Forest Practices Technical Note Number 6

Determination of Rapidly Moving Landslide Impact Rating

Version 2.0
Effective December 10, 2024

Objective

Technical notes are written to highlight current issues related to protecting and managing forestland resources and are tied to various aspects of the Oregon Forest Practices Act. After using *Forest Practices Technical Note 2: High Landslide Hazard Locations, Shallow, Rapidly Moving Landslides and Public Safety: Screening and Practices* to screen proposed forest operations for the need to apply the landslides and public safety rules, this note is intended to be used by a Geotechnical Specialist to determine the rapidly moving landslide impact rating(s). The impact rating categorizes the potential for a shallow, rapidly moving landslide to reach a specific location. The impact rating, coupled with the type of exposure (e.g. residence, highway, etc.), categorizes the potential risk of serious bodily injury or death. The focus of the impact rating determination is on the geomorphic characteristics of a hillslope or channel that influence debris flow transport and deposition.

Background

Policy and authority for protection of the public from landslide hazards is found in 1999 Senate Bill 12. The Shallow, Rapidly Moving Landslide and Public Safety Rules, OAR 629-623-0000 through 0800, became effective January 1, 2003. Forest Practices Technical Note 2, version 3.0, provides a summary of administration and application of the landslides and public safety rules and outlines how operations can be screened for high landslide hazard locations (HLHLs) and exposed structures and roads. Proposed forest operations that pose potential risk to public safety from shallow, rapidly moving landslides must be further evaluated to determine public safety risk levels and the corresponding rules that apply. This includes a number of steps. This document provides technical guidance for completing one of those steps, determining the rapidly moving landslide impact rating (OAR 629-623-0250). It has been updated from Version 1.0 with additional clarifying information. This determination should be performed by a Geotechnical Specialist and should be based on site specific field observations, measurements, and professional judgement.

The impact rating reflects the expected frequency and severity of impact from a shallow rapidly moving landslide on a structure or road. Shallow rapidly moving impact potential is rated as unlikely, moderate, serious and in limited cases, extreme. When impact ratings are combined with exposure categories, the resulting public safety risk level identifies the relative risk of serious bodily injury or death due to shallow rapidly moving landslide impact to structures or roads. The resulting harvest modifications are intended to prevent forest practices that increase public safety risk. However, in many cases, the natural landslide risk for structures or roads can be high. The Shallow, Rapidly Moving Landslides and Public Safety Rules can keep the risk from becoming even greater (at least in the short-term) but cannot reduce the natural background risk. Some people in areas with high natural landslide risk remain at high risk of serious bodily injury or death, regardless of forest practices regulations and the resulting upslope forest practices.

Table 1 is a matrix that shows how the exposure category (OAR 629-623-0200) of structures or roads and the rapidly moving landslide impact rating (OAR 629-623-0250) are used to determine the public safety risk level (OAR 629-623-300). Most forest operations are prohibited if the downslope public safety risk is substantial and there are significant restrictions on operations if the downslope public safety risk is intermediate.

Table 1. Public Safety Risk Levels

Exposure Category	**Rapidly Moving Landslide Impact Rating**			
	EXTREME	***SERIOUS***	***MODERATE***	***UNLIKELY***
A	Substantial	Substantial	Intermediate	Low
B	Substantial	Intermediate	Low	Low
C	Intermediate	Low	Low	Low

Terminology

A ***debris fan*** is a deposit formed as an open-slope debris flow or debris torrent comes to rest. Debris fans are typically located at the mouth of canyons or anywhere else channels lose confinement. They can also be located at the base of steep slopes. Debris fans typically consist of unsorted deposits of fines, sand, and gravel, as well as boulders and wood debris.

Exposure categories [629-600-0100] are used to designate the likelihood of persons being present in structures or on public roads during periods when shallow, rapidly moving landslides may occur.

A ***Geotechnical Specialist*** is an Oregon registered Professional Engineer (PE) or a Certified Engineering Geologist (CEG).

