Landslides 4

Help me protect my house

Goals for today

1. **Identify** tell-tale signs of an unstable slope.
2. **Compare** and **contrast** avoidance, prevention, and protection strategies for dealing with landslide hazards.
3. **List** the mitigation techniques commonly used for avoidance, prevention and protection strategies.
4. **Identify** the appropriate mitigation strategy for a variety of risk situations.

Discussion - Telltale signs

You are thinking of purchasing a home built on a steep slope.

In groups of 2 or 3, list things to look for that could suggest the slope is unstable.

Landslide Cause & Effect

Cause
Reduces shear strength or increase shear stress

Trigger
Initiates motion

Effect
Fall, slide, flow, or complex movement

Once we identify a hazard we move to mitigation (solving the problem)

Mitigation

Start with investigation and monitoring

All of this is expensive!

In some cases, especially very slow slides, it is cheaper to repair damage and ignore the landslide

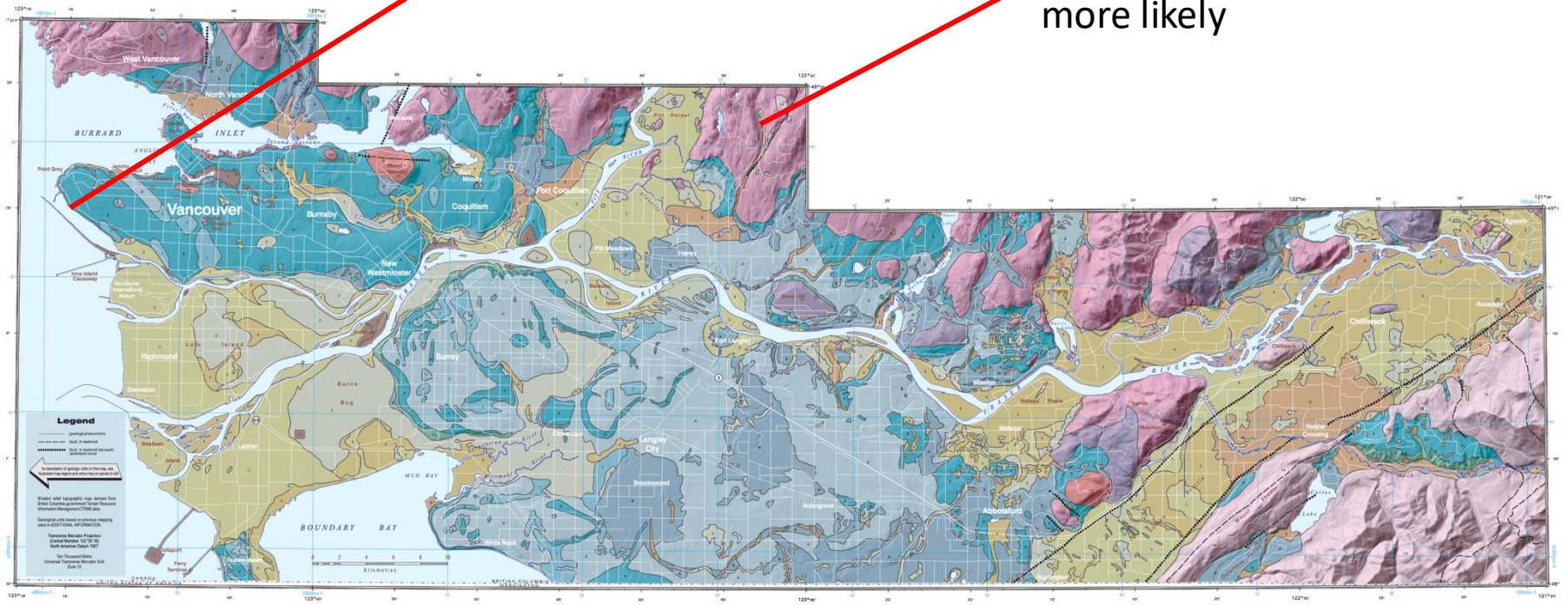
Investigation – Geologic Mapping

Map materials and properties on site

Predict type of failure

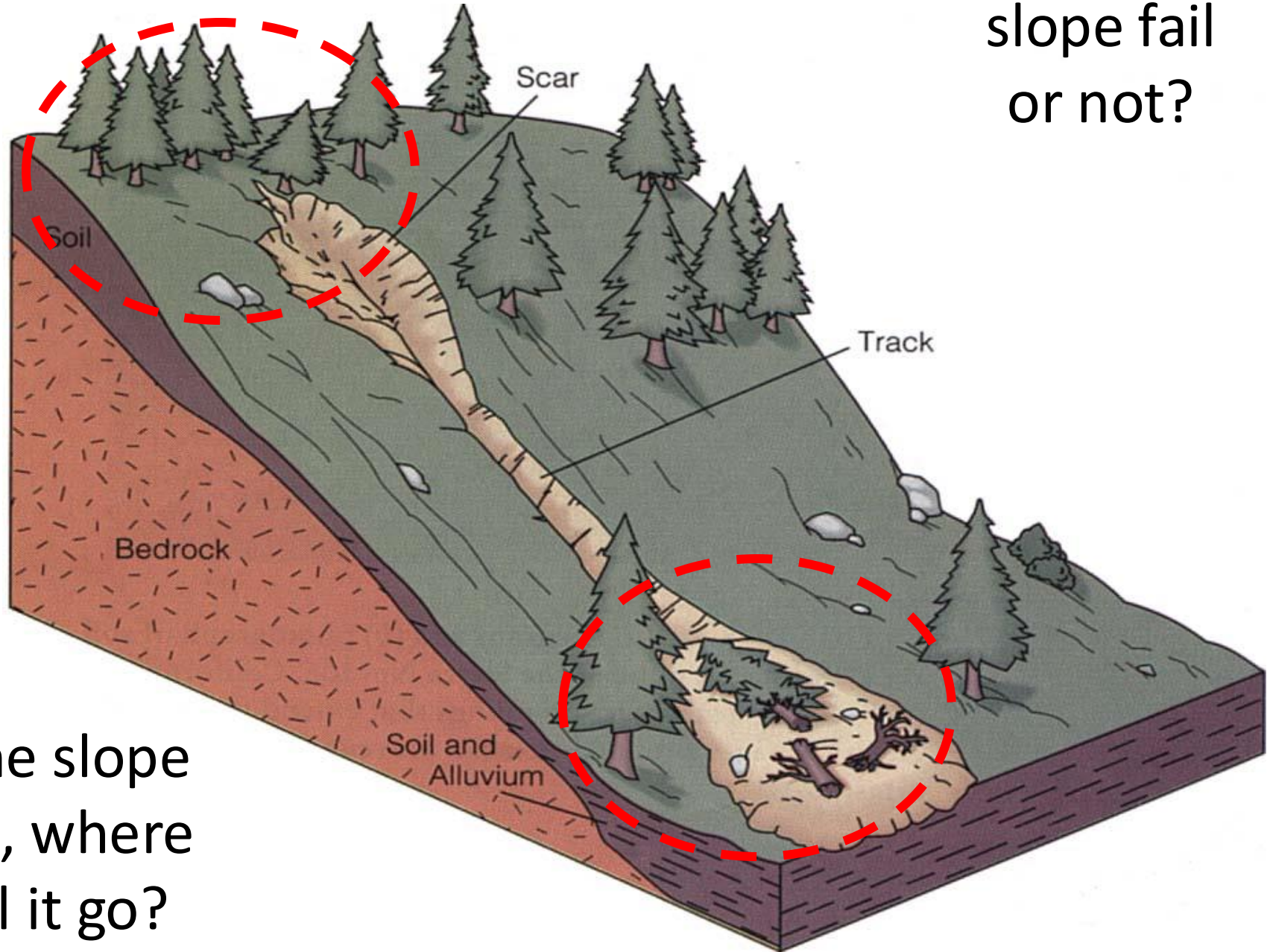
Glacial sediment =
Rotational landslide more likely

