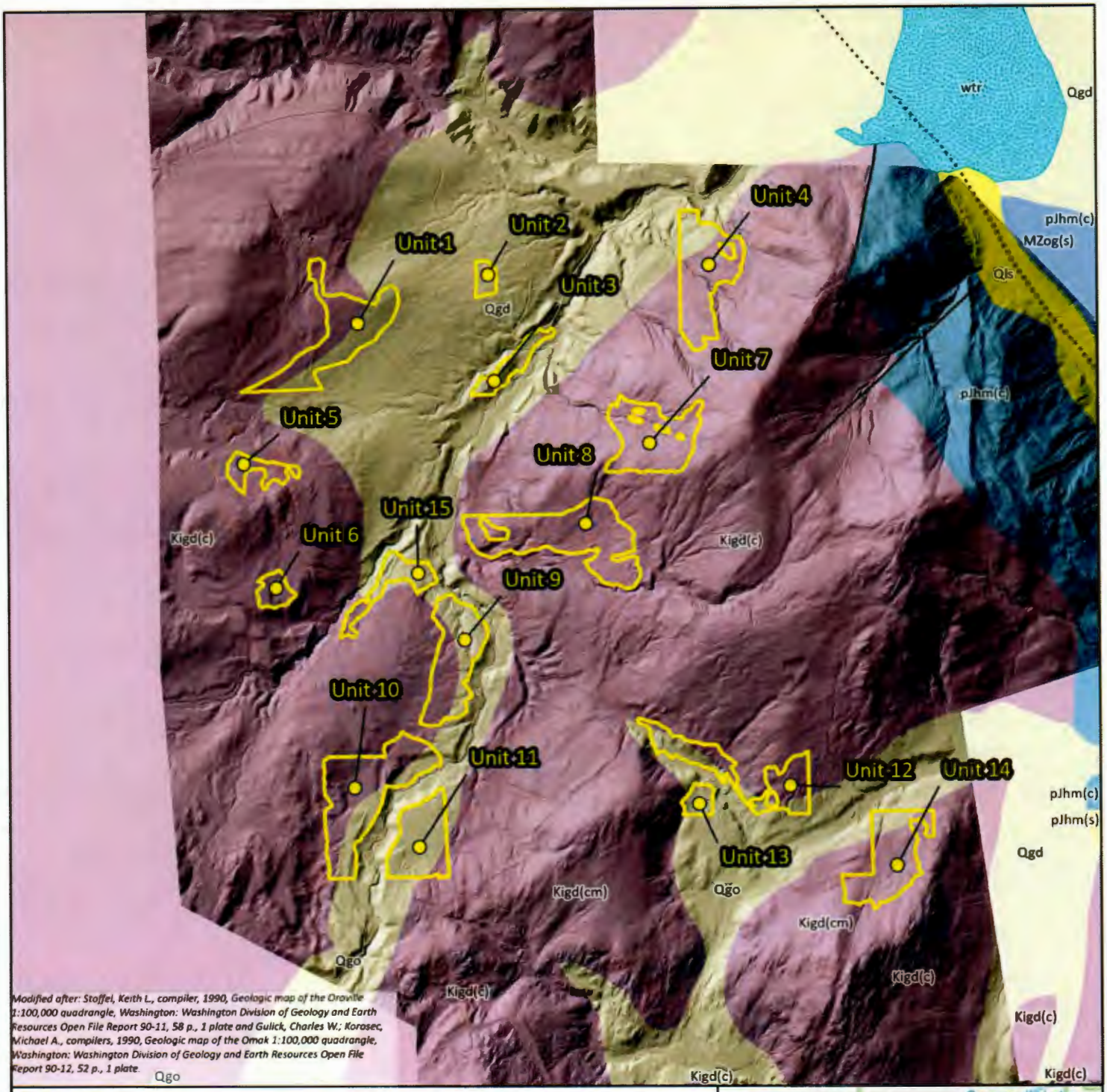

Harvest Unit Boundary

1:100,000 Geologic Units

- Kigd(c),granodiorite
- Kigd(cm),granodiorite
- MZog(s),orthogneiss
- Qgd,continental glacial drift, Fraser-age
- Qgo,continental glacial outwash, Fraser-age
- Qls,mass-wasting deposits, mostly landslides
- pJhm(c),heterogeneous metamorphic rocks
- pJhm(s),heterogeneous metamorphic rocks
- wtr,water

