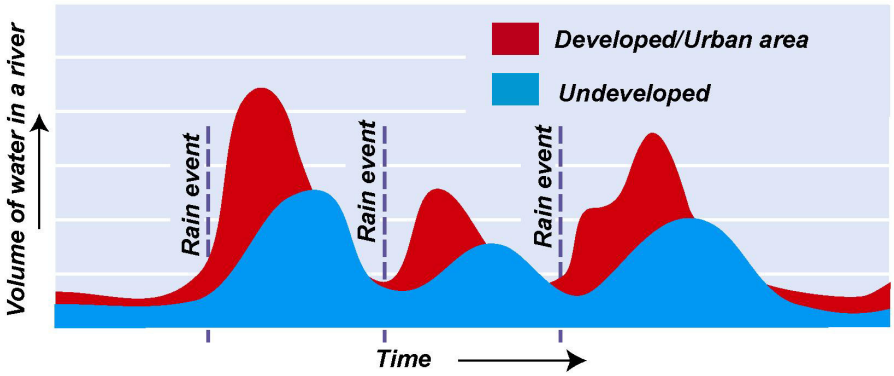
Rivers and Valley Lands

Over the last 10,000 years, rainwater and snowmelt from higher land, like the Niagara **Escarpment**, the Oak Ridges **Moraine**, and also from the Lake Iroquois shoreline, flowed by gravity to lower lands and eventually lead to lakes. The natural process of **erosion**, influenced by factors such as: slope, plant cover, soil type, sediment cover, bedrock, and water flow, determined the pathway the water followed and shaped the **valleys** we see today. The steep-sided valleys occurring along the **rivers** such as the Rouge and the Don provide stunning examples of how powerful the process of erosion can be over time.

Many of the **watersheds** in the Greater Toronto Area (GTA) receive their **headwaters** on the Oak Ridges Moraine. The remainder originate from the Niagara Escarpment or the Lake Iroquois shoreline. River valleys are the natural water collection systems for a watershed. A watershed is all the land that is drained by a river and its **tributaries**. The boundary of a watershed is determined by the surface **topography** and follows the height of land where water drains to one watershed or another. In some cases, it may move into another watershed once it gets underground, in other words, surface watersheds and ground watersheds are not always the same.

The constant movement of water, between water bodies, on land, and within the **atmosphere** is known as the **hydrologic cycle**. Water **evaporates** from lakes, oceans, and land. It also moves from plants into the atmosphere by a process called **transpiration**. Moisture returns to the Earth as **precipitation** (rain, snow, **hail, sleet**). Some water evaporates again during this process, but most reaches the ground and travels overland to streams and rivers, or soaks into the ground to become **groundwater**. The top of the surface of groundwater in the saturated part of the subsurface is called the water table. Over time, groundwater moves laterally and reappears on the surface as **springs** and **seeps** to supply headwater tributaries and then proceed further down stream. In the case of groundwater, it can take tens to thousands of years for water infiltrating into a highland, like the Oak Ridges Moraine, to find its way into a nearby or distant stream. It is groundwater reappearing at the surface that provides year round **base flow** to the streams of the GTA. Without this base flow, many streams would dry up during the summer. Base flow is relatively constant. Waters emerging from the ground are typically cold, having been underground for so long. Groundwater-fed streams and rivers provide an ideal habitat for fish species like brook trout, rainbow trout and salmon to lay their eggs and hatch their young.

Urbanization has altered the natural hydrologic cycle due to increased amounts of hard, impermeable, surfaces such as buildings, pavement and roof tops. These surfaces reduce the amount of water that would otherwise soak into the ground and increase the amount of surface run-off draining into streams and rivers during rain storms and the spring snow melt. Surface run-off flows into storm drains in urbanized areas. Storm drains are the entrance to a network of underground pipes, called storm sewers that collect run-off from city streets and transport it to local rivers. Storm sewers increase the amount of stormwater being conveyed to rivers over a short period of time. This causes stream banks to erode rapidly and promotes **flooding**.



This graph compares the time it takes for the volume of water to increase in a river after a rain event, in both developed and undeveloped areas. Before a rain event, the volume of water in the river is fairly constant over time. After a rain event, the volume of water in a river in a developed area is not only greater the then undeveloped area, the volume of water actually increases more rapidly. If the river cannot accommodate the rapid influx of water, stream banks will erode rapidly and flooding could occur.

Stormwater does not go to a treatment plant for cleaning. When rain washes urban environments such as buildings, yards, streets, sidewalks, and parking lots, it picks up contaminants and soil from the surface. Some of the most common contaminants in urban surface run-off are from cars: motor oil, antifreeze, heavy metals from brake linings, and particles from auto exhaust. The fertilizers, pesticides and pet wastes from yards also contaminate run-off. The quality of run-off is worst during "first flush" storm events. First flush events occur each year when the first rainstorms wash the accumulated pollutants off the surfaces where they have built up since the last rainfall. Soil erosion adds enormous volumes of soil to streams as **sediment**. The sediment comes from construction, roadsides and stream banks. Contaminates and too much sediment can destroy stream habitat and threaten the health of aquatic life.

New urban developments in the GTA have been designed to divert stormwater into stormwater ponds before being released into rivers. Stormwater ponds hold the run-off to allow time for some of the particles of sediment and heavy metals to settle out of the water and sink to the bottom. Other approaches to solving problems associated with urban stormwater include preserving or restoring wetlands along stream corridors to naturally filter out sediment and other contaminants.

The natural processes of flooding and erosion, which carved the valley lands, are ongoing and are now recognized as potential natural hazards. To avoid loss of life and property damage, these natural processes must be taken into consideration prior to building houses and structures in the vicinity of valleys. Flooding and erosion cause rivers to alter their course as they seek out the path of least resistance. The flow of rivers within a valley can lead to **meandering**. Rivers can also flood beyond their banks. Historically, "engineered" rivers and streams were piped, channelled and/or straightened to prevent meandering and flooding. These developments are expensive, require constant maintenance, and in many cases disrupt or destroy stream ecology. Today such engineering approaches are being reconsidered for economic and ecological reasons. Developers and environmental groups now rely on numerous studies on flooding and meandering when they engage in development in the vicinity of **floodplains**. This renewed approach allows streams and rivers to take their natural courses.

Rivers and valley lands are used increasingly for recreational pursuits. They are now the subject of strong protection, management and ongoing restoration programs to help bring back their natural state. Understanding the geology and natural processes of our rivers will help us to refine approaches to manage urban storm water, improve fish habitat and make rivers and valley lands more accessible and usable by people.

Did you know?

Rivers and valley lands are important to our environment and communities because they have valuable functions such as:

- storing and conveying rain and melt water
- **discharging** and **recharging** groundwater
- providing habitat and migration routes for fish and other wildlife
- providing open spaces for public use and recreation
- providing transportation corridors and space for urban infrastructure, such as hydro lines

Rivers and Valley Lands

The Wonders of Watersheds

After you have finished reading the **Information Bulletin** *Rivers and Valley Lands* answer the following questions in your notebook.

1. How do watersheds form and how are the surface boundaries of a watershed defined?
2. How does the process of erosion shape river valleys?
3. If you had to determine the health of a river, what indicators would you measure? List at least three factors that you would consider important for a healthy river.
4. Watersheds such as the Humber, Don and Rouge Rivers have their headwaters on the Oak Ridges Moraine. These rivers flow south from the Oak Ridges Moraine into Lake Ontario. The Oak Ridges Moraine appears as the "height of land" north of Lake Ontario and forms the boundary between rivers flowing south into Lake Ontario and rivers flowing north into Lake Simcoe. Use the watershed map in the **Information Bulletin** and a coloured pencil to mark the location of the Oak Ridges Moraine.
5. Why is the hydrologic cycle so important?
6. Complete the attached diagram of *The Hydrologic Cycle* by filling in the blanks with the appropriate terms.
7. Write a paragraph describing how the development of land influences the hydrologic cycle and the environment within watersheds.
8. Use the grid sheet to design a new neighbourhood that can decrease the amount of urban stormwater run-off. The grid sheet represents the area of town that you will develop. The development is 1.6 square kilometres of grassy hills and trees. Each box (1 square centimeter) is equal to 10,000 square metres. Using this sheet you must design a new part of town using the guidelines below.

