1.1 UNSTABLE SLOPES RULE GROUP

Rule Overview and Intent

The FP HCP goal for the management of potentially unstable slopes is to prevent forest practices from increasing or accelerating mass wasting (landslides) beyond the naturally occurring rate. The intent of the goal and its related rules is to protect water quality and aquatic habitat by minimizing sediment delivery from management-related increases in mass wasting.

The rules assume that (1) the administrative process of identifying, reviewing, and regulating forest practices on potentially unstable slopes will maintain a naturally occurring rate of mass wasting following forest practices; (2) implementation of the unstable slopes prescriptions will achieve the Schedule L-1 resource objectives of clean water and substrate and will maintain channel-forming processes; and (3) implementation of the unstable slopes prescriptions will meet FP HCP landscape-scale performance targets (there are no site-scale targets).

The forest practices rules' default protective measure for potentially unstable slopes is avoidance. The rule protection strategy begins with definition of unstable landforms and the identification of unstable slopes. The strategy then is either to avoid the area or conduct a risk evaluation through the State Environmental Protection Act (SEPA) process. The rule protection strategy relies on the ability of forest managers and regulators to recognize and mitigate for unstable slopes within the forest practices application (FPA) and approval process. If forest practices are planned on potentially unstable slopes, the FPA process includes a SEPA review. The correct identification and assessment of unstable slopes is achieved by the rules defining unstable landforms at a statewide level and DNR regions defining regional unstable landforms using local knowledge. As further protection, a specific forest practices rule relates to timber harvest on the groundwater recharge areas of deep-seated landslides in glacial sediments.

Rule Group Resource Objectives and Performance Targets

Resource Objectives:

- Sediment: Provide clean water and substrate and maintain channel-forming processes by minimizing to the maximum extent practicable the delivery of management-induced coarse and fine sediment to streams (including timing and quantity) by protecting stream bank integrity, providing vegetative filtering, protecting unstable slopes, and preventing the routing of sediment to the streams.

Performance Targets:

- Road-related: Virtually none triggered by new roads; favorable trend on old roads.
- Timber harvesting–related: No increase over natural background rates from harvest on a landscape-scale on high-risk sites.

Rule Group Strategy

Table 1 presents critical questions for the Unstable Slopes Rule Group and identifies a series of programs to address them. The strategy is to immediately implement an unstable-landform identification program to address the first two critical questions, and then to design and implement mass wasting effectiveness monitoring and validation programs to assess the effectiveness of landform recognition and mitigation at various scales. All effectiveness, extensive, and intensive tasks are administered by UPSAG; rule tools are administered by DNR in collaboration with UPSAG.

Table 1. Unstable Slopes Rule Group Critical Questions and Programs

Rule Group Critical Questions	Program Names	Task Type	SAG
What screening tools can be developed to assist in the identification of potentially unstable landforms that minimize the omission of potentially unstable landforms?	Unstable Landform Identification Program	Rule Tool	UPSAG
Does harvesting of the recharge area of a glacial deep-seated landslide promote its instability?	Glacial Deep-Seated Landslides Program	Rule Tool	UPSAG
Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard? How does the rate of landsliding on managed lands compare to an estimate of the natural (background) rate? Are the forest practices unstable-landform rules reducing the rate of management-induced landsliding at the landscape scale? Are the mass wasting prescriptions and mitigation measures effective in preventing landslides from roads and harvest units? Does windthrow on mass wasting buffers (leave areas) increase mass wasting?	Mass Wasting Effectiveness Monitoring Program	Effectiveness	UPSAG
What levels of cumulative sediment inputs are harmful to aquatic resources at the basin scale?	Mass Wasting Validation Program	Intensive	UPSAG

1.1.1 Unstable Landform Identification Program (Rule Tool)

Program Strategy

The purpose of the Unstable Landform Identification Program is to provide a set of screening tools to identify forested areas containing potentially unstable slopes and to focus field verification activities on potential problem areas, thereby improving our ability to avoid them.

