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# Geology Report

## North Clack Integrated Resource Project

**Clackamas Ranger District, Mt. Hood National Forest**

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# Table of Contents



## Table of Tables



## Table of Figures

## 1.1 Summary of Effects

This report shows that the project complies with Forest Plan direction in terms of land stability (s. 1.3.xx). Areas of concern have been examined in the field by a stability specialist. As a result, some treatment area boundaries were adjusted to eliminate the areas of concern for potential landslides. There would be no increased risk of landslides with the action alternatives with implementation of project design criteria and compliance with the LRMP standards and guidelines. Known unstable areas are deleted from harvest units. Where regeneration harvest partially intersects dormant landslides (inactive landslides that can be reactivated), there would be a slightly elevated, but not substantive, risk of dormant landslide reactivation or shallow slides in steeper dormant landslide areas (such as the head scarps). This is because of greatly reduced evapotranspiration and root strength across large areas of slope for up to 30 years. For variable density thinned units, tree cover and groundwater quantity would return to normal within a few years as trees are released. However, in regeneration units, groundwater quantity would likely increase in a measurable way in the long term for up to 30 years. All other proposed actions should have no substantial adverse effects on geologic resources and slopes. There would be no impact to cave or paleontological resources as they are not in the project area.

**Table 1 - Anticipated Effects with implementation of Project Design Criteria**

| *Resource* | **Summary** |
|---|---|
| **Caves**<br><br>No known caves | No impacts. |
| **Fossils**<br><br>No known occurrences | No impacts. |
| **Groundwater** | Subsurface flow could be intercepted at new temporary road and landing cuts but effects on groundwater quality and quantity should be negligible as hillslope cuts would be minimal with PDC restricting construction generally to gentle ground; groundwater levels may temporarily increase post-variable density thinning logging but should recede to background within 3-5 years as trees are released with increased vigor with higher evapotranspiration rates. Groundwater levels in regeneration harvests would stay elevated for up to 30 years as trees regenerate, potentially increasing stream flows (unlikely to be measurable at small, patchy scale of regeneration harvests). The beaver pond restoration project, if successful, would likely increase groundwater quality and quantity for the long-term. |

| *Resource* | **Summary** |
|---|---|
| **Minerals Access**<br>No claims or mines and little mineral potential | The North Fork quarry may be used for pit run. The South Eagle quarry may be utilized for road aggregate if stockpiles are adequate. No new quarries would be developed and there would be no new ground disturbances. There would be no permanent impacts to public access for mineral exploration. |
| **Slopes**<br>Unstable areas such as active landslides, earthflows, and other slopes | Previously mapped earthflows are Low Risk and have been field verified as Low Risk. All observed unstable areas are mapped and allocated into the riparian reserve. With implementation of project design criteria, no new landslides or reactivated landslides are expected to occur from harvests and related activities (such as temporary road reconstruction). Slopes with variable density thinning should largely see maintained or increased slope stability as trees are released and increase their vigor within 3-5 years. Risk of High-intensity wildfire and insect and disease should decrease in treated stands. Regeneration harvest on steep dormant landslide slopes may slightly elevate risk of the landslides reactivating. High-intensity regeneration harvests largely occur on gentle slopes with little risk of being adversely affected. Where the units partially include dormant landslides, there would be a very small risk of reactivation due to slope-wide reduction in evapotranspiration and root strength for up to 30 years. |

## 1.2 Compliance with law, regulation, policy, and the Forest Plan

Compliance for this project include: Clean Water Act (1977), National Forest Management Act (1976), Federal Cave Resources Protection Act (1988), Paleontological resources are now specifically protected by the Paleontological Resources Preservation Act (2009), Mt. Hood National Forest Land and Resource Management Plan (1990), the Northwest Forest Plan, and Forest Service Manual 2880 which requires integrating geologic resources and hazards into NEPA processes.

# 1.3 Geology

## 1.3.1 Introduction

The purpose of this document is to characterize geologic resources and hazards within the North Clack Integrated Resource Project area and analyze any potential effects.

Discussions include regulations related to geologic resources and hazards, current conditions, and discloses foreseeable environmental effects.

Geologic resources and hazards analysis includes potential impacts to slope stability, groundwater, changes to cave environments, impacts to paleontological resources and others. Mineral access is also considered.

## 1.3.2 Methodology

The Mt. Hood National Forest Land and Resource Management Plan requires that unstable areas or areas that are suspected of instabilities be evaluated as part of project planning. Furthermore, it requires that areas with a high probability of mass wasting from ground disturbing activities be protected to maintain or enhance slope stability.

To describe the affected environment, evaluate and protect unstable areas or suspected areas of instability, 4 days were spent in the field by a qualified geologist to evaluate proposed activities of the North Clack project. Dense understory on northern slopes generally obscures signs of active slide movement, especially in stands that were logged in the last 100 years. Therefore, methodology focuses on 1) reviewing mapping of previous landslides, 2) aerial photography and satellite imagery review and mapping of landslides, and 3) LiDAR (sparsely available for this project at western-most and southern-most areas). Where possible, units were visited in the field.

Rock types were observed to verify bedrock mapping available in the Forest's GIS bedrock layer. Field activities include observing if timber had been previously harvested and if there were any observable stability impacts. Any field, air photo or lidar observed unstable areas with sound evidence of movement in the las 400 years were mapped.

Aerial photos (1:16,000 scale, color) were examined to identify unstable landforms, and to verify previous mapping in the Forest's GIS geomorphology and landslides layer. By using 1953, 1972 aerial photos and modern USDA National Agriculture Imagery Program (NAIP) imagery as recent as 2016, one could make the determination if previous logging activities resulted in landslides. Aerial photos provide insights of potential stability issues.

