

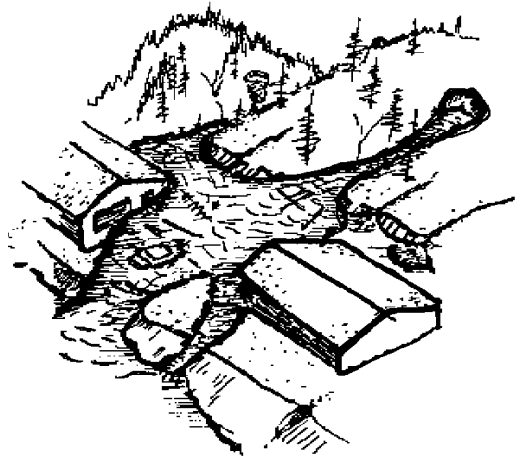
homeowners landslide guide

for
landslide control
hillside flooding
debris flows
soil erosion

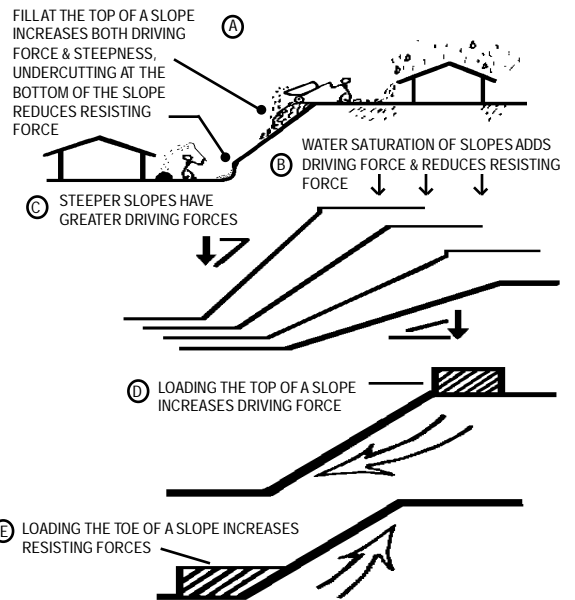


HOW TO RECOGNIZE PROBLEMS

Water generates & triggers most slope problems. Find where the water is coming from. Get out in the rain & check areas like hillslopes, gullies, driveway & street drainage, roof gutters & downspouts. Next, see where it flows & where it goes. Concentrated flow can cause great damage.

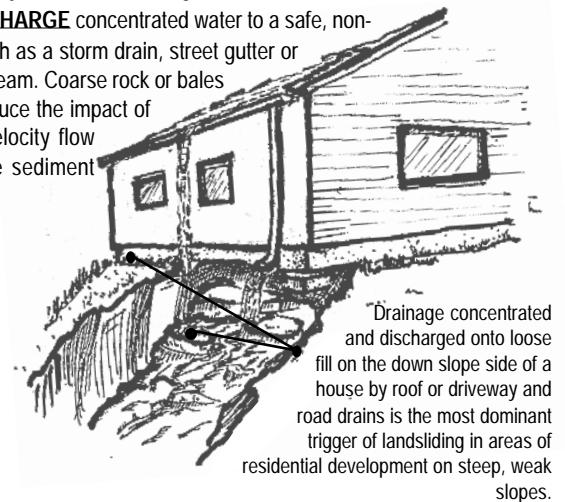


- **WET, WEAK** and **STEEP** -- Slope failure problems are caused by any combination of water saturation and flow; weak, heavy earth materials; and, steep slopes. *Remember, WATER is the most common trigger of slope failure!*
- **STEEP SLOPES** -- Problems occur on steep slopes, especially when slope of one vertical to two horizontal is exceeded.
- **DRAINAGE** -- Channels, streams, gullying, ponding and erosion on slopes all indicate potential slope problems. Road and driveway drains, gutters, down spouts and other drainage can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are a major cause of slope problems and landslide triggering.
- **DEBRIS** -- Deposition of soils and vegetation at the base of slopes show erosion, flow and creep from ground cover above.
- **VEGETATION** -- Condition of vegetation indicate slope conditions. Bare slopes may show erosion and sliding. Trees that bend downhill show creep of upper soils. Trees tilting uphill may show deep rotational landsliding. Patches of younger vegetation may show former slope failure. Horsetail ferns or other wet loving plants often indicate saturated ground and springs.
- **DEFORMED STRUCTURES** -- Foundation cracks; doors and windows out of line or sticking; tilted floors; sagging decks; cracks in masonry and chimneys; cracks in driveways, curbs & roads, gaps between floors & walls, failing retaining walls & tilted power poles can be warnings of slope instability.
- **LOOSE FILL** at the top of a slope due to yard waste, cut & fill land grading or other process can aggravate slope instability.



