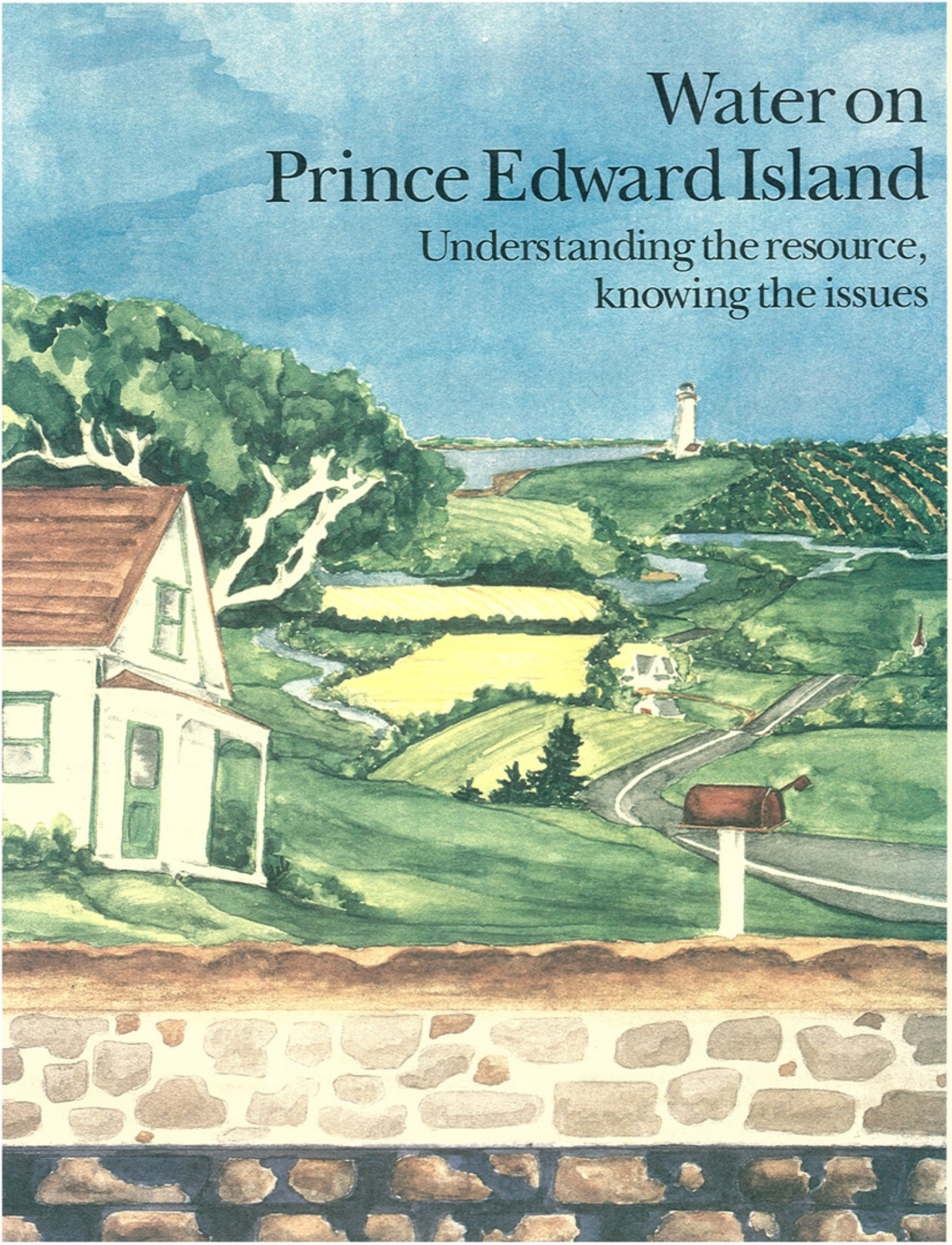
Water on Prince Edward Island

Understanding the resource, knowing the issues



Published by the Prince Edward Island Department of Fisheries and Environment,
and Environment Canada
under the Canada-Prince Edward Island Water Annex
to the Federal/Provincial Framework Agreement
for Environmental Cooperation in Atlantic Canada

4th printing October 2005

Prince Edward Island
CANADA
Fisheries and Environment

Environment Canada
Environnement Canada

Table of Contents

Why should Islanders care about water?

Prince Edward Island is blessed with an abundance of clean, cool water. We draw it up from the ground, use it, enjoy it - and there's always more. We have beautiful, freshwater streams - rich in fish and wildlife - and the waves of the salt Atlantic Ocean crash on our shores. We're never far from water on PEI.

If we are so blessed, why should we care about water?

We tend to think of PEI as different from other places. Other places have big cities, big industry and big pollution. We have small communities and farmland. Life is different here. Surely *our* water is safe.

But the truth is that there are threats to our water on PEI. Drinking-water wells can be contaminated. River habitats can be destroyed. It's important that we understand water and the vital part it plays in ecosystem health, so that we can keep it safe for ourselves and for future generations.

How do we go about taking care of our water? The first step is becoming informed. That is what this book is for. It's for anyone who wants to know more about water on PEI. It is meant to give you a general understanding of our water resources - ground, surface and coastal - as well as a look at the issues we face in improving and protecting Island water for future generations.

Water is life

Water brings our planet to life. From the tiniest insect to the tallest tree, all living things need water for survival. People must drink water to remain healthy. A person can survive without food for more than a month, but can live for just a few days without water.

Water is essential to all life, and to all "ecosystems". Ecosystems are communities of living organisms that depend on one another and where they live for food and shelter. On PEI, we have many kinds of ecosystems: there are natural ponds, woodlands of many types, streams, fresh water wetlands and bogs, salt marshes and estuaries, coastal sand dune complexes, beaches, cliffs, coastal waters, and offshore islands. Each depends on having enough of the right kind of water to survive and flourish.

But what is the right kind of water?

We tend to think of water as being either "clean" or "contaminated". But clean water is not the same as "pure" water. Nearly all natural water has some dissolved or suspended material in it, such as minerals, sediment and bacteria. And whether or not water is contaminated depends entirely on who or what is using that water. Many materials in water are actually essential to certain ecosystems. For instance, high concentrations of

salt are a necessary part of marine waters. But that same level of salt renders water undrinkable for people.

Water can be said to be "contaminated" only when the amounts of dissolved or suspended materials or chemical compounds are too high for the continued health of the ecosystem.

Water is wealth

Clean water and plenty of it is crucial to a strong economy on PEI. Commercial development in communities can only go ahead if there is abundant clean water. Many of PEI's industries, such as the shellfish industry, aquaculture, the commercial fishery, tourism, food processing, and farming all depend heavily on water-based resources.

For the shellfish and aquaculture industries, good quality water is absolutely essential to its production and sale of clams, mussels and oysters. The commercial fishery relies on our streams and estuaries to provide habitat for fish and shellfish. Tourism promotes our unspoiled watercourses to encourage people to visit our province. The food processing industry uses large quantities of groundwater for cleaning and cooking. And though farmers on PEI have traditionally relied on rainwater for crops, some use stream water or high-capacity wells for irrigation.

When we protect the health of our water, we protect the health of Islanders, our environment and our economy.

Who's in charge?

Under the Prince Edward Island Environmental Protection Act, the Minister of Fisheries and Environment is in charge of all beaches, sand dunes, and wetlands. This includes land under tidal water to five kilometres off shore.

The PEI minister is responsible for all surface water, groundwater and shore water, though in some cases there is joint control with the federal Department of Fisheries and Oceans or Environment Canada. Provincial control of PEI water includes water in streams that cross private property. Anyone wanting to make changes to any streams, or any other watercourse or wetland, must first apply to the Department of Fisheries and Environment for a "Watercourse Alteration Permit".

The department has guidelines and regulations designed to protect PEI's water resources. It uses environmental impact assessments to help ensure that new developments do not harm the sustainability of our water systems. It has also introduced *Stewardship and Sustainability: A Renewed Conservation Strategy for PEI*, which provides an overall vision for the environment of PEI.

The cycle of water

Water is always moving and changing form. It falls to the earth, flows across and under the earth and rises again into the air. It is taken up, used and then released by living organisms. As it moves, it changes form - from vapour to liquid to solid and back again. This continuous process of movement and change is called the "hydrologic cycle", or the water cycle. Here's how it works.

Precipitation

Gravity pulls rain, snow, sleet and hail down from clouds to the earth. This is called "precipitation". PEI gets about 1100 millimetres of precipitation annually, distributed fairly evenly throughout the year.

Evaporation and transpiration

A lot of precipitation returns directly to the air. It happens in two ways. The first process is called "evaporation". Energy from the sun heats water from the earth's surface, rivers and ocean and changes it into an invisible gas called water vapour. The second process is called "transpiration". Here, the sun's energy is used by growing plants that release water into the air as they take up food and water from the soil. Evaporation and transpiration are most active in the summer when temperatures are high and plant growth is vigorous. During the winter, their effect is very small. Between them, evaporation and transpiration send about 40% (440 millimetres) of PEI's annual precipitation back into the air.

Streamflow

The remaining 60% (660 millimetres) of PEI's precipitation remains earthbound, controlled by gravity which pulls the water downhill and underground.

Some of the water (about 300 millimetres) runs fairly directly overland into streams and ponds or directly into the ocean. This is called "surface runoff". On PEI, runoff tends to be highest during the spring. This is because much of the winter's precipitation is stored as snow. When the snow melts, it adds to the spring rainfall to make more surface runoff than Islanders see at other times of the year.

Surprisingly, the balance of PEI's streamflow comes from groundwater. About 360 millimetres of precipitation soaks into the earth each year and becomes groundwater. This mostly happens in the spring, again because of melting snow and because low temperatures limit the amount of water that returns to the air through evaporation and transpiration.

Groundwater is water that flows underground under the force of gravity until it discharges through seeps, springs and wetlands to streams, ponds and the ocean. Groundwater flows very slowly, and may not find its way to the ocean for years or even decades.

Together, this discharging groundwater and surface runoff make up "streamflow", the water we see in our streams. This streamflow will eventually reach the ocean.

Eventually, stream water reaches the ocean. The "fresh" stream water mixes with "salt" marine water, not at a fixed boundary but within an area that changes with the tide. Areas where this

mixing takes place are called "estuaries". A number of PEI rivers are estuaries for much of their length.

Streamflow that reaches the ocean eventually evaporates into water vapour again. As it rises into the air, it cools and "condenses" into tiny droplets of water. This evaporation and condensation cleans the water of most of its suspended and dissolved material. The cleaning process is the same one that scientists use to make pure water for use in laboratories. When the condensed droplets get heavy enough, they fall as precipitation and the water cycle begins anew.

The cycle is the same on PEI as it is everywhere, though the amounts and proportions differ from place to place. All types of water are linked. Rain water becomes groundwater, groundwater feeds our streams and rivers, and our rivers empty through coastal estuaries into the ocean. Water's constant movement through the hydrologic cycle makes it a self-renewing, and to some extent, a self-purifying resource.

Watersheds and water balance

Scientists can measure the movement and change of water through the water cycle. All land can be divided into areas called "watersheds". A watershed is the land that water flows over or under on its way to a given stream, river or lake. For example, the Winter River Basin, located northeast of Charlottetown is a watershed. All of the water on or under the basin flows to the Winter River. If it were to flow to another river, it would be in another watershed.

