

Mapping of Potential Landslide Hazards in King County

October 27, 2016

Meadowbrook Farm Interpretive Center

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



King County



**KING COUNTY
FLOOD CONTROL
DISTRICT**

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

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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

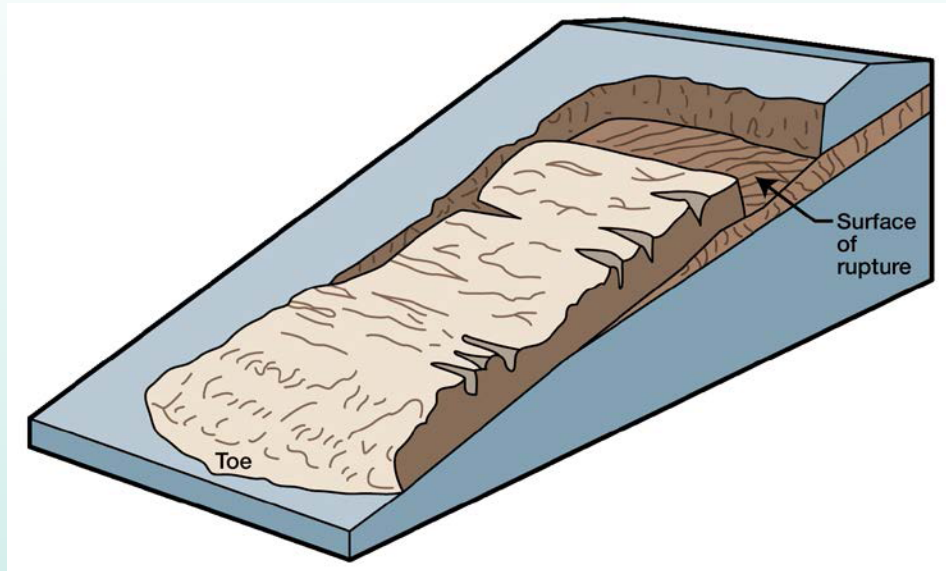
- **We live in landslide country**
- **Why landslide mapping now?**
- **Why two mapping efforts?**
- **Hazard vs. Risk**

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



(Source: USGS Fact Sheet: Landslide Types and Processes, 2004-3072. <http://pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf>)

**BNSF Railway
Everett to Seattle**



[View landslide video \(external link\)](#)

Concerns with Shallow Debris Slides

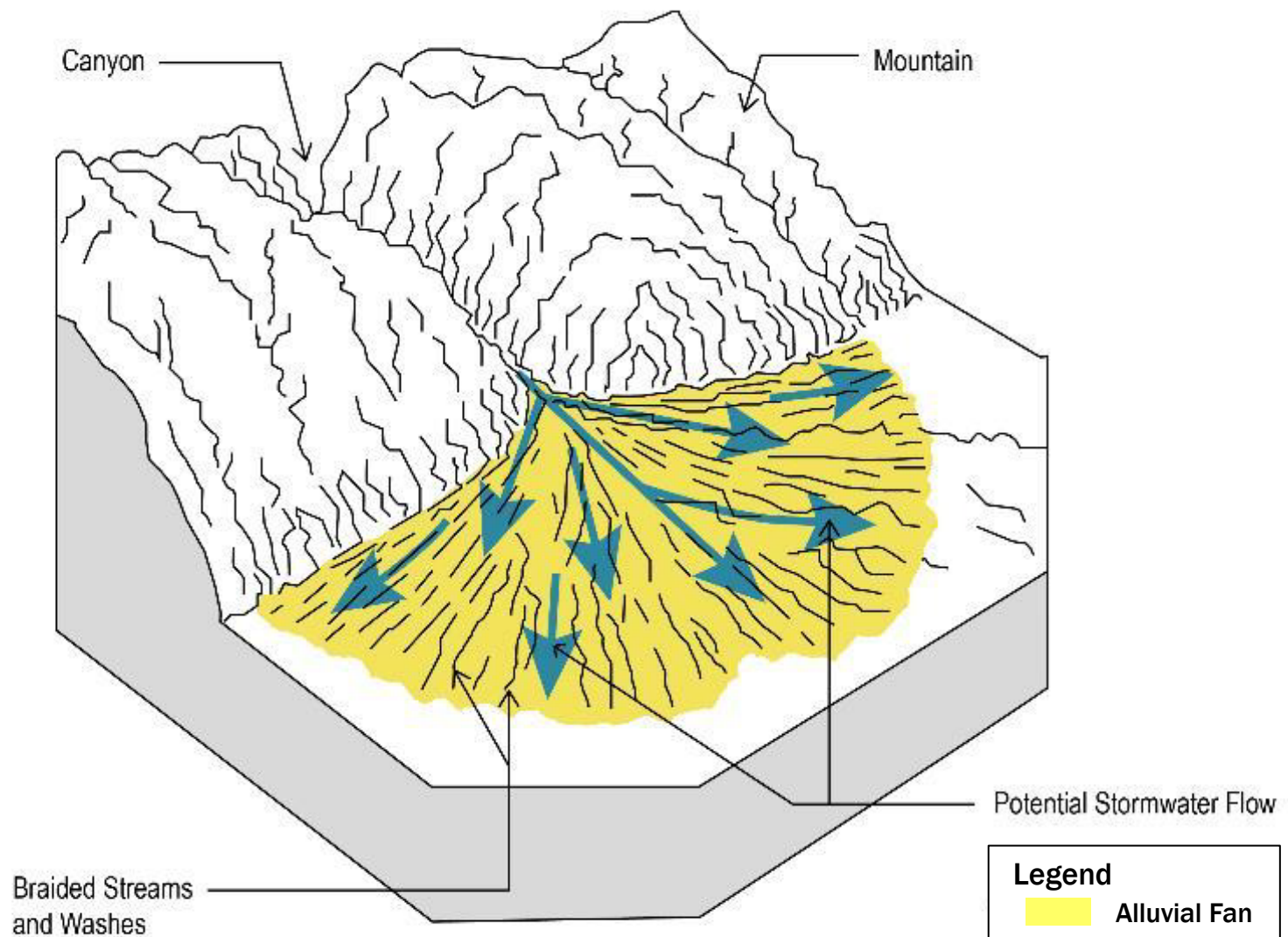
- Can move quickly
- Can be highly destructive



(Photo courtesy of WA Department of Ecology)