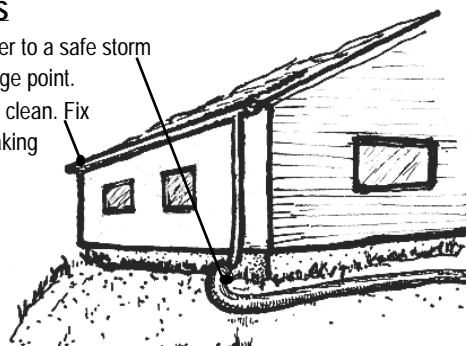
What **YOU** can do to prevent landslide and slope stability problems:

- **DIVERT, CONTAIN** and safely **DISCHARGE** water around and away from unstable slopes, yards and structures.
- Use **SANDBAGS** to divert water from uncontrolled spilling, such as over curbs or from gutters and downspouts, or from washing into buildings.
- Use **GROUND COVER** to protect sensitive and unstable areas with plastic sheeting or tarps, burlap or other material. Wood chips and straw may be worked into the surface. Straw bales can retard velocity flow and erosion. Cover ground cracks, such as from sliding or erosion, with plastic sheeting staked or loaded down with weights. Protect cover from wind damage or other forces.
- **CONTAIN FLOW** by directing into road gutters, storm drains or non-eroding stream beds. Flexible plastic pipe can be quickly installed. Redirect flow away from slopes and properties. **DO NOT** concentrate flow onto slopes or your neighbors property, or behind retaining walls.
- **SAFELY DISCHARGE** concentrated water to a safe, non-erodible site such as a storm drain, street gutter or rock bed of a stream. Coarse rock or bales of straw can reduce the impact of concentrated velocity flow and can reduce sediment transport.



SAFETY TIPS

- Conduct water to a safe storm drain discharge point.
- Keep gutters clean. Fix broken & leaking downspouts



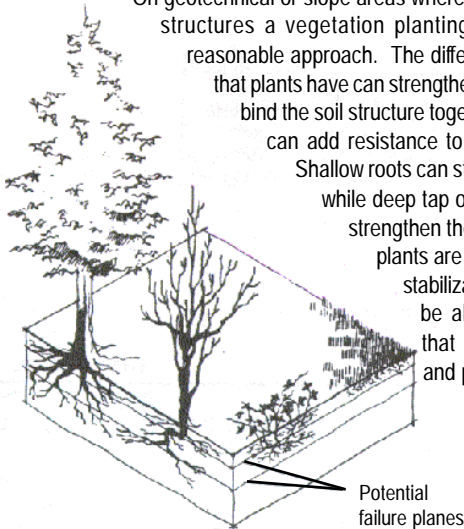
BANK STABILIZATION

Banks that are steep and susceptible to landslides, or are already sloughing off and encroaching upon a structure, are in need of a bank stabilization effort. Many different levels of protection are possible and it is best to consult with a geotechnical or structural engineer if you are in a hazardous area.

VEGETATION

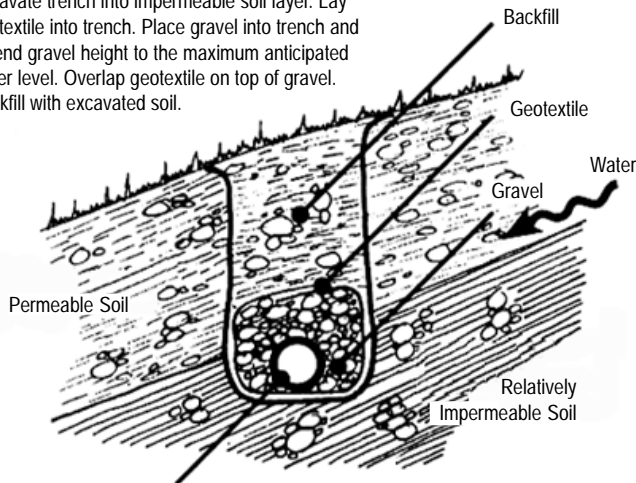
On geotechnical or slope areas where there is no threat to life or structures a vegetation planting plan may be the most reasonable approach. The different types of root systems that plants have can strengthen the cohesion of soils and bind the soil structure together into a larger unit. This can add resistance to potential landslide areas.

Shallow roots can stabilize the top layer of soil, while deep tap or lateral root networks can strengthen the lower base layers. Many plants are particularly useful for bank stabilization. Your local nursery will be able to recommend plants that grow well in your climate and particular soils conditions.



INTERCEPTOR DRAIN

Excavate trench into impermeable soil layer. Lay geotextile into trench. Place gravel into trench and extend gravel height to the maximum anticipated water level. Overlap geotextile on top of gravel. Backfill with excavated soil.