The knowledge that all water flowing through a watershed has a common destination gives us an important tool for maintaining our high quality of water on PEI. It allows us to see that all activities in the watershed, no matter how far from water they might be, can affect water quality. A farmer, for example, might think that because his land has no nearby streams that he need not be concerned about how his farming practices could affect water quality. But because we know that surface runoff and groundwater beneath his farm *will* find its way into streams, we must promote safe farming practices *throughout* the watershed.

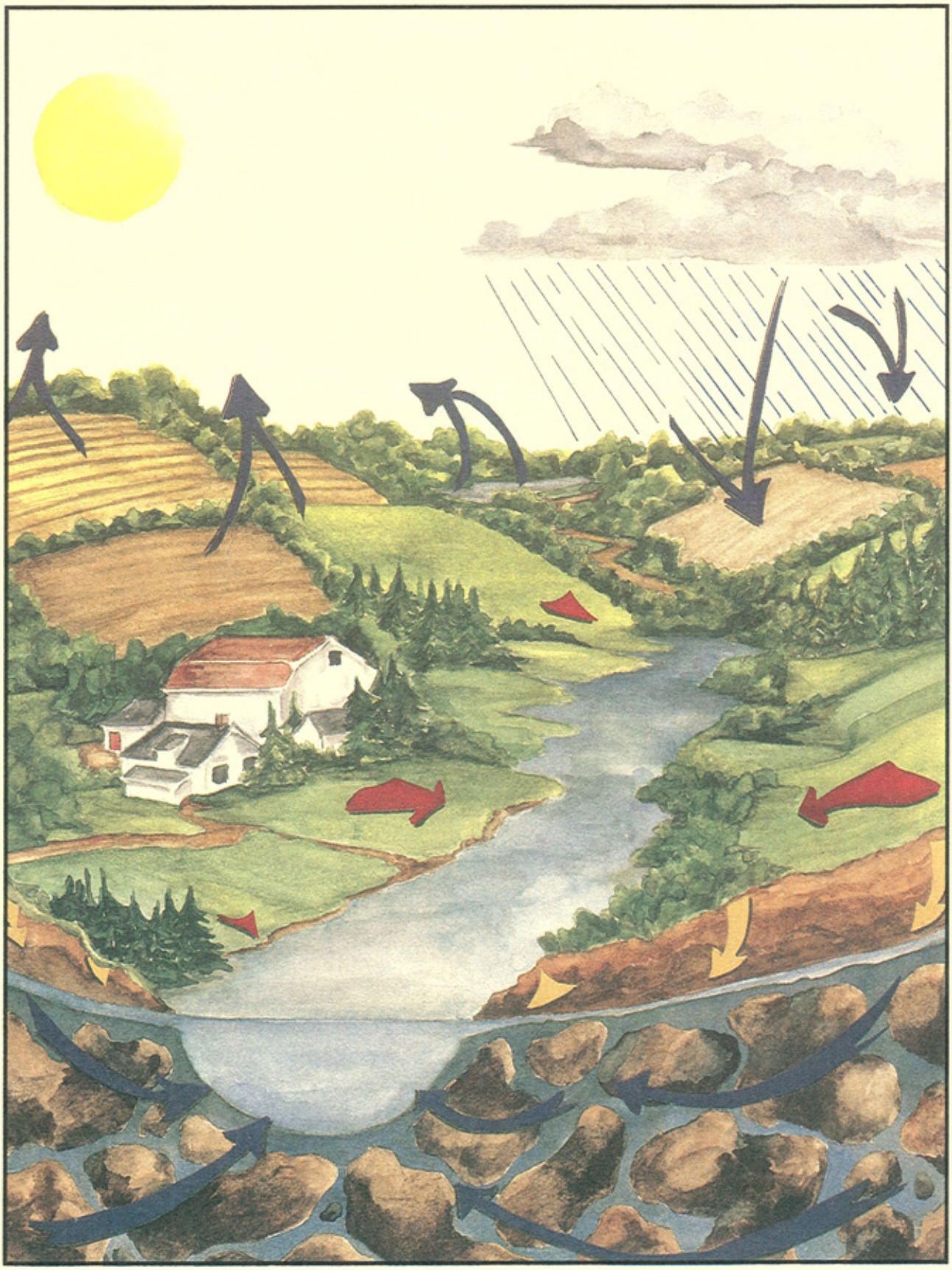
On an average PEI watershed, 1100 millimetres of rain falls in a year. Of that, 440 millimetres returns to the air through evaporation and transpiration and 660 becomes streamflow. Of that 660 millimetres, 300 millimetres becomes surface runoff, and 360 millimetres soaks into the ground to become groundwater. Scientists have an equation to describe this distribution: It is called a "water balance".

$$P = ET + Q \pm \text{change in } S$$

where:

- P — Precipitation
- ET — Evaporation and transpiration
- Q — Streamflow
  - = [Qr + Qg]
  - = [300 mm + 360 mm]
    - Qr — Surface runoff
    - Qg — Groundwater discharge to streams
- S — Stored water

The cycle of water



Map of typical PEI watersheds

All land can be divided into areas called "watersheds". A watershed is the land that water flows over or under on its way to a given stream, river or lake.

All of the water that flows through a watershed has the same destination. Therefore, all activities in the watershed, no matter how far from water they might be, can affect water quality.

In the long term, the amount of change in stored water (for example in groundwater aquifers) is about zero and can be ignored for rough calculations.

1100 mm = 440 mm + 660 mm

What the water balance shows is that water is neither created nor destroyed, it just moves from place to place.

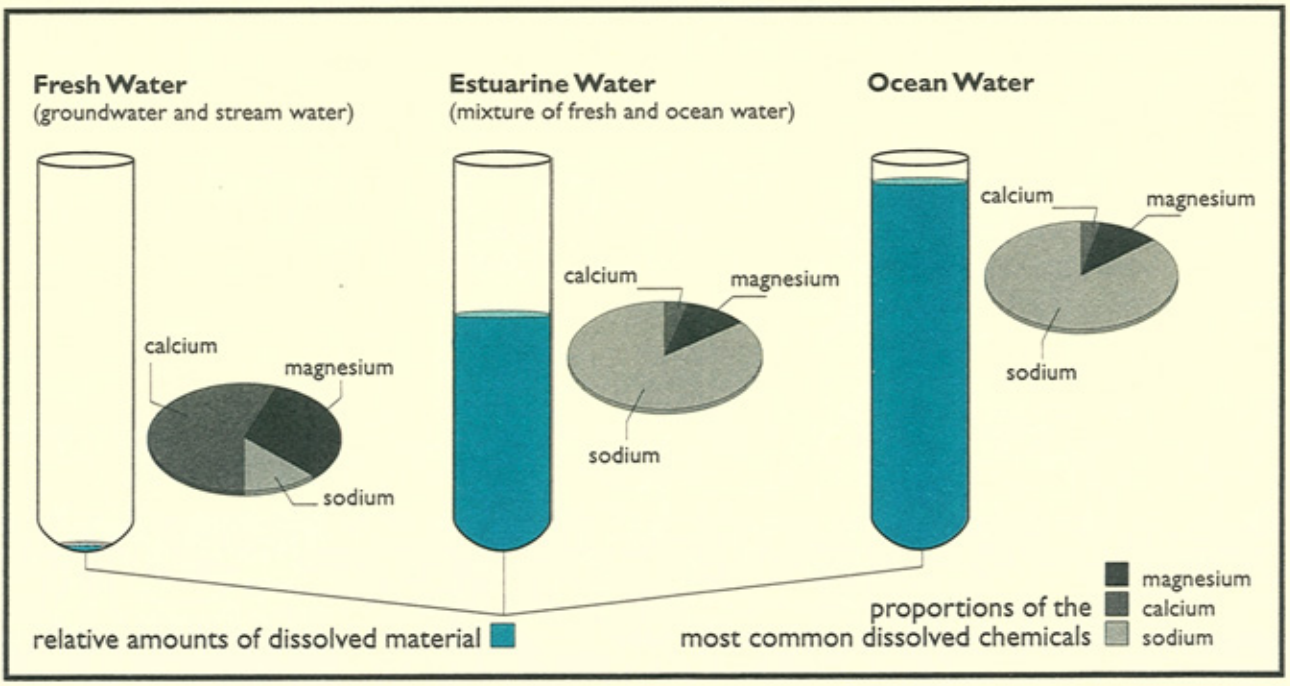
Natural quality of water

The water cycle helps us to examine water in its natural state. Water in each part of the cycle has different material dissolved or suspended in it.

Precipitation is the purest of natural waters. But even it contains small amounts of dissolved gases such as oxygen, carbon dioxide and sulphur dioxide and traces of other contaminants. Rain usually also contains small amounts of dust. It is slightly acidic. In recent years there has been concern about rain becoming more acid as a result of industrial air pollution.

As surface runoff flows across the land, it dissolves material from the soil and carries it with it. As it does so, it becomes less and less acidic. The most common dissolved minerals are calcium, magnesium and carbonate. There are

Chemical constituents of PEI natural water



Nearly all natural water has some dissolved or suspended material in it, such as minerals, sediment and bacteria. Whether water is "clean" or "contaminated" depends entirely on who or what is using that water.

lesser amounts of salt, as well as some iron and manganese, which don't dissolve easily. When rain or snowmelt water crosses over or seeps through farmland it can dissolve nutrients such as nitrogen from fertilizers and manure. Flowing water will also pick up soil particles and bacteria and carry them with it, particularly during storm conditions.

Groundwater has many of the same components as surface water, with a few differences. Because groundwater travels so slowly, it has much more time to dissolve minerals on the way. The higher mineral content changes the water from slightly acidic to slightly alkaline. Also, as groundwater seeps down, the soil acts as a filter, removing particles and bacteria that are suspended in it. This filtering action will not remove material that is dissolved, however. For instance, nutrients dissolved from fertilizer or manure can leach into the groundwater system.

Precipitation, surface runoff and groundwater all mix together in PEI streamwater. Streamwater has a high level of oxygen dissolved in it due to turbulence. The acidity of streamwater is neutral to alkaline, even after heavy snowfall or rainfall. PEI generally doesn't have the kind of acidity problems that plague other regions.

As stream water moves closer to the ocean, it eventually mixes with marine water and becomes an estuary. Estuarine waters have quite high levels of sodium and chloride (salt) from sea water and calcium, magnesium and carbonate from fresh water. The amounts vary depending on how much there is of each kind of water.

Groundwater quality may also be affected by the sea. In some areas next to the coast, salt levels in groundwater can be very high. This is called "salt water intrusion". Although salt-water wells are not desirable for Island homes, they are prized in the aquaculture industry because they provide water that is free of bacteria at a good temperature for shellfish.

Some physical facts about PEI

Our Island has some unique physical characteristics that have a direct impact on our water.

PEI is cradled in a vast ocean of salt water. Fresh water streams and rivers flow through rolling hills; small communities are scattered throughout, amid a patchwork of forests and fields.

PEI has about 1600 kilometres of coastline. In many places, wind and tide have eaten into the bedrock, leaving rugged sandstone cliffs. This process is called "erosion". Erosion of soil and bedrock produces much of the sand that makes our beaches, bars, dunes and spits we see offshore and in the mouths of bays.

Because PEI is surrounded by a large body of water, we enjoy humid, temperate weather.

Winters are long and fairly cold and summers are cool. The average annual temperature is six degrees Celsius.