Igneous/metamorphic rocks
Without soil cover = rockfall/slide more likely



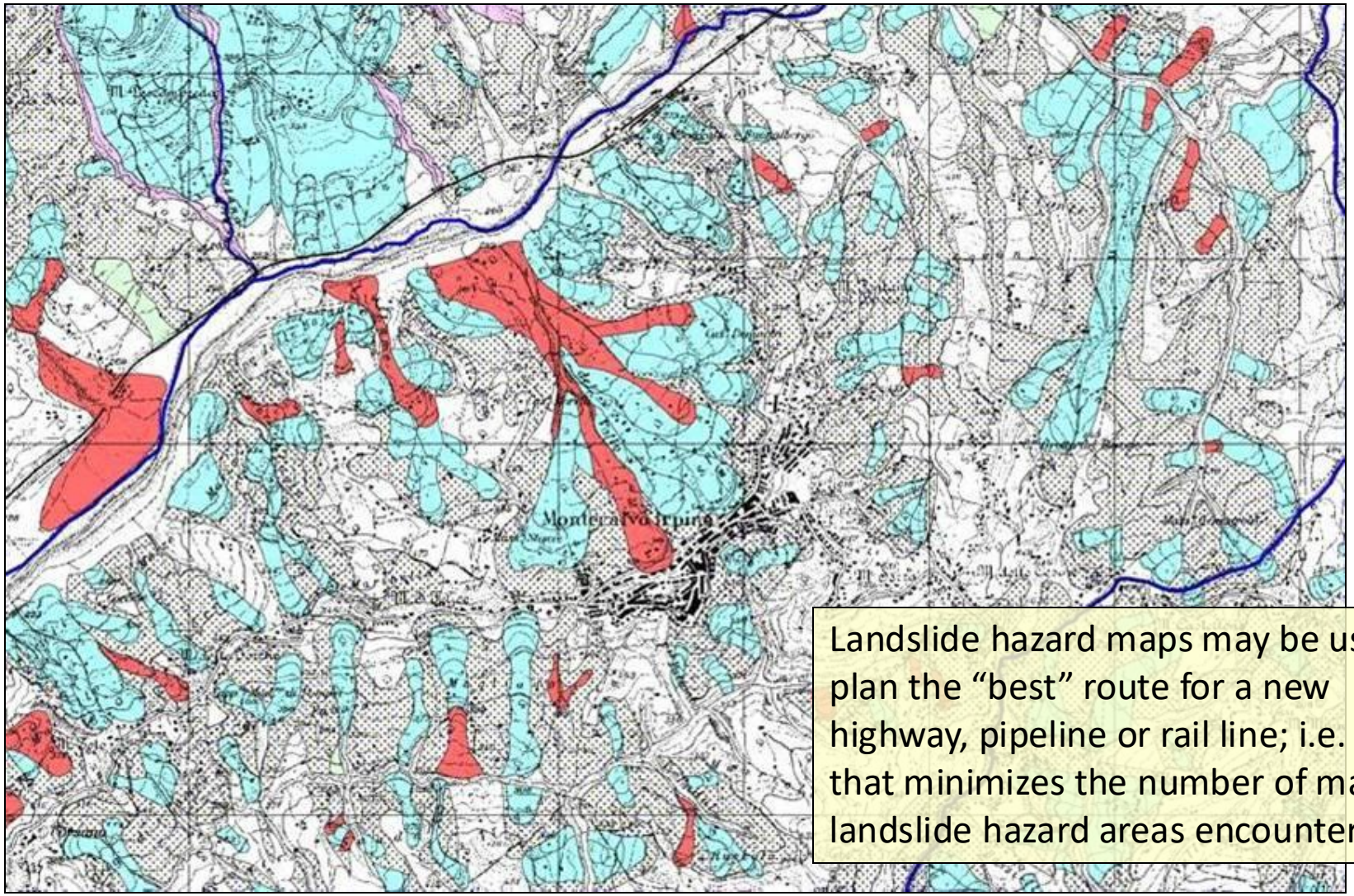
Investigation

Will the slope fail or not?



