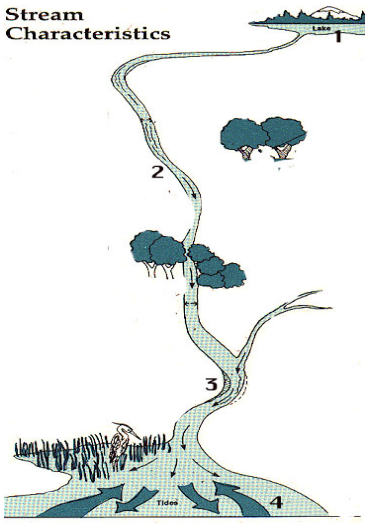
Topic 3 – Fresh Water Systems (pgs. 390 – 409)

Freshwater systems exist above ground as **surface water** and below ground as **groundwater.**
Water exists in all three forms on the Earth: solid, liquid and gas. It is found underground, on the surface and in the air. Water affects living and non-living things within the Earth's environments.

Lakes, Ponds and Wetlands

A **lake** and a **pond** are holes in the ground filled with water. A lake is deeper than a pond and sunlight does not reach the bottom, whereas in a pond sunlight will penetrate right through to the bottom, depending on the **clarity** of the water. The clarity is determined by the amount of suspended solids in the water. In lowland areas, **wetlands** exist. They are saturated with water most of the time. Wetlands provide habitat for a vast diversity of living organisms.

Streams and Rivers



Streams and rivers are fast flowing waterways and vary in speed, temperature, clarity, the nature of their banks and their bottoms. Rivers and streams that flow quickly are usually rich in oxygen.

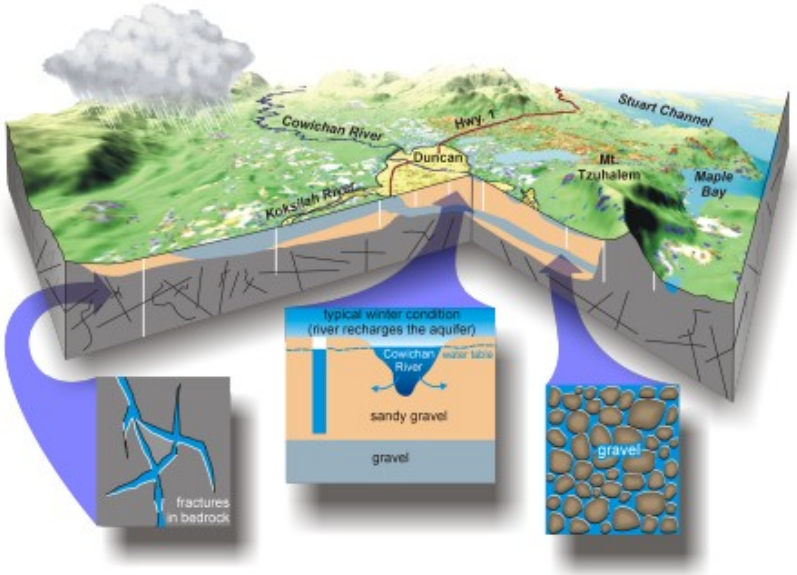
A **stream profile** is a description of its characteristics, including flow rate, steepness of stream's bed, and erosion rate of its banks.

The source of a river may be high in the mountains, where a glacier is melting. As small streams form together into one channel, the volume and speed of the river grows. In the early stages, the river is flowing very quickly and usually fairly straight. As the river reaches lower elevations it begins to slow, causing curves to form (***meanders***), until it reaches a fairly flat flood plain and the sediment it has picked up is deposited in a fan-shaped deposit called a **delta**.

Topography Website:
http://education.sdsc.edu/optiputer/teachers/shapingtopography.html

Water Underground

Groundwater is found below the surface in small pores between rocks and soil.



Freshwater links: The Watershed Concept

A **watershed** is all the area of land that drains into one main body of water. It can contain many smaller streams, rivers and even lakes, which all eventually drain into a larger lake, sea or ocean. The location of the highest land on the continent determines the direction that a watershed drains.