Headwall [629-600-0100] means steep, concave slopes that can concentrate subsurface water, which can lead to increased landslide susceptibility. Headwalls are typically located at the head of stream channels, draws, or swales. Headwalls have slope gradients of 65 percent or greater in the Tyee Core Area and 70 percent or greater in the rest of the state, as measured in the axis of the headwall. Landslides that occur in headwalls are more likely to initiate channelized debris flows that can travel down streams (also known as debris torrents) than landslides that occur in other areas of the slope.

A ***high landslide hazard location [629-600-0100]*** means a specific site that is subject to initiation of a shallow, rapidly moving landslide. The following criteria shall be used to identify high landslide hazard locations:

(a) The presence, as measured on site, of any slope in Western Oregon (excluding competent rock outcrops) steeper than 80 percent, except in the Tyee Core Area (see Technical Note 2 for a map of the Tyee Core Area), where it is any slope steeper than 75 percent;

(b) The presence, as measured on site, of any headwall or draw in Western Oregon steeper than 70 percent, except in the Tyee Core Area, where it is any headwall or draw steeper than 65 percent; or

(c) Notwithstanding the slopes specified in (a) or (b) above, field identification of atypical conditions by a Geotechnical Specialist may be used to develop site specific slope steepness thresholds for any part of the state where the hazard is equivalent to (a) or (b) above. The final determination of equivalent hazard shall be made by the State Forester.

A ***shallow, rapidly moving landslide [629-600-0100]*** means any detached mass of soil, rock, or debris that begins as a relatively small landslide on steep slopes and grows to a sufficient size to cause damage as it moves down a slope or stream channel at a velocity difficult for people to outrun or escape.[1] For the context of this technical note there are two types of these landslides: open-slope debris flows and debris torrents.

An ***open-slope debris flow*** is a slide that does not enter a confined channel or narrow draw. They occur on open topography such as Uniform Slopes or Ridge-forms. They travel tens to hundreds of feet from the initiating high landslide hazard location and typically deposit on gentler lower slopes or at the base of consistently steep slopes.

A ***debris torrent*** is a debris flow which becomes confined within a channel or narrow draw, often combining with the streamflow present. They often scour the channel to bedrock, increasing in size as they travel hundreds or thousands of feet beyond the site of initial failure, delivering significant volumes of material to their deposition area. They may exhibit laminar or turbulent flow, their content ranging from mostly solids to mostly water.

Tyee Core Area [629-600-0100] means a location with geologic conditions including thick sandstone beds with few fractures. These sandstones weather rapidly and concentrate water in shallow soils creating a higher shallow, rapidly moving landslide hazard. The Tyee Core Area is located within coastal watersheds from the Siuslaw watershed south to and including the Coquille watershed, and that portion of the Umpqua watershed north of Highway 42 and west of Interstate 5. Within these boundaries, locations where the bedrock is highly fractured or not of sedimentary origin, as determined in the field by a Geotechnical Specialist, are not subject to the Tyee Core area slope steepness thresholds. See Tech Note 2 for map and link to GIS layer.

[1] Other sources may use the terms Debris Avalanche and Debris Flow referring to mass movements which are fragmented or slurry-like, respectively, regardless of confining conditions. Also, 629-600-0100(30) defines Debris Flow differently than this Technical Note to refer only to confined mass movements which deliver to certain stream types, using the definition to develop a modeled mapping exercise to delimit Debris Flow Traversal Areas [629-0600-0100(33)]. Division 623 and associated Technical Notes 2 and 6, will define mass movements for use in administration of the Landsides and Public Safety context.

Overview

The impact rating is location specific, identified at a home, road, or other structure where people may be present. It describes the likelihood that a shallow, rapidly moving landslide can impact that location. The impact rating, in conjunction with the “exposure category” in Table 1, identifies the relative risk of serious bodily injury or death due to rapidly moving landslide impact to structures or roads. Property damage alone is not considered in determination of impact rating, unless that damage is so severe that serious injury or death to those inside the structure or vehicle can reasonably be expected. The impact rating reflects both the expected frequency and expected severity of impact.

Impact rating factors may include but are not limited to: the location of the structure or road in relationship to the debris torrent-prone stream or steep slope; channel confinement; channel gradient; channel junction angles; and debris in the channel [OAR 629-623-0250(1)].