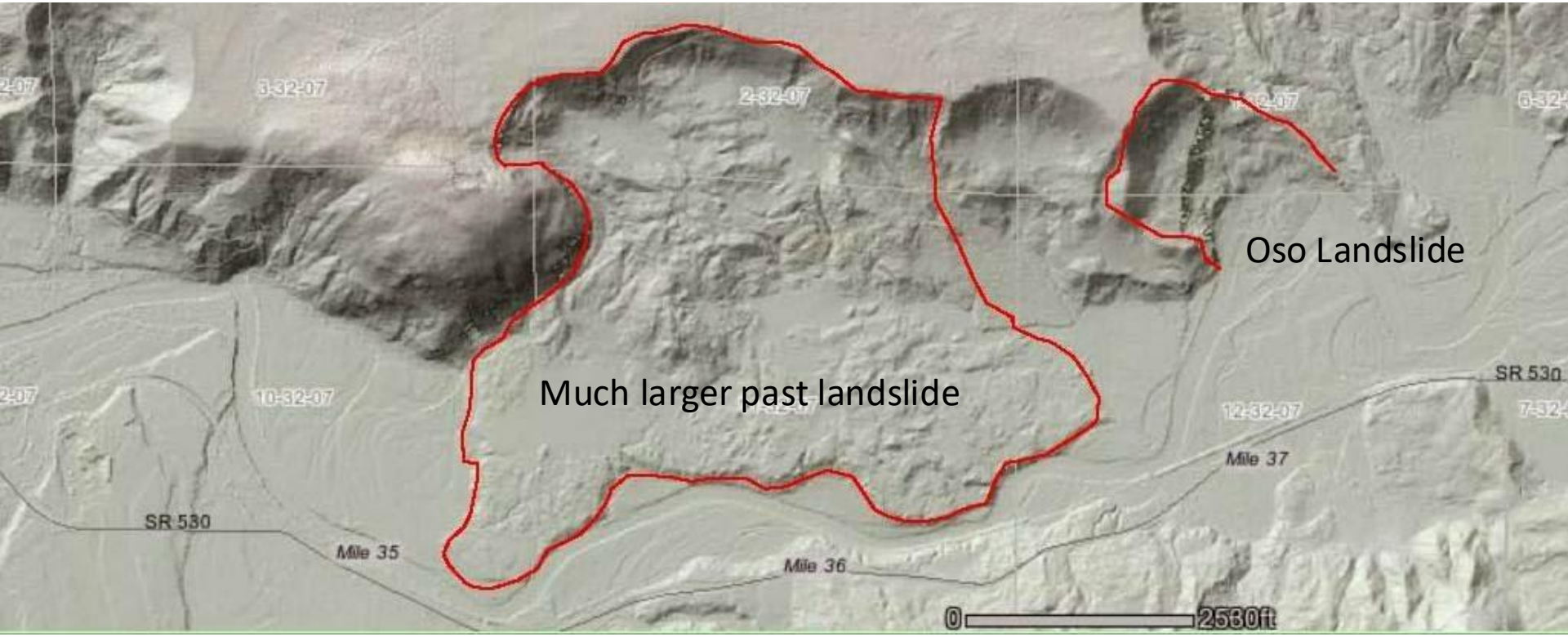
If the slope fails, where will it go?

Investigation - Hazard Mapping



Landslide hazard maps may be used to plan the “best” route for a new highway, pipeline or rail line; i.e. one that minimizes the number of major landslide hazard areas encountered.

