Headwaters
The Ontario Headwaters Institute

Backgrounder on Watershed Management

What is a watershed?

A watershed is an area of land that drains to a body of receiving water, such as a river, lake, or ocean. The term watershed is somewhat elastic as it can be used to describe various scales, from Primary to Quaternary watersheds and beyond, while individual tributaries can be described by a variety of stream order classifications

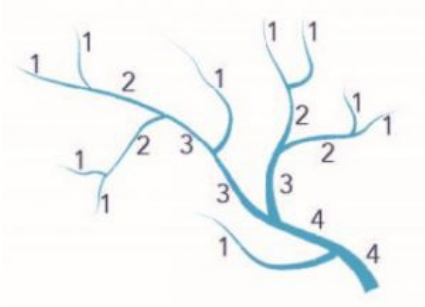
The five primary watersheds in Canada flow to the Pacific, Arctic, and Atlantic oceans, as well as to Hudson Bay and, little known to most people, the Gulf of Mexico. Our twenty-three secondary watersheds are made up of major "basins" flowing toward the primaries, such as the Frazer, Mackenzie, and Great Lakes-St Lawrence Basin.

Ontario's 23 secondary basins in turn consist of 145 tertiary watersheds, such as the Grand River watershed flowing to Lake Erie, the Credit River flowing to Lake Ontario, the Madawaska River flowing to the Ottawa River, and the Attawapiskat River flowing to James Bay. These tertiary watersheds are made of quaternary sub-watersheds, such as the 22 sub-watersheds of the Credit River or the 18 sub-watersheds of Lake Simcoe. A graphic description of all the above can be found in a Water and Watersheds powerpoint on our YouTube Channel.

While quaternary watersheds can be sub-divided into smaller tributary areas such as the West Credit River and even into individual catchments, this is a good point to describe stream order and headwaters.

Stream Order and the Importance of Headwaters

Stream order is another way to address the scale of watersheds, as it which assigns values to streams as they converge. In the Strahler stream order method, as per the drawing, a first-order stream, or reach, is one with no tributaries, while a second-order stream starts where two first-order streams converge, and so on. First and second-order streams can be ephemeral (where flow is based on precipitation) or intermittent (flowing when the water table rises).



It is worth noting that drainage area essentially doubles as stream order rises. Picture, for example, the network of tributaries needed to provide a second fourth-order stream to converge in the diagram to form a fifth-order stream.

Another way to address scale is to think about the size of the Amazon, the world's only 12th order stream. The final section of the Amazon is created by the confluence of two of the only three eleventh order streams in the world, with the other being the Nile. And there are only three tenth-order streams world-wide. One is completely in Canada, the Mackenzie, while, as alluded to above, Canada also hosts a fraction of the headwaters of a second: the Mississippi.

In general, first to third order streams are considered headwater streams; fourth to sixth are medium streams; and those above sixth order are considered large streams. It is important to understand, however, that headwater streams can occur anywhere in a watershed, and that small streams can flow to any other order stream, or lake, and not necessarily into the next order stream.

As with the term watershed, the term headwaters is used with some elasticity. For example, lakes upstream of where water levels are regulated, such as in the Trent-Severn system, are often referred to as headwater lakes, when in fact lakes are not assigned any orders.

Secondly, people often refer to headwaters as the upper reaches of many of South-central Ontario's watersheds, such as those in the Oak Ridges Moraine, as per the drawing below. While it is true that areas of the moraine can have a lot of small streams, these streams can merge quickly into 4th and 5th order streams due to the hilly topography. In such instances, people are referring more to the general elevation of the upper reaches of a watercourse compared to its mouth rather than describing an area made exclusively of 1st, 2nd, and 3rd order streams.

<u>What is Watershed Management</u>?

Watershed management is:
1. An inventory of the *characteristics* of a watershed;
2. An assessment of the *pressures* upon those characteristics; and,
3. The design and implementation of a watershed plan.

Characteristics tend to describe base-line conditions. Will water fall as rain or snow, due to climate and elevation? Is the area relatively flat or significantly sloped? Does the area have extensive forests or wetlands, with high retention rates or rapid run-off? Is the surficial geology impervious, expediting surface runoff, or is it porous, allowing infiltration to groundwater? Do streams have high or low levels of sediment, nutrients, and organic material? Do regional temperatures and other conditions result in the presence of cold, cool, or a warm-water fishery?

Clearly, characteristics are not focused solely on water but require a holistic view of both the watershed and its natural heritage. Characteristics also vary greatly across regions, as described more fully in the second of the powerpoints on our YouTube Channel, Watershed Characteristics.

Pressures are more short-term, arising mostly from human action, and can be felt either across huge areas, such as by acid rain or climate change, or be highly localized. Local pressures can result from aggregates & mining, agriculture, energy generation, forestry, housing, industrial & manufacturing activity, recreational use, and transportation & utility corridors.