4/14/97

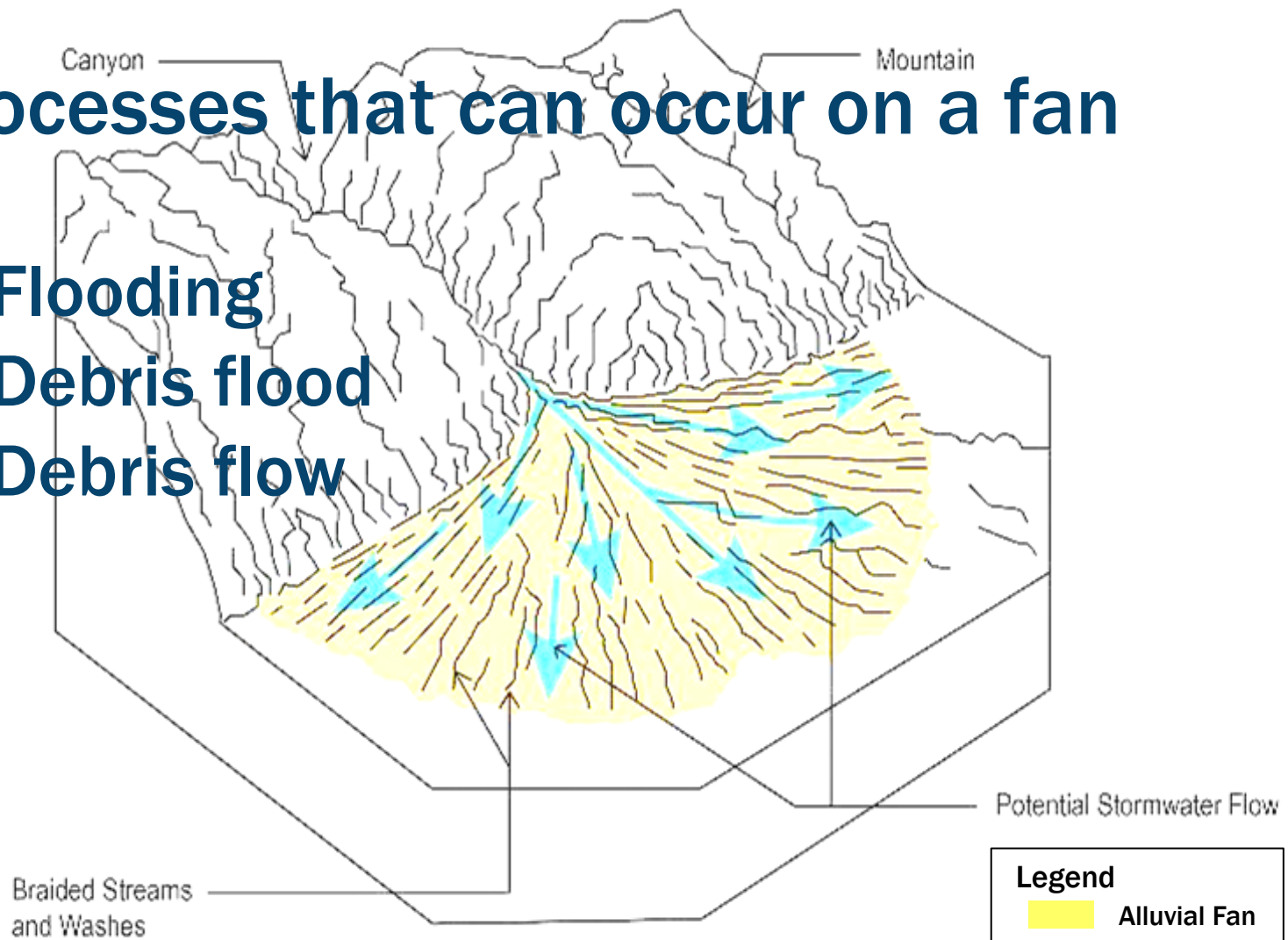
Depositional Fans



Depositional Fans

Processes that can occur on a fan

- Flooding
- Debris flood
- Debris flow





Flooding, Issaquah Creek



Debris Flood, Green Valley Rd. SE



Debris Flow, Washington Pass, SR 20

Concerns on Depositional Fans

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

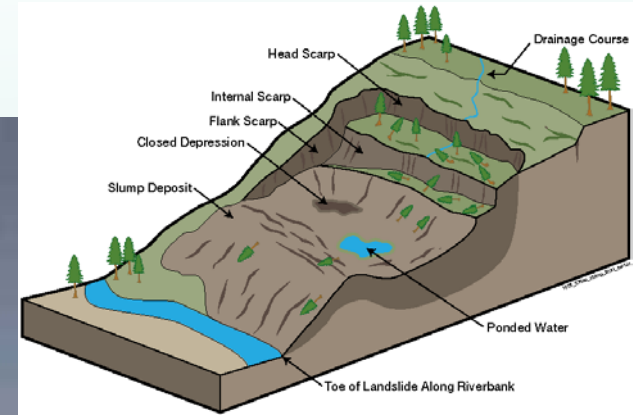
Residence near Clough Creek



Debris flow on Deer Creek (2012)



Deep-Seated Landslides



Concerns with Deep-Seated Landslides

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

Aldercrest Banyon Landslide, Kelso, WA
(1998 - 1999)

- 57 homes were destroyed



(Source: J. Rogers)



Landslide offset along a residential access road, Cedar River.