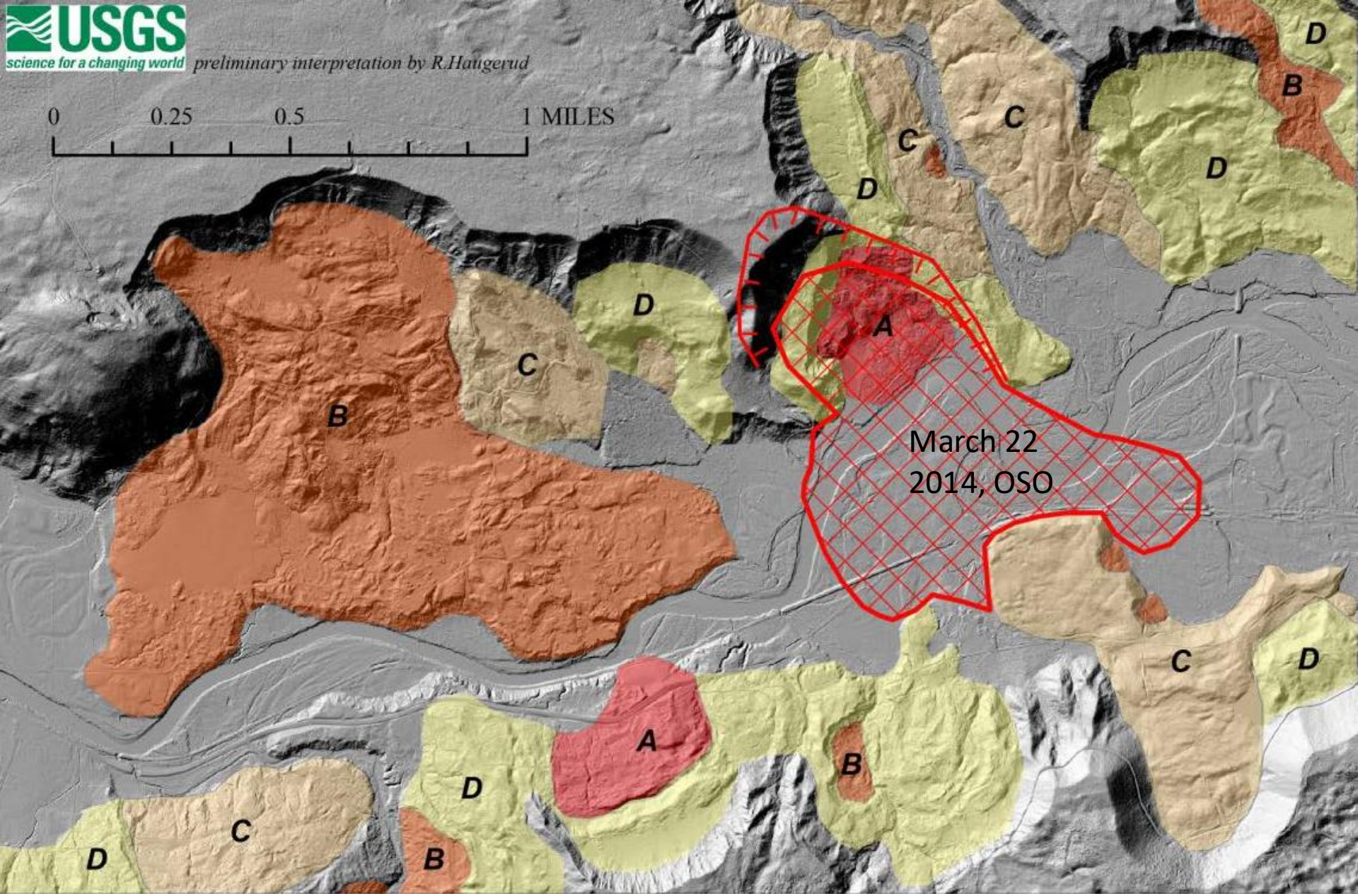
Investigation – imaging and modelling



LiDAR imagery is a technique used to scan the surface topography of the Earth. The technique 'sees through' trees.

Technique used to see where previous landslides have occurred.

Dan McShane



Yellow = past, oldest landslides Orange = past landslides Red = past, recent landslides

Mitigation

After investigation, three paths to mitigate landslides

1) **Avoidance** – move to a different area, avoid problem
2) **Prevention** – do something to make sure landslides don't occur or don't occur when people are there
3) **Protection** – armour or strengthen the area that might be affected if landslides occur

1) Avoidance

In almost all cases avoidance is too expensive

Scenarios:

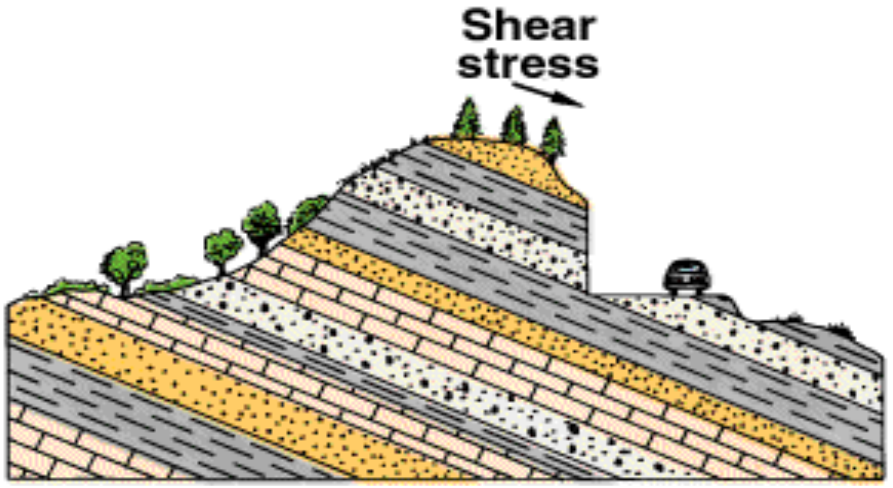
- Buying all the property in a town
- Moving a completed highway
- Or convincing someone to leave a family home