Farming is a productive way of life on PEI. We are blessed with fine, sandy loam soils, plenty of rain, and a gently sloping terrain. More than a third of our 5,700 square kilometres of land is used for farming, a higher proportion than in any other province.

Beneath the PEI soil is a thick, fractured formation of sandstone bedrock that was formed some 220 to 300 million years ago. Water flows through the bedrock resulting in an immense reservoir of fresh, clean groundwater, readily available, close to the surface.

Because of the fractured nature of the sandstone bedrock, a comparatively high proportion of our rainfall seeps readily down through the permeable soil and "recharges" the groundwater supply. PEI's high rate of recharge is a mixed blessing. It gives us lots of groundwater, yet it also means that our supply can be affected by contaminants from the surface. Groundwater is the principal source of drinking water on PEI. It's our job to keep it safe.

Groundwater – our invisible resource

Beneath the Island soil is a vast supply of water that has soaked down into the ground. We call it "groundwater". It fills and moves slowly through the tiny spaces around soil particles and within cracks in the sandstone bedrock. It feeds our streams and rivers, supplies our wells, and supplies all of our water needs across the Island.

Groundwater is not like an underground pond or river. Rather, it soaks into the tiny spaces in the soil and bedrock as it would an immense sponge, until it becomes saturated. We can sink wells down into it and take enough water from it to supply a city. This saturated soil and bedrock sponge is called an "aquifer". At shallow depths, the tiny spaces in the soil, known as pore spaces, still have some air in them - they are unsaturated. The boundary between the zone of unsaturated soil and that of the saturated aquifer beneath it, is called the "water table" (see illustration p. 7).

In some cases, the situation is reversed: the soil filled with water is sitting above unsaturated soil. When this happens, it is usually because there is a layer of poorly draining material, such as clay, between the two zones. Water takes a long time to seep through the clay and so the soil above the clay becomes saturated. Once the water passes through the clay, however, it moves more quickly, leaving an unsaturated zone immediately below the clay. The top zone in this case is known as a "perched" water table. These make less reliable sources of water than the permanent water table because they can dry up during periods of dry weather.

Like surface water, groundwater is always moving. It is pulled down through the aquifer by the force of gravity. However, groundwater moves very slowly. Rather than flowing through large open channels, as surface water does, groundwater is forced through very small, often poorly connected pore spaces and fractures in the bedrock. The more permeable the aquifer and the steeper the slope of the water table, the faster the groundwater flows. But it's still very slow, sometimes moving only a few metres per year.

The movement of water through an aquifer is called a "groundwater flow system". On PEI, the boundaries of groundwater flow systems are virtually the same as for the watersheds on the surface. (This is not always the case elsewhere in the world. In some places, a single large groundwater flow system lies underneath several surface watersheds. And in other places a single watershed contains several separate groundwater flow systems.)

Groundwater comes originally from the surface, from rain and snow that has filtered down through the porous soil. Every year, about one third of our rainfall finds its way into underground aquifers. As it soaks down into the soil, it is said to "recharge" the aquifer. The greatest amount of recharge happens in the spring when there is abundant water from melting snow as well as normal precipitation to soak into the ground. Also, there is not much loss of water through evaporation or transpiration because temperatures are low and there is as yet little plant growth. This is why the water table is highest in the spring.

During the summer months, higher temperatures and vigorous plant growth result in more evaporation and transpiration of water into the air. This leaves less water available to soak into the ground. So from spring until fall, the water table gradually lowers.

In the fall, plant growth slows and temperatures drop. As a result, it is not unusual on PEI to have a second, smaller, recharge event in the fall. It lasts until the ground freezes or precipitation falls as snow. Water table levels then gradually become lower until the spring.

The extent of rise and fall of the water table varies from place to place and from year to year depending on weather conditions and topography. In general, though, the greatest fluctuations happen in the higher portions of a watershed, where the water table can fluctuate by five metres or more. Closer to sea level, the water table may rise or fall by a metre or less in the course of a year.

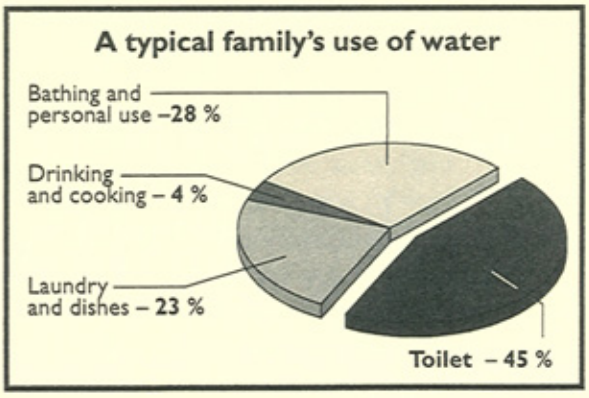
Although the levels of PEI's water tables vary from place to place and from season to season, there is always plenty of groundwater on PEI. In fact, we use only about *two per cent of the total recharge* to our groundwater system. In some areas with heavy industrial or municipal water demands, withdrawals may be as high as 50 per cent of recharge. As a general rule, this is the maximum level of withdrawal that is approved, so that enough groundwater is left to discharge into our streams and maintain a healthy level of flow.

How is our water used?

We use water so much and so often that we hardly notice it. In our homes, our communities and our workplaces, water forms a kind of invisible background to all of our activities. We turn a tap and there it is, ready for washing dishes, making ice at the community rink, or cleaning potatoes at the local processing plant. Water flows so easily through our lives that we tend to take it for granted.

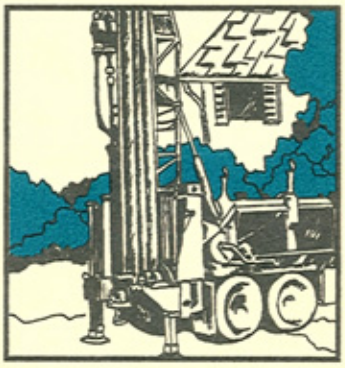
Water use in Island homes

We're most aware of water when we're drinking it or bathing in it. We use it to wash and cook our food, and to carry heat through our rooms. But we flush more water down our toilets than we use for any other purpose in the home.



Groundwater – our invisible resource

One hundred years ago, Island families drew their water by hand, and they were satisfied with 23 litres per day. Today we get water by turning a tap, and the average family uses between 1140 and 1820 litres of water per day.



On PEI, we rely on groundwater for almost all of our water use. In many homes, water is pumped up from a household well.

Water for many Island homes comes from private wells. A well is a hole in the ground that lets us extend pipes into the aquifer and pump water out. As water is pumped out of a well it is replaced by water flowing in from the surrounding aquifer. The more permeable this aquifer, the faster the well is refilled and the more water the well can provide. Fractured sandstone, for example, is often quite permeable: water flows much more quickly through it than through clay. On PEI, almost all wells can provide enough water to run a household. In the rare case where a well goes dry, it is usually because the well (or the pump inlet to the well) is not deep enough to tap the water in the aquifer.

Water that is pumped up from the household well is then distributed to sinks, bathtubs, toilets, washing machines and heating systems throughout the house by a system of pipes. In most homes, these pipes are hidden from view within the walls of the house. After it is used, household water travels down a drain to another system of pipes leading to the wastewater treatment system.

Water use in Island communities

Although about 40 per cent of the Island population are supplied through private wells and nearly 50 per cent use on-site wastewater treatment, many communities have a central water supply and/or a central wastewater treatment system. Because the groundwater is of such high quality, treatment for drinking purposes is generally not necessary.

On PEI, central water supply systems pump the groundwater from "high capacity wells" and "well fields" directly to a distribution system. A high capacity well is one that pumps a large amount of water from the aquifer on a regular basis. A well field is a group of wells that are connected to the same distribution system.

In addition to supplying homes, central water supply systems provide water for shopping malls, office buildings, hospitals, schools and manufacturing plants. Water is pumped to fire hydrants and public swimming pools, and eventually is flushed through pipes to central wastewater treatment systems.

Prince Edward Islanders are among the largest water users in Canada. Conservation has not been a high priority because water seems as plentiful as

air. But if we take a lesson from other communities, we learn that water should be used as efficiently as possible – it's an essential resource that must be protected for the future. It doesn't make sense to wait until there is a crisis.

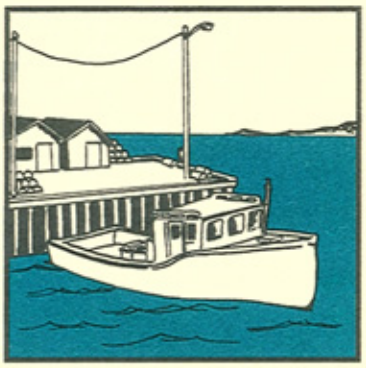
By using water-efficiency measures, other communities in Canada have avoided the need to expand their municipal water supplies *and* the need to spend millions of dollars to expand their wastewater treatment plants.

There are many ways to use water more efficiently. Replacing older fixtures with low-water-use toilets, showerheads and faucet aerators can save between 30 and 50 litres of water per day per person. When new fixtures are used in hotels, hospitals, and schools, the savings are considerable.

The Town of Port Elgin, Ontario (population 6,857) avoided a $5.5 million expansion of its water treatment plant with the help of a water conservation program. The program promoted the use of low-water-use fixtures and a summer schedule for watering lawns and gardens. The town's water use in 1993 dropped by 25 percent. This saved the town $12,000 on energy and chemical costs for water and sewage treatment.

People tend to waste less water if they have to pay for it. About 50 percent of municipal water customers in Canada are on a water meter system, where people pay according to the amount of water they use. In PEI, however, most central water supply systems are unmetered. Metering has been known to reduce residential water consumption in small towns and large cities alike. Since the City of Vernon, British Columbia (population 23,514) installed water meters in 1992, the per household water consumption has decreased by 28 percent.

It makes no sense to squander the Island's excellent water supply, especially when there are benefits to using it more wisely. Water efficiency programs are a likely part of PEI's future.



Groundwater – our invisible resource

Water use in Island industries

Most of PEI's economic productivity comes from farming, tourism, fisheries, forestry, and aquaculture. Except for quarrying, there is no mining and no heavy industry. The main secondary industry is food processing. All of these industries use water to a greater or lesser extent.

The Island's food processing industry is a heavy user of water. Typically large food processing plants in PEI use between two and eight million litres of groundwater per day to clean, mix and cook their products. Withdrawals of this magnitude may in some cases approach maximum safe limits. In these cases, groundwater withdrawals are limited in order to leave enough groundwater discharge to sustain a healthy base flow in streams.

Large food processing plants in PEI typically use between two to eight million litres of groundwater per day to clean, mix and cook their products.

Along with municipalities and some farmers, some Island industries use high capacity wells. The Department of Fisheries and Environment has stringent regulations in place to protect PEI's water supply. It reviews all applications for high capacity wells before issuing construction permits. Once the well is drilled, it must undergo testing before it is allowed to be put into service. The testing varies depending on the nature of the project and the sensitivity of the surrounding environment. This testing has three main goals:

1) to ensure that enough water can be pumped from the well and to provide information about expected water levels in the well during pumping. This helps ensure that appropriate pumping equipment is used and that it is installed correctly.
2) to estimate what effect pumping will have on the local water table and nearby wells under the well's operating conditions.
3) to estimate what effect pumping will have on the overall watershed. This assessment is done only for wells that would withdraw large amounts of water and for wells situated in sensitive areas. In these cases, the overall water balance of the watershed is considered, including what effect the new well would have on streamflow (by reducing the base flow contribution of groundwater to the stream).