Geologic Faults 100K

- (A) Fault, certain accurate
- (A) Fault, certain concealed

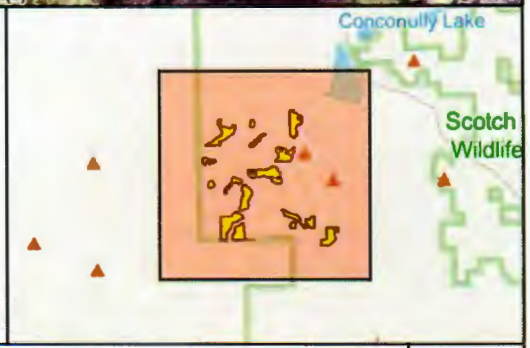

Fig. 3

1:100,000 GEOLOGIC MAP

Conk Timber Sale

0 1,000 2,000 3,000 Feet

Scale: 1:36,000

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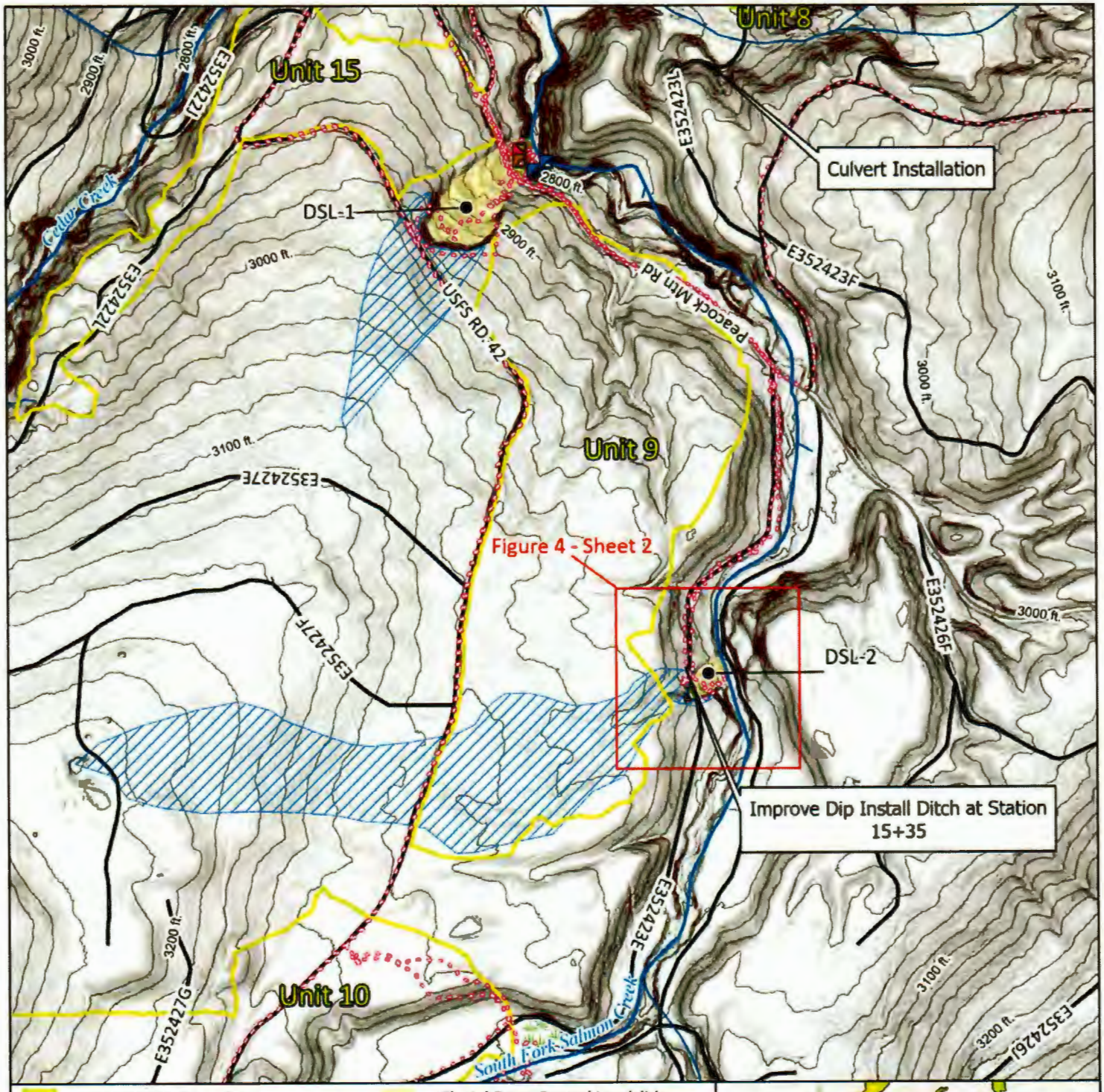

Harvest Unit Boundary
Forester-Delineated Stream
Wetland Areas

Geologic Material
Bedrock
Glacial Till
Shallow Scarp
Geologist Tracks

Glacial Deep-Seated Landslide
Topographic GWRA
Major Stream
Active roads
Non-DNR roads
Slope 0 - 70%
Slope >70%

