EROSION QUESTIONS AND ANSWERS

What type of erosion are we talking about?

We are talking about the loss of land caused by moving water in rivers, lakes and the ocean. *Read more >>>*

Why should we care about erosion along stream banks and along shorelines?

Erosion can destroy property, human development (homes and businesses), and most importantly, in extreme situations, can cause loss of life. *Read more >>>*

What can be done to protect my home, business and my family from erosion?

- **Building Setbacks**
  The simplest and most cost effective means of protection is to avoid building in areas prone to erosion. This can be achieved by building at a safe distance from the watercourse or water body. *Read more >>>*

- **Protective Works**
  Properly engineered protective works can be very effective in preventing or reducing erosion hazards, but can be very expensive and are environmentally sensitive.
  Read more >>>

What can be done about erosion during an emergency event like a large flood?

Erosion rates are greatly accelerated during large floods and often it is too dangerous or impractical to effectively halt erosion. *Read more >>>*

What can be done about erosion after an emergency event has occurred?

- **Is it possible to replace land lost due to erosion?**
  It is generally difficult to replace land loss due to erosion since the required construction is expensive and also the streamside area is environmentally sensitive. *Read more >>>*

- **Is financial assistance available to replace land and structural losses due to erosion?**
  Assistance for erosion loss is not generally available as it is NOT eligible for Disaster Financial Assistance. *Read more >>>*

- **Appendices**
  - **A Erosion Glossary**
  - **B Legal Matters**
  - **C Other Technical Resources and Examples**

What type of erosion are we talking about?

There are different types of erosion, but our discussion will focus only on erosion caused by moving water.

Stream Erosion

First let us consider erosion from a stream (creeks and rivers). Stream erosion is the displacement and transportation of solids (soil, sand, gravel, mud, boulders, and other particles) by moving water. This type of erosion is natural and occurs in and adjacent to every stream. However, the rate or severity of erosion is the important difference. Two important factors controlling the rate of erosion is the depth and speed of water in the stream. Basically, the bigger and faster the stream, the bigger the size and the amount of material than can be eroded and transported.

A stream can erode downwards and also horizontally. Although downward erosion is an important engineering consideration for structures like bridge piers we will focus primarily on horizontal or lateral erosion. Streams erode laterally or migrate across the valley or its floodplain moving back and forth continuously.

Two common types of channel migration in BC include braided streams and meandering streams. Braided streams are found on steeper terrain including alluvial fans while meanders are typically found on flatter terrain (see Appendix C for examples).

Horizontal erosion occurs primarily on the outside bend or banks of a stream. In addition to the factors mentioned above the rate of erosion of the banks of the stream are dependent on the type of material in the bank, the tightness (radius of curvature) of the bend in the stream and the bank's protective cover (type and amount of vegetation).

Smaller non cohesive (without binding properties) bank material erodes more readily than larger material. For example sand erodes more easily than gravel and gravel erodes more easily than boulders.

The tighter the bend of a stream, the more the force of the stream is directed against the bank.

Vegetation not only slows the speed of the water flowing against the bank, but in addition the roots help bind the bank material together. However, larger leaning trees may pull out bank material when their root structure is undermined.

Pond, Lake, Reservoir and Ocean Erosion

Now let us consider erosion of land adjacent to ponds, lakes, reservoirs and the ocean. Here erosion is still caused by moving water except the movement is caused by wave action. Other things being equal larger waves cause greater erosion. The size of the waves is dependent on the strength and duration of the wind, the distance the wind can blow along the body of water (fetch length) and the depth of water.

The rate of erosion of land adjacent to ponds, lakes, reservoirs and oceans is also dependent upon the type of material found there, similar to stream erosion. Obviously a rocky shore or solid bedrock sea cliff will erode much slower than a sandy shore, or a clay or silt sea cliff.

Properties adjacent to large lakes or reservoirs and oceans also experience erosion from currents moving along the shoreline (longshore drift). These currents develop from waves striking the shore at an angle. These currents remove sands from one area and deposit them further down the beach in the direction of the shoreline current (see Appendix C for examples).

Since reservoirs have not had the same length of time to stabilize their shores, they may be much more prone to shoreline erosion than natural lake systems. The erosion process may also result in more sudden and large scale landslips along the shoreline than usually occur along natural shorelines.

Back

Why should we care about erosion along streams banks and along shorelines?