Sharing our water resources

We have a small province. Agricultural, fisheries, residential and tourism operations are all physically close together. They all depend to some extent on the same water resources. Water use by one can have a detrimental and often costly effect on all the others.

We use water in our homes, communities and industries. But not all of these uses are compatible. We use water for drinking, yet we also use it for disposing of sewage and waste. We mix fertilizers and pesticides with water to help grow crops, but surface run-off from fields can harm fish and shellfish habitat downstream. Our challenge is to share our water resources in ways that benefit all.

Groundwater issues

The natural quality of Island groundwater is excellent. The challenge is to keep it that way.

The difficulty lies in the chemical nature of water. Water is a solvent. It dissolves some amount of almost everything it meets. During the hydrological cycle, water moves through air, soil and rock, picking up traces of where it has been. If it comes into contact with hazardous materials, it can dissolve chemicals from those materials and carry them down to our groundwater.

A little bit of contamination can go a long way. Just one litre of leaked oil can contaminate a million litres of our drinking water.

Groundwater is usually safer to drink than surface water, because as groundwater seeps through soil and rock, some contaminants are filtered out. But if contamination does reach the aquifer, it may be impossible to clean. In the case of petroleum, its effects can persist for decades. Most of the time, the technology to clean up a contaminated aquifer simply does not exist; if it does, it is either impractical or far too expensive. This means we must make strong efforts to prevent contamination in the first place.

On PEI, the most serious risks of groundwater contamination are petroleum leaks and spills, agricultural wastes, agricultural fertilizers and pesticides, faulty wastewater treatment systems, road salt, and waste disposal sites of older design. We are also concerned with the proper construction of wells to prevent bacterial contamination, and with the sealing of abandoned wells.

Groundwater – our invisible resource

Threats to Island groundwater

Petroleum products

While currently not the most common problem, leaks and spills from petroleum storage tanks continue to be a serious threat to groundwater in PEI. The provincial government has strict regulations designed to prevent contamination from these sources.

One well-known disaster happened in 1977 in Kensington, where 31 wells were contaminated by a leaking underground storage tank that had become corroded. Since then, the government has required owners to remove more than 2,000 old steel storage tanks from the ground. Many of these were leaking and required extensive cleanup.

Above-ground tanks at private homes are also a threat to groundwater quality. In 1994, the Environmental Emergency Response Team responded to 349 spills. Most were from above-ground tanks for storing home heating fuel.

In winter months, settling snow and ice can cause pipes to collapse and spill oil. A survey of three communities carried out in 1991 showed that most outside storage tanks were not installed properly. To help solve this problem, the Water Resources Branch organizes courses for tank installers on a regular basis.

Pesticides

Pesticides are commonly thought to affect groundwater quality. But not all pesticides behave in the same manner and many products, especially newer pesticide formulations, are unlikely to reach the water table. Studies have shown that under normal use conditions, pesticides are rarely detected in PEI groundwater, and then only at very low concentrations, well below levels of health concern.

Problems have occurred when large quantities of concentrated material have been released through leaks or spills. Two Island communities, Kensington and Tignish, have had significant portions of their groundwater rendered unusable due to such incidents.

Nitrates

Wherever there is agriculture, there is the potential for elevated levels of nitrates in the groundwater. PEI is no exception. Studies conducted in PEI and elsewhere have shown that there is a strong link between land use and nitrate levels in groundwater, with agricultural areas often showing higher than average nitrate concentrations. One survey in an intensively cultivated watershed in PEI found that nearly 7% of well-water samples had nitrate concentrations higher than the level recommended in the *Guidelines for Canada on Drinking Water Quality.*

Because of PEI's dependence on both ground water and agriculture, a balance must be found between the interests of keeping our water clean and of keeping our farms productive.

Manure

Manure on farms can also contaminate groundwater. Bacteria- and nitrate-laden water can wash off the fields and soak down into the groundwater or can leach from manure storage sites. Also, hog farmers now use storage lagoons for liquid manure. Those built without an impermeable liner, or directly into fractured bedrock, are of most concern. Efforts are being made to educate farmers on proper construction techniques.

Wastewater treatment

Wastewater treatment can be a problem if septic tanks are improperly installed or faulty, and leaking sewage pipes can allow nitrates, chemicals, bacteria and viruses to seep into groundwater supplies. The current system of assessing the suitability of soils for on-site sewage disposal will help address this issue.

Road salt

Road salt can sometimes contaminate wells on PEI. About 23,000 tonnes of salt is spread over 500 kilometres of PEI roads every winter. Another 1,500 tonnes is spread on streets in Charlottetown and Summerside. Because management of storage piles has been improved in recent years, cases of wells being contaminated by salt have been limited to areas near high traffic roads and steep hills.

Solid Waste disposal

High volumes of waste can overwhelm nature's ability to purify. Landfill sites, for example, hold large amounts of potential contaminants in one place. When rain falls on the site and leaches down into the soil, it can carry contaminants with it. Moderate amounts of a contaminant, bacteria for instance, may be filtered out by a few feet of soil, but larger or continuous quantities can contaminate significant portions of an aquifer. And some contaminants, such as petroleum products, are not as effectively filtered by soil particles. Groundwater around four regional landfill sites in the province is regularly monitored by the Water Resources Branch of the Department of Fisheries and Environment.

Groundwater has long been PEI's invisible resource. Its abundance and excellent quality has nourished the lives of all Islanders, flowing through our homes, our communities and our economy. As Islanders become more aware of the importance of groundwater and the potential threats to its quality, we must rise to the challenge of keeping this precious resource safe for all.

Surface Water – beautiful and full of life

Surface Water – beautiful and full of life

You can't go far in PEI without meeting a freshwater stream: in total, more than 4,000 kilometres of streams wind their way across the province. Although many are called rivers - Mill River, Hillsborough River, Montague River, Morell River - none have freshwater portions large enough to warrant the name. They are all freshwater streams that become estuaries for a good part of their length (Estuaries are bodies of water made up of fresh water from streams mixed with salt water from the ocean.).

PEI has few *natural* freshwater lakes or ponds: Glenfinnan Lake and O'Keefe's Lake in Queen's County are two. Over the years many people have dammed streams to create ponds. Now, hundreds of human-made ponds are sprinkled across the Island.

Wetlands are the shallow, marshy areas found on the edges of streams, bays and estuaries. Wetlands account for about 2% of PEI. Streams, estuaries, lakes, ponds and wetlands are all surface water bodies. Surface water is any body of water that is in contact with the atmosphere.

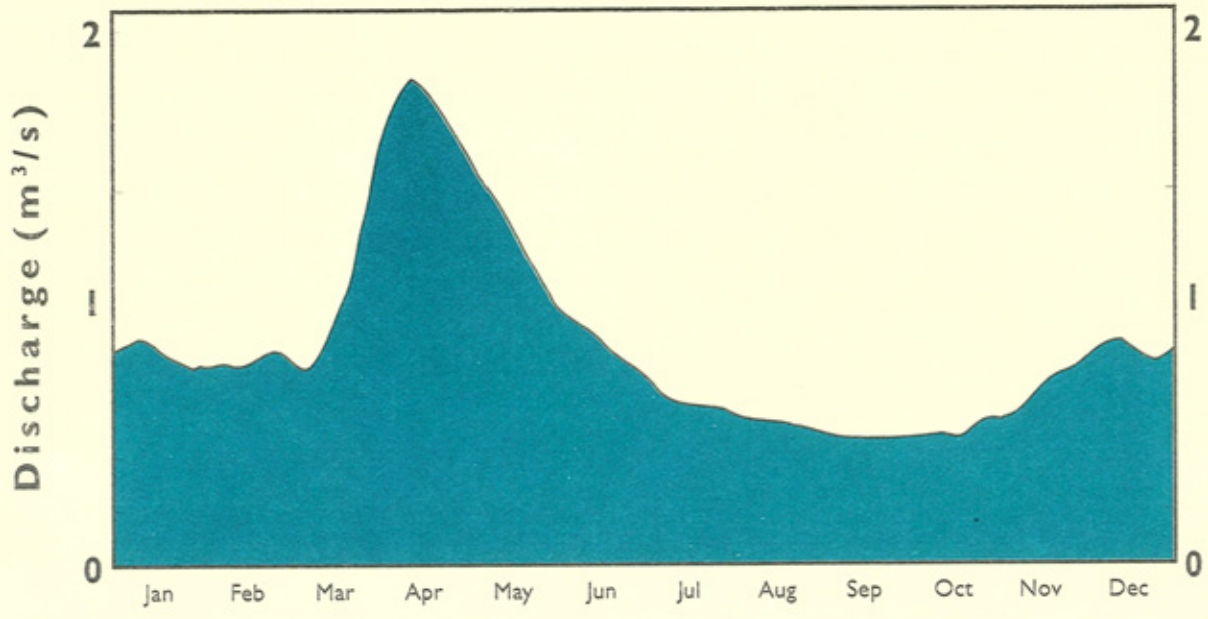
Freshwater streams

PEI streams are small and shallow. They generally vary in width from 30 centimetres to 6 metres and in depth from 15 centimetres to 1 metre. Any PEI streams that are wider or deeper than this are actually estuaries. Most streams are quite short: less than 16 kilometres in length. They don't travel fast, rather they tend to meander and spread out.

On an annual basis, about 60 to 70 percent of the water in our streams comes from groundwater; the rest from rainwater or run-off from the land during rainfall or winter melting events. A typical stream begins from a spring, where groundwater has bubbled up to the surface. As it winds its way to the ocean, the stream is joined by run-off from the land. Eventually, it mixes with salt water to become an estuary.

The high proportion of groundwater in PEI streams has a moderating effect on the temperature of streamwater. The temperature of groundwater stays constant year round at about 8° Celsius. Its influence prevents Island streamwater from becoming either very cold in winter or very warm in summer. Stream temperatures range

Typical streamflow hydrograph for PEI



The amount of water flowing in our streams changes throughout the year.

from 0˚-4˚ Celsius in winter to 12˚-20˚ in summer. This moderating influence is important for wildlife in streams, particularly in the winter. Trout, for example, can often be found near springs in the winter taking advantage of the warmer water.

Ponds have the opposite effect. Because of their small size and shallow depth, ponds are usually a lot warmer in summer than the streams running through them. As a result they tend to increase the temperature of those streams.

Groundwater also has a moderating effect on stream*flow*. The groundwater portion of stream water is often called "base flow". Base flow in PEI streams is substantial and remains fairly constant throughout the year. Therefore, variations in the amount of streamflow from season to season are less on PEI than in many other places.

For a large part of the year, base flow is the only water in our streams. This is because our watersheds are so small that rainfall can affect streamflow for only about a day. Streamflow rises quickly after rain or a winter melt, but falls nearly to base levels shortly thereafter.

Base flow is highest during the spring when the winter snow melts and while temperatures are too low for evaporation or transpiration to have much

What's wrong with this picture?

This beautiful illustration depicts a typical Prince Edward Island scene. However, once we become educated about protecting PEI's water, we notice that there are a few things wrong with this picture. Can you spot them?

effect. Storm conditions can cause a sharp rise in streamflow so that the highest streamflows are found during storms when the base flow is high.