Perforated drainage pipe placed on 3-6 inches of gravel. Pipe midpoint should be located into the permeable soil layer

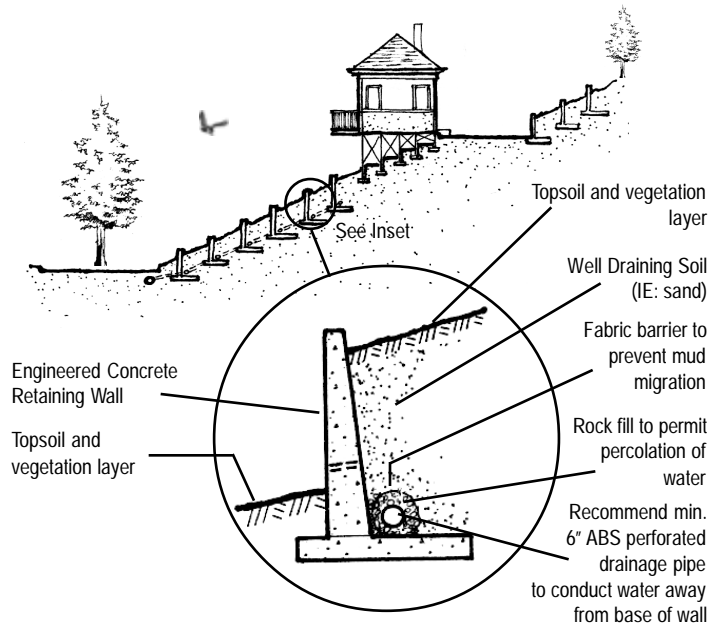
MORE PERMANENT SOLUTIONS

Major problems require major hazard mitigation and repairs. The best and easiest cure is to avoid the hazardous sites. Urban population pressures increase the uses of marginal building sites requiring greater investment in stabilization measures. Steep, weak hillslope areas require increased code and ordinance controls to reduce risks to homeowners. Professional site investigations by both a technical engineer and an engineering geologist have been shown to reduce landslide damage over 95%. Technical solutions can greatly reduce the risks. But, private insurance or government hazard programs DO NOT protect the homeowner at this time.

Serious problems require serious help. Hillside flooding, debris flows, erosion, and sliding often generate greater damage than the homeowner can manage on his/her own. Serious problems require specialized professional expertise of registered civil engineers with geotechnical speciality and registered engineering geologists.

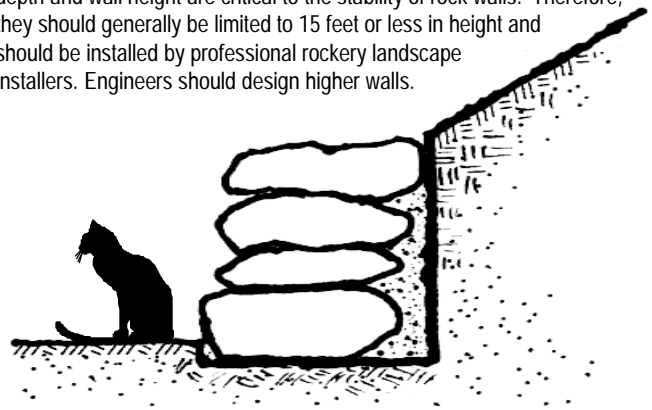
CONCRETE RETAINING WALLS

Concrete retaining walls can be constructed to withstand a large variety of structural loading conditions. They are particularly useful in steep situations where protection is needed close to the top or base of a slope. The strength of the retaining wall is highly dependent upon the strength of the materials it is made of and the manner in which they are put together. Because of the design detail required for each situation a structural or geotechnical engineer should be consulted when a concrete retaining wall is going to be used.



ROCK WALLS

Rock walls are essentially gravity walls made of stacked large rock. They primarily provide erosion protection and limited earth support. Slope, rock depth and wall height are critical to the stability of rock walls. Therefore, they should generally be limited to 15 feet or less in height and should be installed by professional rockery landscape installers. Engineers should design higher walls.



WARNING!

If your house is in danger of landslide damage, protect people first and ***EVACUATE IMMEDIATELY!***

Danger Signs Include:

- Rapid water or slurry flow impacting house.
- In steep terrain; if flow stops or is irregular, evacuate fast! Debris-dam bursts occur very quickly.
- House cracks actively opening.
- House making noises.
- Walls or floors tilting.
- Ground cracks opening under house.
- Any portion of house falling away.

Serious problems require professional assistance. For help with major hazards, consult a licensed building professional in your community and your local building authority.