We should care about erosion and particularly severe erosion along stream banks and along shorelines because erosion can destroy property, human development (homes and businesses), and most importantly, in extreme cases, can cause loss of life.

Erosion does not occur at a constant rate and is highly dependent upon the amount of flow (discharge) in the stream or the strength of a storm on a lake or ocean and the size of that body of water. Not only are erosion rates highly seasonal, but erosion rates can vary substantially from year to year. A stream that appears to be stable for decades may erode several metres to hundreds of metres during one large flood. Similarly a sea cliff that has stood for many years may suddenly collapse from one large storm.

It is human nature to want to build close to streams and lakes. It is simply dangerous to build too close. Unfortunately most people fail to recognize the hazards of building or living too close to a creek, river, lake or ocean. It takes training in fields of study, including hydrology, geology, geomorphology and geotechnical engineering to recognize the type and degree of erosion hazard posed by streams and other bodies of water.

Back

What can be done to protect my home, business and my family from erosion?

Building Setbacks

The simplest and most cost effective means is to avoid building in areas prone to erosion. You can achieve this by building at a safe distance from the watercourse or body of water of concern.

You can check local floodplain bylaws to see if they have building setbacks from watercourses. You can also check the certificate of title of properties to see if any building setbacks from watercourses are prescribed in the form of covenants registered against the title.

Not all local governments have floodplain bylaws. In addition, not all properties affected by erosion have covenants on title addressing hazards. So the absence of floodplain bylaws or building covenants does not necessarily indicate the property is free of erosion hazards. Furthermore floodplain bylaws cover large areas and the setback descriptions are general and usually not site specific. Even properties with covenants may not have been thoroughly assessed for erosion hazards and in addition, conditions may change over time.

For a definition and examples of floodplains, alluvial fans and other potential erosion hazard areas see the Appendices A and C.

The Provincial Guidelines set out minimum setbacks from watercourses, see the following web site http://www.env.gov.bc.ca/wat/flood/brochur3.html#guidelines. Download the document "Flood Hazard Land Use Management Guidelines". It should be stressed that these guidelines are general in nature and a site specific assessment by a qualified professional is strongly recommended.

To determine if your property is at risk from erosion (or flooding) you should hire a qualified professional trained in the recognition of flooding and erosion hazards (see http://www.env.gov.bc.ca/wat/flood/brochur3.html#guidelines and download "Guidance for Selection of Qualified Professionals and Preparation of Flood Hazard Assessment Reports".

Back

Protective Works

Properly engineered protective works can be effective in preventing or reducing erosion hazards, but can also be expensive. In addition, there are often engineering and environmental considerations that prevent protective works from being practical. Protective works also require long term maintenance and if more than one property is involved and the work is considered to be a dike, an Approval under the *Dike Maintenance Act* may be required and a local authority willing to fund and carry out maintenance may be required as well.

Back

What can be done about erosion during an emergency event like a large flood?

Erosion rates are greatly accelerated during large floods and often it is too dangerous or impractical to effectively halt erosion. It is difficult to place bank protection during a flood event due to the high flows and velocities, and expensive due to the cost of materials and equipment.

Evacuation is always the priority if lives are threatened.

This is why it is so important to recognize the hazard before an event. Avoid building too close to a watercourse at the start or if the structure or house is already built too close, construct adequate protection before large floods occur.

Back

What can be done about erosion after an emergency event has occurred?

Is it possible to replace land lost due to erosion?

It is generally difficult to replace land loss due to erosion since the required construction is expensive and also the streamside area is environmentally sensitive and therefore construction work in this area is subject to a number of regulatory approval requirements.

Back

Is financial assistance available to replace land and structural losses due to erosion?

Assistance for erosion loss is not generally available as "eroded or damaged land except for essential access routes and removal of debris" is NOT eligible for Disaster Financial Assistance under the Compensation and Disaster Financial Assistance Regulation of the provincial *Emergency Program Act* (EPA) as administered by the Provincial Emergency Program.

However, Disaster Financial Assistance is available for “structural repair to or replacement of an eligible [residence or structure] . .. .”. An eligible residence “means a structure owned by a claimant and occupied by the claimant as the claimant’s principal residence”, and eligible structures and principal residences are defined in the Compensation and Disaster Financial Assistance Regulation.

Back

Appendix A Erosion Glossary

Please see the Definitions in the Provincial Guidelines, Appendix A.