The management strategy for regulating forest practices on unstable slopes consists primarily of an administrative process for identifying and reviewing forest practices on potentially unstable slopes. The main elements include defining and screening unstable slopes and improvements to the SEPA process. The success of the management strategy for unstable slopes is dependent on early recognition of potentially unstable slopes by forest managers in order to avoid or mitigate the hazards posed by them. The projects in this program are specifically referenced in the FP HCP as necessary for implementing forest practices that meet resource objectives.

This program consists of five projects that provide statewide information on the distribution of unstable landforms. Two projects are completed, one was underway but is now on hold due to budget constraints, one is partially completed and has been on hold, and one has not yet been started. Because the projects consist of the development of screening tools that are used for information only and not as regulatory tools, we do not anticipate that program results will require Policy action.

Table 2. Unstable Landform Identification Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What screening tools can be developed to assist in the identification of potentially unstable landforms that minimize the omission of potentially unstable landforms?	Shallow Rapid Landslide Screen for GIS Project
	Technical Guidelines for Geotechnical Reports Project
	Regional Unstable Landforms Identification Project (RLIP)
	Landform Hazard Classification System and Mapping Protocols Project
	Landslide Hazard Zonation Project

Shallow Rapid Landslide Screen for GIS Project

Description:

This project has three phases. The first phase of this project compared different slope stability models. Based on the results of that study, Policy directed DNR to develop a GIS-based screen of modeled slope stability based on DEM topography for the westside. This first phase was completed in 2001 and was released as TFW Report 118 titled, “Comparison of GIS-Based Models of Shallow Landsliding for Application to Watershed Management.” The second phase produced a modeled slope stability screen, which is available on the DNR forest practices website. A third phase has been proposed to identify topographic model(s) appropriate for similar mapping on the eastside. This phase is on hold while the Landslide Hazard Zonation (LHZ) Project is being conducted. Should the LHZ Project not complete mapping of the eastside, the eastside GIS screen could be used to create a complete coverage.

Status:
Phase 1 — Complete.
Phase 2 — Complete.
Phase 3 — On hold.

Technical Guidelines for Geotechnical Reports Project

Description:
This project develops technical guidelines for geotechnical reports used in the SEPA review process. The guidelines will include identification of appropriate analytical tools and techniques appropriate for different projects and at different scales.

Status:
On hold.

Regional Unstable Landforms Identification Project (RLIP)

Description:
This completed project provided a coordinator to work with Timber, Fish and Wildlife (TFW) cooperators within each DNR region in order to identify unstable landforms that do not meet the statewide landform descriptions. Its results also serve as an interim screen for deep-seated landslides by identifying lithologies that promote deep-seated landslides; however, the project did not actually map individual deep-seated landslides but rather the areas where they occur in abundance. The information created by the RLIP was recommended by UPSAG and CMER to be incorporated into the LHZ Project. In 2005, data from this project were placed into the hazard zones spatial database, which is used by DNR for classifying applications and by the LHZ team as preexisting work that they incorporate into their studies.

Status:
Complete.

Landform Hazard Classification System and Mapping Protocols Project

Description:
This project developed a detailed protocol to be used to map landslides and potentially unstable landforms in a consistent manner, leading to the assignment of hazard to unstable slopes in the forested environment. This project was completed in 2004; the protocol has subsequently been used for the implementation of the LHZ Project (described below) and by state lands geologists for large blocks of land under state ownership.

Status:
This project was completed in 2004 and has been utilized in the LHZ Project.

Landslide Hazard Zonation (LHZ) Project

Description:
This is a multiphase project. During Phase 1, all mass wasting modules from completed watershed analyses and other information on unstable landforms, landslides, and unstable slopes

were collected and compiled in a GIS database. This database has been made available for free download to the public and is utilized as a screening tool in the Forest Practices Application process. During Phase 2, mass wasting modules from incomplete watershed analyses were either finished, reviewed, and added to the database or were rejected. During Phase 3, the protocol was being implemented at the watershed scale following a list of priority watersheds based on presence of steep slopes and FP HCP lands.