This high land is called the **Continental Divide.**

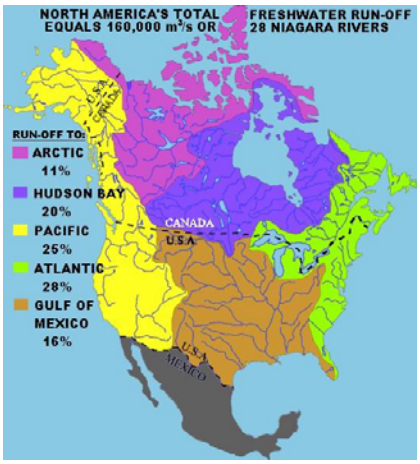
In North America it is in the **Rocky Mountains**.

On the west side of the divide, the rivers all flow into the Pacific Ocean. On the East side of the divide, the rivers flow into either the Arctic Ocean or the Atlantic Ocean.

A **watershed** (also called a drainage basin) is a region of interconnected rivers and streams.

Streams and Drainage Systems:
http://www.tulane.edu/~sanelson/geol111/streams.htm

Watersheds In Canada
Canada has **9%** of the world's freshwater.



The upstream areas of a watershed are called **headwaters** and the end point is called the **outflow,** usually at the mouth of a river.

A **reservoir** is an artificial lake.
It is used for storage and management, because many of the larger populated centers in Alberta are far from major river systems.

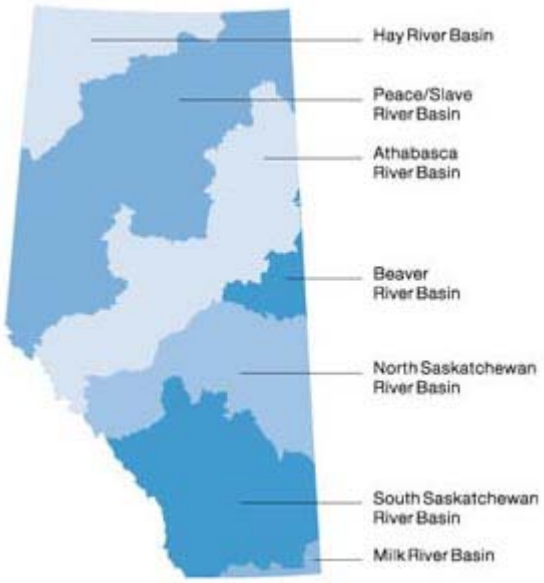
Watersheds In Alberta

There are 7 major watersheds, or river basins, in **Alberta**.

Peace/Slave River Basin
Athabasca River Basin
Hay River Basin
(flows into the **Arctic Ocean**)

Beaver River Basin
North Saskatchewan River Basin
South Saskatchewan River Basin
(flows into the **Hudson's Bay**)

Milk River Basin
(flows into the **Gulf of Mexico**)



Watersheds and Land Use

Storm drains in a city act as a watershed to remove water from the streets after a heavy rainfall. The paved roadways change the run-off patterns in a city, because the water would normally seep into the ground. Logging can also affect watersheds. GIS (Geographic Information Systems) are used to store data and generate maps showing a river's watershed, allowing them to predict what would happen if run-off patterns changed. The amount of water discharged by a watershed is influenced by soil conditions, vegetation, and human activity.

Run-off and Erosion

Moving water is a powerful force. When water wears away rock the fragments are carried as sediment and deposited elsewhere. A river's **sediment-load** is the amount of water-borne materials (rock, soil, organic matter) it carries. The faster the river flows, the more water-borne materials it can carry. Factors that can affect the amount of sediment-load are vegetation, steepness the geological characteristics of the banks and bottom.

Deposition

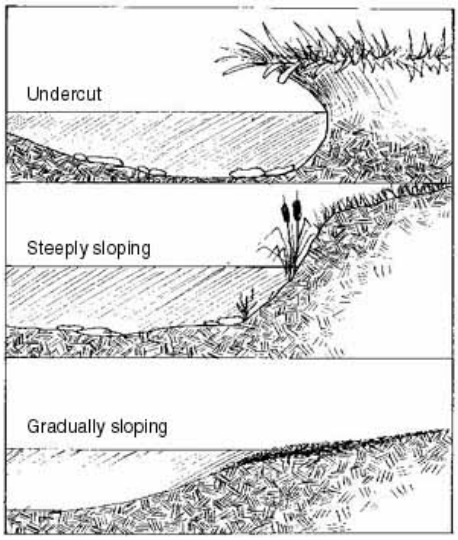
As a river slows water-borne materials are deposited as **sediment.**
(Review - **Stream Characteristics**)
The volume and speed of water in a river determines how the landscape can be shaped and changed.