Surface runoff carries a lot of soil into our streams during the course of a year. Much of this eroded soil settles to the bottom of streambeds as "sediment". During high streamflow conditions, large amounts of sediment are picked up and moved downstream. This can cause problems for fish if the sediment is deposited on their spawning beds.

Flooding, on the other hand, is rare on PEI because of the permeable soil and short stream length. Only when the ground is frozen or

Did you spot the problems?

1) The household well is downstream from the septic tank: it could be contaminated by sewage carried by groundwater flow.
2) The cow should be fenced out of the stream. Livestock manure could cause bacterial contamination of the stream, and trampling could cause the stream bank to erode.
3) The farmer has ploughed the steep, sloped land rather than the flat land. This would result in more soil erosion.
4) The farmer *has* ploughed up and down *some* of the slopes (rather than across the slopes). Ploughing across the slope is called contour ploughing — the contours help to slow down the flow of rain water and reduce soil erosion.

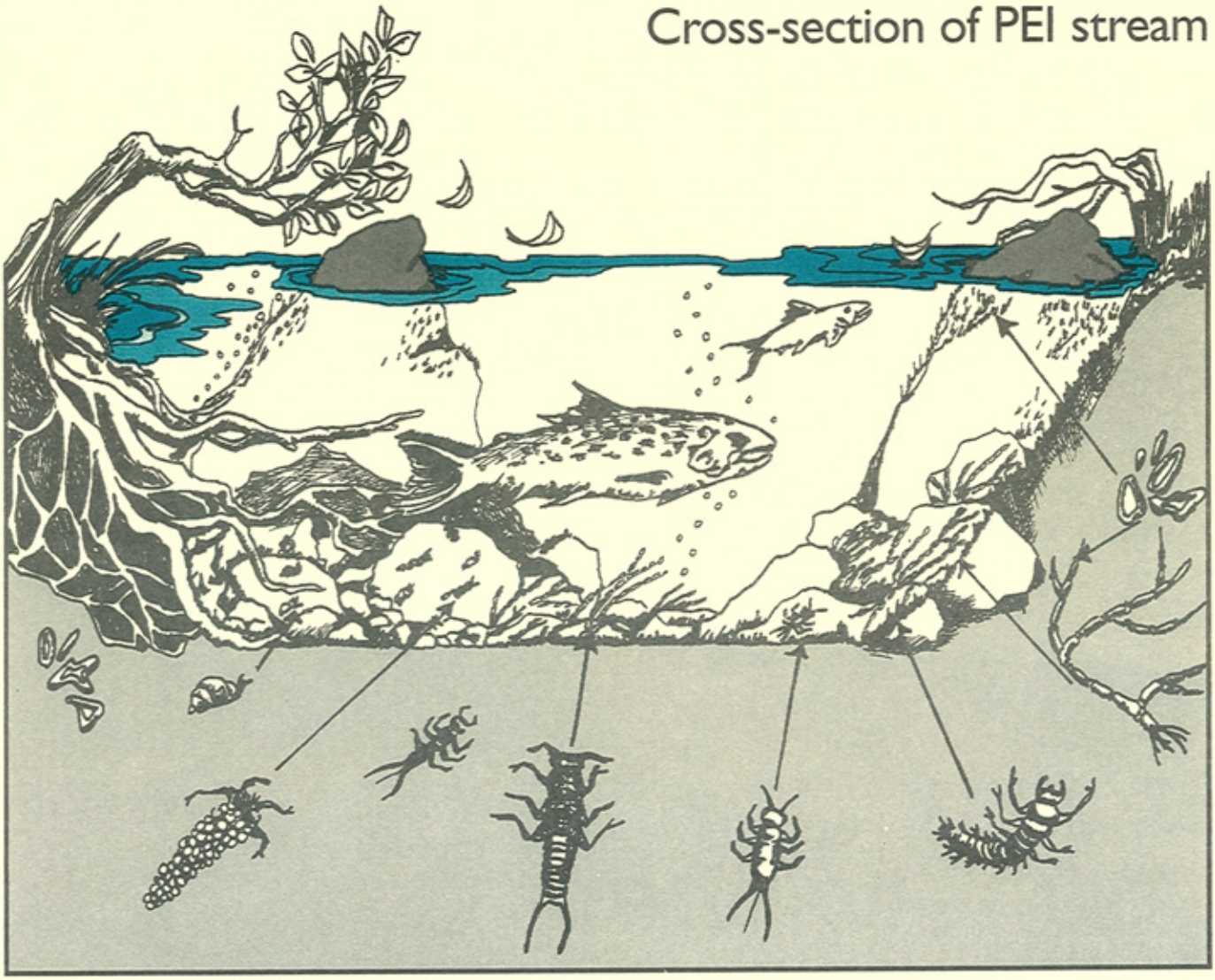
saturated does flooding generally occur. Flooding can also happen in urban areas with poorly designed storm water management systems.

Protecting the Quantity of Water in Island Streams

Most concerns about surface water are related to the quality of the water. But the *quantity* of water is equally important.

While PEI's rainwater is plentiful, farmers sometimes need extra water for irrigating their crops. High capacity wells are used by some farmers to irrigate their crops, but they must apply for a permit to construct such a well, and the use of this water is strictly regulated. The reason for these regulations is that as water is taken from groundwater supplies, less is available for

Cross-section of PEI stream



discharge to streams. In order to protect fish habitat, it is necessary to maintain a minimum amount of water flow in the stream at all times.

Likewise, a person must obtain a permit before they can take any water from an Island stream or river. A limited number of permits are granted each year, and the level of flow in the streams is monitored to make sure that it does not drop below normal levels for fish and other aquatic organisms.

Artesian spring. Pisquid, PEI.

Surface Water – beautiful and full of life

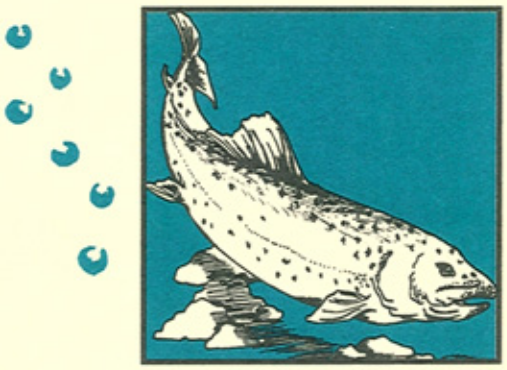
Island estuaries -- nurseries to the sea.
The mouth of a river, where fresh water mixes with salt water from the ocean, is called an estuary. Estuaries are known as "nurseries to the sea" because they provide a remarkable source of food for marine life.

An estuary is a unique environment that supports abundant marine life. Fresh river water carries nutrients from the land, some of which become trapped in the estuary. Turbulence from wind, streamflow and tidal mixing help keep high levels of dissolved oxygen in the water. And in the broad, shallow waters of Island estuaries, sunlight reaches to the bottom. In this ideal nursery, all of the ingredients required for marine life are readily available: water, nutrients, oxygen and sunlight.

The diverse life within an estuary makes up an intricate and interconnected "aquatic ecosystem". An aquatic ecosystem is a group of organisms who interact with each other and depend on each other *and* their water environment for food and shelter. Aquatic ecosystems usually have a wide variety of life forms including bacteria, fungi, and protozoans; bottom-dwelling organisms such as insect larvae, snails and marine worms; free-floating microscopic plants and animals known as plankton; large plants such as various types of algae, bulrushes, grasses and reeds, and also fish, reptiles, mammals and birds.

Water plants like phytoplankton, eel grass and sea lettuce grow and release oxygen that sustains mussels, oysters, clams, trout and salmon. Algae and other organisms are food for insects, shellfish and finfish.

To support life, estuaries must maintain a delicate biological balance. All levels of the food chain must stay intact, as must the shelter that the ecosystem provides. If an estuary does not have enough oxygen, plants die off and fish have no food supply. If an estuary bottom does not have



enough oxygen, animals die off. This is why the health of aquatic ecosystems is so important to the Island's aquaculture and fishing industries.

Estuaries are usually only found in the mouths of rivers, but on PEI they extend far up the length of our streams. This is because our estuaries are actually "drowned river valleys".

During the last ice age, melting ice produced much larger flows in our streams. Deep channels were carved and flood conditions formed broad valleys along the stream beds.

Also, for many years the polar ice caps have been melting, due to rising global temperatures. Currently, the rate of sea-level rise is about 30 centimetres every hundred years.

The result has been that PEI's glacial flood plains (river valleys) have filled with ocean water and become broad, shallow estuaries that are ideally suited to the growth of marine life.

Water in Island estuaries

Estuarine water has quite high levels of dissolved material such as salt (from sea water) and calcium, magnesium and carbonate (from fresh water). There are also high levels of phosphorus. Nitrate tends to be the element that has the greatest impact on estuarine productivity. Estuarine water also carries a lot of suspended sediment.

The temperature of estuarine water on PEI ranges from -2°-+2° Celsius in winter to 20°-25° degrees in summer. The seasonal warming and cooling of estuarine water tends to lag about a month behind that of streamwater, reaching its warmest temperature in mid-August.

During the winter, our estuaries are usually covered in 0.3 to 0.6 metres of ice, because they are sheltered from open ocean conditions. The water around PEI isn't actually ocean water at all. It is part of the Gulf of St. Lawrence, which is a very large estuary. The salt content of water in the Gulf is in the order of 30 parts per thousand, whereas Atlantic Ocean water is 33 parts per thousand.

Ice cover affects our estuaries in several ways. Winter storms have less impact on the water, resulting in reduced wave action. This in turn prevents sediment from being stirred up and resuspended in the water. Ice cover also limits the growth of marine life by acting as a barrier to both oxygen and light. Ice cover is significant for our fisheries, which are therefore restricted to the ice-free seasons. Only the mussel fishery has found ways to operate year round.

Water flow in estuaries

Water that flows into an Island estuary comes from two directions: from upstream and from the ocean. Water from upstream is fresh and water from the ocean is salt. When the two meet in the estuary, they mix. But because salt water is heavier than fresh water, the estuary becomes stratified into layers - saltier water at the bottom and fresher water at the top. The closer to the ocean it gets, the greater the mixing that occurs and the smaller the difference in salinity between the layers.

The flow of water in an estuary is more complex than in a stream. Fresh water flows in at the head of the estuary. Because of the tides, water flows both in and out at the mouth of the estuary. Overall, there is a net flow out of the estuary into the ocean.

The length of time that water stays in an estuary before being flushed out to sea is referred to as the "residence time" of the estuary. Residence times in Island estuaries are quite short, usually a matter of days. A long residence time here would be a month. Charlottetown Harbour has a residence time of just 3 days and in Mount Stewart it is 20 days.

Surface Water – beautiful and full of life

Wetlands give food and shelter
to many species of wildlife.
Some of the more well-known wetland areas in PEI
are Forest Hills Wildlife Management Area,
Johnston's River Marsh and Desroche's Pond.

Wetlands -- food and shelter for Island creatures

Freshwater wetlands are the marshes, swamps, bogs and shallow waters that border freshwater streams. Salt marshes are coastal wetlands found in protected bays and estuaries, often behind protective barrier beaches and sand spits. Wetlands have naturally low acidity. They don't cover much of the total area of PEI, but wetlands are home to much of PEI's wildlife. Some of the more well-known wetland areas in PEI are Forest Hills Wildlife Management Area, Johnson's River Marsh and Desroches Pond.