Fig. 4
Sheet 1

UNIT 9 GEOMORPHOLOGY MAP
Conk Timber Sale

0 350 700 Feet
Scale: 1:7,200

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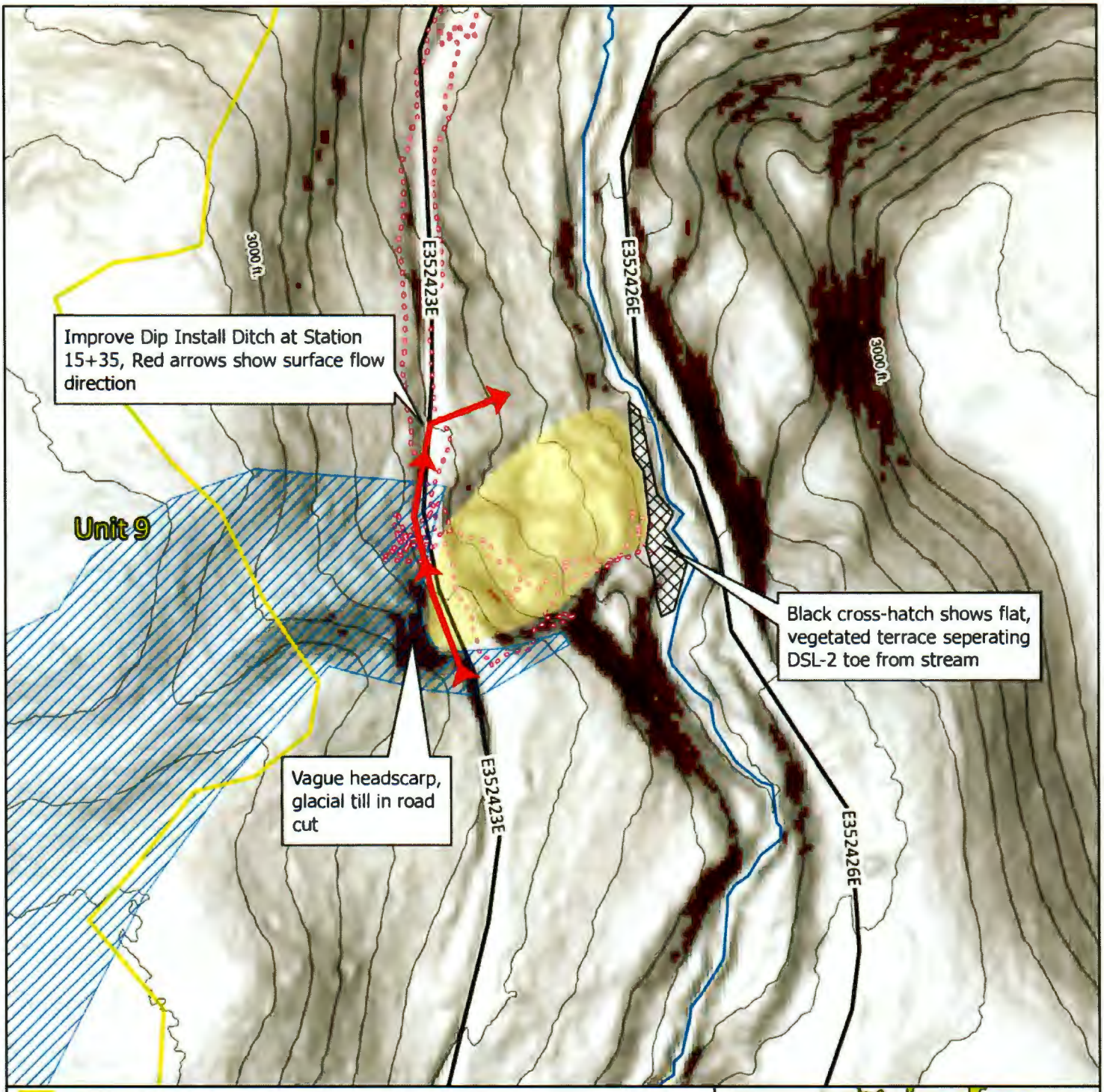

Harvest Unit Boundary
Glacial Deep-Seated Landslide
Topographic GWRA
Geologist Tracks
Stream
Active roads