River Flow Monitoring

Streamflow is the amount of water (volume) that flows past a certain point over a period of time (velocity). Watershed managers measure this streamflow over a period of years to calculate the average.

This is important because it helps scientists analyze water quality and predict flooding, drought conditions and design water control projects (such as irrigation or drainage projects).

The greater the river's rate of flow the higher the sediment load it has. Sediment is classified as suspended, rolling or bouncing or stationary.



Why Is Monitoring Sediment Important

Sediment monitoring plays a major role in understanding and determining the movement of toxic substances in the water. By studying the quantity, quality and characteristics of sediment, scientists can determine the sources of pollutants and measure their impact on the aquatic environment.

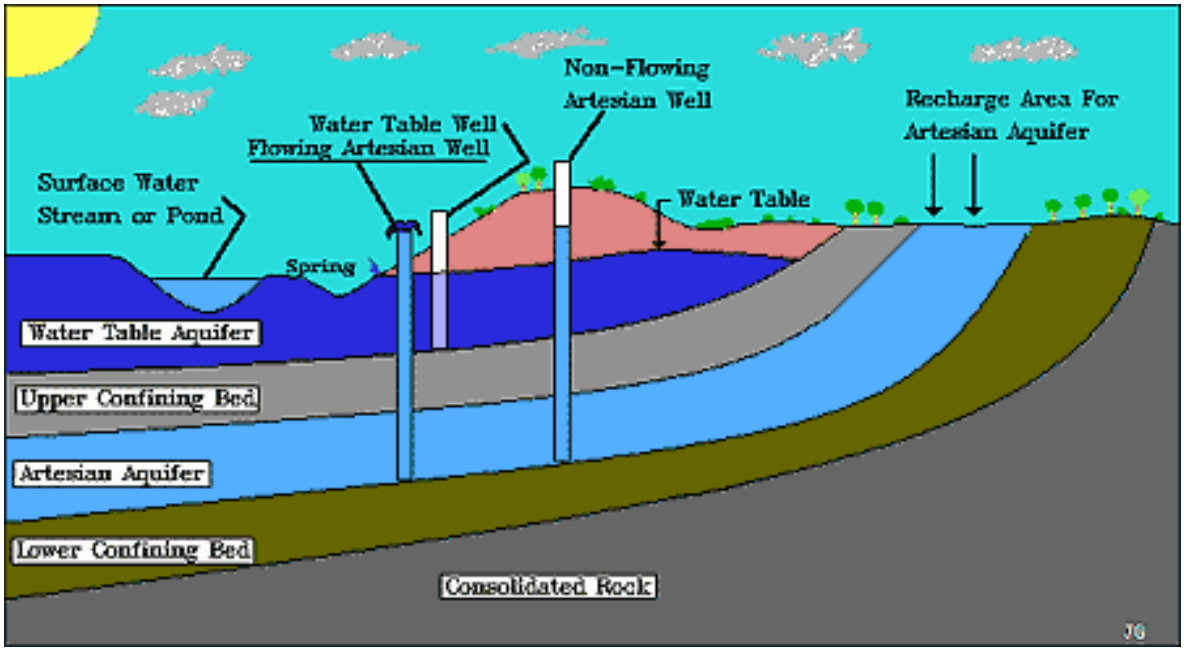
- Pollutants released into fish habitats can cause abnormalities or death in fish
- Farming practices can increase the sediment-load of a stream and add sediment-borne chemicals to the waterway
- Deposition of sediment can decrease water depth, making navigation more difficult
- Sediment can affect the delivery of water, by wearing out pumps and turbines

Sediment can carry harmful toxins far from their source and change the landscape quite dramatically.