Some of the following definitions are from the Guidelines as indicated. Additional descriptive material and definitions are provided to aid understanding in connection with erosion issues.

Alluvial Fan - The alluvial deposit of a stream where the stream issues from a steep mountain valley or gorge upon a plain or at the junction of a tributary stream with the main stream. [From Guidelines]

The fan-shaped deposit (clay, silt, sand, gravel or boulders) of a stream where there is a significant flattening or widening of the channel. The ability of a stream to carry larger and heavier material (alluvium) is dependent on its speed and depth. Examples of alluvial fan deposits are where a steep, confined mountain side stream emerges onto flatter terrain like a valley bottom, river terrace or plain.

Alluvium - material or sediment (clay, silt, sand, gravel, boulders, rock) moved, carried or deposited by running water (streams and rivers).

Apex – the top of an alluvial fan where it flattens in gradient as a watercourse exits from a steeper confined portion of the watershed and deposits its heavier and larger sediment.

Avulsion – an abrupt change in the course of a stream, especially on alluvial fans. As water-borne material is deposited, it may unpredictably change stream channels.

Bedrock – the solid rock beneath the soil and superficial rock. A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material and which is resistant to erosion and weathering. (See http://mvhs1.mbhs.edu/riverweb/glossary.html for other useful water science definitions)

Braided Stream – a braided channel consists of a network of smaller channels separated by small and often temporary islands called braid bars. Braided streams are common wherever a drastic reduction in stream gradient causes the rapid deposition of the stream's sediment load. Braided channels are also typical of river deltas.

Channel – the physical confine of a river or other watercourse, consisting of a bed and banks.

Channel migration – the lateral movement of a river or stream as it adjusts to balance erosion with deposition of sediment carried by the watercourse.

Cohesive bank material – fine material like clay or silt that has binding properties.

Covenant – a legal document usually attached to a land title registration which contains provisions restricting or otherwise respecting the use of land, or the use of a building on or to be erected on the land, for reasons cited in the covenant.

Debris Flow - The rapid downslope movement descending steep pre-existing drainage channels of water-saturated soil and debris by true flow processes. [From Guidelines] A highly mobile slurry that may travel long distances.

Debris torrent – similar to debris flow and sometimes used interchangeably, it often indicates a larger amount of material and greater velocity as it moves downstream.

Disaster Financial Assistance – a provincial program to help disaster victims cope with the cost of repairs and recovery from disaster-related "uninsurable" damage to property (as well as contents, personal effects, equipment etc.) The Ministry of Public Safety and Solicitor General administers the Disaster Financial Assistance (DFA) program through the Provincial Emergency Program. Disaster Financial Assistance is available to help victims of a disaster with the cost of essential losses that can't be covered by insurance or other programs. These funds may be available to replace or restore items essential to a home, livelihood or

community service. Other items such as recreational or seasonal residences, luxury goods, and recreational items are not covered by the program (See http://www.pep.bc.ca/dfa_claims/dfa.html).

Discharge – the volume of water transported by a river or stream in a certain amount of time.

Erosion – progressive loss of stream bank material by processes associated with moving water.

Fetch – 1) the distance over which the wind can blow unobstructed by land before reaching the observer; or 2) the distance which the effect of seas can travel unobstructed by land before reaching the observer.

Floodway - The channel of the watercourse and those portions of the flood plains that are reasonably required to discharge the flood flow of a Designated Flood. A minimum required floodway shall be equal to the width of the channel within the natural boundary plus a minimum setback of thirty metres from the natural boundary on each side of the channel or channels unless otherwise approved. [From Guidelines] The floodway must be kept open so that floods can proceed downstream and not be obstructed or diverted onto other properties.

Geology – the science and study of the Earth, its composition, structure, physical properties, history, and the processes that shape it.

Geomorphology – the study of landforms, including their origin and evolution, and the processes that shape them.

Geotechnical – work relating to soil mechanics, foundation engineering, rock mechanics, engineering geology, hydrogeology and materials testing.

Hydrology – the scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Littoral Drift or Longshore Drift – the process by which a current moves sediments along a surf zone. Longshore drift typically consists of sand, gravel, shell fragments, and pebbles.

Meander - a loop-like bend in a stream or river that develops when a watercourse flows through level land and erodes its floodplain.