Status:
Phase 1 — Complete.
Phase 2 — Complete.
Phase 3 — On hold waiting for additional funding.

Link to Adaptive Management

This section should be developed in the next year.

Knowledge Gained or Anticipated:

Identified Gaps:

Recommendations for Addressing Gaps:

1.1.2 Glacial Deep-Seated Landslides Program (Rule Tool)

Program Strategy

The purpose of the Glacial Deep-Seated Landside Program is to develop science, tools, and/or guidance for assessing the resource impact potential of deep-seated landslides in glacial sediments resulting from changes in groundwater hydrology during and after timber harvest in the landslide recharge area. Each of the five listed projects develops tools or science that help us address the critical question, "Does harvesting of the recharge area of a glacial deep-seated landslide promote its instability?"

Recent Developments:

At the budget retreat in 2006, Policy requested that UPSAG investigate pathways to resolve difficulties in the application of rules governing timber harvest on groundwater recharge areas of deep-seated landslides. In 2007, UPSAG hired a contractor to provide assistance in scoping several alternative studies. UPSAG evaluated the scoped projects and presented their findings to CMER in the fall of 2007. When there is time available, UPSAG plans to develop recommendations about these three scoped projects and about a fourth project and will present them to CMER and Policy. These four potential projects and one completed project are described below.

Table 3. Glacial Deep-Seated Landslides Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Does harvesting of the recharge area of a glacial deep-seated landslide promote its instability?	Model Evapo-Transpiration in Deep-Seated Landslide Recharge Areas Project
	Evapo-Transpiration Model Refinement Project
	Landslide Classification Project
	Groundwater Recharge Modeling Project
	Board Manual Revision Project

Model Evapo-Transpiration in Deep-Seated Landslide Recharge Areas Project

Description:

This completed project developed an analytical model for assessing the evapo-transpiration changes resulting from timber harvest. The model was intended to be applied to timber harvest within the recharge area of deep-seated landslides in glacial sediments. The model has been developed but was not directly validated and refined because of insufficient field data to verify model parameters. As such, UPSAG and CMER did not recommend a policy change, even though the results of the model suggest that there is likely a nonsignificant, detectible change in water availability when converting an entire groundwater recharge area from mature forest to a clear-cut. A follow-up validation/refinement study could be pursued as a second phase, as described below.

Status:

Complete.

Evapo-Transpiration Model Refinement Project

Description:
This potential project would use fine-scale meteorological data to validate or refine the evapo-transpiration model developed previously and would develop materials to facilitate application of the model. UPSAG presently recommends that this project not be pursued due to the low likelihood that fundamental scientific uncertainties will be resolved.

Status:
Scoped and on hold.

Landslide Classification Project

Description:
This potential project would categorize the common stratigraphic and geomorphic situations present among deep-seated landslides in glacial sediments to hypothetically evaluate which situations are most sensitive to changes in groundwater produced by upslope timber harvest. UPSAG recommends that this project, in its present form, not be pursued. However, this project may be more attractive if expanded to include an empirical component that evaluates movement of active landslides where harvest occurred in the groundwater recharge area. With CMER and Policy support, UPSAG could further scope a revised version of this study as time and resources allow.

Status:
Scoped and on hold.

Groundwater Recharge Modeling Project

Description:
This potential project would use groundwater modeling to determine whether there are ways of evaluating which parts of the groundwater recharge zone are most influential on landslide movement. This project might be useful if modeling efforts were focused on the common and probably sensitive types of stratigraphic and geomorphic situations as might be identified by the Landslide Classification Project.

Status:
Scoped and on hold.