The Geotechnical Specialist should note that the focus of the impact rating determination is on the geomorphic characteristics of the hillslope or channel that influence shallow rapidly moving landslide initiation, transport and deposition. The ratings are judgement based. Other information such as published landslide or debris torrent risk maps can be used to help inform the impact rating, but, since these tend to be non-site specific, they should not be the only basis for an impact rating.

Rapidly moving landslide impact potential is rated as **unlikely, moderate, serious** and, in limited cases, **extreme** [OAR 629-623-0250(2)].

- **“Unlikely”** impact rating indicates that any shallow, rapidly moving landslide initiating within the operation area is unlikely to directly impact a structure or road.
- **“Moderate”** impact rating indicates that it is uncertain whether any shallow, rapidly moving landslide initiating within the operation area is likely or unlikely to directly impact a structure or road. Dangerous impacts cannot be ruled out.
- **“Serious”** impact rating indicates that any shallow, rapidly moving landslide initiating within the operation area is likely to directly impact a structure or road.
- **“Extreme”** indicates that any shallow, rapidly moving landslide initiating within the operation area is likely to directly impact a structure or road. In addition, there are unusual conditions that make dangerous impacts almost certain, such as a structure or road located in the transport zone of a potential debris torrent.

Special circumstances

Certain structures in the path of rapidly moving landslides such as dams, powerlines or oil tanks, that might fail upon impact and injure people in structures or on roads further downstream should also be included in the impact rating [OAR 629-623-0250 (4)].

Determining the Impact Rating

Documentation of the geotechnical determination of impact rating(s) [OAR 629-623-0250(3)] should include data and observations supporting that impact rating. Individual potential initiation sites or tributaries within an operation may have different impact ratings. Behavior of shallow, rapidly moving landslides is complex, depending on the interaction of many factors. Geomorphic characteristics which may influence initiation, transport and deposition of shallow, rapidly moving landslides are discussed below. The Geotechnical Specialist may determine there are additional factors controlling the impact rating which are not presented below. After the Geotechnical Specialist has submitted information and their impact rating determination, the State Forester will review the impact rating and make the final determination [OAR 629-623-0250(5)].

The path of a shallow, rapidly moving landslide can be broken into three main phases (Figure 1):

I. Initiation (high landslide hazard location, HLHL);
II. Transport (ability of a slope or channel to transport a rapidly moving landslide); and
III. Deposition (terminal deposition of a rapidly moving landslide).