Meandering channels form where streams are flowing over a relatively flat landscape with a broad floodplain. Technically, a stream is said to be meandering when the ratio of actual channel length to the straight line distance between two points on the stream channel is greater than 1.5. Channels in these streams are characteristically U-shaped and actively migrate over the extensive floodplain.

Natural Boundary - The visible high watermark of any lake, river, stream or other body of water where the presence and action of the water are so common and usual and so long continued in all ordinary years as to mark upon the soil of the bed of the lake, river, stream or other body of water a character distinct from that of the banks thereof, in respect to vegetation, as well as in respect to the nature of the soil itself (*Land Act,* section 1). For coastal areas, the natural boundary shall include the natural limit of permanent terrestrial vegetation. In addition, the natural boundary includes the best estimate of the edge of dormant or old side channels and marsh areas. [From Guidelines]

BC Land Surveyors are authorized to determine the location of a natural boundary. The natural boundary is often used as a reference point for setbacks from a watercourse.

Non-cohesive bank material – typically unconsolidated cobble, gravel and sand susceptible to erosion and displacement by a stream.

Protective works – may be a wall, rock riprap, dike, or other structural means which confines a watercourse to its existing channel and thus limits erosion.

Setback – A withdrawal of a building or landfill from the natural boundary or other reference line to maintain a floodway and to allow for potential land erosion. [From Guidelines] Such requirements are often placed in covenants registered on the title.

Back

Appendix B Legal Matters

1. Legal Authority

Where does the legal authority to require building setbacks related to erosion come from in British Columbia?

- Building inspector – building permit, and covenant
  Section 56, *Community Charter*
  http://www.qp.gov.bc.ca/statreg/stat/C/03026_03.htm#section56

- Land use decision-maker – Crown land disposition
  Section 11, *Land Act*
  http://www.qp.gov.bc.ca/statreg/stat/L/96245_01.htm#section11

- Approving officer, whether on behalf of a municipality or Ministry of Transportation – land subdivision, and covenant
  Section 86 (1) (c) (v) and 86 (1) (d) of the *Land Title Act*
  http://www.qp.gov.bc.ca/statreg/stat/L/96250_07.htm#section86

- Local government – floodplain bylaws and development permits
  Sections 910, 919.1 and 920 of the *Local Government Act*
  http://www.qp.gov.bc.ca/statreg/stat/L/96323_26.htm#section910
  http://www.qp.gov.bc.ca/statreg/stat/L/96323_26.htm#section919.1

2. The Role of Covenants

A covenant is a legal document usually attached to a land title registration which contains provisions restricting or otherwise respecting the use of land, or the use of a building on or to be erected on the land, for reasons cited in the covenant.

- See Section 219 of the *Land Title Act* regarding registration of covenants:
  http://www.qp.gov.bc.ca/statreg/stat/L/96250_14.htm#section219

- See Sections 1.5 and 1.6 of Flood Hazard Area Land Use Management Guidelines regarding covenant measures
  http://www.env.gov.bc.ca/wat/flood/pdfs_word/guidelines.pdf

- See Appendix B of Flood Hazard Area Land Use Management Guidelines for standard forms including covenants
  http://www.env.gov.bc.ca/wat/flood/pdfs_word/guidelines.pdf

3. The Provincial Guidelines and Guidance Documents

- For guidance on **erosion setback requirements** see the Provincial Guidelines
  Flood Hazard Land Use Management Guidelines

- For guidance on the **selection of engineering professionals** in BC and **hazard assessment guidelines**, including for erosion, see
  Guidance for Selection of Qualified Professionals and Preparation of Flood Hazard Assessment Reports

Back

Appendix C Other Technical Resources and Examples

1. For a good discussion of **erosion hazards:**

- Section 7.2 in the Ontario Ministry of Natural Resources publication, Understanding Natural Hazards (although the regulatory requirements are not the same as BC).
  http://www.mnr.gov.on.ca/mnr/water/publications/nat_haz2.pdf