Wetlands give food and shelter to many species. Every drop of water contains microscopic organisms that are a vital part of the food chain. Both the water's surface and the wetland bottom are covered with insect eggs, larvae, nymphs, worms, plants, bacteria and protozoa.

In freshwater wetlands, frogs bury themselves in wetland mud to survive the winter, and some insects use bottom debris to form a protective covering. Fish swim and feed in the wetlands, often eating the eggs of insects. Wetland plants provide nesting materials to ducks, herons and other waterfowl. Small mammals use the lush vegetation at the edge of wetlands for cover and as a source of food. They, in turn, are food for hawks, owls, and eagles.

Salt marshes and their associated mud flats are important areas for commercial species, such as oysters, clams, quahogs and various fish species.

Wetlands reduce flooding and erosion by storing water and evening out streamflow.

Wetlands are also important to water quality. They act as filters, protecting the quality of water downstream. They trap chemicals such as nitrogen and phosphorus so efficiently that artificial wetlands are sometimes constructed as part of wastewater treatment systems.

Productivity and limits to productivity

Streams, estuaries, ponds, lakes and wetlands provide habitat for a great diversity of life. In one sense, understanding surface water habitats is immensely complex: they form intricate webs of interdependence amongst many species and many individual organisms. But in another sense, it is very simple: green plants make life.

Green plants take energy from the sun and use it to turn non-living matter into living plants. All other forms of life either eat green plants or eat those that do. It is the green plants that make it all possible. This is why scientists call green plants "primary producers". Other forms of life are called "secondary producers" because they also

produce living matter, or "biomass", but can do so only if primary producers provide them with food.

The amount of *increase* in total biomass is called "productivity". Productivity is essential to the growth of an ecosystem because without it, harvesting becomes mining. Shellfish, for example, are a renewable resource. Every year, some can safely be harvested because next year more will have grown. If the ecosystem was very productive and harvesting moderate, there might even be more shellfish the next year. But without productivity, every year there would be less shellfish until they were all gone. Increasing biomass is the work of the primary producers, the green plants, and is called "primary productivity".

There are several factors that can limit primary productivity: temperature, sunlight, nutrients, current speed, oxygen and residence time.

In freshwater streams, sunlight, current speed and water temperature are the limiting factors. If the stream is heavily loaded with suspended sediment, sunlight doesn't reach to the stream bottom, which limits the energy available to primary producers. If current speed is too fast, attached primary producers can't hold on to the bottom and are swept downstream. If the water temperature is too cold, growth is inhibited. As a result, primary productivity in freshwater streams reaches its peak in mid-summer, when water temperatures are highest and current speed moderate. Overall, the productivity of freshwater streams is low when compared to that of estuaries and wetlands.

Estuaries are more productive than either the ocean water or streamwater that feed into them. This is mostly due to nutrients from the two sources mixing together. Estuaries also receive nutrients from associated wetlands, which are extremely productive areas. Because the availability of nutrients is the main limiting factor in estuaries, productivity there reaches its peak in the spring and early summer. That's when streamflow into estuaries, carrying high levels of nutrients, is highest.

We know that stream water carries high levels of nutrients into an estuary. But what happens when something, such as an improperly constructed causeway, bridge or wharf, interferes with the ability of tides to flush out part of that estuary? Nutrient levels become quite high in an area where, previously, nutrients had been a limiting factor. Primary producers, such as algae, undergo extremely rapid growth. When the algae dies, bacteria and fungi feed on it, breaking it down. These organisms use a lot of oxygen, which is a limiting factor for aquatic life. Oxygen then becomes a limiting factor for both primary and secondary producers. In some cases all of the

oxygen gets used up. If that happens, all oxygen-using life in that part of the estuary will die. This process of excess productivity is called "eutrophication". Some symptoms of eutrophication are foul odour, fish and shellfish kills, oxygen depletion, and poor water clarity.

Bacteria in water

Too much bacteria in water can be a health risk. Many kinds of bacteria can cause disease in humans, animals and aquatic life. And although Islanders don't use surface water for drinking, we do depend on it to provide a healthy environment for recreation and edible shellfish.

The shellfish industry is particularly vulnerable to bacterial contamination, and although shellfish will cleanse themselves of bacteria, it has still been necessary to close many productive shellfish areas on PEI to harvesting for direct sale to the public.

The main sources of bacterial contamination are livestock, manure and human waste. Bacteria from manure enters our water through livestock

Bacterial contamination of surface waters can result in shellfish closures.

that are free to enter streams, and from surface run-off that washes over pastures and barnyards into our rivers.

On the Island, many of our food processing plants and communities are clustered around the mouths of rivers, where wastewater is discharged.

Wastewater treatment plants are now better able to limit bacterial contamination of surface water from human waste. All new and upgraded treatment plants on PEI must include bacterial disinfection as part of their wastewater treatment process. But even after disinfection, effluent may contain some bacteria.

Pesticides

Pesticides, by their nature, are toxic. They are used to control certain insects and plants as well as a variety of plant diseases. Unfortunately, these pesticides are also toxic to some other organisms in the environment. If enough pesticide escapes the field where it was applied and enters a stream, lethal effects can occur. The more pesticide that escapes and the higher its toxicity, the more likely it is there will be a problem.

Pesticides have *rarely* been detected in Island surface water, and then only in very low concentrations - with a few exceptions. Pesticide spills and run-off from recently treated fields *have* resulted in fish kills in the past. In several cases, intense rainfall has washed lethal amounts of pesticide into streams from fields where *normal* amounts of pesticide had recently been applied. This happened in Big Pierre Jacques River in 1994 and 1995 and in Long Creek in 1996.

While fish kills due to pesticides are rare, they are of concern. Taking the proper care while applying pesticides can reduce the risk of spills. Care must also be taken to be sure that a pesticide will dry on the plant and soil before the next rain. Since many of the pesticides currently in use bind tightly to soil particles, action taken to reduce soil erosion will also reduce the migration of pesticides from fields to streams. And wherever possible, alternatives to pesticides and lower-toxicity pesticides should be chosen.

Sediment, silt and soil erosion

The land underlying Island coastal waters is of two basic types. The deeper waters, as well as those along the surrounding coastline, have rock bottoms. Shallow estuarine waters have bottoms made up of soft sediments, such as mud, sand and silt.

The soft sediments are particles of eroded soil that have washed into streams and estuaries. They become suspended in the water and are carried downstream until the current becomes slow enough to allow them to sink to the bottom.

The smaller the particle, the longer it stays suspended and the further it is carried downstream. Also, the greater the streamflow, the further particles are carried downstream before being deposited. The smallest suspended particles are called silts and clay. All streams contain a certain amount of silt, but it becomes a major problem when a waterway becomes overloaded. On PEI, many of our waterways *are* overloaded.

Silt can kill aquatic plants and animals by blocking the sunlight necessary for their growth. It can settle to the bottom of streams and cover the gravel where fish would normally spawn. It can suffocate fish eggs and kill aquatic insects that serve as fish food. Herons and other birds that hunt by sight can go hungry because the water is so muddy they can't see their prey.

Silt can smother marine plants and shellfish beds. Oysters, for example, prefer relatively firm bottoms to grow on. Also, when soil gets carried into the water, it can bring bacteria, chemicals and fertilizers with it, resulting in a significant pollution threat.

In PEI, the siltation problem results from a variety of activities: primarily farming, but also road construction, unpaved roads, improper watercourse alterations, construction of buildings and subdivision construction.

Agricultural activities often account for most of siltation because so much of PEI is farmland, about a third. As much as 14 tons of valuable topsoil can be lost from each acre of Island farm land every year.

Farmers often clear their land right to the water's edge, and remove hedgerows to make their fields larger. No trees or vegetation are left to slow and trap soil. By ploughing directly up and

Surface Water – beautiful and full of life

down slopes, and by leaving fields bare over the winter, farmers create water slides that wash soil directly into nearby streams and estuaries.

Soil erosion is an important example of how land-use practices can have a huge impact on water and aquatic habitats.

Stewardship and Sustainability: a Renewed Conservaton Strategy for PEI calls soil erosion the single most important resource problem facing the province. Islanders have long understood that our soil is highly erodible: when it's not protected, Island soil is easily carried away by rain, wind, and snow melt.

Soil erosion is a lose/lose situation. The productivity of our farms is eventually lowered when valuable topsoil is lost and the productivity of our surface water is lowered when streams are choked with silt.

We don't drink surface water on PEI, yet it *is* vitally important to Island wildlife and to our economy. Both the commercial fishery and the shellfish industry are dependent on stock that live and spawn in coastal estuaries. Agriculture and tourism also rely on healthy streams, rivers and ponds.

Our surface waters provide beautiful, natural settings for recreation. Tourists and residents alike

enjoy canoeing, sailing, moon-lit strolls, fishing, digging for clams ... activities that form the backbone of PEI's tourism industry and contribute to a high quality of life for Islanders.

Rivers and ponds are also crucial to PEI's environment because they provide a habitat for a great diversity of life: plants, fish, shellfish, aquatic mammals, and waterfowl.

The quality of water varies from stream to stream, but as we have seen, there are some dramatic problems facing Island surface waters. Our streams and estuaries need to be protected from siltation, bacterial contamination, nutrient overload and other contaminants. The future of our surface waters will depend on decisions that Islanders make today.