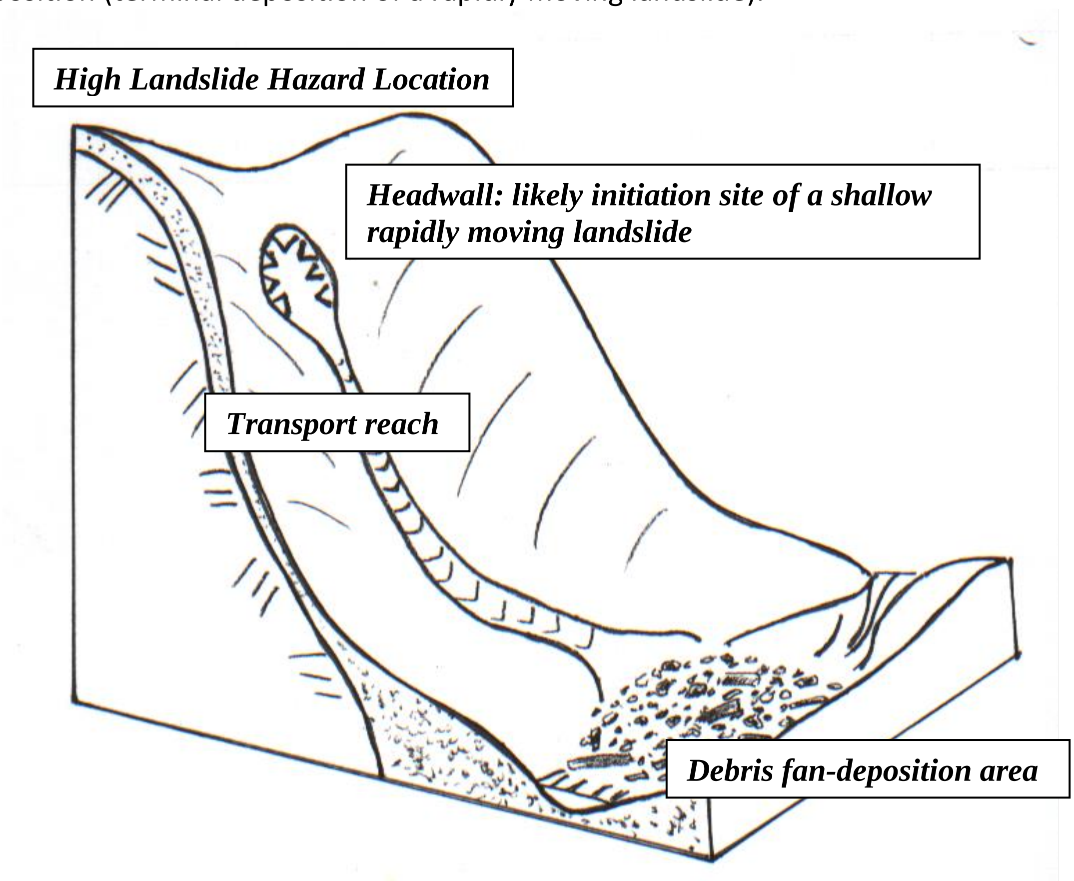

Figure 1. Debris flow initiation, transport, and deposition.

I. INITIATION – HIGH LANDSLIDE HAZARD LOCATIONS

The Department considers the location of the rule-specified high landslide hazard locations (HLHLs) to contain any potential initiation sites. The impact rating can be informed by both the expected frequency of delivery to a location of concern (structure, road) and the total acreage likely to initiate a landslide and potentially deliver material to that location. The more HLHL acreage up-basin, the more potential initiation sites there may be. The definition of HLHLs is in the terminology section of this document and outlined in the table, below. Specific criteria for determining HLHLs are further described in Forest Practices Technical Note 2, version 3.0. Slopes that appear planar or convex (ridge-form) in plan view fall into part (a) of the HLHL definition. Slopes that appear concave in plan view should be considered a headwall or draw and fall into part (b) of the HLHL definition.

Table 2.

High Landslide Hazard Location Criteria		
	W. Oregon	***Tyee Core Area***
A. Uniform Slopes/Ridge-forms	**>=80%**	**>=75%**
B. Headwalls/draws	**>=70%**	**>=65%**
AND > 30 feet long (slope distance)		
C. As indicated by a Geotechnical Specialist		

Standard measurements and observations

The reader is referred to Technical Note 2 for using Lidar products to screen for HLHLs. Slope steepness of the HLHL should be measured on-site whenever Lidar is not clear, or distance thresholds are close. Good on-site measurements should take precedence over Lidar-measured features. Short pitches of steep slopes that are less than 30 feet slope length are not considered HLHLs. Constructed cutslopes are not considered HLHLs. Sidecast and fillslopes are considered HLHLs only if they meet both the slope steepness and slope length criteria. Slope measurements should be taken both up and down the slope and averaged to determine actual slope steepness if slopes are very close to HLHL thresholds.

Atypical Conditions

The definition of HLHLs assumes homogenous geologic and subsurface conditions. Section (c) of the definition recognizes that there are site-specific characteristics, which may give the Geotechnical Specialist reason to modify the slope thresholds in Sections (a) or (b). For example, slope thresholds might be adjusted to be steeper on a site in the Cascade Range with a well-drained talus slope. Conversely, evidence of slope instability, such as actively failing slopes, may justify the decision to lower the slope thresholds. There are several factors which may influence initiation hazard such as soil depth, soil material properties, slope-shape, vegetative characteristics, bedrock characteristics, subsurface water flow, and others. The Geotechnical Specialist will have to present supporting evidence to demonstrate that modification of the standard slope thresholds is appropriate for the specific site.

Tables 3 and 4 below show initiation site geometry data from the Robison et al. (1999) study of the 1996 Oregon storms. Both tables include initiation sites located adjacent to channels and upland. Road-related failures were not included. Initiation site geometry does not reflect the shape of transport zones or deposition of these events, only the initial failure zone. Initiation sites can be quite small, in fact, the “typical” (see 50^{th} percentile, Table 3) concave or headwall HLHL initiation site is 20 ft wide, 2 ft deep, and 30 ft long. After initiation, landslide material may then be translated either into open-slope debris flows or become channelized as debris torrents.