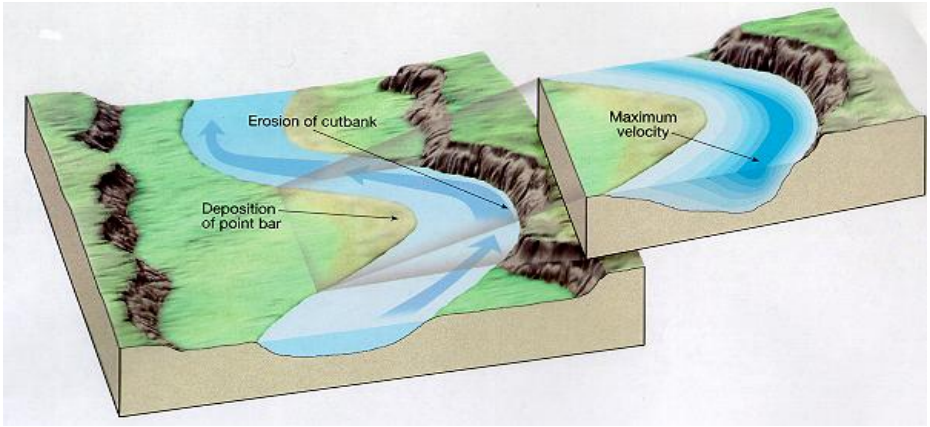
Similarly, the same publication describes a general process for working through an **assessment** of erosion and similar hazards:

- Section 9.3
  http://www.mnr.gov.on.ca/mnr/water/publications/nat_haz2.pdf

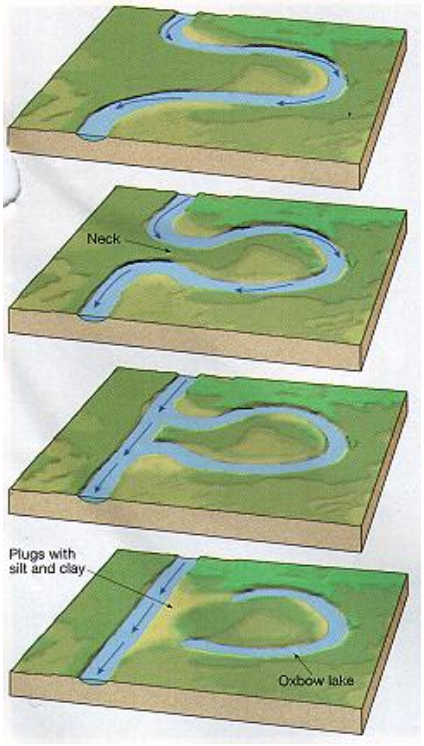
- The first chapters of this publication, sections 1 – 6, are available at
  http://www.mnr.gov.on.ca/MNR/pubs/nat_haz1.pdf

2. For information on **channel migration** see the 2006 King County Flood Hazard Management Plan (Washington State) at http://dnr.metrokc.gov/wlr/flood/fhrpupdate.htm

3. Illustrations of **erosion and meander**:



Source:
http://courses.missouristate.edu/ejm893f/creative/glg110/streams.html#page219