Denny Mt, Alpentel area

Concerns with Rock Falls

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

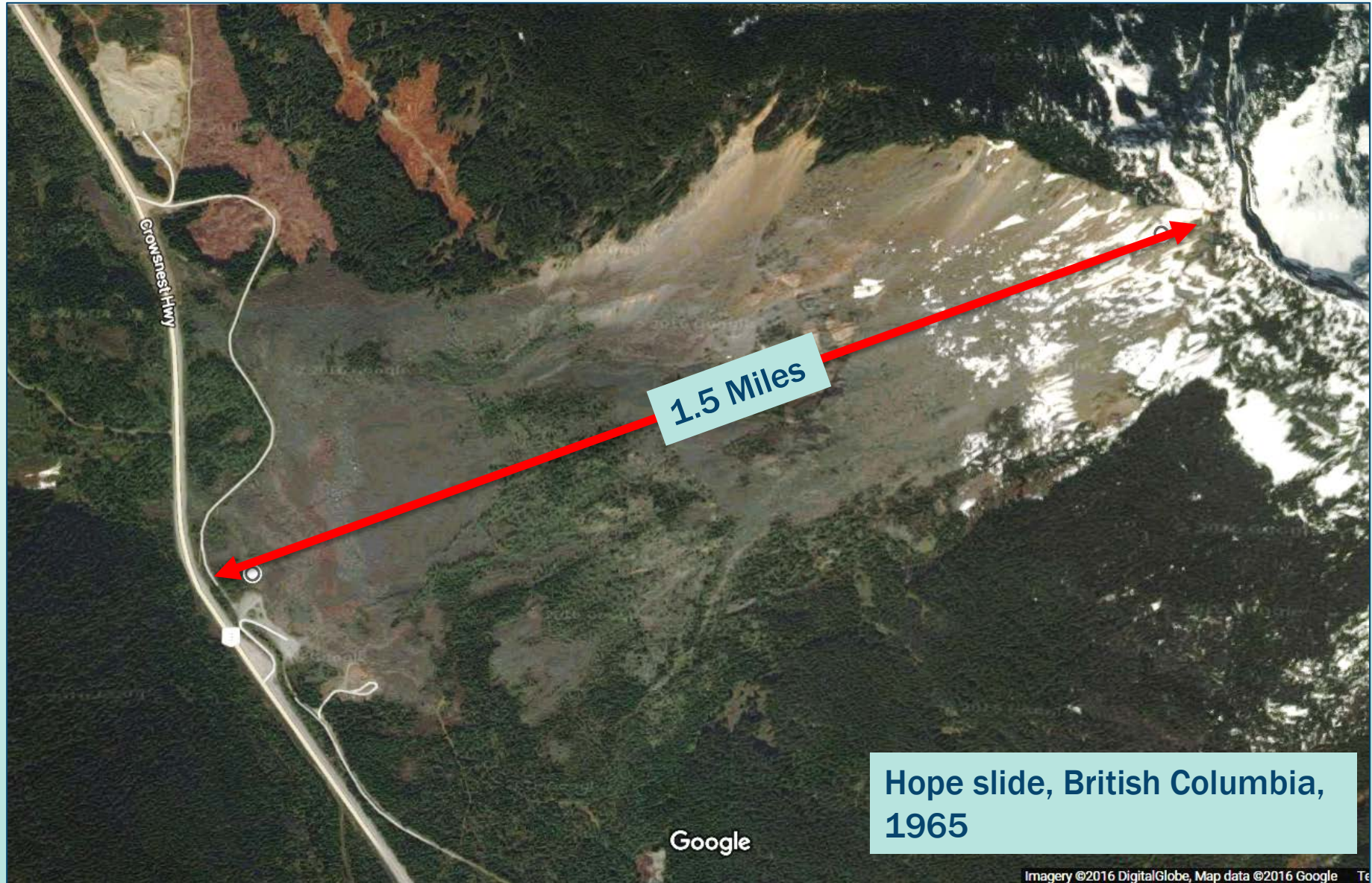


Boulder on Highway 2, Tumwater Canyon (2010)

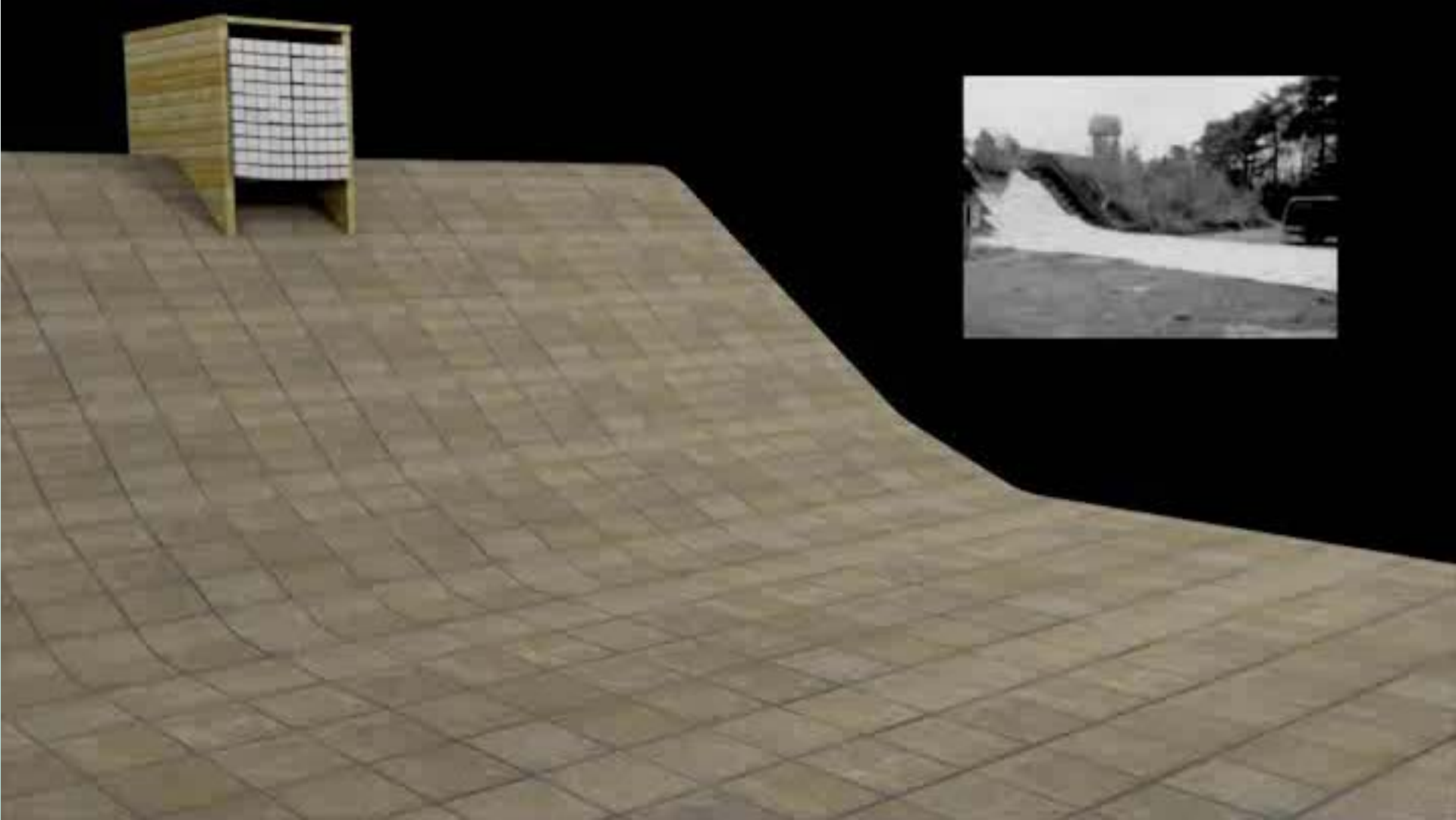
“Huge boulder flattens 300-year-old house,” Northern Italy (2014)



Rock Avalanches



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



Mt Si area

North Fork Snoqualmie River



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

Snow Avalanches



Large scale avalanche control

(Source: King County OEM)



Small accidental slab avalanche

(Source: NAC,
[http://www.nwac.us/observations/pk/262/
December 2015](http://www.nwac.us/observations/pk/262/December%202015))