Dormant and active landslides were partially mapped using hillshaded Digital Elevation Models in ArcGIS 10.5.1. The Digital Elevation Models were derived from lidar acquired by the Oregon Department of Geology and Mineral Industries (DOGAMI) in 2013. Only the far western and southern edges of the project had lidar coverage.

Direct, indirect and cumulative effects are analyzed qualitatively as there are currently no available Mt. Hood NF specific models to assess potential impacts on landslides or slopes from diverse project activities. The primary focus for geology, per the LRMP, is existing unstable areas delineated using office (remote sensing) methods. While all high-priority areas were reviewed by a geologist, there is potential that small areas of instability were not discovered.

Project Design Criteria require that contract administrators, engineers, or anyone else that observes land stability issues report them to a geologist prior to any activities occurring so that adjustments can be made if necessary.

#### *1.3.2.1 Existing Information Used for this Report*

- Mt. Hood National Forest and Region 6 Corporate GIS Library, including: Bedrock and landforms and landslide risk
- Region 6 Hillshaded Lidar Digital Elevation Model (area of interest was acquired in 2013)
- Aerial and Satellite imagery, including: 2016 digital NAIP imagery, 1953 aerial photos, 1972 aerial photos and 2000 BLM 1m aerial photography.
- Forest Service/USGS 7.5-minute topographic maps.

#### *1.3.2.2 Spatial and Temporal Bounding of Analysis Area*

Qualitative analysis of direct, indirect, and cumulative effects relevant to geology for each activity was made. The qualitative analysis is founded on an understanding of how the environment reacted to past activities and the body of best available scientific information on the influence of land management practices on landslides. Cumulative effects are qualitatively analyzed using direct and indirect effects. Effects were analyzed within and adjacent (including private lands) to the project boundary. See Figure 2.

Effects are analyzed 30 years into the future and 30 years into the past. This is chosen as most human-induced effects on landslides appears to diminish over this period. On the other hand, natural events such as major floods may still be influencing hillslope stability. Generally past management (such as logging over 20 years ago) fades into the environmental baseline and is part of the Affected Environment.

# 1.4 Affected Environment

## 1.4.1 History

Most of the project area's units were extensively logged 60-70 years ago, especially in the 1920s and 1930s. Presumably, rail and road building occurred in earnest during that period. Tree plantations are generally 25-75 years old. In 2014, LaDee Flat's south slopes experienced high severity burns by the 36 Pit Fire. Some stands, such as those at the far western end of the project, that had been thinned prior to the fire burned at lesser severity, with much of the retained overstory surviving. Some stands not included in units or are in thin/brush units (such as in vicinity of 184 and 190) had even aged treatment sometime before 2000. In the intervening 18 years, it appears from high resolution satellite imagery that no landslides occurred within those even-age treatment units.

## 1.4.2 Bedrock Geology, Fossil Resources

The project area is primarily underlain by andesitic rocks, except portions of the LaDee Flat area and south, which is mapped as basalt (Figure 1 in **Appendix** A – Maps). Bedrock appears largely stable but there are areas where it is clearly weaker than surroundings (e.g., at earthflows). It is possible large landslide areas are underlain by weak volcaniclastic rocks. No fossil resources are known to be recorded within the project area.

### 1.4.3 Landslides

For reference, Figure 4 in the Appendix shows different kinds of landslides and their descriptions.

The proposed North Clack project area has deep-seated dormant landslides and active landslides, including previously mapped low-risk earthflows (Figure 3 in **Appendix** A – Maps). Most mapped slides toe into named perennial streams such as the North Fork Clackamas River and Boyer Creek. According to the Northwest Forest Plan (1994), active landslides or unstable land components have sound evidence of movement in the last 400 years. All other landslides are considered dormant or ancient.

There are mapped landslides in units, especially in the western part of the project area, where slopes are steeper and adjacent to perennial streams. Most previously mapped landslides are considered dormant, or likely older than 400 years old with no sound evidence of active movement. Dormant landslides are inactive and have an unknown risk of being reactivated. These areas are more sensitive to management actions compared to un-failed slopes. Evidence of active landslides or movement may include: uneroded hummocky (benchy) terrain, widespread, broadly swooped conifers; pistol butted conifers; jackstrawed or chaotically leaning trees; springs and seeps (on slide benches and base of toe zones); sag ponds or depressions; cracks in the ground; steep and not eroded fresh scarps; linear stretches of churned or overridden soil and vegetation (such as at a landslide toe zone); dropped or moved roads; and deep-seated slides, slumps or debris slides (especially in toe zones). Special attention is paid to previously logged areas to collect evidence if logging resulted in landslides. However, it should be disclosed that even-age logged areas can hide that a slide has moved in the last 400 years as movement may not be recorded in younger trees and other slide indicators may not be clearly present. But generally, the post-logging hillslope conditions are usually a good indicator of risk to hillslopes. Other areas with similar geology and slopes that were even-aged logged decades ago but have no unstable areas, may be assumed suitable for logging.

Earthflows on the Mt. Hood National Forest fall into three categories: low, moderate and high risk (Table 3 in **Appendix** C – Tables and Data). Previously mapped earthflows that were categorized as low risk are in the project area. Units 6, 4, 2, 54, 58 and 62 and 50 overlap mapped low-risk earthflows (Figure 3 in **Appendix** A – Maps). Field review verified that these earthflows are low risk with no evidence of road failures or other slide activity in vicinity of those units. The nearest road failure is in section 33 (far south-eastern part of the project, east of unit 62) on the 4611 road. These lands had even-aged trees with noticeable stumps. No recent active landslides were observed.

A previously mapped low-risk earthflow and undifferentiated landslide or landslide deposit intersects units 2, 4 and 6 (Figure 3 in **Appendix** A – Maps). This area was logged about 70 years ago and is plantation. The terrain is very hummocky with some steep scarps. Only toe zone failures, mostly within the existing riparian reserve, were observed on LiDAR and aerial photography (between 1953 and 1972). The toe zone slides were first observed on 1972 air photos in the North Fork Clackamas River. The 1953 air photos show the area completely logged with the same landforms except no toe zone failures into the North Fork Clackamas.