Table 3: Characteristics of landslides initiating from HLHLs >=70% and concave.

Statistic (n = 141)		Average Width (ft)	Average Depth (ft)	Length (ft)
Maximum		50	8	110
Minimum		5.0	.5	8.0
Percentiles	90th	35.0	4.0	60.0
	80th	30.0	3.0	48.0
	70th	25.0	3.0	40.0
	50th	20.0	2.0	30.0
	20th	11.0	1.0	20.0
	10th	9.0	1.0	15.0

Table 4: Characteristics of landslides initiating from HLHLs >= 80% and not concave.

Statistic (n = 198)		Average Width (ft)	Average Depth (ft)	Length (ft)
Maximum		239	25	184
Minimum		2.0	0.1	5.0
Percentiles	90th	40.0	4.0	60.0
	80th	30.0	3.0	45.0
	70th	25.0	3.0	38.7
	50th	19.0	2.0	25.0
	20th	10.4	1.0	15.4
	10th	8.0	1.0	12.0

II. TRANSPORT

The characteristics of transport and deposition are different for the two types of shallow, rapidly moving landslides; open-slope debris flows (non-channelized) and debris torrents (channelized). Structures and roads located very near the base of a steep slope with HLHLs are most at risk from open-slope debris flows. Structures and roads located within or near confined channels or canyons or near the mouth of those channels or canyons are most at risk from debris torrents. The following characteristics are known or thought to influence transport and deposition of open-slope debris flows and debris torrents. The Geotechnical Specialist should investigate these factors, where applicable, and use them to help determine how transport affects the impact rating(s) for the proposed forest operation.

Open-Slope Debris Flows

Open-slope debris flows are controlled primarily by slope steepness. Open-slope debris flows can travel tens to hundreds of feet on steep slopes, but deposition is expected to begin on slopes of 40% or less. Open-slope debris flows commonly deposit at the base of steep slopes, but may also deposit on mid-slope benches, usually of 50-foot slope distance or more. Benda (1999) developed a combined theoretical-empirical model for predicting landslide runout on open-slopes.

Hillslope steepness and the presence and width of mid-slope benches between the HLHLs and the structure or road should be measured using Lidar or on site and included in the geotechnical report.

Open-slope debris flows entering channels from steep side-slopes can be expected to deposit and not continue as debris torrents where the receiving channel has a relatively gentle gradient.

Debris Torrents

When a landslide enters a stream channel it becomes a debris torrent. Channel confinement, gradient, and junction angles exhibit the most control over debris torrent transport and deposition. However, other factors such as the amount and type of material available to be entrained, the potential energy available, and obstructions or barriers can also affect debris torrent transport and deposition.

Impact area

Debris torrents leave zones of disturbance along the travel path known as the impact area. The impact area is created by the width and height of the passing torrent, resulting in visible effects left on the channel sides. The three types of impacts noted by the Robinson et al (1999) and described in table 5 were scour, transport, and deposition. The impact rating may be informed by the table if the issue of concern (home or road) is located within a certain impact area type along a channel. For example, if the expected height of the passing torrent is smaller than a home’s height above the channel, it may be less likely to be impacted.

Table 5. Typical impact parameters for debris torrents, from (Robison et al., 1999).

Channel Impact Type		Impact Width (feet)	Impact Height (feet)	Channel Gradient (%)
	average	20	6	38
	minimum	0	0	0
Scour	5th percentile	6	0.5	9
n = 483	20th percentile	11	2	21
	80th percentile	26	10	55
	95th percentile	45	18	80
	maximum	110	40	110
	average	37	9	23
	minimum	3	0.2	0
Transport	5th percentile	7	1.5	3
n = 583	20th percentile	13	4	8
	80th percentile	50	13	35
	95th percentile	90	20	53
	maximum	300	62	110
	average	62	6	14
	minimum	0	0	0
Deposition	5th percentile	10	1	2
n = 718	20th percentile	22	2.5	3
	80th percentile	90	9	21
	95th percentile	170	16	42
	maximum	350	30	100

Channel junction angles

Benda and Cundy (1990) developed a simple empirical model for predicting debris torrent deposition based on channel junction angles and channel gradient. Channel junction angles of 70 degrees or greater were found to predict deposition of most debris torrents, as long as the channel gradient of the receiving channel was 36 percent or less. Robison et al. (1999) validated the Benda-Cundy model with their study of 361 debris torrents, finding that the Benda and Cundy (1990) model predicted the maximum run-out of torrents 92% of the time. Methods for determining a junction angle can be found in Benda and Cundy (1990). Small turning angles at stream junctions or stream bends along fairly straight debris torrent paths will have little effect on slowing the torrent down.

Robison also found that for torrents that travelled further than the empirical model predicted, the average initiating landslide volume was about an order of magnitude larger (1,281 cubic yards) than the average of those travelling equal or less distance than the model predicted (137 cubic yards). Robison states: "*This result indicates that initial landslide volume can affect debris torrent run-out distance but is of a lessor significance than junction angles and channel gradient*".

Channel gradient

Benda and Cundy (1990) and Robison and others (1999) both found that, in the absence of a sharp channel junction angle, debris torrents typically deposit along channel gradients less than 6 percent. The British Columbia Ministry of Forests (1994) found "Major velocity reductions and significant deposition of materials occur when channel gradients drop below 7 or 8 degrees (12 to 16 percent)", although this range may not be appropriate for debris torrents in Oregon. Channel gradients of less than 6 percent for 300 feet should result in deposition of most debris torrents. There are rare instances where serious impacts may extend more than 300 feet along a channel gradient of less than 6 percent. This might be indicated in the field by debris torrent deposits further downstream than would normally be expected. Typically, the gradient of the gentlest section of channel is averaged over a distance of 300 feet and reported in percent. Channel gradients with debris torrent impacts from Robison et al. (1999) are shown in Table 5.

Channel confinement

Channel confinement has a significant effect on the transport and deposition of debris torrents (VanDine, 1985). Confinement is the horizontal distance between valley or canyon walls. Debris torrent mobility requires a certain thickness of flow and confinement for forward movement to continue. Therefore, confinement should be considered in making the impact rating. Stream channels flowing within relatively wide canyons are unlikely to carry a debris torrent because torrents that can spread and thin tend to come to rest sooner. Very narrow, low gradient canyons may also stop debris torrents if the material is "wedged" between the canyon walls. Table 5 summarizes debris torrent impact height and widths presented by Robison et al. (1999).

Determination of confinement can be problematic, since it is dependent in part on the volume of the debris torrent. The authors of this technical note are unaware of any published data regarding numeric values for canyon or channel confinement and debris torrent transport and deposition. A rule of thumb for the "typical" Coast Range stream is to measure the width of the confining valley walls at a height of 10 feet above the channel bed (Figure 2). If the horizontal distance as measured from a point approximately 10 feet above the channel bed is greater than 200 feet, the channel is considered to be unconfined. The 200-foot criterion is likely conservative since most torrents have volumes too small to remain mobile at this valley width.

Note that streambanks that are shallow and narrowly incised in an otherwise broad valley are unlikely to carry a significant volume of material. An arriving torrent would not be influenced by the normal stream flow path and may take a different path if the flow thickness is much deeper than the nominally incised stream channel.

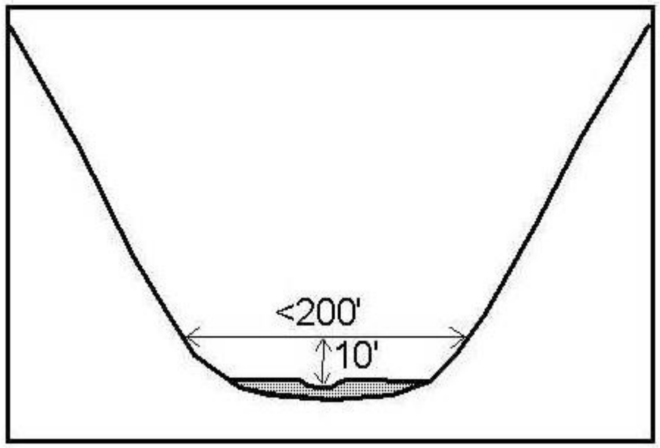

Figure 2. A "marginal" example of a confined channel.