Negative outcomes from pressures include losses of cultural and natural heritage; air, chemical, light, noise and water pollution, as well as greenhouse gas emissions; and changes in water quantity & availability, channel form, groundwater infiltration, sediment & nutrient distribution, and overall water quality, clarity, chemistry, and temperature.

Watershed plans are efforts to maintain or restore watershed health, and can be addressed by numerous levels of government and via public stewardship. In Canada, the federal government is responsible for transboundary and navigable waters, fisheries, and some chemicals and other pollutants, such as radionuclides, while the management of natural resources is largely a provincial responsibility.

<u>Water and Watershed Management in Ontario</u>

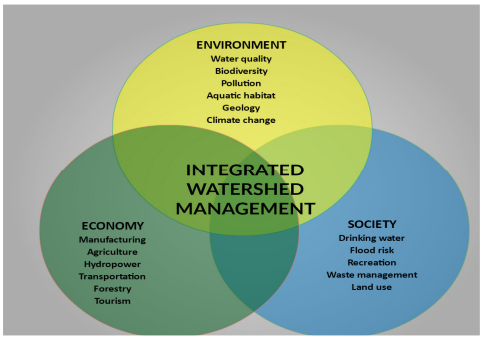
Ontario addresses water and watershed management at a number of levels, through provincial statutes, regulation, permits, and ministers orders. Primary responsibility is vested in various ministries through acts such as the Environmental Protection Act, the Great Lakes Protection Act & the Great Lakes Strategy, the Lakes and Rivers Improvement Act, the Nutrient Management Act, the Ontario Water Resources Act, the Safe Drinking Water Act, the Sustainable Water and Sewage Systems Act, and the Planning Act, its Provincial Policy Statement and the Growth Plan and its subsidiary plans.

In addition, various acts or other initiatives deliver water protection and watershed management in partnership with other levels of government. Examples include the establishment of provincial/regional/municipal partnerships under the Conservation Authorities Act; similar partnerships for source water protection under the Clean Water Act for action under the Lake Simcoe Protection Plan; the publications of guidelines for planning authorities, such as the Ontario Natural Heritage Reference Manual; and the management of a provincial water quality monitoring network and similar efforts.

Of all these efforts, the role of Conservation Authorities in watershed management across the more populated areas on Ontario stands out. Formed in the 1940's as a result of rampant deforestation and resulting droughts and flooding, although now under review, Conservation Authorities (CAs) function as a collaboration of provincial, regional, and municipal governments.

CA mandates include protecting people and property from natural hazards, commenting on and/or issuing permits on various land use plans, and developing watershed management plans. In pursuing their mandate, CAs deliver flood and drought planning and response with the Province; own hazard lands such as valley corridors that can flood; restore or create forests and wetlands; led the development of natural heritage system strategies, adaptive management, integrated watershed management, and low impact development planning in Ontario; facilitate regional Source Protection Authorities; and protect key landscapes in conservation areas.

In fact, driven by conservation authorities, watershed management has evolved in Ontario toward Integrated Watershed Management, as per the drawing from Conservation Ontario, which seeks to engage key government agencies, as well as the public and private sector, in a watershed framework to secure environmental, economic, and social wellbeing.



The Importance of Headwaters in Watershed Management

Even for watersheds in excellent health, headwaters:

- Drain the majority of the surface area of a watershed;
- Comprise the majority of stream length in a watershed;
- Contribute the majority of flow to most watercourses;
- Help regulate that flow to both surface and groundwater through natural cover, soil type, and geology, which impacts flooding, erosion, and water budgets for downstream areas;
- Furnish key habitat types for the breeding, feeding, and sheltering of upstream species. In fact, more species require headwaters at some point in their lives than any other type of habitat in Canada; and,
- Nurture downstream ecosystems by providing significant portions of a watershed's nutrients, organic material, and sediment, thereby providing the base of a watershed's biodiversity and resilience.

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- ***What are Headwaters?***
- ***Why are Headwaters Important? and***
- ***Headwaters of the Greater Golden Horseshoe***

Currently, in spite of the evolution of the progressive environmental policy regime described above, the lower sections of many watersheds in the more developed areas of the province can be characterized as having insufficient natural heritage and reduced hydrologic integrity. As a result, many headwater areas have become de facto reservoirs for regional forests, wetlands, niche habitats, and water quantity and quality.

In the future, our watersheds and headwaters will face growing and not dwindling pressures, from continuing development, a changing climate, and increases in invasive species. While some restoration of our downstream areas would be beneficial, that will be difficult to achieve.

As a result, the OHI believes it to be imperative that our headwater areas are better protected in the future than how we have managed our downstream areas in the past in order to better ensure Ontario's continued ecological, economic, and social wellbeing.