Outside of the toe zone, no evidence of active landslides was field observed or lidar observed within units 2, 4 and 6. Logging on the main earthflow body appears to not have caused instability such as slumps or debris slides. These toe zone failures may be related to logging prior to 1953. However, these failures alone are not sound evidence that the earthflow is active; therefore, the overall earthflow, given its lack of history of causing problems or having movement, remains low risk.

A major landslide, confirmed in the field, is on the south side of Boyer Creek, south of unit 88 and 86. This landslide is verified as active but no proposed actions would occur within it or around it. In 1972 aerial photos, the slide appeared to be a recently active with down logs and little vegetation. It appears to have an earthflow at the bottom of the slide with a pond.

At the east end of unit 174, a variable density thin unit, an apparently dormant landslide (no evidence of movement since the last even age timber harvest) has an impressive headwall/head scarp graben. There's no evidence that the slide, which goes from ridge to North Fork Clackamas River, is active. Road 4613013 stays below the ridge top, adjacent to and at the bottom of the head scarp and in the graben area. Eventually the road leaves the graben and, narrowing, heads down to unit 192. Head scarps have elevated risk for mass wasting.

Other previously mapped landslides in the project area, have no signs of active landslides and most have no sound evidence of movement in the last 400 years based on aerial photography

In 2014, the 36 Pit Fire caused slope-wide tree mortality along the southern portion of the project boundary. It is expected that slope stability in and adjacent to the burn area would be at risk for the next thirty years; shallow landslides may occur and dormant landslides (including any earthflows) may be reactivated within or adjacent to high intensity burn areas.

# 1.5 Environmental Consequences

No-Action provides a background from which to analyze the other alternatives' direct, indirect, and any resulting cumulative effects. The No-Action alternative was analyzed based on the Affected Environment.

## 1.5.1 No Action

The no-action alternative continues the current management of the North Clackamas project area. Current environmental trends would continue. For example, plantations would not be treated thus there would be an increasing potential for high-intensity wildfire and/or decline in health of stands (e.g., insect and disease, water stress). Poor stand health could, eventually, result in wide spread tree mortality and greatly increased risk of landslides – especially during the wet season.

## 1.5.2 Action Alternatives

There would be no substantial cumulative increased risk of landslides with implementation of project design criteria and compliance with the LRMP standards and guidelines. Known unstable areas are deleted from harvest units. Where regeneration harvest partially intersects dormant landslides, there would be a slightly elevated, and not substantial, risk of dormant landslide reactivation. The most sensitive parts of dormant landslides in the project area are the toe zones and these areas would not be treated with a regeneration prescription due to being in the riparian reserve or outside of the unit altogether. No geologic resources such as caves, fossils and groundwater would be adversely affected.

## 1.5.3 Skyline Logging and Helicopter Logging

Aerial cable or skyline yarding corridors for yarding of logs would be setup. These narrow yarding corridor "strips" may be cleared of vegetation (as needed). Humans or certain mechanical equipment would fell trees. Yarding of trees would occur up to a landing using the suspended cable yarding system. Ground disturbances would be largely restricted to the narrow yarding corridors, landings and any temporary roads required for the system (see Temporary Roads, Existing Road Alignment Reconstruction and Landing). Project design criteria requires suspension systems appropriate for the terrain to help prevent soil gouging by fully suspending logs. Criteria also requires erosion control measures on slopes affected by yarding systems to prevent rills and gullies. Soil project design criteria such as erosion control, ground cover requirements would greatly reduce the risk of shallow landslides within and adjacent to yarding corridors. In addition, per project design criteria, "few trees, if any" would be cut to obtain proper deflection of yarding corridors in riparian reserves. Generally, cable logging systems causes far less ground disturbance than ground-based systems as there is no skidding. Most units have a variable density thinning treatment, which is also a relatively low-intensity action that usually results in more vigorous stands (see Thinning, Sapling Release, Sapling Thin/Brush Effects). There would be no harvest in unstable riparian reserves.

Helicopter logging would have no yarding corridors thus ground disturbance would be restricted only to tree cutting activities. Thus, effects on slope stability and other resources would be largely restricted to reduction of trees (see sections on variable density thinning and regeneration harvest).

### *1.5.3.1 Ground Equipment*

Tractor-based equipment or combination of ground-based and skyline may disturb soil throughout units and change surface hydrology as soils are disturbed by skidding or general driving activities. Water may concentrate and increase the risk of soil slips and debris slides – particularly if concentrated water is routed to slopes above 57% or onto unstable areas. Without adequate ground cover and vegetation, this could increase the risk of landslides on steeper slopes. However, soil project design criteria (such as ground cover requirements) would in most cases prevent new landslides from occurring. Most units have a variable density thinning treatment, which is relatively low-intensity action that usually results in more vigorous stands (see Thinning, Sapling Release, Sapling Thin/Brush Effects). Tractor-based equipment are excluded from operating in unstable areas, which are riparian reserves. Skidding, yarding and equipment use design criteria requires: ground cover for mechanically created disturbances; erosion control; wet weather operations; requirements for skid trails such as route planning; reuse of existing trails; spacing; accounting for slope hydrology; and finally slope limits. All these design criteria and others greatly reduces the risk of shallow landslides in ground-based harvest and fuels units. Area units treated by thinning in the past with tractor logging systems have rapidly recovered their ground cover and understory – greatly decreasing the risk of shallow landslides. There would be no harvest in verified unstable riparian reserves.