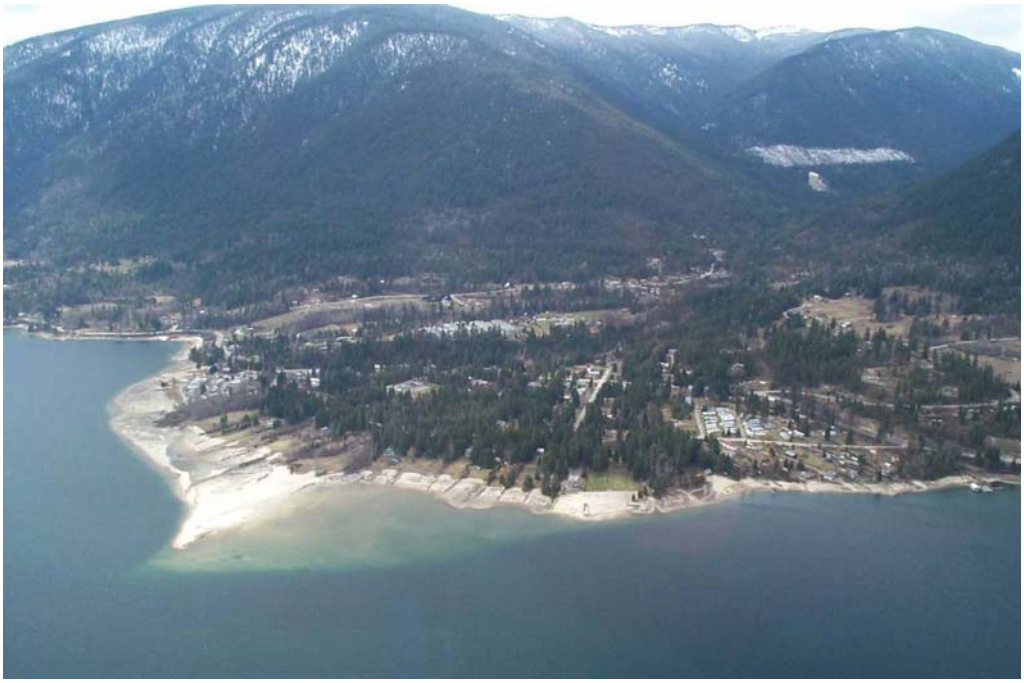
4. Braided streams

Sparwood

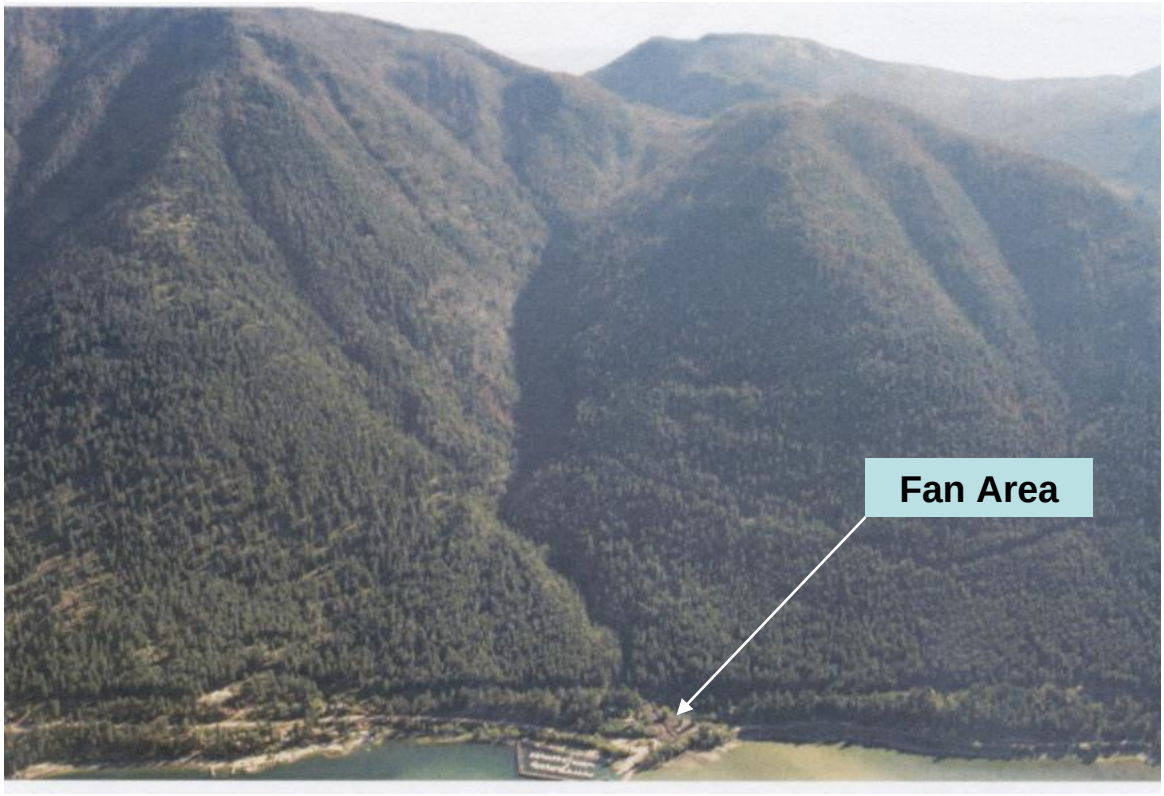
Chilliwack River

5. Alluvial fans

Campbell Creek



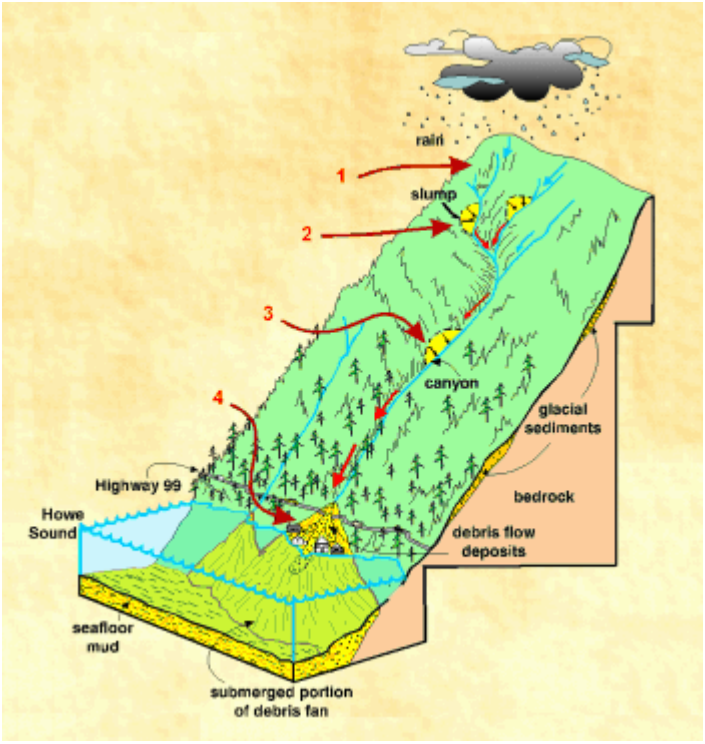
Duhamel Creek



Kuskonook Creek

Kuskonook Creek

6. Debris flow schematic

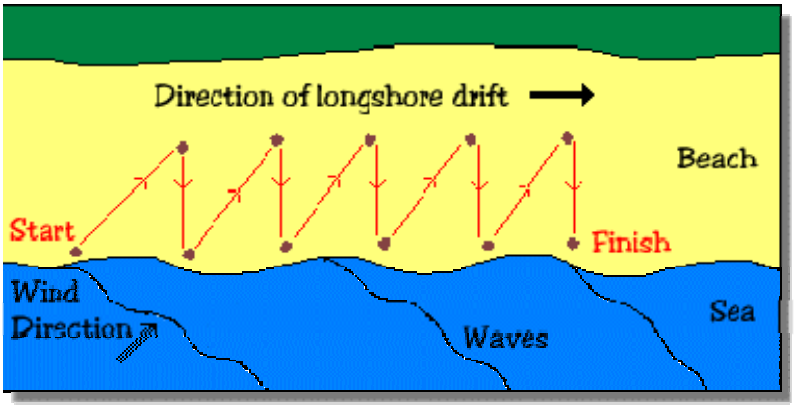


Debris flows are common in our coastal mountains because heavy rains fall on steep slopes mantled by loose sediments. Highway 99 between Horseshoe Bay and Britannia has a history of destructive debris flows.

1. Torrential rainfall swells streams along the mountain crest.
2. Sediment slumps into a raging stream, forming a slurry (debris flow) that surges down the channel.
3. The debris flow swells in volume as it picks up additional sediment and trees from the channel and canyon walls.
4. The debris flow emerges from the canyon onto a fan where it damages houses, roads, bridges, and a rail line.

Source, Geological Survey of Canada at http://geoscape.nrcan.gc.ca/vancouver/seasea_e.php