Fig. 4
Sheet 2

DSL-2 GEOMORPHOLOGY MAP

Conk Timber Sale

0 50 100 Feet
Scale: 1:1,200

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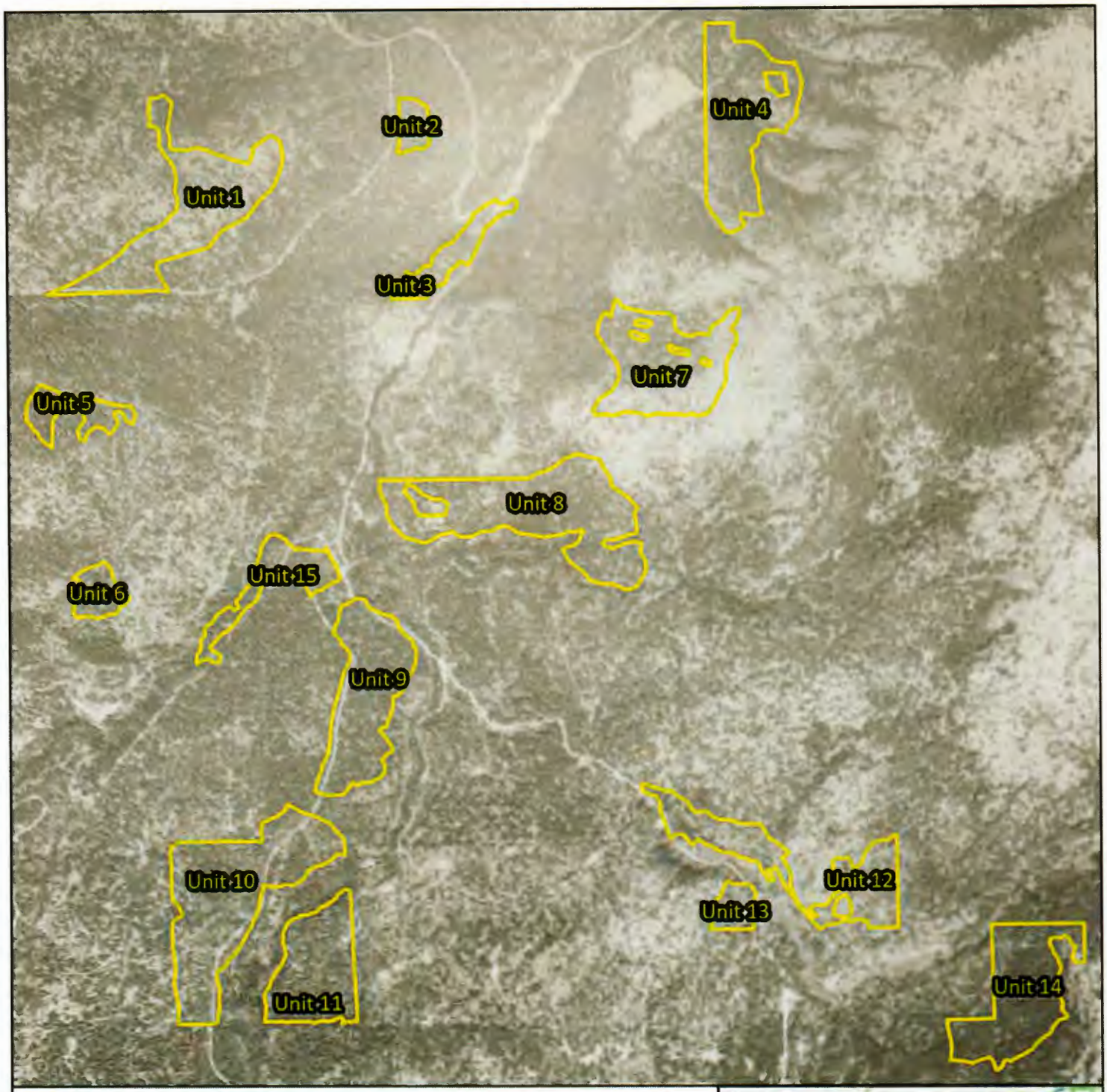
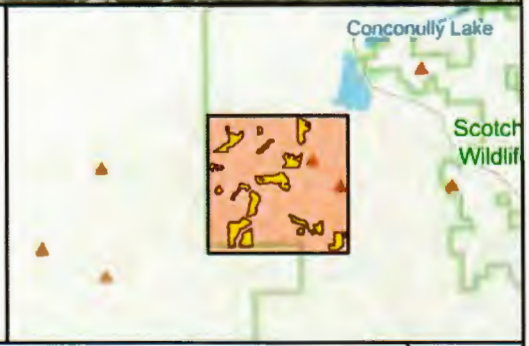