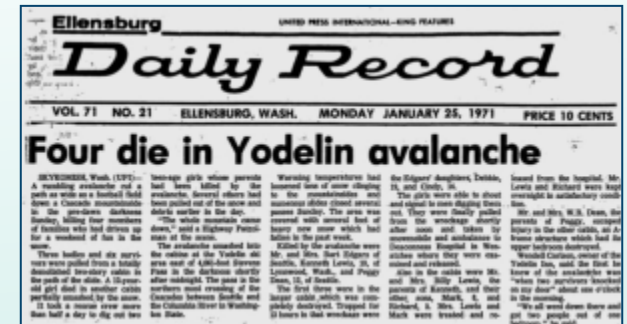
Concerns with Snow Avalanches

- 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

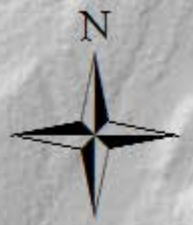
Department of Natural Resources and Parks

John Bethel

Environmental Scientist/Engineering Geologist



Tolt River Valley

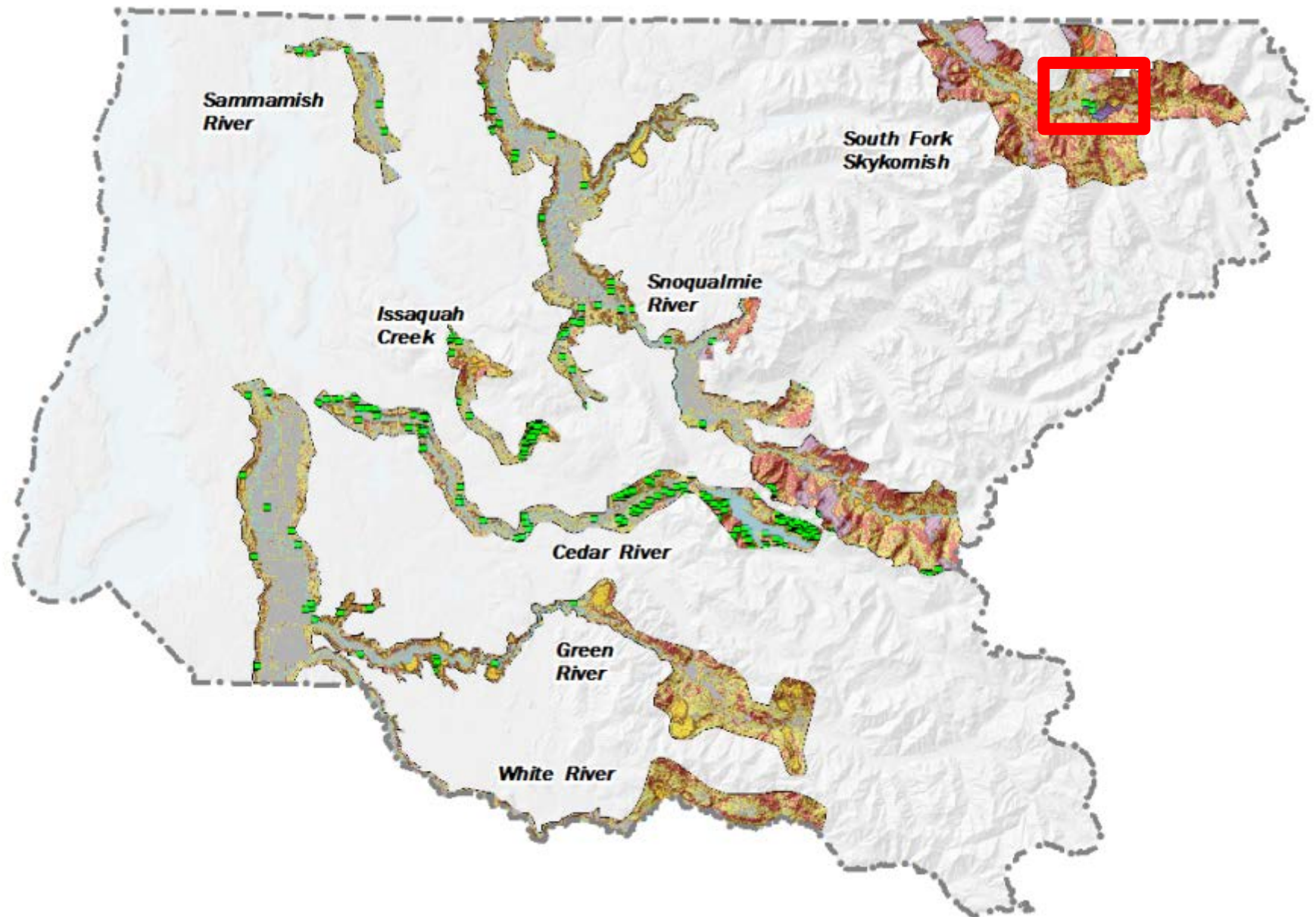


Landslide Types Mapped in River Corridors