Reducing Erosion and Stream Sediment Load

Sediment from construction can be prevented from entering the waterways by setting up a **de-sedimentation site**. **Dredging** can remove sediment from the river bottom, so the river can flow more easily. Restoring an eroded river can be achieved by planting **native vegetation** along its banks, reinforce the banks with **logs**, or rock baskets - **rip-rap** - that could include discarded concrete and boulders. **Deflector Logs, Log Dams and Digger logs** ((which force the water down, carving a deeper channel) are also used. **Wetlands** store excess water and slow the rate of run-off. They also trap and neutralize harmful chemicals in run-off.

Watershed Management and Groundwater



A groundwater system is similar to a river system. Connecting pores in rocks and soil enable the water to seep through – making it **permeable**. This is called an **aquifer**. When the water reaches the bedrock, which is **impermeable**. The layer of porous rock, in which the connecting pores are full of water, forms the **water table**.

Wells and Springs

As the illustration shows above, wells are dug to reach the aquifer, below the water table. If too many wells are dug too close to each other, they may deplete the aquifer and the wells will dry up. If the water in an aquifer flows naturally to the surface, it is called a **spring**. Hot springs occur when this water is heated by rocks that come into contact with molten material below the Earth's surface.

(Banff Hot Springs)

Aquifer Depletion

Underground aquifers supply water to many cities, farming communities and industries. If too much is used, the aquifer can become depleted, drying up creeks, springs and wells for many kilometres. Responsible use of water is essential in order to sustain this natural resource.

Groundwater Contamination

Contaminants in groundwater can spread the effects of dumps and spills far beyond the **point source**. **Non-point sources** are those where a pollutant comes from a wide area (run-off from agricultural land is an example). **Hydro-geologists** are scientists who study groundwater by drilling **test wells** to determine groundwater availability, movement, quantity and quality.

Too Little Water

When there is too little water, (like in Southern Alberta) management projects, such as **irrigation** help to maintain a constant supply of water for agricultural purposes.

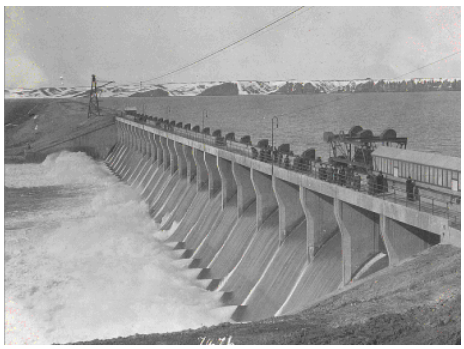
The Western Irrigation District supplies water to farmers, ranchers, acreage owners and industries through a complex system of **irrigation canals**.

There are *four major types of irrigation* used in Southern Alberta. **Flood irrigation** is still used somewhat by farmers in the sugar beet industry, but is not widely used in other types of crop production. In flood irrigation, the canals near a farm are opened up onto a field, where the field is thus flooded with a few inches of water. Modern irrigation uses pipes and sprinkler systems. Water is pumped from a canal into a series of pipes, and is distributed by sprinklers. There are *three major types of sprinkler irrigation* used in Southern Alberta. The first is the ***hand move pipes***, where farmers have to periodically move pipes from one site of irrigation to another, in a regular fashion as not to over irrigate a section of farm. The second type is ***wheel move irrigation*** where the pipe and sprinkler system is attached to wheels where a motor drives the piping system forward over a field. The third system gaining world popularity with farmers is ***pivot irrigation***. Like wheel move irrigation, there is a system of pipes and sprinklers which are then mounted on wheels with a motor(s), moving in a circular or pivotal fashion much like the hands of a clock. Pivot irrigation is advantageous because it allows the system to continually irrigate without the need to control how far it will go in one direction.

Irrigation canals also provide storm water removal systems and municipal water for several towns.

Too Much Water

When a river system has too much water in it, **flooding** may occur. The likely place for this to occur is in the part of the river called the **flood plain**. Dams are used to control the flow of a river for many purposes, to generate hydro-electricity, reduce flooding and provide irrigation. Many environmental considerations go into the building of a dam. The environmental standards are designed to protect the rivers, streams and their habitats. The controlled flow of a river can provide flood relief, but can also reduce diversity of aquatic organisms, because less oxygen may be dissolved in the slower moving stretches of the river.



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