Harvest Unit Boundary



Note: Aerial photographs are approximately georeferenced

Fig. 5

1954 AERIAL PHOTOGRAPHY
Conk Timber Sale

0 980 2,000 Feet
Scale: 1:24,000

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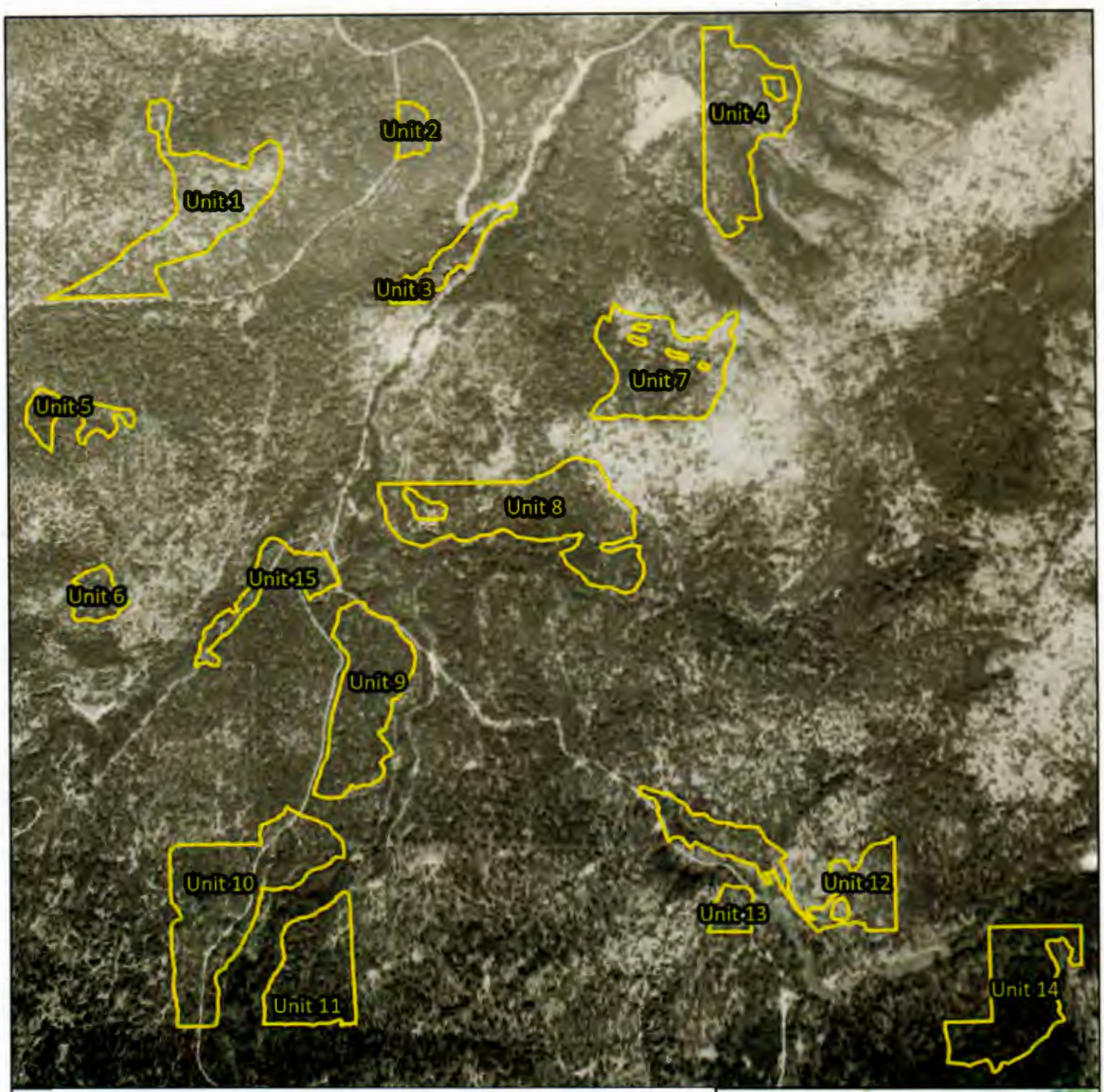
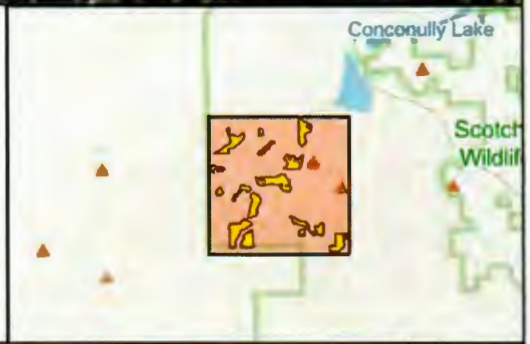


Harvest Unit Boundary



Note: Aerial photographs are approximately georeferenced

Fig. 6

1985 AERIAL PHOTOGRAPH
Conk Timber Sale

0 980 2,000 Feet
Scale: 1:24,000

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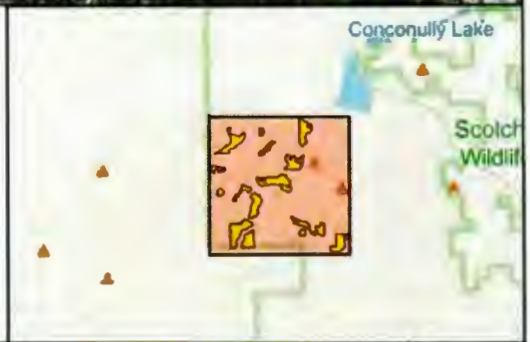
Harvest Unit Boundary