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




















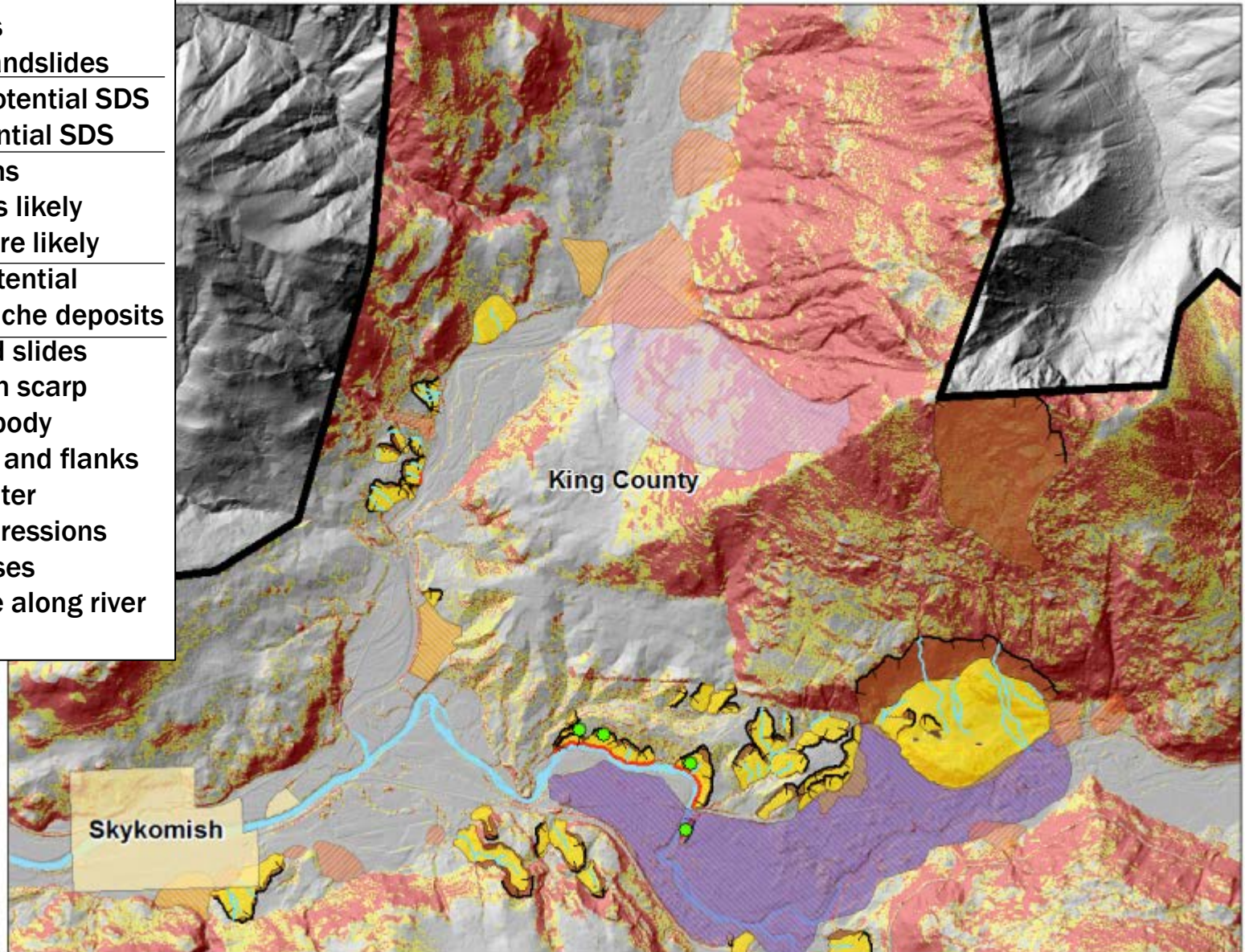
River Corridor Landslide Hazard Map



River Corridor Landslide Hazard Map

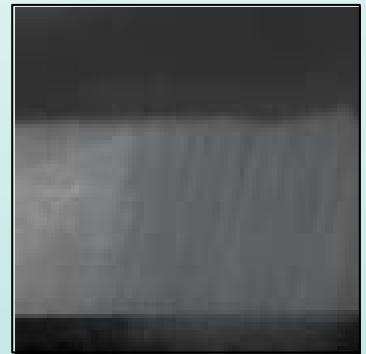
Legend

-  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?).

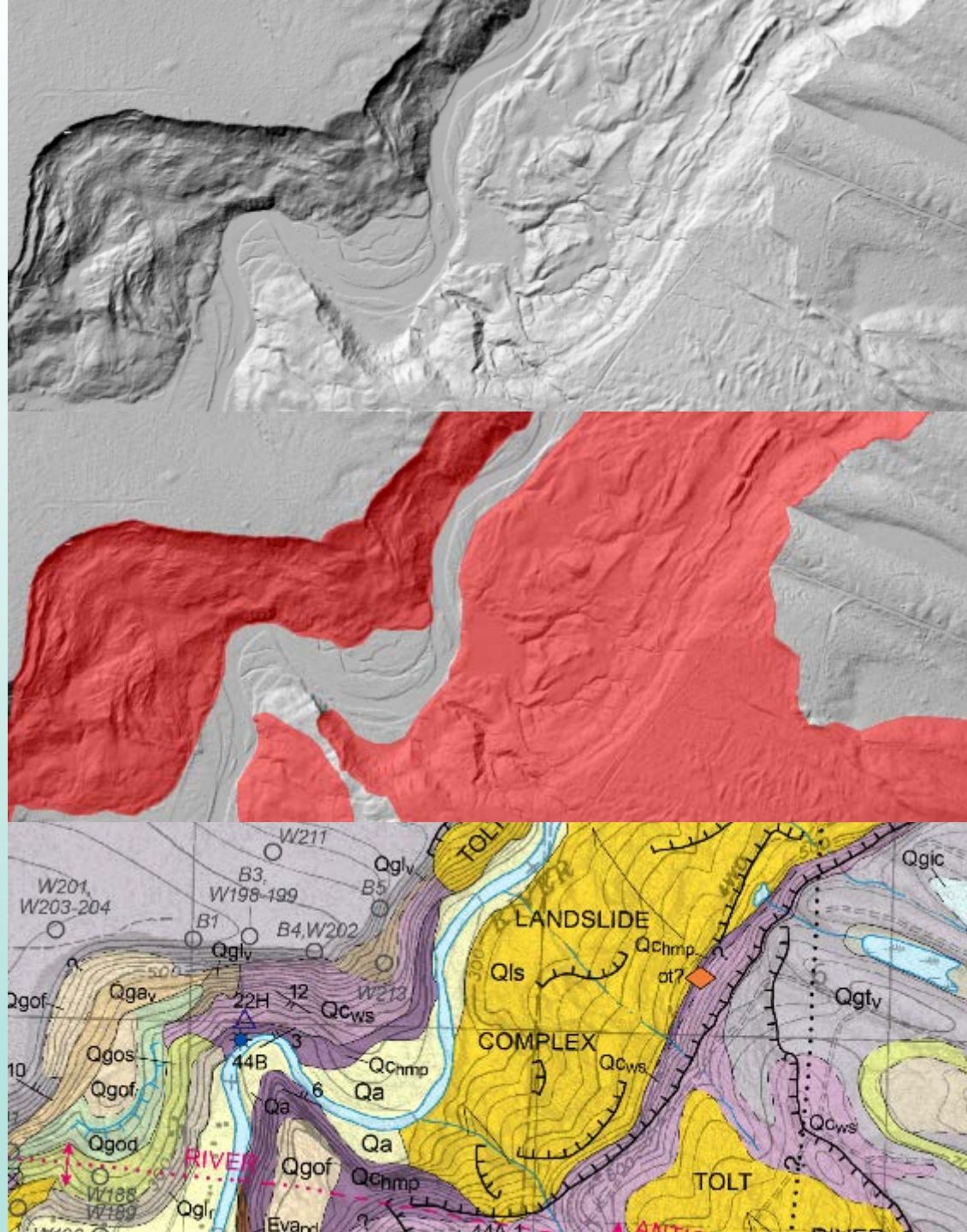
KCC 21A.24.280 Landslide hazard areas — development standards and alterations