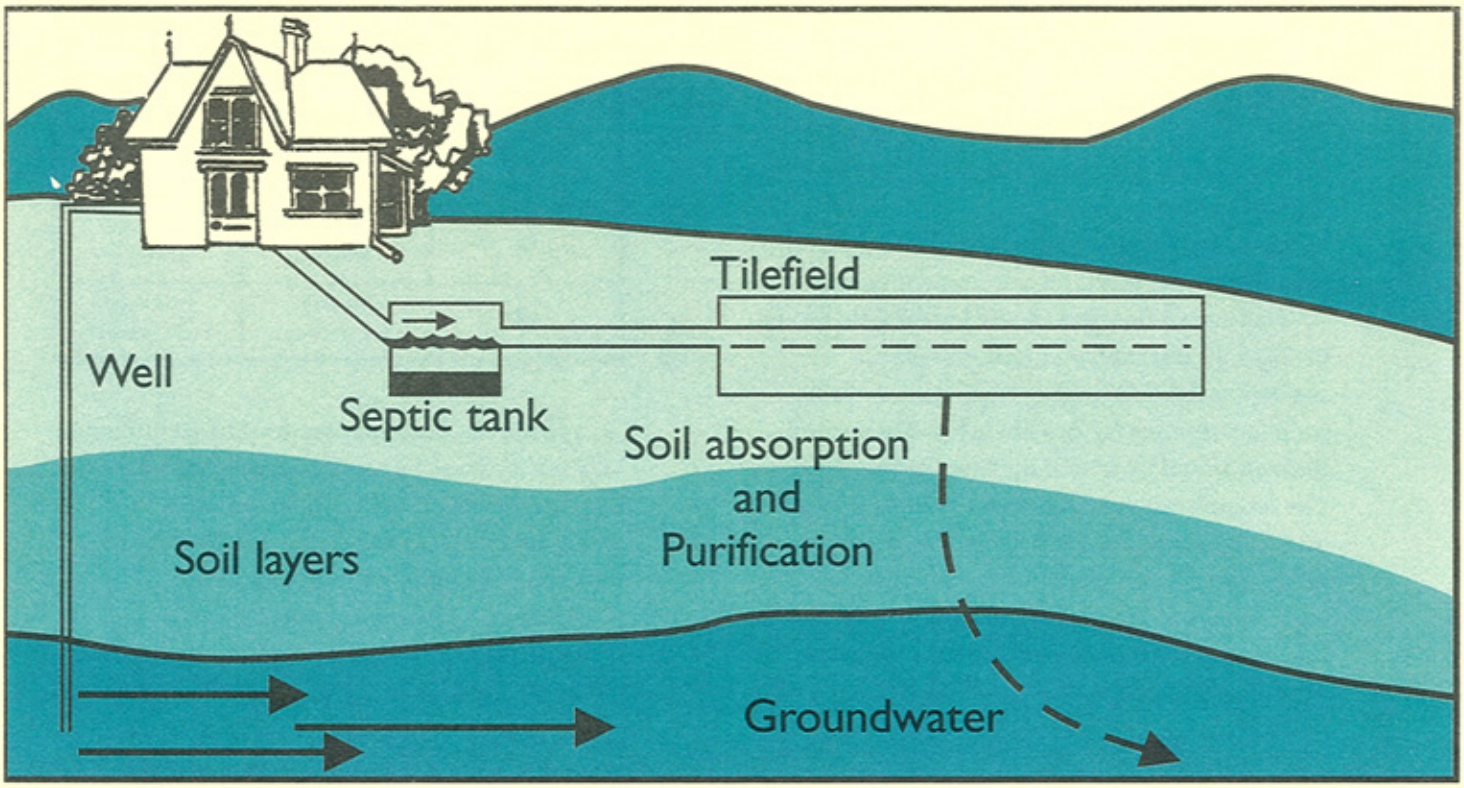
Wastewater treatment

Wastewater treatment in Island homes

Household wastewater contains many undesirable substances such as human waste, food scraps, oils, soaps, chemicals and bacteria. Wastewater treatment cleans the water until it is safe to return to the environment.

Nearly half of PEI's homes, mostly those in small communities and rural areas, have on-site wastewater treatment. Almost all are "subsurface soil absorption systems". These simple, stable systems treat wastewater effectively at a low cost and require a minimum of maintenance. Subsurface soil absorption systems have three components: a sewer pipe, a septic tank and a tile field.

Typical on-site sewage disposal system



Wastewater treatment

The sewer pipe carries wastewater to the septic tank, which is buried in the soil outside the house. In the tank, fats and greases rise to the top and solids settle to the bottom. Bacterial action partially breaks down the solid material. This "sludge" builds up and must be removed every three to five years.

The treated liquid in the middle, called "effluent", flows out of the tank and is distributed along the tile field. The tile field is a series of pipes buried in gravel-filled trenches. The pipes have many holes in them, so that as the effluent spreads out across the tile field, it seeps down through the gravel into the soil below.

Subsurface soil absorption systems normally need just 0.6 metres of soil underneath them to filter nutrients and bacteria from the effluent, leaving it safe for its return to the aquifer below. PEI is somewhat unique in Atlantic Canada in that it generally has deep enough soil for this filtering process.

However, adequate soil depth is not the only requirement for this type of treatment system.

There must be space on the building lot for the tile field. In fact, under current provincial regulations for subdividing land, there must be room on new lots for two tile fields. The second location would be used if the first became filled. The lot area required for these tile fields depends on the tightness of the soil: generally, the more permeable the soil, the smaller the space requirement. If too much effluent is spread over impermeable soil, it can bubble back up to the surface and cause a public health risk. The solution is to spread the tile field over a larger area. Conversely, soil that is too permeable can also be a problem, with untreated effluent reaching the water table.

Another important consideration is the distance from the soil surface to the water table. A minimum of 1.2 metres is required before on-site waste treatment can be approved for the site. Approving sites with a lesser distance would run the risk of untreated effluent seeping down into the water table.

All land on PEI can be classified into three categories of lots based on depth of soil and depth to water table:

Normal Lot Category	Permeable Soil Depth	Depth to Highest Water Table Elevation
I	0.6 metres or more	1.2 metres or more
II	0.3 metres to 0.6 metres	1.2 metres or more
III	less than 0.3 metres	less than 1.2 metres

The lot classifications are used to set minimum lot sizes for on-site waste treatment and water supply. The classification is part of a site assessment process that is now required for all new buildings and lot subdivisions. The permitting process is administered by the Department of Community Affairs and Attorney General. The process is designed both to protect public health and groundwater and to ensure the long-term viability of each new building site.

Wastewater treatment in Island communities

Presently, 29 Island communities are served by central wastewater treatment plants. PEI is now in an enviable position in that its entire municipal population is serviced by wastewater treatment of one sort or another. With the exception of the Yukon, this achievement is unique in Canada. Municipal wastewater includes household wastewater as well as waste from shopping malls, office buildings, hospitals, schools and, in some cases, manufacturing plants. The goal of a central wastewater treatment system is to clean the water until it is safe to return to the environment.

The process is similar to that of household treatment systems. Wastewater is flushed into a containment area, where solids settle out and are broken down by bacterial action. The remaining solids are concentrated into sludge, which is then disposed of at landfill sites, or used on farm land. The liquid effluent flows out and is further treated before being returned to the environment.

But whereas most household treatment systems on PEI empty treated wastewater into the soil, central treatment systems usually send their effluent into rivers and harbours, called "receiving waters". The treatment process is different because the effluent is being sent into a different environment.

When sewage breaks down, oxygen is used. Many forms of life in rivers and harbours need oxygen to live. If too much wastewater is pumped into a river, all of the oxygen can get used up as the waste further decomposes - and life in the river can be at risk. Therefore, one of the primary goals of central wastewater treatment is to reduce the amount of sewage waste in effluent to a level that the receiving waters can handle.

There are three levels of wastewater treatment in use on PEI: primary, secondary and tertiary.

In *primary treatment systems*, the focus is on removing solid waste. Screens are used to remove solid materials, such as wood, rock and cloth from the wastewater. Then it is pumped into settling tanks where light material floats to the surface and the organic sludge settles to the bottom. The effluent in the middle, primary effluent, is then disinfected to kill bacteria before being discharged into the receiving waters. Not all wastewater treatment plants on PEI currently use disinfection. But all new plants, and plants receiving refits and upgrades, are required to include it. This is the case for primary, secondary and tertiary treatment systems.

Charlottetown and Summerside treatment plants use primary treatment processes, because they discharge into large bodies of water that can assimilate large quantities of primary effluent.

Advanced wastewater treatment of industrial effluents protects our surface water.

Wastewater treatment

Secondary treatment systems focus on reducing the waste material that is dissolved in primary effluent. Bacteria do the work. First, bacteria are encouraged to grow in the wastewater. As they grow, they feed on organic material and make more bacteria. Bacteria tend to clump together, becoming solid masses of organic sludge, which can then be removed in settling tanks.

There are four main types of secondary treatment plants in operation on PEI: waste stabilization ponds, aerated lagoons, activated sludge plants, and rotating biological contactors. Each is designed to promote bacterial growth, and so remove organic material from wastewater.

Waste stabilization ponds, such as the one in Tignish, are often used by small communities because they are low in cost and need minimal maintenance. They are large shallow ponds where the wastewater sits and gradually becomes cleaned of its organic waste by resident bacteria.

Aerated lagoons, like the one in Cornwall, are smaller, deeper ponds where air is pumped into the water to speed the process of bacterial growth.

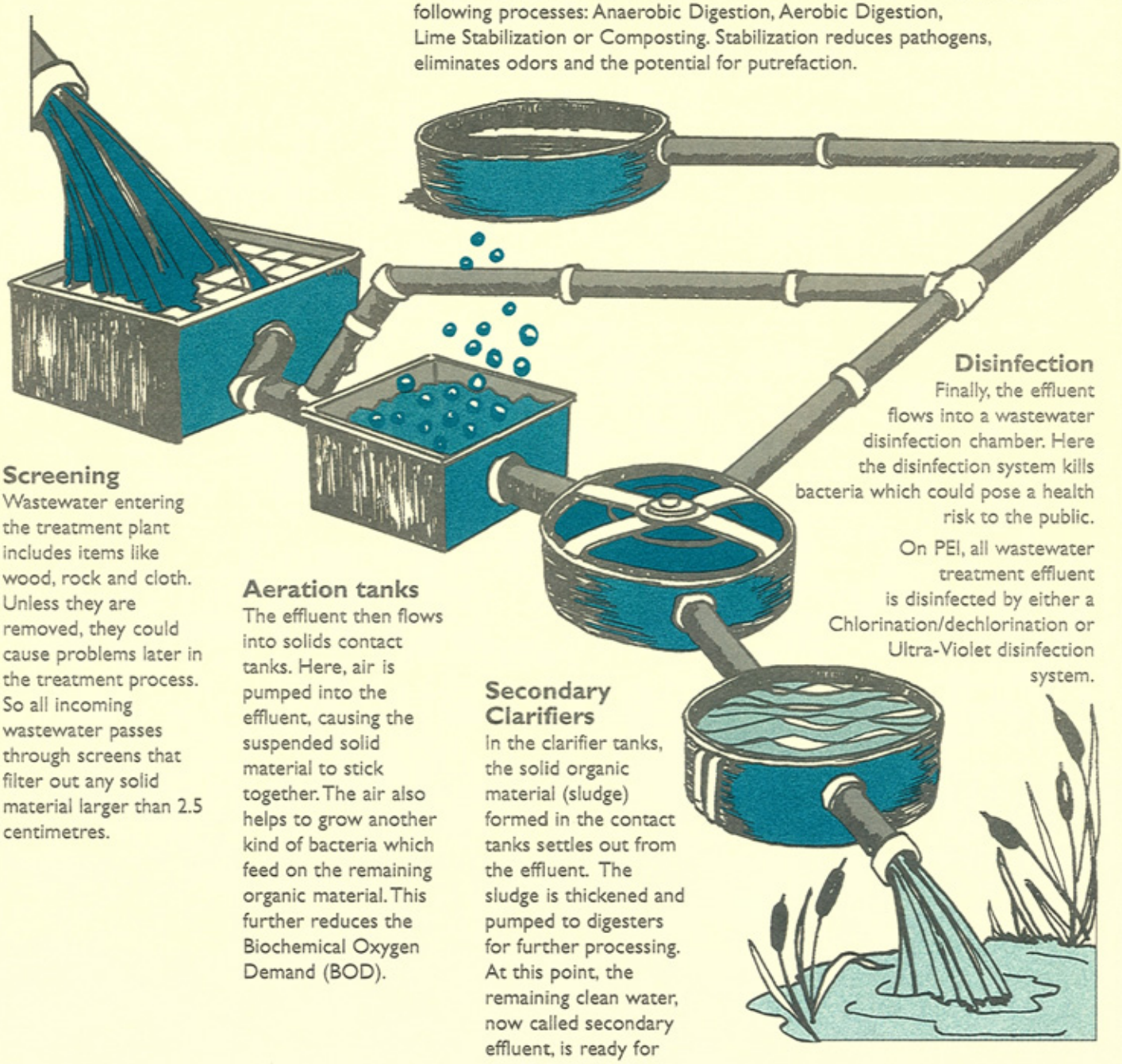
Another form of secondary treatment is an activated sludge plant, such as the one in the Town of Montague. Primary effluent is aerated to promote bacterial growth, then sent to secondary settling tanks, where the sludge settles to the bottom. Because the sludge has a high concentration of live bacteria, it is then recycled back into the aeration tank. The more bacteria there are, the faster they grow, provided there is enough food. The end result is a much faster process of wastewater treatment.