Board Manual Revision Project

Description:
This potential project would involve revising the Forest Practices Board Manual (Section 16) to more clearly describe which deep-seated landslides are at risk and what intensity of study is required by the activity level of the landslide described by the groundwater recharge rule. This project would not require additional science but would use the expertise of geologists that have extensive experience with deep-seated landslides. It would not require contractors but would require input from Policy and regulatory personnel. UPSAG will recommend that this project be conducted at the time the recommendations about the three scoped projects are presented.

Status:
On hold.

Link to Adaptive Management

This section should be developed in the next year.

Knowledge Gained or Anticipated:

Identified Gaps:

Recommendations for Addressing Gaps:

1.1.3 Mass Wasting Effectiveness Monitoring Program

Program Strategy

The purpose of this program is to assess the degree to which implementation of the forest practices rules is preventing or avoiding an increase in landsliding beyond natural background levels. The Mass Wasting Effectiveness Monitoring Program will address the critical question that defines the program: "Are the mass wasting prescriptions effective in meeting the performance targets?" The strategy is to (1) evaluate the effectiveness of identifying unstable slopes for applying prescriptions (avoidance or mitigation); and then (2) to evaluate effectiveness at two scales, the landscape scale (extensive monitoring) and the site scale (prescription effectiveness monitoring).

Four projects are proposed. The first, Testing the Accuracy of Unstable Landform Identification Project, has a completed study design in the review process but may be extensively rescoped and redrafted in response to Policy feedback and results of the Mass Wasting Prescription-Scale Effectiveness Monitoring Project. The second, Mass Wasting Prescription-Scale Effectiveness Monitoring Project, is being implemented. The third, Mass Wasting Landscape-Scale Effectiveness Monitoring Project, has been preliminarily scoped and UPSAG plans to begin work on a study design soon. The fourth, Mass Wasting Buffer Integrity and Windthrow Assessment Project, is on hold. Table 4 lists critical questions identified for the Mass Wasting Effectiveness Monitoring Program and the associated projects.

Table 4. Mass Wasting Effectiveness Monitoring Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard?	Testing the Accuracy of Unstable Landform Identification Project
Are the forest practices unstable-landform rules reducing the rate of management-induced landsliding at the landscape scale? Are the mass wasting prescriptions and mitigation measures effective in preventing landslides from roads and harvest units?	Mass Wasting Prescription-Scale Effectiveness Monitoring Project
How does the rate of landsliding on managed lands compare to an estimate of the natural (background) rate? Are the forest practices unstable-landform rules reducing the rate of management-induced landsliding at the landscape scale? Are the mass wasting prescriptions and mitigation measures effective in preventing landslides from roads and harvest units?	Mass Wasting Landscape-Scale Effectiveness Monitoring Project
Does windthrow on mass wasting buffers (leave areas) increase mass wasting?	Mass Wasting Buffer Integrity and Windthrow Assessment Project

Testing the Accuracy of Unstable Landform Identification Project (aka Accuracy and Bias)

Description:
This project tests the accuracy and bias in the identification and delineation of potentially unstable landforms. The extent of variability and/or bias and the degree of influence it has on accurately identifying hazards in the field are unknown. This study will test the extent of accuracy and bias in slope hazard identification, specifically:

1. Are unstable slopes currently being uniformly recognized?
2. Are some unstable slopes currently going unrecognized?
3. Is the hazard of unstable slopes being correctly and uniformly recognized?

This study will provide recommended improvements to reduce variability related to proper landform identification and hazard assessment.

Status:
The study design has received preliminary CMER approval prior to ISPR submission. However, UPSAG may rescope and redraft the study in response to Policy feedback and results of the Mass Wasting Prescription-Scale Effectiveness Monitoring Project.