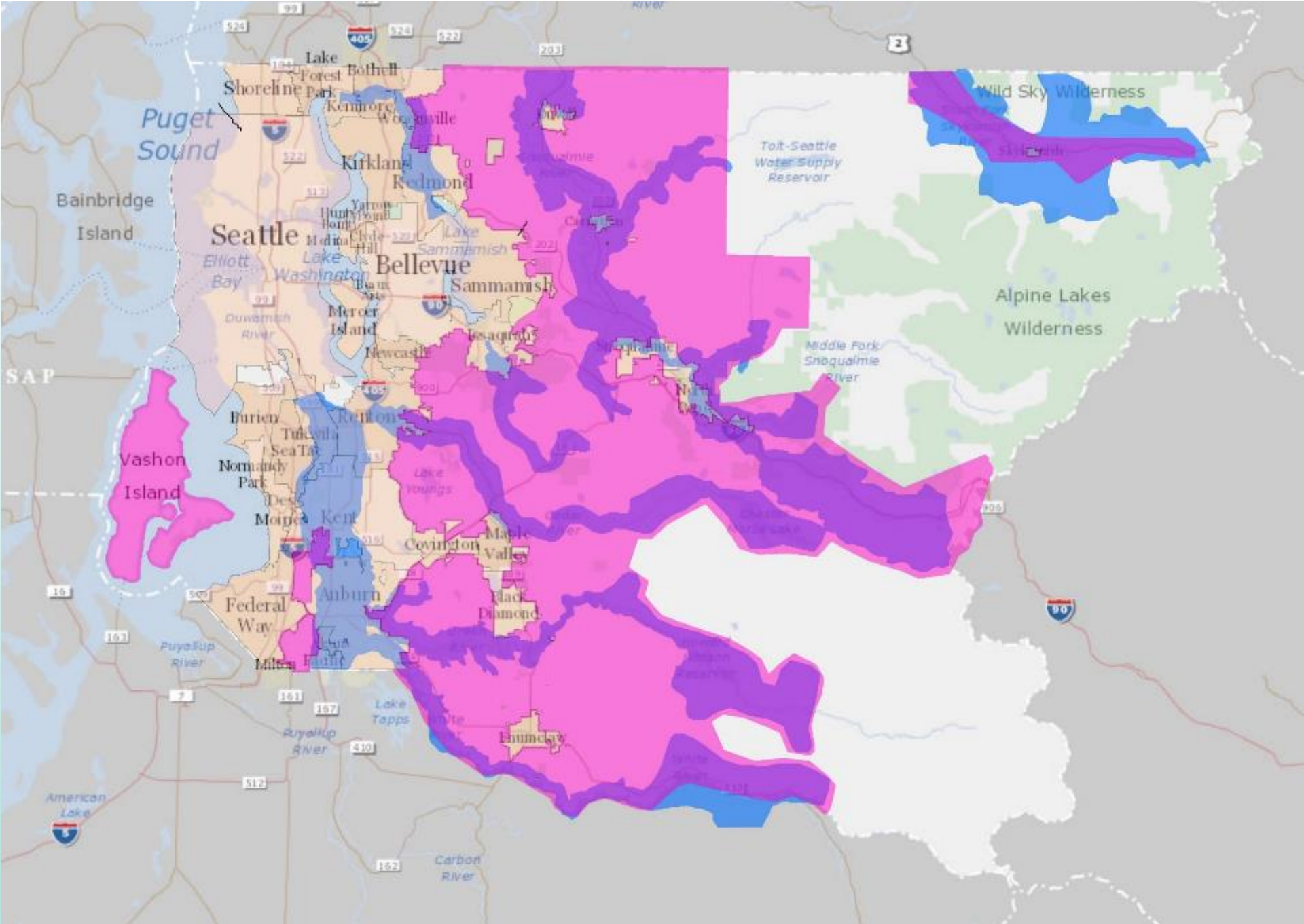
- A buffer is required from all edges of the landslide hazard area. Without a geotechnical study, the buffer is 50 feet wide.
- Alterations in a landslide hazard area located on a slope less than forty percent are allowed if:
 1. The proposed alteration will not decrease slope stability on contiguous 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.

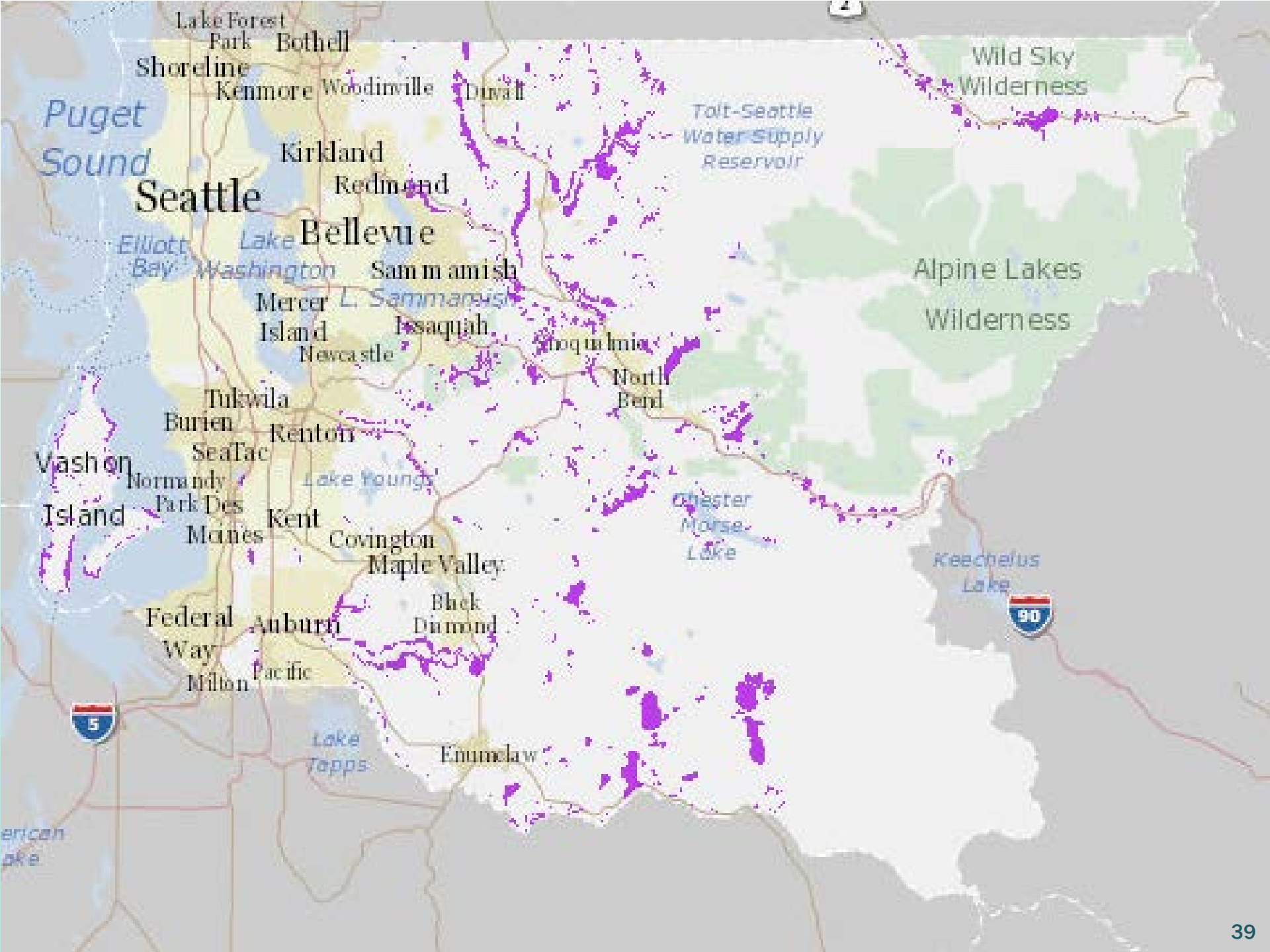
**Comparison of LiDAR
hillshade, potential
landslide hazards, and
mapped geology,
lower Tolt River valley,
King County, WA**
(geology from Dragovich, et al, 2012)





