San Juan County
[Draft] Best Available Science Synthesis

GEOLOGICALLY HAZARDOUS AREAS

Janice Biletnikoff, AICP
Community Development & Planning Department

DEFINITION OF GEOLOGICALLY HAZARDOUS AREAS

"…*those areas that are susceptible to erosion, sliding, earthquake, or other geological events and are not suited to the siting of commercial, residential, or industrial development consistent with public health and safety concerns*" (RCW 36.70A.030 (9))

Functions and values:

- Form and modify the land surface over time
- "Feed" sediment to beaches and the nearshore
- Create protective land features such as spits and tombolos

TYPES OF GEOLOGICALLY HAZARDOUS AREAS

- Erosion
- Landslide
- Seismic
- Other areas subject to geological events (*e.g.*, coal mines, volcanic hazards)

In San Juan County:

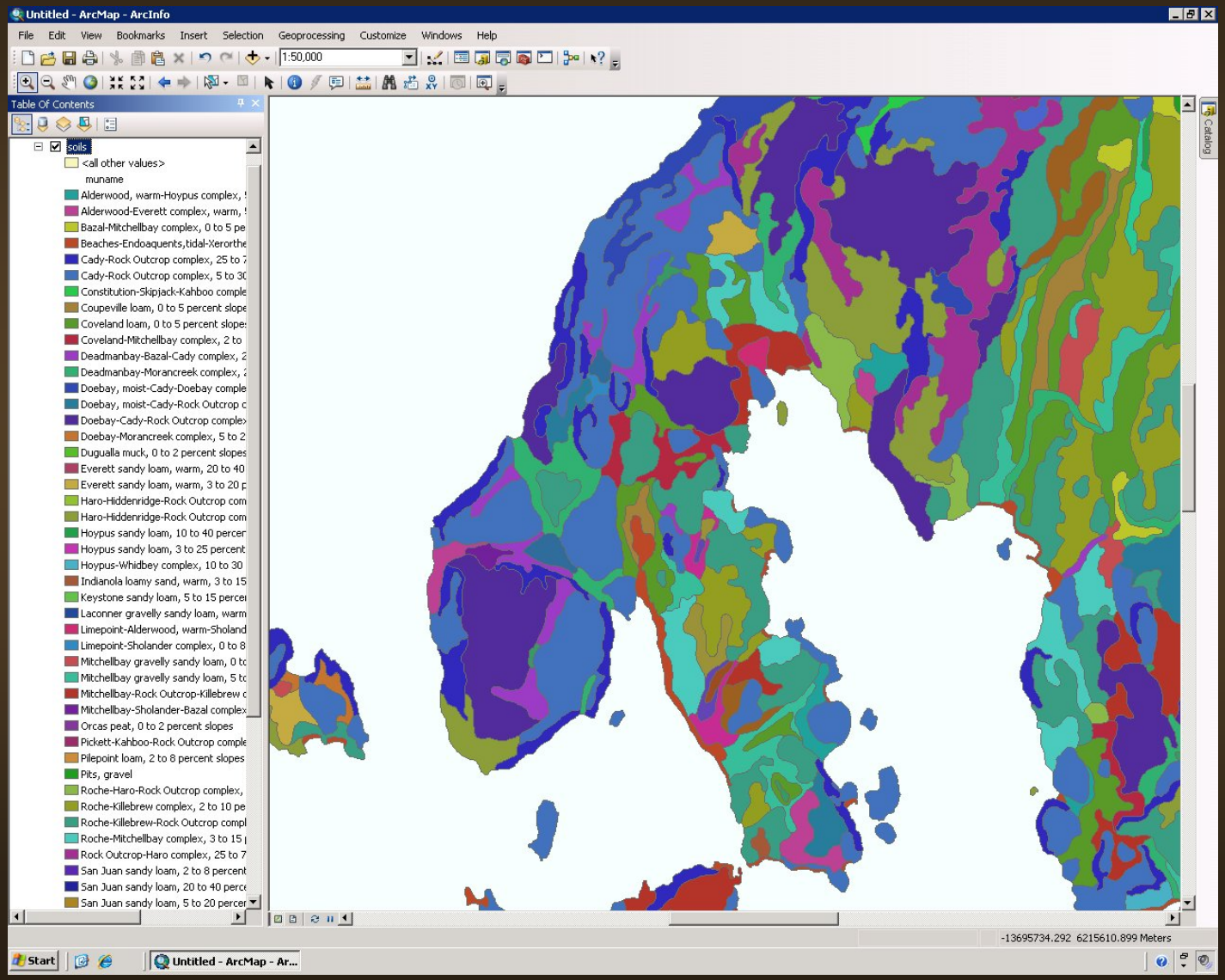
- Most common: erosion and landslide hazard areas
- Coastline: primarily exposed bedrock, plus about 13 miles of erodible unstable bluffs.
- A given property can contain multiple types of landforms, presenting varying levels of risk