Mass Wasting Prescription-Scale Effectiveness Monitoring Project (aka Post-Mortem)

Description:
This project is designed to statistically compare landslide rates among five harvest treatments and five road treatments. The treatments are sets of prescriptions associated with the period in which different forest practices rules were in effect. Given a storm event that produces a significant population of landslides, landslide data will be collected within 4-square-mile blocks, and all area encompassed by the block will be stratified into one of the five harvest or five road treatment strata, respectively. Harvest and road landslides will be analyzed separately, and all analyses will be made relative to the block response. Tests will be conducted to determine whether there are differences in the density or volume of landslides associated with each of the harvest and road strata. The statistical design will answer two critical questions in Table 4: “Are the forest practices unstable-landform rules reducing the rate of management-induced landsliding at the landscape scale?” and “Are the mass wasting prescriptions and mitigation measures effective in preventing landslides from roads and harvest units?” The detailed data collection at individual landslides will be used to help evaluate the effectiveness of specific best management practices.

ISPR of the study design was completed over the summer of 2007. UPSAG was revising the study design and asking for final CMER review when the landslide-producing December 2–3, 2007, storm occurred. Final approval of the study design was given by CMER in January 2008. Policy and the Forest Practices Board approved moving forward with implementation in February 2008. UPSAG implemented this project in the spring of 2008. Additional data were incorporated into the study in the fall of 2009. The study is currently undergoing review and is expected to be finalized in 2010.

Status:
The study is currently undergoing review and is expected to be finalized in 2010. The report is expected to lead to at least one peer-reviewed journal publication, and the data are likely to be used for additional analyses. This project is administered by UPSAG.

Mass Wasting Landscape-Scale Effectiveness Monitoring Project

Description:
This project will be designed to evaluate trends in the number and volume (or area) of landslides over time at the watershed scale using landslide inventory methods similar to those of watershed analysis. In broad terms, the trend monitoring will include sites that sample statewide variability in the factors that control landslide occurrence. These sites will consist of tracts containing both FP HCP–regulated lands and other forestlands under no or less extensive management (representative of natural or background conditions). Landslide rates and volume fluxes from both will be compared. Data to infer status and trends may consist of an inventory of landslides using data collected through the Landslide Hazard Zonation Project, complemented with aerial photography, terrain, topographic, forest cover, and road network maps. During 2010 or 2011, UPSAG will work to better understand how a study might be designed to isolate the mass wasting trends associated with the forest practices rules from the dynamic noise of the natural system.

Status:
Scoped and on hold.

Mass Wasting Buffer Integrity and Windthrow Assessment Project

Description:
This project will be designed to test the effect of windthrow in mass wasting leave areas on overall landslide rates. There is a school of thought that suggests that mass wasting leave areas are especially prone to windthrow. If that is true, then mass wasting leave areas would be counterproductive for reducing sediment load to streams. However, downed timber from windthrow has been documented as being effective at slowing the rate of sediment movement on the hillslope. How these two divergent effects affect actual sediment yield to streams is not known.

Status:
There has been no action on this project, but site-specific buffer data collected during the Mass Wasting Prescription-Scale Effectiveness Monitoring Project may help UPSAG with future recommendations about this project.

Link to Adaptive Management

The following section looks at each rule group critical question for the Mass Wasting Effectiveness Monitoring Program. Knowledge gained or anticipated, identified gaps, and recommendations for addressing gaps are discussed for each critical question. The rule group critical questions are listed in bolded italics. None of the projects in this program have been completed and approved by CMER. The “Knowledge Gained or Anticipated” section represents anticipated knowledge only. For this program, there are four CMER projects (see Table 4) that address five different critical questions. The Testing the Accuracy of Unstable Landform

Identification Project (aka Accuracy and Bias) program has been referred back to Policy with questions that affect the study design. The study design should be completed in 2010. The Mass Wasting Landscape-Scale Effectiveness Monitoring Project has been scoped, but the study will not be designed until the Mass Wasting Prescription-Scale Effectiveness Monitoring Project (aka Post-Mortem) has been completed. The Mass Wasting Prescription-Scale Effectiveness Monitoring Project (aka Post-Mortem) is going through SAG review and should be ready for CMER review and ISPR in early 2010. And finally, the Mass Wasting Buffer Integrity and Windthrow Assessment Project has been put on hold, and the study is most likely to be scoped within one of the existing Type N riparian projects. As projects and associated final reports are completed within this program, this section will be updated to better address knowledge gained, identified gaps, and recommendations for addressing those gaps.

Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard?

Knowledge Gained or Anticipated:
The unstable slope rules use the avoidance of harvest on unstable slopes as a mitigation strategy. The Testing the Accuracy of Unstable Landform Identification Project (aka Accuracy and Bias) will determine the degree to which unstable landforms are currently being recognized and avoided. The study may also determine whether there is bias (positive or negative) in the amount of buffer left on those landforms. This study will help determine whether the current rule set is being implemented correctly, and it should identify measures that can be used to improve correct implementation.

Identified Gaps:
Gaps not yet identified.

Recommendations for Addressing Gaps:
Gaps not yet identified.

How does the rate of landsliding on managed lands compare to an estimate of the natural (background) rate?

Knowledge Gained or Anticipated:
The Mass Wasting Landscape-Scale Effectiveness Monitoring Project will be designed to compare landslide rates in managed and unmanaged forests and to evaluate long-term trends in landslide rates in managed forests. UPSAG will begin work on the study design in 2010 or 2011.

Identified Gaps:
Making comparisons between managed and unmanaged forests in western Washington is complicated by the fact that the two are only found in close proximity over relatively small proportions of western Washington; and unmanaged forests are typically found in higher elevations, which affects both slope and precipitation.

Recommendations for Addressing Gaps:
Recommendations have not yet been developed.

Are the forest practices unstable-landform rules reducing the rate of management-induced landsliding at the landscape scale?

Knowledge Gained or Anticipated:
The Mass Wasting Prescription-Scale Effectiveness Monitoring Project (aka Post-Mortem) is anticipated to show the effectiveness of current forest practices rules for unstable slopes relative to previous practices and relative to landslide densities in mature industrial forest.

Identified Gaps:
The results of the study are unlikely to be significant for improving rules.

Recommendations for Addressing Gaps:
Additional data mining and limited additional data collection will probably be necessary to inform potential changes to rules or best management practices.

Are the mass wasting prescriptions and mitigation measures effective in preventing landslides from roads and harvest units?

Knowledge Gained or Anticipated:
The Mass Wasting Prescription-Scale Effectiveness Monitoring Project (aka Post-Mortem) is expected to show how effective the current rules are with respect to roads and harvest units.

Identified Gaps:
The results of the study are unlikely to be significant for improving rules.

Recommendations for Addressing Gaps:
Additional data mining and limited additional data collection will probably be necessary to inform potential changes to rules or best management practices.

Does windthrow on mass wasting buffers (leave areas) increase mass wasting?

Knowledge Gained or Anticipated:
It does not appear that there was a significant amount of windthrow in the Mass Wasting Prescription-Scale Effectiveness Monitoring Project (aka Post-Mortem) study area, and so this question was not resolved by the study.

Identified Gaps:
The results of the Post-Mortem study suggest that windthrow research must be focused on areas that do experience windthrow.

Recommendations for Addressing Gaps:
Focus windthrow research in areas that experience significant windthrow (i.e., near coastal areas).

1.1.4 Mass Wasting Validation Program (Intensive)

Program Strategy

No program strategy has been developed, but it is presumed that when UPSAG has time to work on this program that the efforts of the Monitoring Design Team will be a useful starting point.

Table 5. Mass Wasting Validation Program: Applicable Rule Group Critical Questions with Associated Research Projects

Rule Group Critical Questions	Project Names
What levels of cumulative sediment inputs are harmful to aquatic resources at the basin scale?	No projects have been developed

Link to Adaptive Management

This section will be completed as the program is further developed.

Knowledge Gained or Anticipated:

Identified Gaps:

Recommendations for Addressing Gaps: