Mapping of Potential Landslide Hazards in King County

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Lake Wilderness Lodge

Presented by

Department of Natural Resources and Parks
Water and Land Resources Division
River and Floodplain Management Section

and

Department of Permitting and Environmental Review
Presentation Outline

- Welcome and Introductions
- Landslide Types
- New Mapping Products
  - River Corridor Mapping
  - Department of Permitting and Environmental Review’s Map of Potential Landslide Hazards
- Resources
- Question and Answer
Introductions

Department of Natural Resources and Parks
John Bethel, Geologist, WA LEG
Sevin Bilir, Geologist, WA LHG
Jeanne Stypula, Supervising Engineer, PE

Department of Permitting and Environmental Review
Greg Wessel, Geologist, WA LEG

Resource Tables
- WA State Department of Natural Resources, Geologic Hazards Section, Division of Geology & Earth Resources
- King County Office of Emergency Management
- King County Department of Natural Resources and Parks
Some Introductory Comments

- We live in landslide country
- Why landslide mapping now?
- Why two mapping efforts?
- Hazard vs. Risk
Types of Landslide Hazards in King County

- Shallow debris slides
- Fans and debris flows
- Deep-seated landslides
- Rock fall
- Rock avalanches
- Snow avalanches
Shallow Debris Slides


BNSF Railway
Everett to Seattle

View landslide video (external link)
Concerns with Shallow Debris Slides

- Can move quickly
- Can be highly destructive

(Photo courtesy of WA Department of Ecology)
Depositional Fans

Legend
- Alluvial Fan

Potential Stormwater Flow

Braided Streams and Washes

Canyon

Mountain
Processes that can occur on a fan

- Flooding
- Debris flood
- Debris flow
Flooding, Issaquah Creek
Debris Flood, Green Valley Rd. SE
Concerns on Depositional Fans

- Flooding, Channel Migration, Debris Impact
- Hazard depends on process

Residence near Clough Creek

Debris flow on Deer Creek (2012)
Deep-Seated Landslides

View landslide video (external link)
Concerns with Deep-Seated Landslides

- Can be remobilized
- Hazard depends on location on slide
- Can travel long distances

- 57 homes were destroyed

(Source: J. Rogers)
Denny Mt, Alpental area
Concerns with Rock Falls

- Fast moving
- Pose a serious threat to anything in their path

“Huge boulder flattens 300-year-old house,” Northern Italy (2014)

Boulder on Highway 2, Tumwater Canyon (2010)
Rock Avalanches

Hope slide, British Columbia, 1965

1.5 Miles
Video of Rock Avalanche Simulation

View landslide video (external link)

(Source: Tipe, Avalanches Rocheuses https://www.youtube.com/watch?v=ZABf78WS1AE)
Concerns with Rock Avalanches

- Fast moving
- Pose a serious threat to anything in their path

Mt Si area

North Fork Snoqualmie River
Snow Avalanches

Large scale avalanche control

(Source: King County OEM)

Small accidental slab avalanche

Concerns with Snow Avalanches

- Fast moving
- Pose a serious threat to anything in their path

1910 Wellington Avalanche resulted in 96 fatalities.
(Source: Seattle Times (2010); Image from Skykomish Historical Society 2016)

Hyak ski area slide impacting cabins (2009)
(Source: Don Whitehouse, NWAC, https://www.nwac.us/photo-archive/view/13/)
SR 530 (Oso) Landslide
New King County Landslide Products

- River Corridor Mapping
- Potential Landslide Hazards Mapping
Department of Natural Resources and Parks

John Bethel
Environmental Scientist/Engineering Geologist
Approach

- Use new and latest available LiDAR imagery, new geologic maps, and reports.
- Work at landscape scale.
- Identify and utilize mapping methods appropriate to each different landslide type.
- Review mapping approaches with local experts through a Technical Review Committee.
- Make information available via Internet.
Landslide Types Mapped in River Corridors

- Shallow debris slides
- Fans and debris flows
- Deep-seated landslides
- Rock fall
- Rock avalanches
River Corridor Landslide Hazard Map
River Corridor Landslide Hazard Map

Legend

- Study Limits
  - Historical Landslides

- Moderate potential SDS
- Severe potential SDS

- Lowland Fans
- Alpine – less likely
- Alpine – more likely

- Rock fall potential
- Rock avalanche deposits

- Deep-seated slides
- Top of main scarp

- Landslide body
- Headscarp and flanks

- Ponded water

- Closed depressions
- Watercourses

- Toe of slide along river
Considerations in Using Map Information

- Timing and probability of future movement
- Impacts from climate change
- Effects from earthquakes
Uses of River Corridor Mapping

- Intended to support King County river corridor planning and capital projects for flood risk reduction.

- It may also be of use to:
  - City and County emergency planners
  - Transportation and utility managers
  - Geotechnical consultants
  - Residents
Department of Permitting and Environmental Review

Greg Wessel
Environmental Scientist/Engineering Geologist
Basic principles for mapping and regulating geologic hazards

- Both justification and authority should be clear.
- Specific and understandable criteria: definitions are important.
- Only qualified geologists with applicable experience.
- In line with existing codes.
- Recurrence intervals are important, if known (When is a landslide not a hazard?).
KCC 21A.24.280 Landslide hazard areas — development standards and alterations

- A buffer is required from all edges of the landslide hazard area. Without a geotechnical study, the buffer is 50 feet wide.

- Alterations in a landslide hazard area located on a slope less than forty percent are allowed if:
  1. The proposed alteration will not decrease slope stability on contiguous properties; and
  2. The risk of property damage or injury resulting from landsliding is eliminated or minimized through mitigation.

- Mitigation may include avoidance or engineering (special structural design additions).
KCC 21A.24.310 Steep slope hazard areas — development standards and alterations

- A buffer is required from all edges of the steep slope hazard area. Without a geotechnical study, the buffer is 50 feet wide.

- New development on or near a steep slope is only allowed if accompanied by a geotechnical study that confirms there will be no adverse impact from the development, either to the development itself or to adjacent properties. *(Note: this is essentially the same standard to which landslide hazards are held.)*

- As with landslide hazards, mitigation may be required for development on or near steep slopes.
Comparison of LiDAR hillshade, potential landslide hazards, and mapped geology, lower Tolt River valley, King County, WA (geology from Dragovich, et al, 2012)
Landslide Hazards Mapped

- Slumps and other deep-seated landslides
- Rockfalls
- Rock avalanches
- Debris/alluvial fans
- Snow avalanche zones (to a degree)
- Slopes undercut along a shoreline
- Unclassified larger-scale mass wasting
- Landforms suggestive of dominant mass wasting
- Slopes potentially susceptible to shallow landsliding (steep slopes)
What the mapping is:

- A reasonable approximation of what may be landslide hazards based upon LiDAR photointerpretation by experienced geologists and the best available geologic mapping, which though best available may not be all that good everywhere.

- No field data were collected to use in creating these maps.

What the mapping is not:

- A definitive representation of landslide hazards.

- No field data were collected to use in creating these maps.

- *Further site-specific investigations are necessary to determine the presence and nature of any hazard and the level of risk.*
King County Landslide Resources

King County iMAP

Permitting

Department of Permitting and Environmental Review

King County GIS Center

River Corridors Mapping

River and Floodplain Management Section

Emergency Management

Office of Emergency Management
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