### *1.5.3.2 Thinning, Sapling Release, Sapling Thin/Brush Effects*

Trees would be released by this action, thereby allowing trees to grow more vigorously. This generally results in: root length increases; increases in root strength and soil holding capacity; and increased evapotranspiration (Rice, 1977; Dhakal & Sidle, 2003; Sakals & Sidle, 2004). Larger contiguous areas held in place by roots of a single tree increases slope stability. If soils are shallow, roots that can reach deeper or more laterally with reduced competition may have greater anchorage into underlying bedrock (Swanston & Dyrness, 1972). Bedrock is typically shallow in the project area. Evapotranspiration rates and rooting would likely increase over current conditions in 3-5 years as trees are released from stress of competition for water and sunlight (Ziemer, 1981). Thinning is not proposed on unstable areas where it might trigger a landslide or earth movement. Thinning can increase tree vigor and decrease the risk of catastrophic wildfire or rapid decline in stand health due to insects and disease. Increasing forest health in unstable areas and slopes in general can help maintain slope stability or increase slope stability. Per the LRMP, Low risk earthflows may be harvested of trees provided treatments do not increase the risk of slope failures. Proposed treatments in low risk earthflow areas should not increase the risk of new or reactivated landslides because treatments follow LRMP standards and guidelines and project design criteria. Clear cuts made from before 1953 and recently show that most slopes in the project area are suited for commercial harvest as they've largely recovered without new mass wasting. Harvest related landslides are rare in the project area and newer slides seem generally restricted to slopes that terminate at major perennial drainages. These areas along perennial streams are protected as riparian reserves. Variable density commercial thinning would be a low risk, low-intensity activity. Unstable areas are mappable and excluded from ground-disturbing activities.

Project activities include sapling release and thinning adjacent to the 36 Pit Fire scar. These activities may help reduce risk of landslides in the activity areas due to release and increased vigor of trees. Treatments adjacent to the burn scar are low-intensity and are not expected to increase the risk of slope failures.

**Past unrelated action:** in the last couple of years, BLM lands at the western end of the project had units treated by thinning. Thus far no new landslides have been observed road-side or on satellite imagery, post-treatment.

### *1.5.3.3 Regeneration Harvest*

This high-intensity harvest type removes most trees in a stand. Within a few years, the unit is then regenerated by planting and/or natural seeding. Skips, where trees are not harvested, are prescribed in this treatment. Removal of most trees would increase groundwater table elevation (due to hillslope-wide greatly reduced evapotranspiration) and reduce soil strength (due to root rot in 3-10 years) for up to 30 years until stands fully recover hydrologically and in rooting (Ziemer, 1981). Regeneration units in the project area avoid steep areas (e.g., slopes above 57%), known unstable areas, and for the most part avoid dormant landslide areas. Unit 165 is the only unit that intersects mapped dormant landslides. However, these dormant landslides are highly eroded (therefore likely ancient) and have relatively gentle slopes. The units also avoid the most sensitive part of dormant landslides: the toe zones in the North Fork Clackamas. It is unlikely that completing a regeneration harvest on portions of dormant landslides would cause enough groundwater changes to reactivate the dormant landslides. Indeed, based on historical aerial photo interpretation, past clear-cut harvests on dormant landslides did not result in whole dormant landslide reactivations. Skips (where trees are not harvested) may be incorporated into dormant landslides, which would help to decrease the risk. Nevertheless, there would be some unquantifiable elevated but not substantial risk of landslides for up to 30 years where regeneration harvest occurs in dormant landslides. Required ground cover and erosion control would help prevent shallow landslides and gullying from occurring within dormant landslide areas.

### 1.5.3.4 Temporary Roads, Existing Road Alignment Reconstruction and Landings

An estimated 15 miles of new temporary roads would alter hillslopes and to some degree, mass balance (hillslope equilibrium). Project design criteria minimize the risk of landslides because roads are located on relatively gentle side slopes where road cuts would be minimal (Swanston & Dyrness, 1972). Water pathways, including subsurface water at cuts, may be altered and could concentrate water onto slopes where risk of landslides would increase. The risk of these effects increases the taller the cut height. Project design criteria require adequate drainage features on temporary roads and landings to prevent excessive concentration of water onto hillslopes using erosion control measures. Since unstable areas are excluded from harvest, there would also be no temporary roads or landings in those areas. Existing landings and skid trails would be used whenever possible, helping to minimize new ground disturbances. Reconstructed roads would not negatively impact slope stability as cuts are already made and any modification to those cuts would likely be minimal during reconstruction. With implementation of temporary road construction and reconstruction project design criteria there would be no expected cumulative increased risk of mass wasting. According to project design criteria, new temporary roads would "generally occur on or near stable ridgetop locations, or on stable, relatively gentle topography." This design criteria keeps hillslope alteration (cuts) to a minimum and avoids steep slopes associated with dormant landslide areas or rock-fall prone bluffs. Rehabilitation of temporary roads after unit activities would greatly reduce long-term road related runoff with surface roughness and slash.

**Past unrelated action:** The LaDee OHV staging area project was implemented in May-June of 2018. This involved using heavy equipment to rework the staging area for better drainage. Work also improved facilities for loading/unloading OHV vehicles and preparing ground for a vault toilet. This occurred on flat ground, far from any steep slopes, and does not have any effects with respect to geology.

### 1.5.3.5 Fuels Treatments

Underburning and other fuels treatments reduces fuels loading and understory density and therefore reduces the risk of high-intensity wildfire and encourages overstory to increase their vigor. Some fuels treatments may include mechanical equipment. In that case, effects would be lesser than Ground Equipment logging as there'd be no skidding involved. Areas that naturally should have no tree cover (e.g., meadows) would recover by the next summer. Risk of mass wasting is not expected to increase with this low-intensity activity.

### 1.5.3.6 Enhance Wildlife Habitat

Gaps, thinned stands, under burning and burning of a meadow are low-intensity activities that are not expected to increase the risk of mass wasting.