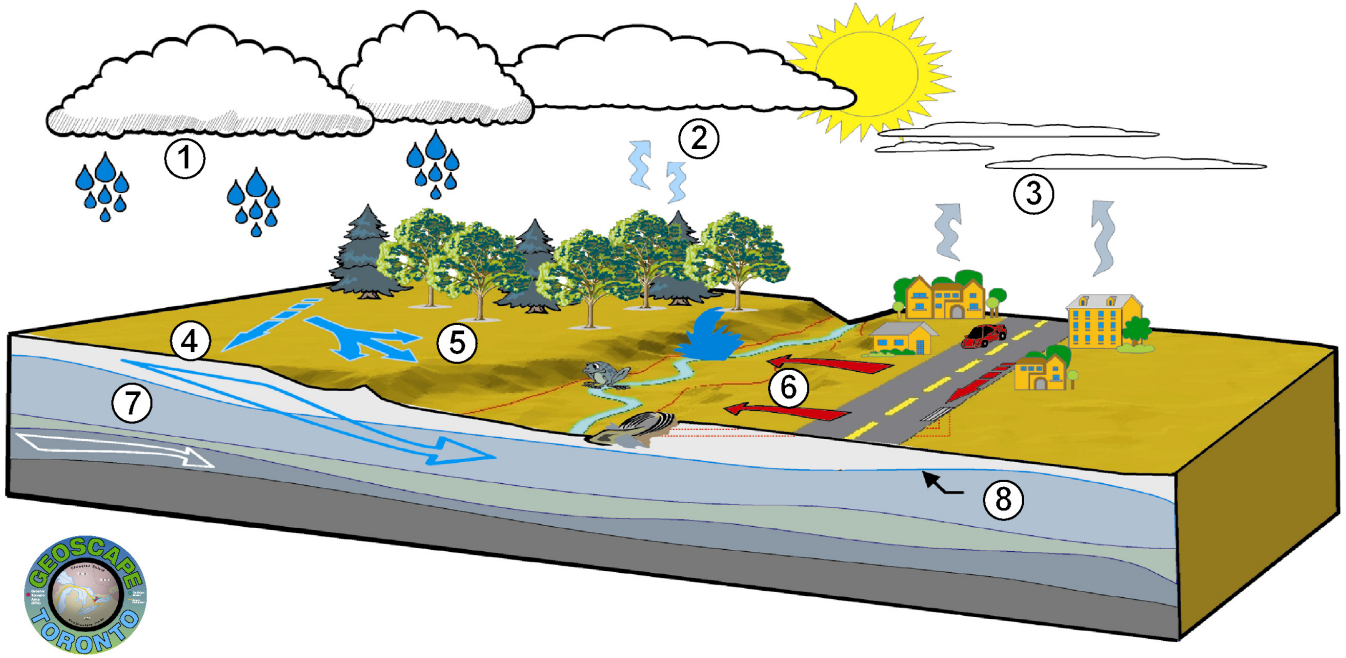
Guidelines for Designing a Neighbourhood to Manage Stormwater:

Feature	Number of Squares	Colour
Stream	Draw this first. Your stream must cross through at least 30 squares. Of these squares only 2 may be on the outer perimeter of the grid and you must include at least one of the four dotted-line squares in the centre. The width of the stream may vary.	Blue
Housing	36	Orange
Shopping mall parking lot	22	Red
Shopping mall buildings	8	Pink
Highway	The highway must cross through 12 squares and take up ¼ of each square it passes through.	Black
Stormwater ponds	Half a square for every six squares of development	Green

Start by drawing your stream and then plan how you will add the other features to the grid. See if you can keep at least one square between the stream and any of the other features. Buildings and pavement seal the surface of the watershed reducing the amount of water that can soak into the ground. This increases the amount of surface run-off draining into streams and rivers during rain storms. Review the chart entitled *Stormwater Management Features for Urban Planning*. Include stormwater management features in your grid that will slow down and filter the run-off from all paved surfaces before the run-off reaches the stream. In your notebook list which stormwater management features you have included in your design. Attach a symbol key for these elements.