A rotating biological contactor (RBC), such as the one in Hunter River, is a very compact system. It promotes bacterial growth by giving bacteria a large surface area to grow on. A series of thin plastic disks is mounted on a shaft. The discs are partially submerged in a tank of wastewater and are rotated slowly. Bacteria cling to the surface of the discs and feed on the wastewater as they rotate through the wastewater.

Tertiary treatment systems are used in situations where high volumes of effluent would otherwise overwhelm the ability of the receiving waters to assimilate the waste. Tertiary treatment removes nutrients, including nitrogen or phosphorus, from secondary effluent. The goal is to limit the growth of algae in the receiving waters. Nitrogen and phosphorus are essential nutrients for the growth of algae.

A variety of physical, chemical and biological processes can be used in tertiary treatment plants. On PEI, there is only one industrial tertiary treatment plant, which concentrates on the removal of nitrogen.

Typical secondary wastewater treatment plant



Sludge stabilization

Here solids removed by the secondary clarifier are stabilized by one of the following processes: Anaerobic Digestion, Aerobic Digestion, Lime Stabilization or Composting. Stabilization reduces pathogens, eliminates odors and the potential for putrefaction.

Disinfection

Finally, the effluent flows into a wastewater disinfection chamber. Here the disinfection system kills bacteria which could pose a health risk to the public.

On PEI, all wastewater treatment effluent is disinfected by either a Chlorination/dechlorination or Ultra-Violet disinfection system.

Screening

Wastewater entering the treatment plant includes items like wood, rock and cloth. Unless they are removed, they could cause problems later in the treatment process. So all incoming wastewater passes through screens that filter out any solid material larger than 2.5 centimetres.

Aeration tanks

The effluent then flows into solids contact tanks. Here, air is pumped into the effluent, causing the suspended solid material to stick together. The air also helps to grow another kind of bacteria which feed on the remaining organic material. This further reduces the Biochemical Oxygen Demand (BOD).

Secondary Clarifiers

In the clarifier tanks, the solid organic material (sludge) formed in the contact tanks settles out from the effluent. The sludge is thickened and pumped to digesters for further processing. At this point, the remaining clean water, now called secondary effluent, is ready for the final step.

Safeguards for the future

Stewardship and Sustainability

PEI has a plan to protect our environment for the future. It is called *Stewardship and Sustainability: a Renewed Conservation Strategy for Prince Edward Island.* The plan is a framework within which all Islanders can work toward making and keeping our environment healthy. It was developed by the PEI Department of Fisheries and Environment, and a wide range of Islanders participated in public consultations to help define the strategies and goals.

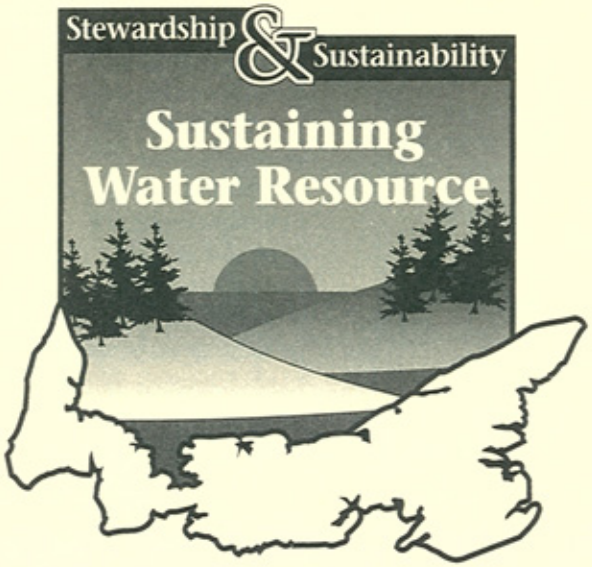
The plan has seven goals: to reduce soil erosion, to maintain and improve water quality, to reduce solid waste, to maintain and improve ecological diversity, to maintain and improve air quality, to increase public involvement, and to protect the Island's landscape.

In the past, plans to deal with social, environmental and economic issues were made separately, each in isolation from the others. Today there is a new attitude. The principle of "sustainable" development recognizes that all of these issues are connected and must be understood and managed as a whole. Sustainability depends on a partnership and balance between the economy, the environment, and the social values of Islanders. It also relies on the cooperation of governments, industry, environmental groups and individual Islanders.

The goal of sustainable development is to meet the needs of present generations without harming the ability of future generations to meet their own needs. It means development that is appropriate for today and for the future.

In some cases, several water users may share an interest in protecting the water resource: reducing soil erosion is important to farmers and it is also important to the fishing and tourism industries. Because we are all dependent on water, PEI has a strong incentive to "look at the whole picture" and manage our water resources in a way that is sustainable for the future.

The idea of "stewardship" is an old one that is making a strong come-back. It means caring for property and resources. It means using them responsibly, taking no more than what we need. As Islanders, we are stewards of one of the smallest, most beautiful places on Earth. We don't *own* it. We are holding it in trust. Stewardship is not the same as self-interest or exploitation. Our responsibility is to care for the Island for its own sake, not just because it's in our interest to do so.



Nature's Perfect Diet Drink

It's fat-free, cholesterol-free, and calorie-free. It's also essential to good health, it tastes great and it's cheap.

Water

$1.00 will buy:
- less than two litres of gasoline
- less than one litre of milk
- less than one litre of soft drink
- over 2500 litres of groundwater,

based on the average household rate for PEI.

The Environmental Protection Act

Under the PEI Environmental Protection Act, there are many important regulations that help protect our water resources. For instance, home owners should know that there are regulations about water wells: who may construct them, where and how they may be built, how they can be abandoned, and how groundwater is shared.

PEI has regulations for underground petroleum storage tanks that govern their installation and removal. These regulations also apply to bulk above-ground storage tanks. Above-ground storage tanks for homes are regulated by the Provincial Fire Marshall's Office.

On PEI, no discharge of contaminants (spill or otherwise) is allowed. The law required that if you have a spill or discharge of a contaminant you must notify the Department of Fisheries and Environment immediately and then take whatever corrective action is required by the Minster.

The Minister of Fisheries and Environment has the power to control or stop any activity on the Island which breaches the Environmental Protection Act or otherwise threatens the environment.

Federal legislation

The federal government, through a number of departments and agencies, administers a wide variety of legislative instruments which have relevance to water and aquatic life. These include but are not limited to:

Fisheries Act

The Fisheries Act is generally concerned with the well being of fish and fish habitat. Under the Fisheries Act, it is unlawful to harmfully alter, disrupt or destroy fish habitat – unless authorized by the Minister of Fisheries and Oceans or permitted by regulations promulgated under the Act. It is also unlawful to deposit or permit the deposit of a substance in waters frequented by fish which is deleterious to fish, fish habitat or the use of fish by persons – unless the deposits are of a type, quality or concentration authorized by regulation.

Safeguards for the future

Canadian Environmental Protection Act

The Canadian Environmental Protection Act (CEPA) deals with toxic substances, nutrients, ocean dumping, environmental research, guidelines and codes of practice. CEPA's comprehensive mandate covers toxic substances throughout the ecosystem and may control any stage of a product's life cycle from development and manufacture to transportation and disposal. Its primary focus is prevention – averting environmental problems before they occur.

Currently, there are over 30 regulations in force under CEPA. Examples that have relevance to PEI include those dealing with Ozone Depleting Substances, PCBs, and Ocean Dumping.

Pest Control Products Act

The Pest Control Products Act addresses the registration and use of pest control products in Canada. The act requires that once registered, pesticide containers must contain a label which sets out the conditions which must be exercised and the precautions which must be taken to protect human health, safety and the environment. Pesticides may also be regulated as toxic substances under the Canadian Environmental Protection Act, such as is the case for banned pesticides.

Canadian Environmental Assessment Act

The Canadian Environmental Assessment Act establishes an open and balanced process to assess the environmental effects of projects requiring federal actions or decisions. It ensures that the environmental effects of projects are considered as early as possible in a project's planning stages. Projects which are implemented, or funded, in whole or in part, by the federal government or which require federal lands or some form of federal regulatory approval are included under the act. Where possible, every effort is made to harmonize federal requirements with those of the Provincial Government.

Other

There are a variety of other federal legislative instruments which have some bearing on water including, among others, the Navigable Waters Protection Act, the Canada Shipping Act, the Transportation of Dangerous Goods Act, the Canada Wildlife Act and the Migratory Birds Convention Act.

Federal/provincial cooperation

Both the federal and provincial levels of government have historically acknowledged overlapping responsibility for the protection and management of PEI's water resources. Monitoring of the quality and quantity of ground and surface water dates back several decades with streamflow monitoring since the 1920s. The database that has been developed over the years has been extremely valuable in identifying changes and trends and has provided water managers with the ability to make predictions and to assess cause and effect relationships.

Most recently, the two levels of government have renewed their commitment to the management of the Island's water resources by the signing of the Canada/Prince Edward Island Water Annex to the Federal/Provincial

Framework Agreement for Environmental Cooperation in Atlantic Canada. The Agreement prescribes long-term water quality, water quantity, and aquatic ecosystem health monitoring programs that are directed at maintaining and improving PEI's water resources.

What are Environmental Impact Assessments?

Environmental Impact Assessments (EIAs) are an important tool currently being used for ensuring sustainable development. They are the process used during the planning stage to review all of the environmental issues associated with certain development proposals. They also allow the agencies involved in the process to identify unwanted effects on the environment – *before* they occur.

Under the Environmental Protection Act, a developer who is planning an undertaking must first file a proposal to the Department of Fisheries and Environment and must receive written approval from the Minister to proceed.

The Minister may order an EIA of any undertaking that requires approval, and may also

notify the public and invite Islanders to give their comments. There is a Technical Review Committee which makes a detailed examination, and in the case of strong public interest, the Minister may appoint a review panel to hold public meetings. All of the environment (air, land, water, plants, animals and human life) is considered. Impacts on groundwater are an important consideration of any EIA.

When the process is complete, the Minister decides whether to approve or deny the undertaking. Any approval might be subject to special requirements or regulations.

Safeguards for the future

What you can do to help

- Turn off the water when you brush your teeth and save about two gallons of water every time. Encourage your family to do the same.
- Install a low-flow shower head.
- Use less weed killer and lawn and garden fertilizers, or stop using them completely. Talk to your neighbours about doing the same.
- Attend a community watershed meeting. Take a friend with you.
- Plant tree seedlings along the stream on your property.
- Join an environmental or community group that helps to take care of local rivers and streams.
- Make sure your septic tank is pumped out every three to five years and watch for oil leaks on your petroleum tank.
- Don't throw dead batteries, old paint cans, or used motor oil in the garbage. Don't let them get on the ground and into the water. Find out if there is a special collection centre in your community, or a day when hazardous wastes are collected.
- Water your garden in the evening or early morning, and only as needed.
- If you are a farmer, follow the agricultural best management practices. And be sure to fence your livestock out of streams.

Did you know that 75 percent of your brain is water? Use it to learn more about how to conserve and protect water on Prince Edward Island.

For more information on water,
call the
Water Resources Division
of the
PEI Department of Fisheries and Environment
or
Environment Canada.

Writing, design and layout by Renaissance Communications, Montague, PEI
Illustrations by Dale McNevin
Printing by Island Offset