LANDSLIDE HAZARDS

Pierce County Threat and Hazard Identification Workshop - May 1 and 2, 2019

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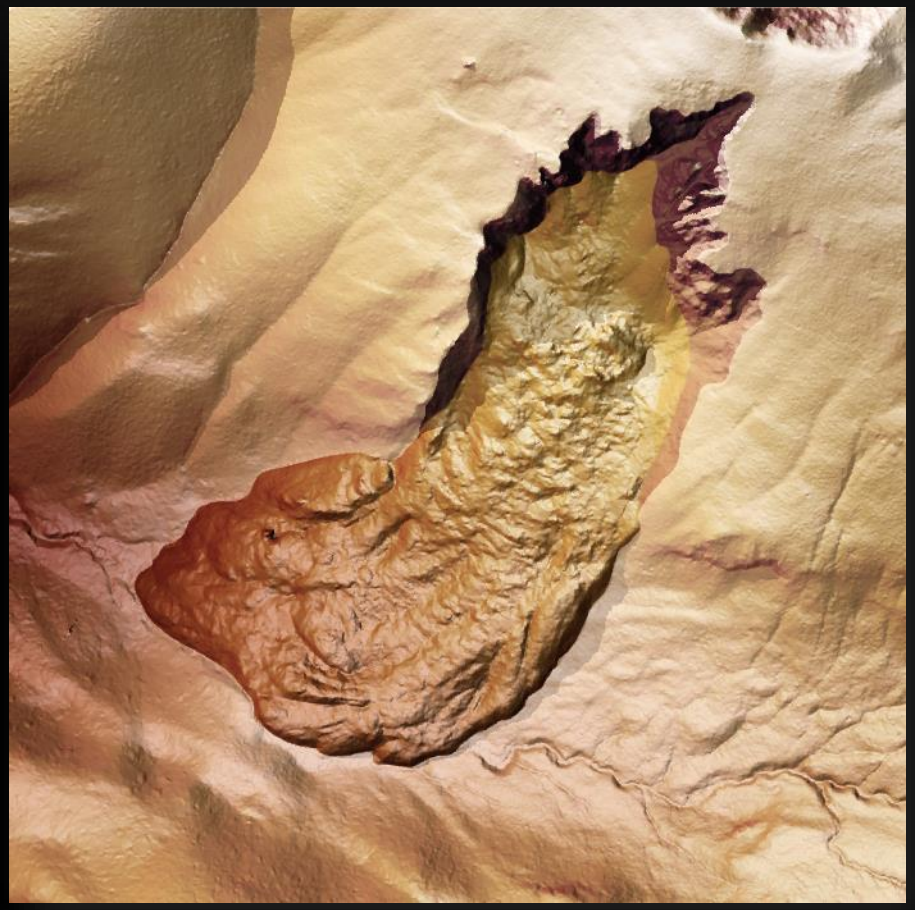
Washington Geological Survey
Washington Department of Natural Resources

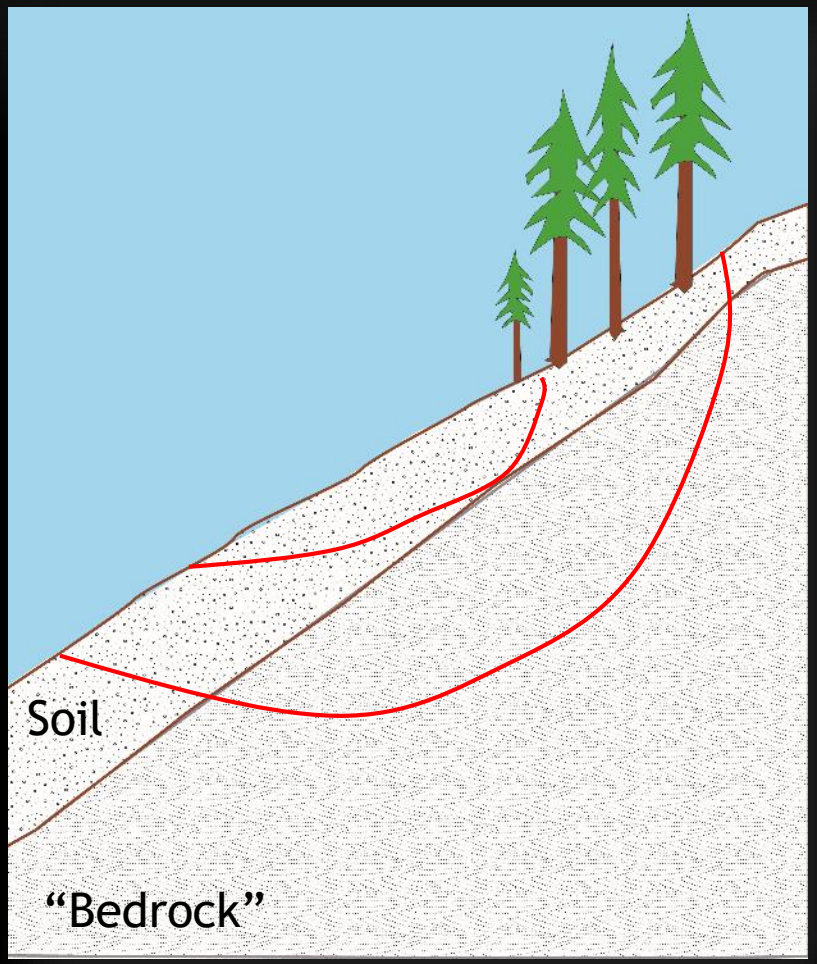
A LANDSLIDE IS…

- …the downslope movement of soil, rocks, vegetation, water, etc. driven by gravity
- Two major categories of landslides
  - Shallow
  - Deep



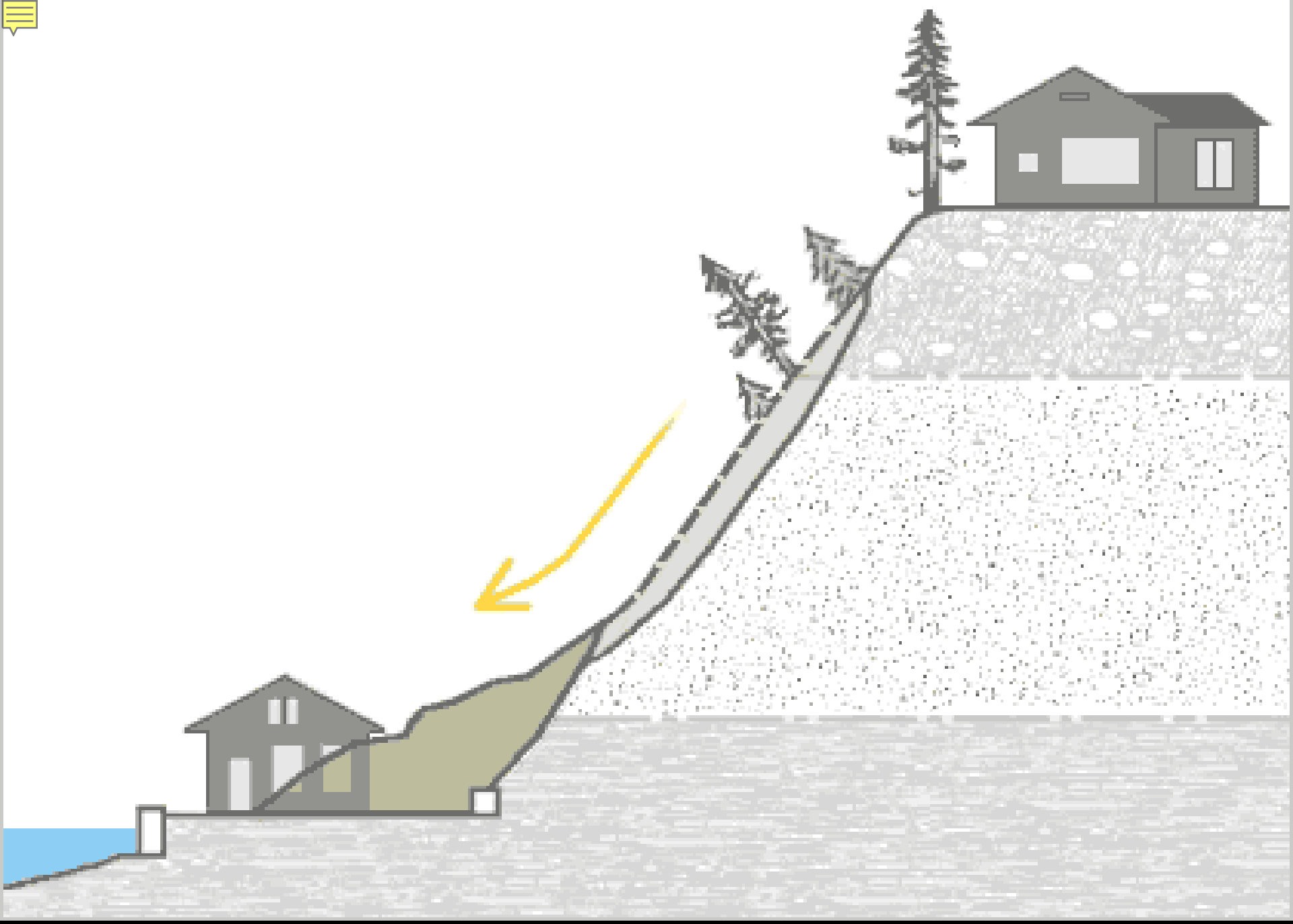
SHALLOW VS. DEEP

- Difference? Location of the failure surface
  - Deep landslide failure surface in bedrock
  - Shallow landslide failure surface in “soil”
  - Rate of movement
  - Hazard: life safety vs. structural



SHALLOW LANDSLIDES

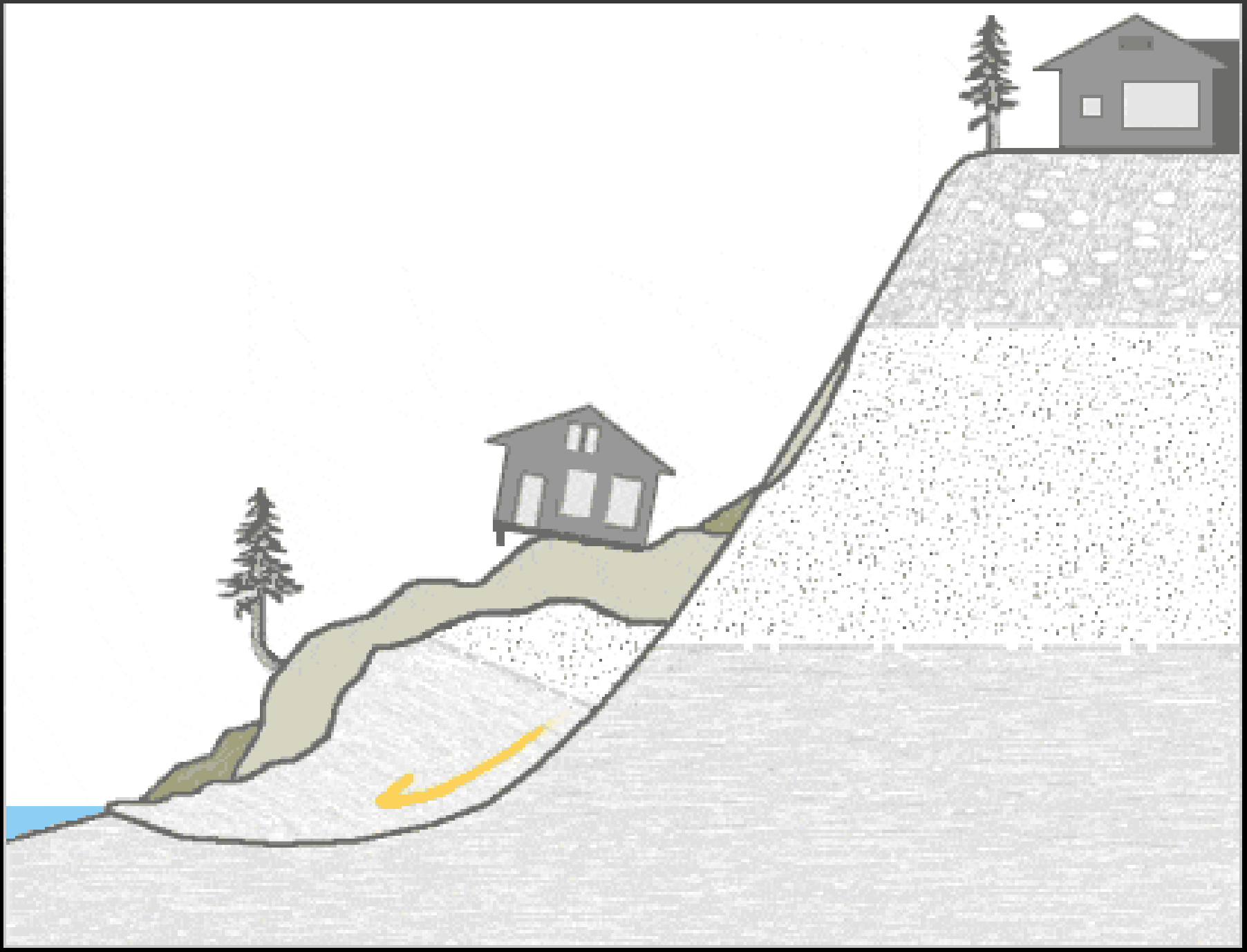
- Debris slides, debris flows
  - Media calls them: mudslide, mudflow, slide
- Most common landslide and often associated with land use
- Often associated with short, intense rain events
- Most fatalities associated with shallow landslides



WA DOE website

DEEP LANDSLIDES

- Often associated with extended periods of precipitation - months to years
- When reported, nearly always a pre-existing landslides that reactivated
- Typically a structural/infrastructure hazard



WA DOE Website

SIGNIFICANT DEEP LANDSLIDES

- Perkins Lane, Seattle, 1997
- Aldercrest-Banyan, Kelso, 1998
- Carlyon Beach, Thurston County, 1999
- Ledgewood, Island County, 2013
- SR 530 “Oso” slide, 2014; killed 43 people
- All reactivated landslides

PERKINS LANE LANDSLIDE, SEATTLE, 1997

WA Dept. of Ecology

- A regional storm damaged or destroyed over 8000 homes
- A reactivated deep-seated landslide in the Magnolia District of Seattle claimed five houses.

1938 - Seattle Municipal Archives

Seattle PI

LANDSLIDE DAMAGE IS COSTLY

- All geologic hazards can be insured ***except*** landslides and earth movement
  - For those with landslide-damaged property litigation is often the only recourse

WGS LANDSLIDE HAZARDS PROGRAM

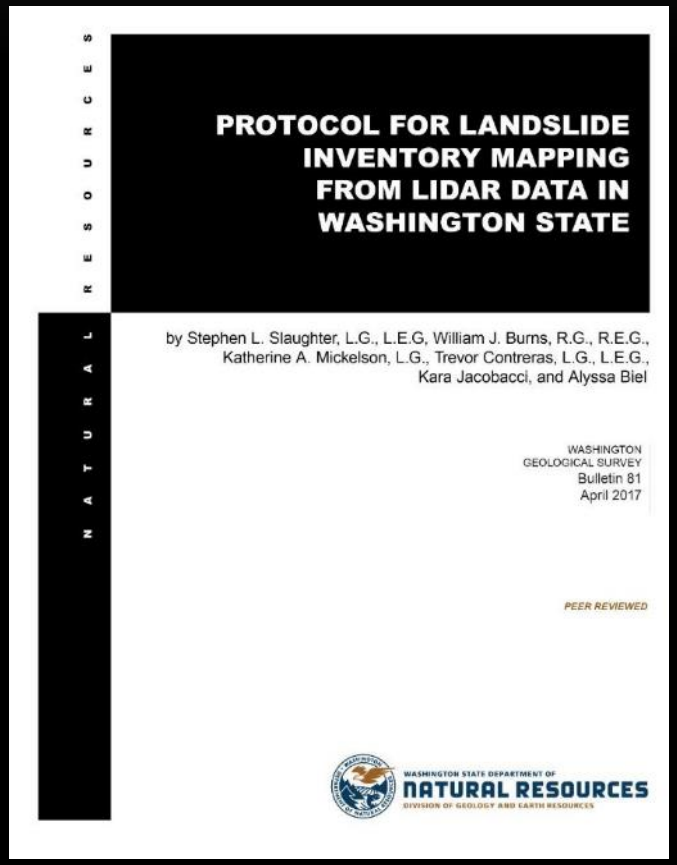
- Emphasis is mapping where there is population, infrastructure, highways
- Map inventory (where landslides have occurred) and susceptibility (where landslides may occur)

The Products

INVENTORY AND SUSCEPTIBILITY

LANDSLIDE MAPPING PRODUCTS

- Detailed landslide inventory
  - Where landslides have occurred
  - Mapped from lidar
  - 10 percent field validated
- Simple landslide inventory
  - Mapping in areas with no people or infrastructure
- Landslide susceptibility
  - Where landslide may occur
  - Deep and shallow landslides
- Fans


NATURAL RESOURCES

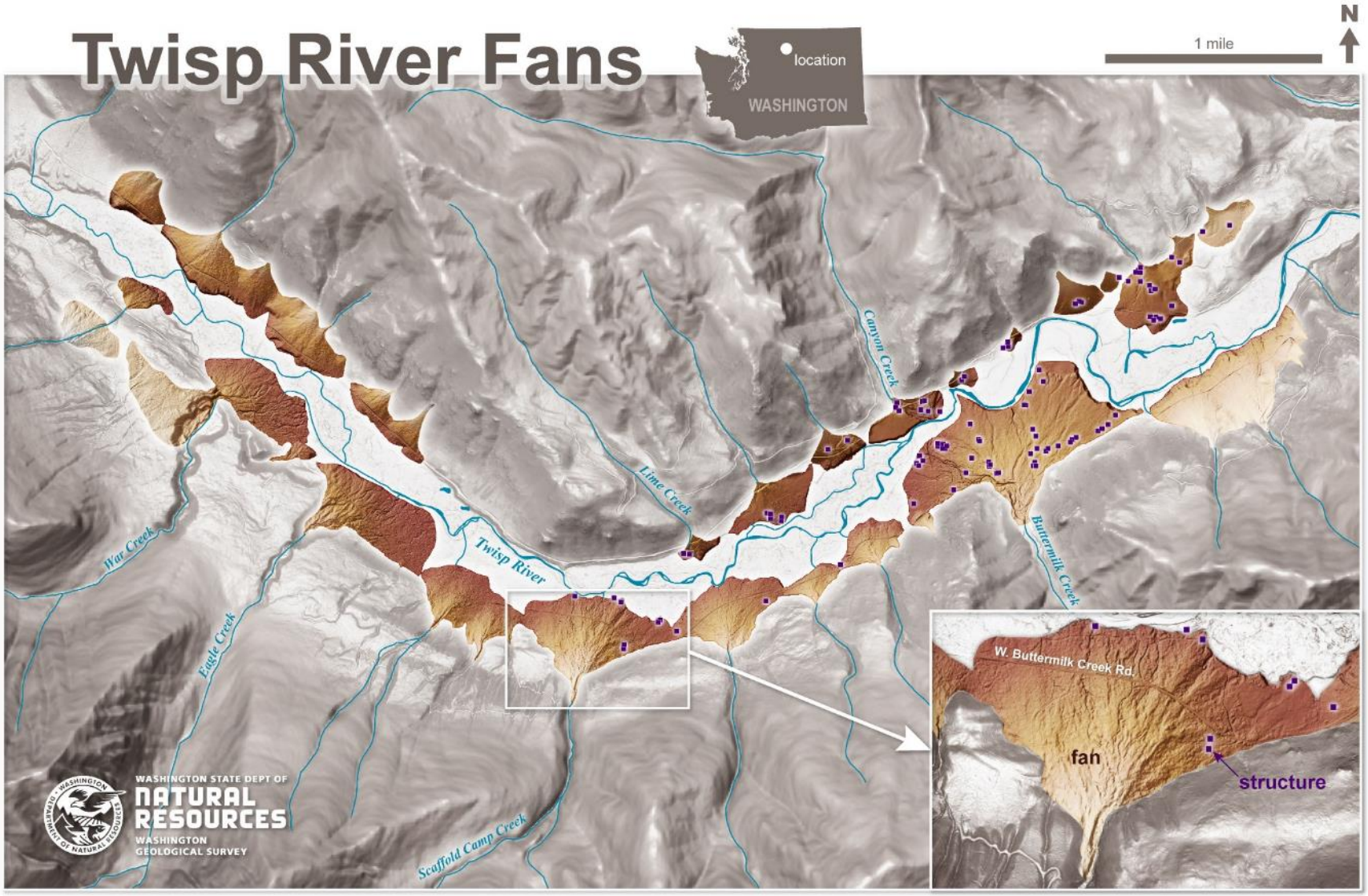
PROTOCOL FOR LANDSLIDE INVENTORY MAPPING FROM LIDAR DATA IN WASHINGTON STATE

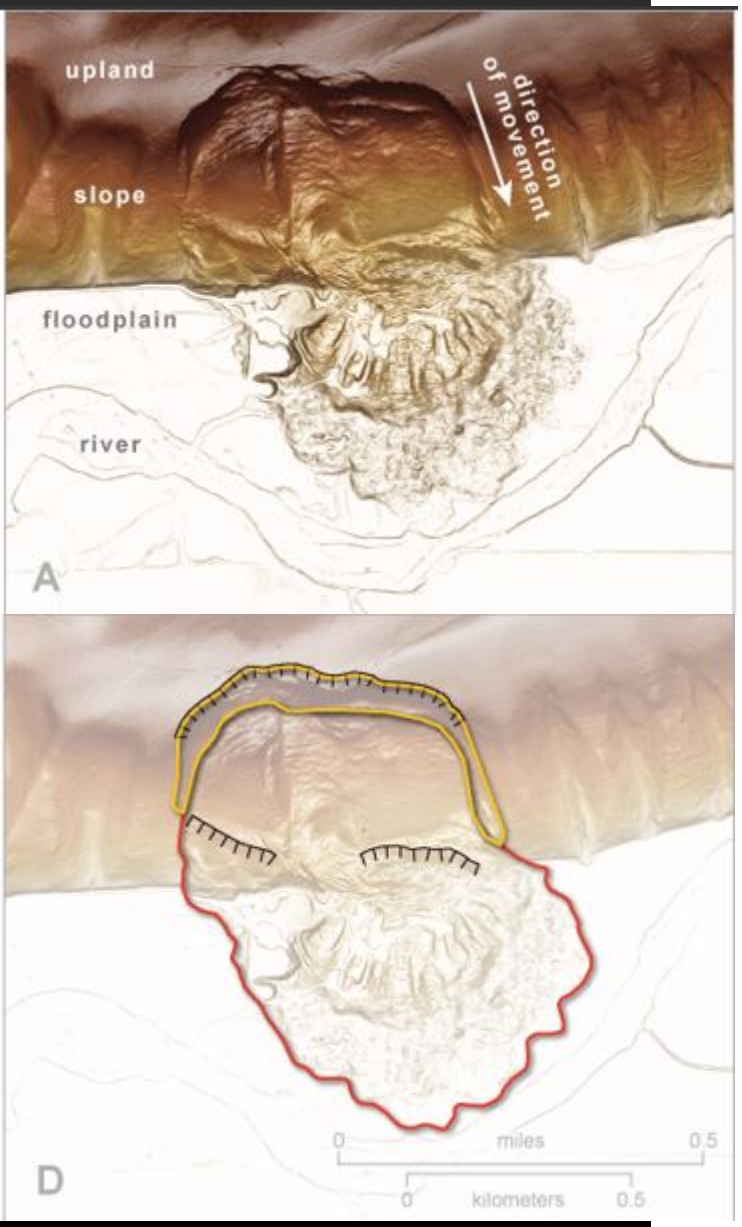
by Stephen L. Slaughter, L.G., L.E.G, William J. Burns, R.G., R.E.G., Katherine A. Mickelson, L.G., Trevor Contreras, L.G., L.E.G., Kara Jacobacci, and Alyssa Biel

WASHINGTON GEOLOGICAL SURVEY
Bulletin 81
April 2017

PEER REVIEWED

WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES


Twisp River Fans
location
WASHINGTON
1 mile
N
Canyon Creek
Lime Creek
Twisp River
War Creek
Eagle Creek
Buttermilk Creek
Scaffold Camp Creek
W. Buttermilk Creek Rd.
fan
structure
WASHINGTON STATE DEPT OF
NATURAL RESOURCES
WASHINGTON
GEOLOGICAL SURVEY



landslide_deposit (polygon)

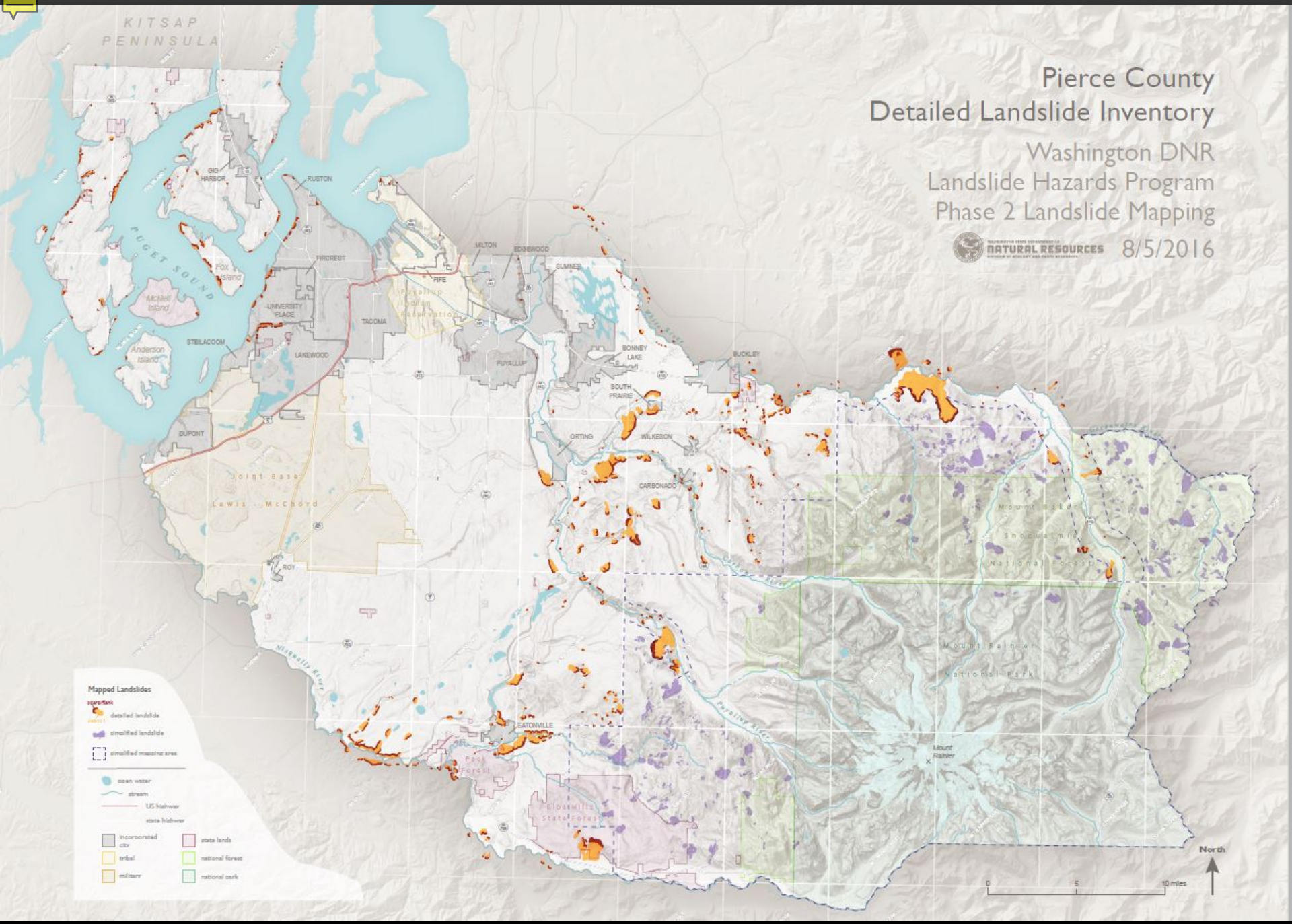
LANDSLIDE_ID
MATERIAL*
MOVEMENT*
MOVE_CODE
CONFIDENCE*
RELATIVE_AGE*
YEAR_MOVE
FIELD_VERIFIED*
SLOPE_DEG
HS_HEIGHT_FT
FAIL_DEPTH_FT
MVMT_AZIMUTH_DEG*
VOLUME_FT3
AVG_SCARP_DIST_FT
LS_NAME
COMMENTS

scarp_and_flank (polygon)

LANDSLIDE_ID
SCARP_FLANK_ID
COMMENTS

scarp (line)

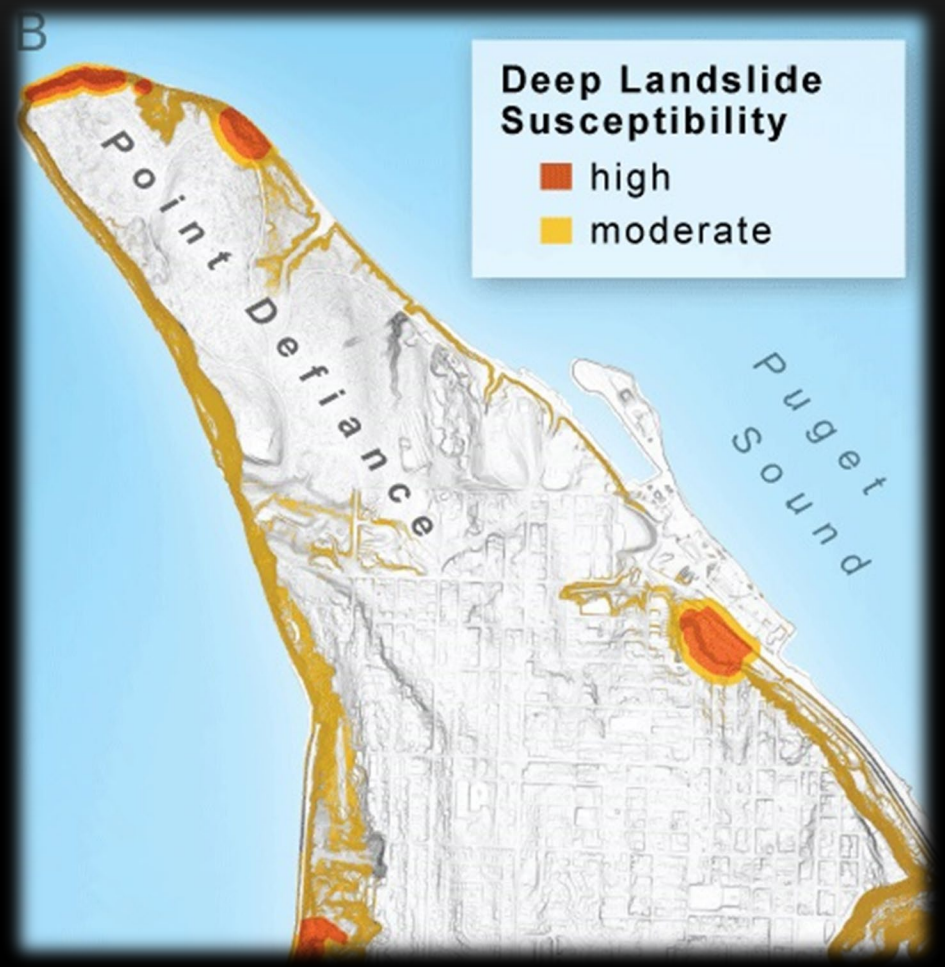
LANDSLIDE_ID
SCARP_ID
COMMENTS


Pierce County
Detailed Landslide Inventory
Washington DNR
Landslide Hazards Program
Phase 2 Landslide Mapping
NATURAL RESOURCES
8/5/2016
KITSAP PENINSULA
PUGET SOUND
GIG HARBOR
RUSTON
FIRCREST
UNIVERSITY PLACE
TACOMA
STEILACOOM
LAKEWOOD
DUPONT
Joint Base Lewis - McChord
ROY
MILTON
EDGEWOOD
SUMNER
FIFE
PUYALLUP
BONNEY LAKE
BUCKLEY
SOUTH PRAIRIE
ORTING
WILKESON
CARBONADO
EATONVILLE
Mount Baker Snoqualmie National Forest
Mount Rainier National Park
Mount Rainier
Mapped Landslides
detailed landslide
simplified landslide
simplified mapping area
open water
stream
US highway
state highway
incorporated city
tribal
military
state lands
national forest
national park
North
0
5
10 miles

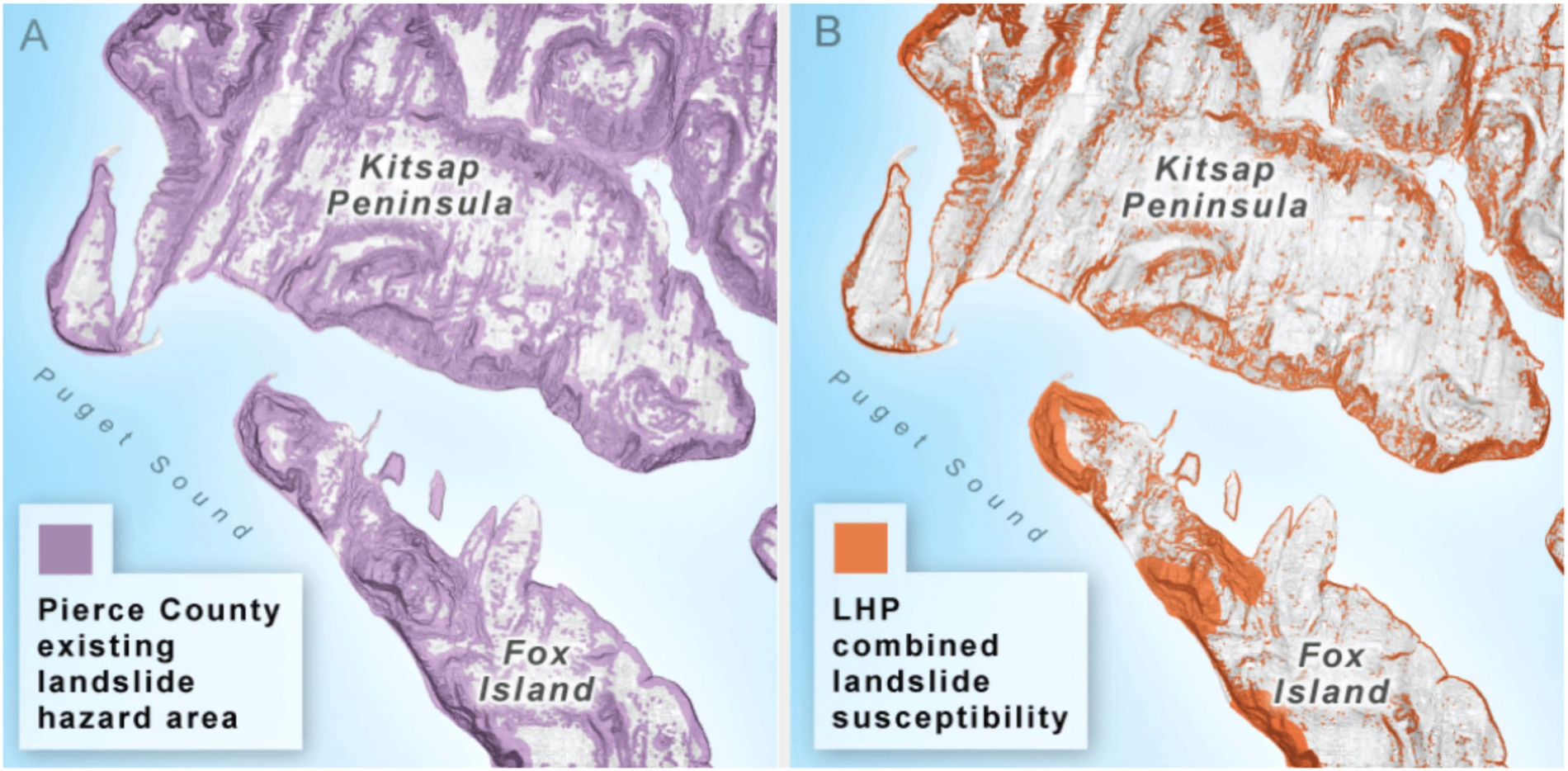
Where landslides may occur

SUSCEPTIBILITY MAPPING

LANDSLIDE SUSCEPTIBILITY

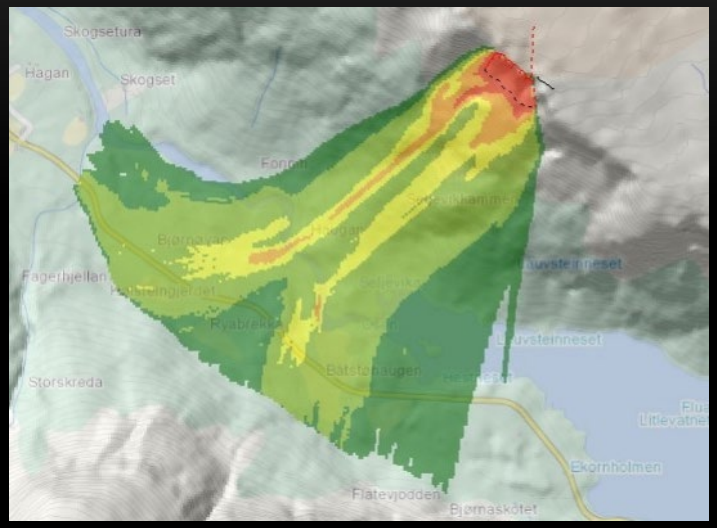


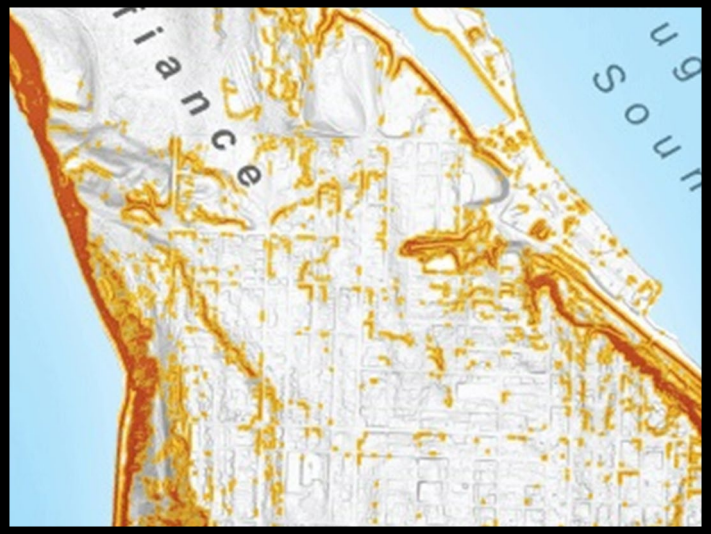
- Comparison of the existing Pierce County unstable slopes map to the WGS landslide and susceptibility map
- Results in a 51 percent reduction in landslide susceptible areas



THE FUTURE?

- Landslide runout modeling – if a landslide occurs, how far will it travel?
  - How do we map runout for EM, planners, etc.?
- Refined susceptibility modeling





THANK YOU!

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LANDSLIDE FACTS FOR PIERCE COUNTY – LANDSLIDE INVENTORY

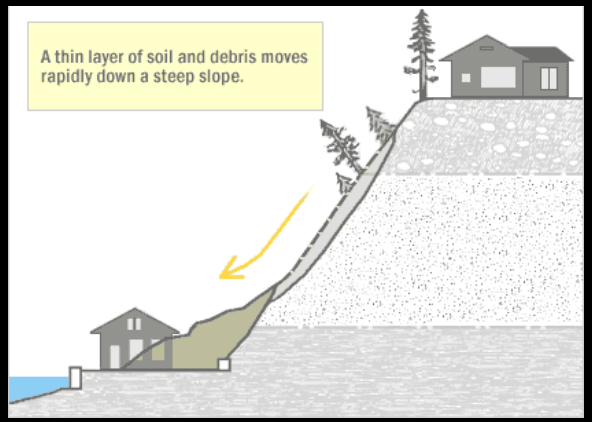
- 628 deep landslides mapped in PC
- Built on existing landslides:
  - 2.4 miles of highway
  - 29.5 miles of arterial roads
  - 1 bridge (University Place)
  - 3.9 miles of rail
  - 21.6 miles^2 of tax parcels ($371M estimated value)
  - 1658 buildings
  - 0 fire, police, and hospitals
  - 1 school play field is on a landslide (Eatonville)
  - 0 miles of high-tension transmission lines, 0 high tension towers

https://fortress.wa.gov/dnr/geologydata/publications/ger_ri39_pierce_county_landslide_inventory.zip

LANDSLIDE FACTS FOR PIERCE COUNTY – SHALLOW LANDSLIDE SUSCEPTIBILITY

High hazard areas

- 14,195 buildings
- 0.8 miles of rail
- 9.0 miles of roads
- 120 bridge
- 48.2 miles^2 of tax parcels ($1.6B estimated value)



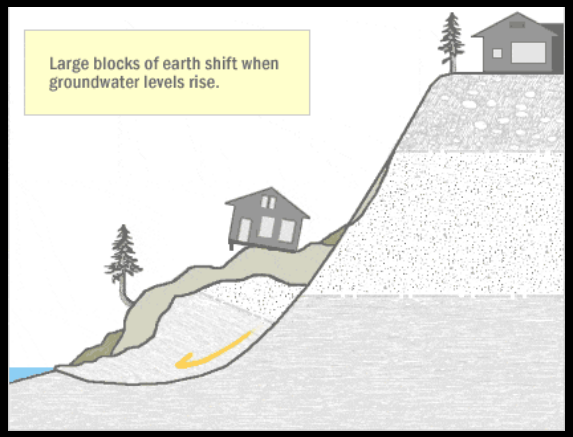
Moderate hazard areas

- 71,225 buildings
- 89.3 miles of rail
- 646.3 miles of roads
- 215 bridge
- 96.0 miles^2 of tax parcels ($10.0B estimated value)

LANDSLIDE FACTS FOR PIERCE COUNTY – DEEP LANDSLIDE SUSCEPTIBILITY

High hazard areas

- 2815 buildings
- 4.7 miles of rail
- 43.0 miles of roads
- 2 bridge
- 27.9 miles^2 of tax parcels ($0.6B estimated value)



Moderate hazard areas

- 12,509 buildings
- 6.6 miles of rail
- 40.7 miles of roads
- 55 bridge
- 83.4 miles^2 of tax parcels ($2.0B estimated value)