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)



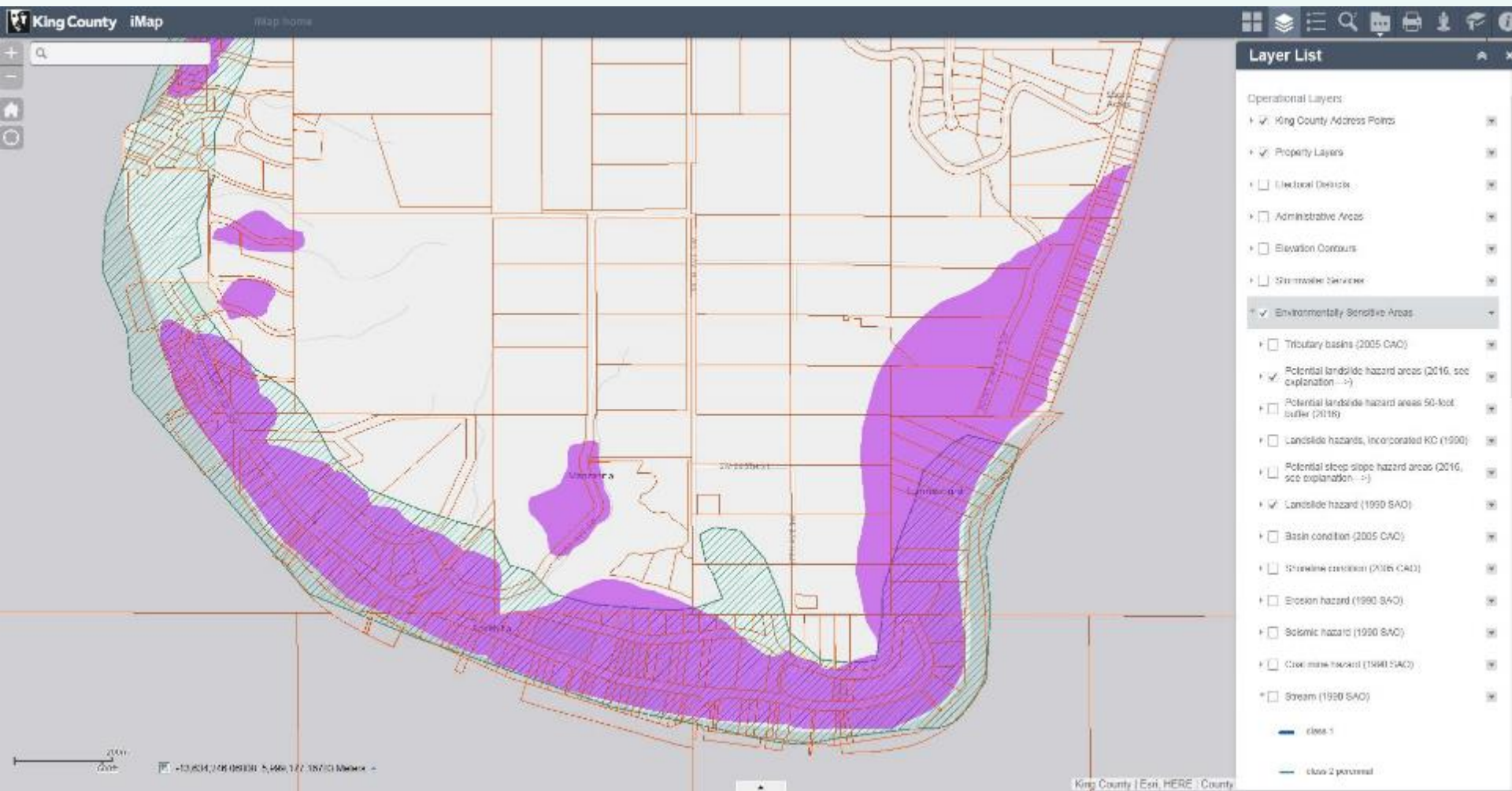
What the mapping is:

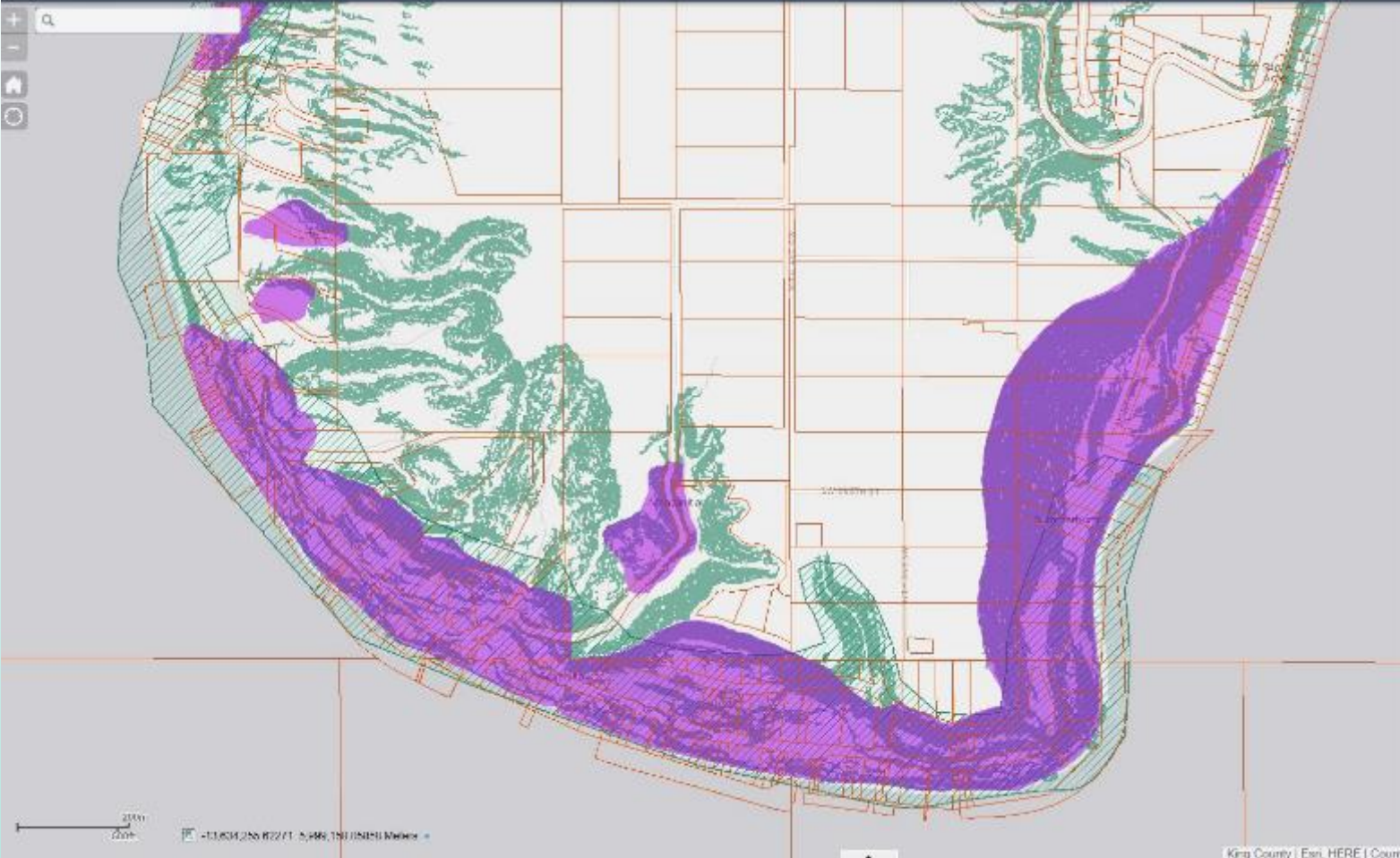
- A reasonable approximation of what may be landslide hazards based upon LiDAR photointerpretation by experienced geologists and the best available geologic mapping, which though best available may not be all that good everywhere.
- No field data were collected to use in creating these maps.