### *1.5.3.7 Road System Maintenance*

Road System Maintenance could include many different activities from road grading, ditch cleaning or reconstruction, to full culvert replacement. Generally, these activities are beneficial in that they reduce the risk of road-related mass wasting. Risk reduction occurs by hydrologically stabilizing roads, providing adequate drainage, cleaning culvert inlets and outlets, and replacing or upsizing culverts as needed. These activities are not expected to increase risk of mass wasting.

**Foreseeable unrelated action:** the Mt. Hood Aquatic Organism Passage and Road-Related Restoration project and decision memo signed on May 31, 2018, covers culvert replacement to enhance aquatic organism passage. The project area may include future culvert replacement under this decision. This activity improves stream flow and reduces the risk of crossing related mass-wasting. These activities are not expected to increase the risk of mass wasting.

### *1.5.3.8 Road Decommissioning*

An estimated 5.7 miles of road would be actively or passively decommissioned. Passive decommission means that beyond closure and barrier devices, no further activities would likely occur, maintaining their current conditions. Active decommissioning means taking actions such as ripping the road to encourage better hydrologic drainage (less concentration of runoff onto slopes below) and growth of vegetation such as trees. Passively closing a road may decrease future damage caused by usage during wet weather and thereby potentially reduce risk of mass wasting. About 1.2 miles of road (#4611) would be converted to non-motorized trail. This involves restoring drainage patterns by removing culverts, decompaction, constructing trail stream crossings (such as low water crossings), and reducing road width to trail tread width. Reducing a road to trail width may involve removing fill material and placing at old road cuts, thus reducing the future risk of large fill failures and road cut failures. These activities are not expected to increase risk of mass wasting. These activities may improve slope stability by reducing runoff.

### *1.5.3.9 Rehabilitate Unauthorized OHV Routes*

The rehabilitation of unauthorized OHV routes would generally reduce concentration of runoff onto or below adjacent slopes. This would potentially help prevent mass wasting and could improve infiltration of water into groundwater. Effects are like that of road decommissioning. Therefore, these activities are not expected to increase risk of mass wasting.

**Foreseeable unrelated action:** a segment of OHV trail in the southeastern part of the project area may be decommissioned. In general, decommissioning benefits slope stability by improving drainage with ripping or similar methods that roughens the surface and decreases surface compaction. There are no anticipated adverse effects relating to geologic resources and slope stability from this action.

### *1.5.3.10 Beaver Habitat and Wetland Restoration at Tumala Meadows*

This wetland restoration activity would restore natural processes. Potentially slower stream velocities due to restoration and beaver dams may reduce downstream incision, encourage desired aggradation (sediment infilling) of existing stream incisions, and reduce bank cutting thus reducing risk of mass wasting. Restoration would very likely increase groundwater recharge and storage, thereby improving resilience of the meadows and surrounding lands in the face of climate change. These activities are not expected to increase risk of mass wasting.

#### *1.5.3.11 Non-Federal Land Foreseeable and Past Activities*

Non-Federal lands are actively managed for timber around the project area, especially to the north of the project boundary. Regeneration, clear-cuts, and thinning are common treatments on these lands. Non-Federal land timber management, including harvests and road construction, are regulated by Oregon's Forest Practices Act. Specifically, Oregon Administrative Rule Chapter 629, Division 623 regulates timber management to reduce or prevent landslides and related sediment. Management actions by private and Forest Service along a shared boundary may add cumulatively to increase landslide risk on those slopes. However, as previously discussed, slopes in the project area are generally stable and have shown almost no slope response to intensive regeneration or clear-cut harvests. Therefore, it is not expected that adjacent non-NFS land management would cause slope stability issues and add cumulatively to this project's actions.

## 1.6 Compliance with law, regulation, policy, and the Forest Plan

Clean Water Act, 1977, was created to restore and maintain the chemical, physical and biological integrity of the Nation's waters (Section 101 (a)). It also regulates discharge of dredged or fill material into navigable waters (waters of the U.S.) (Section 404).

Forest Service Manual (FSM). Title 2800 provides directives for the management of mineral activities, planning and protection of geologic resources and management of geologic hazards on National Forest System lands. FSM 2880 requires integration of geologic resources and hazards into NEPA processes.

National Forest Management Act 1976, which ensures that forest planning and management activities provide for the conservation and sustained yield of soil and water resources. It facilitates the development of sound vegetation manipulation practices based on watershed conditions and land capability rather than decisions based solely on silvicultural characteristics and the public demand for goods.

Federal Cave Resources Protection Act of 1988. This act provides that Federal lands be managed to protect and maintain, to the extent practical, significant caves.

Paleontological Resources Preservation Act of 2009. This act provides that paleontological resources are protected using scientific principals and expertise. The Forest Service promulgated its Final Regulations for Paleontological Resources Preservation at Title 36 Code of Federal Regulations (CFR) Part 291.

The Mt. Hood National Forest Land and Resource Management Plan (LRMP). The LRMP provides objectives, standards and guidelines for implementing the NFMA on the Mt. Hood National Forest. Consistency with standards and guidelines occurs with the Design Criteria and/or BMPs.

Record of Decision and the Standards and Guidelines for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl (Northwest Forest Plan). Defines and emphasizes management of riparian reserves, to include unstable areas.

## 1.7 Design Criteria

1. Unstable areas are delineated at the bottom of units 6 and 4. These areas are unstable riparian reserves and are deleted from the units.
2. A feasible route for a new temporary road that extends from the end of Road 4613140 was identified to access Unit 174. This alignment is on a ridgetop above the head scarp of a dormant landslide and is likely the only feasible route that protects the stability of the earthflow. Drainage on this ridgetop road should be directed to the north.
3. Any previously unknown suspected unstable areas shall be reported to the project geologist to determine if they are unstable areas and need to be avoided by certain or all activities.

## 1.8 References


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# Appendix **A – Maps**

Maps are on the following pages.