Note: Aerial photographs are approximately georeferenced

Fig. 7

1990-2000 ORTHOPHOTOGRAPH
Conk Timber Sale

0 980 2,000 Feet
Scale: 1:24,000

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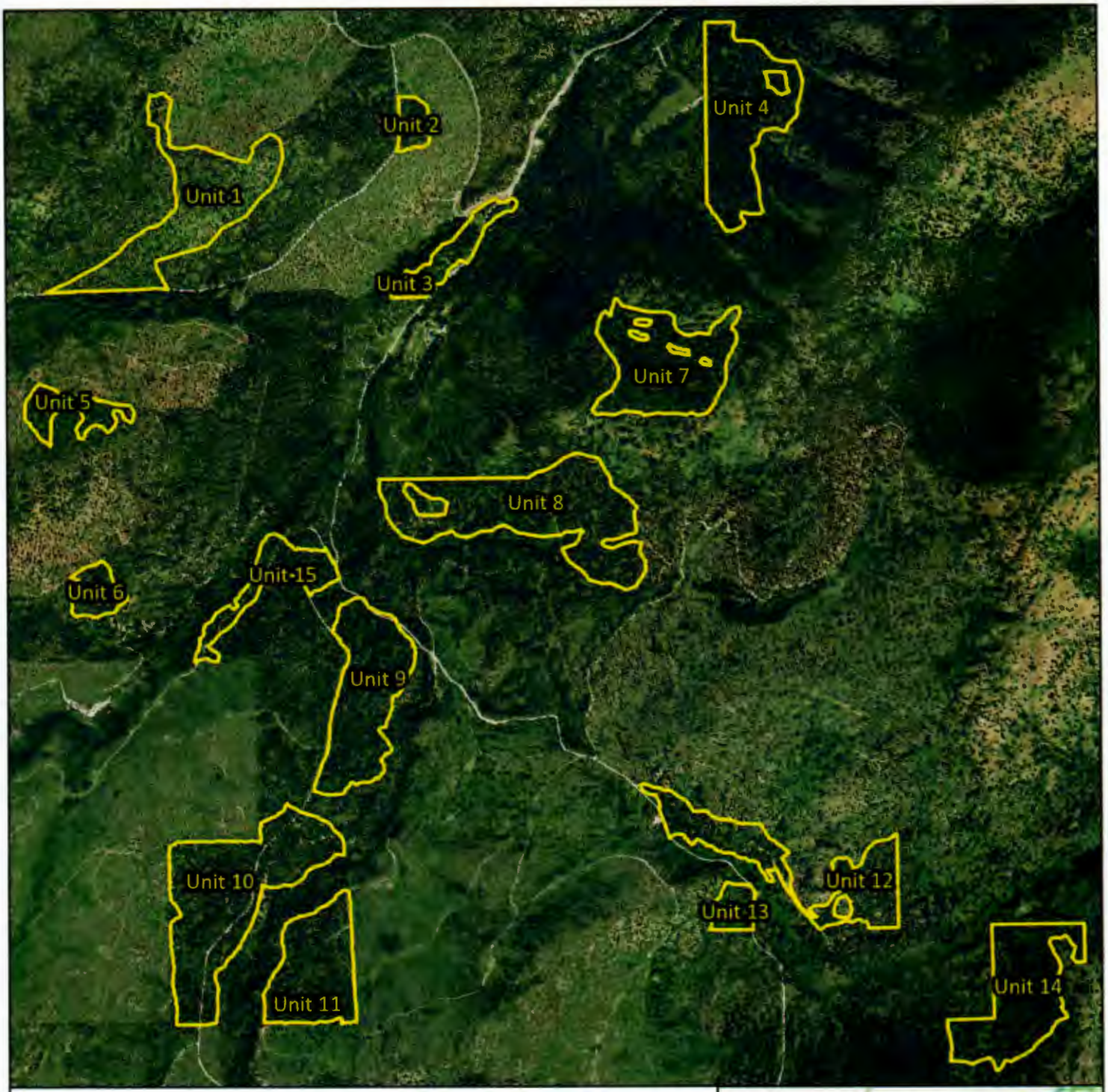
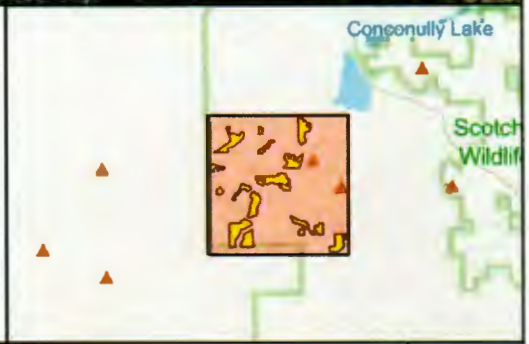