Rivers and Valley Lands

The Hydrologic Cycle



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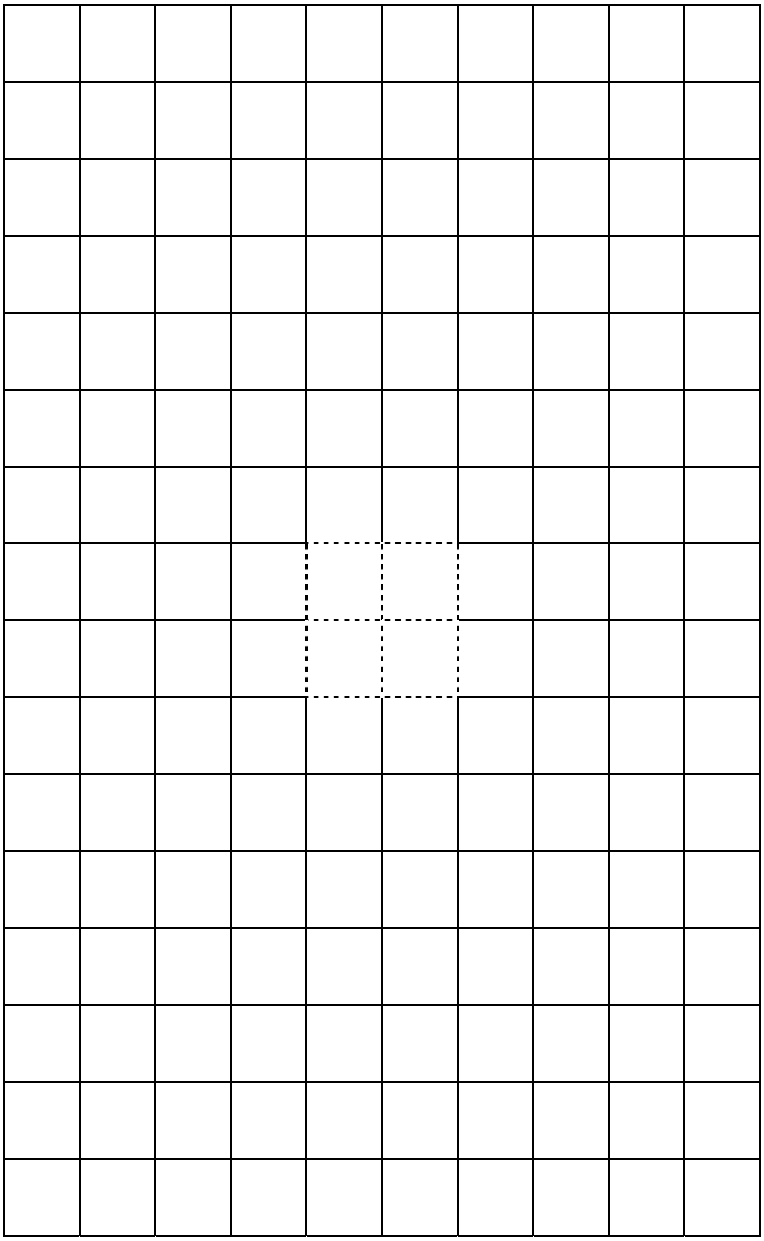
Design a Neighbourhood to Manage Stormwater



Rivers and Valley Lands

Stormwater Management Features for Urban Planning

Water Quality Goals	Stormwater Management Features
Reduce speed and volume of run-off	• Replace concrete with permeable surfaces such as gravel, grass, non-solid paving blocks, gardens and parks • Providing transportation corridors and space for urban infrastructure, such as hydro lines • Create homes that have downspouts that are disconnected from storm drains to allow water to soak into lawns
Reduce pollution from automobiles	• Develop clustered building patterns and leave open space • Connect homes with stores, schools and parks with sidewalks and bike paths • Locate frequented businesses close to homes (groceries, video stores, etc.)
Reduce sediment and pollutants attached to suspended particles	• Prevent erosion of soil by covering bare soil with vegetation • Slow the speed of run-off by transporting it through vegetated areas near roads and zones along creeks • Collect run-off and divert it to stormwater ponds to allow sediments and the attached pollutants to settle out • Install storm drain filters near construction sites to remove sediment
Filter pollutants and provide habitat	• Leave a wide buffer zone (100 metres) on each side of the steam • Grow plants in the buffer zone to slow run-off and filter out pollutants • Preserve or create wetland habitat to filter run-off
Reduce creek temperatures	• Replant trees along the creek to shade the water
Keep garbage out of creeks	• Provide garbage cans and "doggie bags" for pet owners • Face homes and businesses so the creek is not used as a backyard dump • Place trails along creeks to increase recreational use and visibility