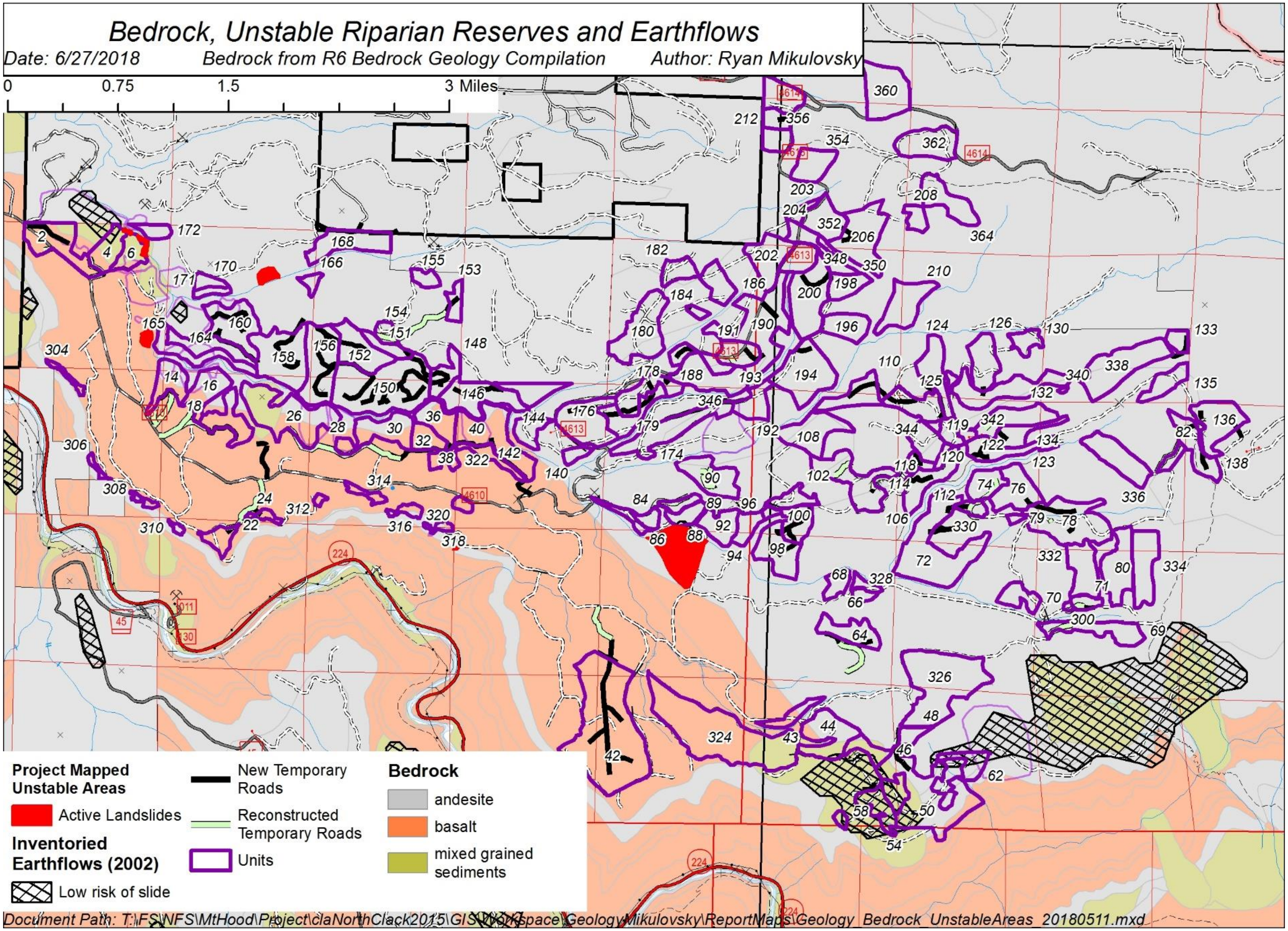



**Figure 1 - Bedrock Map with Unstable Riparian Reserves, and Earthflows**

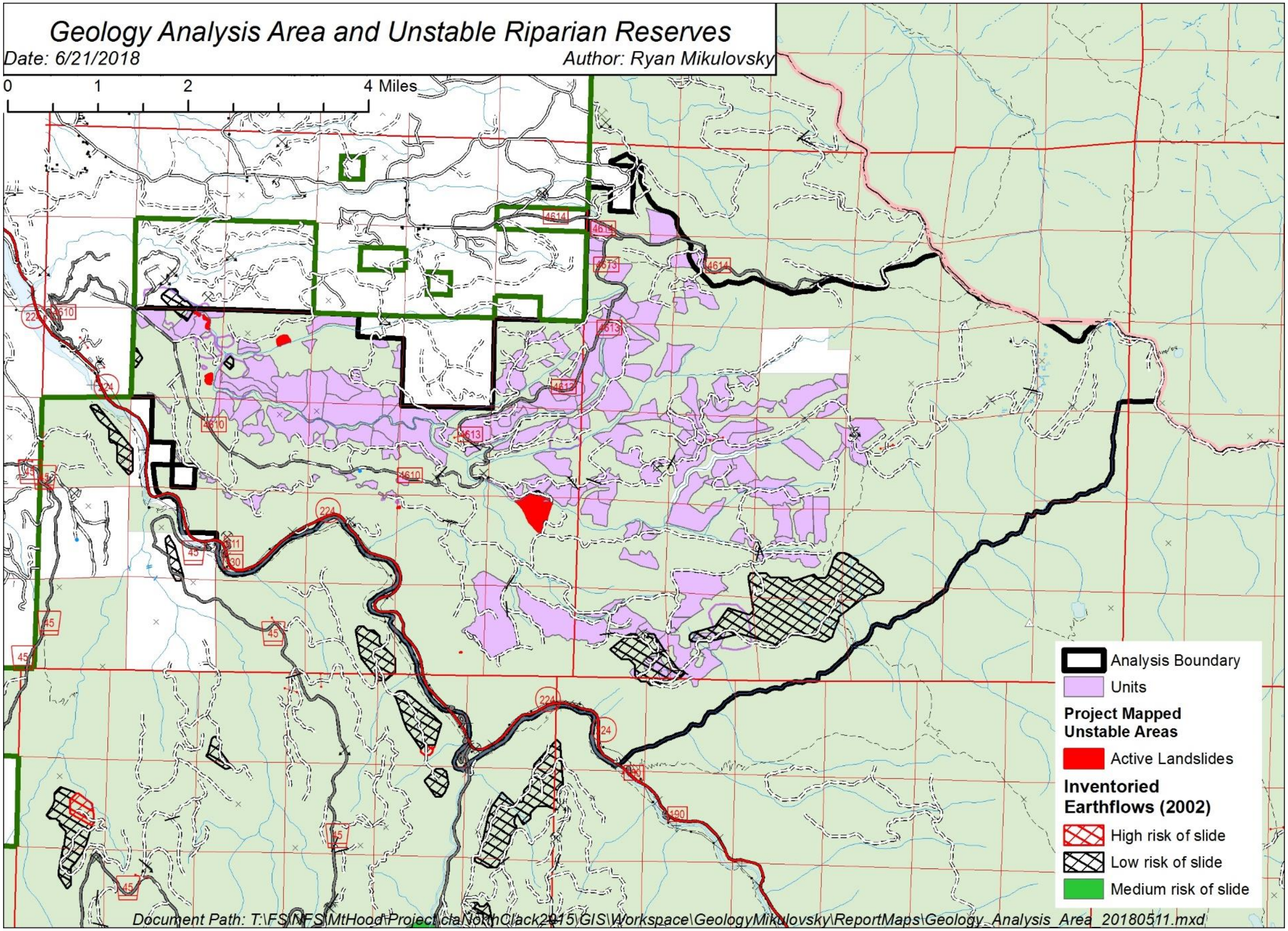



**Figure 2 - Effects Analysis Area**

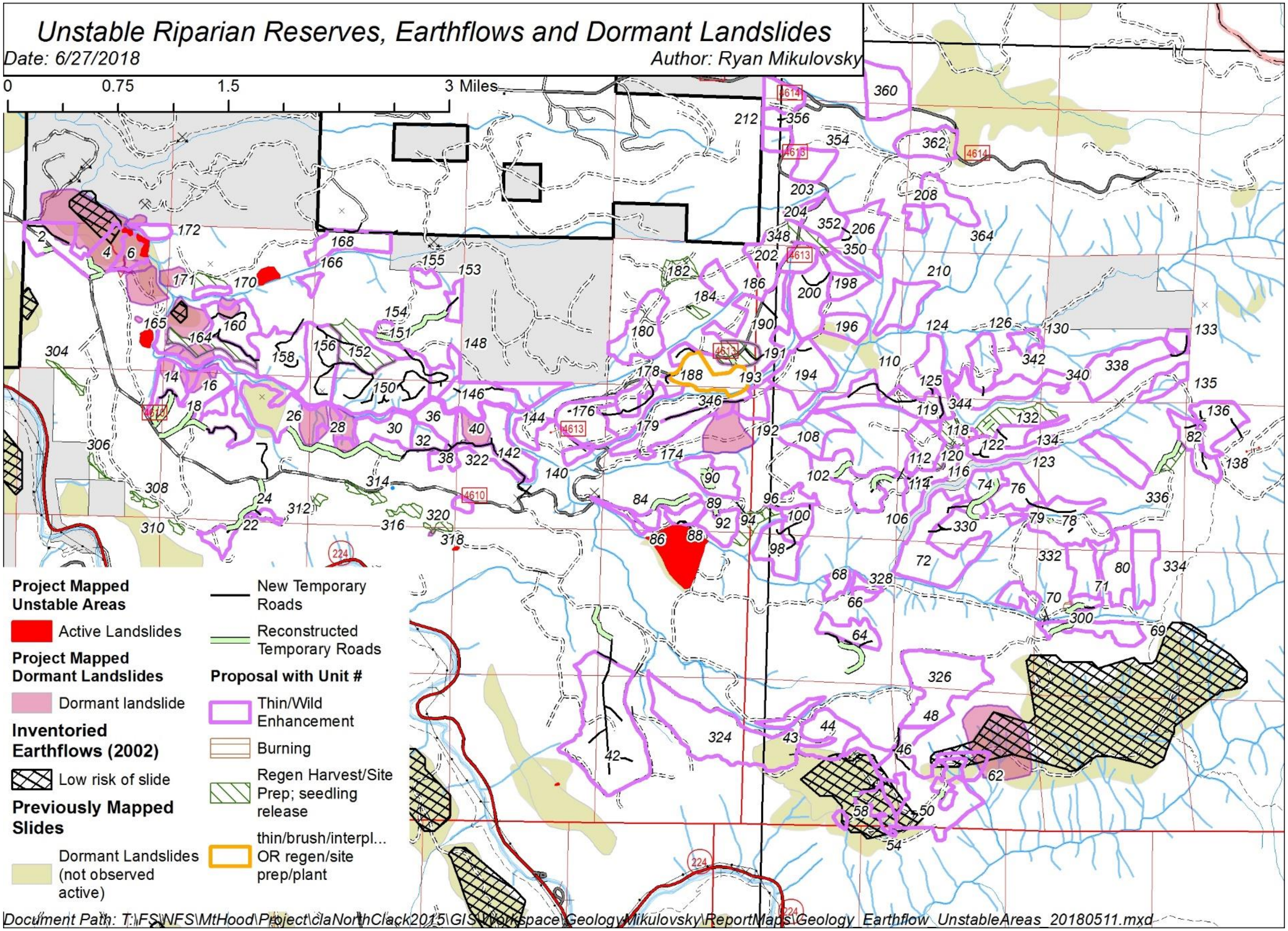


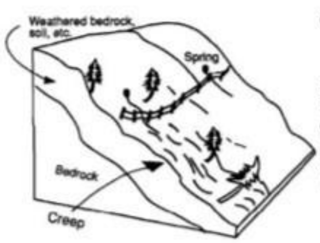
Figure 3 - Unstable Areas

# Appendix **B – Illustrations**

### 1.1.2 Description of Forest-Landslide Categories

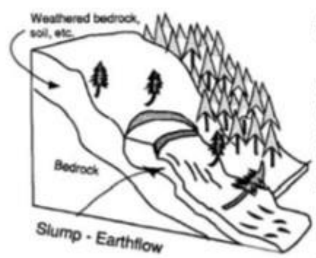
**Falls**

Movement takes place mainly through the air by free-fall, leaping, bounding, or rolling. Falls are very rapid to extremely rapid mass movements (from meters/minute to meters/second).




**Creep**

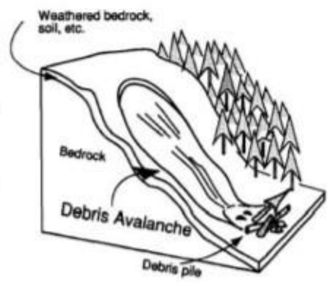
The slow downslope movement of overburden. Rates of movement are very slow (centimeters/year) to extremely slow (millimeters/year).




**Slumps and Earthflows**

These often involve combined processes of earth movement (rotation of a block of overburden over a broadly concave slip surface, or slump), and result in the downslope transport of the resulting mass, either by a flow or a gliding displacement of a series of blocks (earthflow). Creep activity is a common precursor to slumps and earthflows. Rates of movement range from extremely slow (millimeters/year) to rapid (meters/second).

**Debris Avalanches and Debris Flows**




Debris avalanches are rapid, shallow landslides from steep hillslopes. Movement begins when overburden slides along bedrock or along other layers within the overburden having higher strength and lower permeability. If enough water is present, debris avalanches become debris flows. This results in the rapid downslope transport of a slurry of soil, rocks, and organic material (collectively called debris) directly to the valley floor and occasionally to stream channels. Debris avalanches typically begin on open slopes or within shallow hillslope depressions where groundwater is concentrated. Debris flows commonly follow existing drainageways or linear slope depressions created by past landslide activity, although not necessarily. Debris flows tend to increase in volume downstream. Rates of movement range from rapid (meters/minute) to extremely rapid (meters/second).

After: Chatwin, SC, Hogan, DL, & Schwab, JW. 1994. A guide for management of landslide-prone terrain in the Pacific Northwest. Victoria: British Columbia Ministry of Forests.

**Figure 4 - Forest-landslide Categories**

Chatwin et al. (1994). Debris avalanches are known as debris slides. Deep-seated landslides commonly fall under the Slumps and Earthflow category.

# Appendix **C – Tables and Data**

**Table 2 - Summary of Present Environmental Field and Data Observations**

| **Geologic Hazard or Resources** | **Observations Summary** |
|---|---|
| <u>Unstable Areas (riparian reserve)</u><br>High to moderate risk earthflows, landslides, potentially unstable areas, etc. | Unit 4 and 6 has clear stream-side landslides. These are mapped as unstable riparian reserves though they are well within the perennial riparian reserve. |
| <u>Rockfall sources/areas</u> | Lower section of 4611-024 has vertical cuts and boulder falls |
| <u>Bedrock Geology</u> | Primarily extrusive andesite and minor basalt. |
| <u>Groundwater</u> | Hillslope springs are common especially where there's a change in bedrock or different volcanic layers |
| <u>Earthquake Faults</u><br>Safety | Cascade volcanic activity and plate subduction could result in seismic activity. The Clackamas River Fault zone is 15 miles south of the project area. Seismicity would likely only have slight to moderate impacts in the area. |
| <u>Caves</u> | None in the project area |