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.*

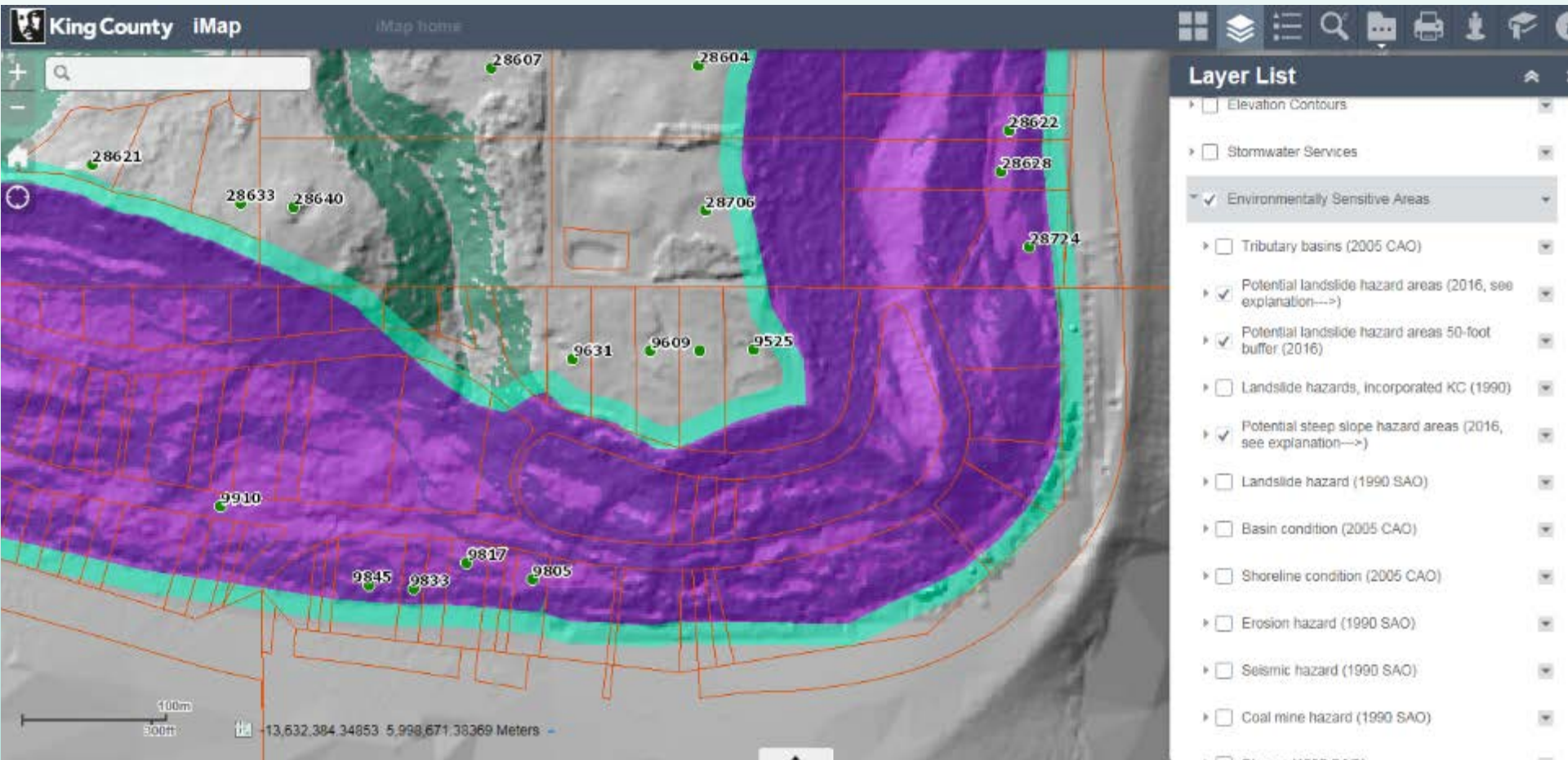






Layer List

- ☒ King County Address Points
 - ☒ Property Layers
 - ☐ Historical (Zabriskie)
 - ☐ Administrative Areas
 - ☐ Elevation Contours
 - ☐ Streamable Services
 - ☒ Environmentally Sensitive Areas
 - ☐ Tributary basins (2005 CAO)
 - ☒ Potential landslide hazard areas (2016, see explanation-->)
 - ☐ Potential landslide hazard areas 50-foot buffer (2016)
 - ☐ Landslide hazards, Incorporated KC (1990)
 - ☒ Potential steep slope hazard areas (2016, see explanation-->)
 - ☒ Landslide hazard (1997 SAC)
 - ☐ Basin condition (2005 CAO)
 - ☐ Shoreline condition (2005 CAO)
 - ☐ Erosion hazard (1997 SAC)
 - ☐ Seismic hazard (1990 SAC)
 - ☐ Coal mine hazard (1990 SAC)
 - ☐ Stream (1990 SAC)
- class 1
- class 2 potential
- class 2 actual



King County Landslide Resources

King County

Permitting



Department of Permitting and
Environmental Review



River Corridors Mapping



River and Floodplain
Management Section

King County iMAP



King County GIS Center

Emergency Management



Office of Emergency Management



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