Amount and type of material available to be entrained
There are four types of material typically present in channels that may influence transport and deposition: soil, boulders, downed wood, and standing vegetation. Channels which have been recently scoured by a debris torrent or are otherwise lacking material in the channel or banks will have less material available for debris torrent “bulking” and, therefore, less destructive potential. However, these channels can still transport debris torrents. Conversely, debris torrents in channels through deep colluvium may scour a large volume of material.

The role of downed wood in debris torrent movement is not clear. One simplistic model suggests that debris torrents with higher wood content tend to deposit at steeper gradients than debris torrents with less wood (Lancaster et al. 2000). The role of standing trees in the torrent path is also unclear. Data from Robison et al. (1999) suggests that mature riparian vegetation along channels where debris flows are starting to lose momentum may cause debris torrents to terminate sooner than expected, though their effects on runout seem secondary to junction angles and gradient.

Potential energy available
The potential energy available for a shallow, rapidly moving landslide may be another important factor for evaluating impact potential. Important measures include the elevation drop from the high landslide hazard location to the structure or road and the angle of reach (Johnson, Swanston and McGee, 2000; Corominas, 1996; Benda and Cundy, 1990). The angle of reach is the average slope angle of the line connecting the initiation point of a landslide to the distal end of the deposit.

Obstructions or barriers
Natural or human-made obstructions may influence transport and deposition. For example, road fills, particularly in the deposition zone, may block transport. However, fills in steep transport reaches may fail, and increase the volume of debris and water comprising the rapidly moving landslide. Man-made deflection berms will likely change the impact rating.

III. DEPOSITION

Debris fan deposits

Evidence of past open-slope debris flow or debris torrent deposition may be used to indicate the likelihood of future occurrence. Debris fans or deposits indicate past deposition of a shallow rapidly moving landslide at a site. Debris fans can be differentiated from alluvial fans in several ways. Debris fans are composed of unsorted deposits of coarse materials and fines and often have a noticeable number of gravels, cobbles, and large boulders. Large wood debris may be present in younger fans. Alluvial fans are composed of sorted deposits of gravel and finer materials. Due to differences in sorting, debris fan deposits are unstratified or poorly stratified while alluvial deposits have distinct layers. Generally, debris fans have steeper snouts than alluvial fans. Shallow rapidly moving landslide processes can be thought of as different than alluvial processes in terms of the competence of the flow, i.e. shallow rapidly moving landslides can transport rock fragments and “debris” of sizes which cannot be transported by normal fluvial processes. In many cases, after significant fluvial re-working of landslide debris deposits, material which the stream cannot transport with typical fluvial mechanisms remain as lag deposits. Therefore, the presence of large rock fragments (boulders) may be one of the more reliable indications of previous shallow rapidly moving landslide deposition when finer material has been eroded away.

Elevation of the structure or paved road

Structures or paved roads located at an elevation higher than the expected elevation of the torrent transport/deposition area are likely to be at a lower level of risk.

Depositional reach

Deposition of debris torrents often begin some distance above where the furthest deposits are expected to come to rest. In the transport reach the torrent is expected to actively scour and mobilize material toward lower parts of the channel, whereas in the depositional reach the torrent starts slowing and can be expected to begin leaving behind deposits. As the torrent slows, deposition begins, and the torrent volume becomes smaller. The depositional reach may begin where the channel gradient decreases notably, and/or channel width increases notably. Often, the start of the depositional reach contains older debris deposits. These locations may contain an active stream channel which seems undersized for the width of the deposits present. Internal Department guidance indicates these reaches may start when gradients drop below 15%. Generally, the same geomorphic considerations that influence the impact rating can be taken into account to help determine the start of a depositional reach which is important due to 629-623-0600(4).