| <u>Paleontological Resources</u><br>Resources Preservation Act of 2009; 36 CFR 261.9(b); 36 CFR 291.12(a)(1) | None observed in the project area and likelihood is low given extrusive volcanics geology. |
| <u>Abandoned Mine Lands</u> | None in the project area |
| <u>Minerals</u><br>36 CFR 228 | No known claims or other activity |
| <u>Mineral Materials</u><br>(potential for rock sources) | North Fork Quarry and South Eagle Quarry are available |
| <u>Geologic Special Interest Areas</u> | None in the project area |

Table 3 - Earthflow Risk and Factors (Emery, Strachan, Dodd, & Collier, 1990)

| Risk and Indicators | Low Risk | Moderate Risk | High Risk |
|---|---|---|---|
| Potential Movement Rate and Values | Potential movement has no impact on downslope values | Potential moderate movement may affect downslope values on small streams and small roads | Potential movement has ability to severely impact downslope values such as structures, powerlines and major roads |
| Toe Zone Erosion | Streams are not eroding into toe zone | Streams are not eroding into toe zone but have potential to reactivate the slide | Streams or rivers are actively eroding into the toe zone, contributing to active movement |
| Observable Movement | Little or no evidence of present active movement | Active movement may not be apparent | Earthflow movement is active |
| Size | Cover less than 1 square mile | The earthflow may be large or small | The earthflow covers a large extent, greater than one square mile |
| Past Observed Problems | No past observed problems | Past observations show cause for concerns | Past observations show problems have been caused by the earthflow such as road failures |
| LRMP Standard and Guide | Any land allocation may include low risk earthflows | B-8 Lands (see B8-032) | B-8 Lands (see B8-031) and can be allocated into the riparian reserve allocation. |