Unstable Slope Criteria Project: Empirical Evaluation of Landslide Susceptibility and Frequency by Landform and Empirical Evaluation of Shallow Landslide Runout, Study Design

Answers to Prospective Six Questions from the CMER / Policy Interaction Framework Document

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Approved by CMER on: TBD
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Brief Project Description: This is the study design for the combined projects Empirical Evaluation of Shallow Landslide Susceptibility and Frequency by Landform (Project 3) and Empirical Evaluation of Shallow Landslide Runout (Project 4) of the five sequential studies that comprise the Unstable Slope Criteria Strategy. Projects 3 and 4 are focused on spatially distributed empirical quantification of shallow landslide initiation and runout potential.

1. **Will the study inform a rule, numeric target, Performance Target, or Resource Objective?**
   Yes, Washington Administrative Code (WAC) 222-16-050 addresses forest practices conducted on unstable slopes or landforms with the potential to deliver sediment or debris to a public resource or that have the potential to threaten public safety. These activities are evaluated as a Class-IV-Special forest practice and undergo State Environmental Policy Act (SEPA) review.

   Unstable slopes and landforms are defined in subsection d(i) of WAC 222-16-050; these are referred to as Rule-Identified Landforms (RILs). The WAC 222-16-050(1)(d)(i) lists the five RILs and directs the reader to Section 16 of the board manual where the RILs and their criteria are described in detail. Those five RILs are utilized by DNR's Forest Practices Application (FPA) approval process to evaluate a timber harvest's likelihood of causing landslides that could deliver sediment or debris to a public resource or in a manner that would threaten public safety (see WAC 222-10-030(2)(b): SEPA policies for potentially unstable slopes and practices). The performance target for mass-wasting sediment delivered to streams specified in Schedule L-1 is: "no increase over natural background rates from harvest on a landscape scale on high-risk sites."

   The sequence of five studies specified for the Unstable Slopes Criteria Project, of which this study design addresses Projects 3 and 4, is to deliver data and analyses to provide a basis for potentially updating the RIL definitions.

2. Will the study inform the Forest Practices Rules, the Forest Practices Board Manual guidelines, or Schedules L-1 or L-2?

Yes, as described above, the study seeks to evaluate the effectiveness of current RIL definitions for meeting the Schedule L-1 performance target for mass-wasting sediment delivered to streams. As stated in the 2023-2025 Biennium CMER Work Plan (page 85), this study addresses the original Forests & Fish Report Schedule L-1 research topic to "Test the accuracy and lack of bias of the criteria for identifying unstable landforms in predicting areas with a high risk of instability" and will provide information to answer the Unstable Slopes Rule Group critical question "Are unstable landforms being correctly and uniformly identified and evaluated for potential hazard?" This study will also provide additional information and examples for the Forest Practices Board Manual, Section 16, "Guidelines for Evaluating Potentially Unstable Slopes and Landforms."

3. Will the study be carried out pursuant to CMER scientific protocols (i.e., study design, peer review)?

Yes, the Unstable Slopes Criteria Project – Research Alternatives document went through UPSAG, CMER, and ISPR evaluation and approval (02-28-2017). This study design has gone through UPSAG, CMER, and ISPR evaluation and approval (09-26-2023). All deliverables from the study will also be subject to UPSAG, CMER, and ISPR evaluation and approval.

4. a. What will the study tell us?

This study will provide a methodology, empirical data (e.g., landslide inventory), and software tools for determining how landslide rate, the potential for delivery of sediment and debris to public resources, and threats to public safety vary by landform. The study may result in recommendations to modify the related landform criteria to better identify and delineate unstable areas. This will provide the ability to calculate the proportion of sediment and debris delivered to public resources (primarily stream channels) from both RIL and non-RIL landforms and to see how those proportions change regionally in response to differences in geology, topography, and climate. This information may then be used to refine RIL criteria to better deal with regional differences in landslide processes and landslide responses to forest practices.

b. What will the study not tell us?

This study will show how landslide density and delivery potential vary point by point across the studied landscapes but may or may not be able to identify where or if forest practices alter background landslide initiation and delivery rates. Increases in background landslide rates are addressed by the next study in this sequence (Project 5). The current study relies on landscape attributes measured or inferred from remotely sensed data. Relationships between those landscape attributes and landslide and delivery rates are limited by how well available data can resolve the factors that influence landslide potential. The map products generated will provide accurate information when aggregated over a landscape scale but are not intended to substitute for site-specific factors that locally affect landslide potential.

5. **What is the relationship between this study and any others that may be planned, underway, or recently completed?**
   This is the study design for the combined 3rd and 4th Projects in the sequence of five described in the Unstable Slopes Criteria Project – Research Alternatives (2017) document:

   1. Compare/Contrast Landslide Hazard Zonation Mass Wasting Map Units with RIL,
   2. Automated Object-Based Landform Mapping with High-Resolution Topography,
   3. Empirical Evaluation of Shallow Landslide Susceptibility and Frequency by Landform,
   4. Empirical Evaluation of Shallow Landslide Runout, and
   5. Models to Identify Landscapes/Landslides Most Susceptible to Management.

   The 2nd study, Automated Object-Based Landform Mapping with High-Resolution Topography, is currently underway. The empirical studies (3 & 4) will rely on computer-based landform-mapping tools developed with Project 2, but these will not be needed until the end of the study, so CMER has approved concurrent work on Projects 3 & 4 as Project 2 is completed. Note that for Project 1, Mass-Wasting-Map Unit data collected during the Landslide Hazard Zonation project will be incorporated into the other four studies (2-5), as recommended in ISPR comments on the 2017 research alternatives document cited above.

6. **What is the scientific basis that underlies the rule, numeric target, performance target, or resource objective that the study will inform? How much of an incremental gain in understanding will the study results represent?**
   Both theoretical models and empirical observations indicate that shallow landslide initiation and runout extent are strongly influenced by landform characteristics. RILs are intended to encompass the landforms that are most susceptible to landsliding. However, theory and observation also indicate that there is a gradient in landslide susceptibility based on site conditions, such as bedrock geology and soils, with potentially large areas where landslides are extremely rare or associated only with extreme storm events. To determine the effectiveness of RIL criteria for avoiding increases in the rate of landslide delivery of sediment and debris to public resources, this study will compare landslide delivery rates of RIL and non-RIL zones across entire landscapes. This study uses newly available data and analysis techniques to more accurately and precisely resolve landslide locations and runout extent. This will enable rigorous delineations of those landscape locations prone to landslide initiation and runout and an understanding of landslide density within these areas. These techniques will also provide the ability to quantify landslide sediment delivery rates to streams as a function of landscape position, (i.e., of landform type, so that RIL and non-RIL zones can be compared in terms of the proportion of landslide-delivered sediment and debris originating from each). Such comparisons are possible now because this study includes quantification of delivery potential using newly developed methods unavailable to previous studies.