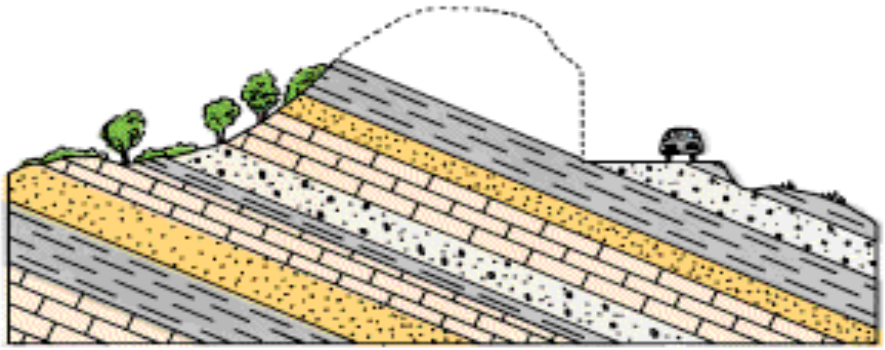
Before the 2014 Oso Landslide a buyout program was considered but not implemented

2) Prevention

a) Removal of material

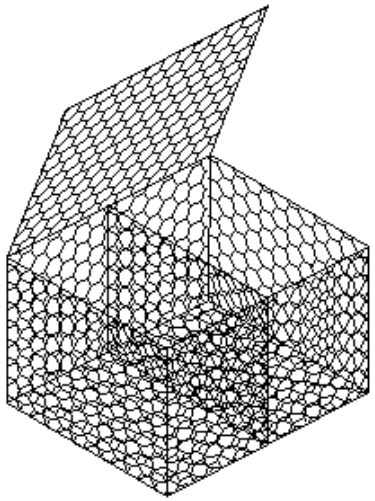
- Very simple
- Remove the material (somehow)
- Too expensive for many situations, but cheaper than avoidance
- Pretty good for some rockfalls





2) Prevention – Stabilizing Slopes

No retaining wall



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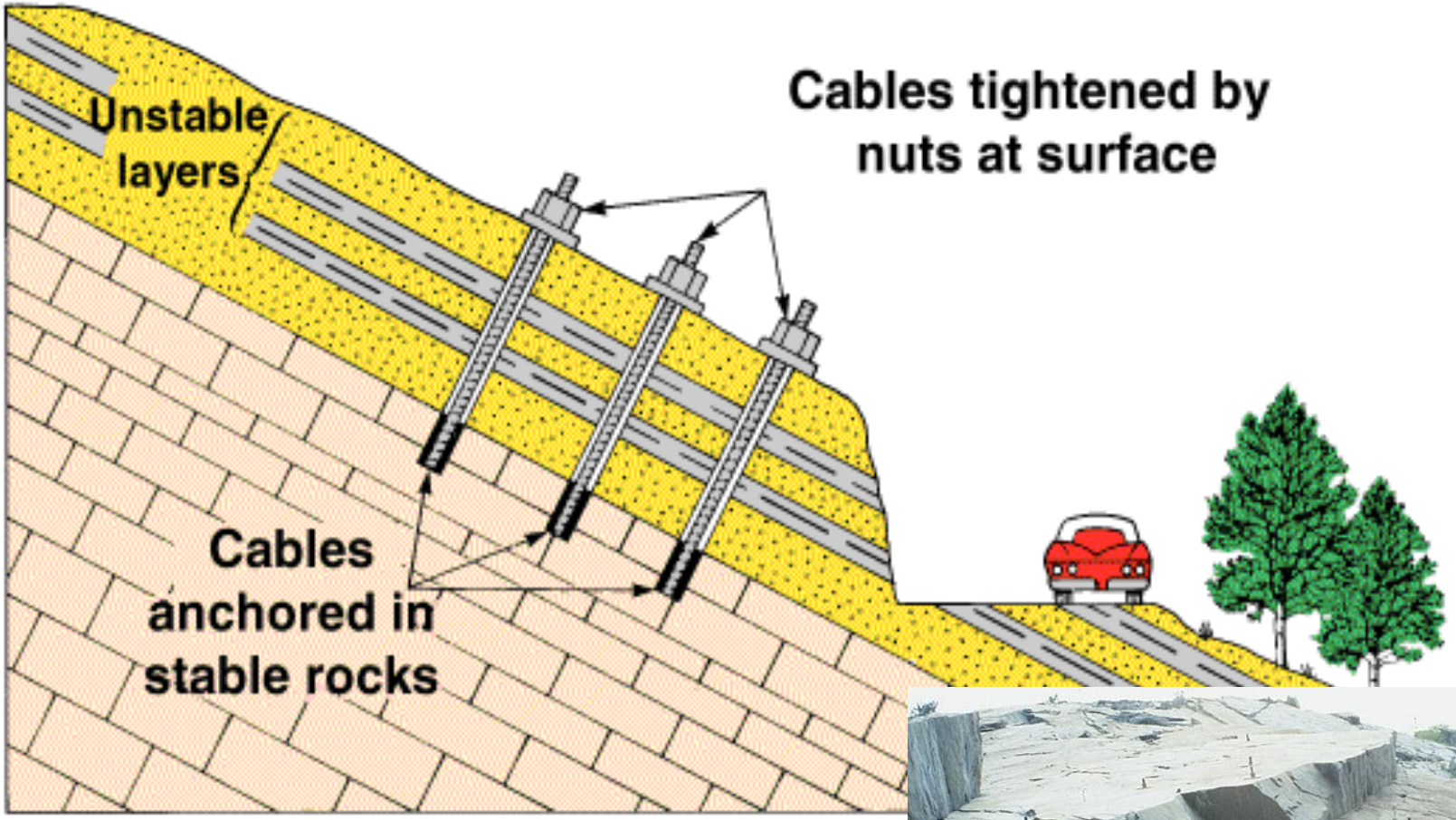
Slopes undercut when building roads?