IDENTIFICATION OF GEOLOGICALLY HAZARDOUS AREAS

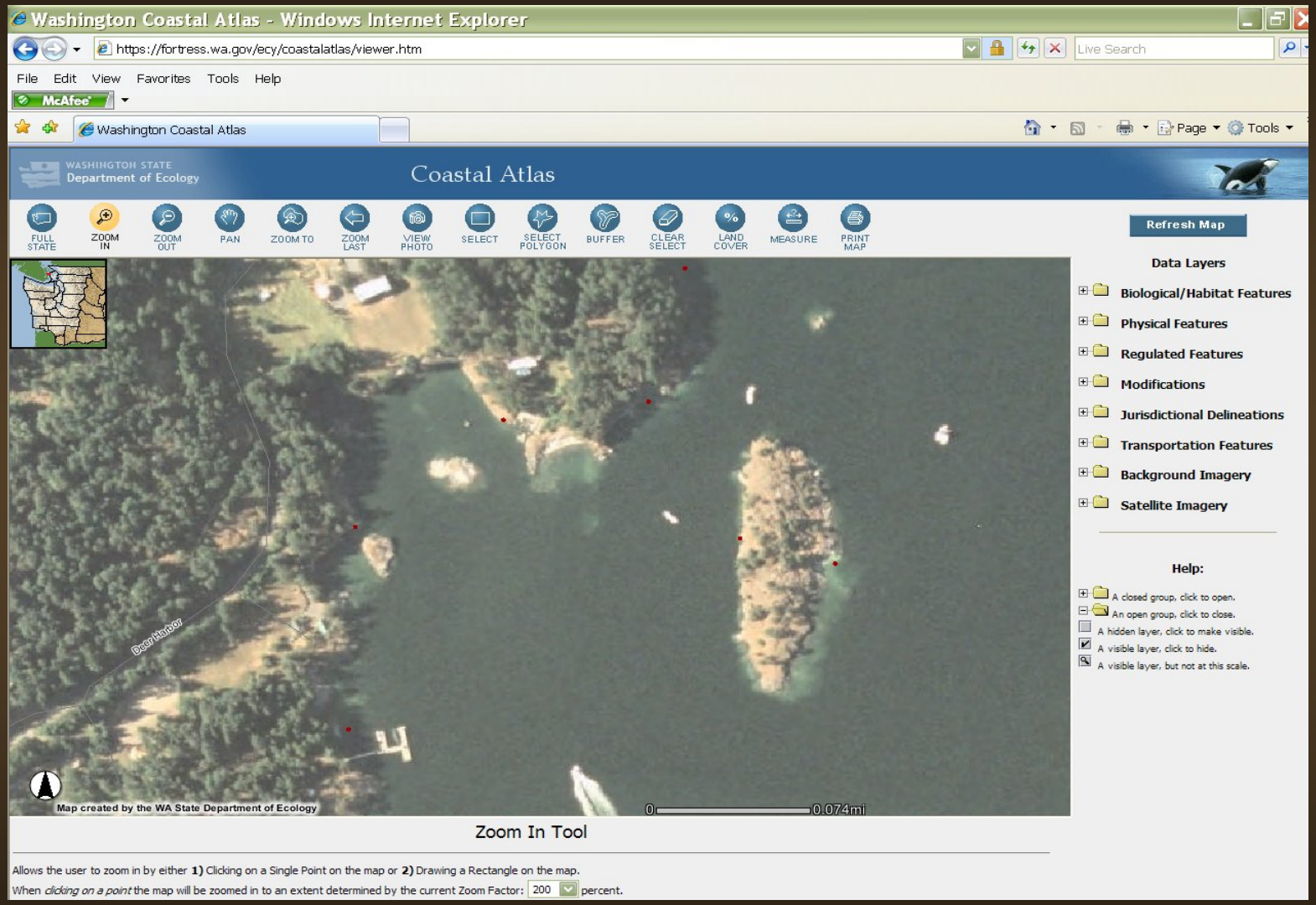
Two primary sources:

- Erosion Hazard Areas
  - Identified by their soil type
    - *Soil Survey of San Juan County, Washington* (Regan [USDA], 2009)
- Landslide Hazard Areas
  - Identified by their geological composition and slope
    - *Washington State Coastal Atlas* (Ecology, 2010)

SOIL SURVEY OF SAN JUAN COUNTY



WASHINGTON COASTAL ATLAS



*Note: this is an *example* snapshot from this graphic tool. No geologic hazard is necessarily present on these properties.

EROSION HAZARD AREAS

- Definition: *"…areas likely to become unstable (such as bluffs, steep slopes, and areas with unconsolidated soils), as well as coastal erosion areas as identified in the Washington State Coastal Atlas" (see WAC 365-190-120(5)).*

- Erosion is influenced by:
  - soil structure
  - environmental factors

EROSION HAZARD AREAS, CONTINUED

SOIL STRUCTURE

- Soil type indicates the soil's risk of 'erodibility'
  - grouped into types by their attributes (*e.g.*, structure, permeability, and amount & type of organic matter)
- Soil types with a high water-erosion hazard potential in San Juan County:
  - the Pickett Soil portion within the Pickett-Rock Outcrop Complex
  - the Roche Soil portion within the Roche Rock Outcrop Complex

EROSION HAZARD AREAS, CONTINUED

Photo credit: Maine Bureau of Land and Water Quality

ENVIRONMENTAL FACTORS

- Amount of vegetative cover
- Landform shape
- Slope gradient and length
- Rainfall quantity and duration
- Drainage and watershed conditions
- Land use and development

LANDSLIDE HAZARD AREAS

- Definition: Areas susceptible to landslides based on a combination of geographic, geologic (and stratigraphic), topographic, and hydrologic factors, which show evidence of movement within a certain period of time (see WAC 365-190-120(6))

  – includes known, existing landslides AND areas at risk of future failure

  – involve the sliding, toppling, falling, or spreading of relatively large (and often intact) masses along a failure surface or combination of surfaces

- Equilibrium

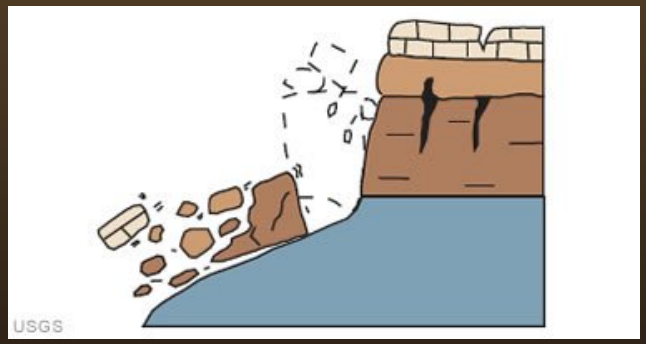
  – Slopes are stable at an angle of approximately 30-40 degrees and seek this angle through erosion and mass wasting events

LANDSLIDE HAZARD AREAS, CONTINUED

Landslides are caused by:

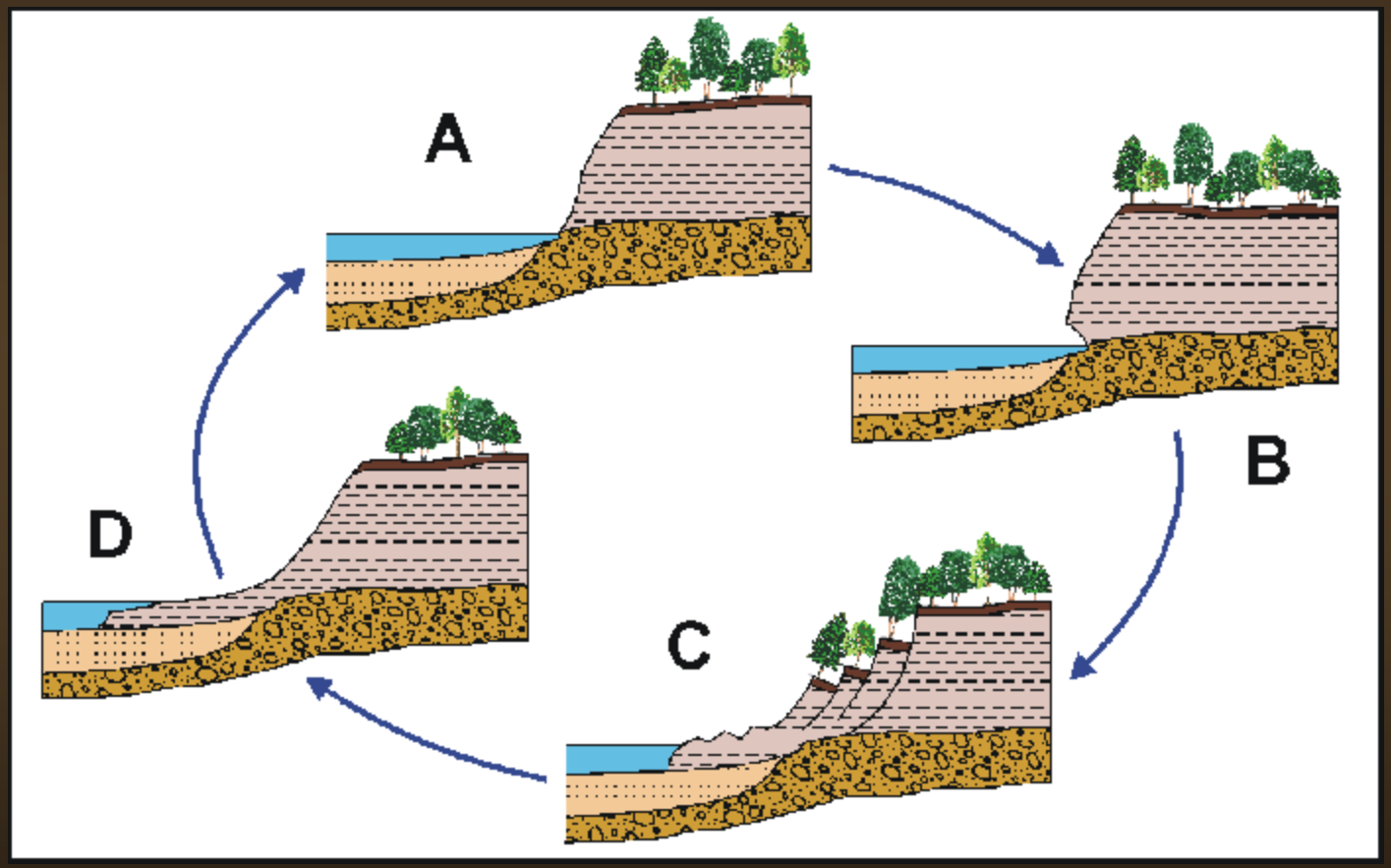
1. Wave action at the toe of the slope
2. Impacts of development
3. Hydrologic processes

**The exposed bedrock that is found throughout the county is typically resistant to erosion, but is still subject to bedrock landslides. These typically take the form of small topples, as illustrated here*



LANDSLIDE HAZARD AREAS, CONTINUED

1. Wave action at the toe of the slope



"The Life Cycle of a Landslide." Illustration credit: Maine Geological Survey, modified from Kelley and others, 1989.

LANDSLIDE HAZARD AREAS, CONTINUED

2. Impacts of development

Typical development of a property can involve actions that optimize conditions for a landslide:

- constructing structures in locations where they can overload the top of a bluff
- grading and removal of topsoil, exposing vulnerable subsurface layers to precipitation
- removal of vegetation and its binding roots
- adding water (*i.e.*, changing hydrologic conditions)

Common sources of “added water:”

- lawn watering or irrigation systems
- improperly installed drainage systems
- septic system drainfields

LANDSLIDE HAZARD AREAS, CONTINUED

3. Hydrologic processes

Added water commonly becomes “perched water”

- permeable sand and gravel units lie directly on top of less permeable silts and clays

- the layer of saturated soils eventually gives way to the forces of gravity in the form of slumps, earthflows, and debris avalanches

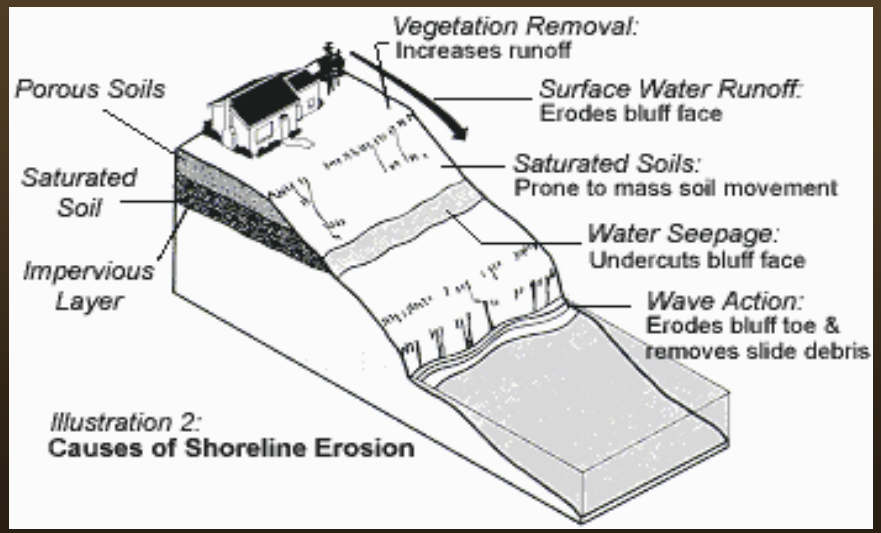


Illustration credit: WSDOE

LANDSLIDE HAZARD AREAS, CONTINUED

Benefits of vegetative cover:

- Trees, especially conifers, intercept precipitation and directly evaporate water from their foliage
- Roots remove moisture from soils (evapotranspiration) and anchor (bind) the soil layers in place
- Ground cover intercepts precipitation, slowing the velocity of runoff and filtering sediment

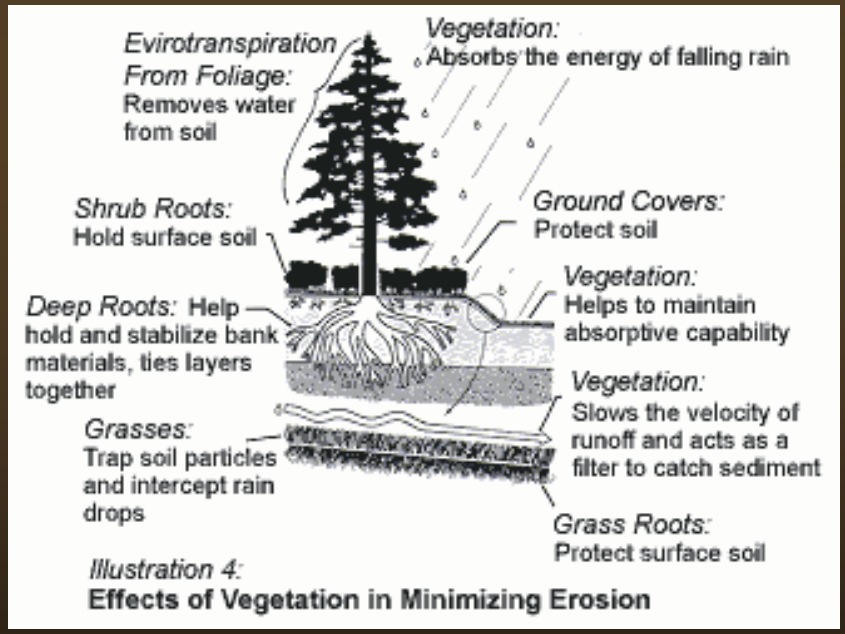


Illustration credit: WSDOE

LANDSLIDE HAZARD AREAS, CONTINUED

SEISMIC HAZARD AREAS

- All of San Juan County is in Seismic Zone 3 of the Unified Building Code (UBC), which is adopted by reference into the County Code
- Seismic risks include:
  - Large subduction earthquake
  - Smaller, local earthquake, originating from small surface faults in San Juan County (Orcas and Lopez) or nearby faults (*i.e.*, Devils Mtn. fault, South Whidbey Island fault)
  - Tsunami (including tsunamis generated from subaqueous landslides)
- Seismic Hazard Areas could be more specifically identified by using the following graphic resources in combination:
  - WDNR Liquefaction map
  - LiDAR
  - topographic data
  - bathymetric data

THE REGULATION OF GEOLOGICALLY HAZARDOUS AREAS

- Currently, Geologically Hazardous Areas are regulated by categorizing them, based on environmental factors such as steep slopes, landslides, exposed bedrock, groundwater, and mine workings
  - Category I, II, or III
- Under certain circumstances, a geotechnical report is required
- The existing regulations generally meet the requirements to protect the functions and values of these areas; significant changes are not anticipated

WHAT THE SCIENCE SAYS

PROTECTING FUNCTIONS AND VALUES

- Minimize development within the area most likely to slide when the slope is seeking equilibrium
- Retain original vegetative cover when possible
  - Replacement vegetation is not as effective
- Reduce sources of “added water”
- Stabilization options (*e.g.*, dewatering wells, bulkheads) warrant thorough review to adequately assess feasibility and impacts
- The geology of the shorelines in San Juan County are so varied that uniform buffers are not appropriate
  - Site-specific assessment through geotechnical review

OPTIONS FOR PROTECTING GEOLOGICALLY HAZARDOUS AREAS

- Avoidance
- Determine the angle of equilibrium, based on site-specific characteristics, and avoid the area where mass wasting will likely occur
- Limit certain types of land uses in certain types of hazard areas
- Require building setbacks or buffers
- Require vegetation retention or management
- Stabilization (*i.e.*, drainage collection and/or diversion, bulkheads, and slope stabilization engineering)
  - Vertical dewatering well
  - Bulkheads
  - Biotechnical stabilization techniques

DATA GAPS

- LiDAR technology can be used in combination with other data sources to better identify the extent of landslide hazard areas
- More info. is needed on the geological and biological interaction of bluffs and the nearshore environment
- Deficiencies in the *Washington State Coastal Atlas*
- More info. is needed on the status of local fault lines