7. Littoral Drift or Longshore Drift Diagram

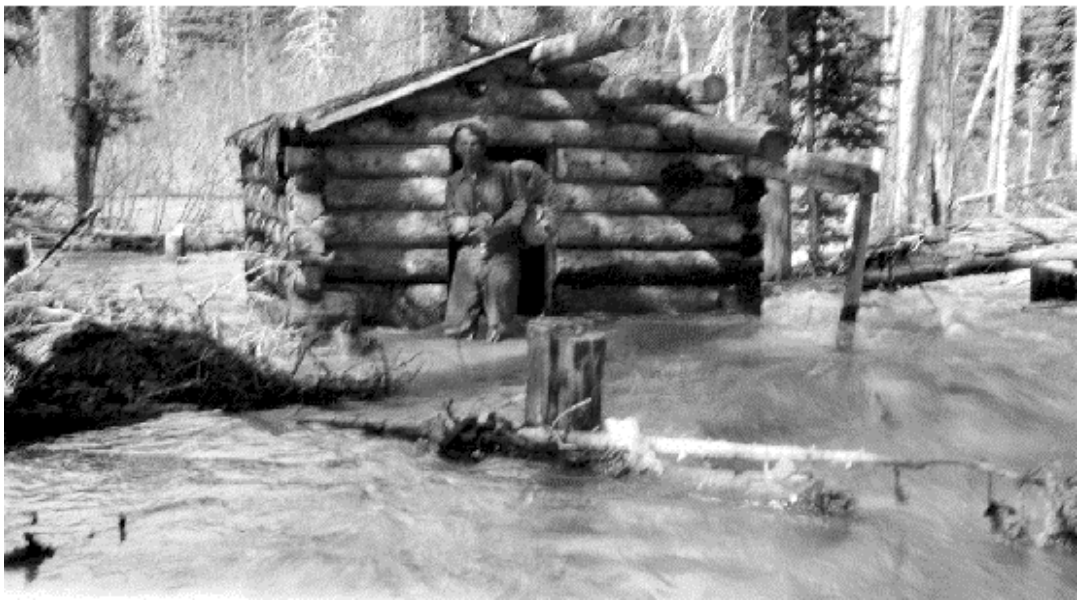


Source http://www.georesources.co.uk/leld.htm

See longshore drift animation

8. Examples of **erosion and flooding** (and why setbacks are a good idea) in BC:

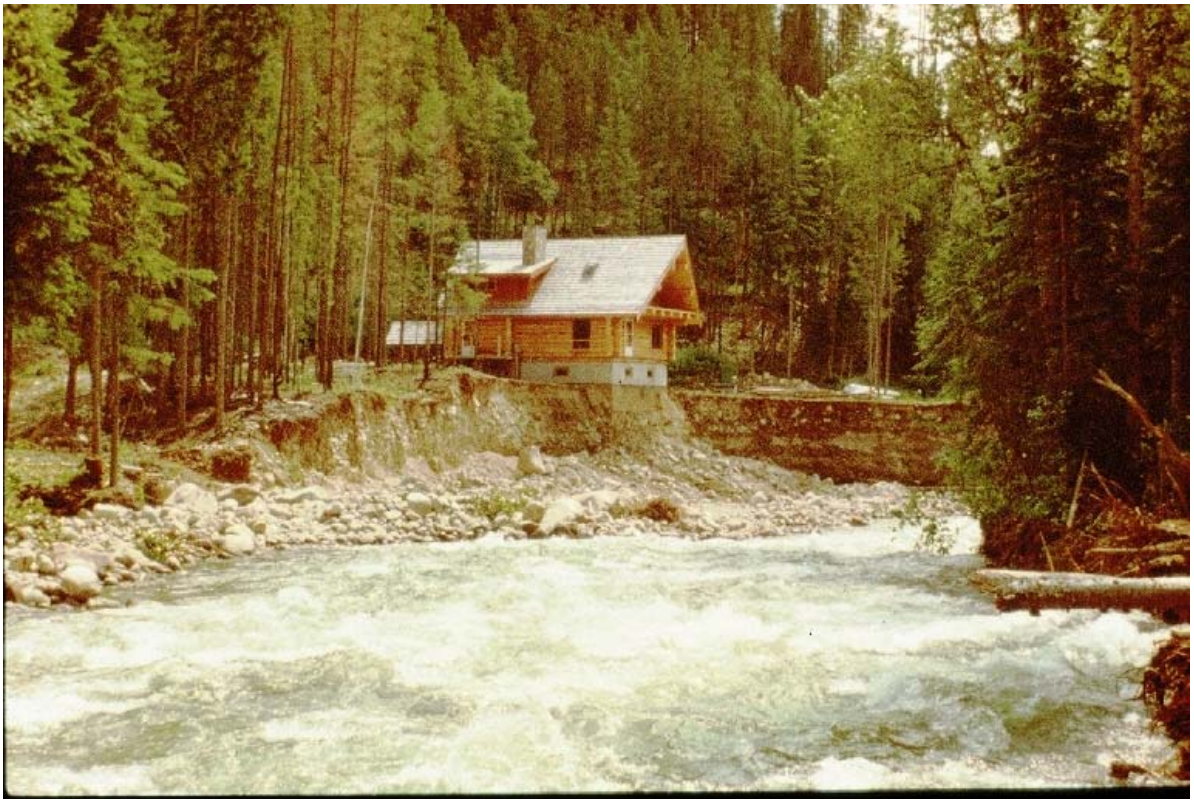
(Black and white photos courtesy of BC Archives, all others Ministry of Environment)



Morice River, 1927

Skeena River at Terrace, 1936

Sandon, 1955



Swift Creek at Valemount, 1984

Chilliwack River Valley, 1989

Stone Creek, 1990

Coquihalla River at Hope, 1990s

Back to top of document