Apply a resisting force at the bottom. Retaining walls, or gabions

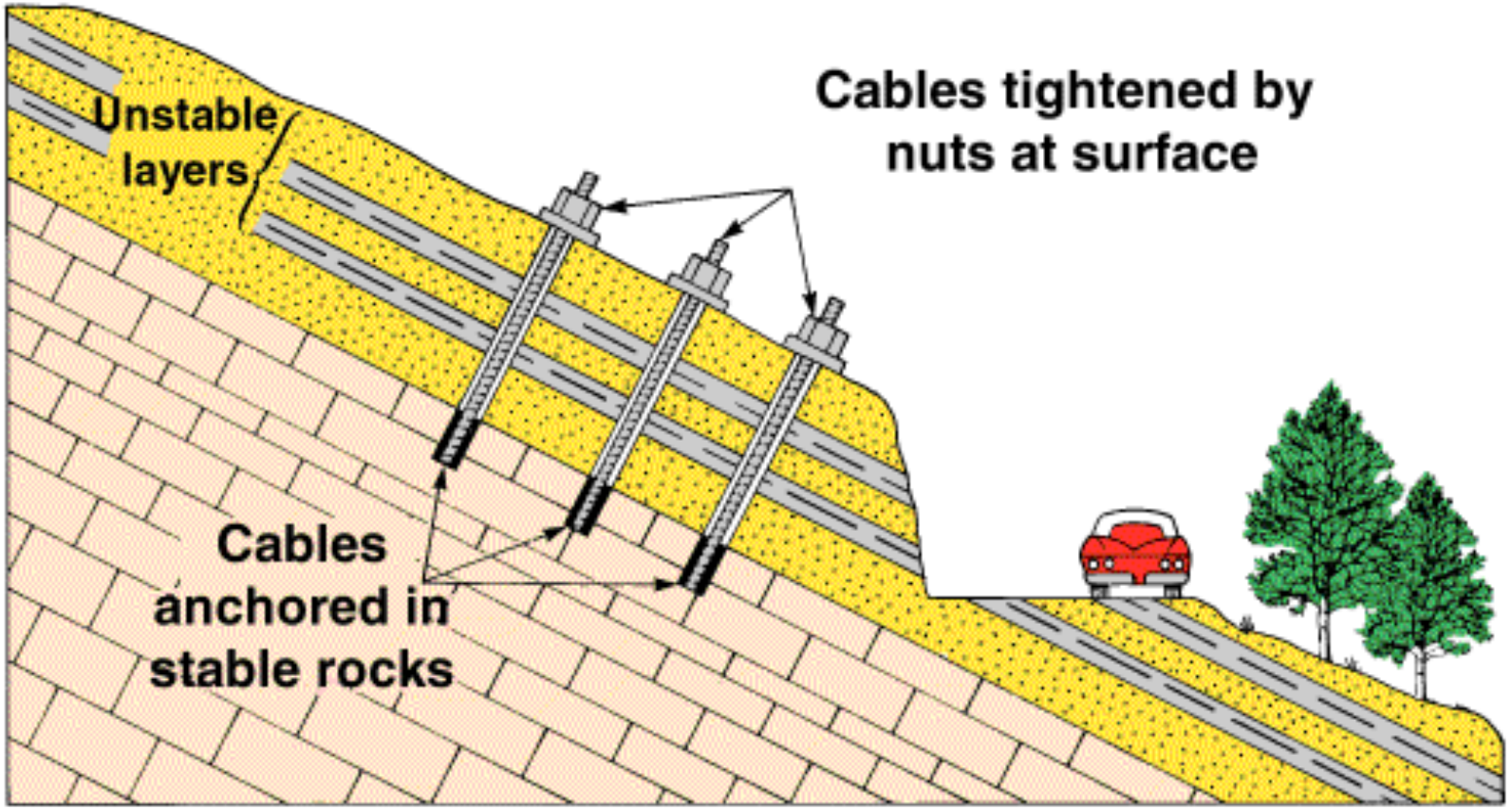
2) Prevention – Stabilizing Slopes



Sliding rock?

Apply rock bolts (rock anchors)

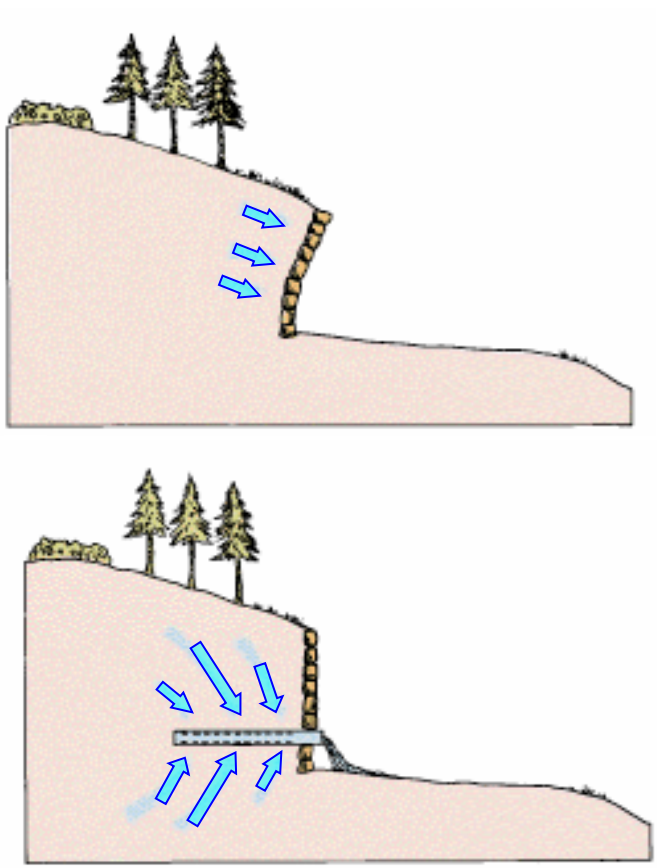
2) Prevention - Anchors



$$FS = \frac{\text{resisting forces } (\tau_f)}{\text{driving forces } (\tau)}$$

2) Prevention - Drainage

Too much water? Remove with drainage pipes



Stabilization with Vegetation

Planting trees and shrubs (or Hydroseeding) to hold slopes together with roots.

3) Protection

Minimize hazard

Let the landslides occur but control where they go

Or armour where they go

Rock Barrier

Rock Net

Rockfall Shed

3) Protection

Rock Fences

Catch falling/rolling rocks
and dissipate kinetic energy

D. Weis

D. Weis

3) Protection

Debris flow retention structures

- Debris Flow = Water + debris
- Remove debris from water
- No more flow

Whistler Creek

Mitigation Activity

List the mitigation techniques commonly used for prevention and protection strategies.

Identify the appropriate mitigation strategy for a variety of risk situations.

Slide 1


STOP


Slide 3

Slide 3

Slide 4