An ODF field investigation of 18 debris torrents with varying degrees of impacts to roads and structures identified three factors associated with severe debris torrent impacts (Figure 3). These factors are:

1. ***Distance and offset of the structure or paved road from the likely depositional area:*** Specifically, a structure location that is within 110 feet of the channel at the loss of confinement and within 12 degrees of the channel alignment.
    a. Channel offset is measured by the horizontal angle from the mouth of the confined canyon to the structure or road. ODF (2001) found that structures in direct alignment with channels received greater damage from debris torrents (Figure 3). Structures unaligned with channels did not experience significant damage from debris torrents. Debris torrents tend to deposit most of their load over relatively short distances when the channel or canyon loses confinement. For open-slope failures the depositional distances tend to be even less.
2. ***Steeper gradients:*** Channel gradients over 9 percent in the last 300 feet of channel above structures or roads; and
3. ***Large road failures***: When slide initiation involves a large road fill failure, larger impacts can be expected.

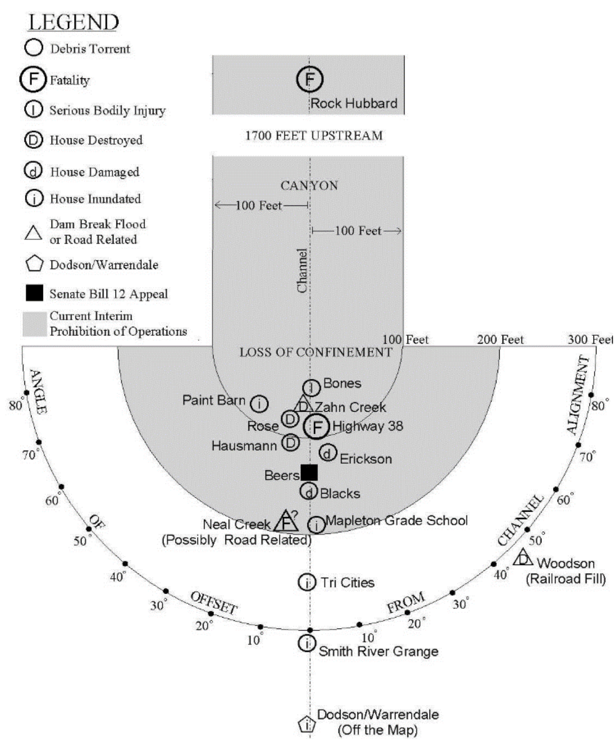

Figure 3. Plot of structures impacted by debris torrents in relation to the point where the delivering channel lost confinement. Different types of events are represented with different symbols. Letters within those symbols are used to denote the level of impact and the occurrence of fatalities and serious bodily injuries.

Mitigation

Structural mitigation can be used to lower the rapidly moving landslide impact rating, as described in OAR 629-623-0800 (1) and (2). Structural methods that mitigate deposition or impact may be constructed by the landowner under the direction of a Geotechnical Specialist. Deflection berms or walls, driven piles, structural elevation, and other forms of mitigation can be considered if they reduce the public safety risk. Mitigation must be completed before the start of the forest operation and must be proposed in a written plan submitted by the operator. The Geotechnical Specialist should inspect the mitigation site after construction to see if mitigation is properly constructed and if unforeseen conditions exist. Given the likely (or unlikely) effectiveness of the mitigation, a new impact rating then needs to be assigned to the location.

Geotechnical Reports

The geotechnical report should include a map of the proposed operation along with a determination of the rapidly moving landslide impact rating associated with different high landslide hazard locations or initiation sites with a discussion and documentation of the geomorphic characteristics or other factors which the Geotechnical Specialist used to reach their conclusion.

If an impact rating was determined for an operation, then the geotechnical report or communication documenting that determination needs to be uploaded to ODF's Forest Activity Electronic Reporting and Notification System (FERNS) so that it can be reviewed by an ODF Geotechnical Specialist. Since HLHLs outside of and near notified boundaries can still require windfirm buffers within the notified area, this also provides an opportunity to make sure appropriate windfirm buffers will be established for operations with substantial risk. It also can help ensure that proper intermediate risk harvest restrictions will be followed.

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Oregon Department of Forestry Field Offices

For more information about the Oregon Forest Practices Act or the Forest Practice Rules, please contact your local Oregon Department of Forestry office which can be found at http://www.oregon.gov/ODF/Working/Pages/FindAForester.aspx *or the headquarters office at 2600 State Street, Salem, Oregon 97310. 503-945-7200.*