Harvest Unit Boundary



Note: Aerial photographs are approximately georeferenced

Fig. 8

2013 ORTHOPHOTOGRAPHY
Conk Timber Sale

0 980 2,000 Feet
Scale: 1:24,000

Washington State Department of Natural Resources

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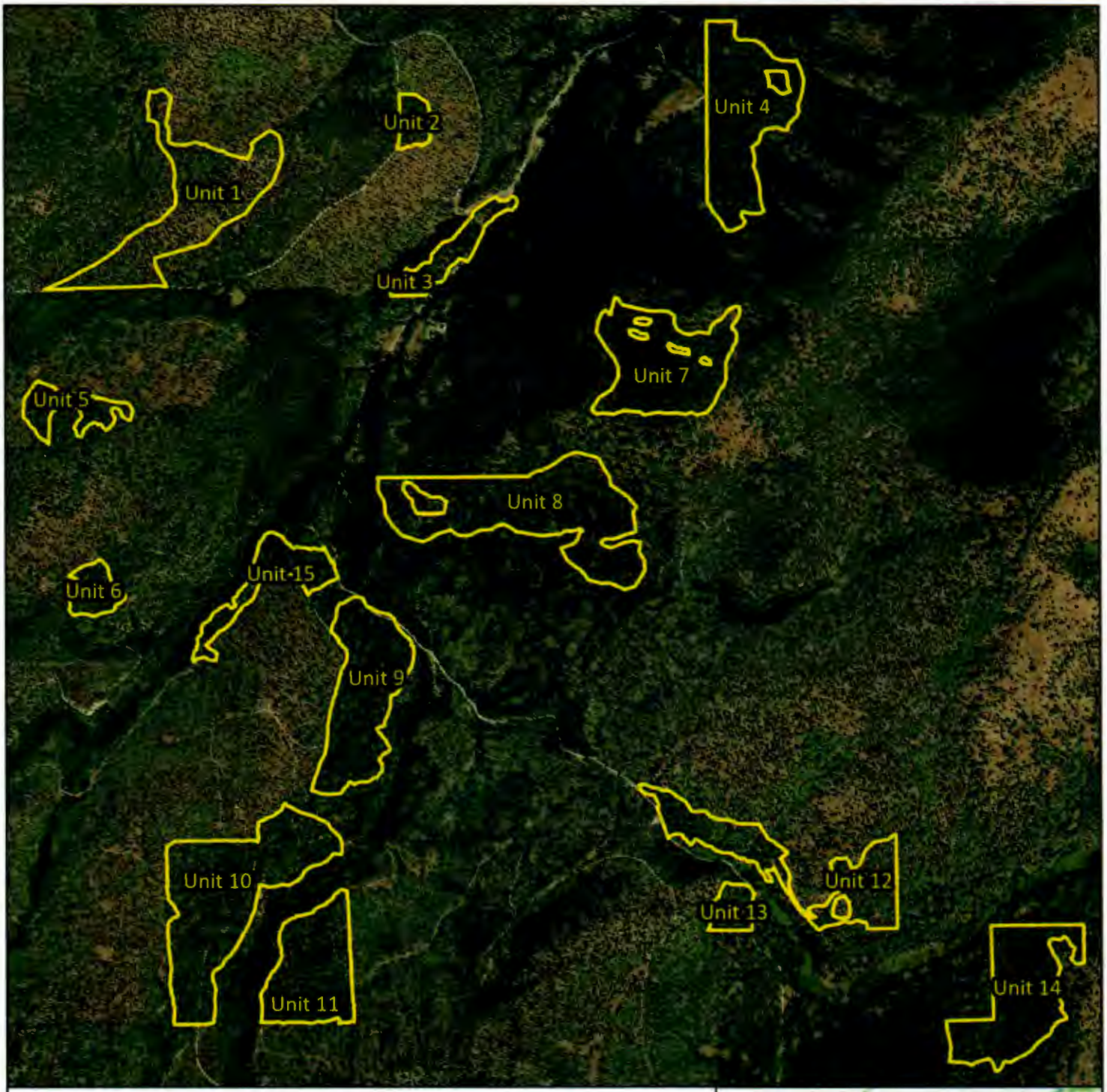

Harvest Unit Boundary

Note: Aerial photographs are approximately georeferenced

Fig. 9

2015 ORTHOPHOTOGRAPH
Conk Timber Sale

0 980 2,000 Feet
Scale: 1:24,000

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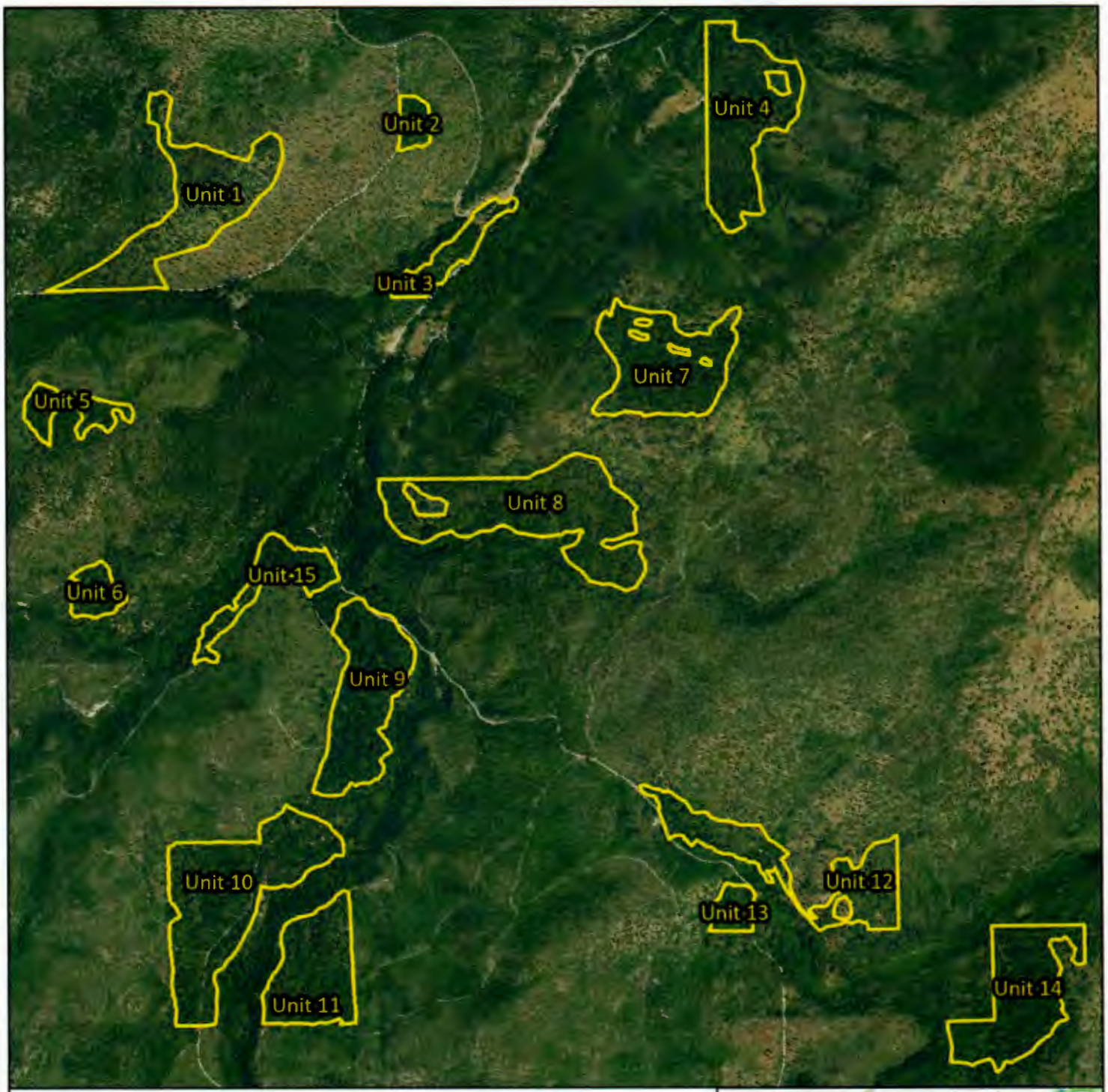
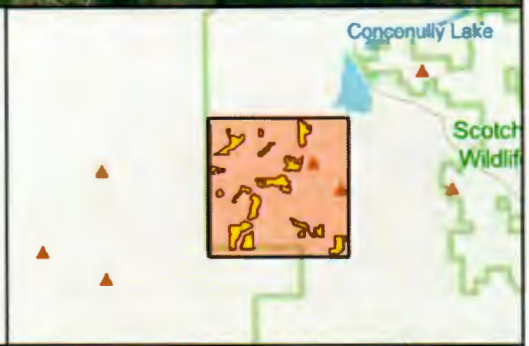


Harvest Unit Boundary



Note: Aerial photographs are approximately georeferenced

Fig. 10

2021-2022 ORTHOPHOTOGRAPH
Conk Timber Sale

0 980 2,000 Feet
Scale: 1:24,000

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Appendix A
Geologist Qualifications

Gregory Morrow has a Bachelor of Science degree (2013) in environmental geology from Western Washington University in Bellingham, Washington. He has over 10 years of experience in conducting site characterizations, geotechnical engineering and slope stability assessments for public agencies and private parties. Mr. Morrow has been employed by the Washington State Department of Natural Resources since January 2016. He is a Washington State Licensed Engineering Geologist (LEG #19110652) and meets the definition of a "qualified expert" as outlined in WAC 222-10-030(5).

Zach Click has a Bachelor of Science Degree (2013) in environmental geology from Western Washington University in Bellingham, Washington. He conducted site characterizations, geotechnical engineering and slope stability assessments for public agencies and private entities from 2014 to 2023. Mr. Click has been employed by the Washington State Department of Natural Resources since September 2023. He is a Washington State Licensed Engineering Geologist (LEG #19110583).